

ONTARIO

MANITOBA

NUNAVUT

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& LABRADOR

TOROMONT





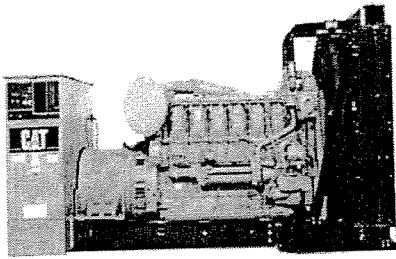


Image shown may not reflect actual package.

STANDBY

**2000 e kW 2500 kVA
60 Hz 1800 rpm 480 Volts**

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES

EMISSIONS / FUEL STRATEGY

- Low Fuel Consumption

UL 2200

- UL2200 Listed packages are available. Certain restrictions may apply. Consult with your Caterpillar dealer

FULL RANGE OF ATTACHMENTS

- Wide range of bolt-on system expansion attachments, factory designed and tested

SINGLE-SOURCE SUPPLIER

- Fully prototype tested with certified torsional vibration analysis available

WORLDWIDE PRODUCT SUPPORT

- Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
- Caterpillar dealers fill 99.7% of parts orders within 24 hours
- Caterpillar dealers have over 1,798 dealer branch stores operating in 200 countries
- The Cat® S·O·SSM program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

CAT 3516B TA DIESEL ENGINE

- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight

CAT SR4B GENERATOR

- Matched to the performance and output characteristics of Caterpillar engines
- Optimum winding pitch for minimum total harmonic distortion and maximum efficiency
- Single point access to accessory connections
- UL 1446 recognized Class H insulation

CAT EMCP3 CONTROL PANELS

- Controls designed to meet individual customer needs:
- EMCP 3 provides the option for full-featured power metering and protective relaying
- Segregated low voltage, AC/DC accessory box provides single point access to accessory connections

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FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Air Inlet	<ul style="list-style-type: none"> • Single element canister type air cleaner • Service indicator 	<ul style="list-style-type: none"> • Dual element & heavy duty air cleaners (with pre-cleaners) • Air inlet adapters & shutoff
Cooling	<ul style="list-style-type: none"> • Radiator with guard (43°C) • Low Profile with (frontal area) • Low airflow • Radiator duct flange • Coolant drain line with valve • Fan and belt guards • Caterpillar Extended Life Coolant* • Coolant level sensors *Not included with packages without radiators 	<ul style="list-style-type: none"> • Radiator with 27°C and 50°C ambient capability • Radiator option for 57°C ambient with treated water • Radiator removal • Heavy duty, harsh environment radiator at 43°C and 50°C • Heat exchanger and expansion tank • Coolant level switch gauge • Jacket water heater
Exhaust	<ul style="list-style-type: none"> • Dry exhaust manifold • Flanged faced outlets 	<ul style="list-style-type: none"> • Mufflers and Silencers • Stainless steel exhaust flex fittings • Elbows, flanges, expanders & Y adapters
Fuel	<ul style="list-style-type: none"> • Secondary fuel filters • Fuel priming pump • Flexible fuel lines • Fuel cooler* *Not included with packages without radiators 	<ul style="list-style-type: none"> • Water separator • Duplex fuel filter
Generator	<ul style="list-style-type: none"> • Permanent magnet excited • Class H insulation • Class F temperature (105°C prime/130°C standby) • Winding temperature detectors(select models) • Anti-condensation space heaters 	<ul style="list-style-type: none"> • Oversize & premium generators
Power Termination	<ul style="list-style-type: none"> • Bus bar (NEMA and IEC meachanicallug holes) right side standard • Top and bottom cable entry 	<ul style="list-style-type: none"> • Circuit breakers, UL listed, 3 pole with shunt trip, 80% or 100% rated, choice of trip units, manual or electrically operated (low voltage only) • Circuit breakers, IEC compliant, 3 or 4 pole with shunt trip (low voltage only), choice of trip units, manual or electrically operated • Shroud cover for bottom cable entry • Power terminations can be located on the left and/or rear as an option. Also, multiple circuit breakers can be ordered (up to 3)
Governor	<ul style="list-style-type: none"> • ADEM™ 3 	<ul style="list-style-type: none"> • Load share module
Control Panels	<ul style="list-style-type: none"> • User Interface panel (UIP) - rear mount • EMCP3.1 Genset Controller • Voltage and Speed adjust • AC&DC customer wiring area (right side) • CAT digital voltage regulator (CDVR) with KVAR/PF control, 3-phase sensing • Reactive droop • Emergency Stop Pushbutton 	<ul style="list-style-type: none"> • EMCP3.3 • Option for right or left mount UIP • Local & remote annunciator modules • Load share module • Discrete I/O module • Generator temperature monitoring & protection
Lube	<ul style="list-style-type: none"> • Lubricating oil and filter • Oil drain line with valves • Fumes disposal • Gear type lube oil pump 	<ul style="list-style-type: none"> • Oil level regulator • Deep sump oil pan • Electric & air prelube pumps • Manual prelube with sump pump • Duplex oil filter
Mounting	<ul style="list-style-type: none"> • Structural steel tube • Anti-vibration mounts (shipped loose) 	<ul style="list-style-type: none"> • Isolator removal • Spring-type isolator, zone 4
Starting/Charging	<ul style="list-style-type: none"> • 24 volt starting motor(s) • Batteries with rack and cables • Battery disconnect switch 	<ul style="list-style-type: none"> • Battery chargers (10&20AMP) • 45 amp charging alternator • Oversize batteries • Ether starting aid • Heavy duty starting motors • Barring device (manual) • Air starting motor with control & silencer

STANDBY 2000 kW 2500 kVA

60 Hz 1800 rpm 480 Volts



SPECIFICATIONS

CAT GENERATOR

SR4B Generator
Frame size..... 825
Excitation..... Permanent Magnet
Pitch..... 0.6667
Number of poles..... 4
Number of bearings..... Single Bearing
Insulation..... UL 1446 Recognized Class H with tropicalization and antiabrasion
IP rating..... Drip Proof IP22
Alignment..... Pilot Shaft
Overspeed capability - % of rated..... 150
Wave form..... 003.00
Paralleling kit/Droop transformer..... Standard
Voltage regulator.3 Phase sensing with selectable volts/Hz
Voltage regulation..... Less than +/- 1/2% (steady state)
Less than +/- 1% (no load to full load)
Telephone Influence Factor..... Less than 50
Harmonic Distortion..... Less than 5%

CAT DIESEL ENGINE

3516B TA, V-16, 4-stroke-cycle watercooled diesel
Bore - mm..... 170.00 mm (6.69 in)
Stroke - mm..... 190.00 mm (7.48 in)
Displacement - L..... 69.00 L (4210.64 in³)
Compression ratio..... 14.0:1
Aspiration..... TA
Fuel system..... Electronic unit injection
Governor type..... Caterpillar ADEM control system

CAT EMCP3 CONTROL PANELS

- EMCP 3.1 (standard)
- EMCP3.3 (additional features)
- Integral to generator terminal box
- Single location for customer connection
- 24 Volt DC Control
- IP 23 enclosure
- Electronically dead front
- Lockable hinged door (option)
- UL/CSA/CE
- Generator terminal box mounted
- Panel illuminating lights
- Auto start/stop control
- Voltage adjust (optional on 3.1)
- True RMS metering, 3-phase
- Digital indications for:
 - RPM
 - Operating hours
 - Oil pressure
 - Coolant temperature
 - System DC volts
- Shutdowns with indicating lights for:
 - Low oil pressure
 - High coolant temperature
 - Overspeed
 - Emergency stop
 - Failure to start (overcrank)
- Programmable protective relaying functions:
 - Under and over voltage
 - Under and over frequency
 - Reverse power
 - Overcurrent
- MODBUS isolated data link (RS-485 half-duplex) supports 3.3 serial communication at data rate up to 115.2 kbaud (*)

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60 Hz 1800 rpm 480 Volts



TECHNICAL DATA

Open Generator Set - - 1800 rpm/60 Hz/480 Volts	DM7917	
Package Performance Genset Power rating with fan Genset Power rating @ 0.8 pf	2000 kW 2500 kVA	
Low Fuel Consumption Coolant to aftercooler temp max	60 ° C	140 ° F
Fuel Consumption 100% load with fan 75% load with fan 50% load with fan	518.3 L/hr 390.2 L/hr 272.0 L/hr	136.9 Gal/hr 103.1 Gal/hr 71.9 Gal/hr
Cooling System¹ Engine coolant capacity Radiator coolant capacity Engine Coolant capacity with radiator/exp. tank	233.0 L 18.8 L 2518.0 L	61.6 gal 5.0 gal 665.2 gal
Inlet Air Combustion air inlet flow rate	167.2 m ³ /min	5904.6 cfm
Exhaust System Exhaust stack gas temperature Exhaust gas flow rate Exhaust flange size (internal diameter) Exhaust system backpressure (maximum allowable)	476.4 ° C 438.1 m ³ /min 203.2 mm 6.7 kPa	889.5 ° F 15471.4 cfm 8.0 in 26.9 in. water
Heat Rejection Heat rejection to coolant (total) Heat rejection to exhaust (total) Heat rejection to aftercooler Heat rejection to atmosphere from engine Heat rejection to atmosphere from generator	768 kW 1949 kW 481 kW 146 kW 74.7 kW	43676 Btu/min 110839 Btu/min 27354 Btu/min 8303 Btu/min 4248.2 Btu/min
Alternator² Motor starting capability @ 30% voltage dip Frame Temperature Rise	4647 skVA 825 130 ° C	266 ° F
Lube System Sump refill with filter	401.3 L	106.0 gal
Emissions (Nominal)³ NOx g/hp-hr CO g/hp-hr HC g/hp-hr PM g/hp-hr	9.27 g/hp-hr .32 g/hp-hr .28 g/hp-hr .076 g/hp-hr	

¹ Ambient capability at 300 m (984ft) above sea level. For ambient capability at other altitudes, consult your Caterpillar dealer.

² UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics. Generator temperature rise is based on a 40 degree C ambient per NEMA MG1-32.

³ Emissions data measurements are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. This engine's exhaust emissions are in compliance with the US EPA and California nonroad regulations as identified above. Data shown is based on steady state operating conditions of 77° F, 28.42 in HG and number 2 diesel fuel with 35° API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations.

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RATING DEFINITIONS AND CONDITIONS

Meets or Exceeds International Specifications: ABGSM TM3, AS1359, AS2789, BS4999, BS5000, BS5514, DIN6271, DIN6280, EGSA101P, IEC34/1, ISO3046/1, ISO8528, JEM1359, NEMA MG 1-22, VDE0530, 89/392/EEC, 89/336/EEC

Standby - Output available with varying load for the duration of the interruption of the normal source power. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046/1, AS2789, DIN6271, and BS5514. Standby ambients shown indicate ambient temperature at 100 percent load which results in a coolant top tank temperature just below the shutdown temperature.

Ratings are based on SAE J1995 standard conditions. These ratings also apply at ISO3046/1, DIN6271, and BS5514 standard conditions.

Fuel Rates are based on fuel oil of 35° API (16° C or 60° F) gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.).

Additional Ratings may be available for specific customer requirements. Consult your Caterpillar representative for details.

STANDBY 2000 eKW 2500 kVA
60 Hz 1800 rpm 480 Volts



DIMENSIONS

Package Dimensions		
Length	6075.2 mm	239.18 in
Width	2587.6 mm	101.87 in
Height	3015.1 mm	118.7 in
Weight	16 293 kg	35,920 lb

Note: Do not use for installation design.
See general dimension drawings for
detail (Drawing #2748723).

Performance No.: DM7917

Feature Code:: 516DE3R

Source:: U.S. Sourced

31 March 2006

6549454

www.CAT-ElectricPower.com

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Materials and specifications are subject to change without notice.
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SYSTEMS DATA [516DE3R]**MARCH 31, 2006**Can't find what you're looking for? [Click here](#)

Reference Number: 2560758

Version Symbol: -

Change Level: 00

Sales Model: 3516B DI TA SCAC

Eff. Serial Number Prefix: ZAP

Engr. Model: GS225

Description	Answer	Unit
Air Intake System		
The installed system must comply with the system limits below for all emissions certified engines to assure regulatory compliance.		
MAX ALLOW INTAKE RESTR W/CLEAN ELEMENT	10.0	IN WTR
MAX ALLOW INTAKE RESTR W/DIRTY ELEMENT	24.9	IN WTR
Cooling System		
ENGINE ONLY COOLANT CAPACITY	61.6	GAL
ENGINE & EXPANSION TANK COOLANT CAPACITY	96.6	GAL
MAX ALLOW ENGINE COOLANT OUTLET TEMP	210	DEG F
REGULATOR START-TO-OPEN TEMP	178	DEG F
REGULATOR FULL OPENING TEMPERATURE	198	DEG F
REGULATOR LOCATION	OUTLET	
MAX UNINTERRUPTED FILL RATE	5	GPM
Engine Spec System		
CYLINDER ARRANGEMENT	60V	
NUMBER OF CYLINDERS	16	CYL
CYLINDER BORE DIAMETER	6.6929	IN
PISTON STROKE	7.4803	IN
TOTAL CYLINDER DISPLACEMENT	4,211	CU IN
COMPRESSION RATIO (TO ONE)	14.0	
CRANKSHAFT ROTATION (FROM FLYWHEEL END)	STD	
CYLINDER FIRING ORDER	1-2-5-6-3-	
CYLINDER FIRING ORDER - CONTINUED	4-9-10-15-	
CYLINDER FIRING ORDER - CONTINUED	16-11-12-	
CYLINDER FIRING ORDER - CONTINUED	13-14-7-8	
NUMBER 1 CYLINDER LOCATION	R FRONT	
STROKES/COMBUSTION CYCLE	4	STROKES
Exhaust System		
The installed system must comply with the system limits below for all emissions certified engines to assure regulatory compliance.		
MAX ALLOWABLE SYSTEM BACK PRESSURE	26.9	IN WTR
MANIFOLD TYPE	DRY	
MAX ALLOW STATIC WT ON EXHAUST CONN	62	LB
MAX ALLOW STATIC BEND MOMENT ON EXH CONN	31	FT LB
Fuel System		
MAX FUEL FLOW TO TRANSFER PUMP (TO ENG)	332.9	GPH
MAX ALLOW FUEL SUPPLY LINE RESTRICTION	8.9	IN HG
MAX ALLOW FUEL TEMP AT TRANSFER PUMP IN	151	DEG F
MAX FUEL FLOW TO RETURN LINE (FROM ENG)	322.3	GPH
MAX ALLOW FUEL RETURN LINE RESTR	8.0	IN HG

NORMAL FUEL PRESSURE-CLEAN SYSTEM	60.2	PSI
FUEL SYSTEM TYPE	EUI	
MAX TFR PUMP PRMG LIFT W/O PRMG PUMP	12.1	FT FUEL
<i>Lube System</i>		
RECOMMENDED OIL TYPE - API	CF-4	
OIL FILTER TYPE	FULL FLOW	
LUBE SYSTEM OIL COOLER TYPE	BUNDLE	
NOM OIL PRESS W/SAE 10W30 OIL @ 99 DEG C	65.0	PSI
MIN LI OP W/SAE 10W30 OIL @ 99 DEG C	55.0	PSI
CRANKCASE VENTILATION TYPE	TO ATM	
<i>Mounting System</i>		
C/G LOC - X DIMEN - FRM REAR FACE OF BLK	47.2440	IN
CENTER OF GRAVITY LOCATION Y DIMENSION	7.9527	IN
CENTER OF GRAVITY LOCATION Z DIMENSION	0.1969	IN
STD - FLYWHEEL HOUSING SIZE-SAE NUMBER	00	
GENERAL DIMENSION DRG REF NUM (ENG ONLY)	2057240	
MASS MOMENT OF INERTIA - X AXIS	10,620.8936	LB IN SEC2
MASS MOMENT OF INERTIA - Y AXIS	123,910.4297	LB IN SEC2
MASS MOMENT OF INERTIA - Z AXIS	132,761.1719	LB IN SEC2
DRY WT ENG ONLY (DRAINED OF FLUIDS)	17,494	LB
CRANKSHAFT DESIGN ENDPLAY	0.0157	IN
CSHFT DESIGN ENDPLAY TOLERANCE + OR -	0.0091	IN
ENGINE LENGTH	129.6060	IN
ENGINE HEIGHT	75.9841	IN
ENGINE WIDTH	59.4881	IN
<i>Starting System</i>		
MIN CRANKING SPD REQUIRED FOR START-RPM	120	RPM

CATERPILLAR

Caterpillar Confidential: Green

Content Owner: Alan Scott

Current Date: Fri Mar 31 08:59:44 2006

Web Master: PSG Web Based Systems Support
PSG Web Support

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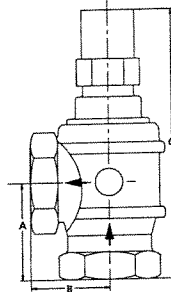
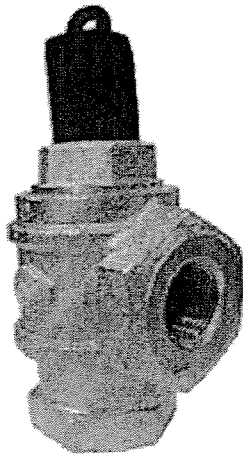
Aboveground Storage Tank Equipment

Model 605, 606, 616, and 636 Anti Siphon Valves

EBW's Anti-Siphon Valves are recommended for all aboveground storage applications to prevent fuel from exiting the storage tank in the event of a broken line or leak.

The Anti-Siphon valves automatically shut off product flow when lines are broken, preventing fuel spillage and fire hazards. Each valve has an adjusting mechanism allowing for various liquid head pressure settings within the valve range. The adjusting mechanism is lockable after the preferred setting is made. EBW Anti Siphon Valves are set to maximum head pressure when shipped from the factory. The Anti Siphon Valve also includes a pressure relief valve, eliminating thermal expansion of fluid in the lines.

In addition to the sturdy ductile iron construction, the valves all meet the NFPA 30 and API/RP 2000 requirements.



PART	DIM "A"		DIM "B"		DIM "C"	
	IN.	MM.	IN.	MM.	IN.	MM.
605	2.22	56.38	1.80	45.72	5.94	150.88
606	2.22	56.38	1.80	45.72	5.94	150.88
615	2.61	66.29	2.19	55.62	6.56	141.22
636	2.66	67.56	2.69	68.32	6.97	151.63

PART	SIZE		WEIGHT		HEAD PRESSURE RANGES (FT.)
	IN.	MM.	LBS	KG	
605-300-01	.75	19.05	3.40	1.54	0 to 12
605-300-02	.75	19.05	3.40	1.54	12 to 25
605-300-21*	.75	19.05	3.40	1.54	0 to 12
605-300-22*	.75	19.05	3.40	1.54	12 to 25
606-300-01	1.00	25.40	3.20	1.45	0 to 12
606-300-02	1.00	25.40	3.20	1.45	12 to 25
606-300-21*	1.00	25.40	3.20	1.45	0 to 12
606-300-22*	1.00	25.40	3.20	1.45	12 to 25
616-300-01	1.50	38.10	4.60	2.09	5 to 12
616-300-02	1.50	38.10	4.60	2.09	12 to 25
616-300-03	1.50	38.10	4.60	2.09	0 to 5
616-300-21*	1.50	38.10	4.60	2.09	5 to 12
616-300-22*	1.50	38.10	4.60	2.09	12 to 25
636-300-01	2.00	50.80	7.20	3.27	5 to 12
636-300-02	2.00	50.80	7.20	3.27	12 to 25
636-300-03	2.00	50.80	7.20	3.27	0 to 5
636-300-21*	2.00	50.80	7.20	3.27	5 to 12
636-300-22*	2.00	50.80	7.20	3.27	12 to 25

* BSPT Threads: Consult factory for availability

Features:

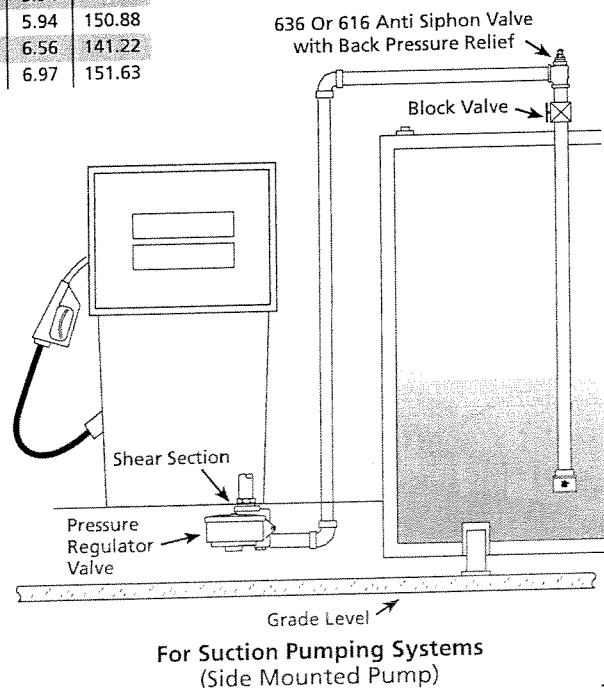
- Three different head pressures to choose from
- Hydrostatic pressure adjusting mechanism with durable weather cap
- Built in thermal expansion pressure relief valve
- .75" and 1.00" models are ideal for fuel oil and generator applications
- Meet NFPA 30 and API/RP 2000 requirements

Materials

Body: Ductile Iron - zinc plated
 Cap: Brass
 Spring: Zinc plated steel
 Poppet: Brass
 Seat: Brass
 Adjustment Screw: Stainless Steel
 Disc: Fluorocarbon seal

Certifications / Listings

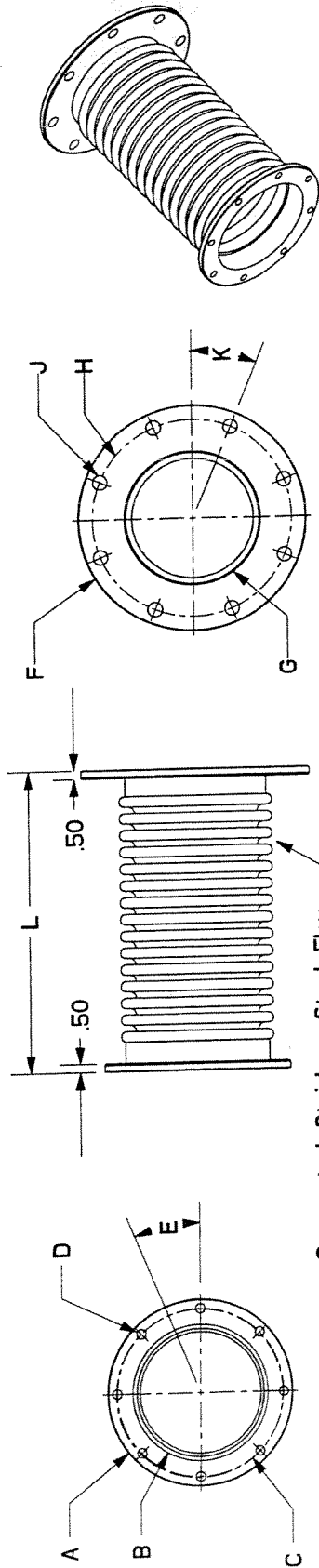
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For Suction Pumping Systems (Side Mounted Pump)

Engine Model No.: 3408 - 3516

Model No.: FF-CAT-Rd.



Corrugated Stainless Steel Flex

Caterpillar Models	Flange		Silex		Inlet Flange						Outlet Flange						
	CAT	ASA	Engine Exhaust Flex Part No.	Tube O/D	A O/D	B I/D	C BHC	D DIA	QTY. HOLES	E ROT'D	F O/D	G I/D	H BHC	J DIA	QTY. HOLES	K ROT'D	L LGTH
3408/3412	7.00/7.88/8.00	8	FF-8-18-221	8	11.00	8.00	9.88	0.56	8	0°	13.50	8.00	11.75	0.87	8	22.5°	18.00
3412	7.88/8.00	10	FF-8-18-222	8	11.00	8.00	9.88	0.56	8	0°	16.00	8.00	14.25	1.00	12	15°	18.00
3412/3516B	7.88/8.00	12	FF-8-18-223	8	11.00	8.00	9.88	0.56	8	0°	19.00	8.00	17.00	1.00	12	15°	18.00
3412	7.88/8.00	14	FF-8-18-224	8	11.00	8.00	9.88	0.56	8	0°	21.00	8.00	18.75	1.13	12	15°	18.00
3508B/3512B	7.99	8	FF-8-18-243	8	11.00	8.00	9.88	0.44	8	22.5°	13.50	8.00	11.75	0.87	8	22.5°	18.00
3512B/3516	7.99	10	FF-8-18-240	8	11.00	8.00	9.88	0.44	8	22.5°	16.00	8.00	14.25	1.00	12	15°	18.00
3508/3512	7.99	12	FF-8-18-241	8	11.00	8.00	9.88	0.44	8	22.5°	19.00	8.00	17.00	1.00	12	15°	18.00
3512B/3516B	7.99	12	FF-8-18-241	8	11.00	8.00	9.88	0.44	8	22.5°	19.00	8.00	17.00	1.00	12	15°	18.00
3412	7.99	12	FF-8-18-241	8	11.00	8.00	9.88	0.44	8	22.5°	19.00	8.00	17.00	1.00	12	15°	18.00
3512	7.99	14	FF-8-18-242	8	11.00	8.00	9.88	0.44	8	22.5°	21.00	8.00	18.75	1.13	12	15°	18.00
3516	11.50	18	FF-12-18-254	12	15.75	11.50	14.80	0.44	12	15°	25.00	12.00	22.75	1.25	16	11.25°	18.00
3516	11.50	12	FF-12-18-251	12	15.75	11.50	14.80	0.44	12	15°	19.00	12.00	17.00	1.00	12	15°	18.00
3516	11.50	14	FF-12-18-252	12	15.75	11.50	14.80	0.44	12	15°	21.00	12.00	18.75	1.13	16	15°	18.00
3516	11.50	16	FF-12-18-253	12	15.75	11.50	14.80	0.44	12	15°	23.50	12.00	21.25	1.13	16	11.25°	18.00

Silex Inc.
6659 Ordan Drive
Mississauga, Ontario
L5T 1K6
1-800-387-7818

Silex

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Drawn By: ES Date: 10/21/99

Scale: N.T.S. DWG Number: FF-CAT-Rd.

Description:
Caterpillar Engine Exhaust Flexible Connectors, Type FF (Flange x Flange)

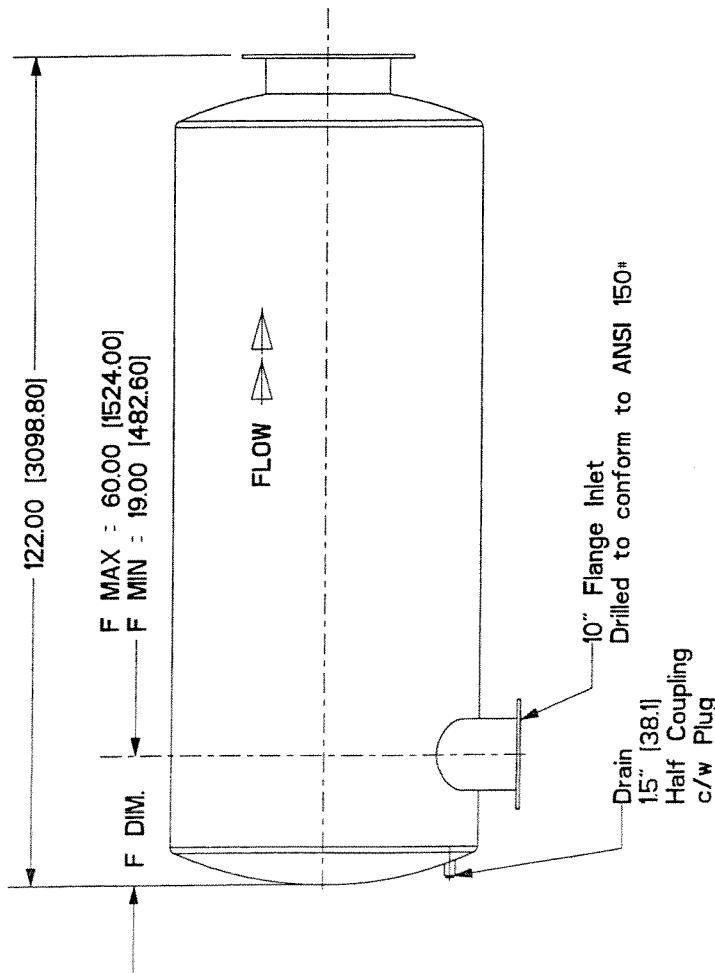
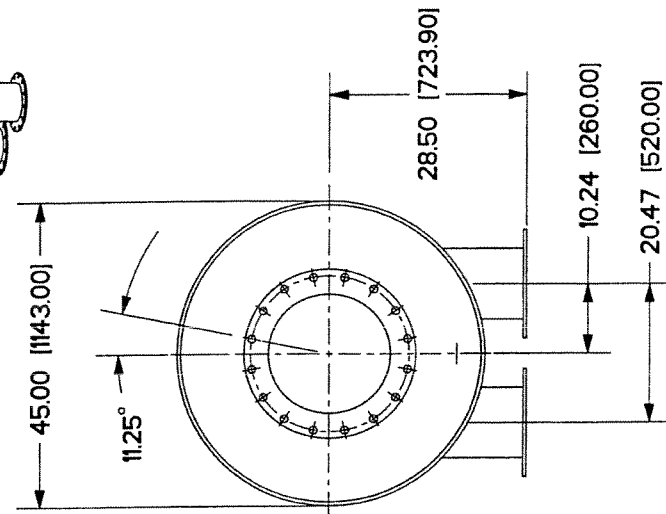
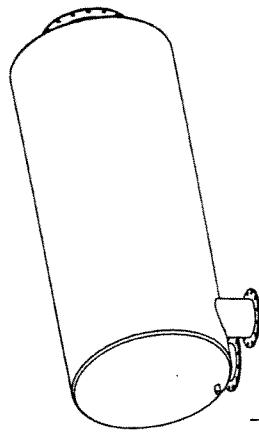
Engine: 3408 - 3516

Ref. No.:

- Notes:
1. Flex is not designed to absorb pipe growth.
 2. Finish high temperature black paint.
 3. Standard Silex construction tolerances apply ($\pm 1/4"$)
 4. Other lengths are available upon request.
 5. Drawing subject to change without notice.

Engine Model No.: 3516B-2000KW

Model No.: JB-18-3516B



Notes:

1. Silencer is all welded construction.
2. Standard Silex construction tolerances apply ($\pm 1/4$).
3. Finished in high temperature black paint.
4. Stainless steel available on request.
5. Specify "F" dimension at time of order.
6. Drawing subject to change without notice.

Flange Details	Inlet	Outlet
Size	10" x 2	18"
Outside diameter	16"	25"
Bolt Hole Circle Dia.	14.25"	22.75"
No. of Bolts	12"	16"
Bolt Hole Diameter	1"	1.25"
Flange Thickness	0.5"	0.5"

Description:

Critical Grade Silencer

Engine: 3516B-2000KW

Attenuation: 25-30 dBA

Silex
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 Mississauga, Ontario
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Drawn By: ES Date: 10/15/99

Scale: N.T.S. DWG Number: JB-18-3516B

Silencers - Cylindrical

JB Series

25 - 32 dBA

Critical Grade

Silencer Selection

Call Silex for immediate assistance in selecting the appropriate silencer that best suits your application's acoustical and backpressure requirements or consult the silencer selection guide in our catalogue. You can also use Silex's exclusive Silencer Sizing and Selection Program "Silex Digital Engineer" found on the Company's secure website at www.silex.com.

Application & Performance

The Critical Grade series are reactive silencers. All of the silencers are manufactured from light to heavy gauge steel and finished with high temperature paint. Flanges are ANSI 125/150# and a drain is included as a standard component on the silencer.

Dimensions

Model	A	B	C	D	F**	G	H	Wgt.
JB-1.5	1.5	9 (229)	24 (610)	30 (762)	4.0 (102)	7.5 (191)	27 (686)	21 (10)
JB-2	2	9 (229)	24 (610)	30 (762)	4.5 (114)	7.5 (191)	27 (686)	22 (10)
JB-2.5	2.5	10 (254)	28 (711)	34 (864)	5.0 (127)	8.0 (203)	31 (787)	31 (14)
JB-3	3	12 (305)	32 (813)	38 (660)	5.5 (140)	9.0 (229)	35 (889)	44 (20)
JB-3.5	3.5	14 (356)	36 (914)	42 (1067)	6.0 (152)	10.0 (254)	39 (991)	63 (29)
JB-4	4	14 (556)	40 (1016)	48 (1219)	6.0 (152)	11.0 (279)	44 (1118)	77 (35)
JB-5	5	16 (406)	49 (1245)	57 (1448)	7.0 (178)	12.0 (305)	53 (1346)	103 (47)
JB-6	6	18 (457)	55 (1397)	63 (1600)	8.0 (203)	13.0 (330)	59 (1499)	130 (59)
JB-8	8	22 (559)	68 (1727)	76 (1930)	9.5 (241)	15.0 (381)	72 (1829)	204 (93)
JB-10	10	26 (660)	81 (2057)	89 (2261)	11.5 (292)	17.0 (432)	85 (2159)	401 (182)
JB-12	12	30 (762)	94 (2388)	102 (2591)	13.0 (330)	19.0 (483)	98 (2489)	535 (243)
JB-14	14	36 (914)	99 (2515)	109 (2769)	15.5 (394)	23.0 (584)	104 (2642)	684 (310)
JB-16	16	40 (1016)	109 (2769)	119 (3023)	16.5 (419)	25.0 (635)	114 (2896)	1114 (505)
JB-18	18	45 (1143)	117 (2972)	127 (3226)	18.0 (457)	27.5 (699)	122 (3099)	1579 (716)
JB-20	20	50 (1270)	127 (3226)	137 (3480)	20.5 (521)	30.0 (762)	132 (3353)	2189 (993)
JB-22	22	54 (1372)	139 (3531)	149 (3785)	22.5 (572)	32.0 (813)	144 (3658)	2538 (1151)
JB-24	24	60 (1524)	152 (3861)	162 (4115)	24.0 (610)	35.0 (889)	157 (3988)	3116 (1413)
JB-26	26	64 (1626)	173 (4394)	183 (4648)	25.5 (648)	37.0 (940)	178 (4521)	3778 (1714)
JB-28	28	68 (1727)	190 (4826)	200 (5080)	26.5 (673)	39.0 (991)	195 (4953)	4342 (1970)
JB-30	30	72 (1829)	206 (5232)	216 (5486)	28.0 (711)	41.0 (1041)	211 (5359)	4946 (2244)

**For F dimension other than that specified, please contact Silex.

Available in sizes up to 60" inlet

Options

- Aluminized steel, 304, 316 or 316L stainless steel, Corten Steel
- Dual inlet or Custom inlet/outlet configurations
- Thermal insulation blankets to suit all configurations
- Mounting brackets, gussets and lifting lugs available at additional cost

Metric dimensions rounded to nearest mm.

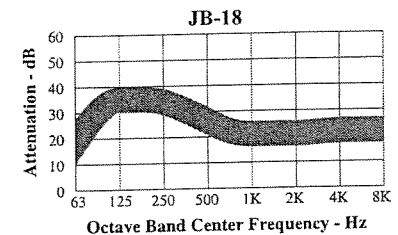
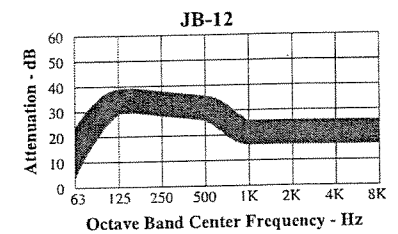
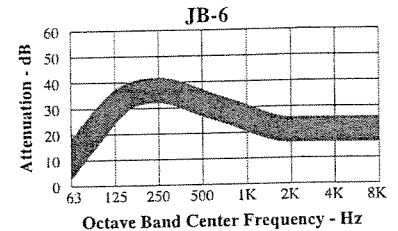
Dimensions and weights are nominal and may vary slightly in production models.

The inlet and discharge on silencers up to 3 1/2" are Sch. 40 NPT pipe. On silencers 4" and larger the inlet and discharge are flanged, manufactured from minimum 1/2" thick plate and drilled to ANSI 150 lb.

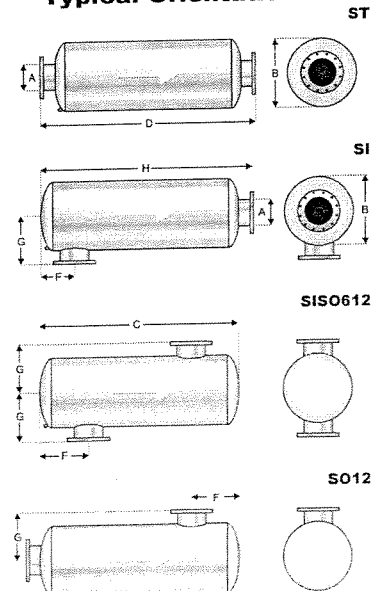
Silex Innovations Inc.
 Phone 905 612 4000
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10-0011 03-11

Typical Attenuation Curve



Typical Orientations



800 387 7818

GEN SET PACKAGE PERFORMANCE DATA [516DE3R]

MARCH 31, 2006

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Performance Number: DM7918

Change Level:

Sales Model: 3516BDITA	Combustion: DI	Aspr: TA
Engine Power: 2000 W/F EKW 2060 W/O F EKW 2,876 HP	Speed: 1,800 RPM	After Cooler: SCAC
Manifold Type: DRY	Governor Type: ADEM3	After Cooler Temp(F): 194
Turbo Quantity: 4	Engine App: GP	Turbo Arrangement: Parallel
Hertz: 60	Engine Rating: PGS	Strategy: Low BSFC Strategy
Rating Type: STANDBY	Certification: N-C 1970 - 2100	

General Performance Data

GEN W/F EKW	PERCENT LOAD	ENGINE POWER BHP	ENGINE BMEP PSI	FUEL RATE LB/BHP-HR	FUEL RATE GPH	NTAKE MFLD TEMP DEG F	INTAKE MFLD P IN-HG	INTAKE AIR FLOW CFM	EXH MFLD TEMP DEG F	EXH STACK TEMP DEG F	EXH GAS FLOW CFM
2,000.0	100	2885	301	0.340	140.2	228.9	80.3	5,802.2	1,246.1	957.9	16,029.3
1,800.0	90	2601	272	0.336	124.9	223.2	72.7	5,487.9	1,176.8	901.2	14,521.4
1,600.0	80	2320	243	0.334	110.7	218.7	64.3	5,099.4	1,118.8	861.3	13,084.1
1,500.0	75	2181	228	0.333	103.7	216.7	59.8	4,866.4	1,094.0	847.4	12,356.6
1,400.0	70	2041	213	0.332	96.9	215.1	55.2	4,629.8	1,070.8	834.8	11,625.6
1,200.0	60	1763	184	0.333	83.8	212.2	46.0	4,138.9	1,031.4	813.2	10,223.6
1,000.0	50	1487	155	0.335	71.1	209.5	36.8	3,640.9	993.9	792.3	8,839.3
800.0	40	1215	127	0.339	58.9	207.1	27.6	3,146.5	957.7	767.5	7,476.1
600.0	30	938	98	0.349	46.7	204.6	18.2	2,641.5	921.0	730.8	6,088.3
500.0	25	798	83	0.356	40.6	203.4	13.4	2,380.2	902.7	709.3	5,382.0
400.0	20	657	69	0.368	34.5	202.1	8.5	2,118.9	884.3	685.8	4,672.1
200.0	10	369	39	0.420	22.2	199.8	1.4	1,585.6	846.9	636.8	3,227.8

Heat Rejection Data

GEN W/F EKW	PERCENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXHAUST BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
2,000.0	100	46,520	9,099	118,744	66,993	15,071	23,544	122,327	300,614	320,234
1,800.0	90	42,880	8,303	104,584	56,984	13,421	19,450	110,328	268,085	285,544
1,600.0	80	39,297	7,734	92,015	48,794	11,886	15,525	98,385	237,489	252,957
1,500.0	75	37,534	7,507	86,101	45,212	11,146	13,592	92,470	222,646	237,204
1,400.0	70	35,771	7,279	80,357	41,799	10,407	11,715	86,556	208,087	221,679
1,200.0	60	32,188	6,881	69,211	35,601	8,985	8,303	74,784	179,652	191,367
1,000.0	50	28,606	6,540	58,519	29,800	7,621	5,346	63,069	152,127	162,022
800.0	40	24,966	6,313	48,396	24,227	6,313	2,843	51,524	125,853	134,042
600.0	30	21,212	6,085	38,444	18,426	5,005	796	39,809	99,807	106,290
500.0	25	19,222	5,971	33,496	15,639	4,379	-57	33,838	86,897	92,527
400.0	20	17,288	5,914	28,662	12,909	3,697	-796	27,866	74,045	78,879
200.0	10	13,251	5,744	18,824	8,189	2,389	-2,218	15,639	48,112	51,240

EXHAUST Sound Data: 6.6 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
2,000.0	100	116	107	121	117	109	108	109	109	107
1,800.0	90	116	106	121	117	109	107	108	108	106
1,600.0	80	114	105	119	115	107	106	107	107	105
1,500.0	75	114	104	119	115	107	105	107	107	105
1,400.0	70	113	104	118	114	106	105	106	106	104
1,200.0	60	112	103	117	113	105	104	105	105	103
1,000.0	50	111	101	116	112	104	103	104	104	102
800.0	40	110	100	115	111	103	101	102	102	100
600.0	30	108	98	113	109	101	100	101	101	99
500.0	25	107	98	112	108	100	99	100	100	98
400.0	20	106	97	111	107	99	98	99	99	97
200.0	10	104	94	109	105	97	96	97	97	95

EXHAUST Sound Data: 23.0 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
2,000.0	100	103	95	111	105	97	95	96	96	93
1,800.0	90	102	94	110	104	96	94	95	95	92
1,600.0	80	101	93	109	103	95	93	94	94	91
1,500.0	75	101	92	109	103	94	93	93	93	90
1,400.0	70	100	91	108	102	94	92	93	93	90
1,200.0	60	99	90	107	101	92	91	92	91	89
1,000.0	50	98	89	106	100	91	90	90	90	87
800.0	40	96	88	104	98	90	88	89	89	86
600.0	30	95	86	103	97	88	87	87	87	85
500.0	25	94	85	102	96	88	86	87	86	84
400.0	20	93	84	101	95	87	85	86	86	83
200.0	10	91	82	99	93	84	83	83	83	81

EXHAUST Sound Data: 49.2 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
2,000.0	100	96	88	104	99	90	88	89	89	86
1,800.0	90	96	87	104	98	89	88	88	88	85
1,600.0	80	94	86	102	97	88	86	87	87	84
1,500.0	75	94	85	102	96	88	86	87	87	84
1,400.0	70	93	85	101	96	87	85	86	86	83
1,200.0	60	92	84	100	94	86	84	85	85	82
1,000.0	50	91	82	99	93	85	83	84	84	81
800.0	40	90	81	98	92	83	82	82	82	79
600.0	30	88	80	96	90	82	80	81	81	78
500.0	25	87	79	95	90	81	79	80	80	77
400.0	20	86	78	94	89	80	78	79	79	76
200.0	10	84	76	92	86	78	76	77	77	74

MECHANICAL Sound Data: 3.3 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
2,000.0	100	122	110	119	128	119	110	104	99	103
1,800.0	90	122	110	119	128	119	110	104	99	103
1,600.0	80	122	110	119	128	119	110	104	99	103
1,500.0	75	122	110	119	128	119	110	104	99	103
1,400.0	70	122	110	119	128	119	110	104	99	103
1,200.0	60	122	110	119	128	119	110	104	99	103
1,000.0	50	122	110	119	128	119	110	104	99	103
800.0	40	122	110	119	128	119	110	104	99	103
600.0	30	122	110	119	128	119	110	104	99	103
500.0	25	122	110	119	128	119	110	104	99	103
400.0	20	122	110	119	128	119	110	104	99	103
200.0	10	122	110	119	128	119	110	104	99	103

MECHANICAL Sound Data: 23.0 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCJ 8000HZ DB
2,000.0	100	108	96	105	114	105	96	91	88	92
1,800.0	90	108	96	105	114	105	96	91	88	92
1,600.0	80	108	96	105	114	105	96	91	88	92
1,500.0	75	108	96	105	114	105	96	91	88	92
1,400.0	70	108	96	105	114	105	96	91	88	92
1,200.0	60	108	96	105	114	105	96	91	88	92
1,000.0	50	108	96	105	114	105	96	91	88	92
800.0	40	108	96	105	114	105	96	91	88	92
600.0	30	108	96	105	114	105	96	91	88	92
500.0	25	108	96	105	114	105	96	91	88	92
400.0	20	108	96	105	114	105	96	91	88	92
200.0	10	108	96	105	114	105	96	91	88	92

MECHANICAL Sound Data: 49.2 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
2,000.0	100	101	89	99	108	99	90	86	82	86
1,800.0	90	101	89	99	108	99	90	86	82	86
1,600.0	80	101	89	99	108	99	90	86	82	86
1,500.0	75	101	89	99	108	99	90	86	82	86
1,400.0	70	101	89	99	108	99	90	86	82	86
1,200.0	60	101	89	99	108	99	90	86	82	86
1,000.0	50	101	89	99	108	99	90	86	82	86
800.0	40	101	89	99	108	99	90	86	82	86
600.0	30	101	89	99	108	99	90	86	82	86
500.0	25	101	89	99	108	99	90	86	82	86
400.0	20	101	89	99	108	99	90	86	82	86
200.0	10	101	89	99	108	99	90	86	82	86

EMISSIONS DATA

N-C 1970 - 2100 ***** N1
This engine rating is not emission certified by any domestic or foreign agency.

EXHAUST STACK DIAMETER	8 IN
WET EXHAUST MASS	26,543.6 LB/HR
WET EXHAUST FLOW (957.20 F STACK TEMP)	16,039.94 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	5,520.00 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	5,057.06 STD CFM
FUEL FLOW RATE	140 GAL/HR

RATED SPEED "Not to exceed data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
2,000.0	100	2885	70.82	5.64	1.36	.660	9.60	1.2	1.28
1,500.0	75	2181	54.81	2.57	1.17	.470	11.00	0.9	1.28
1,000.0	50	1487	38.63	2.14	0.91	.430	11.90	1.2	1.28
500.0	25	798	21.95	1.80	0.83	.440	13.10	2.3	1.28
200.0	10	369	12.78	1.52	0.79	.460	14.10	3.3	1.28

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
2,000.0	100	2885	59.02	3.13	1.02	3,122.2	0.470	9.60	1.2	1.28
1,500.0	75	2181	45.68	1.43	0.88	2,310.3	0.330	11.00	0.9	1.28
1,000.0	50	1487	32.20	1.19	0.68	1,614.1	0.310	11.90	1.2	1.28
500.0	25	798	18.29	1.00	0.62	990.0	0.320	13.10	2.3	1.28
200.0	10	369	10.65	0.84	0.59	624.1	0.330	14.10	3.3	1.28

Altitude Capability Data(Corrected Power Altitude Capability)

Ambient Operating Temp.	50 F	68 F	86 F	104 F	122 F	NORMAL
Altitude						
0 F	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp
984 F	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp
1,640 F	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,876 hp
3,281 F	2,876 hp	2,876 hp	2,876 hp	2,876 hp	2,808 hp	2,876 hp
4,921 F	2,876 hp	2,876 hp	2,816 hp	2,726 hp	2,642 hp	2,876 hp
6,562 F	2,835 hp	2,737 hp	2,647 hp	2,563 hp	2,484 hp	2,763 hp
8,202 F	2,663 hp	2,572 hp	2,488 hp	2,407 hp	2,333 hp	2,624 hp
9,843 F	2,500 hp	2,415 hp	2,335 hp	2,261 hp	2,190 hp	2,492 hp
10,499 F	2,437 hp	2,353 hp	2,277 hp	2,203 hp	2,135 hp	2,441 hp

The powers listed above and all the Powers displayed are Corrected Powers

Identification Reference and Notes

Engine Arrangement:	2560758	Lube Oil Press @ Rated Spd(PSI):	55.8
Effective Serial No:	ZAP00001	Piston Speed @ Rated Eng SPD(FT/Min):	2,173.2
Primary Engine Test Spec:	0K6352	Max Operating Altitude(FT):	5,249.3
Performance Parm Ref:	TM5739	PEEC Elect Control Module Ref	
Performance Data Ref:	DM7918	PEEC Personality Cont Mod Ref	
Aux Coolant Pump Perf Ref:			
Cooling System Perf Ref:		Turbocharger Model	GTA5518BL-1.23
Certification Ref:	NOT CERTIFIED	Fuel Injector	2563663
Certification Year:		Timing-Static (DEG):	--
Compression Ratio:	14.0	Timing-Static Advance (DEG):	--
Combustion System:	DI	Timing-Static (MM):	--
Aftercooler Temperature (F):	194	Unit Injector Timing (MM):	64.3
Crankcase Blowby Rate(CFH):	2,874.6	Torque Rise (percent)	--
Fuel Rate (Rated RPM) No Load(Gal/HR):	13.1	Peak Torque Speed RPM	--
Lube Oil Press @ Low Idle Spd(PSI):	20.0	Peak Torque (LB/FT):	--

Reference
Number: DM7918

N-C 19702100N1

Parameters
Reference: TM5739

GEN SET - PACKAGED - DIESEL

TOLERANCES:

AMBIENT AIR CONDITIONS AND FUEL USED WILL AFFECT THESE VALUES.
EACH OF THE VALUES MAY VARY IN ACCORDANCE WITH THE FOLLOWING
TOLERANCES.

ENGINE POWER	+/-	3%
EXHAUST STACK TEMPERATURE	+/-	8%
GENERATOR POWER	+/-	5%
INLET AIR FLOW	+/-	5%
INTAKE MANIFOLD PRESSURE - GAGE	+/-	10%
EXHAUST FLOW	+/-	6%
SPECIFIC FUEL CONSUMPTION	+/-	3%
FUEL RATE	+/-	5%
HEAT REJECTION	+/-	5%
HEAT REJECTION EXHAUST ONLY	+/-	10%

CONDITIONS:

ENGINE PERFORMANCE IS CORRECTED TO INLET AIR STANDARD CONDITIONS
OF 99 KPA (29.31 IN HG) AND 25 DEG C (77 DEG F).

THESE VALUES CORRESPOND TO THE STANDARD ATMOSPHERIC PRESSURE AND
TEMPERATURE IN ACCORDANCE WITH SAE J1995. ALSO INCLUDED IS A
CORRECTION TO STANDARD FUEL GRAVITY OF 35 DEGREES API HAVING A
LOWER HEATING VALUE OF 42,780 KJ/KG (18,390 BTU/LB) WHEN USED AT
29 DEG C (84.2 DEG F) WHERE THE DENSITY IS 838.9 G/L (7.002
LB/GAL).

THE CORRECTED PERFORMANCE VALUES SHOWN FOR CATERPILLAR ENGINES WILL
APPROXIMATE THE VALUES OBTAINED WHEN THE OBSERVED PERFORMANCE
DATA IS CORRECTED TO SAE J1995, ISO 3046-2 & 8665 & 2288 & 9249 &
1585, EEC 80/1269 AND DIN70020 STANDARD REFERENCE CONDITIONS.

ENGINES ARE EQUIPPED WITH STANDARD ACCESSORIES; LUBE OIL, FUEL
PUMP AND JACKET WATER PUMP. THE POWER REQUIRED TO DRIVE
AUXILIARIES MUST BE DEDUCTED FROM THE GROSS OUTPUT TO ARRIVE AT THE
NET POWER AVAILABLE FOR THE EXTERNAL (FLYWHEEL) LOAD. TYPICAL
AUXILIARIES INCLUDE COOLING FANS, AIR COMPRESSORS, AND CHARGING
ALTERNATORS.

RATINGS MUST BE REDUCED TO COMPENSATE FOR ALTITUDE AND/OR AMBIENT
TEMPERATURE CONDITIONS ACCORDING TO THE APPLICABLE DATA SHOWN ON
THE PERFORMANCE DATA SET.

GEN SET - PACKAGED - DIESEL

ALTITUDE:

ALTITUDE CAPABILITY - THE RECOMMENDED REDUCED POWER VALUES FOR
SUSTAINED ENGINE OPERATION AT SPECIFIC ALTITUDE LEVELS AND AMBIENT
TEMPERATURES.

COLUMN "N" DATA - THE FLYWHEEL POWER OUTPUT AT NORMAL AMBIENT
TEMPERATURE.

AMBIENT TEMPERATURE - TO BE MEASURED AT THE AIR CLEANER AIR INLET
DURING NORMAL ENGINE OPERATION.

NORMAL TEMPERATURE - THE NORMAL TEMPERATURE AT VARIOUS SPECIFIC
ALTITUDE LEVELS IS FOUND ON TM2001.

THE GENERATOR POWER CURVE TABULAR DATA REPRESENTS THE NET
ELECTRICAL POWER OUTPUT OF THE GENERATOR.

DEFINITIONS:

STANDBY - MAXIMUM OUTPUT AVAILABLE FOR NON PROGRAMMED POWER OUTAGES. THE EXPECTED USAGE SHOULD BE APPROXIMATELY 30 HOURS PER YEAR AND THE AVERAGE DEMAND, DURING THE OUTAGE, SHOULD NOT EXCEED THE CORRESPONDING INDUSTRIAL ENGINE CONTINUOUS RATING. STANDBY RATINGS MAY BE USED IN PEAK SHAVING AND DURING INTERRUPTIBLE UTILITY SERVICE IF THE FOLLOWING CRITERIA ARE MET.

500 HOURS/YEAR OR LESS
60% MAXIMUM AVERAGE LOAD FACTOR
80% LOAD PEAK DEMAND
100% LOAD USED ONLY FOR EMERGENCIES

PRIME POWER - OUTPUT AVAILABLE FOR PEAK DEMAND OF A VARIABLE ELECTRIC LOAD INCLUDING PEAK SHAVING AND PROGRAMMED OUTAGES. THE AVERAGE DEMAND DURING ANY 24 HOUR PERIOD SHOULD NOT EXCEED THE CORRESPONDING INDUSTRIAL ENGINE CONTINUOUS RATING. ALL PRIME POWER RATINGS, EXCEPT D SERIES, HAVE 10% OVERLOAD FOR EMERGENCY USE.

CONTINUOUS - OUTPUT WHICH MAY BE UTILIZED CONTINUOUSLY WITHOUT LOAD CYCLING. ALL 3600 ENGINE CONTINUOUS RATINGS HAVE 10% OVERLOAD CAPABILITY.

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Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: June 21/06 By: (Signature) MECH

NOTE: PROGRAMMING BY INSTALLATION CONTRACTOR.

BY SUPPLY CONTRACTOR

OPW
TANK GAUGES

SITESENTINEL
Magnetostrictive Probe

Proven Magnetostrictive Technology For Automatic Tank Gauging Systems

Highly accurate, trouble-free performance for inventory management and in-tank leak detection. Unlike competitive probes that have to be upgraded to handle different liquids, this highly-accurate, trouble-free probe comes standard in stainless steel and can be used with a variety of liquids gasoline, diesel, water. The probe also measures water level, providing information to ensure product quality.

Applications

- Compatible with SiteSentinel Models 1, 2, 3 and (Petrosonic) automatic tank gauging systems
- Supports extended operating temperature range: -40°F to 140°F (-40°C to 60°C)
- Designed for both underground (UST) and above-ground (AST) storage tanks
- Compatible with gasoline, diesel and other approved fluids

Features

- The Magnetostrictive Probe accurately measures product and water levels
- Supports Automatic Leak Detection (ALD) with SiteSentinel I
- Five-point temperature sensing element provides accurate temperature compensation for product volume contraction and expansion for accurate inventory management and in-tank leak detection
- Automatically transmits probe profile to SiteSentinel on start-up to eliminate programming errors
- Adjustable probe head centering disks provide a tight fit inside risers with diameters ranging from 7.6" (3 cm) to 10.2" (4 cm)
- Available with 2" or 4" float kits

Compliance

- The system is certified to meet U.S. Environmental Protection Agency's performance standards for 0.1 gallons per hour (0.38 liters per hour) volumetric tank tightness testing and 0.2 gph (0.76 lph) monthly monitoring.
- Supports ALD with SiteSentinel I:
 - monitors for leaks based on user selectable settings
 - can be set to automatically perform daily, weekly, monthly and annually required leak tests

Magnetostrictive Level I Probe Data

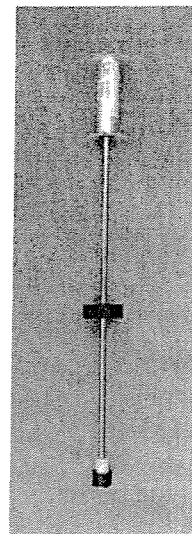
- Measures product level changes to a resolution of 0.0005" (0.0127 mm)
- Measures product temperature changes to a resolution of 0.001° F (0.0005° C)
- Measures water level changes to a resolution of 0.01" (0.254 mm)
- Linearity over entire probe length is ± 0.04 " (1 mm)

Approvals

- ETL
- BASEEFA
- ETL
- ULC

Leak Test Performance

- 0.2 gph (0.76 lph) Static Leak Test: 99.93% Pd, 0.07% Pfa,
- 0.1 gph (0.38 lph) Static Leak Test: 97.25% Pd, 1.95% Pfa
- 0.2 gph (0.76 lph) Automatic Leak Detection (ALD)
- 0.1 gph (0.38 lph) Automatic Leak Detection (ALD)
- EPA Certified: 20,000 gallon tank (75,700 liters)



- o Indicate Part numbers and quantities
- o Indicate communication connection to Generator control PLC for inventory display and leak detection.
- o interface for fuel transfer system interlock

Proven Magnetostrictive Technology For Automatic Tank Gauging Systems

Probe Specifications

Type:	Magnetostrictive/Float
Material:	Stainless steel shaft, aluminum head
Location:	Hazardous, Class I, Division 1, Group D
Probe Inputs:	Intrinsically safe
Probe Power Supply:	12VDC
Level Precision:	± 0.0005" (0.0127 mm)
Level Accuracy:	± 0.04" (1 mm)
Temperature:	± 0.5°F (0.3°C)
Temperature:	5 RTDs
Temperature Range:	-40°F to 140°F (-40°C to 60°C)
Data Cable:	1000' (300 m) Belden 88760 or Alpha 55371

Level I Probe Length

Part No.	Description
■ 30-EA053	53" (135 cm)
■ 30-EA069	69" (175 cm)
■ 30-EA077	77" (196 cm)
■ 30-EA089	89" (226 cm)
■ 30-EA101	101" (257 cm)
■ 30-EA105	105" (267 cm)
■ 30-EA113	113" (287 cm)
■ 30-EA125	125" (317 cm)
■ 30-EA137	137" (350 cm)
■ 30-EA149	149" (376 cm)

Probe Float Kits

Part No.	Description
■ 30-1508-02	4" (102 mm) Gas/Water Nitrophenyl Float Kit
■ 30-1508-01	4" (102 mm) Diesel/Water Nitrophenyl Float Kit
■ 30-1509-02	2" (51 mm) Gas/Water Nitrophenyl Float Kit
■ 30-1509-01	2" (51 mm) Diesel/Water Nitrophenyl Float Kit

Probe Interface Cable

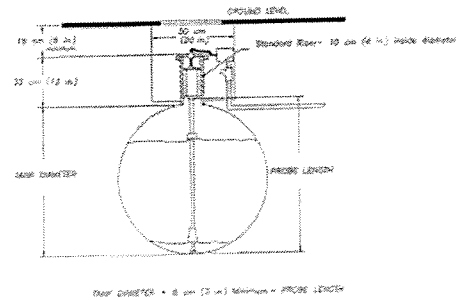
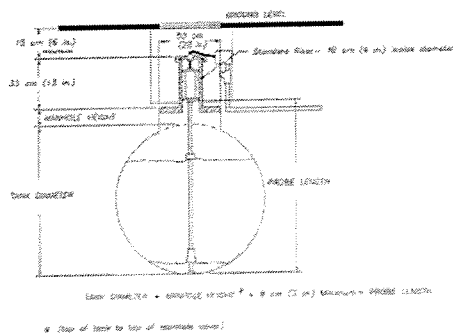
Part No.	Description
■ 10-1185	6' (1.8 m) Probe Interface Cable (Yellow, part of the float kit)

Probe Installation Kits

Part No.	Description
■ 30-0219	OPW 4" (10.2 cm) Cap
■ 30-0219-E	OPW 4" (10.2 cm) Cap (BSI Thread)

Probe Interface Field Wire

Part No.	Description
■ 12	TLM Belden 88760 Cable, minimum 500' (150 m)



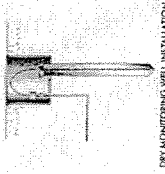
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Monitoring Well Sensors

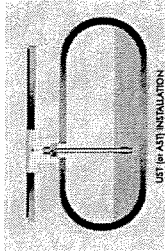
Hydrocarbon Vapor
The Hydrocarbon Vapor Sensor is installed in dry monitoring wells. It detects the presence of hydrocarbon vapors. Hydrocarbon vapors are heavier than air and will settle to the lowest point. Therefore, these sensors must be installed close to the bottom of the monitoring well.



DRY MONITORING WELL INSTALLATION
Part Number: Q0003-010
Used In: Dry Monitoring Wells
Detects: Hydrocarbon Vapors
Operating Temp: -13° to 158°F (20° to 70°C)
Interface Types: Q439970 - 6 Channel Input

High/Low/Liquid Level Sensors

Low Level
The Low Level Liquid Sensor provides low cost inventory management for both above-ground (AST) and underground (UST) storage tanks. This sensor creates the simplest form of inventory management by indicating a low liquid level.



AST (or UST) INSTALLATION
Part Number: Q0003-014
Used In: ASTs, USTs
Detects: Liquid Level
Operating Temp: -40° to 180°F (-40° to 82°C)
Interface Types: Q439970 - 6 Channel Input

EECO Sensors

Interstitial Dispenser Pan / sump Monitoring Well
High / Low Liquid Level



OPW TANK GAUGERS

High/Low/Liquid Level Sensors

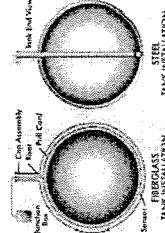
High/Low Level
The High/Low Level Liquid Sensor provides low cost inventory management for both above-ground (AST) and underground (UST) storage tanks. This sensor has a contact closure to the green which indicates that the liquid level has reached a high or low point - dependent on the positioning of the floats on the sensor.



AST (or UST) INSTALLATION
Part Number: Q0003-011 • Up to 5' (1.5 meters) Length
Q0003-012 • 5' to 10' (1.5 to 3.0 meters) Length
Used In: ASTs, USTs
Detects: Liquid Level
Operating Temp: -40° to 180°F (-40° to 82°C)
Interface Types: Q439970 - 6 Channel Input

Interstitial Sensors

Liquid Only
The Liquid Only Interstitial Sensor is easily installed to monitor the dry interstitial space of double-wall fiberglass or steel tanks. It detects the presence of liquids, but does not discriminate between fuel and other liquids.



BIODIESEL TANK INSULATION TANK INSULATION
Part Number: Q0003-006
Primary Use: Double-wall Tanks (Steel & Steel)
Alternate Use: Storage Tanks
Detects: Liquids Only
Operating Temp: -4° to 175°F (-20° to 80°C)
Interface Types: Q439970 - 6 Channel Input

EECO Sensors

EECO sensors provide protection by monitoring the environment in and around the tank, interfacing directly to the EECO systems through a single sensor interface that accommodates all sensor types and locations including: Tank Interstitial Spaces, Piping Sumps, Containment Sumps, Dispenser Sump/Sumps, and Monitoring Wells.

The EECO discriminating sensors detect the presence of liquid in contained areas, and provide alarms indicating if the fluid detected is water or fuel. The EECO non-discriminating sensors detect the presence of either water or fuel in contained areas and provide an alarm indicating the presence of a liquid.

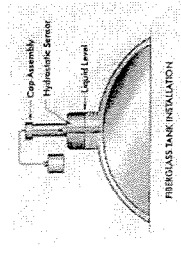


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Intermittent Sensors

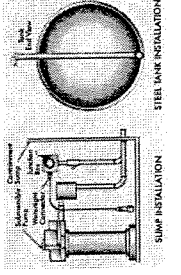
Dual Level Hydrostatic
The Dual Level Hydrostatic Sensor is installed in the interstitial space reservoir of double-wall fiberglass tanks. It detects changes in the liquid brine level between the wells of the tank. Alarms are made for temperature changes to present the occurrence of false alarms.



Part Number: Q0003-003
Used In: Double Wall Tanks with Brine Solution
Detector: Liquid Level Change
Operating Temp: -40° to 140°F (-40° to 60°C)
Interface Types: Q439970 - 6 Channel Input

Intermittent & Dispenser Pan/Sump Sensors

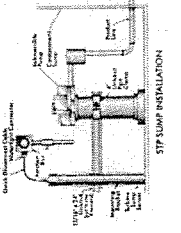
Liquid Float
The Liquid Float Sensor is installed in sumps and the interstitial space of double-wall steel tanks. It detects the presence of liquids, but does not discriminate between fuel and other liquids.



Part Number: Q0003-009
Used In: Sumps & Double-wall Steel Tanks
Detector: Liquids Only
Operating Temp: -40° to 180°F (-40° to 82°C)
Interface Types: Q439970 - 6 Channel Input

Dispenser Pan/Sump Sensors

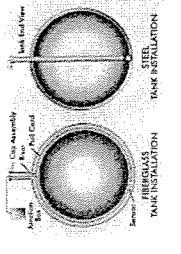
Fuel/Water STP Sump
The discriminating Sump Sensor detects low and high liquid levels and distinguishes between water and fuel. Detection of liquid in the sump will result in an alarm notification at the console. Detection of either fuel or high water can be used for pump shut down (requires optional multi-relay board or LLD module).



Part Number: Q0003-1002
Used In: STP Sumps
Detector: Liquids, Low & High Level
Differentiates: Fuel vs. Water
Product Detection: 2/10" fuel only, 1/10" fuel
Operating Temp: -40° to 150°F (-40° to 65°C)
Interface Types: Q439970 - 4 Channel Input

Intermittent Sensors

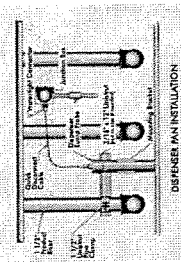
Fuel/Water
The discriminating Fuel/Water Interspatial Sensor is installed in the interstitial space of either fiberglass or steel double-wall tanks to detect the presence of fuel or water.



Part Number: Q0003-003
Used In: Double-wall Tanks (Fiberglass & Steel)
Primary Use: Sumps
Detector: Liquids
Differentiates: Fuel vs. Water
Operating Temp: -4° to 176°F (20° to 80°C)
Interface Types: Q439970 - 6 Channel Input

Dispenser Pan/Sump Sensors

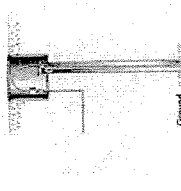
Fuel/Water Dispenser Pan
The discriminating Fuel/Water Dispenser Pan Sensor detects low and high liquid levels and distinguishes between water and fuel. Detection of liquid in the dispenser pan will result in an alarm notification at the console. Detection of either fuel or high water can be used for dispenser power shut down (requires optional control module or multi-relay board).



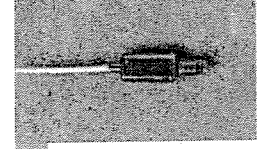
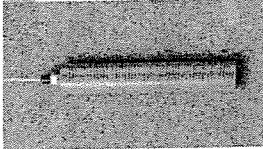
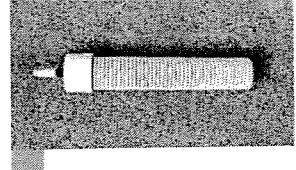
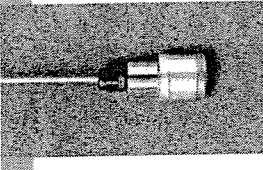
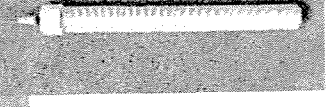
Part Number: Q0003-001
Used In: Dispenser Pans
Detector: Liquids, Low & High Level
Differentiates: Fuel vs. Water
Product Detection: 2/10" fuel only, 1/10" fuel on water
Operating Temp: -40° to 150°F (-40° to 65°C)
Interface Types: Q439970 - 6 Channel Input

Monitoring Well Sensors

Fuel/Water
The discriminating Fuel/Water Monitoring Well Sensor is installed in groundwater monitoring wells to detect fuel floating on the water surface. If the groundwater level drops below the sensor (not suitable for dry wells), it will activate an alarm indicating a dry well.



Part Number: Q0003-xxx4
Used In: Wells (Water Table Present)
Detector: Fuel on Water Surface
Differentiates: Fuel vs. Water
Product Detection: As Little as 1/10" of Product
Operating Temp: -20° to 150°F (-28° to 65°C)
Interface Types: Q439970 - 6 Channel Input





SiteSentinel[®]

Automated Monitoring System
Installation Manual

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Notes:

1.0 Before You Begin

WARNING!

Improper installation may endanger installers and users of this equipment! Read these instructions CAREFULLY.

Model II? Model III?

This manual is for BOTH the Site Sentinel Model II and Model III. The functionality of both is nearly identical. The main differences are in the controller.

The Model II controller is a large, wall-mounted device equipped with a keypad, internal printer (option) and a display screen. Programming the Model II is typically done at the controller itself.

The Model III controller is a small tabletop box with two buttons and a STATUS display. Aside from the buttons there are no operator controls on the Model III controller, and all programming is done through the rear-panel port with a PC or terminal.

Any other differences between II and III are described where necessary.

1.1 Installer Safety

Installers must be experienced with the requirements of intrinsically safe devices, and must strictly obey the instructions in this manual to perform a safe installation.

Installation must be in accordance with the National Electrical Code (NFPA No.70) and the Automotive and Marine Service Station Code (NFPA No. 30A).

A fuel tank is a **hazardous area** as defined in the NEC. Do *not* mount any part of the system, or any external devices (other than probes or sensors) within or above the hazardous area.

1.2 Precision Leak Test

A precision leak test should be performed on each tank - especially older ones - *before* installing the **SiteSentinel**. This test makes sure that leak data generated by the system is accurate and reliable. A *pressurized* precision leak test can be done on a tank after the probe has been installed, but **DO NOT** let the pressure exceed **20 psi**.

1.3 Initial Inspection

The Data Sheet lists specific details about your system. It is packed in the box with this manual. Store this sheet in a secure location.

Be sure to check the packaging carefully for any damage that might have occurred during shipping.

1.4 Manifolded Tanks

Tanks can be physically connected together, or manifolded, so that product flows freely between them.

To monitor manifolded tanks with the **SiteSentinel**, each tank in the group must have its own probe installed, and all probes for the group must be connected to the same Smart Module.

IMPORTANT

Many of the procedures described in the following pages must be followed for each tank that is to be included in the system. Please read the directions carefully before proceeding.

2.0 System Overview

2.1 Model II Controller

The Model II controller (Figure 1 next page) can monitor up to 128 probes, sensors, and external input and output devices. Because only AC power conduit connections are required for the controller, it can be placed almost anywhere.

You can operate the Model II controller either from its front-mounted 16-key keypad and graphic display, or from a terminal and/or personal computer ("PC"). No other hardware is required when you operate via the front panel controls.

When operated from a terminal or PC, the terminal can be connected locally (at the same site), or remotely using modems. The optional PV250 board (part #20-0227) provides RS-232 ports for the modems, terminals, PCs, and other external devices such as the K2500 Fuel Management System. Also included on the PV250 is an RS-232 serial port for an external printer, and inputs for two external contacts.

Any terminal that uses VT52, VT100, or WYSE 50 emulation are compatible with the SiteSentinel. If you are using a PC, it must be equipped with terminal emulation software.

Though all three methods of operation (display/keypad, local terminal/PC, and remote terminal/PC) can be connected to the Model II controller simultaneously, only one method may be used at a time. And, an operator cannot be interrupted by a second operator trying to "log in" by a different connection method.

Model II Controller Specifications	
Width:	19" (48.3 cm)
Height:	16.25" (41.3 cm)
Depth:	5.75" (14.6 cm)
Power	105-125 VAC, 60 Hz or 220-240 VAC, 50 Hz, 60 watts maximum
Temperature Range	32°F to 104°F (0°C to 40°C)
Module Capacity	8 Smart Modules and 8 I/O Modules
Display Backlight:	CCFT
Viewing Area:	5" x 3" (125 mm x 78 mm)
Format:	25 lines x 40 characters
Dot Matrix:	320 x 200 dots
Dot Color:	blue characters, white background
Keypad	16 keys: 10 alphanumeric; 6 function
Optional Internal Printer	40 column; plain paper
Optional Internal Modem (for remote operation)	model 224A; up to 2400 baud
Standard Alarms	one audible, one visible
External Alarm Inputs*	2 inputs for use with closed contact type inputs rated at 12 VDC, 40 mA
RS-232C Communication Ports (modem, PC/terminal, passthrough port)**†	up to 19,200 baud; VT100, VT52 or WYSE 50 emulation required; 7 data bits, even parity, 1 stop bit
RS-232C External Printer Serial Port**†	1200 baud; 7 data bits, even parity, 1 stop bit

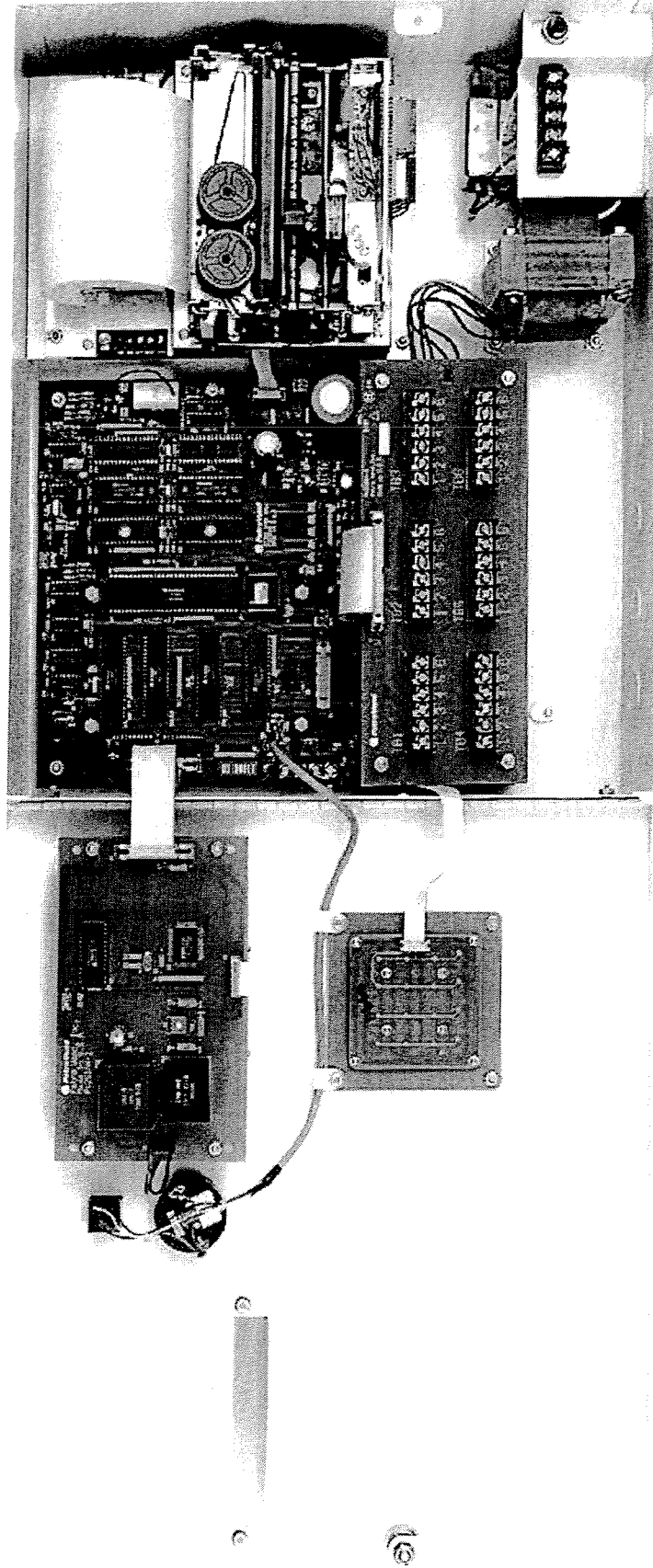


Figure 1 - Model II Controller Interior

2.2 Model III Controller

The Model III controller is a small microprocessor-based device which can monitor up to eight Smart Modules and eight I/O Modules. Because of its small size, it can be placed in many convenient locations. Its "power pack" plugs into any wall outlet.

The Model III controller can only be operated from a terminal and/or PC. The terminal or PC can be connected "locally", (at the same site), "remotely" (using modems and a telephone line), or both.

For local operation, the terminal or PC connects directly to one of the Model III RS-232 communication ports. For remote operation, attach a modem to the Model III controller MODEM port. A second modem is required at the terminal or PC.

Any terminal using VT52, VT100, or WYSE 50 protocol is compatible with the SiteSentinel. For a PC to communicate with the SiteSentinel, the PC must run a software program that emulates one of these terminal standards.

Note that although both methods of operation (local terminal/PC and remote terminal/PC) can be connected simultaneously, only one method may be used at a time. Once a person has begun using the system, he can *not* be interrupted by a second operator.

Model III Controller Specifications	
Cabinet Dimensions	2" H x 10" W x 11" D (5cm H x 25cm W x 28cm D)
Power Requirements Standard Optional	120 VAC, 50/60 Hz 220 to 240 VAC, 50/60 Hz
Module Capacity	8 Smart Modules and 8 I/O Modules
Serial Communication Ports	Petro-Net (RS-485) Printer (RS-232) Terminal (RS-232) Modem (RS-232) 3 Auxiliary Ports (RS-232)
Standard Alarm	one audible
Operating Temperature Range	32°F to 122°F (0°C to 50°C)
Operating Temperature Range for Peripheral Devices	40°F to 85°F (indoors only) (5°C to 29°C)

All equipment connected to the controller must be UL listed, equipped with a standard EIA RS-232C or RS-422A communication protocol, and not installed over a hazardous location.

2.3 Smart Module

The *Smart Module* (Figure 2 next page) gathers probe and sensor data. Up to four devices can be connected to the intrinsically safe (IS) barrier in the Smart Module. The barrier isolates the module from hazardous areas where probes and sensors are installed. Up to four barriers can be in each module, a total of 16 devices per module.

Up to eight modules can be connected to the controller via Petro-Net (twisted pair) wiring, for a total of 128 devices per system. Conduit is recommended for the Petro-Net wiring between the Smart Module and the controller, but it is *not* required.

The standard Smart Module includes one I.S. barrier. The part number for additional I.S. barriers is 20-4306.

SMART MODULE SPECIFICATIONS	
Electrical Requirements Standard Voltage Supply: Optional Voltage Supply: Power Consumption:	105 to 125 VAC, 60 Hz 220 to 240 VAC, 50 Hz 60 watts maximum
Dimensions Width: Height: Depth:	17" (43.2 cm) 9.75" (24.8 cm). <i>Mounting tabs add 1" (2.54 cm) top and bottom.</i> 5.5" (13 cm). <i>Key adds 1.5" (3.8 cm)</i>
Mounting centers:	16.5" (41.9 cm) width by 11" (27.9 cm) height
Temperature Range	32°F to 104°F (0°C to 40°C)
Device Capacity per I.S. Barrier: per Smart Module: per System:	up to 4 devices up to 16 devices up to 128 devices
Probe Cable Requirement	Belden #88760 or Alpha #55371 cable (shielded two-wire twisted pair)
Sensor Wiring Requirement	14 to 18 AWG oil & gas resistant (TFFN, THHN, or THWN)
Petro-Net Communication Wiring Requirement	18 AWG, twisted pair, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Petro-Net Extension	5000 feet (1.5 km)

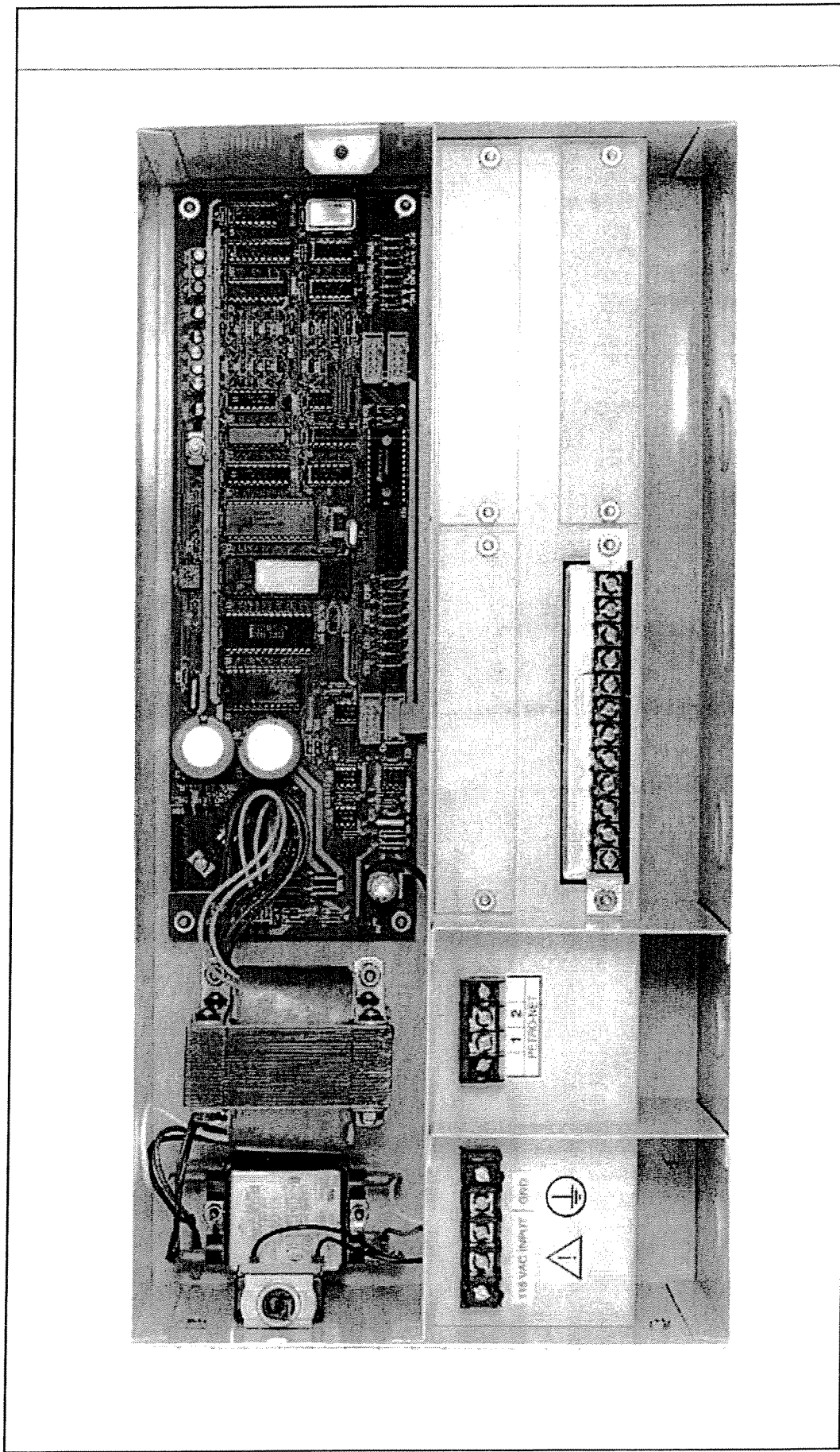


Figure 2 - Smart Module Interior

2.4 I/O Module (Optional)

The optional I/O Module expands either model's capabilities by letting you connect as many as four input devices and 12 output devices to the controller. The I/O Module communicates with the controller via Petro-Net (twisted pair wiring). Up to eight I/O Modules can be connected for a total of 32 input and 96 output devices.

WARNING

The input terminals and output relays for the I/O Module are not intrinsically safe. Probe cables and sensor wiring must not share conduit with the wiring from devices connected to the I/O Module.

The I/O Module has not been evaluated by Underwriter's Laboratories. Interconnection of the I/O Module and the system covered in this manual has not been evaluated by Underwriter's Laboratories.

I/O MODULE SPECIFICATIONS	
Electrical Requirements	105 to 125 VAC, 60 Hz
Standard Voltage Supply:	220 to 240 VAC, 50 Hz
Optional Voltage Supply:	60 watts maximum
Power Consumption:	
Dimensions	
Width:	8" (20 cm)
Height:	10" (25 cm)
Depth:	4" (10 cm)
Temperature Range	32°F to 104°F (0°C to 40°C)
Module Capacity	up to 8 I/O Modules per Controller
Device Capacity	4 input devices 12 output devices
Output Relay Rating	20 amps at 240 VAC (normally open) 10 amps at 240 VAC (normally closed)
Output Relay Wiring Requirement	12 to 14 AWG
Input Rating	10 milliamps @ 5 VDC (sink)
Input Wiring Requirement	12 to 14 AWG
Petro-Net Communication Wiring Requirement	18 AWG, twisted pair, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Petro-Net Extension	5000 feet (1.5 km)

2.5 Model 613 Probe

The Petro Vend 613 probe (Figure 3) has a microcontroller and an EPROM data base. Setup data is stored in the probe, then downloaded to the controller during configuration. All 613 probes have built-in diagnostics for reliable operation.

The 613 can be installed either in aboveground or underground tanks. Use only *Belden #88760* or *Alpha #55371* cable to connect the probe to the Smart Module. If you order the cable from Petro Vend, ask for part number **12-1300**.

Each probe has five temperature sensors in the shaft for measuring product temperature. They are located at positions of approximately 20%, 40%, 50%, 60% and 80% of probe length. The probe head also contains a temperature sensor.

Specifications and available lengths for the Model 613 appear on the next page.

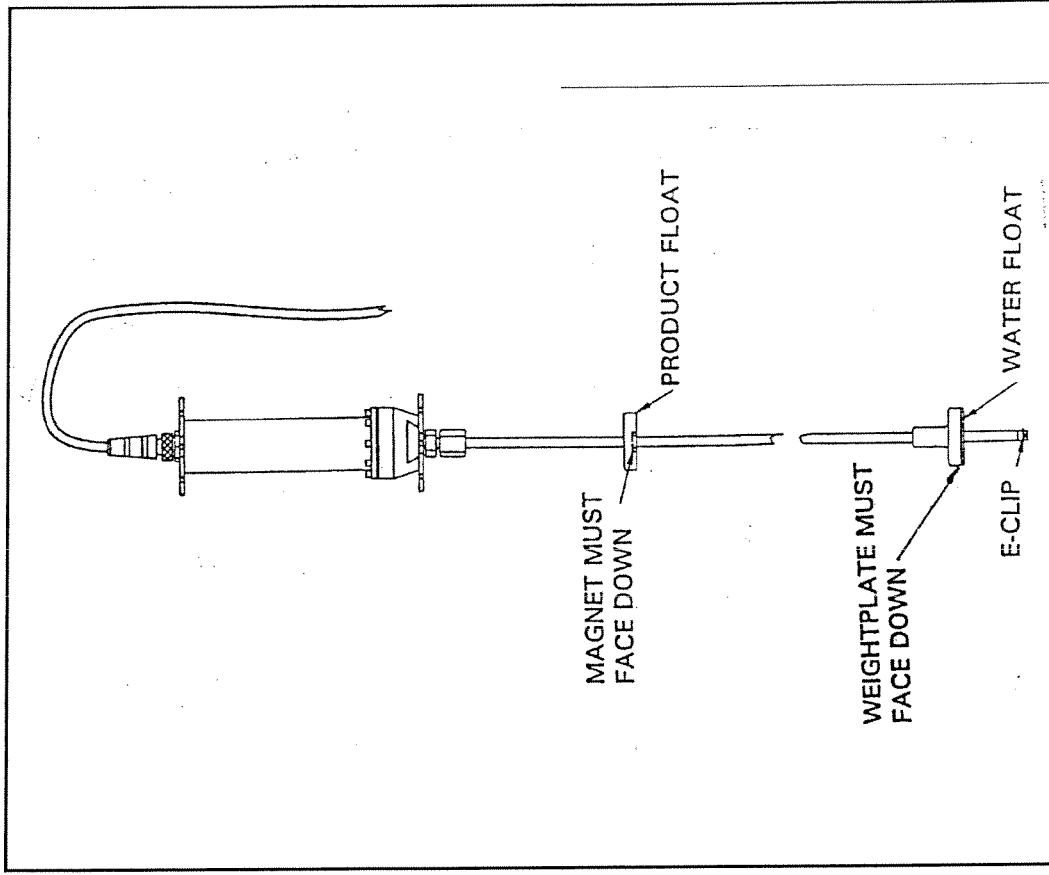


Figure 3 - Model 613 Probe

PV MODEL 613 PROBE SPECIFICATIONS	
Power Requirements	Powered through intrinsically safe barrier in Smart Module only
Operating Temperature	-13°F to 131°F (-25°C to 55°C)
Cable Requirement	Belden #88760 or Alpha #55371 cable (shielded two-wire twisted pair)
Maximum Cable Extension	1000 feet (305 m)
Level Measurement Product:	resolution of 0.0005 inch (0.013 mm)
Water:	resolution of 0.01 inch (0.3 mm); min. measurement: 0.37inch (0.9398 cm,
Temperature:	resolution of 0.001° F (.0005° C)
Classification	Class I, Division 1, Group D hazardous locations

PV MODEL 613 PROBE LENGTHS		
Probe Length	Tank Diameter (or Height)	Location of Temperature Sensors (Measured from Probe End). The probe head also contains a sensor.
53" (135 cm)	48" (122 cm)	7", 12", 20", 28", 36" (18, 30, 51, 71, 91 cm)
69" (175 cm)	64" (163 cm)	10", 16", 27", 37", 48" (25, 41, 69, 94, 122 cm)
77" (196 cm)	72" (183 cm)	11", 18", 30", 42", 54" (28, 46, 76, 107, 137 cm)
89" (226 cm)	84" (213 cm)	13", 22", 36", 49", 63" (33, 56, 91, 124, 160 cm)
101" (257 cm)	96" (244 cm)	15", 25", 41", 55", 71" (38, 64, 104, 140, 180 cm)
105" (267 cm)	100" (254 cm)	16", 26", 42", 58", 74" (41, 66, 106, 147, 188 cm)
113" (287 cm)	108" (274 cm)	17", 28", 46", 62", 80" (43, 71, 117, 157, 203 cm)
125" (317 cm)	120" (305 cm)	19", 31", 51", 69", 89" (48, 79, 130, 175, 226 cm)
149" (378 cm)	144" (366 cm)	24", 38", 61", 83", 106" (61, 97, 155, 211, 269 cm)

3.0 Sensors

3.1 Vapor Sensor

The vapor sensor (Figure 4) can be placed in dry monitoring wells around single-wall tanks, near pipelines, or in the interstitial space of double-wall tanks. The sensor also can be aboveground. Keep the following in mind when considering a vapor sensor:

- Proper installation and sensor placement is CRITICAL.** Installation instructions are in Section 6.
- The sensor detects only certain hydrocarbon vapors. The sensor will NOT work in steam, or in inert or oxygen-deficient atmospheres.
- The sensor will NOT indicate the presence of explosive or combustible mists or sprays, lubrication oils, or explosive dusts such as those from grain or coal.

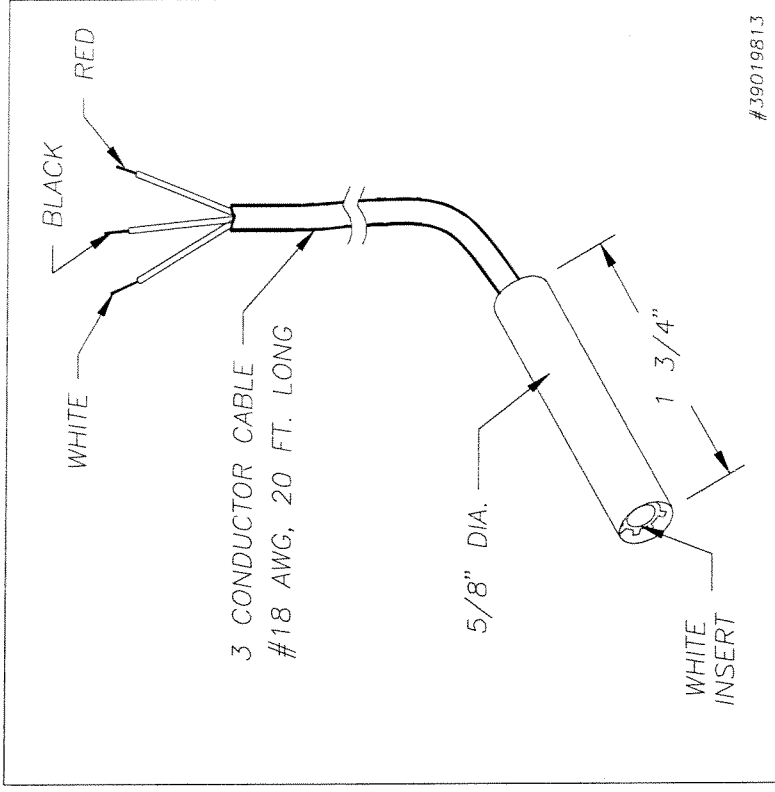


Figure 4 - Vapor Sensor

VAPOR SENSOR SPECIFICATIONS	
Substance Detected	Hydrocarbon vapors
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Storage Temp:	-20°F to 160°F (-28°C to 71°C)
Operating Temp:	-5°F to 122°F (-20°C to 50°C)
Power	12 VDC at 120 mA; case is isolated
Size Length: Width:	1.75" (45 mm) 0.63" (16 mm)
Classification	Class I, Division 1, Group D hazardous locations

3.2 Liquid Sensor

The liquid sensor (Figure 5) is used to detect liquid covering a vapor sensor, or a liquid inside the interstitial space of a double-wall tank, a pipe, or a delivery system. The liquid sensor is *not* destroyed when activated. Installation instructions are in Section 6.

LIQUID SENSOR SPECIFICATIONS	
Substance Detected	Liquid
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Temperature Limits	
Storage:	-20°F to 160°F (-28°C to 71°C)
Operating:	-5°F to 122°F (-20°C to 50°C)
Power	12 VDC at 20 mA
Maximum Fresh Water Submersion	15 feet (4.5 m)
Size	
Length:	1.5" (38 mm)
Width:	0.5" (13 mm)
Classification	Class I, Division 1, Group D hazardous locations

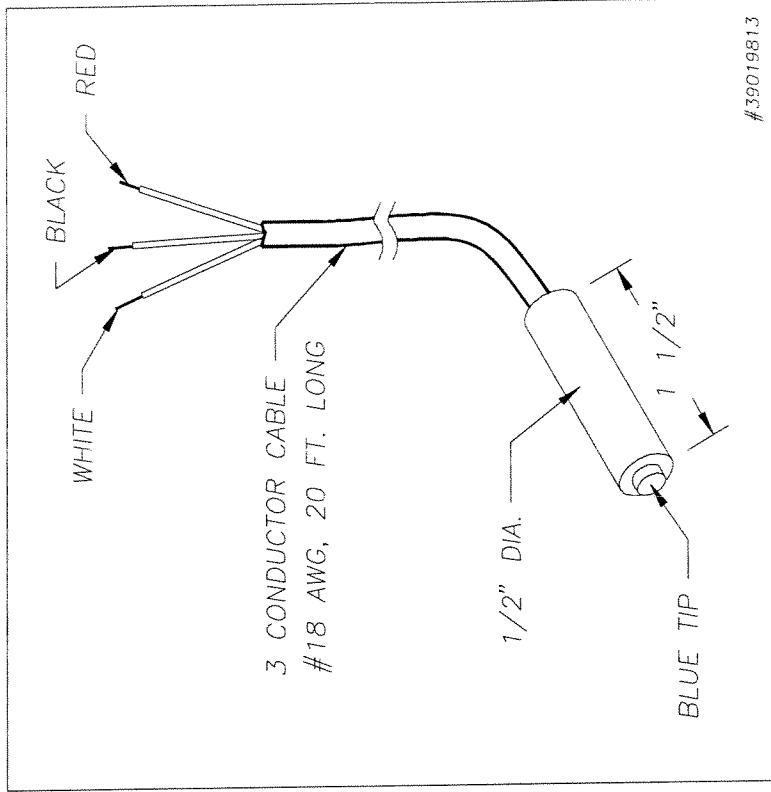


Figure 5 - Liquid Sensor

3.3 Universal Sump Sensor

The universal sump sensor (Figure 6) is used in an attached manway riser or collar riser. The sump sensor detects the presence of any liquid in a piping sump. When enough liquid enters the sump riser, it activates the sump sensor. Installation instructions are in Section 6.

UNIVERSAL SUMP SENSOR SPECIFICATIONS	
Substance Detected	Liquid
Fluid Suitability	Water; Ethylene glycol (up to 50% in water); Propylene glycol (up to 50% in water); Gasoline, kerosene or diesel fuel
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Temperature Limits	
Storage:	-20°F to 160°F (-30°C to 70°C)
Operating:	-5°F to 120°F (-20°C to 50°C)
Power	12 VDC at 1 mA
Size	
Length:	2.5" (64 mm)
Width:	2.5" (64 mm)
Classification	CLASS 1 DIV. 1 GROUP D HAZARDOUS LOCATIONS

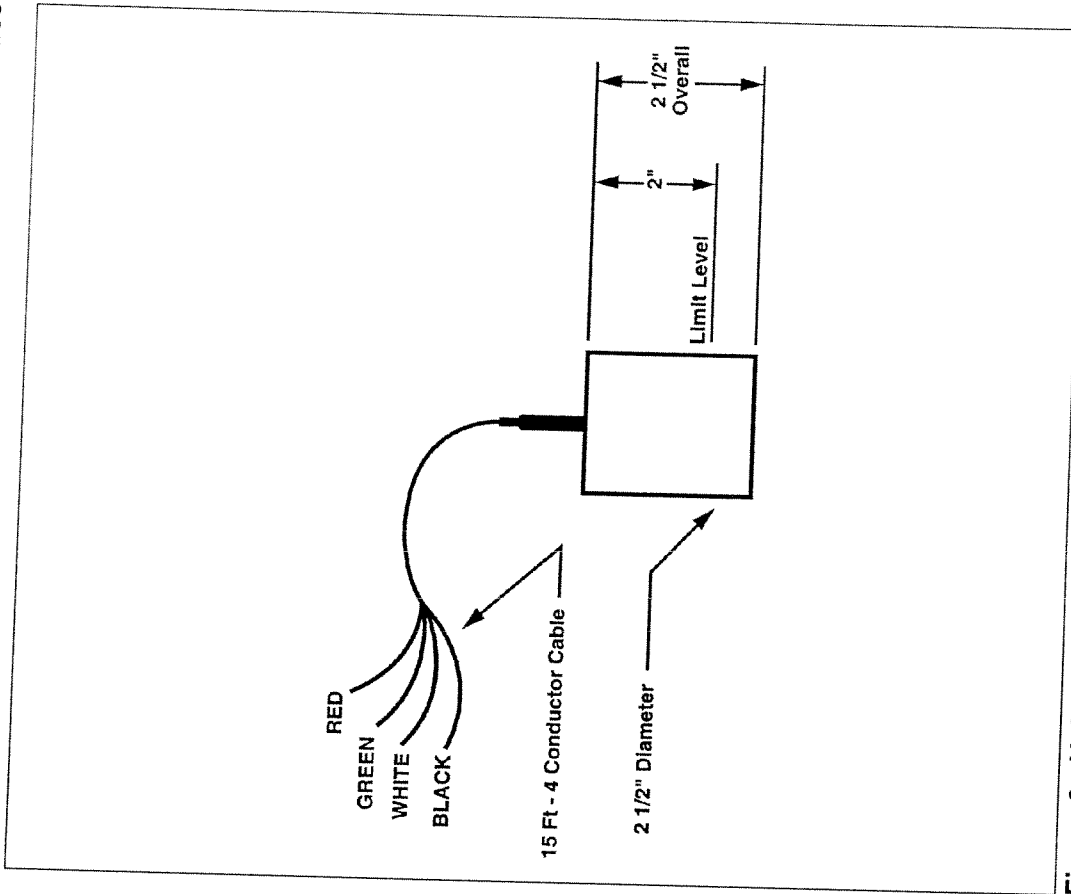


Figure 6 - Universal Sump Sensor

3.4 Universal Reservoir Sensor

The universal reservoir sensor (Figure 7) is used to hydrostatically monitor a double-wall tank. The sensor, placed in a tank reservoir, monitors the level of the liquid in the reservoir.

The sensor has a single float which senses a low or a high liquid level. If a leak occurs in the inner or outer wall of the tank, it causes the liquid in the reservoir to rise or fall. When liquid reaches the upper or lower sensor limit, the sensor is activated. Installation instructions are in Section 6.

UNIVERSAL RESERVOIR SENSOR SPECIFICATIONS	
Substance Detected	Change in Reservoir Fluid Level
Fluid Suitability	Potable water; bacterial Agents; Salt brine (Up to 30% CaCl ₂ in water); Ethylene glycol (up to 50% in water); Propylene glycol (up to 50% in water); Gasoline, kerosene or diesel fuel
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Temperature Limits	
Storage:	-20° F to 160° F (-30° C to 70° C)
Operating:	-4° F to 122° F (-20° C to 50° C)
Power	12 VDC at 1 mA
Size	
Length:	9.9" (250 mm)
Width:	2.5" (64 mm)
Classification	CLASS 1 DIV. 1 GROUP D HAZARDOUS LOCATIONS

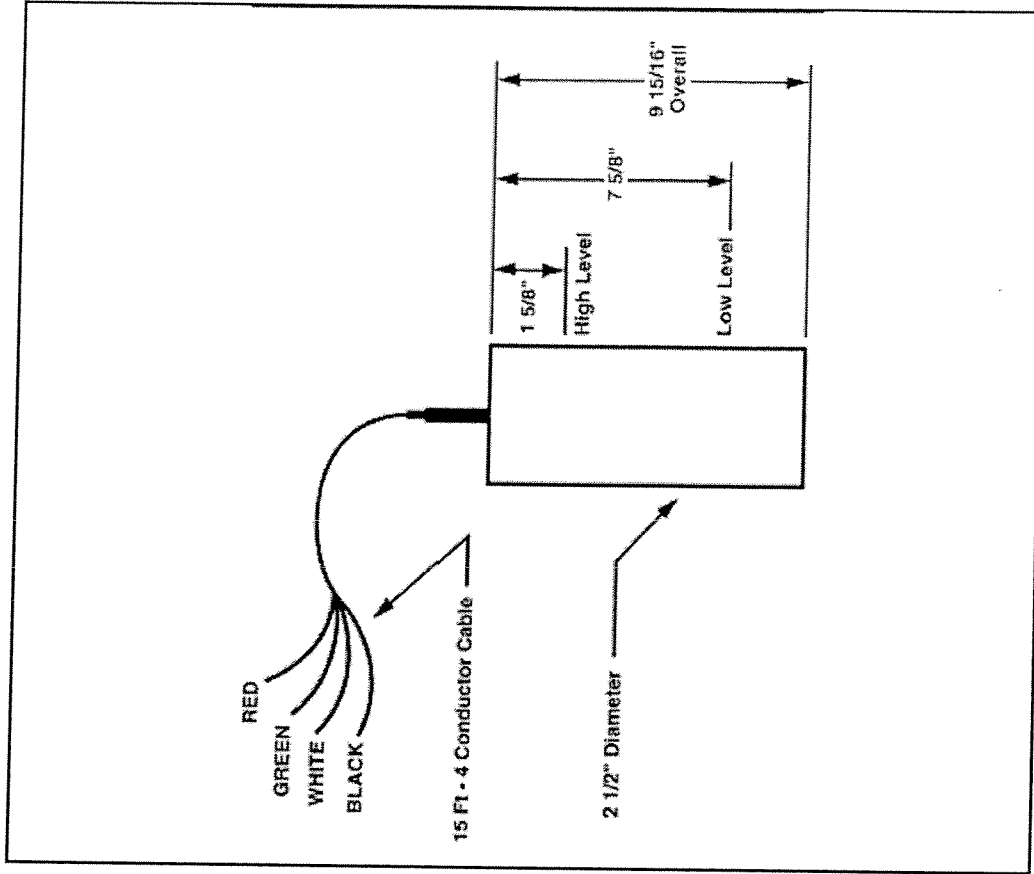


Figure 7 - Universal Reservoir Sensor

3.5 Liquid Phase Sensor

The liquid phase sensor (Figure 8) detects liquid hydrocarbons in wet monitoring wells, in piping (with or without secondary containment), and in above/below grade vaulted tanks.

Liquid phase sensors are available with and without a water-sensing element. When equipped with both hydrocarbon- and water-sensing elements, they go to separate terminals in the Smart Module, allowing the system to show hydrocarbons and water independently. Installation instructions are in Section 6.

LIQUID PHASE SENSOR SPECIFICATIONS	
Substances Detected	Hydrocarbons (other than LPG, heavy crudes, mineral oils and heavier fuel oils), chlorinated hydrocarbons, ethers, organic acids, esters, and higher alcohols
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFEN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Operating Temperature Limits (without water present)	-20° F to 130° F (-30° C to 55° C)
Lengths: Without water element With water element	6, 10 and 15 feet 15 or 20 feet
Power	12 VDC
Classification	CLASS 1 DIV. 1 GROUP D HAZARDOUS LOCATIONS

IMPORTANT

If the sensor comes in contact with a hydrocarbon, see Appendix D in the Ops Guide for instructions on drying the sensor. This is especially important if the contact is with a hydrocarbon product other than gasoline (such as diesel fuel).

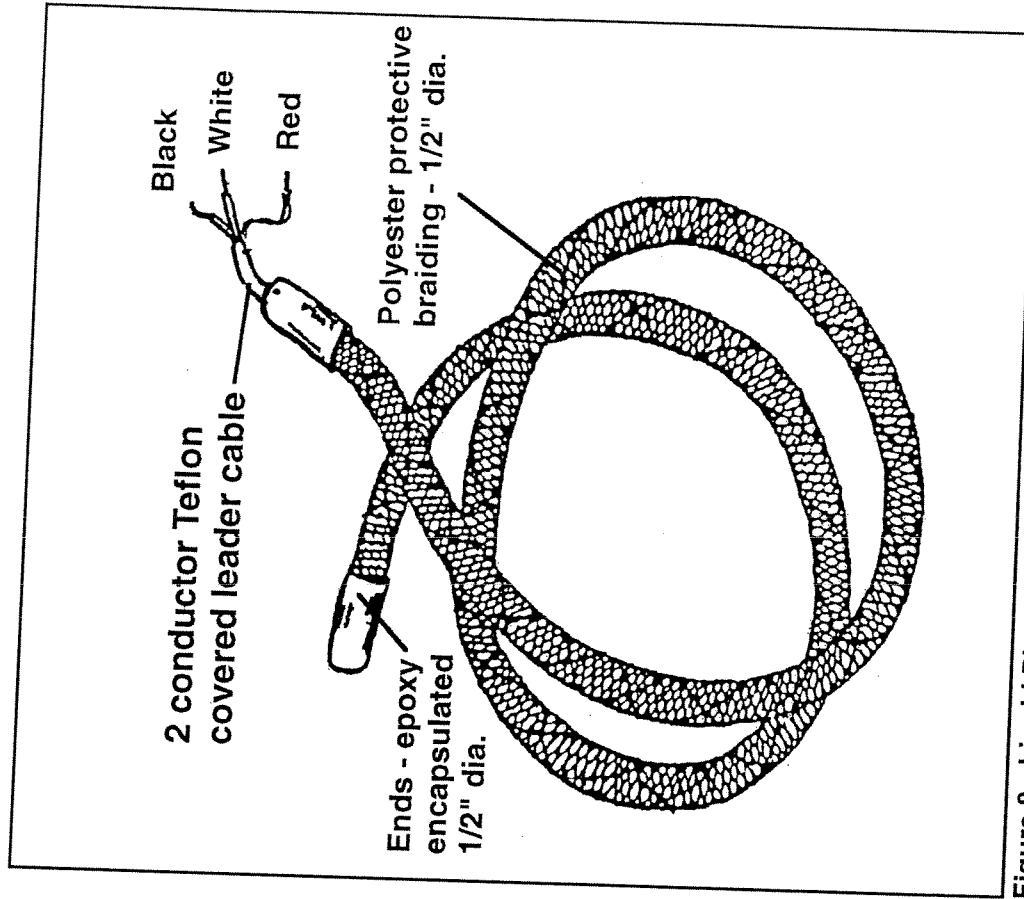


Figure 8 - Liquid Phase Sensor

3.6 Interstitial Sensor

The interstitial sensor (Figure 9) detects liquid hydrocarbons and/or water within any interstitial space of 1/2-inch (13 mm) or more. The two sensing elements are wired to separate terminals in the SiteSentinel Smart Module, enabling the system to indicate the presence of hydrocarbon and water independently. Installation instructions are in Section 6.

INTERSTITIAL SENSOR SPECIFICATIONS	
Substances Detected (Hydrocarbon Sensor)	Hydrocarbons (other than LPG, heavy crudes, mineral oils and heavier fuel oils), chlorinated hydrocarbons, ethers, organic acids, esters, and higher alcohols
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Operating Temperature Limits (without water present)	-20°F to 130°F (-30°C to 55°C)
Power	12 VDC
Size Width: Length:	0.5" (13 mm) 20 feet (6.1 m)
Classification	CLASS 1, DIV. 1 GROUP D HAZARDOUS LOCATIONS

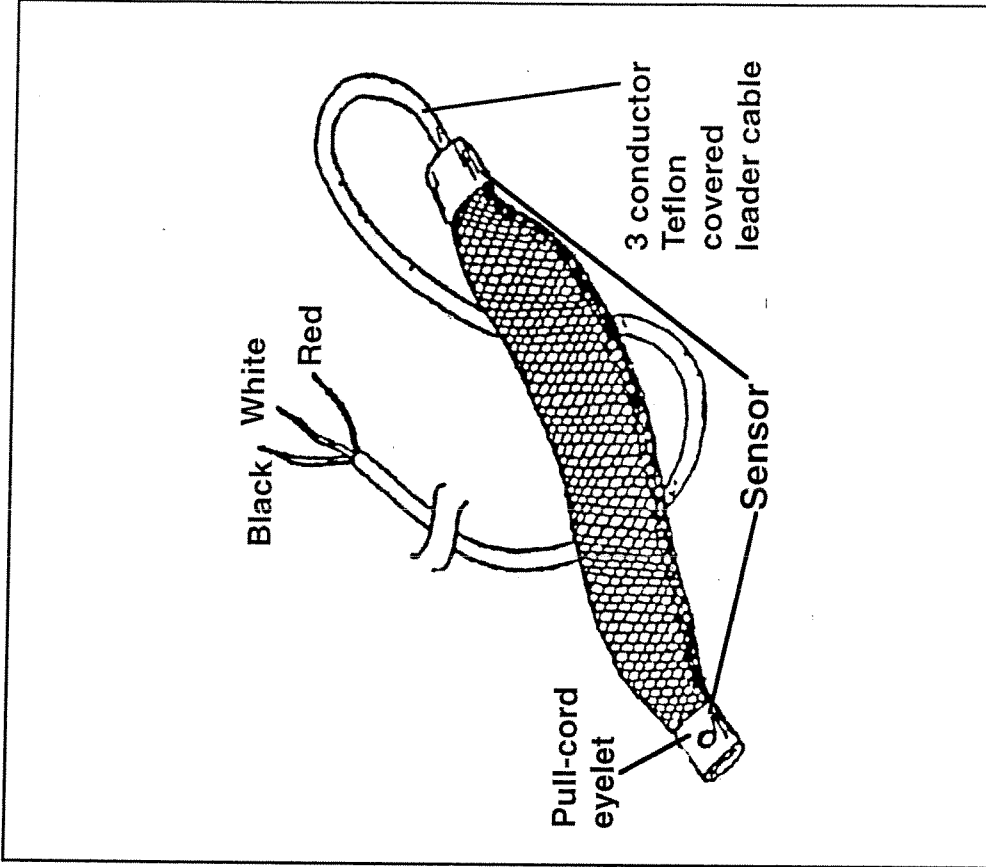


Figure 9 - Interstitial Sensor

IMPORTANT
If the interstitial sensor comes in contact with a hydrocarbon product, refer to Appendix D in the Operator's Guide for instructions on drying the sensor. This is especially important if the contact is with a hydrocarbon product other than gasoline (such as diesel fuel).

3.7 Freon Sensor

The freon sensor (Figure 10) detects refrigerant leaks, possibly preventing asphyxiation due to freon or ammonia displacement of oxygen. The sensor detects freon or ammonia fumes caused by leaks.

Place freon sensors around pipes and vessels containing refrigerants. *Proper installation and sensor placement is CRITICAL!* For areas prone to flooding, a liquid sensor is recommended to prevent the freon sensor from being submerged in liquid. The sealed liquid sensor is protected from particles such as dirt and requires no special orientation or modification. *Installation instructions are in Section 6. There are two models of freon sensors available, one for #12 freon (part # 30-3208) and one for #22 or 134A freon (part # 30-3209).*

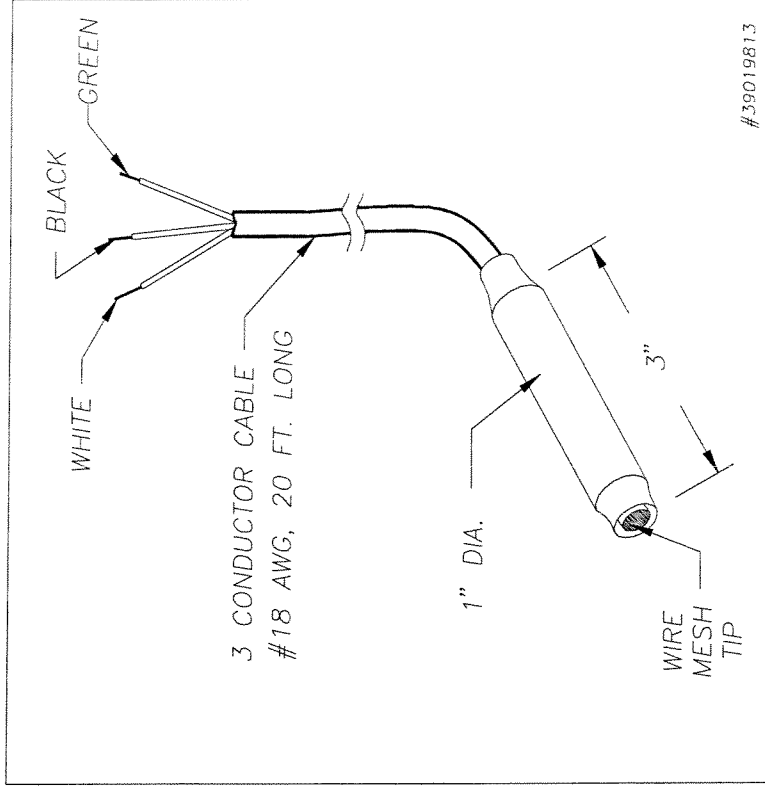


Figure 10 - Freon Sensor

FREON SENSOR SPECIFICATIONS	
Substance Detected	Ammonia or Freon
Maximum Sensitivity Ammonia: Freon:	50 to 150 ppm 100 to 300 ppm
Wiring Requirement	14 to 18 AWG, oil & gas resistant (TFFN, THHN, or THWN)
Maximum Wiring Length	500 feet (152 m) with 18 AWG wire 1000 feet (305 m) with 14 AWG wire
Temperature Limits Storage Operating Temperature Change Effects % Highest Maximum Sensitivity	-40° F to 160° F (-40° C to 70° C) -20° F to 140° F (-30° C to 60° C) ±5% from 15° F to 50° F (-10° C to 10° C) ±30% all other ranges
Power	12 VDC at 120 mA
Size Length: Width:	3" (76 mm) 1" (25 mm)
Classification	CLASS 1 DIV. 1 GROUP D HAZARDOUS LOCATIONS

Notes:

4.0 Tank Preparation

WARNINGS

SiteSentinel probes are safe for Class 1, Div 1, Group D hazardous locations. This includes tanks containing regular, super, diesel and unleaded gasoline; antifreeze; kerosene; mineral spirits; oxinol, methanol and methanol blends; motor, torque and transmission oil; and alcohol.

If you have any questions about whether a product is included in this classification, please contact your product distributor or Petro Vend distributor.

SiteSentinel probes must be installed as described in this section. If the minimum or maximum dimensions specified cannot be met, do not proceed with the installation.

4.1 Probe Placement

The ideal location for a probe is in the **center** of the tank (Figure 11). The probe should be located at least three feet (91 cm) from the tank fill pipe. If this distance is less than three feet, the force of the product entering the tank can cause the water float to rise up the shaft of the probe. This may cause the **SiteSentinel** to generate a false high water alarm. Adjust the drop tube of the fill pipe so that the product flow is diverted *away* from the probe.

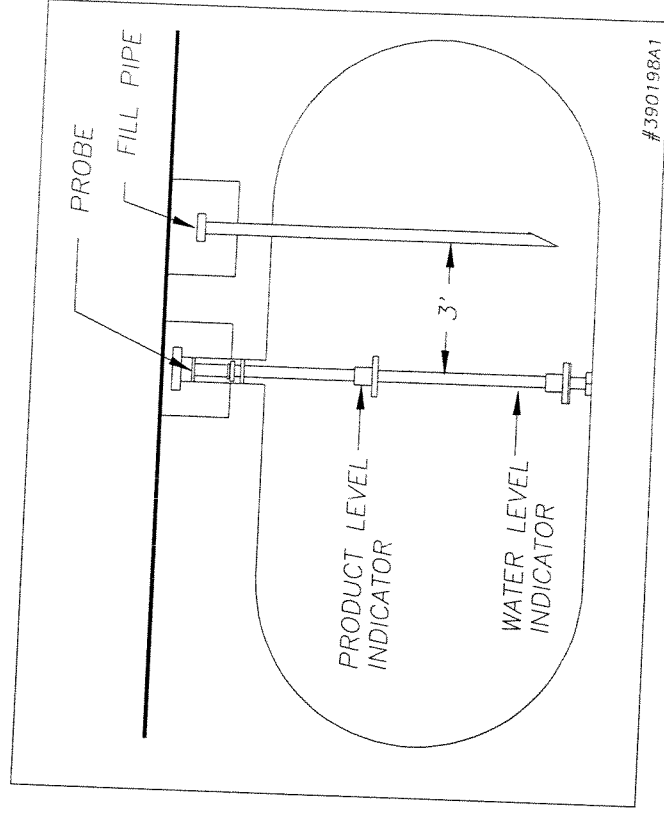


Figure 11 - Probe Placement

4.2 Probe Installation in an Underground Tank

1. Refer to Figure 12. Install a manhole of at least 18" (46 cm) diameter around an unused fitting in the top of the tank. This manhole must be large enough to accommodate a weatherproof junction box.

If this fitting is not in the center of the tank, you must take some additional measurements for probe compensation. Refer to the next page for details.

2. Install a 4" (10 cm) diameter riser pipe in the fitting. This pipe must be 19"- 60" (38 - 152 cm) long, enough to allow the cable from the probe to reach a weatherproof junction box.
3. Install a weatherproof junction box near the riser pipe. The box must be large enough to accommodate ½-inch (13 mm) conduit.
4. Install the ½-inch NPT bushing (supplied with each probe) in the weatherproof junction box.

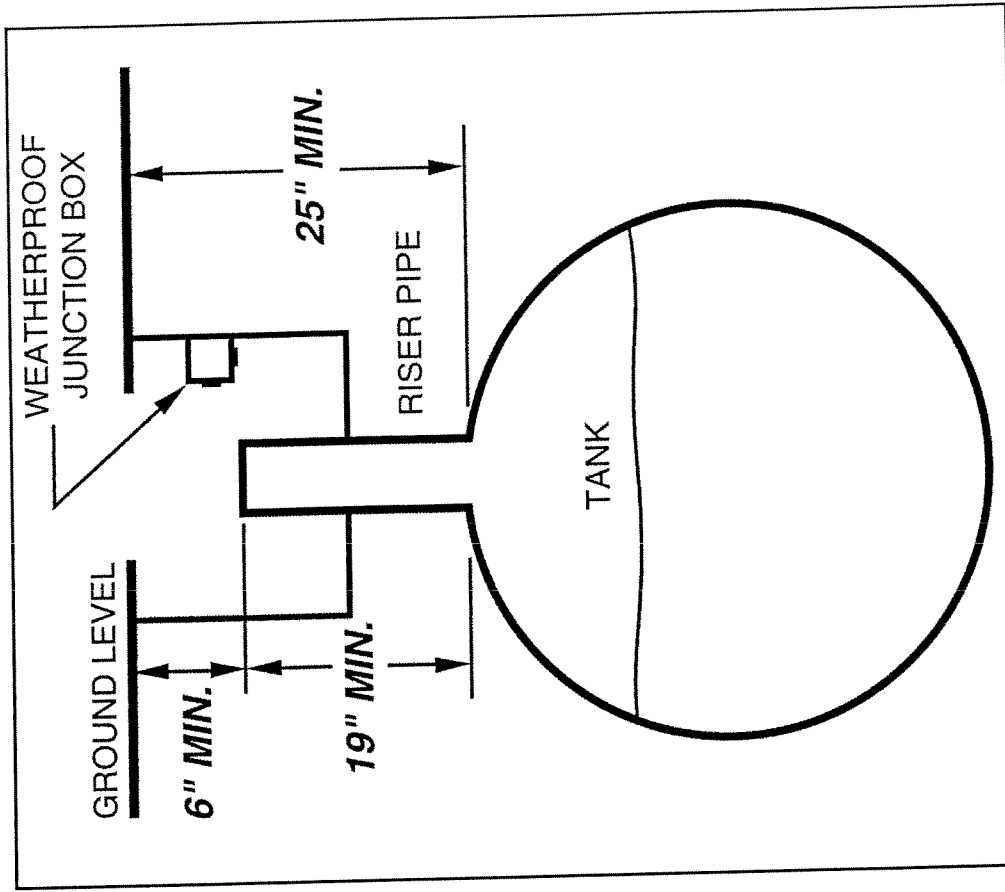


Figure 12 - Underground Tank Preparation

4.3 Calculating Product Offset

You can calculate a product offset for a probe that is *not* installed in the center of a "pitched" tank. Pitch is the tilt of a tank along its horizontal axis. Some tanks are intentionally installed with one end lower than the other. This allows water and sediment to collect at the low end, while clear product is drawn from the high end. Pitch can also be caused by tank settling.

The rate of pitch can be measured by using a dipstick to measure the level of product at two points (preferably opposite ends) of the tank.

See Figure 13. The product depth at the deep (lower) end of the tank is value "A". The product depth at the shallow (higher) end is value "B". The distance between the two measuring points is "C".

The formula for pitch is:

$$\frac{A - B}{C}$$

For example:

$$\frac{46'' - 40''}{120''} = \frac{6''}{120''} = 0.05$$

To calculate the product offset, measure value "D", the distance of the probe from the center of the tank. The formula for product offset is "D" x pitch. For the example above, $36'' \times 0.05 = 1.8''$

If the probe is located closer to the shallow end of the tank, the product offset is positive; for the example, 1.8. If the probe is located closer to the deep end of the tank, the product offset is negative; for the example, -1.8.

Refer to the *Site Sentinel Operator's Guide* for details about entering the product offset.

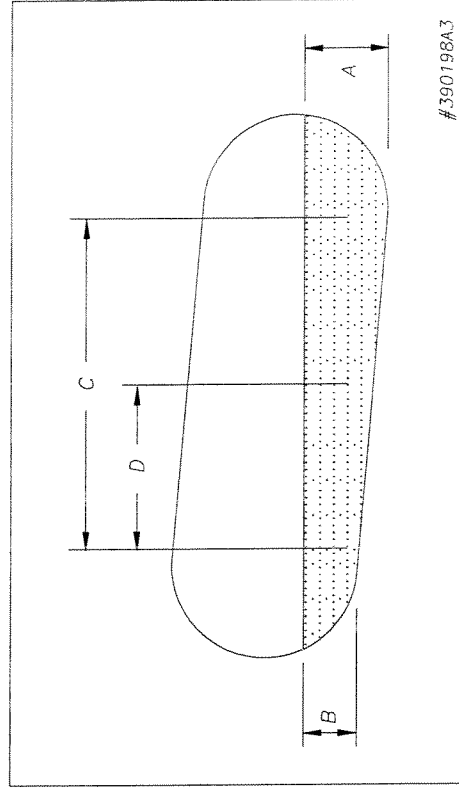


Figure 13 - Calculating Offset in a Tank

Notes:

5.0 Conduit & Cabinet Installation

WARNINGS

Do not mount any system component or external device (other than probes or sensors) within or above the hazardous area. Do not drill holes in ANY SiteSentinel cabinets. Do not connect the controller to equipment that uses or generates more than 250 volts. Probe cables and sensor wiring must not share conduit with any other wiring. *Only* power wiring may share conduit with Petro-Net.

5.1 Controller Installation (Indoors Only)

MODEL II: Mount the Model II controller on a wall in a secure indoor location using the mounting tabs provided. If possible, align the cabinet so that the display is at eye level (approx. 5-6 feet above the floor). Knockout locations are shown in Figure 14.

MODEL III: Place the Model III controller near an electrical outlet, and close to where your system wiring enters the facility. Plug the power pack into the outlet; connect the cable from the power pack to the jack on the back of the controller.

5.2 I/O & Smart Module Installation

Like the controller, the Smart Modules and the I/O Modules must be mounted on a wall in a secure indoor location using the mounting tabs provided. Knockout locations are shown in Figures 15 and 16. *Smart Modules require AC power.*

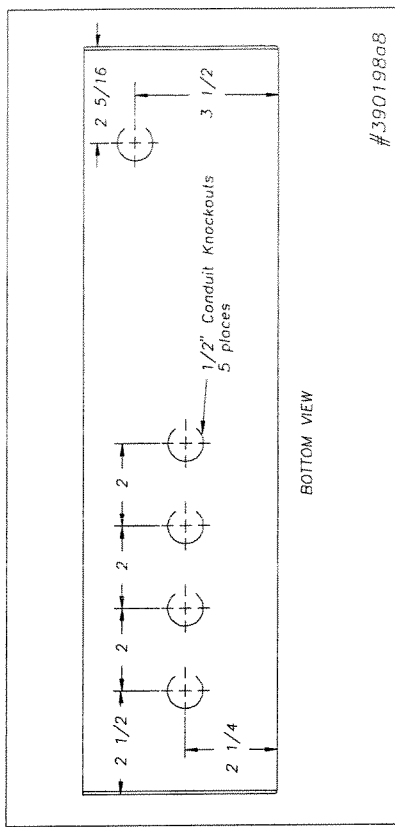


Figure 14 - Model II Controller Knockouts

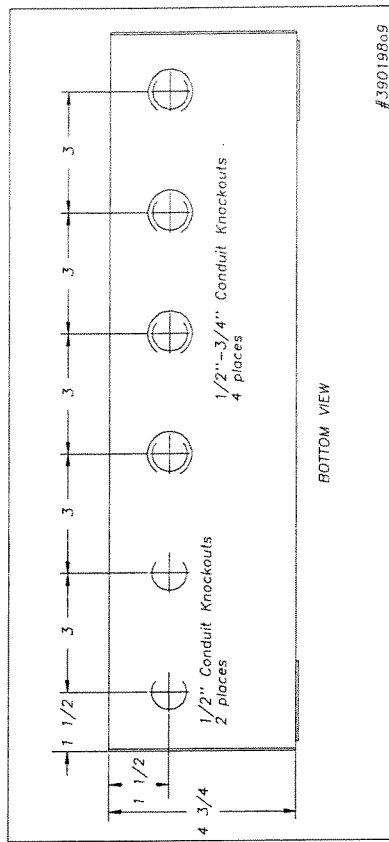


Figure 15 - Model II Smart Module Knockouts

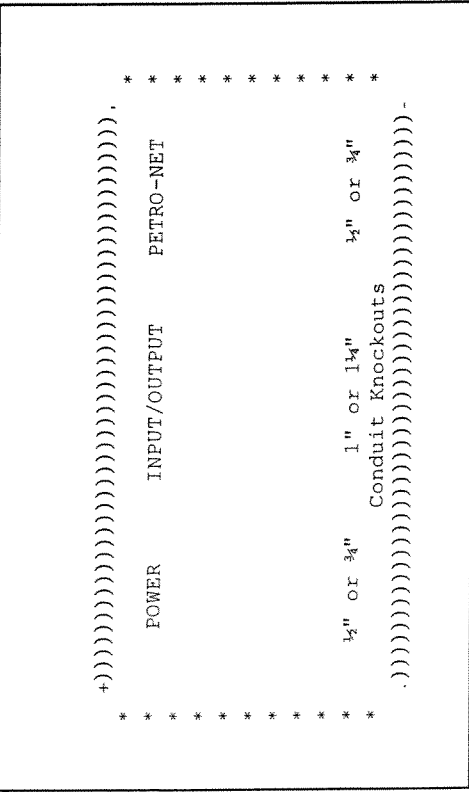


Figure 16 - I/O Module Knockouts

5.4 RS-232 Communication Conduit

Conduit installation is shown in Figure 17. If a terminal or PC located over 6 feet from the controller is to be connected, you must install conduit for the RS-232 cable.

Install a 1/2-inch (13 mm) conduit from a knockout in the controller to a 4"x4" (10 cm x 10 cm) peripheral junction box.

5.5 I/O Device Conduit

Conduit installation is shown in Figure 17. You should use rigid steel conduit for wiring runs to all I/O devices, especially for runs of over 50 feet (15 m).

5.3 Circuit Breaker Conduit

Conduit installation is shown in Figure 17.

Install a 1/2-inch (13 mm) conduit from the power knockout in the controller to the circuit breaker box.

Install a 1/2-inch (13 mm) conduit from the power knockout in each module to the circuit breaker box. *This conduit can also be used for Petro-Net wiring.*

WARNING

To prevent interference, all wiring to and from a Smart Module must be protected by rigid steel conduit. *Probe and sensor wires must be alone in their conduits. DO NOT run with wiring from other manufacturer's probes, sensors or alarms.*

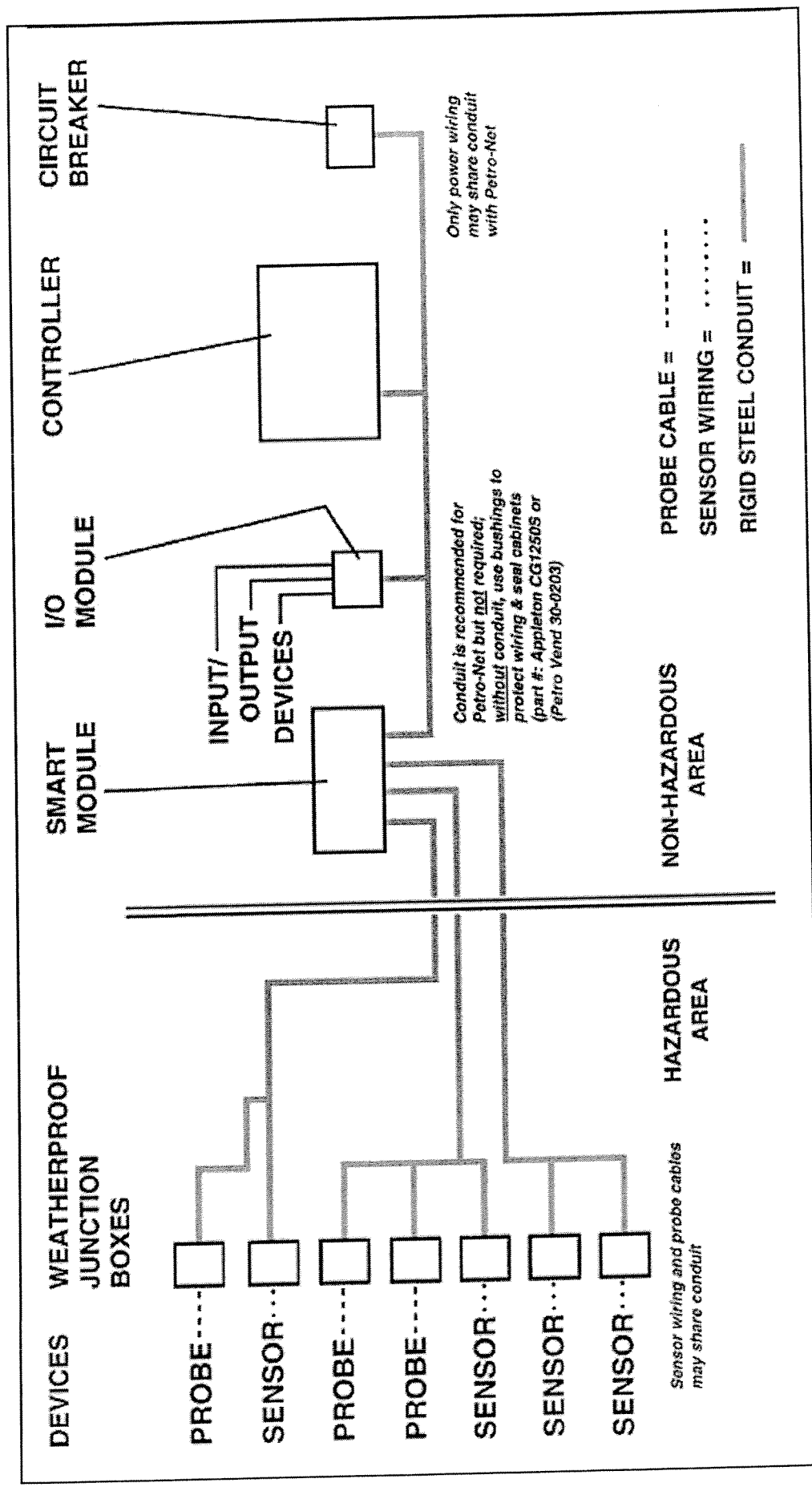


Figure 17 - Conduit Installation

5.6 Probe & Sensor Conduit

Conduit installation is shown in Figure 17. *All probe cables and sensor wiring must be protected by rigid steel conduit.* Each Smart Module has four 1/2-3/4-inch (13-19 mm) knockouts to accommodate the conduit for probe cables and sensor wiring. Additional knockouts are also provided for power and communication wiring conduits.

Use the table below to determine the number and size of the conduits run between each Smart Module and its corresponding probes and sensors.

Group probe and sensor wires into single dedicated conduits for each barrier.

PROBES/SENSORS	NUMBER & SIZE OF CONDUIT
1 to 2	one 1/2-inch
3 to 4	one 3/4-inch
5 to 6	one 1/2- & one 3/4-inch
7 to 8	two 3/4-inch
9 to 12	three 3/4-inch
13 to 16	four 3/4-inch

IMPORTANT

All probes for a manifold tank group must be connected to the same Smart Module.

Petro-Net communication wiring may share conduit with the AC power supply wiring for the Controller and the modules. Power supply wiring for other devices or equipment (such as pumps and lighting) must *not* share conduit with either Petro-Net or the power supply wiring for any **SiteSentinel** components.

5.7 Petro-Net Conduit

Conduit installation is shown in Figure 17. The communication link between the Smart Module(s), the I/O Module(s), and the controller is *Petro-Net*. Petro-Net uses 18 AWG, twisted pair wiring and is immune to most background electrical noise.

Conduit is highly recommended as added protection for the wiring. If conduit is *not* used, you must install a bushing at each cabinet knockout; the bushings seal the cabinets and provide strain relief for the wiring. Order the bushing from **Petro Vend** (part # 30-0203) or from Appleton Corp. (their part # CG1250S).

Petro-Net wiring for the modules can be "daisy-chained" - numerous modules can be tied together, as long as one module in the "chain" is connected to the controller. See Page 51 for a typical arrangement.

6.0 Probe & Sensor Installation

6.1 Probe Installation

6.1.1 ADAPTER COLLAR & RISER CAP

A modified adapter collar and riser cap are required for each probe. These collar and riser cap kits are available from **Petro Vend**; order kit number **030-2000**.

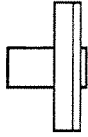
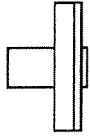

First, install the modified adapter collar onto the riser pipe. Next, screw in the bushing supplied with the probe into the $\frac{3}{8}$ -inch (10 mm) NPT hole in the riser cap. After the probe is lowered into the tank, snap the cap into place.

6.1.2 PROBE FLOATS

There are three types of floats used with the probes: *Product*, *Water for Diesel* and *Water for Gasoline*.

Keep in mind that the two types of water floats are NOT interchangeable.

Because diesel is more dense than gasoline, the water/diesel floats are heavier than the water/gasoline floats. If the wrong water float is installed in a diesel tank, it does not sink through the product to the water below. As a result, the tank will have unusually high water measurements and possibly erratic product measurements as the water float interferes with the product float.

FLOAT TYPE	APPEARANCE	DESCRIPTION
water/diesel		weight plate with 3 holes
water/gasoline		weight plate with 6 holes
product		no weight plate

6.1.3 INSTALLATION PROCEDURE

A stainless steel plug is welded in the end of the probe. An E-ring is attached to the plug to keep the floats from slipping off the probe shaft.

1. Remove the E-ring.
2. With its magnet oriented toward the *end* of the probe, carefully slide the *product* float onto the shaft.
3. With its magnet oriented toward the *head* of the probe, carefully slide the *water* float onto the probe shaft.

If your station has tanks with products of different density (such as diesel and regular fuel), be sure that the water floats are properly matched to the products.

4. Replace the E-ring and slide both floats to the bottom of the probe.
5. A yellow cable is provided with each probe. This cable has a 3-prong connector that attaches to the probe head and three leads to wire at the weatherproof junction box. Feed the yellow cable through the riser cap. Attach the cable connector to the socket in the probe head.
6. Using the cable, carefully lower the probe into the riser pipe until it rests on the bottom of the tank. Be careful not to damage the floats.
7. Tighten the bushing and leave a few inches of slack in the cable.
8. Snap the riser cap in place and secure with a lock.
9. Install the cable bushing with the ½-inch (13 mm) NPT into the weatherproof junction box. Pass the cable through this bushing and tighten.

IMPORTANT

The end of the probe must rest on the bottom of the tank.

6.2 Sensor Installation

6.2.1 INTRODUCTION

The **SiteSentinel** sensors (described in Section 3, beginning on Page 11) must be installed, located and operated according to all applicable codes. These codes include, but are not limited to, the **National Fire Prevention Code** and the **National Electrical Code**.

Due to the variety of surface and soil conditions, placement of monitoring wells should be determined by someone familiar with local conditions and codes. Do a ground water survey for best results.

All sensors are intrinsically safe for use in hazardous locations Class 1, Group D, Division 1 and 2, as defined by the National Electrical Code. Connect to Smart Modules using 14 to 18 AWG twisted pair wiring and rigid steel conduit. *Never* "common wire" sensors together.

The maximum distance between a sensor and the Smart Module is 500 feet (152 m) with 18 AWG wire and 1000 feet (305 m) with 14 AWG wire. *Seal off all wiring for vapor protection!*

Four common scenarios are illustrated and described next:

Single-Wall Tank/Dry Well Monitoring
Single-Wall Tank/Wet Well Monitoring
Double-Wall Tank/NO Well Monitoring
Double-Wall Tank/WITH Well Monitoring

Additional sections explain containment sump monitoring, aboveground tank monitoring, trench/manway monitoring and freon sensor installation. Follow the appropriate sections for your site.

6.2.2 SINGLE-WALL TANK - DRY WELL MONITORING

Figure 18 on page 31 represents a typical dry monitoring well layout for a single-wall tank. The sensors are placed around the perimeter of the tanks. Monitoring wells are dug as close as possible to the tanks or product lines for optimum sensor response.

Figure 18 also shows a typical monitoring well cross-section. The manhole should be watertight, and the monitoring well should be at least two feet deeper than the bottom of the tanks to be monitored. Use either two-inch or four-inch well casing.

To obtain an adequate sample area, the *perforated* section should be a large part of the well casing's length. Place a cap on the bottom of the well casing to prevent dirt entry. Backfill dirt around the casing.

The vapor sensor monitors hydrocarbon vapors. A *liquid* sensor should also be installed, and placed lower than the vapor sensor to detect any liquid buildup.

Though vapor sensors are *not* damaged by submersion in liquid, it will not function properly until removed from the liquid and given sufficient time to dry. The sealed liquid sensor is protected from particles such as dirt. It requires no special placement. Any combination of vapor and liquid sensors may be used.

WARNING

Do not "common" wire any of the sensors as damage to the Smart Module will result.

Failure to cover monitoring wells may result in personal injury and/or monitoring well contamination.

PROCEDURE

1. Drill the bore hole *away* from any surface spill area to prevent spilled products from flowing into the hole.
2. Line the bore holes with perforated casing to prevent collapse.
3. Fill the area between the bore hole walls and the casing with the proper backfill material to permit gas and water diffusion.
4. Connect the sensor directly to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN (oil and gas resistant) cabling which, after running thru vapor sealoffs, goes into the Smart Module.
 - If the total distance (from sensor to controller) is 500 feet (152 m) or less, use **18 AWG** wire for the wiring.
 - If the total distance is 500 to 1000 feet (152 m to 305 m), you use 14 AWG wire.

Follow all applicable codes! Use appropriate splicing materials and tools when splicing and wiring the sensor.

5. Determine the depth of each sensor installation and mark that length on the sensor wiring.
6. Check the sensor ID tag (on the metal portion of the sensor) for the sensor type (see Page 11). Mark the end of the wiring to identify the sensor type.

7. Lower the sensors into the well, to the mark on the wiring. *The liquid sensor should not touch the bottom of the well.* The vapor sensor should be about halfway down the well.
8. Thread a cap on the top of the well casing to prevent water and other contaminants from entering the monitoring well.
9. Run separate wiring from each sensor to the Smart Module. Note that probe cables and sensor wiring can share the same conduit.

Keep track of sensor wiring to ensure proper wiring at the Smart Module.

NOTE: *The site diagram shows a Model II controller. Layout is identical for a Model III controller.*

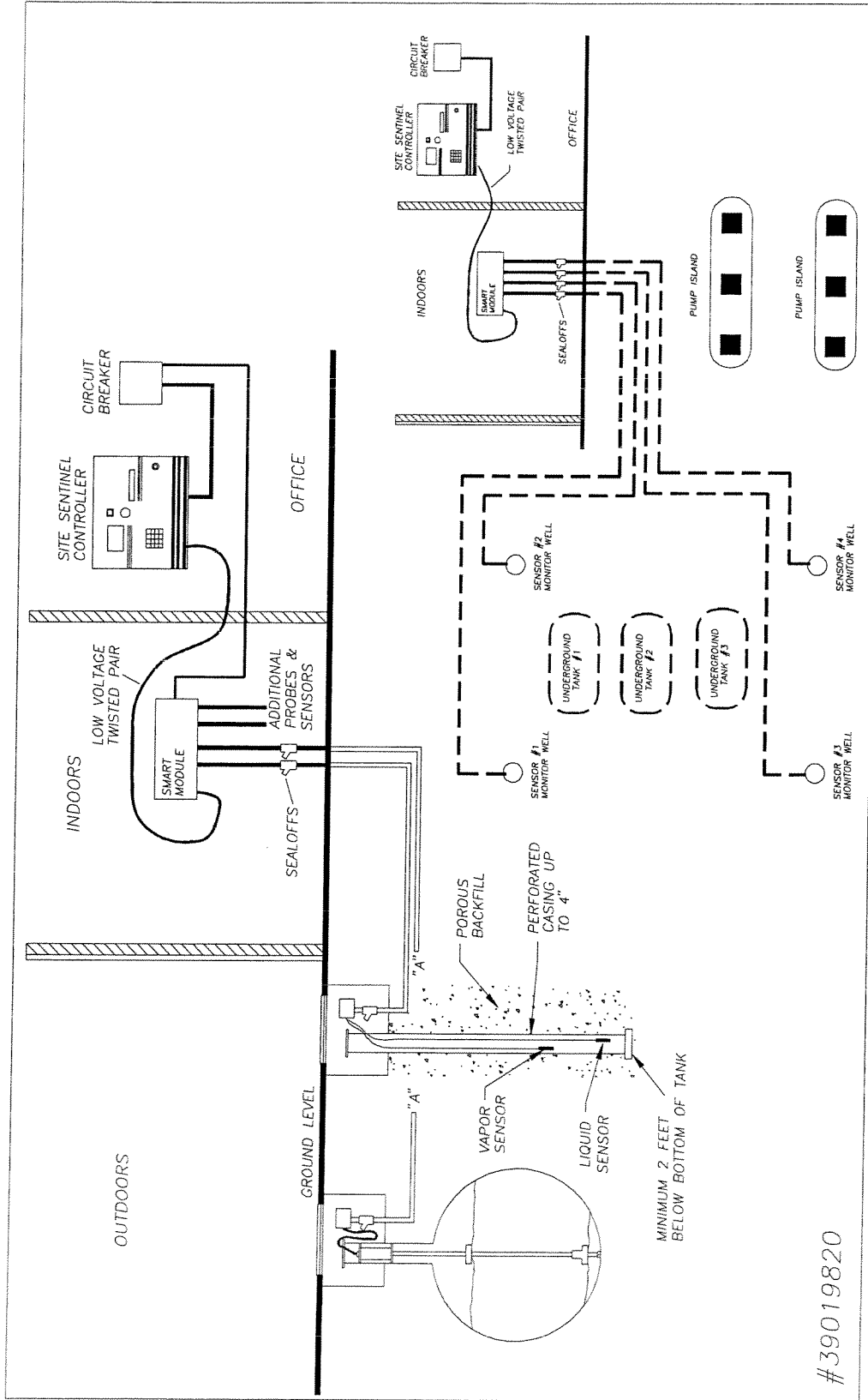


Figure 18 - Single Wall Tank/ Dry Well Monitoring (Model II Controller shown, same overall layout with Model III Controller)

6.2.3 SINGLE-WALL TANK - WET WELL MONITORING

Figure 19 shows a typical wet monitoring well layout for a single-wall tank. The sensors are placed around the perimeter of the tanks. The monitoring wells are dug as close as possible to the tanks or product lines for best sensor response.

Figure 19 also shows a typical monitoring well cross-section. Instructions are the same as that for the dry well monitoring - see Page 29.

WARNINGS

Do not "common" wire any of the sensors as damage to the Smart Module will result.

Failure to cover monitoring wells may result in personal injury and/or monitoring well contamination.

PROCEDURE

1. Drill the bore hole away from any surface spill area to prevent spilled products from flowing into the hole.
2. Line the bore holes with a perforated casing to prevent collapse.
3. Fill the area between the borehole walls and the casing with backfill material to permit gas and water diffusion.
4. Connect the sensor directly to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN (oil and gas resistant) cabling which, after running thru vapor sealoffs, goes into the Smart Module.

- If the total distance (from sensor to controller) is 500 feet (152 m) or less, use **18 AWG** wire for the wiring.

- If the total distance is 500 to 1000 feet (152 m to 305 m), you use **14 AWG** wire.

Follow all applicable codes! Use appropriate splicing materials and tools when splicing and wiring the sensor.

5. Determine the depth of each sensor and mark that length on the sensor wiring. To make sure the sensor will rest on the bottom of the well, measure the well from the bottom to the top and add six inches. Then, use the combined measurement to determine the total length, within the well, of the sensor and wiring to be used.
6. Lower the sensors in the well to the mark on the wiring.
7. A liquid-tight straight-fitting is supplied with each sensor. This fitting lets you pass the leader wiring through most caps and still maintain a liquid-tight passage. The clearance hole for non-threaded mounting is $\frac{5}{8}$ -inch (16 mm) diameter. Insert the leader wiring through the well cap, using the supplied fitting.
8. Run separate wiring from each sensor to the Smart Module. Note that probe cables and sensor wiring *can* share the same conduit.

Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

NOTE: *The site diagram shows a Model II controller. Layout is identical for a Model III controller.*

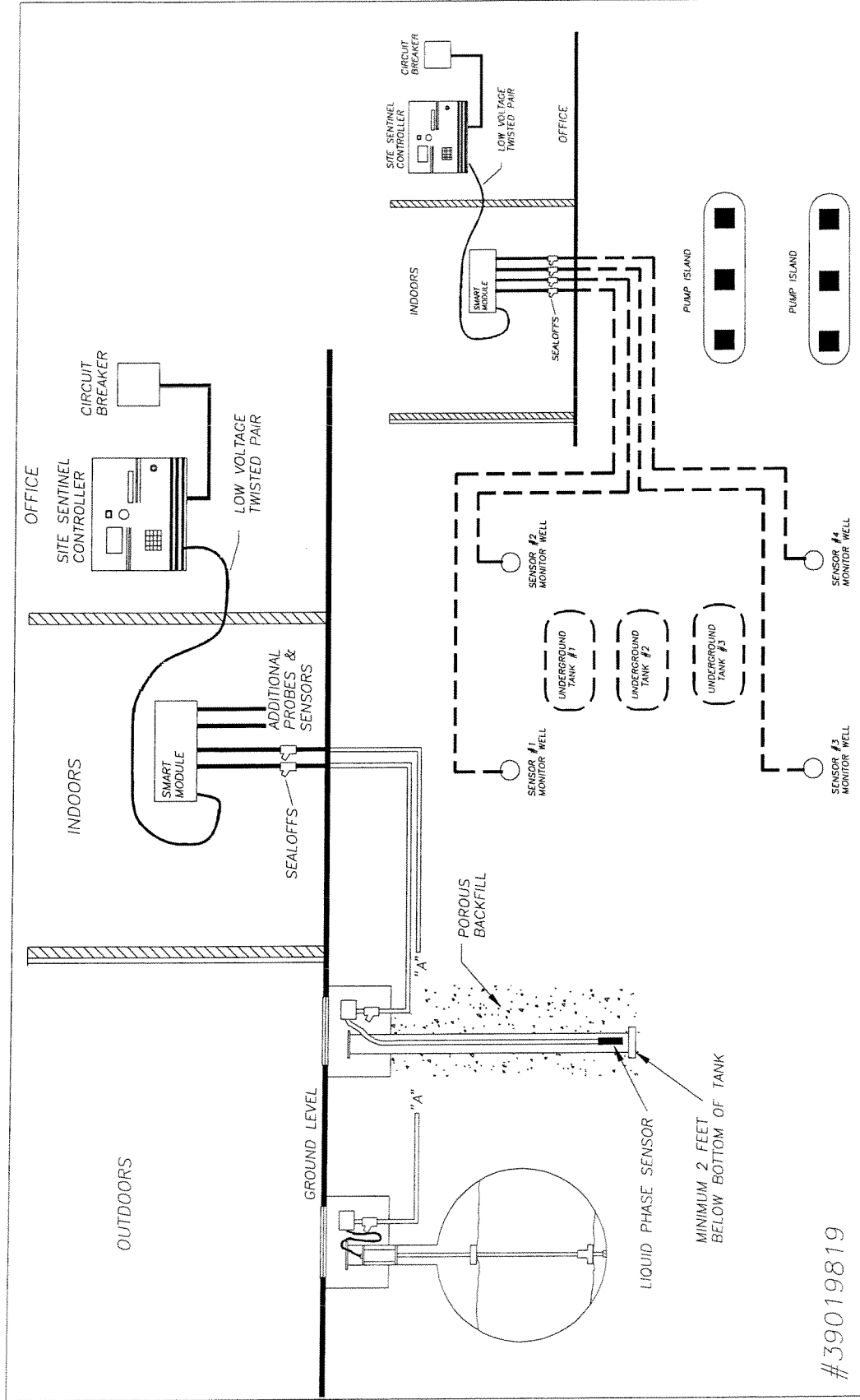


Figure 19 - Single-Wall Tank/Wet Well Monitoring (Model II Controller shown. Layout is identical with a Model III Controller)

6.2.4 DOUBLE-WALL TANK - NO WELL MONITORING

The space between the walls of a double-wall tank is the *interstitial* space, and it is an ideal location for vapor and liquid sensors.

If the *outside* tank wall develops a leak, water enters the interstitial space, and the liquid sensor indicates an alarm. If the *inside* wall develops a leak, the tank contents enter the interstitial space and both sensors indicate an alarm condition.

Figure 20 on the following page shows a typical sensor layout for a double-wall tank.

WARNING

Do not "common" wire any of the sensors as damage to the Smart Module will result.

2. Mark the end of the wiring to identify the sensor type.
3. Lower the liquid sensor into the interstitial space of the tank until it is near the bottom of the tank.
4. Lower the vapor sensor into the interstitial space of the tank, and place it mid-way around the circumference of the tank.
5. Ensure that no water or other contaminants enter the space between the walls of the tank, since this may cause one of the sensors to trigger an alarm.
6. Run separate wires from each sensor to the Smart Module. Note that probe cables and sensor wiring can share the same conduit. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

NOTE: *The site diagram shows a Model II controller. Layout is identical for a Model III controller.*

PROCEDURE

1. Splice the sensor wires to TFFN, THHN or THWN (oil and gas resistant) wires. These wires pass thru vapor seal-offs, and enter the Smart Module.
 - If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
 - If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor.

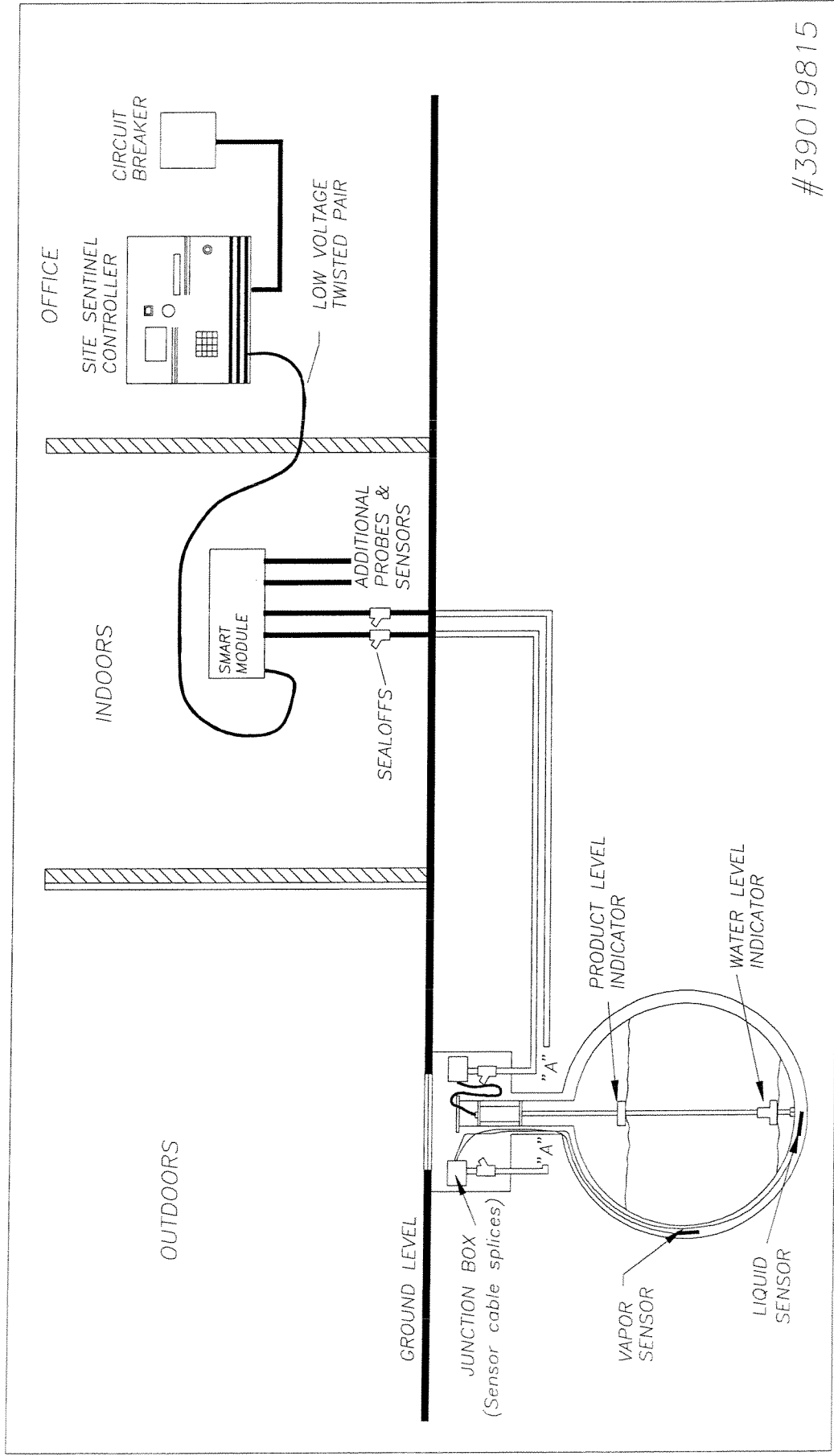


Figure 20 - Double-Wall Tank with NO Well Monitoring (Model II Controller shown. Layout is identical with a Model III Controller)

6.2.5 DOUBLE-WALL TANK - WITH WELL MONITORING

A monitoring well is used with a double-wall tank only if the local water table reaches tank level. Because of the danger of water table contamination, install the well with a liquid phase sensor (Page 15).

Figure 21 is a typical wet monitor well layout for a double-wall tank. Place sensors around the tank's perimeter. Locate wells as close as possible to the tanks or product lines for best sensor response. A monitoring well cross-section is also shown. Manholes are water-tight.

The monitoring well should be at least two feet deeper than the bottom of the monitored tanks. Use two- or four-inch well casing; the perforated section should be a large portion of the casing length. The bottom of the casing should have a cap to prevent dirt from entering it, and porous material should be back-filled around the casing.

WARNING

Do not "common" wire any of the sensors as damage to the Smart Module will result.

PROCEDURE

1. Drill the bore hole away from any surface spill area to prevent spilled products from flowing into the hole.
2. Line the bore holes with perforated casing to prevent collapse. Fill area between the bore hole walls and casing with the proper backfill material to permit gas and water diffusion.
4. Connect the sensor to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN wires. These wires, in turn, pass thru

vapor seal-offs, and enter the Smart Module.

- If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
- If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor.

5. Measure the depth of each sensor installation. Mark that length on the sensor wiring. The sensor should rest on the well bottom, so measure the well from the bottom to the top and add six inches. Use the combined measurement to determine the total length, within the well, of the sensor and wiring to be used.
6. Lower the sensors in the well to the mark on the wiring.
7. A liquid-tight straight-fitting is supplied with each sensor. This fitting enables you to pass the leader wiring through most caps and still maintain a liquid-tight passage. The clearance hole for non-threaded mounting is $\frac{5}{8}$ -inch (16 mm) diameter. Insert the leader wiring through the well cap, using the supplied fitting. **COVER THE WELLS!** Failure to cover monitoring wells may result in personal injury and/or monitoring well contamination.
8. Run a separate wiring from each sensor to the Smart Module (or the Smart Module junction box). Note that probe cables and sensor wiring can share the same conduit. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

NOTE: The site diagram shows a Model II controller. Layout is identical for a Model III controller.

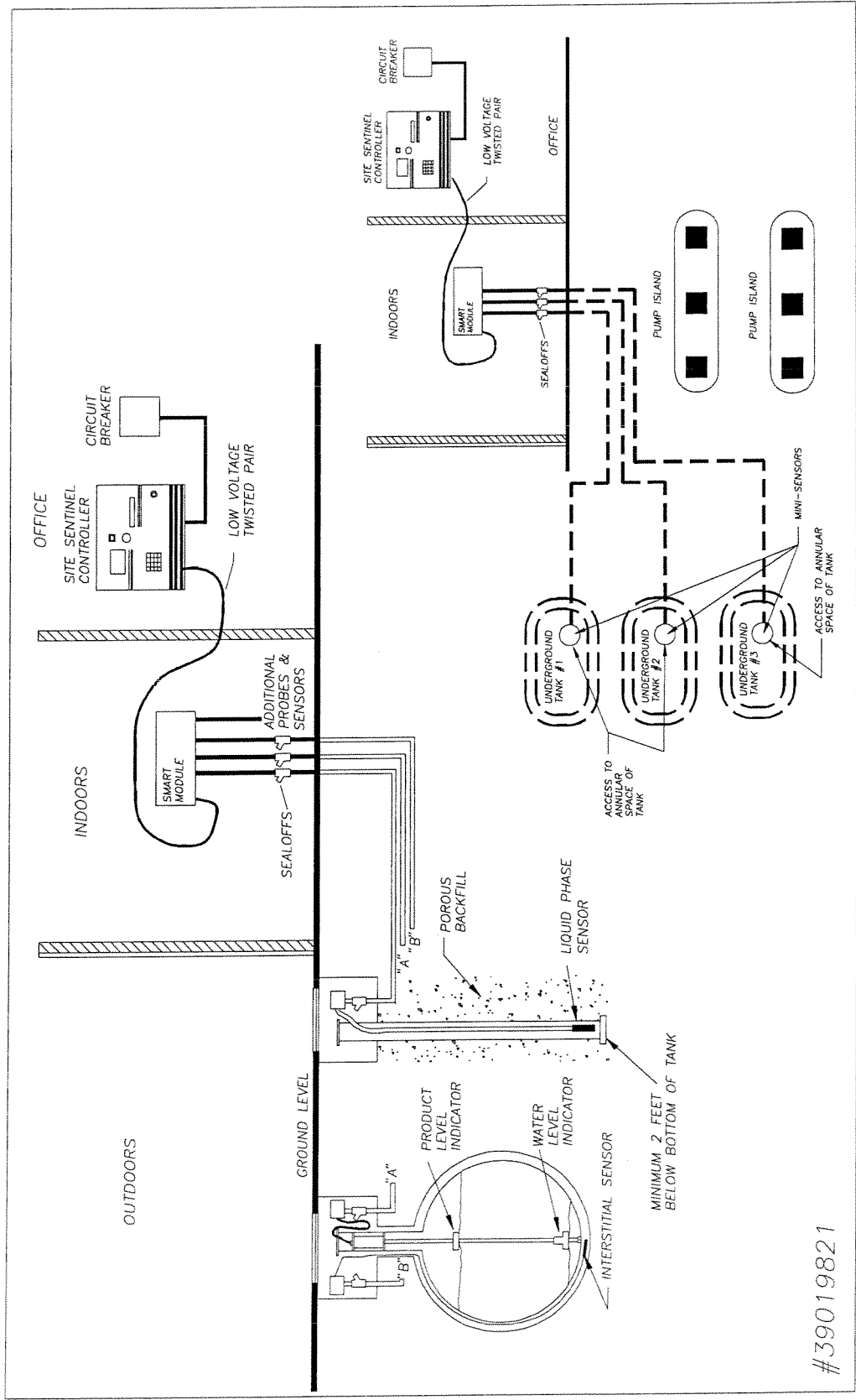


Figure 21 - Double-Wall Tank WITH Well Monitoring (Model II Controller shown. Layout is identical with a Model III Controller)

6.2.6 RESERVOIR SENSOR INSTALLATION

Use a universal reservoir sensor (described on Page 14) with hydrostatically monitored tanks. The reservoir sensor monitors the level of the liquid in the reservoir of a double-wall tank. An installation example appears in Figure 22.

The sensor has a single float which senses a low or a high liquid level within the reservoir. If a leak occurs in either wall of a tank, it causes the liquid in the reservoir to rise or fall. When liquid reaches the upper or lower limit on the sensor, the sensor activates.

PROCEDURE

1. The depth of liquid in the reservoir should be between 4½ inches (114 mm) and 5½ inches (140 mm).
2. Drill a hole in the standpipe large enough for the PVC bushing. Using an appropriate adhesive, insert the bushing into the hole. Allow to dry.

3. Wrap the end of the strain relief bushing with thread sealing tape, and thread into the PVC bushing.

4. Feed the sensor lead wiring through the clamp bushing from the inside of the pipe. *Do not tighten the clamp onto the wiring.*

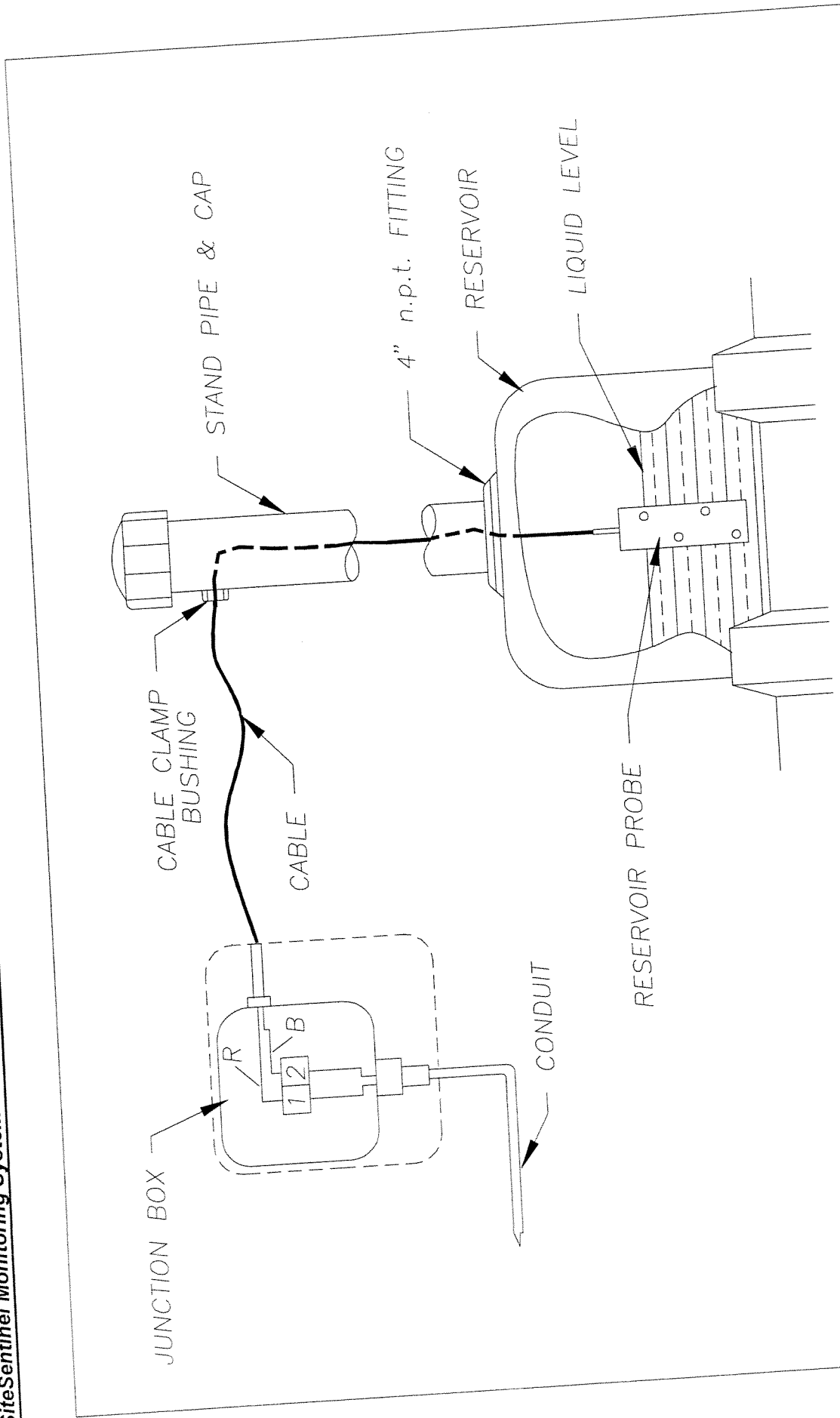
5. Lower the sensor into the reservoir until the sensor rests on the bottom of the reservoir. Take up the slack in the lead wiring by pulling the wiring out through the clamp bushing until all of the slack is removed.

6. Tighten the clamp bushing onto the wiring. Route the lead wiring into the junction box and secure the wiring.

7. Connect the sensor to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN wires. These wires, in turn, pass thru vapor seal-offs, and enter the Smart Module.
 - If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
 - If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor. Identify sensor wires to ensure proper wiring at the Smart Module. Follow all applicable codes.

8. Run a separate wiring from each sensor to the Smart Module. Note that probe cables and sensor wiring can share the same conduit.



#39019814

Figure 22 - Reservoir Sensor Installation

6.2.7 SUMP SENSOR INSTALLATION

The universal sump sensor (described on Page 13) is used in an attached manway riser, double-wall piping, or an attached collar riser. A sump sensor detects the presence of any liquid in a piping sump. When enough liquid enters the sump riser, it activates the sump sensor.

PROCEDURE

1. Place the universal sump sensor into the sump.
2. Route the lead wiring into the junction box.
3. Adjust the length of the wiring until the sensor is suspended on the sump floor (this dimension can be changed at your discretion). Secure the wiring into the box.
4. Connect the sensor to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN wires. These wires, in turn, pass thru vapor seal-offs, and enter the Smart Module.
 - If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
 - If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor. Identify sensor wires to ensure proper wiring at the Smart Module. Follow all applicable codes.

5. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module. *Follow all applicable codes.*
6. Run separate wiring from each sensor to the Smart Module.

Note that probe cables and sensor wiring can share the same conduit. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

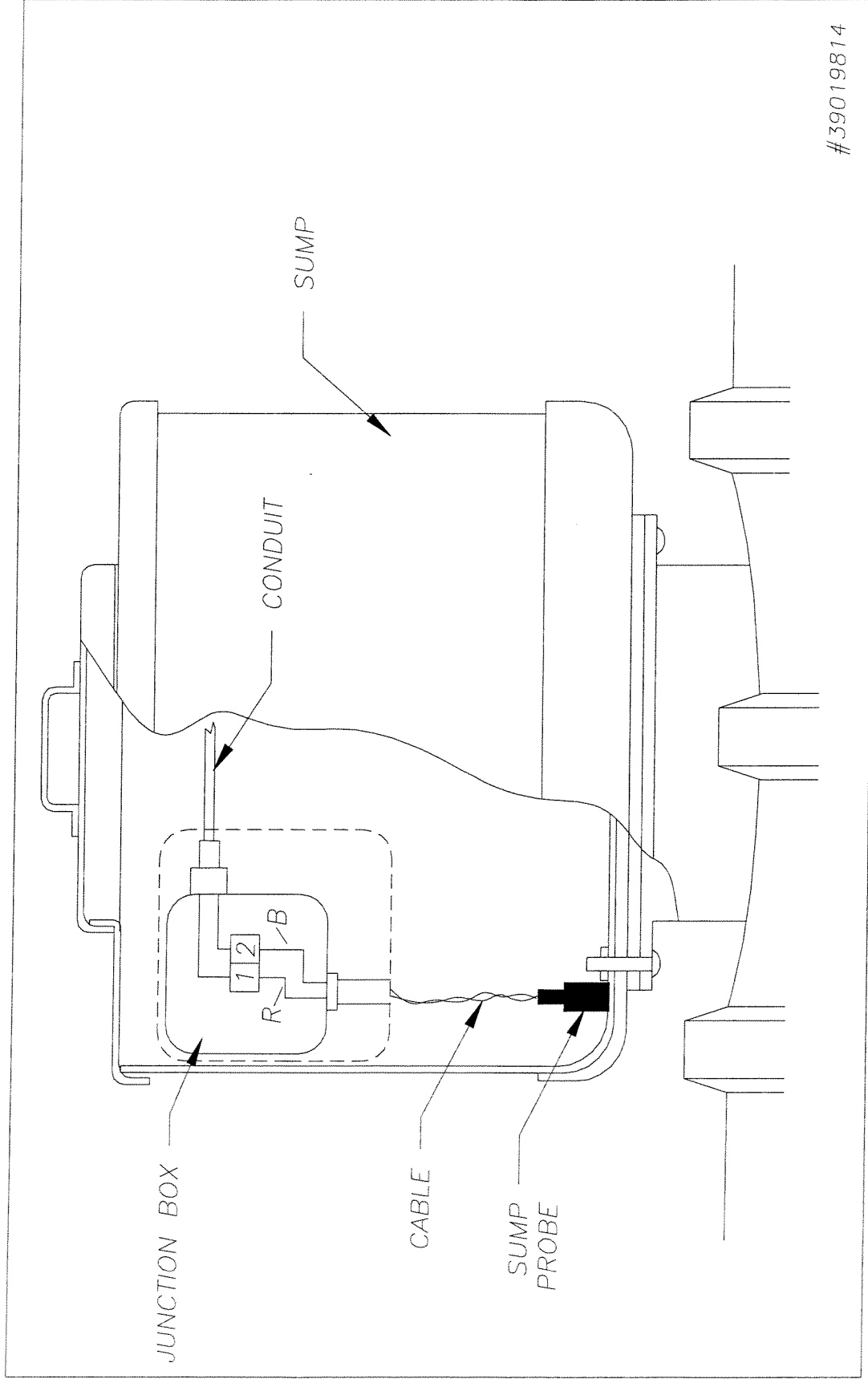


Figure 23 - Sump Sensor Installation

6.2.8 INTERSTITIAL SENSOR INSTALLATION

As shown in Figures 24 and 25, an interstitial sensor (described on Page 16) can be installed around the inside perimeter of the retaining wall or "snaked" under the length of an aboveground tank within the retaining wall area.

Figure 25 shows the interstitial sensor installed in a manway. The sensor can also be installed in trenches and inside of a sump.

PROCEDURE

1. Place the interstitial sensor in its intended location.

When installing the sensor in a sump, place the sensor at the bottom of the sump.

2. Connect the sensor to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN wires. These wires, in turn, pass thru vapor seal-offs, and enter the Smart Module.

- If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
- If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor. Identify sensor wires to ensure proper wiring at the Smart Module. Follow all applicable codes.

3. Keep track of sensor wiring identity to ensure proper wiring at the

Smart Module. A below grade wiring work box can be used as a junction box for the splice when wiring underground. Follow all applicable codes.

4. Run separate wiring from each sensor to the Smart Module.

Note that probe cables and sensor wiring can share the same conduit. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

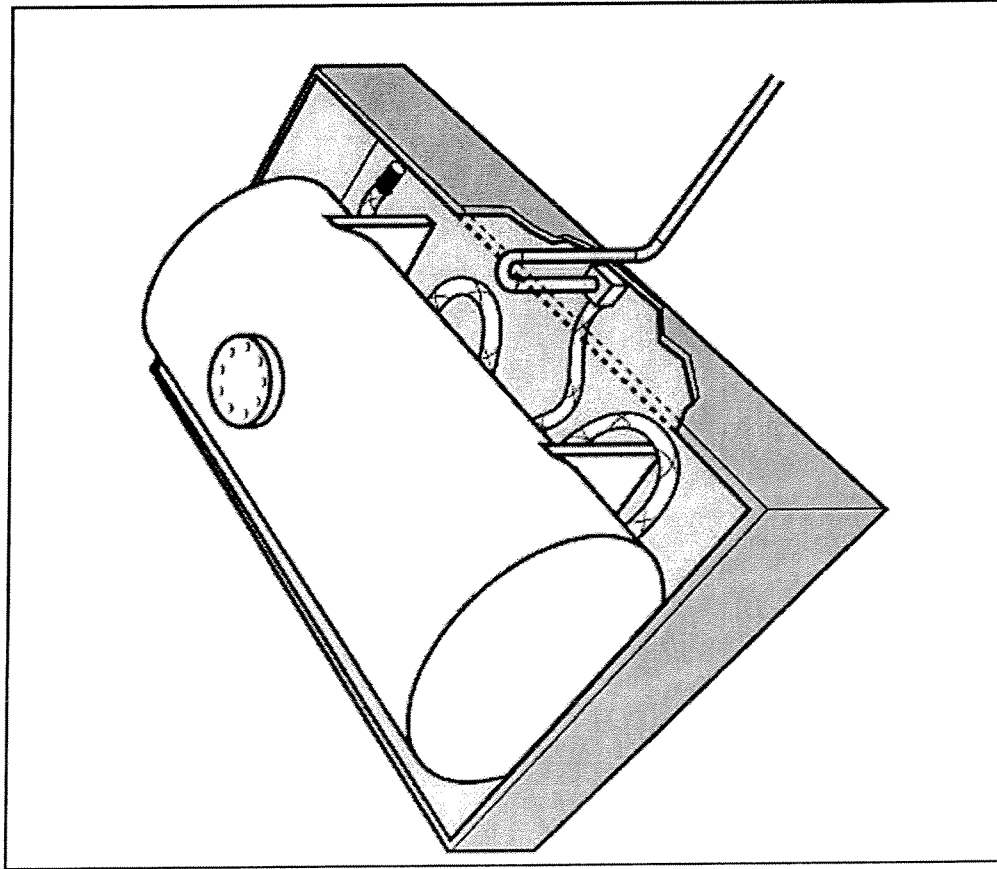


Figure 24 -Interstitial Sensor in Aboveground Tank Installation

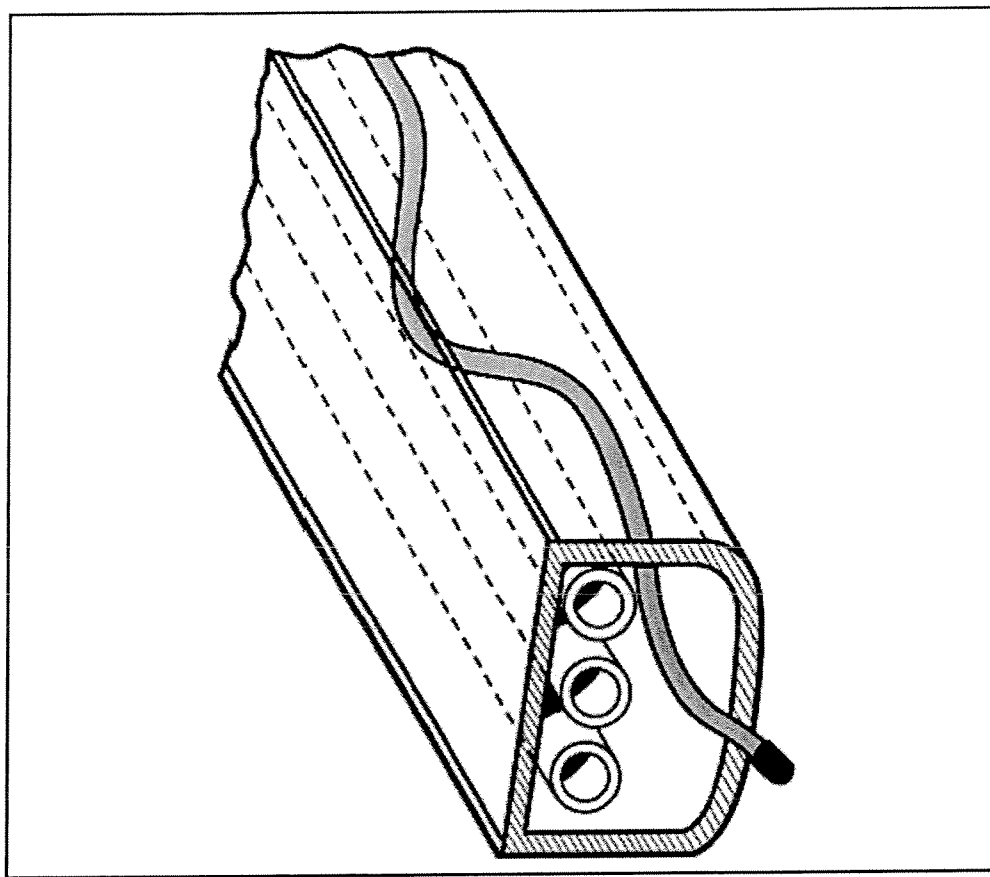


Figure 25 - Interstitial Sensor Installed in "Manway"

6.2.9 FREON SENSOR INSTALLATION

Freon sensors are described on Page 17. A typical installation is shown in Figure 26.

PROCEDURE

1. Place any combination of liquid and refrigerant gas sensors in the vicinity of the pipe or refrigeration system to be monitored.
2. Each freon sensor must be mounted in a standard 4"x4" (10 cm x 10 cm) junction box.
 - All freon sensor wiring must be protected by steel conduit to prevent contact with any non-intrinsically safe wiring.
3. Connect the sensor to the Smart Module by splicing the sensor wires to TFFN, THHN or THWN wires. These wires, in turn, pass thru vapor seal-offs, and enter the Smart Module.
 - If the total distance from sensor to controller is 500 feet (152 m) or less, use 18 AWG wire for the wiring.
 - If the total distance is 500 to 1000 feet (152 m to 305 m), use 14 AWG wire.

Follow all applicable codes and use appropriate splicing materials and tools when splicing and wiring the sensor. Identify sensor wires to ensure proper wiring at the Smart Module. Follow all applicable codes.

4. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module. Follow all applicable codes.
5. Run a separate wiring from each sensor to the Smart Module. Note

that probe cables and sensor wiring can share the same conduit. Keep track of sensor wiring identity to ensure proper wiring at the Smart Module.

WARNING

DO NOT allow PV freon vapor sensors to be submerged in water! Submerged sensors may be damaged, causing improper monitoring. If submerged, always check for proper operation.

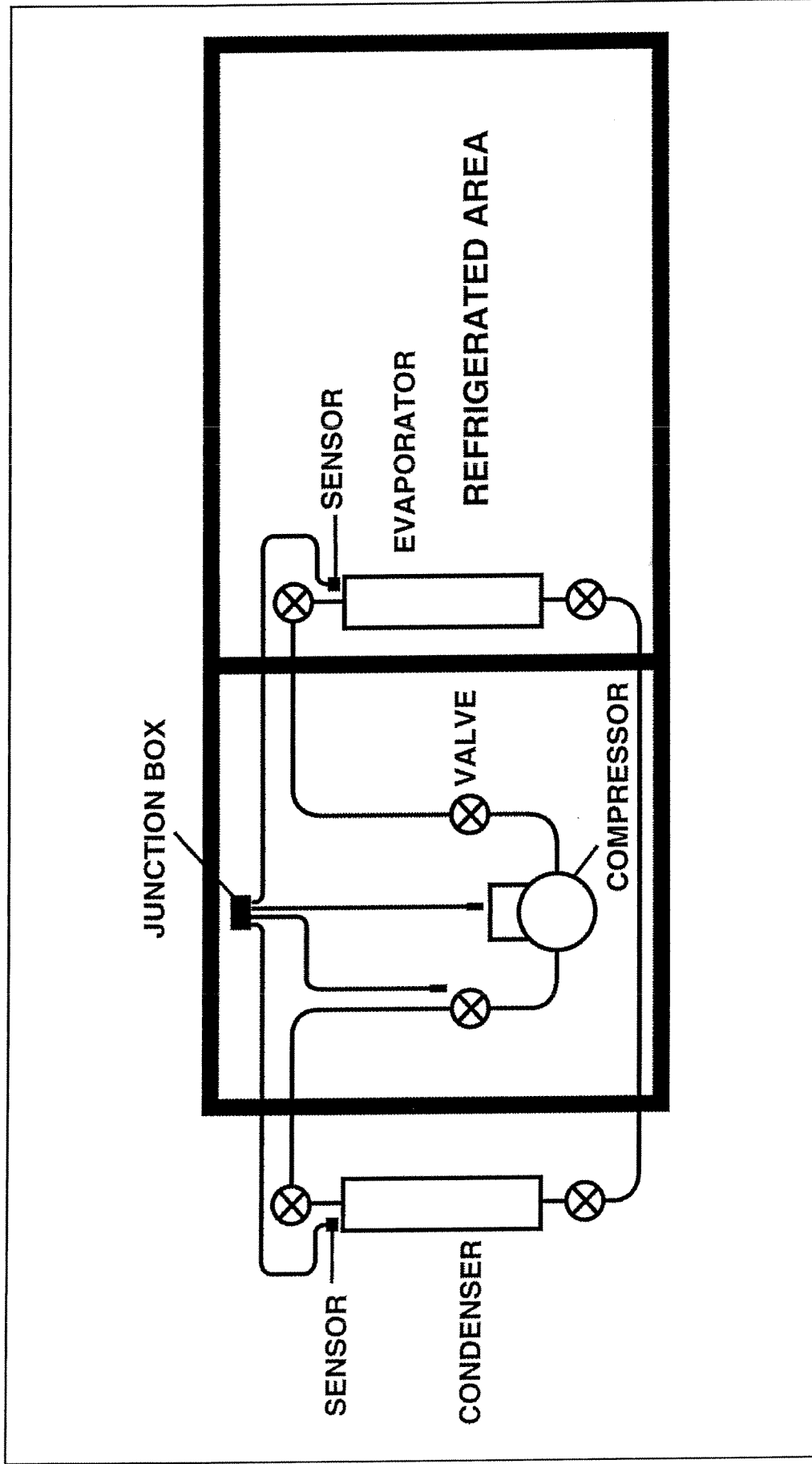
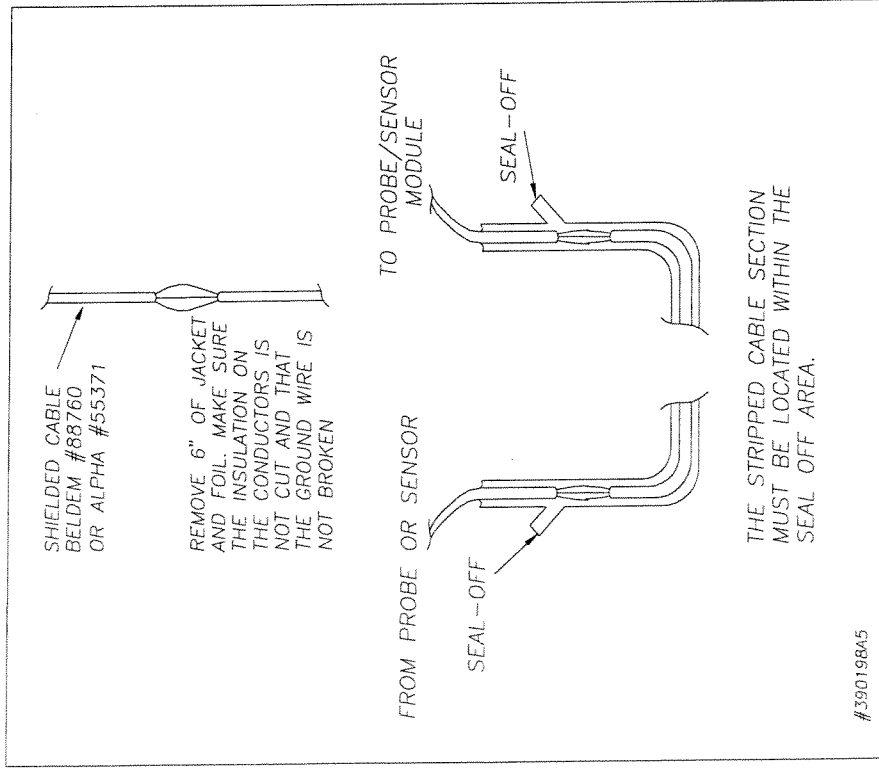


Figure 26 - Freon Sensor Installation

Notes:

7.0 Overall System Wiring



WARNINGS

Only Petro Vend probe cables and sensor wiring can share the conduit to the Smart Modules.

Improper cables, wiring, or conduit allow electronic noise to interfere with probe/sensor measurements. This may cause measurement readings at the controller resembling hardware failure.

The warranty is voided if improper cables, wiring, and/or conduit are installed.

The ground wire must be properly installed for the operation of the noise filtering circuitry. Do not rely on the conduit for the operation of the ground.

The controller must have a dedicated power circuit.

7.1 Probe Cable Seal-Offs

Seal off probe cables (Figure 27) before they enter the Smart Module! This prevents explosive vapors from entering the module. Remove enough of the jacket to allow approximately three inches of wire leads to extend past each sealoff. *DO NOT nick the wire installation.*

Probe or sensor wires come off the probe or sensor, connect to prepared Belden or Alpha cable, and then go through NPT bushing into a weatherproof junction box. *Bushings must be used in all junction boxes.* The cable is then routed - via rigid steel conduit - out of the box and

Figure 27 - Seal-off Creation

directly to the Smart Module. Label each cable and wire.

All probes for a manifold tank group must be connected to the same Smart Module

7.2 Smart Module Connections

See Figure 28. Each Smart Module handles up to 16 probes and sensors. Devices are identified via the **Module Number** and **Device Letter** (for example, "Module 1 Device A") on the terminal strip to which it is wired. You must remove the intrinsically safe barrier panel to attach wiring. Connect the *probe* wires and cables according to the following chart (*sensor* wiring appears on the following page):

PROBE WIRING		
Probe Wire	Probe Cable (Belden #88760 or Alpha #55374)	Smart Module "Device" Terminal
white	red	PWR (power)
black	black	SIG (signal)
green	shield	GND (ground)

WARNING

Replace barrier panel in the Smart Module before power-up!

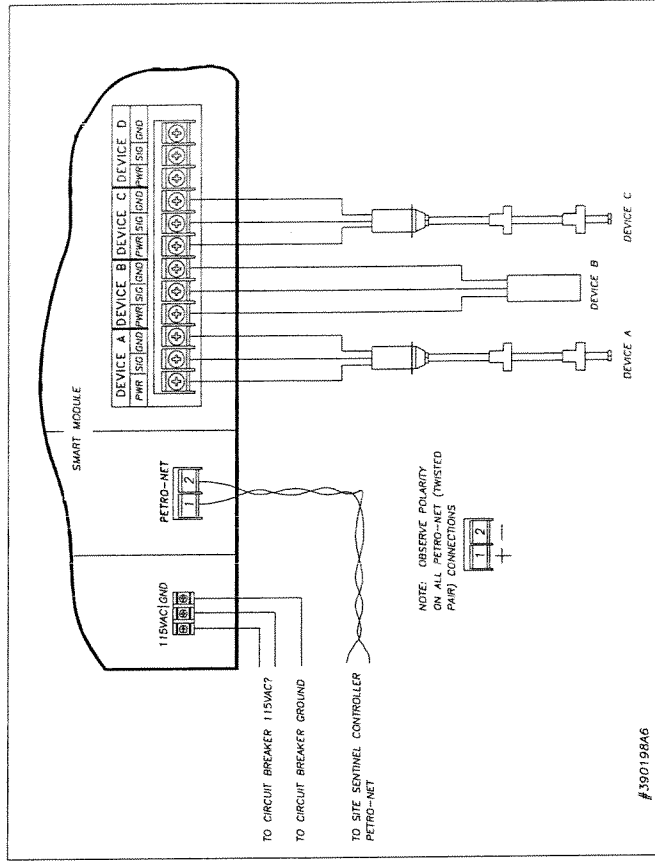


Figure 28 - Smart Module Connections

SENSOR WIRING									
Liquid	Hydrocarbon Vapor	Sump	Reservoir	Liquid Phase		Interstitial		Freon	Smart Module "Device" Terminal
				Hydrocarbon	Water	Hydrocarbon	Water		
white	white	red	red	red	red* (jumper)	red	red* (jumper)	white	PWR (power)
red	red	black	black	black	white	black	white	green	SIG (signal)
black	black							black	GND (ground)

Like probe wiring, sensor wires attach to prepared Belden or Alpha wiring in weatherproof junction boxes. The wiring is routed via rigid steel conduit to the Smart Module. Connect the sensor wires according to the table above.

IMPORTANT

The interstitial sensor has both hydrocarbon- and water-sensing elements. The liquid phase sensor is also available with both.

The two sensing elements *must* be wired to two separate terminal positions.

Install a jumper between the power terminals of the two positions.

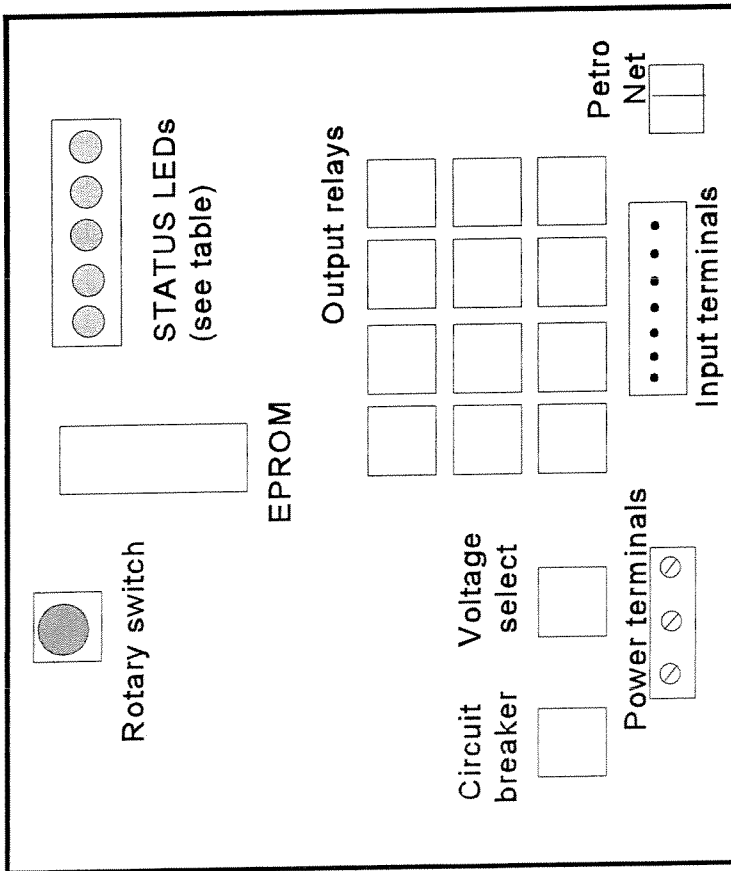


Figure 29 - I/O Module Board Overview

7.3 I/O Module Inputs & Outputs

7.3.1 INPUTS

See Figure 29. There are four pairs of pins ("Input Terminals") in each I/O Module for input devices. Pins 2, 4, 6, and 8 are common. Pins 1, 3, 5, and 7 are at 5 VDC potential. Inputs are all optically isolated.

I/O input devices must be wired for "normally open" operation: The **SiteSentinel** defines an input device as "active" when the device terminals are *closed*.

7.3.2 OUTPUTS

There are 12 output relays (Figure 29) in each I/O Module for output devices. Each relay has three "quick connect" terminals: (1) common, (2) normally open, and (3) normally closed. Female "quick connect" terminals for the device wiring are provided with each I/O Module.

7.3.3 STATUS LEDs

STATUS LEDs	
COLOR	FUNCTION
Green	Status: slow = unconfigured; fast = data download
Yellow	Reset
Green	Petro-Net RX
Red	Petro-Net TX
Yellow	Petro-Net TX Enable

WARNINGS

Petro-Net wiring *must* be twisted pair wiring. Conduit is suggested, but not required, for Petro-Net. If conduit is *not* used, bushings must be installed in the cabinet knockouts to protect wiring and seal the enclosures.

Polarity must be observed for Petro-Net wiring!

PV250 TERMINAL BOARD (MODEL II ONLY)

The optional PV250 board is used to connect the SiteSentinel Model II controller to communication devices, such as a terminal, a PC, a printer and/or a modem. These connections are explained below:

Terminal Strip	Function
TB1	External Alarm & Phone Input
TB2	External Modem
TB3	Passthrough Port
TB4	External Printer
TB5	Terminal or PC
TB6	Future use

7.4 PETRO-NET Connections

Petro-Net is the communication link between the Smart Module(s), the I/O Modules, and the Model II or Model III controller. Two-wire, twisted pair wiring must be used. *Polarity must always be observed for Petro-Net connections* - the wire connected to the #1 position in each module must be connected to the #1 position in another device, etc.

Twisted pair wiring is available from **Petro Vend** as part #12-1029. You can easily make this type of wiring by twisting together two 18 AWG gas and oil resistant wires (THHN, TFFN, or THWN). Use between five and ten twists per foot (15 cm).

At each module, Petro-Net is connected to positions #1 and #2 of the PETRO-NET terminal block. Petro-Net can be "daisy-chained;" - modules may be connected to each other in various combinations as long as one module in the "chain" is connected to the controller. Refer to Figure 30 on the following page for a typical arrangement.

MODEL II CONTROLLER. At the Model II controller, Petro-Net is connected to either of the following:

- Positions 1, 2 of TB4 terminal block on the PV250 board (if present) *OR*
- Positions 1, 2 of PS terminal block on the PV235 controller board.

MODEL II PETRO-NET WIRING			
Module	Controller		
"Petro Net" Terminal	PV250 Board "TB4" Terminal	PV235 Board "PS" Terminal	
Position #	Position #	Position #	
1	1	1	
2	2	2	

MODEL III CONTROLLER: At the Model III controller, plug the round 4-pin DIN connector end of the Controller Petro-Net cable into the PN socket on the controller (See Figure 30).

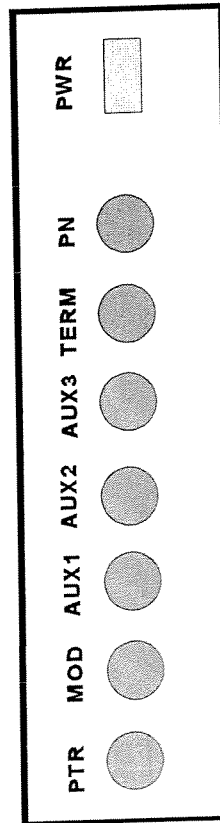


Figure 30 - Model III Controller Rear Panel

WARNING

Proper grounding is critical for safe system operation and the proper operation of the noise filtering circuitry.

- Do *not* rely on conduit to provide a ground.
- Only power wiring may share conduit with Petro-Net.

7.5 Model III Peripherals

IMPORTANT

If RS-232 communication will be used for a terminal, PC or other device more than six feet (1.8 m) from the controller, the comm cable must be inside conduit..

TERMINALS/PCs. Connect a terminal or PC to the TERMINAL socket on the Model III controller (Figure 30). The PC must be running emulation software.

PRINTER. To connect an optional journal printer, plug the connector at the end of the printer cable into the PTR socket. *Only a Petro Yend printer can be used with the Model III SiteSentinel.*

MODEM COMMUNICATION. To connect the local modem to the Controller, plug one end of the modem cable into the MOD socket; connect the other end to the modem. Configure the modem for the same baud rate as used by the SiteSentinel.

7.6 Connecting a Second System to the Model III

The SiteSentinel Model III has a passthrough mode that lets you communicate with a second system, such as Petro-Vend's System2 Fuel Management System. With PASSTHRU enabled, you can set up and operate the second system in the usual manner.

To connect the second system, plug the DIN connector of a modem cable into the AUX3 socket of the Model III controller. The other end of the cable connects to the second system, either directly or via modems. A gender adapter may be required to connect the modem cable to the second system hardware.

7.7 AC Power Connections

7.7.1 MODEL II CONTROLLER AC WIRING

1. Pull two AC power wires and one ground wire from the circuit breaker to the controller. Run through a bushing on the bottom of the controller.
2. Connect the neutral and hot wires (in either order) to the power input terminal block.

Be sure the controller is wired for the correct line voltages (115 VAC or 230 VAC) by checking the decal near the terminal block.

3. Connect the ground wire to the ground lug. Replace the safety cover over the terminal block when the wiring is done.

7.7.2 Model III CONTROLLER AC WIRING

Simply plug the Model III controller's "power-pak" into a wall outlet protected by the same circuit breaker that protects other system components.

7.7.3 SMART & I/O MODULE AC WIRING

1. See Figure 33 on Page 55. Pull two AC power wires from the circuit breaker to each module; you may "daisy chain" the wires from module to module, not to exceed the circuit breaker rating.
2. Connect the live and neutral power wires to the appropriate terminals in each module.
 - Make sure the modules are set for the correct voltages (115 or 230 VAC). For *Smart Modules*, check the decal near the terminal block. For *I/O Modules*, check the "line voltage selector" switch on the circuit board.
3. Determine grounding method: There are two versions of Smart Module: one has a single ground terminal, the other has a second ground terminal for the I.S. barrier. These grounding methods are illustrated in Figures 31 and 32 on the next page.

All ground connections must be done with 12 AWG wire.

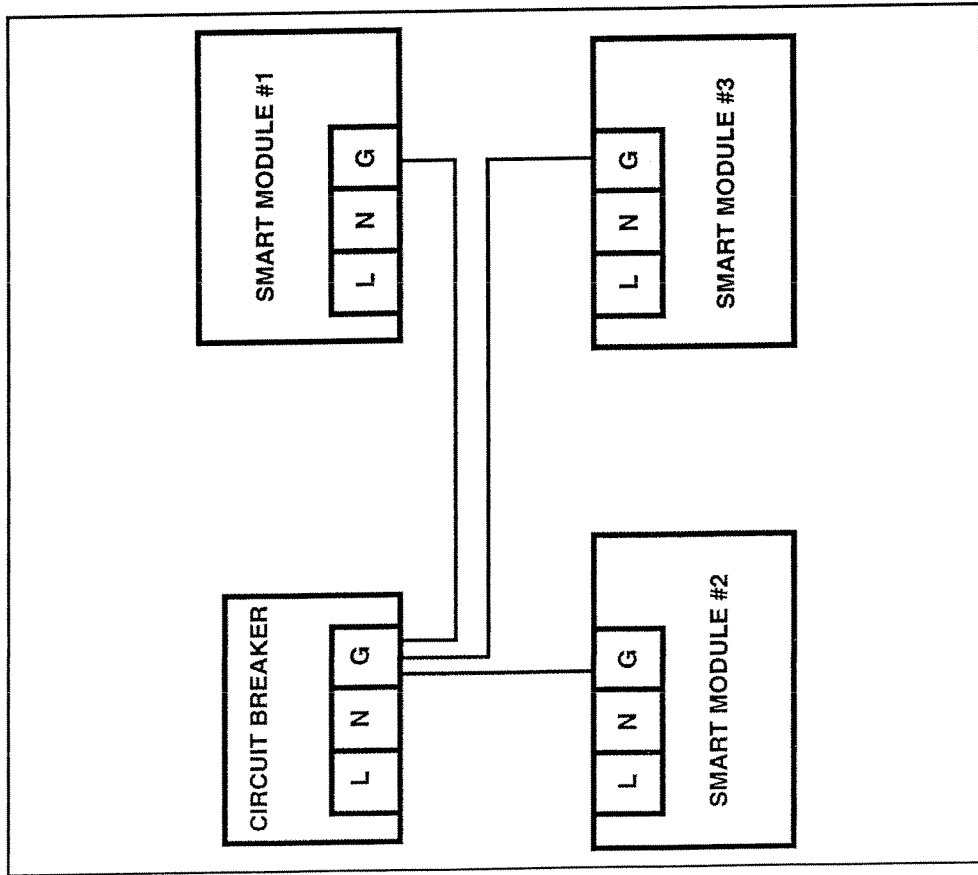


Figure 31 - Smart Module Single-Ground Wiring

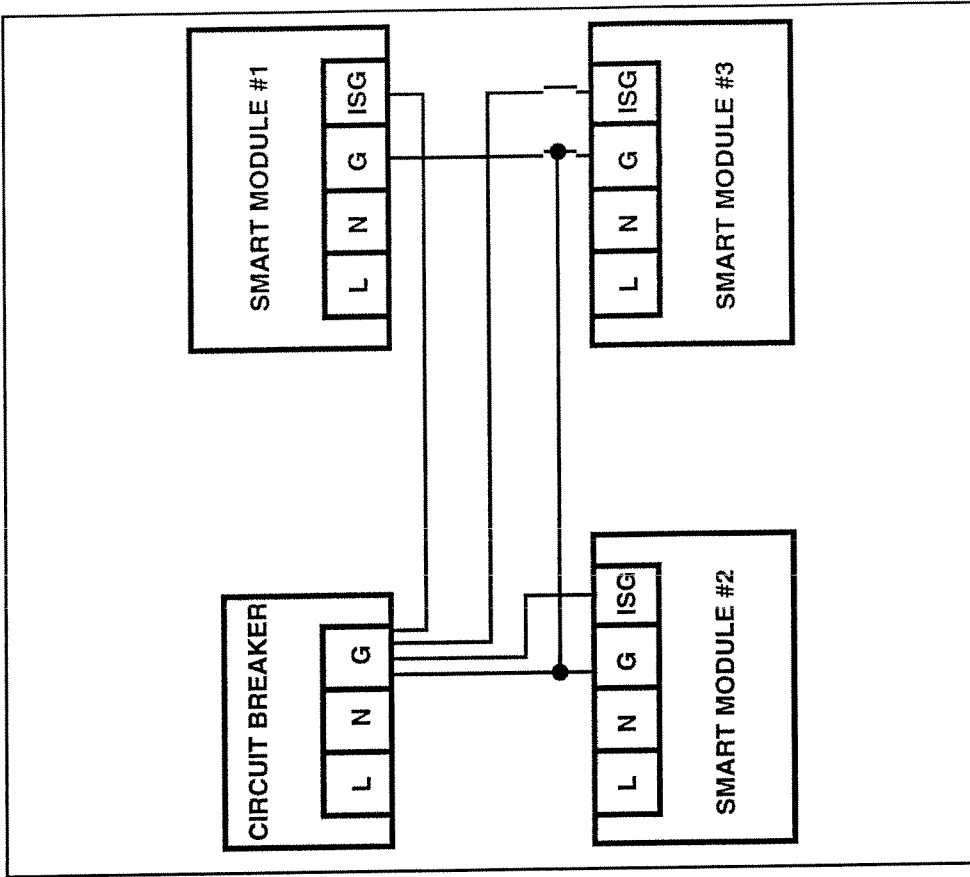


Figure 32 - Smart Module Dual-Ground Wiring

- For the *single ground* version (Figure 31), connect the ground terminal from each Smart Module directly to the ground bar in the circuit breaker. *Do not daisy chain the ground wires*
- For the *dual ground* version (Figure 32), connect the I.S. ground terminal from each Smart Module directly to the ground bar in the circuit breaker. *Do NOT daisy chain the I.S. ground wires!*

The second ground terminal must also be connected, but these connections may be daisy chained.

4. Each I/O Module has a single ground terminal, which can be connected to the circuit breaker ground bar directly or the wires may be daisy chained.
5. Replace the safety cover over the terminal block when the wiring is done.

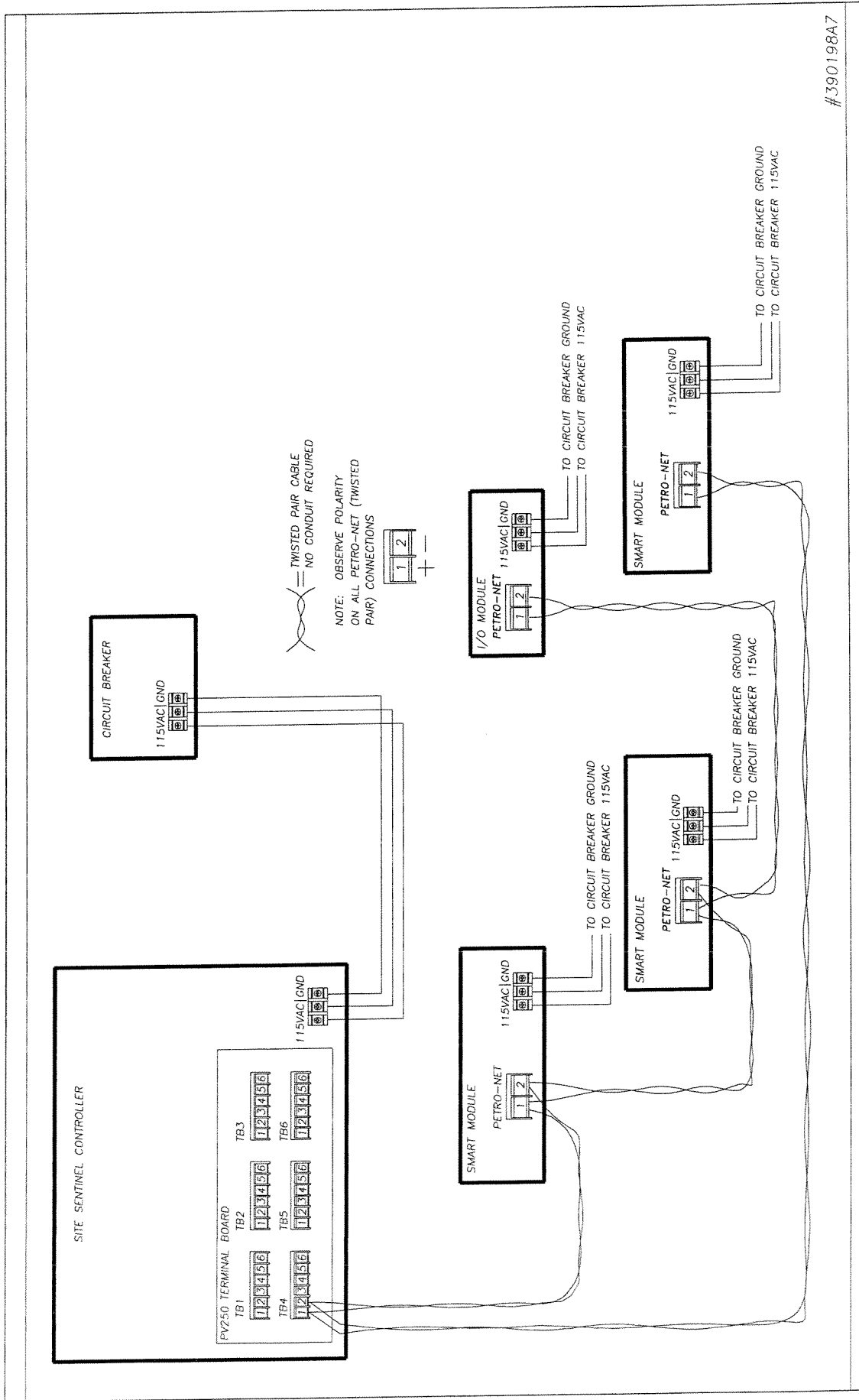


Figure 33 - Smart/I/O Module Wiring, Site Sentinel Model II

7.8 Model II Alarm Wiring

Your **SiteSentinel Model II** has two built-in alarms: (1) a buzzer and (2) a lighted pushbutton switch (which turns either or both alarms off).

Your *SiteSentinel Operator's Guide* (Part number *M56-01.XX*) describes how to set up the buzzer or switch to buzz and/or light to signal various conditions in the system.

The buzzer and light are prewired to the 4-terminal block on the PV235 controller board (Figure 34) according to the table below. This terminal block is labeled **P4** on the PV235 board.

BUZZER/LIGHT/SWITCH WIRING (Model II ONLY)	
PV235 BOARD / "P4" Terminal	
Position #	Connection
1	+12 volt common
2	Buzzer
3	Light
4	Switch

To connect a remote buzzer, light, and/or switch, disconnect the prewired device(s) and wire the new alarm device(s) according to the table above. Note that the remote alarm devices must be rated at 12 VDC with a maximum of 0.5 amp. The switch must be rated at 0.5 amp minimum.

You can wire two external alarm inputs to the first terminal block on the Model II PV250 board (Figure 35) according to the following table. The inputs must be closed-contact type.

MODEL II EXTERNAL ALARM WIRING	
PV250 BOARD / "TB1" Terminal	
Position #	Connection
1	Ground
2	Input #1
3	Input #2
4	Ground

The optional PV250 board is required to connect the SiteSentinel Model II Controller to external devices.

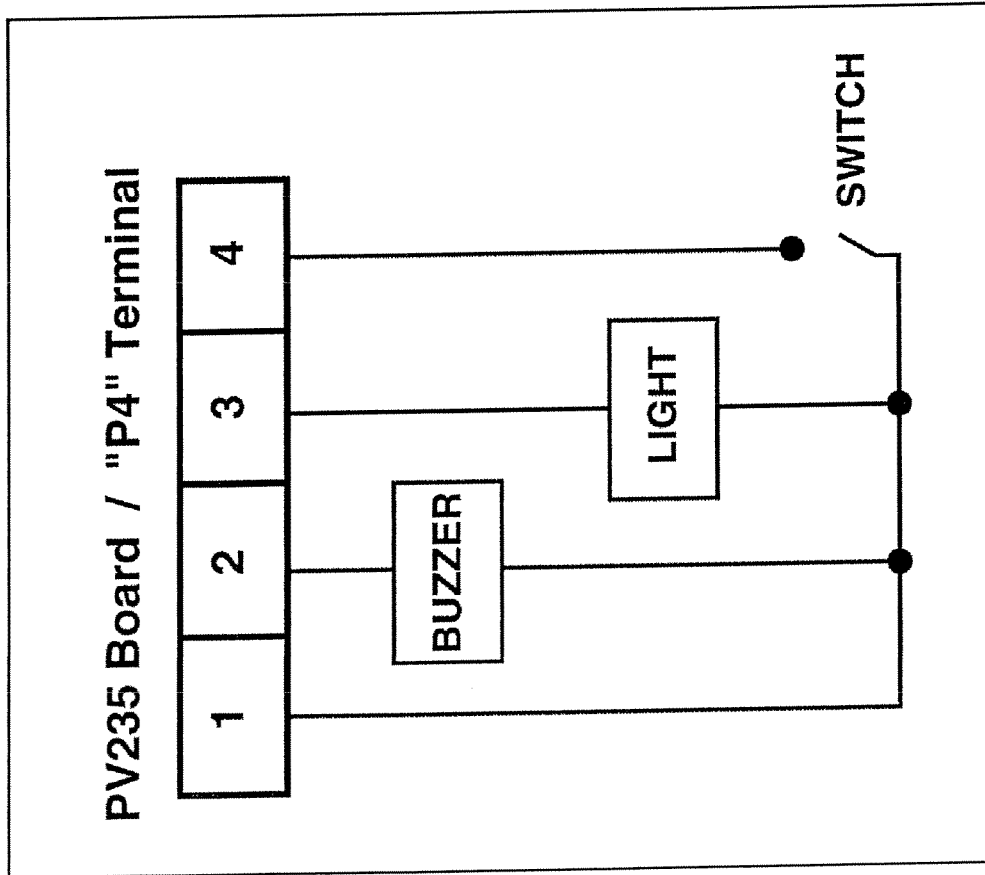


Figure 34 - Model II Buzzer/Light/Switch Wiring

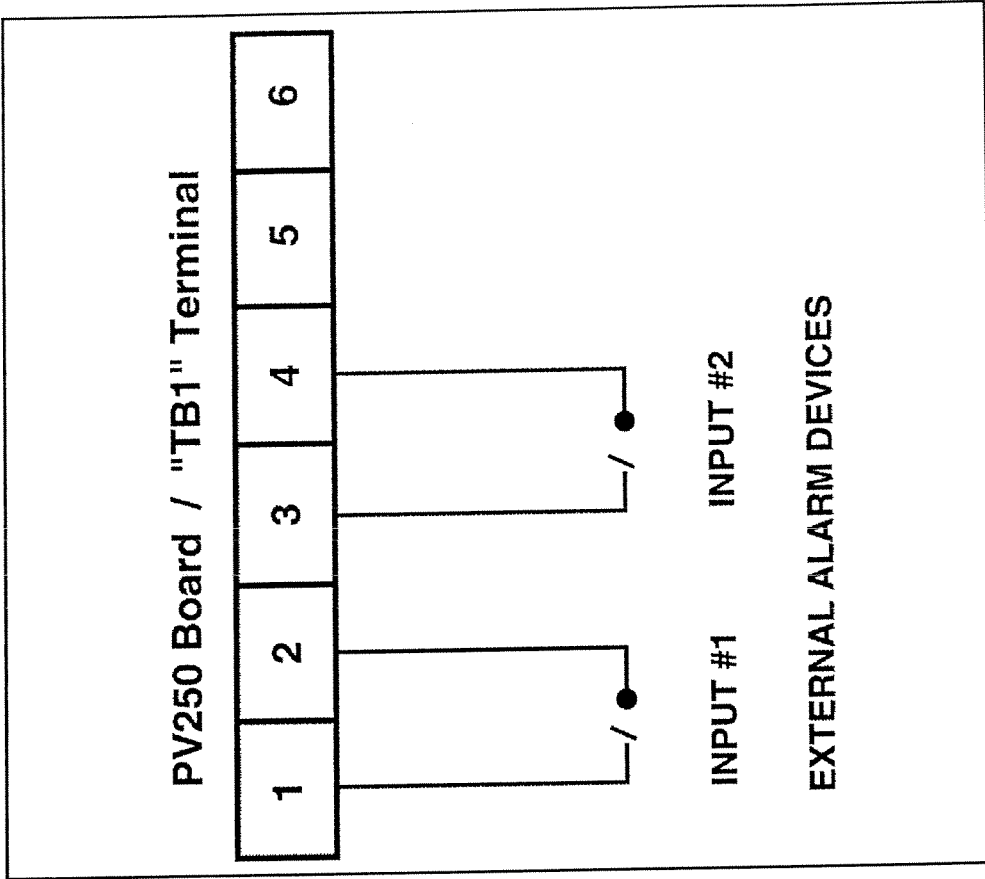


Figure 35 - Model II External Alarm Wiring

7.9 Model II External Printer Wiring

The SiteSentinel Model II works with all standard serial printers. Set the printer for 1200 baud, seven data bits, one stop bit, EVEN parity.

You must install a bushing in the controller knockout used by the printer cable. The bushing is available from **Petro Vend** (part # 30-0203) or from Appleton (part # CG1250S).

The wiring for the external printer is shown in the table below.

MODEL II EXTERNAL PRINTER WIRING			
PV250 BOARD "TB4" Terminal		DATA FLOW	CABLE & CONNECTOR
Position #	Signal		Wire Color Pin #
3	TX	---->	Orange 3
4	CTS	<-----	White 20
5	DTR	<-----	Blue 6
6	SIG GND	----	Black 7

The optional PV250 board is required to connect the SiteSentinel Model II controller to external devices.

7.10 Model II External Terminal or PC Wiring

(DB25 CONNECTOR) The Model II controller can be operated from a VT52, VT100 or WYSE 50 terminal, or from a PC using software to emulate one of these terminals.

Use a DB25 connector and cable to connect the terminal or PC to an RS-232 port in the Model II controller. This port is located at **TB5** on the PV250 board. You must install a bushing in the controller knockout used by the cable. The bushing is available from **Petro Vend** (part # 30-0203) or from Appleton (part # CG1250S)

The table below lists the Model II controller terminal connections and the standard connector and cable wiring. Set the **SiteSentinel** to the same baud rate as the external printer. See Page 61, 63 for more information about the baud rate.

MODEL II TERMINAL/PC WIRING			
PV250 BOARD "TB5" Terminal		DATA FLOW	CABLE & CONNECTOR
Position #	Signal		Wire Color Pin #
1	TX	---->	Orange 3
2	RX	<-----	Red 2
3	CTS	<-----	Green 4
4	RTS	---->	Yellow 5
5	SIG GND	----	Black 7
no connections			Blue, Brown, & White 6, 8, & 20

7.11 Model II Modem Wiring

7.11.1 INTERNAL MODEL II MODEM

An optional internal modem is available for the SiteSentinel Model II controller. Note that the **SiteSentinel** must be set to the same baud rate as the internal modem. See Page 61, 63 for more information about the baud rate.

If a **SiteSentinel** Model II controller does *not* have a PV250 board, a special cable is provided for the modem. One end of the cable connects to the RJ-11 socket located on the modem board. The cable must be threaded through one of the knockouts in the controller. The other end of the cable has a socket that can be attached to a telephone line with an RJ-11 plug.

If a PV250 board is installed in the Model II, you must connect the red and green telephone wires to the terminal block according to the table below:

INTERNAL MODEL II MODEM WIRING	
PV250 BOARD "TB1" Terminal	TELEPHONE WIRE
5	Green
6	Red

7.11.2 EXTERNAL MODEL II MODEM

First, install a bushing to protect the cable and to complete the electrical enclosure in the appropriate Model II controller knockout. The table below shows the connections for an external modem. Note that the **SiteSentinel** must be set to the same baud rate as the external modem. See Page 61, 63 for more information about the baud rate.

MODEL II EXTERNAL MODEM			
PV250 BOARD "TB2" Terminal		DATA FLOW	CABLE & CONNECTOR
Position #	Signal		Wire Color Pin #
1	TX	---->	Red 2
2	RX	<----	Orange 3
3	CTS	<----	Green 5
4	RTS	---->	Yellow 4
5	DCD	<----	Brown 8
6	DTR	---->	White 20
"TB5" Terminal			
6	SIG GND	----	Black 7
no connection			Blue 6

7.12 Model II Passthrough Port Wiring

7.12.1 OVERVIEW

Passthru Mode lets your Site Sentinel Model II communicate with another system, such as the Petro Vend's SYSTEM2 Fuel Management System. When passthru is enabled, you can program the second system in the usual manner.

Install a bushing in the controller knockout used by the cable. The bushing is available from Petro Vend (part # 30-0203) or from Appleton (part # CG1250S).

The wiring for the passthrough port is shown in the table below.

MODEL II PASSTHROUGH PORT					
PV250 BOARD "TB3" Terminal		Signal	DATA FLOW	CABLE & CONNECTOR	
Position #	Wire Color			Pin #	
1		TX	----->	Red	2
2		RX	<-----	Orange	3
3		CTS	<-----	Green	5
4		RTS	----->	Yellow	4
5		DCD	<-----	Brown	6
6		DTR	----->	White	20
"TB6" Terminal					
6		SIG GND	-----	Black	7
no connection				Blue	6

The second system, connected to the SiteSentinel passthru port, must possess the following traits:

1. It must be connected to the RS-232 passthrough port in the controller
2. It be set up for seven data bits, one stop bit, and even parity
3. Have the same baud rate as the controller.

Notes:

8.0 Other System Parameters

8.1 Model II Comm Port Setup

The SiteSentinel Model II has communication ports for a modem, a terminal, a PC and/or a point-of-sale device (POS) or Fuel Management System such as Petro Vend's **System2**.

The *baud rate* for the terminal and modem ports is set by the first three positions of the DIP switch on the PV235 board. The switch is located on the left-hand side of the board. The table below lists how to set the switches.

MODEL II PASS-THRU, TERMINAL and MODEM PORT BAUD RATE			
Baud Rate	Switch 1 Position...		
	#1	#2	#3
110	OPEN	OPEN	OPEN
300	CLOSED	OPEN	OPEN
600	OPEN	CLOSED	OPEN
1200	CLOSED	CLOSED	OPEN
2400	OPEN	OPEN	CLOSED
4800	CLOSED	OPEN	CLOSED
9600	OPEN	CLOSED	CLOSED
19200	CLOSED	CLOSED	CLOSED

IMPORTANT!

- In STANDARD (non-POS or ACR) Site Sentinel controllers, the baud rates of the pass-through, terminal and modem ports are all set with Switch #1, positions 1, 2 and 3 (table opposite). Word length and parity are set with position #4 of Switch #1.
- In POS and ACR Site Sentinel controllers, Switch #1 positions 1-3 sets terminal and modem port baud rate.
- Position 4 of Switch #1 sets word length and parity in all models as follows: OPEN = 7-bit word with EVEN parity. CLOSED = 8-bit word with NO parity.
- Positions 5, 6 and 7 of Switch #1 are *not* currently used and should be OPEN. Position 8 is used by the factory to enable a special hardware test. Under normal operating conditions, position 8 must be CLOSED.

ALL ports in all systems must all be set at the *same* baud rate and word length.

You MUST cycle power for any change to take effect.

8.2 Model III Comm Port Setup

IMPORTANT

Plug in the controller's battery *before* configuring the controller.

- In STANDARD (non-POS or ACR) Site Sentinel controllers, the baud rates of the pass-through, terminal and modem ports are all set with Switch #1, positions 1, 2 and 3. Word length and parity are set with position #4 of Switch #1.
- In POS and ACR Site Sentinel controllers, Switch #1 positions 1-3 sets terminal and modem port baud rate. Word length and parity are set with position #4 of Switch #1.
- Positions 5, 6 and 7 of Switch #1 are *not* currently used and should be OPEN. Position 8 is used by the factory to enable a special hardware test. Under normal operating conditions, position 8 must be CLOSED.

ALL ports in all systems must all be set at the *same* baud rate and word length.

MODEL III PAS-THRU, TERMINAL and MODEM PORT BAUD SETUP			
PV271 BOARD, DIP SWITCH #1			
Baud Rate	Switch 1 Position...		
	#1	#2	#3
110	OPEN	OPEN	OPEN
300	CLOSED	OPEN	OPEN
600	OPEN	CLOSED	OPEN
1200	CLOSED	CLOSED	OPEN
2400	OPEN	OPEN	CLOSED
4800	CLOSED	OPEN	CLOSED
9600	OPEN	CLOSED	CLOSED
19200	CLOSED	CLOSED	CLOSED

NOTE: Switch #1 does not affect Petro-Net or other port settings.

SWITCH 1 POSITION 4 - WORD LENGTH and PARITY

Position 4 OPEN = 7-bit word with EVEN parity
 Position 4 CLOSED = 8-bit word with NO parity

SWITCH 1 POSITIONS 5-7 - *Not currently used*

Use the RESET switch to reset ("warm start") the Controller. No completed measurement data or configuration data are lost or changed by resetting the Controller.

8.4 Model III Controller Board LEDs

CR35, 36, 38, and 40 are POS or ACR Site Sentinel specific.

MODEL III PV271 CONTROLLER BOARD LEDs		
Label	Color	Function
CR31	Yellow	Reset
CR23	Red	RS-485 Petro-Net Transmit
CR22	Green	RS-485 Petro-Net Receive
CR24	Yellow	RS-485 Petro-Net TX Enable
CR81	Red	RS-232 Terminal Transmit
CR86	Green	RS-232 Terminal Receive
CR36	Red	RS-232 POS (ACR) or POS2 (POS) Transmit
CR38	Green	RS-232 POS (ACR) or POS2 (POS) Receive
CR32	Red	RS-232 Printer Transmit
CR37	Green	RS-232 Printer Receive
CR80	Red	RS-232 Modem Transmit
CR85	Green	RS-232 Modem Receive
CR35	Red	RS-232 CONSOLE (ACR) or POS (POS) Transmit
CR40	Green	RS-232 CONSOLE (ACR) or POS (POS) Receive
CR41	Red	RS-232 AUX Transmit
CR39	Green	RS-232 AUX Receive

8.5 Module Assignment (Both Models)

Smart Modules and I/O Modules must each be assigned a unique identification number.

Module numbers must be unique within the *module group*; that is, you can assign the same number to both a Smart Module and to an I/O Module, but you can *not* assign the same number to more than one Smart Module or to more than one I/O Module.

The module numbers are used when the system is configured. Refer to your *SiteSentinel Operator's Manual* for details about system setup.

A small, red rotary switch is located at the top of the PC board inside each module. The switch has ten positions, marked "0" to "9". A small arrow on the switch points to the current position. Default switch setting is "1".

Although the switch has ten settings, only settings 1-8 are valid. DO NOT set the switch to either "0" or "9" - the module will NOT be recognized by the system!

1. Turn the module power *off*
2. Use a 1/4-inch (6 mm) blade screwdriver to gently rotate the small white screw inside the rotary switch to the desired location.
3. Turn the module power *on*.

DO NOT change the module number while the module power is ON.

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Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79538-C31-149

Date: June 21/06 By: [Signature]

1. Name of the person: John Doe
 2. Address: 123 Main St, Anytown, USA
 3. Phone Number: 555-123-4567
 4. Date of Birth: 01/01/1980
 5. Occupation: Software Engineer
 6. Signature: [Signature]
 7. Date: 10/27/2023

8. Name of the person: John Doe
 9. Address: 123 Main St, Anytown, USA
 10. Phone Number: 555-123-4567
 11. Date of Birth: 01/01/1980
 12. Occupation: Software Engineer
 13. Signature: [Signature]
 14. Date: 10/27/2023

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 39. Date of Birth: 01/01/1980
 40. Occupation: Software Engineer
 41. Signature: [Signature]
 42. Date: 10/27/2023

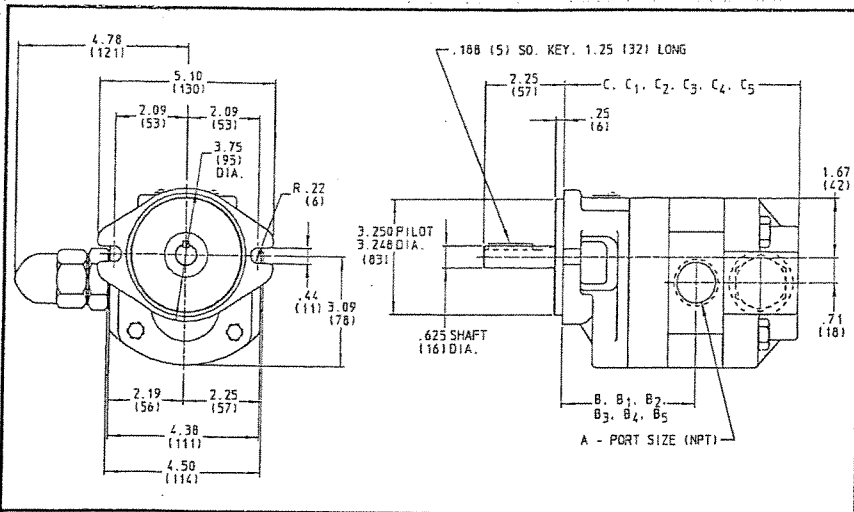
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 45. Phone Number: 555-123-4567
 46. Date of Birth: 01/01/1980
 47. Occupation: Software Engineer
 48. Signature: [Signature]
 49. Date: 10/27/2023

50. Name of the person: John Doe
 51. Address: 123 Main St, Anytown, USA
 52. Phone Number: 555-123-4567
 53. Date of Birth: 01/01/1980
 54. Occupation: Software Engineer
 55. Signature: [Signature]
 56. Date: 10/27/2023



For description, see page 341.4.

DIMENSIONS— SERIES SG-07, SGN-07 UNMOUNTED SINGLE PUMPS (LIP AND MECHANICAL SEAL)



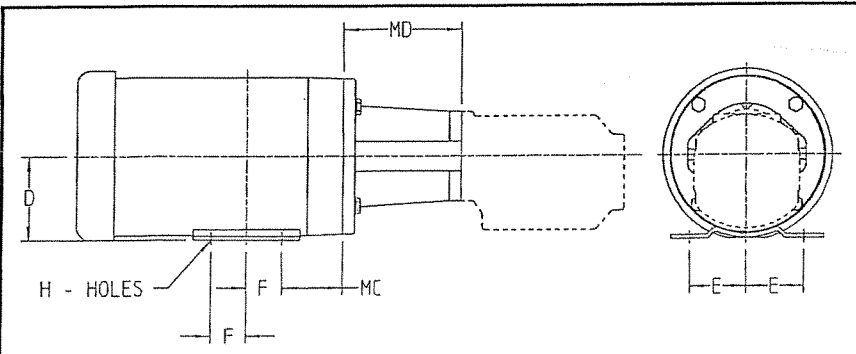
MODEL NO.	A	B	B ₁	B ₂	B ₃	B ₄	B ₅	C	C ₁	C ₂	C ₃	C ₄	C ₅	
SG-0741 SGN-0741	⑥ 1	in mm	3.10 79	4.72 120	3.29 84	4.91 125	3.54 90	5.16 131	6.03 153	7.65 194	4.41 112	6.03 153	6.91 176	8.53 217
SG-0758 SGN-0758	⑥ 1	in mm	3.27 83	4.89 124	3.46 88	5.08 129	3.71 94	5.33 135	6.20 157	7.82 199	4.58 116	6.20 157	7.08 180	8.70 221
SG-0782 SGN-0782	⑥ 1	in mm	3.51 89	5.13 130	3.70 94	5.32 135	3.95 100	5.57 141	6.44 164	8.06 205	4.82 122	6.44 164	7.32 186	8.94 227
SG-0711 SGN-0711	⑥ 1	in mm	3.84 98	5.46 139	4.03 102	5.65 144	4.28 109	5.90 150	6.77 172	8.39 213	5.15 131	6.77 172	7.65 194	9.27 235
SG-0716 SGN-0716	⑥ 1	in mm	4.34 110	5.96 151	4.53 115	6.15 156	4.78 121	6.40 163	7.27 185	8.89 226	5.65 144	7.27 185	8.15 207	9.77 248
SG-0722 SGN-0722	⑦ 1 1/2 x 1 1/4	in mm	4.28 109	5.90 150	4.28 109	5.90 150		10.42 265	12.04 306	8.80 224	10.42 265			
SG-0732 SGN-0732	⑦ 1 1/2 x 1 1/4	in mm	4.78 121	6.40 163	4.78 121	6.40 163		11.42 290	13.04 331	9.80 249	11.42 290			

- ① These dimensions apply when the mechanical shaft seal option is selected.
- ② These dimensions apply when the relief valve is deleted.
- ③ These dimensions apply when the relief valve is deleted and the mechanical shaft seal option is selected.
- ④ These dimensions apply when the oversize port option (1 1/2" NPT suction, 1 1/4" NPT discharge) is selected, with or without the relief valve.
- ⑤ These dimensions apply when the oversize port option (1 1/2" NPT suction, 1 1/4" NPT discharge) and the mechanical seal option are both selected, with or without the relief valve.
- ⑥ Standard ports for these size pumps are 1" NPT. Oversize ports are available (1 1/2" NPT suction, 1 1/4" NPT discharge) as an option on clockwise rotation pumps only. See footnotes 4 and 5 for appropriate dimensions. (See Price page P341.2).
- ⑦ Standard ports for these size pumps are 1 1/2" NPT suction, 1 1/4" NPT discharge. These pumps are only available in clockwise rotation.

NOTE: Dimensions shown in parentheses are millimeters; others are inches.

DIMENSIONS— SERIES SG-07, SGN-07 C-FLANGE MOTOR MOUNT ("M" DRIVE)

INDICATE MOTOR



MOTOR FRAME SIZE		D	E	F	H	MC	MD	APPROX. DRIVE ① EQUIP. SHIPPING WEIGHT (POUNDS)
56C	in	3.50	2.44	1.50	.34 SLOT	2.56	4.88	41
	mm	89	62	38	9	65	124	
143TC	in	3.50	2.75	2.00	.34	2.88	4.88	60
	mm	89	70	51	9	73	124	
145TC	in	3.50	2.75	2.50	.34	2.88	4.88	70
	mm	89	70	64	9	73	124	
182TC	in	4.50	3.75	2.25	.41	3.62	5.37	108
	mm	114	95	57	10	92	136	
184TC	in	4.50	3.75	2.75	.41	3.62	5.37	123
	mm	114	95	70	10	92	136	
213TC	in	5.25	4.25	2.75	.41	4.50	6.26	161
	mm	133	108	70	10	114	159	
215TC	in	5.25	4.25	3.50	.41	4.50	6.26	195
	mm	133	108	89	10	114	159	

① Drive equipment shipping weight includes typical TEFL motor, pump/motor adaptor, and couplings. (If a more accurate drive equipment shipping weight is required, consult factory with complete motor specifications.) For total unit shipping weight, add the drive equipment shipping weight to the pump shipping weight shown on the pump specification chart.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 79538-C31-16

Date: June 21/06 By: 

FV-500 SPCL KEY BASE TANK w/ SADDLES

REV		P. NO.		DESCRIPTION		QTY		* SIZE		COMMENTS/MTL.		WT.	
REV		ITEM		P. NO.		DESCRIPTION		QTY		* SIZE		COMMENTS/MTL.	
BILL OF MATERIAL													
PRIMARY		280217		PRIMARY HEAD		2		.250" x116.0" O.D.		TYPE: FLG & OFF		800	
3		104517		PRIMARY SHELL		3		.250" x96.0" x367.0"		TYPE: OFFSET		2500	
2		280266		WEAR PLATE		2		.250" x16.0" x16.0"				20	
SECONDARY													
4		280218		SECONDARY HEAD		2		.250" x117.0" O.D.		TYPE: FLG & OFF		810	
5		105647		SECONDARY SHELL		1		.250" x60.0" x327.0"		TYPE: OFFSET		1395	
105648		105648		SECONDARY SHELL		1		.250" x72.0" x327.0"		TYPE: OFFSET		1670	
105635		105635		SECONDARY SHELL		2		.250" x96.0" x327.0"		TYPE: OFFSET		2230	
FITTINGS													
8		271320		WELD FLANGE		1		1/4" NPT		A181		0.1	
9		272514		PLUG		1		1/4"		STEEL		0.1	
271535		271535		COUPLING - FULL		1		2" NPT		STD.		1.5	
272539		272539		PLUG		1		2" NPT		C.I.		1.5	
10		271409		WELD FLANGE		1		4" NPT		A181		2	
272547		272547		PLUG		1		4" NPT		C.I.		3.5	
11		271409		WELD FLANGE		1		4" NPT		A181		2	
280710		280710		INLOAD PIPING		1		3"		DWG: 18866-IP		500	
12		266190		COUPLING - FULL		1		1/4" NPT - REF.		3000# (SP. BX DRAIN)		0.5	
280145		280145		DRAIN PLUG ASSEMBLY		1		REF.		BRASS		0.2	
272211		272211		LUG		1		REF.				0.2	
280128		280128		RETAINING CLIP		1		1-1/4" NPT - REF.		A181		0.2	
271325		271325		WELD FLANGE		1		1-1/4" NPT		C.I.		0.6	
272531		272531		PLUG		1		4" NPT - REF.		A181		0.6	
14		271409		WELD FLANGE		1		4" NPT		P.V.C.		2	
273436		273436		VENT PLUG		1		4" NPT				1.5	
15		271397		WELD FLANGE		1		3" NPT		A181		1.5	
272543		272543		PLUG		1		3" NPT		C.I.		2	
16		271397		WELD FLANGE		1		3" NPT		A181 (VENT)		1.5	
272543		272543		PLUG		1		3" NPT		C.I.		2	
17		271327		WELD FLANGE		1		2" NPT		A181		1	
271820		271820		REDUCING BUSHING		1		2"X1-1/2" DBL.TAP		MALLEABLE IRON		1	
280169		280169		WAT.DRWOFF PIPE ASSY		1		1-1/2" STD x116.4" LG.		A63 - T.O.E. ASSY		26.5	
272537		272537		PLUG		1		1-1/2" NPT		C.I.		1	
18		280180		WAT. DRAWOFF BRACKET		1		.25" x4.0" x8.0"		A36 FLAT BAR		2.5	
20		271327		WELD FLANGE		1		2" NPT		A181 (INSPEC.)		1	
272539		272539		PLUG		1		2" NPT		C.I.		1.2	
21		271409		WELD FLANGE		3		4" NPT		A181		2	
272547		272547		PLUG		3		4" NPT		C.I.		3.5	
SHIP LOOSE ITEMS													
100		273443		GAUGE STICK		1		12'				3	
101		273509		GAUGE OPENING KIT		1						HARDWOOD	
102		273540		ANTI-SYPHON VALVE KIT		1		2"					
103		276863		OPEN VENT CAP		1		3"					
104		280028		STAIR & PLATFORM		1		FV-500					
PAINT - EXTERIOR													
272710		272710		PRIMER (LITERS)		30		GREY EPOXY		2-PART		1	
530415		530415		PAINT (LITERS)		28		WHITE URETHANE		5:1 D.T.M.		1	
TOROMONT CAT POWER													
Dwn.		SW		TOROMONT CAT POWER		P.N.		026154		MODEL		FV-500TK	
Chk.		NK		R18866		REV:		0		TOTAL WT. (LBS)		20518	
App.		NK				DATE		06.05.20		BRANCH		63	

* All dimensions in INCHES unless otherwise mentioned.
Refer to ENG. STD. DRAWING ES15312 for assy details.

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REVIEWED

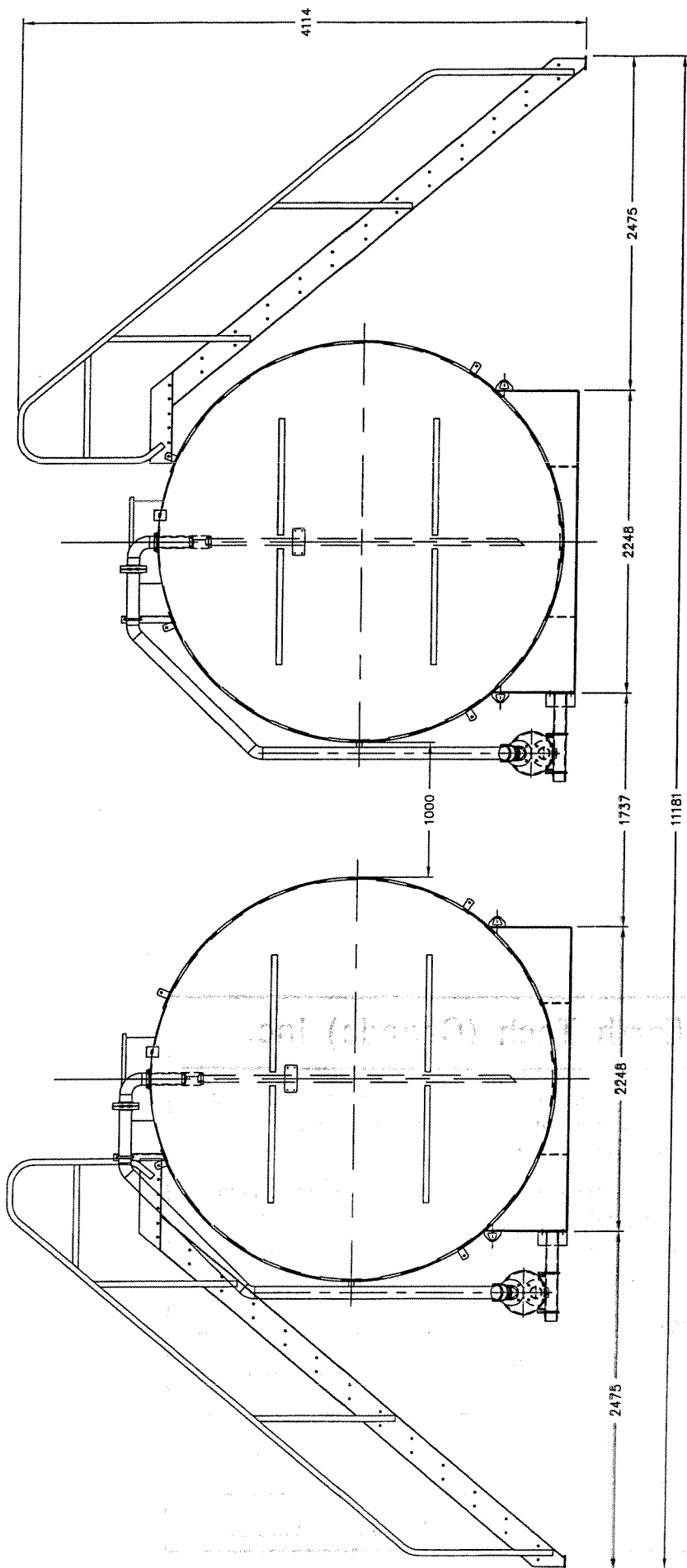
REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

NOT REVIEWED

Project No. 79538-0346

Date: June 21/06 By: (Signature) (MCH)



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REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

NOT REVIEWED

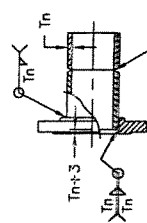
Project No. 79538-346

Date: June 21/06 By: (Mech)

PK	QTY	PART NO.	SIZE	RATING	DESCRIPTION	MATL.	REMARKS
1A	1	273511	1 1/2" x 3/8"		DROP TUBE	ALUM.	CUT @ 45°
1B	1	273566	2" x 3/8"		FILL LIMITER	ALUM.	CAB F-35 MODIFIED
2	1	270309	3/8"	STD	RIPPLE x 279 LG. - T.B.E.	A53	
3	1	264587	1/2" x 3/8"	125#	BUSHING D.T. - NPT	C.I.	
4	1	270309	3/8"	STD	NIPPLE x 56 LG. - I.O.E.	A53	
5	2	550189	3/8"	STD	WELD ELBOW x 90° L.R.	A234	
6	1	270309	3/8"	STD	PIPE x 78 LG.	A53	
7A	1	271447	3/8"	STD	RFM FLANGE	A105	
7B	3	271389	3/8"	150#	RFSD FLANGE	A105	
8	5	271860	3/8"	150#	C/W GASKET	A105	
9	12	1566005	65/8x3.5"		C/W STUD	AR20-L7M	GARLOCK GYLON 3510
10	4	530204	65/8x4.5"		C/W STUD	A194-7M	WAFER VALVE
11	32	1566013	65/8"		C/W NUT	A53	
12	8	270309	3/8"	STD	PIPE x 410 LG.	A53	
13	1	270309	3/8"	STD	PIPE x 1190 LG.	A53	
14	3	550190	3/8"	STD	WELD ELBOW x 45° L.R.	A234	
15	12	270309	3/8"	STD	PIPE x 1950 LG.	A53	
16	13	270309	3/8"	STD	PIPE x 130 LG.	A53	
17	20	530540	3/8"	150#	CHECK VALVE - WAFER	STL	MRSON #646
18	22	280711	1/2"	STD	SPILL PREVENTER TANK	A53	SEE DWG. 280711
19	23	530150	3/8" NPS	150#	BALL VALVE RF FLANGE	D.I.	
20	24	271584	3/8" NPT	3000#	HALF COUPLING	A105	
21	25	016268-01	3/8" NPT		CAMLOCK ADAPTOR 3MCM	ALUM.	
22	26	273594	1 3/8" NPS		CAMLOCK DUSTCAP 3MCM	ALUM.	
23	52	028476-07	3/8" NPS		FLEXIBAR PIPE CLAMP	GALV	
24	53	107125			ANG [1/4" x 2" x 2"] x 371 LG.	A36	SEE DETAIL
25	55				TANK MNT BRKT		SEE DWG. 18866-1
26	60	434513	3/8" NPS	STD	U-BOLT w/NUTS/WASHERS	ZN PL	
27	61	156528	1/2" x 2.5"	GR 2	BOLT - HEX	ZN PL	
28	62	271709	1/2"	GR 2	NUT - HEX	ZN PL	
29	63	154981	1/2"		WASHER - FLAT	ZN PL	

SEE CALLED FOR 100 RD UNLOADING FITTINGS TO BE CONFIRMED

- NOTES:
1. ALL THREADED PIPING TO BE SEALED WITH GASOLIA OR EQUIVALENT.
 2. ALL PIPING TO BE PRE-ASSEMBLED AND SHIPPED INSTALLED.
 3. TEST ALL PIPING TO MIN. 200 MPA (30 PSI).
 4. FINISH: SAME AS TANK.



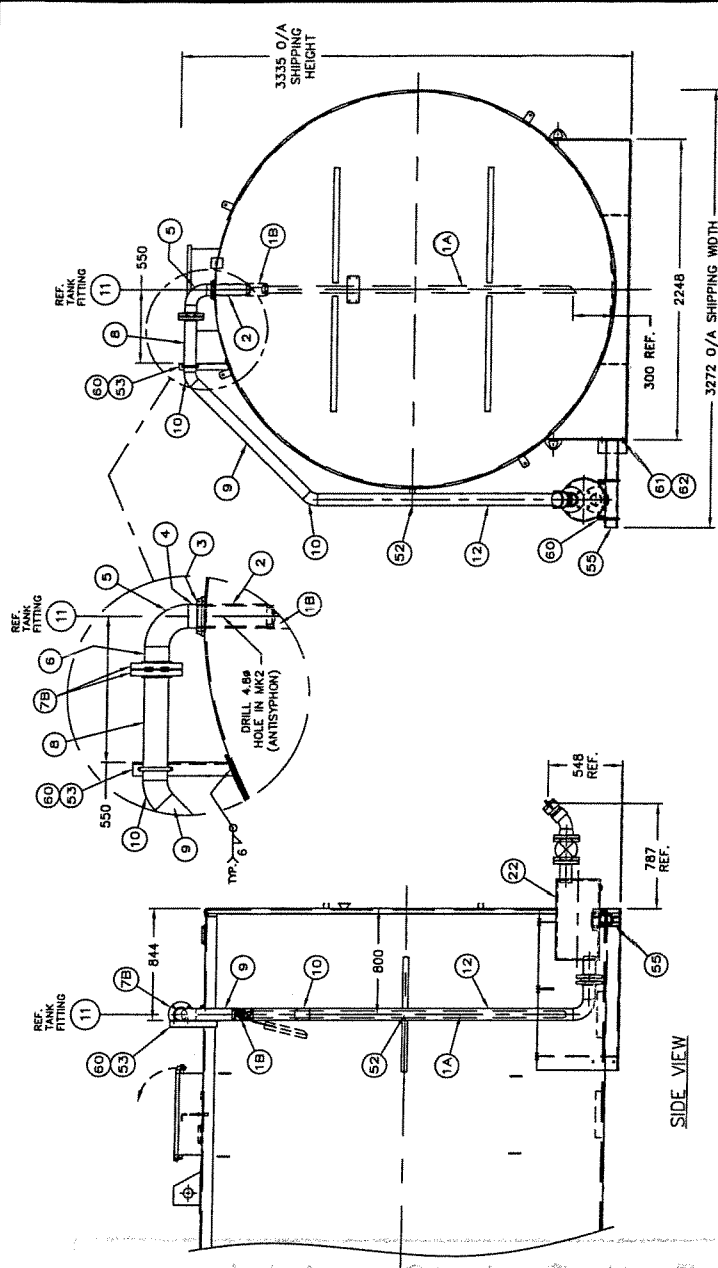
PIPE WELD DETAIL (3'')

WELD MAP: ALL FILLET/GROOVE WELDS PER WPD# 312-1

!!! IMPORTANT !!!
CHECK ALL PIPE/BRACKET DIMS FOR EXACT LENGTHS BEFORE MAKING ANY CUTS.

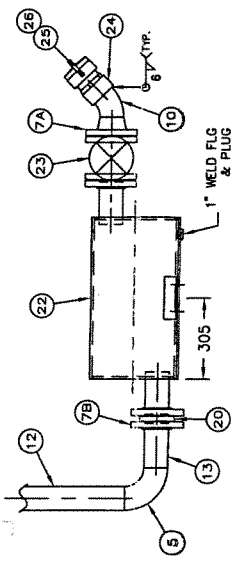
ALL DIMENSIONS HAVE A TOLERANCE OF ± 3mm, UNLESS OTHERWISE SPECIFIED.

METRIC DWG - ALL DIMENSIONS IN MM - IMPERIAL UNITS IN []

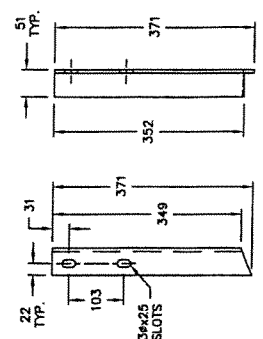


SPILL PREVENTER FRONT VIEW

END VIEW



SPILL PREVENTER



MK. 53 DETAIL

		THIS DRAWING IS THE EXCLUSIVE PROPERTY OF WESTTEEL AND ALL RIGHTS ARE RESERVED. NO PART OF THIS DRAWING IS TO BE REPRODUCED IN ANY MANNER WITHOUT WRITTEN PERMISSION FROM WESTTEEL LTD.	SCALE: N.T.S. DATE (Y/M/D): 06.05.20 LOCATION: BRANCH 63
DRAWING TITLE: (3'') INLOAD PIPING SYSTEM FOR FV-500TK SPCL FUEL VAULT TANK		SIZE: B DRAWING NO.: 18866-IP	PART NO.: TORONTO CAT POWER 280710 REV. NO.: 0
CUSTOMER: TORONTO CAT POWER		REVISIONS/APPROVALS:	BY:
NO.	DATE	REVISIONS/APPROVALS	BY

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REVIEWED _____

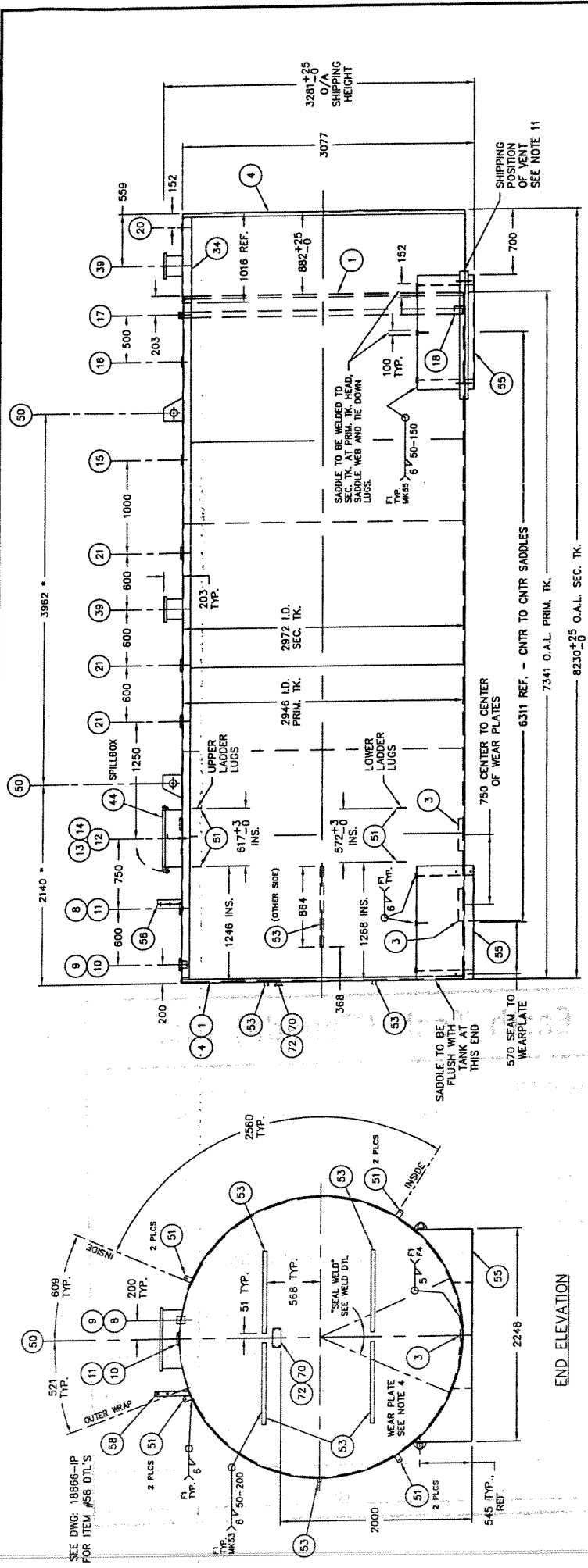
REVIEWED AS MODIFIED _____

REVISE AND RE - SUBMIT _____ ✓

NOT REVIEWED _____

Project No. 79538-C3116

Date: June 21/06 By: (Signature)



ALL DIMENSIONS HAVE A TOLERANCE OF ± 5mm, UNLESS OTHERWISE SPECIFIED.

ELEVATION

2438 (96") 2438 (96") 2438 (96")

PRIMARY SHELL OFFSET DETAIL

SEE DESIGN STANDARD ES 15360 FOR DECAL/STENCIL LOCATIONS

SEE DESIGN STANDARD ES 15312-W FOR WELD/INSTALLATION DETAILS FOR BOM. SEE EXCEL FILE 18866_BOM.

All dimensions are in SI Units (millimeters) unless otherwise specified. Brackets [] = Imperial measure.

UNDERWRITERS LABORATORIES OF CANADA LISTED FOR FLAMMABLE LIQUIDS - ULC 5653

NO. [] CAPACITY []

CONSTRUCTED TO ACCORDANCE WITH []

ITEM 70 DTL

WESTEEL LTD.

NAMEPLATE DETAIL

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SCALE: DOWN (Y.M.D.) LOCATION: N.T.S. 06.05.20 63

SIZE: DRAWING NO. 18866

REV. NO. 0

FW-500TK SPL SYSTEM TANK MAX FILL CAP-47,500L

2946 I.D.x 8230 O.A.L.

TOROMONT CAT POWER

- NOTES:
- AIR TEST PRIMARY TWICE BEFORE WRAPPING: 20-30 kPa (3-4 PSI)
 - Secondary offer oil welding complete (without skids).
 - 1 HOUR HOLD TEST ON PRIMARY PRESSURE SEC. secondary pressure 1.5 psi less than primary. ANY PRESSURE DROP IN EITHER GAGE INDICATES A PROBLEM.
 - WELD PIPING BRACKETS TO TANK BEFORE BLASTING/PAINTING TANK.
 - WHERE POSSIBLE STAGGER PRIMARY AND SECONDARY CIRC. SEAMS.
 - LOCATE WEAR PLATE BEFORE CLOSING TANK.
 - LOGGATION MAY BE WELDED TO AVOID SEAMS.
 - INTERIOR FINISH: SEE W.O. FOR DETAILS.
 - STANDARD EXTERIOR FINISH: BLAST AND PAINT PER WESTEEL COATING WCS-2.
 - CHECK ALL INTERNAL PIPING FOR SPECIFIED CLEARANCE FROM BOTTOM OF TANK.
 - ENSURE ALL INTERNAL PIPE THREADS ARE DOPED WITH PRODUCT SUITABLE FOR FUELS.
 - INSTALL DIPSTICK HOLDER COVER, LABELS & EMERGENCY VENT GASKET AFTER PAINTING HAS BEEN COMPLETED.
 - ENSURE SURFACE IS CLEAN BEFORE APPLYING DECALS.
 - DO NOT APPLY OVER ANY SEAMS.
 - WRAP VENT RISER IN CARDBOARD & STRAP THROUGH BOLT HOLES IN SADDLE.
 - PLACE OWNER'S MANUAL & PAINT KIT IN PLASTIC BAG IN SPILL BOX.
 - ESTIMATED SHIPPING WEIGHT: 9,230 KGS (20,300 LBS).
 - VOLUME: ACTUAL CAPACITY: 50,280 litres
 - MAXIMUM FILL CAPACITY: 47,700 litres

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REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

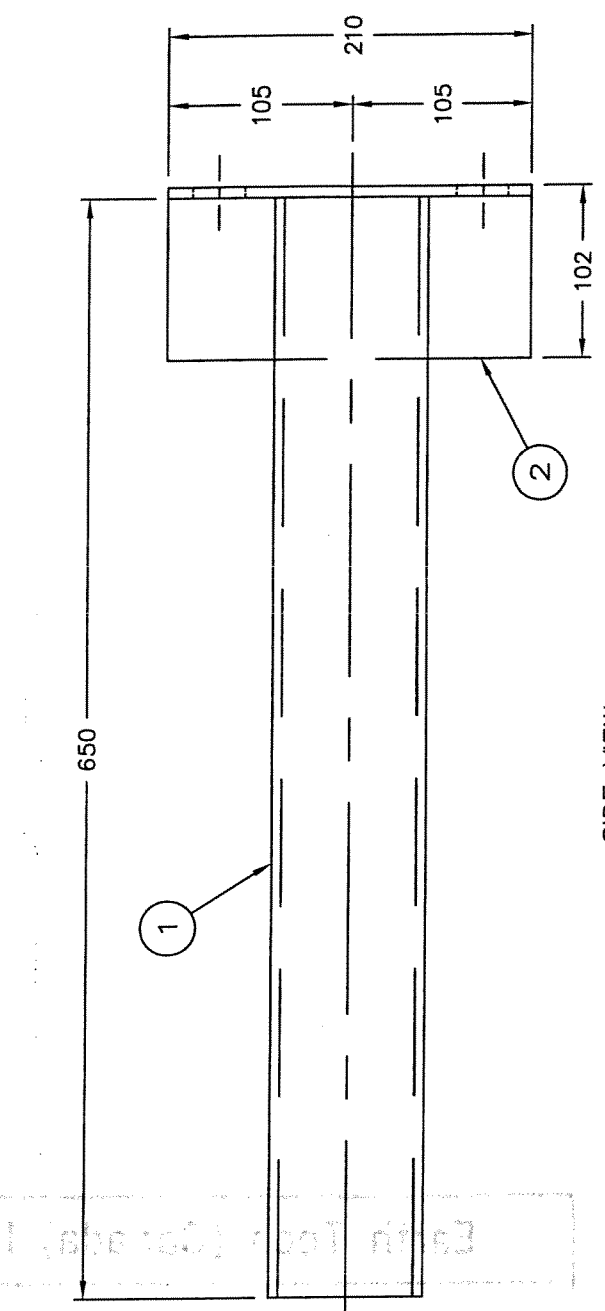
NOT REVIEWED

Project No. 79538-(31)-16

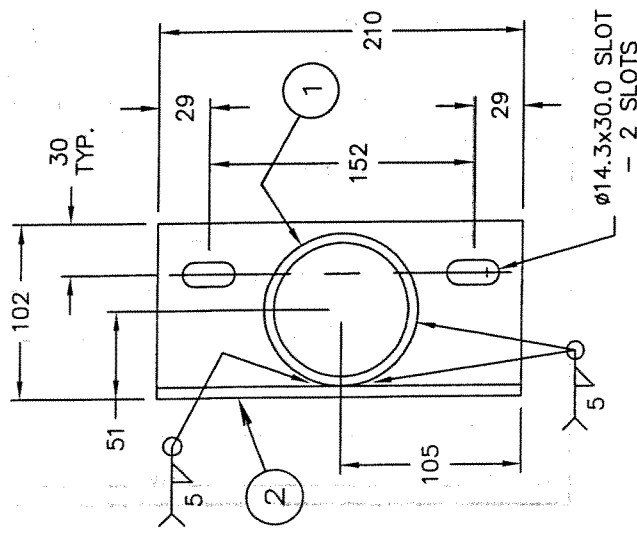
Date: June 21/06

By: (Signature)

MK	QTY.	PART. NO.	DESCRIPTION	MAT'L	WGHT
1	1	270309	PIPE - 76Ø [3"] x 650 LG. - STD.	A53	
2	1	107129	L - 6.4 x102 x102 [1/4"x4"x4"] x 210 LG.	44W	
TOTAL WEIGHT (KG):				8.5	



SIDE VIEW



END VIEW

- NOTES:
- BLAST TO SP6 (COMM.) AND APPLY ONE COAT BLUE URETHANE 5:1 D.T.M.
 - PIPE TO BE CENTERED ON MK 2.

NO.	DATE	REVISION	E.C.R.	BY	CH.

DIMENSIONS SHOWN ARE IMP. UNITS SHOWN IN BRACKETS (UNLESS OTHERWISE NOTED)		DESNO. DWN. SW CHKD. NIK APPD. -	WESTEEL THIS DRAWING IS THE EXCLUSIVE PROPERTY OF WESTEEL NO PART OF THIS DRAWING MAY BE USED OR REPRODUCED IN ANY MANNER WHATSOEVER WITHOUT WRITTEN PERMISSION FROM WESTEEL	SCALE N.T.S. CLIENT	DWN. (Y.M.D.) 06.05.20 EQUIP. NO.	LOCATION 63
DIMENSIONS: IMPERIAL (in.) .XX ± .03 .XXX ± .010 ANGULAR: ± 1°		DRAWING TITLE SPILL PREVENTER MNT BRACKET ABOVEGROUND TANKS	SIZE A	WESTEEL DRAWING NO. 18866-1	REV. NO. 0	
COMPANY TOROMONT CAT POWER		PART NO.				

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REVIEWED _____ ✓

REVIEWED AS MODIFIED _____

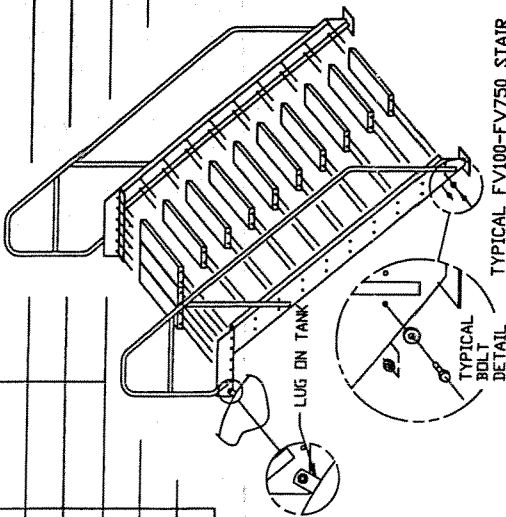
REVISE AND RE - SUBMIT _____

NOT REVIEWED _____

Project No. 79538-C31-16

Date: June 21/05 By: [Signature]

ITEM	REV	PART NO.	DESCRIPTION	UNIT WT. LBS.	MODEL AND KIT NUMBER			DWG. SIZE
					FV100-150 280026	FV250-350 280027	FV500-750 280028	
1		280250	LEFT STAIR STRINGER ASSY, FV100-150	89.1	1			
2		280251	RIGHT STAIR STRINGER ASSY, FV100-150	89.1	1			
3		280252	LEFT STAIR STRINGER ASSY, FV250-350	103.1		1		
4		280253	RIGHT STAIR STRINGER ASSY, FV250-350	103.1		1		
5		280254	LEFT STAIR STRINGER ASSY, FV500-750	132.7			1	
6		280255	RIGHT STAIR STRINGER ASSY, FV500-750	132.7			1	
7		280360	STEP PACKAGE FV100-150	65.2	1			
8		280361	STEP PACKAGE FV250-350	78.2		1		
9		280362	STEP PACKAGE FV500-750	97.8			1	
10								
				NO. OF ITEMS	3	3	3	
				TOTAL WT. (LBS)	245	285	365	



↑ ALL GALVANIZED PARTS
↑ POWDER COATED BLUE/GALV STEPS

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF VESTEEL AND ALL RIGHTS ARE RESERVED. NO PART OF THIS DRAWING MAY BE USED OR REPRODUCED IN ANY MANNER WHATSOEVER WITHOUT WRITTEN PERMISSION FROM VESTEEL LTD.		SCALE	DWN. (Y.M.D.)	LOCATION
WESTEEL		I.D.	96.04.15	61
STAIR KITS FUEL VAULT		E.P. NO.	92-119	V.O.
CUSTOMER		SIZE	DRAWING NO.	
A5954 E.C.R. BY CH.		APPD.	A 280026-8	
REVISION		CHKD.	REV. NO.	
STAIR TREADS WERE SEPARATE		NK	1	
DATE		APPD.	PRINTING DATE (Y.M.D.)	
1 93.07.30		CH. NIK		

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REVIEWED

REVIEWED AS MODIFIED

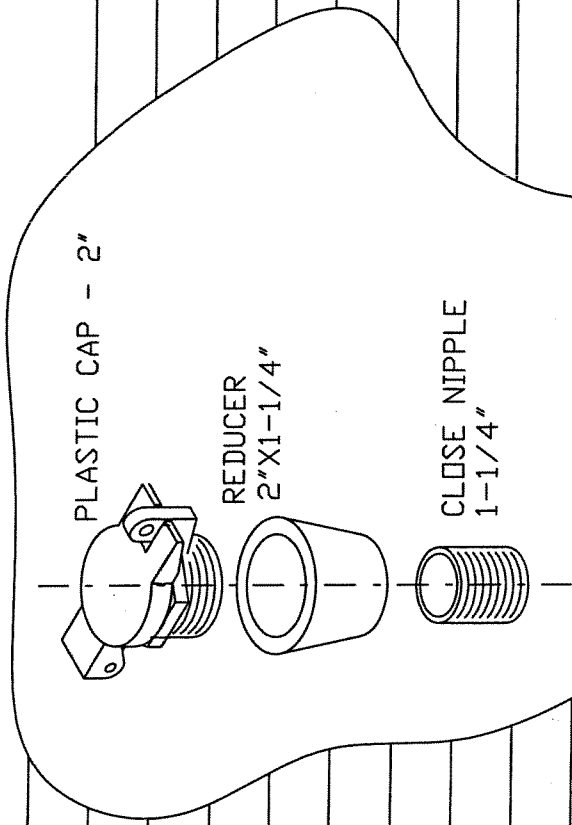
REVISE AND RE - SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: June 21/06 By: BP (MECH)

BILL OF MATERIAL

ITEM	REV	DWG/PART NO.	QTY	DESCRIPTION	UNIT WEIGHT
1		273510	1	GAUGE OPENING COVER, PLASTIC 2" MALE	.28
2		530485	1	REDUCER CPLG 2" x 1-1/4" C.I. (FxF)	1.78
3		435611	1	CLOSE NIPPLE 1-1/4" BLK. STD.	.30
4		198904	1	ACCESSORY INSTALLATION INSTRUCTIONS	-
5		185018	1	BOX 6.0" L X 6.0" W X 6.0" H	.20
					
TOTAL WEIGHT					2.6

PACKAGE ITEMS 1,2,3 & 4 IN BOX
LABEL BOX WITH KIT PART NUMBER

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DESN.	DWN.	CHKD.	APPD.	DRAWING NO.	REV.
	NIK		NIK	A	273509
DATE	E.C.R.	BY	CH.		
NO.					

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REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 79538-C3L16

Date: June 21/06 By: (Signature) (MECH)

BILL OF MATERIAL

ITEM	REV	DWG/PART NO.	QTY	DESCRIPTION	UNIT WEIGHT
1		276868	1	ANTI-SIPHON VALVE ADJUSTIBLE 5-12 FT	7.2
2		271821	1	BUSHING DOUBLE TAPPED 4"X2"X2" MALLEABLE IRON	3.1
3		266247	1	CLOSE NIPPLE 2" NPT XH	1.5
4		198904	1	ACCESSORY INSTALLATION INSTRUCTIONS	-
5					
<p style="text-align: center;">ILLUSTRATION SHOWN FOR INFO ONLY</p> <p style="text-align: center;">ADJUSTIBLE ANTI-SIPHON VALVE - 2' (5-12' HEAD) CLOSE NIPPLE 2' - XH BUSHING 4"X2"X2" MALLEABLE IRON SUCTION PIPE - 2' (SUPPLIED BY OTHERS) WELD FLANGE - 4' NPT</p>					
TOTAL WEIGHT					11.8

OPEN ANTSIPHON VALVE CARTON AND PLACE ITEMS 2,3 & 4 INSIDE RESEAL CARTON

WESTEEL		THIS DRAWING IS THE EXCLUSIVE PROPERTY OF WESTEEL AND ALL RIGHTS ARE RESERVED. NO PART OF THIS DRAWING MAY BE USED OR REPRODUCED IN ANY MANNER WHATSOEVER WITHOUT WRITTEN PERMISSION FROM WESTEEL LTD.		DATE (Y.M.D) 93.08.17	FILE NO. 92.119
DESIGN. DWN. NK	CHKD. NK	APPD. NK	DRAWING TITLE ANTI-SIPHON VALVE KIT 5-12' ABOVEGROUND ULC 601 TANKS	DRAWING NO. 273540	REV. 0
NO.	DATE	E.C.R.	BY	CH.	

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REVIEWED _____ ✓

REVIEWED AS MODIFIED _____

REVISE AND RE - SUBMIT _____

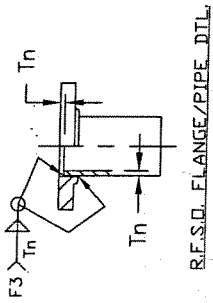
NOT REVIEWED _____

Project No. 79538-C31-16

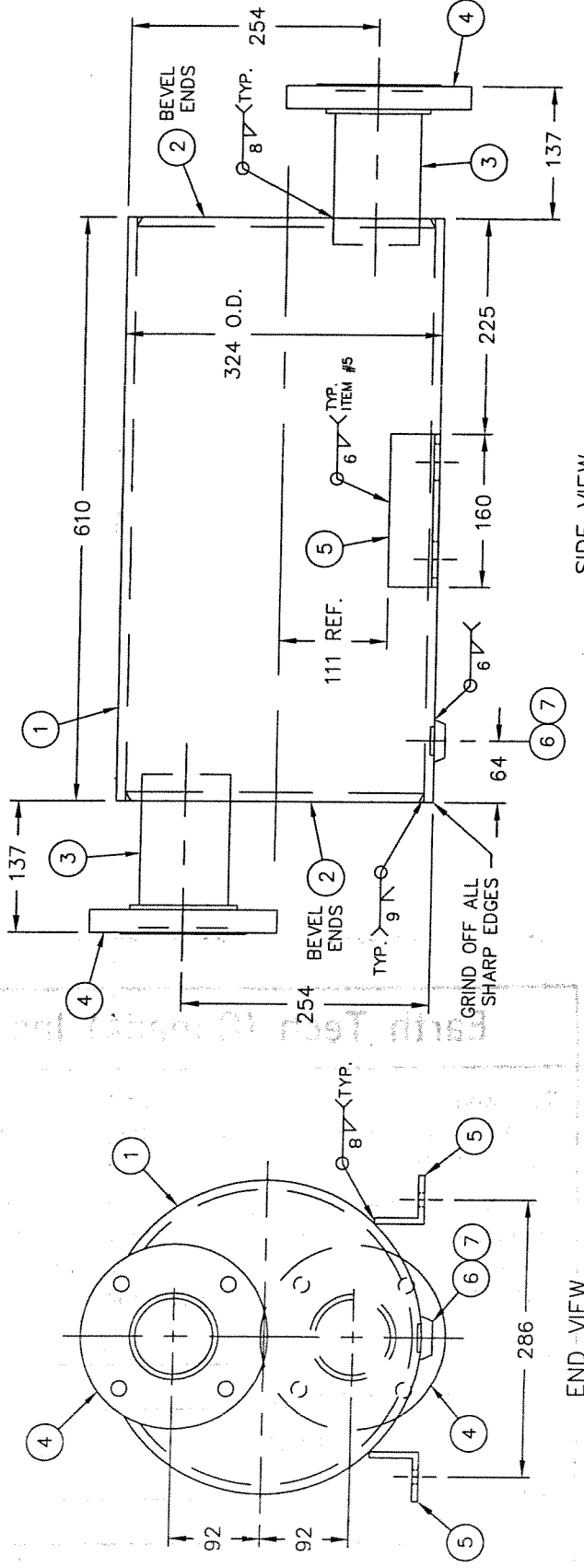
Date: June 21/06 By: (Signature) MECH

- NOTES:
 1. AIR TEST TO 70 kPa
 2. FINISH: SAME AS MAIN PIPING DRAWING.
 3. APPROX. VOLUME: 43 L (9.4 I.G.)
 4. EST. WEIGHT: 69 KGS (152 LBS)

ALL DIMENSIONS HAVE A TOLERANCE OF ±.2mm, UNLESS OTHERWISE SPECIFIED.



MK	QTY	PART NO	DESCRIPTION	MAT'L	REMARKS
1	1	107347	[12"] STD PIPE x 610 LG.	A53	
2	2	270445	9.5 PLT x 300 DIA.	A283C	END CAPS
3	2	107392	[3"] XH PIPE x 160 LG.	A106B	
4	2	271399	[3"] RFSO FLANGE -- 150#	A105	
5	2	107125	L - 6.4 x [2"x2"] x 160 LG.	44W	MNTNG ANGLE
6	1	271322	[1/2"] WELD FLANGE -- NPT	A181	
7	1	272517	c/w [1/2"] PIPE PLUG -- NPT	C.I.	



ITEM #4 DETAIL

METRIC

NO.	DATE	REVISION	E.C.R.	BY	CH.

WESTEEL
 THE DRAWING IS THE EXCLUSIVE PROPERTY OF WESTEEL
 NO PART OF THIS DRAWING IS TO BE REPRODUCED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION FROM WESTEEL.
 S.I. UNITS ARE SHOWN. DECIMAL VALUES ARE SHOWN IN I.I.

DRAWING TITLE: SPILL PREVENTER FOR BOTTOM LOADING SYSTEM

DESIGN STANDARD: PART #

CUSTOMER: B

SCALE: N.I.S.
 I.C.

DRAWING NO: 280711

REV. NO: 0

DRAWN (Y.I.A.D.): 06.04.10
 E.P. NO. W.O.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE - SUBMIT _____

NOT REVIEWED _____

Project No. 79538-C31-16 _____

Date: June 21/06 By: (Signature) MECH _____



**BILL OF MATERIAL
MODEL CATERPILLAR 3516B**

Three Caterpillar Model 3516B Diesel Electric Generating Sets each rated at 4160 Volt, 3 Phase, 0.8 P.F., 60 Hertz, 2000 K.W., 2500 K.V.A Continuous Standby Power complete with 5 KV Switchgear as per the following:

Each generating set will consist of the following:

Standard Equipment:

AIR INLET SYSTEM

Air Cleaner; single element canister type with service indicator

CONTROL PANELS

Control Panel*

EMCP3 controls including:

Emergency stop pushbutton

EMCP3.1 controller including:

24-volt DC operation

Environmental sealed front face

Text alarm/event descriptions

Warning/shutdown with common LED indication of shutdowns with indicating lights for:

Low oil pressure

High coolant temperature

Overspeed

Emergency stop

Failure to start (overcrank)

Low coolant level

Generator mounted - rear facing

Controls:

Speed adjust

Auto/start/stop control

Engine cool-down timer

Engine cycle crank

Alarm acknowledge

Lamp test

True RMS AC metering, 3-phase, +/-2% accuracy

Digital indication for:

RPM

DC volts

Operating hours

Oil pressure (psi, kPa or bar)

Coolant temperature

Volts (L-L & L-N), frequency (Hz)

Amps (per phase & average)

4 programmable digital inputs

4 programmable digital outputs

COOLING SYSTEM

See TMI for heat rejection, pump performance, air flow, and ambient capability information.

SCAC - 3500B only

Water Temp to SCAC pump:

Low BSFC standard PGS are provided with radiators for 90 C (194 F).





Radiator fan and fan drive
Fan and belt guards
Coolant drain line with valve
Coolant level sensors
Caterpillar Extended Life Coolant

EXHAUST SYSTEM

Exhaust manifold - dry - single - 8 in.
203 mm (8 in) ID round flanged outlet.

FUEL SYSTEM

Secondary fuel filters
Fuel cooler
Flexible fuel lines - shipped loose
Fuel priming pump

GENERATORS AND GENERATOR ATTACHMENTS

3 Phase Brushless, Salient Pole
Permanent Magnet Excited
6 lead (> 1000 kVa @ 50 Hz and > 1250 ekW @ 60 Hz)
Permanent Magnet generators include Caterpillar's digital voltage regulator (CDVR). CDVR includes KVAR/PF modes, RFI suppression, min/max exciter limiter and exciter diode monitor.
Class H insulation, Class F temperature rise at 40C ambient
(105C prime/130C standby)(LV)(MV)
Reactive droop
Bus bar connections, right hand mounted, bottom entry
(60 Hz models: NEMA standard hole pattern)
Winding temperature detectors
Anti-condensation space heaters
(820 Frames: 120/240 VAC, 1200 W)

GOVERNING SYSTEM

ADEM III

LITERATURE

English

LUBE SYSTEM

Lubricating oil
Gear type lube oil pump
Integral lube oil cooler
Oil filter, filler and dipstick
Oil drain lines and valve
Fumes disposal

MOUNTING SYSTEM

Rails - engine/generator/radiator mounting.
Rubber anti-vibration mounts (shipped loose).

STARTING/CHARGING SYSTEM

24-volt electric starting motor
Battery rack w/cables
Battery disconnect switch





GENERAL

PAINT

Caterpillar Yellow with high gloss black rails & radiator

RH Service

Flywheel and Flywheel housing-SAE No. 00

SAE Standard Rotation

Description

3516B DIESEL ENGINE LO BSFC

60HZ 4160 VOLTS

STANDBY POWER APPLICATION

2000 EKW W/FAN

EMCP 3.3 CONTROL PANEL - B EMCP 3.3 PANEL. PROVIDES POWER METERING, PROTECTIVE REALYING, REVERSE POWER, ENHANCED ENGINE MONITORING AND DISPLAY FOR GENERATOR BEARING AND STATOR TEMPERATURES. MODBUS COMMUNICATIONS AS STANDARD

GENERATOR 825 FRAME PMG 1 BEARING

GENERATOR MONITORING PACKAGE. PROVIDES GENERATOR BEARING TEMPERATURE AND STATOR TEMPERATURE MONITORING CAPABILITIES. PARAMETERS VIEWABLE ON THE EMCP 3.3

CONTROL PANEL MOUNT REAR (STD)

CUSTOMER CONNECTION MTG RH STD

REMOTE SPEED ADJUST

SPARE DISCRETE I/O PACKAGE

PANEL LIGHTS

1ST LOCAL ANNUNCIATOR NFPA 110/CSA282

LOCAL PC MONITORING

OPTIONAL MODULE HARNESS

CURRENT TRANSFORMER, 400:5 RATIO

ENGLISH LANGUAGE OPTION

EXTRA ENGLISH LIT (CD) (1-6)

ENGLISH PAPER PARTS BOOK (1-6)

WATER SEPARATOR

HEAVY DUTY ELECTRIC STARTING MOTOR DUAL 24V

24V BATTERY SET-DRY

JACKET WATER HEATER WITH CIRCULATING PUMP-DUAL 6 KW EACH AT 240 VAC

ELECTRIC PRELUBE PUMP 24 VOLT

STANDARD GEN SET TORSIONAL VIBRATION REPORT

CSA TEST AND CERTIFICATION

PGS TEST REPORT @ 0.8 PF. UNIT WILL BE FACTORY TESTED WITH A REACTIVE LOAD BANK AS SPECIFIED. DATA REPORTED FOR RPM, FREQ, VOLTAGE, L TO L AND L TO N, CURRENT FOR ALL THREE PHASES AND ALL VOLTAGES AS REQUIRED.

1000A MV BUS BARS LEFT (NEMA)

EMPTY ENCLOSURE RIGHT

BOTTOM CABLE ENTRY

1000A MV BB REMOVAL-RH (NEMA)

GROUNDING CONNECTION RH-LH

LINEAR SPRING ISOLATORS

*Drawing shows 600:5
for line CT's
and 300:5 for NGR
CT
is it the NGR
or line CT?*





Local

600 US GALLON DOUBLE WALL, CLOSED TOP DIKED SUB BASE FUEL TANK
C/W LOCKABLE FUEL CAP, FILL/SPILL CONTAINMENT BOX, DIP TUBE ASSEMBLY,
MECHANICAL FUEL GAUGE, LEVEL SWITCHES AND ALARMS, LEAK DETECTOR, 1 ¼"
NORMAL VENT, 1 ¼" NORMAL VENT AND WHISTLE, 6" EMERGENCY VENT.
RACOR FUEL WATER SEPARTORS
EXTRA PAINT
VULCAN BATTERY CHARGER RATED AT 40 AMP, ALARM PACKAGE, AUTO EQ TIMER,
GROUND FAULT ALARM, DIGITAL METERS, AND TIME DELAY AC FAIL
HYDROMETER, THERMOMETER, WRENCH, PLASTIC TOP UP BOTTLE AND SPARE CABLE
CONNECTORS
CAT BATTERY RACKS AND RUBBER BATTERY CASE
SILEX CRITICAL GRADE EXHAUST SILENCER AND FLEXIBLE EXHAUST CONNECTIONS,
CAT FLANGES ONE END, ASA OTHER END. INLCUDES HARDWARE.

Labor

LOAD BANK TEST IN SHOP, INCLUDES 4 HOUR LOAD TEST. LABOR TO INSTALL 4160
VOLT TEST CABLE AND HI POT CABLE AS REQUIRED.
MEGGAR TESTING OF GENERATOR SET
VIBRATION TESTS AS SPECIFIED
STRIP CHART RECORDING
WRITE REPORTS
INSTALL PRELUBE PUMP
CRANE TO UNLOAD UNIT AND LOAD UNIT IN YARD

LOT ADDITIONAL EQUIPMENT AND SERVICES INCLUDED IN OUR PROPOSAL:

SPARE PARTS CONSISTING OF FOUR OIL, FUEL, AND AIR. TWO VEE BELT SETS. FUSES
FOR GEN SET CONTROL PANEL
GEN SET TORSIONAL VIBRATION REPORT
LOT TRAINING SESSIONS CONSISTING OF THREE EIGHT HOUR TRAINING SESSIONS,
AND TRAINING MANUALS. CONDUCTED BY A PROFESSIONAL TOROMONT
INSTRUCTOR
VIDEO TAPE OF TRAINING SESSION
TWELVE (12) OPERATION AND MAINTENANCE MANUALS
DIESEL FUEL FOR TESTING PLUS 20% ADDITIONAL, 15,000 LITRES
TWO 50,000 LITRE OUTDOOR FUEL VAULTS, DOUBLE WALL, 110% SECONDARY
CONTAINMENT CONSTRUCTED TO ULC-S653. INLCUDES CLAY AND BAILEY FILL
LIMTER C/W ALUM. DROP TUBE, 3" PIPING, 3" SWING CHECK VALVE, 12 X 24 SPILL
PREVENTER, 3" BRASS GATE VALVE, 3" KAMLOK CAP AND COLLAR. GAUGE STICK DIP
OPENING, 2" ADJUSTABLE ANTI-SYPHON VALVE (TOP MOUNT), 3" DIAMETER VENT
PIPE, 3" OPEN VENT CAP, STAIRS C/W HAND RAILS AND PLATFORM, GAUGE STICK,
PAINT TOUCH UP KIT.
FUEL PUMPING SYSTEM, CONSISTS OF TWO VIKING PUMP MODELS SG-40711-GOV
WITH 5 HP MOTOR. SHIPPED LOOSE FOR INSTALLATION BY OTHERS.
OPW GALAXY 120 CONSOLE FUEL MONITORING AND CONTROL PACKAGE. INCLUDES
LEAK SENSORS, SMARTTALK SOFTWARE, MAGNETOSTRICTIVE PROBES FOR LARGE
TANKS, AND LEVEL SENSORE IN EACH DAY TANK. SHIPPED LOOSE FOR INSTALLTION
BY OTHERS
ENERVISTA SOFTWARE PACKAGE *INSTALLED ON PC (supplied)*
HI POT AND MEGGAR TEST SWITCHGEAR PACKAGE.

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FRIEGHT TO SITE FOR GEN SETS AND SWITCHGEAR, OFF LOADING BY OTHERS. CLEAR ACCESS TO BE PROVIDED

FRIEGHT TO SITE FOR TWO 50,000 LITRE FUEL TANKS. INCLUDES OFFLOADING ON SITE.

CO-ORDINATION STUDY AND GROUND SYSTEM STUDY. ALL GROUND TESTING SHALL BE PERFORMED USING LEM UNILAP GEOX TEST EQUIPMENT USING THE FOLLOWING METHODS, WENNER METHOD, FALL OF POTENTIAL, AND STAKLESS CLAMPON. ALL COORDINATION, SHORT CIRCUIT AND ARC FLASH STUDIES WILL BE CONDUCTED USING EDSA TECHNICAL 2006 SOFTWARE.

6 MW LOAD BANK, CABLES, 4160:600 VOLT TRANSFORMERS FOR ON SITE LOAD BANK TEST. INLCUDES HI POT TEST FOR TEST CABLES AND CONNECTION ON SITE.

START UP AND COMMISSION GEN SET AND VERIFY OPERATION. COMPLETE ON SITE CHECKS AND VERIFICATION ON INSTALLATION

8 HOUR ON SITE LOAD TEST ON COMPLETE SYSTEM. THREE UNITS WILL BE RUN AT ONE TIME UNDER FULL LOAD. ✓



CATERPILLAR SWITCHGEAR USING POWERLYNX® 3000 TECHNOLOGY

The proposed switchgear and control system will consist of two 5kV class switchgear lineups, E100 and E200, as well as a separate arrangement of control panels housing all master and Synchronizing controls for the proposed switchgear lineups. The switchgear and controls will be interconnected via fiber optic line for overall system communications. Our proposal is as follows:

Switchgear E100:

Two (2) Utility Main Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 3000A, 50kA, Utility Main Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO ³
- 1 - Set of (2) Line-Connected VTs, standard accuracy
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Transformer management Multilin T60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.
- 1 - Utility-Grade Device 32 in a draw-out case

One (1) Bus Tie Circuit Breaker Section provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 3000A, 50kA, Bus Tie Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO ³
- 2 - Sets of (2) Bus-Connected VTs, standard accuracy
- 1 - Set of (3) CTs, standard accuracy
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Three (3) Feeder Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 3000A, 50kA, Feeder Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

configuration of parts of 1000kV can be terminated

2



Seven (7) Feeder Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 1200A, 50kA, Feeder Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Four (4) Feeder Circuit Breaker Provision Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 1200A Feeder Provision

Switchgear E200:

Three (3) Generator Main Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 1200A, 50kA, Generator Main Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 1 - Set of (2) Line-Connected VTs, standard accuracy
- 2 - Set of (3) CTs, standard accuracy (one set CTs shipped loose for generator installation)
- 1 - ION 7550 Power Meter
- 1 - Generator management Multilin G60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

One (1) Bus Tie Circuit Breaker Section provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *duct*
- 1 - 3000A, 50kA, Bus Tie Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 1 - Set of (3) CTs, standard accuracy
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

a

b

c

Two (2) Load Lug Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others. *dw*
- 1 - 1200A Load Lugs
- 1 - Sets of (2) Bus-Connected VTs, standard accuracy

3

Controls Cubicles:

Two (2) Utility Controls each as follows:

- 1 - PowerLynx® utility controls with:
Device 27/59 – Under/Over Voltage
Device 81O/U – Under/Over Frequency
Device 32 – Reverse Power
Device 25 – Synchronizing Check
Device 15 – Auto Synchronizer
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

Three (3) Generator Controls each as follows:

- 1 - PowerLynx® generator controls with:
Device 27/59 – Under/Over Voltage
Device 81O/U – Under/Over Frequency
Device 40 – Loss of Excitation
Device 32 – Reverse Power
Device 25 – Synchronizing Check
Device 15 – Auto Synchronizer
Device 65 – Governor Load Sharing, Soft Loading Control
Device 90 – VAR/PF and Cross Current Compensation Controller
- 1 - Local Start/Stop switch.
- 1 - Local Emergency Stop switch.
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

Two (2) Bus Tie Controls each as follows:

- 1 - PowerLynx® bus tie controls with:
Device 27/59 – Under/Over Voltage
Device 81O/U – Under/Over Frequency
Device 25 – Synchronizing Check
Device 15 – Auto Synchronizer
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.



- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

Ten (10) Feeder Controls each as follows:

- 1 - PowerLynx® feeder controls
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

One (1) Master Controls provided as follows:

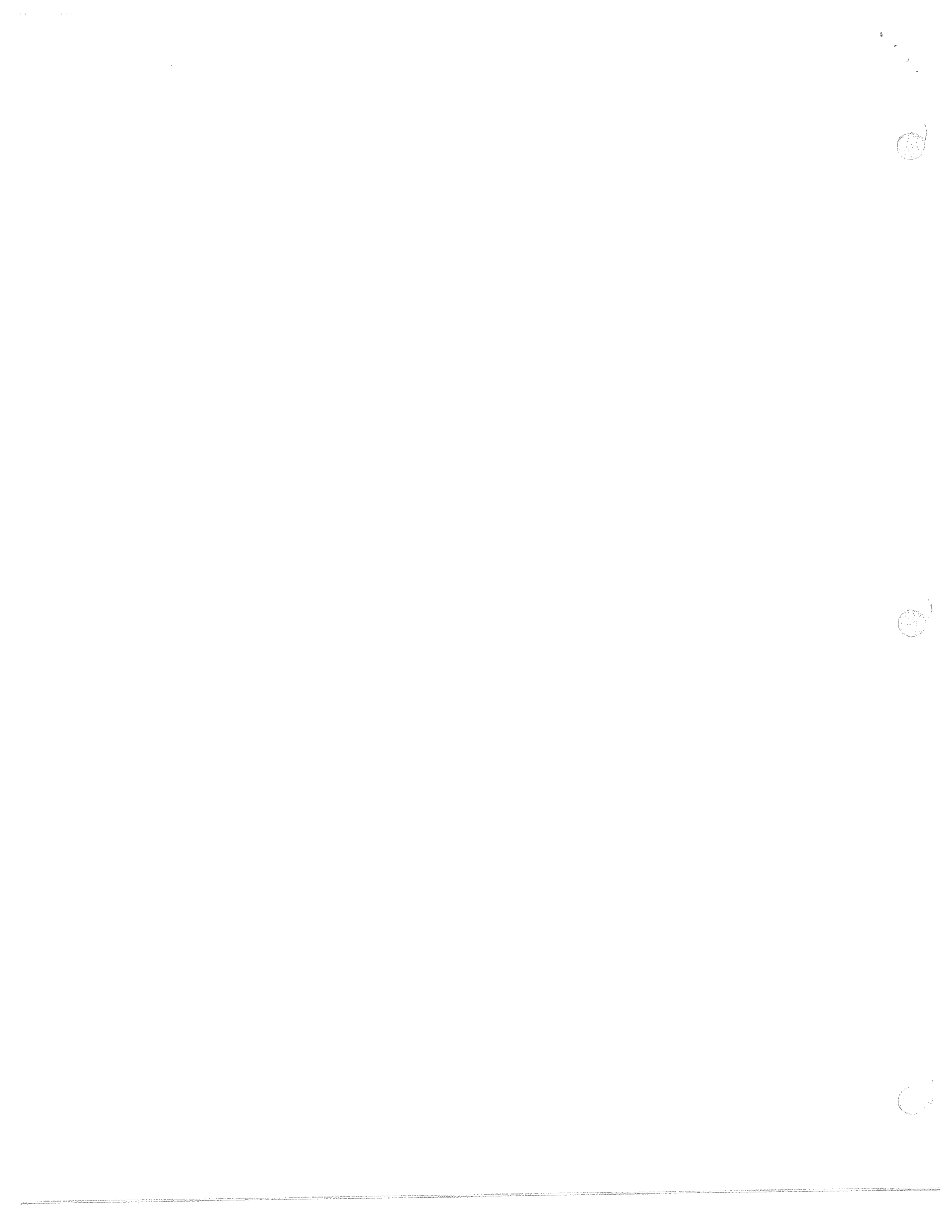
- 1 - PowerLynx® 15" Color Touch Screen
- 1 - Modbus RTU Data Export PLC
- 1 - Redundant Master Processor
- 1 - System Graphic One Line Mimic. The Mimic shall graphically show each Generator source with its respective Main CB in a one-line representation. Utilizing colored lights and digital meters, the Mimic shall actively display the following:
 - Utility CB Open/Closed/Tripped
 - Utility Volts/Amps/kW/Frequency
 - Generator CB Open/Closed/Tripped
 - Generator Volts/Amps/kW/Frequency
 - Engine Stopped/Running/Cooldown/Pre-Alarm/Shutdown
 - Engine ECS Position Off/Auto/Manual/Cooldown
 - System Output Volts/Amps/kW/Frequency
 - System Summary Alarm with horn
- 1 - PowerLynx® System Metering (3P Voltage, 3P Current, Frequency, Power Factor, KW, KVAR), Control (Normal Mode, Emergency Mode, Load Management Mode, Load Shed/Add), and Protective Relaying including:
 - Device 27/59 – Bus Under/Over Voltage
 - Device 81O/U – Bus Under/Over Frequency
- 1 - PowerLynx® System local Annunciation including:
 - Status, Light Only (Non-Latching)
 - Manual Mode (Red)
 - Auto Mode (Green)
 - Test without Load (Amber)
 - Test with Load (Amber)
 - System Not in Auto (Red)
 - Engine Running (Red)
 - Engine Stopped (Green)
 - Engine Cooldown (Amber)
 - Gen CB Open (Green)
 - Gen CB Closed (Red)
 - Gen CB Tripped (Amber)
 - Engine Pre-Alarm (Amber)
 - Engine Shutdown Fault (Red)
 - Alarm, Light and Horn (Non-Latching)
 - Emergency Mode (Red)
 - Bus Underfrequency (Red)

Q

Q

Q

- Bus Undervoltage (Red)
- Processor Fault (Red)
- Emergency Stop (Red)
- 3 - PowerLynx® Generator Metering (3P Voltage, 3P Current, Frequency, Power Factor, KW, KVAR, Synchroscope), Control, and Protective Relaying including:
 - Device 27/59 – Under/Over Voltage
 - Device 81O/U – Under/Over Frequency
 - Device 40 – Loss of Excitation
 - Device 32 – Reverse Power
 - Device 25 – Synchronizing Check
 - Device 15 – Auto Synchronizer
 - Device 65 – Governor Load Sharing, Soft Loading Control
 - Device 90 – VAR/PF and Cross Current Compensation Controller
- 3 - PowerLynx® Engine-Generator local Monitoring/ Annunciation including:
 - Status, Light Only (Non-Latching)
 - Gen Not in Auto (Red)
 - Gen Circuit Breaker Closed (Red)
 - Gen Circuit Breaker Open (Green)
 - Engine Stopped (Green)
 - Engine Running (Red)
 - Engine Cooldown (Amber)
 - Pre-Alarm, Light and Horn (Non-Latching)
 - Pre-High Coolant Temp (Amber)
 - Pre-Low Oil Pressure (Amber)
 - Low Coolant Temp (Amber)
 - Engine Low Battery (Amber)
 - Gen Fail to Synch (Amber)
 - Shutdown Alarm, Light and Horn (Latching)
 - Engine Overcrank (Red)
 - Engine Overspeed (Red)
 - Engine Low Oil Pressure (Red)
 - Engine High Coolant Temp (Red)
 - Engine Low Coolant Level (Red)
 - Engine Remote Emergency Shutdown (Red)
 - Gen Circuit Breaker Tripped (Red)
 - Gen Loss of Field (Red)
 - Gen Reverse Power (Red)
 - Gen Undervoltage (Red)
 - Gen Overvoltage (Red)
 - Gen Underfrequency (Red)
 - Gen Overfrequency (Red)



ADDITIONAL ITEMS:

- 3 - Neutral Grounding Resistor, 200A 10Sec rated, Indoor/Outdoor Enclosure for mounting by others, with Startco SE-330 NGR Monitor with Ethernet communications
- 1 - 125VDC Sealed Lead-Acid Battery System with batteries, charger, and rack.
- 1 - Data PLC with Modbus Interface
- 1 - Redundant Hot-Backup Master PLC
- lot - Fiber-optic repeaters for connections between switchgear lineups and controls
- 1 - Breaker Transportation Dolly
- 1 - Manual ground and test device
- 1 - Circuit breaker test cabinet
- 3 - Spare primary PT fuses for each switchgear lineup
- 1 - Spare Multilin T60 Relay
- 1 - Spare Multilin G60 Relay
- 1 - Spare Multilin F60 Relay
- 1 - Spare PLC base with I/O terminals
- 1 - ION Enterprise 55 Energy Management Software, includes base software package and device licenses for 30 devices.
- lot - Load Shed control for up to 21 feeder breakers
- lot - Factory Witness Testing, all transportation, airfare, lodging, and misc expenses not included.
- 12 - O&M Manual provided after site startup is complete
- 6 - Submittal binders & 2 CD copy of submittal package
- lot - ISO Standard Manufacturer's One Year Warranty (18 months after shipment or 12 months after startup)

Earth Tech (Canada) Inc.	
Reviewed for general performance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.	
Responsibility for verification and coordination of field dimensions, fabrication, erection, techniques of construction, installation and completion of all parts of the work rests with the Contractor.	
REVIEWED	_____
REVIEWED AS MODIFIED	_____
REVISE AND RE-SUBMIT	_____ ✓
NOT REVIEWED	_____
Project No.	<u>79538-C21-16</u>
Date:	<u>June 21/06</u> By: <u>P-S</u>

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{ www.toromontcat.com }

Index

Submittal Documentation and PowerLynx® Standard Brochures

- 24-Hour Emergency Response Information
- Submittal Cover Sheet

Bill of Materials

- City of Winnipeg WTP Proposal Bill of Material (TOR-112805-TKE-017 REV1)
- PowerLynx® Control Section Bills of Materials
 - System Control Section Bill of Material
 - Generator Control Section Bill of Material
 - Utility Control Section Bill of Material
 - Power Envelope Bill of Material

Manufacture Cut Sheets (Alphabetical Order)

Engineering Drawings

- Information Drawing Set

Drawing Number	Drawing Title
G01	Drawing Legend
G02	Circuit Breaker Schedule
G03	Front Elevation & One Line (E-100)
G04	Front Elevation & One Line (E-200)
G05	Plan and Side View – 1
G06	Plan View - 2
G07	Control One Line (E-100)
G08	Control One Line (E-200)
G09	Automation Communications Plan
G10	Control Conduit Schedule
G11	Control Conduit Schedule
F01 – F06	Field Drawings
W01 – W52	Production Drawings (E-100)
A01 – A34	Mechanical Drawings (E-100)
W01 – W27	Production Drawings (E-200)
A01 – A11	Mechanical Drawings (E-200)

Sequence of Operations

Drawing Number	Drawing Title
G12	Sequence of Operations

Installation/Maintenance

- Power Envelope Switchgear Instruction Manual
- Sample Warranty
- 24-Hour Emergency Response Information

Earth Tech (Canada) Inc.

Reviewed for general performance with design intent.
Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field construction to technical drawings. Examples of construction not in drawings are responsibility of all parts of the work not within the design team.

REVIEWED _____

REVIEWED BY: _____

REVISE AND RE-APPROVE: _____

NOT RECORDED: _____

Project: 70538-C31-16

Date: 5/16/16 By: J.C.

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, maintenance, or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any maintenance or repair on this product until you have read and fully understand the operation maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury, or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING", or "CAUTION". The safety warning alert signal is shown below.



The meaning of this safety alert symbol is as follows:

ATTENTION! Become alert! Your safety is involved!

The message that appears under the warning explains the hazard and can either be written or pictorially presented.

"NOTICE" labels on the product and in this publication identify operations that may cause product damage.

Caterpillar cannot anticipate every possible circumstance that might involve potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or be made unsafe by the operation maintenance or repair procedure that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including but not limited to physical dimensions, type, strength and material.

Failure to heed this warning can lead to permanent failures, product damage, personal injury or death.

24 Hour Emergency Response Center

(866) 883-3879



Intelligent Switchgear Organization LLC

A Caterpillar Electric Power Business

4016 Nine McFarland Drive • Alpharetta, GA 30004
(770) 442-9442 • Fax: (770) 664-6302

Caterpillar Switchgear
Product Support Group

CONTACT INFORMATION

8:00AM – 5:00PM M-F Normal Business Hours

All calls during Off Business Hours are answered by our Answering Service and forwarded to our On Call Technician

Product Support Center @ 866-883-3879

FOR:

- TECHNICAL ASSISTANCE
- START-UP INFORMATION
- QUOTES FOR
MODIFICATIONS/REPAIR AFTER
COMPLETION OF START-UP
- WARRANTY
- REMEDIAL SERVICE
- PARTS



Date: 5/24/06

Job Name: **City of Winnipeg WTP**

Location: **Dugald, Manitoba**

Purchaser: Toromont Power Systems

Location: Concord, Ontario

PO Number: 050203P001

Job Number: 35701

Sales Engineer: Tim Easterday

Project Manager: Woody McClendon

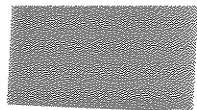
Email Correspondence: 35701@isopowerlynx.com

Drawings For: Submittal X Record

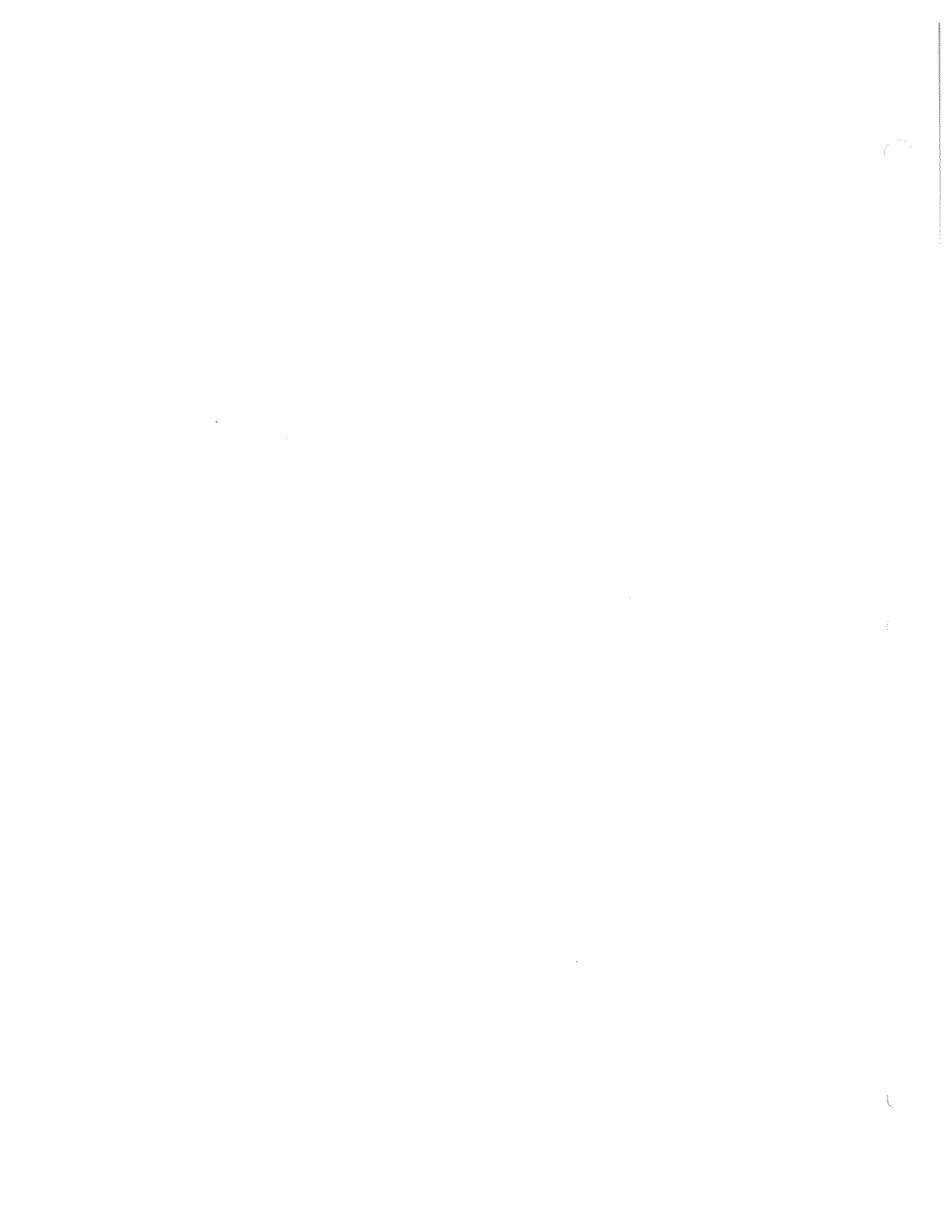
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Bill of Materials



35701- City of Winnipeg WTP- Proposal BOM**CATERPILLAR SWITCHGEAR USING POWERLYNX® 3000 TECHNOLOGY**

The proposed switchgear and control system will consist of two 5kV class switchgear lineups, E100 and E200, as well as a separate arrangement of control panels housing all master and Synchronizing controls for the proposed switchgear lineups. The switchgear and controls will be interconnected via fiber optic line for overall system communications. Our proposal is as follows:

Switchgear E100:**Two (2) Utility Main Circuit Breaker Sections each provided as follows:**

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 3000A, 50kA, Utility Main Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 1 - Set of (2) Line-Connected VTs, standard accuracy
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Transformer management Multilin T60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

One (1) Bus Tie Circuit Breaker Section provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 3000A, 50kA, Bus Tie Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 2 - Sets of (2) Bus-Connected VTs, standard accuracy
- 1 - Set of (3) CTs, standard accuracy
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Three (3) Feeder Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 3000A, 50kA, Feeder Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Seven (7) Feeder Circuit Breaker Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each

- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 1200A, 50kA, Feeder Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 2 - Set of (3) CTs, standard accuracy
- 1 - ION 7550 Power Meter
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Four (4) Feeder Circuit Breaker Provision Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 1200A Feeder Provision

Switchgear E200:**Three (3) Generator Main Circuit Breaker Sections each provided as follows:**

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 1200A, 50kA, Generator Main Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 1 - Set of (2) Line-Connected VTs, standard accuracy
- 2 - Set of (3) CTs, standard accuracy (one set CTs shipped loose for generator installation)
- 1 - ION 7550 Power Meter
- 1 - Generator management Multilin G60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

One (1) Bus Tie Circuit Breaker Section provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 3000A, 50kA, Bus Tie Vacuum CB, 125VDC Trip, 125VDC Charge/Close, EO, DO
- 1 - Set of (3) CTs, standard accuracy
- 1 - Feeder management Multilin F60 multi-function device, microprocessor based, field programmable, draw-out design with protection, metering and monitoring functions.

Two (2) Load Lug Sections each provided as follows:

- lot - 3000A Tin-Plated Copper main bus, 3 phase, 4 wire with bare neutral bus, for use in a 4160V system, NEMA1 enclosure, ANSI #61 Gray, Dimensions 36"W x 97.5"D x 95"H each
- lot - Arc wall for 50kA arc-resistant rating, shipped separately for field installation by others.
- 1 - 1200A Load Lugs
- 1 - Sets of (2) Bus-Connected VTs, standard accuracy

Controls Cubicles:**Two (2) Utility Controls each as follows:**

- 1 - PowerLynx® utility controls with:
 - Device 27/59 – Under/Over Voltage
 - Device 810/U – Under/Over Frequency
 - Device 32 – Reverse Power
 - Device 25 – Synchronizing Check
 - Device 15 – Auto Synchronizer
 - 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
 - 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.
- zero sequence on primary*
** differential protection*
** confirm utility requirements*

Three (3) Generator Controls each as follows:

- 1 - PowerLynx® generator controls with:
 - Device 27/59 – Under/Over Voltage
 - Device 810/U – Under/Over Frequency
 - Device 40 – Loss of Excitation
 - Device 32 – Reverse Power
 - Device 25 – Synchronizing Check
 - Device 15 – Auto Synchronizer
 - Device 65 – Governor Load Sharing, Soft Loading Control
 - Device 90 – VAR/PF and Cross Current Compensation Controller
- 1 - Local Start/Stop switch.
- 1 - Local Emergency Stop switch.
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

Two (2) Bus Tie Controls each as follows:

- 1 - PowerLynx® bus tie controls with:
 - Device 27/59 – Under/Over Voltage
 - Device 810/U – Under/Over Frequency
 - Device 25 – Synchronizing Check
 - Device 15 – Auto Synchronizer
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

Ten (10) Feeder Controls each as follows:

- 1 - PowerLynx® feeder controls
- 1 - ANSI Device 86, high speed, manually resettable, operated by protective relays, causes tripping of the circuit breaker and prevents reclosing of the circuit breaker for utility parallel operation until reset.
- 1 - Circuit Breaker Switch, heavy duty, three (3) position spring return to center with momentary trip and close positions. Includes circuit breaker position indicating lamps.

- ground fault / over current



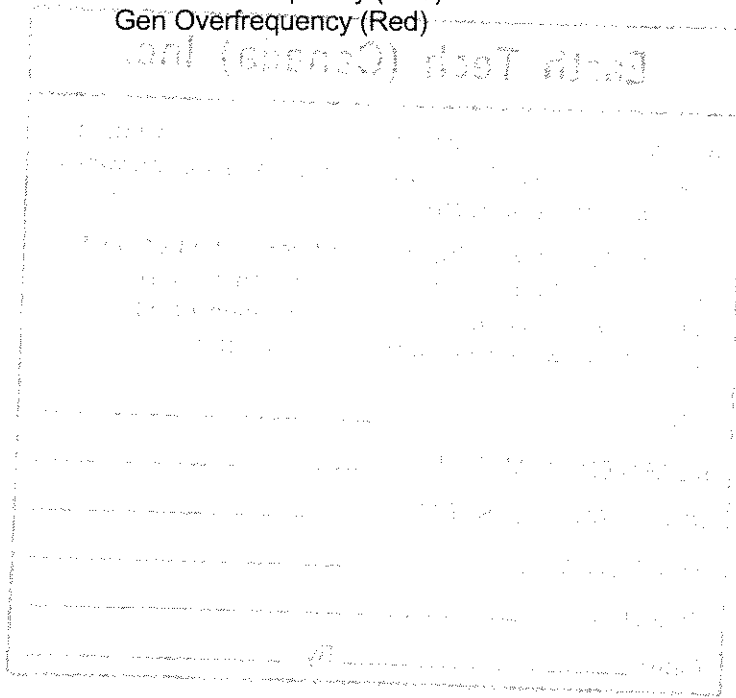
CAT Generator Switchgear Products
 CAT Automatic Transfer Switch Products

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One (1) Master Controls provided as follows:

- 1 - PowerLynx® 15" Color Touch Screen
- 1 - Modbus RTU Data Export PLC
- 1 - Redundant Master Processor
- 1 - System Graphic One Line Mimic. The Mimic shall graphically show each Generator source with its respective Main CB in a one-line representation. Utilizing colored lights and digital meters, the Mimic shall actively display the following:
 - Utility CB Open/Closed/Tripped
 - Utility Volts/Amps/kW/Frequency
 - Generator CB Open/Closed/Tripped
 - Generator Volts/Amps/kW/Frequency
 - Engine Stopped/Running/Cooldown/Pre-Alarm/Shutdown
 - Engine ECS Position Off/Auto/Manual/Cooldown
 - System Output Volts/Amps/kW/Frequency
 - System Summary Alarm with horn
- 1 - PowerLynx® System Metering (3P Voltage, 3P Current, Frequency, Power Factor, KW, KVAR), Control (Normal Mode, Emergency Mode, Load Management Mode, Load Shed/Add), and Protective Relaying including:
 - Device 27/59 – Bus Under/Over Voltage
 - Device 81O/U – Bus Under/Over Frequency
- 1 - PowerLynx® System local Annunciation including:
 - Status, Light Only (Non-Latching)
 - Manual Mode (Red)
 - Auto Mode (Green)
 - Test without Load (Amber)
 - Test with Load (Amber)
 - System Not in Auto (Red)
 - Engine Running (Red)
 - Engine Stopped (Green)
 - Engine Cooldown (Amber)
 - Gen CB Open (Green)
 - Gen CB Closed (Red)
 - Gen CB Tripped (Amber)
 - Engine Pre-Alarm (Amber)
 - Engine Shutdown Fault (Red)
 - Alarm, Light and Horn (Non-Latching)
 - Emergency Mode (Red)
 - Bus Underfrequency (Red)
 - Bus Undervoltage (Red)
 - Processor Fault (Red)
 - Emergency Stop (Red)
- 3 - PowerLynx® Generator Metering (3P Voltage, 3P Current, Frequency, Power Factor, KW, KVAR, Synchroscope), Control, and Protective Relaying including:
 - Device 27/59 – Under/Over Voltage
 - Device 81O/U – Under/Over Frequency
 - Device 40 – Loss of Excitation
 - Device 32 – Reverse Power
 - Device 25 – Synchronizing Check
 - Device 15 – Auto Synchronizer
 - Device 65 – Governor Load Sharing, Soft Loading Control

- 3 - Device 90 – VAR/PF and Cross Current Compensation Controller
- PowerLynx® Engine-Generator local Monitoring/ Annunciation including:
 - Status, Light Only (Non-Latching)
 - Gen Not in Auto (Red)
 - Gen Circuit Breaker Closed (Red)
 - Gen Circuit Breaker Open (Green)
 - Engine Stopped (Green)
 - Engine Running (Red)
 - Engine Cooldown (Amber)
 - Pre-Alarm, Light and Horn (Non-Latching)
 - Pre-High Coolant Temp (Amber)
 - Pre-Low Oil Pressure (Amber)
 - Low Coolant Temp (Amber)
 - Engine Low Battery (Amber)
 - Gen Fail to Synch (Amber)
 - Shutdown Alarm, Light and Horn (Latching)
 - Engine Overcrank (Red)
 - Engine Overspeed (Red)
 - Engine Low Oil Pressure (Red)
 - Engine High Coolant Temp (Red)
 - Engine Low Coolant Level (Red)
 - Engine Remote Emergency Shutdown (Red)
 - Gen Circuit Breaker Tripped (Red)
 - Gen Loss of Field (Red)
 - Gen Reverse Power (Red)
 - Gen Undervoltage (Red)
 - Gen Overvoltage (Red)
 - Gen Underfrequency (Red)
 - Gen Overfrequency (Red)





CAT Generator Switchgear Products
 CAT Automatic Transfer Switch Products

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ADDITIONAL ITEMS:

- 3 - Neutral Grounding Resistor, 200A 10Sec rated, Indoor/Outdoor Enclosure for mounting by others, with Startco SE-330 NGR Monitor with Ethernet communications
- 1 - 125VDC Sealed Lead-Acid Battery System with batteries, charger, and rack. *mounted in cabinet*
- 1 - Data PLC with Modbus Interface
- 1 - Redundant Hot-Backup Master PLC
- lot - Fiber-optic repeaters for connections between switchgear lineups and controls
- 1 - Breaker Transportation Dolly
- 1 - Manual ground and test device
- 1 - Circuit breaker test cabinet
- 3 - Spare primary PT fuses for each switchgear lineup
- 1 - Spare Multilin T60 Relay
- 1 - Spare Multilin G60 Relay
- 1 - Spare Multilin F60 Relay
- 1 - Spare PLC base with I/O terminals
- 1 - ION Enterprise 55 Energy Management Software, includes base software package and device licenses for 30 devices.
- lot - Load Shed control for up to 21 feeder breakers ✓
- lot - Factory Witness Testing, all transportation, airfare, lodging, and misc expenses not included.
- 12 - O&M Manual provided after site startup is complete (additional copies and/or CD can be provided at additional cost)
- lot - ISO Standard Manufacturer's One Year Warranty (18 months after shipment or 12 months after startup)

Earth Tech (Canada) Inc.	
Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.	
Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.	
REVIEWED	_____
REVIEWED AS MODIFIED	_____ ✓ _____
REVISE AND RE-SUBMIT	_____
NOT REVIEWED	_____
Project No. <u>79035-C3116</u>	By: <u>[Signature]</u>
Date: <u>3/16/06</u>	

Power Envelope

35701

City of Winnipeg WTP

Part Number	Manufacturer/Description	Qty
PE-CH-MV	MV CUTLER HAMMER POWER ENVELOPE	1
	ARC-RESISTANT CLASS B, 4160VAC, 3 PH 3W , 50KA, INDOOR, 60 HERTZ, 60KV BIL, COPPER TIN PLATED 3000 AMP MAIN BUS, CSA LABEL, WHITE INTERIOR, BOLT -ON REAR COVERS, IR WINDOWS IN REAR OF EACH SECTION, ARC WALL ENCLOSURE FOR TOP , TOTAL SECTIONS	26
	MASTER CONTROL SECTION	1
	CUTLER HAMMER 350MVA, 50VCP-W 50C 1200A CIRCUIT BREAKER	10
	CUTLER-HAMMER 350MVA, 50 VCP-W 50C 3000A CIRCUIT BREAKER	7
	50VCP-W 50C 1200A PROVISION	4
	CUTLER HAMMER, 5KV VOLTAGE TRANSFORMERS	27
	BREAKER LIFT TRUCK	1
	CURRENT TRANSFORMERS, SR, STD	72
	LUG 2HOLE COMPRESSION	LOT
NGR	NGR - 200A, 10 SEC, N3R	3
BATT-125VDC	125VDC BATTERY SYSTEM- PRIMAX	2

Handwritten notes and circled quantities:
 10 (circled) 11
 7 (circled) 6
 3 (circled) ✓
 2 (circled)

*revise as per
 comments in other
 sections*

106R

System Control Section

35701

City of Winnipeg WTP

Part Number	Manufacturer / Part Description	Qty
PLC-CF1-14.2*6.35X28.5	API DELEVAN CYLINDRICAL FERRITE SUP	4
PLC-BF2930	API DELEVAN SPLIT FERRITE SUPPRESOR	5
PLC-APP-MPB-PCI-R	APPLICOM MB+ PCI INTERFACE BOARD	1
FU-BC6031-3PQ	BUSSMAN 1-3 POLE KTK-R FUSE BLOCK	LOT
FU-KTK-R-1.5-20	BUSSMAN KTK-R 1.5-20 AMP 200KAIC FUSE	LOT
TS-898326-000	ELO 15" 24VDC TOUCHSCREEN	1
BATT-M12-V40	GNB MARATHON 12 VOLT, 40 AH BATTERY	2
BATT-PS1060	GNB-ALCAD BATTERY RACK, 1 TIER, 2 BATT	1
SW-ASW2110	IDEC 2-POS,SEL.SWITCH W/SPRING RTN	LOT
SW-ASW 2K11	IDEC 2-POSITION KEY SWITCH, MAINT	LOT
RLY-RH4B-ULDC24V	IDEC 4 PDT RELAY 24 VDC W/IND.LIGHT	LOT
RLY-SH4B-05	IDEC 4 POLE RELAY BASE	LOT
RLY-RH2BULDC24V	IDEC DPDT RELAY 24VDC W/IND. LIGHT	LOT
RLY-SH2B-05	IDEC DPDT RELAY BASE	LOT
SW-ABW120BGR	IDEC PUSH BUTTON, BLACK NON ILL.	1
COMP-C6220	ISO POWERLYNX TOUCHSCREEN PROCESSOR	1
ANNU-SC628P	MALLORY SONALERT ALARM HORN, 24VDC	1
PLC-170ADM85010	MODICON 24-32VDC 16PT IN/16 PT OUT	4
PLC-170XTS00100	MODICON CONNECTOR SET, SCREW-TYPE	4
PLC-171CCC78010	MODICON M1 PROCESSOR ADPT 512K RAM	4
PLC-172PNN21022	MODICON MB+ ADAPTOR CLOCK & BATTERY	4
PLC-990NAD21110	MODICON MB+ DROP CABLE - 2.4M 8ft	5
PLC-990NAD23000	MODICON MODBUS PLUS TAP	5
BATT-2938604	PHOENIX PWR SUPPLY 10A 24VDC 120VAC	4
DIOD-CS241210	POWEREX 100A POWER DIODE	1
CB-5SX2140-8	SIEMENS 40A, 1POLE CB HIGH-IN-RUSH	1

Generator Control Section

35701

City of Winnipeg WTP

Part Number	Manufacturer / Part Description	Qty
PLC-CF1-14.2*6.35X28.5	API DELEVAN CYLINDRICAL FERRITE SUP	6
PLC-BF2930	API DELEVAN SPLIT FERRITE SUPPRESSOR	12
FU-BC6031-3PQ	BUSSMAN 1-3 POLE KTK-R FUSE BLOCK	LOT
FU-KTK-R-1.5-20	BUSSMAN KTK-R 1.5-20 AMP 200KAIC FUSE	LOT
CAT-188-3080	CATERPILLAR EMCPII CCM	3
PRLY-256-PLDU-PQBX-C6	CROMPTON 25 SYNCH-CHECK RLY W/DEAD	3
SW-7316K36	EATON 2 POS SPRING RTC TOGGLE SWITCH	3
PRLY-7803B	ELECTROSWITCH 86 LOR, 3-DECK	3
SW-74902QF	ELECTROSWITCH CB CONTROL SWITCH	3
RLY-RH4B-ULDC24V	IDEC 4 PDT RELAY 24 VDC W/IND.LIGHT	LOT
RLY-SH4B-05	IDEC 4 POLE RELAY BASE	LOT
RLY-RH2BULDC24V	IDEC DPDT RELAY 24VDC W/IND. LIGHT	LOT
RLY-SH2B-05	IDEC DPDT RELAY BASE	LOT
TMR-RTEB1AD24	IDEC INTERVAL TIMER 24VDC	3
RLY-SR3B-05	IDEC MODE EXIT TIMER BASE	3
PLC-170AMM11030	MODICON 2AI 2AO 16DI 8DO 10-45VDC BASE	3
PLC-170XTS00100	MODICON CONNECTOR SET, SCREW-TYPE	3
PLC-171CCC78010	MODICON M1 PROCESSOR ADPT 512K RAM	3
PLC-172PNN21022	MODICON MB+ ADAPTOR CLOCK & BATTERY	3
PLC-990NAD21110	MODICON MB+ DROP CABLE - 2.4M 8ft	6
PLC-990NAD23000	MODICON MODBUS PLUS TAP	6
DIOD-CS241210	POWEREX 100A POWER DIODE	3
XDCR-POWERLYNX	POWERLYNX TRANSDUCER	3
CB-5SX2140-8	SIEMENS 40A, 1POLE CB HIGH-IN-RUSH	3
SW-ZB4BV033	SQ-D LED 22MM GRN PILOT LIGHT HEAD	3
SW-ZB4BV043	SQ-D LED 22MM RED PILOT LIGHT HEAD	3
SW-ZB4BVB3	SQ-D LED GREEN PL BASE 24VAC/DC	3
SW-ZB4BVB4	SQ-D LED RED PL BASE 24VAC/DC	3
RLY-PRD-11DHO-24	TYCO P&B 24VDC HEAVY DUTY DC RELAY	6
CTSB-KUSC-4WC	USD CT SHORTING BLOCK - FOUR POLE	3
CTSB-KUSC-2WC	USD CT SHORTING BLOCK - TWO POLE	3
POT- 11-1-11	VISHAY 11-TURN MULTIDIAL SPEED POT	3
POT-53411202	VISHAY 2K OHM 10 TURN POTENTIOMETER	3
PRLY- GE G60	GE G60 MFR- GENERATOR PROTECTION	3
MTR-ION 7550	ION 7550 POWER-METER	3
PRLY- SE330	STARTCO-SE 330 NGR MONITOR	3

Utility Control Section

35701

City of Winnipeg WTP

Part Number	Manufacturer / Part Description	Qty
PLC-CF1-14.2*6.35X28.5	API DELEVAN CYLINDRICAL FERRITE SUP	4
PLC-BF2930	API DELEVAN SPLIT FERRITE SUPPRESOR	8
FU-BC6031-3PQ	BUSSMAN 1-3 POLE KTK-R FUSE BLOCK	LOT
FU-KTK-R-1.5-20	BUSSMAN KTK-R 1.5-20 AMP 200KAIC FUSE	LOT
PRLY-256-PLDU-PQBX-C6	CROMPTON 25 SYNCH-CHECK RLY W/DEAD	2
PRLY-7803B	ELECTROSWITCH 86 LOR, 3-DECK	2
SW-74902QF	ELECTROSWITCH CB CONTROL SWITCH	2
RLY-RH2BULDC24V	IDEC DPDT RELAY 24VDC W/IND. LIGHT	LOT
RLY-SH2B-05	IDEC DPDT RELAY BASE	LOT
PLC-170ADM85010	MODICON 24-32VDC 16PT IN/16 PT OUT	2
PLC-170XTS00100	MODICON CONNECTOR SET, SCREW-TYPE	2
PLC-171CCS76000	MODICON M1,PROC.ADPTR,256KRAM RS232	2
PLC-172PNN21022	MODICON MB+ ADAPTOR CLOCK & BATTERY	2
PLC-990NAD21110	MODICON MB+ DROP CABLE - 2.4M 8ft	4
PLC-990NAD23000	MODICON MODBUS PLUS TAP	4
XDCR-POWERLYNX	POWERLYNX TRANSDUCER	2
SW-9001-KS11BH2	SQ-D 2POS MAINT BLK KNOB W/2 9001KA	2
SW-ZB4BV033	SQ-D LED 22MM GRN PILOT LIGHT HEAD	2
SW-ZB4BV043	SQ-D LED 22MM RED PILOT LIGHT HEAD	2
SW-ZB4BVB3	SQ-D LED GREEN PL BASE 24VAC/DC	2
SW-ZB4BVB4	SQ-D LED RED PL BASE 24VAC/DC	2
SW-9001-K7	SQUARE-D SEL. SWITCH LOCKOUT COVER	2
RLY-PRD-11DHO-24	TYCO P&B 24VDC HEAVY DUTY DC RELAY	0
MTR- ION7550	ION 7550 POWER METER	2
PRLY- T60	GE T60 MFR TRANSFORMER PROTECTION	2 ✓

Tie Control Section

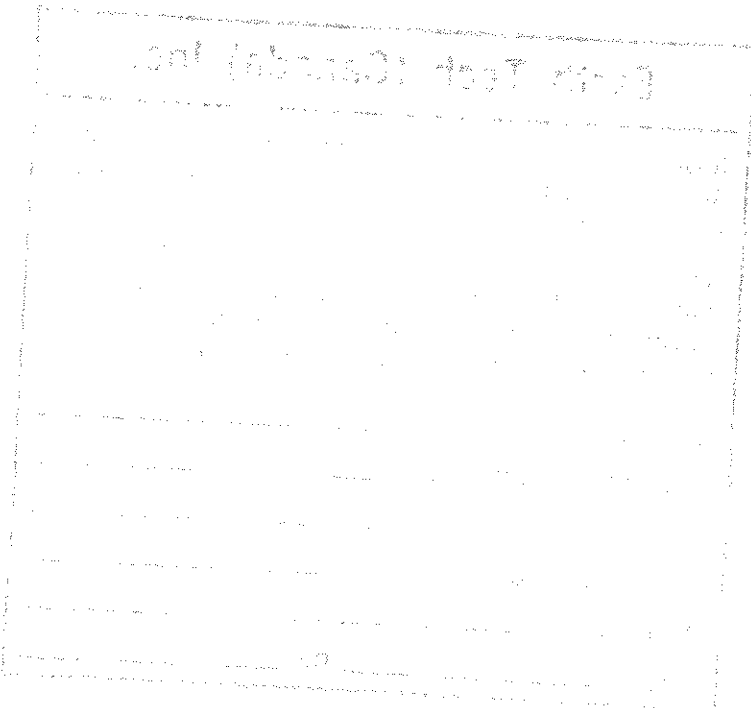
35701

City of Winnipeg WTP

35701

City of Winnipeg WTP

Part Number	Manufacturer / Part Description	Qty
PLC-CF1-14.2*6.35X28.5	API DELEVAN CYLINDRICAL FERRITE SUP	4
PLC-BF2930	API DELEVAN SPLIT FERRITE SUPPRESOR	8
FU-BC6031-3PQ	BUSSMAN 1-3 POLE KTK-R FUSE BLOCK	LOT
FU-KTK-R-1.5-20	BUSSMAN KTK-R 1.5-20 AMP 200KAIC FUSE	LOT
PRLY-256-PLDU-PQBX-C6	CROMPTON 25 SYNCH-CHECK RLY W/DEAD	4
PRLY-7803B	ELECTROSWITCH 86 LOR, 3-DECK	2
SW-74902QF	ELECTROSWITCH CB CONTROL SWITCH	2
PLC-170ADM85010	MODICON 24-32VDC 16PT IN/16 PT OUT	2
PLC-170XTS00100	MODICON CONNECTOR SET, SCREW-TYPE	2
PLC-171CCS76000	MODICON M1,PROC.ADPTR,256KRAM RS232	2
PLC-172PNN21022	MODICON MB+ ADAPTOR CLOCK & BATTERY	2
PLC-990NAD21110	MODICON MB+ DROP CABLE - 2.4M 8ft	4
PLC-990NAD23000	MODICON MODBUS PLUS TAP	4
XDCR-POWERLYNX	POWERLYNX TRANSDUCER	2
SW-ZB4BV033	SQ-D LED 22MM GRN PILOT LIGHT HEAD	2
SW-ZB4BV043	SQ-D LED 22MM RED PILOT LIGHT HEAD	2
SW-ZB4BVB3	SQ-D LED GREEN PL BASE 24VAC/DC	2
SW-ZB4BVB4	SQ-D LED RED PL BASE 24VAC/DC	2
RLY-PRD-11DHO-24	TYCO P&B 24VDC HEAVY DUTY DC RELAY	4
PRLY-GE F60	GE F60 MFR FEEDER	2 ✓



Distribution Control Section

35701

Cvity of Winnipeg WTP

Part Number	Manufacturer / Part Description	Qty
PLC-CF1-14.2*6.35X28.5	API DELEVAN CYLINDRICAL FERRITE SUP	3
PLC-BF2930	API DELEVAN SPLIT FERRITE SUPPRESOR	5
FU-BC6031-3PQ	BUSSMAN 1-3 POLE KTK-R FUSE BLOCK	LOT
FU-KTK-R-1.5-20	BUSSMAN KTK-R 1.5-20 AMP 200KAIC FUSE	LOT
PRLY-7803B	ELECTROSWITCH 86 LOR, 3-DECK	10
SW-2438D	ELECTROSWITCH CB CONTROL SWITCH	10
PLC-170ADM85010	MODICON 24-32VDC 16PT IN/16 PT OUT	3
PLC-170XTS00100	MODICON CONNECTOR SET, SCREW-TYPE	3
PLC-171CCS76000	MODICON M1,PROC.ADPTR,256KRAM RS232	3
PLC-172PNN21022	MODICON MB+ ADAPTOR CLOCK & BATTERY	3
PLC-990NAD21110	MODICON MB+ DROP CABLE - 2.4M 8ft	3
PLC-990NAD23000	MODICON MODBUS PLUS TAP	3
SW-ZB4BV033	SQ-D LED 22MM GRN PILOT LIGHT HEAD	10
SW-ZB4BV043	SQ-D LED 22MM RED PILOT LIGHT HEAD	10
SW-ZB4BVB3	SQ-D LED GREEN PL BASE 24VAC/DC	10
SW-ZB4BVB4	SQ-D LED RED PL BASE 24VAC/DC	10
RLY-PRD-11DHO-24	TYCO P&B 24VDC HEAVY DUTY DC RELAY	10
PRLY- GE F60	GE F60 MFR, FEEDER	10 ✓
MTR- ION 7550	ION 7550 POWER METER	10

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
 Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

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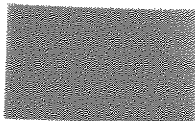
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Project No. 79538-C31-16

Date: 5/21/04 By: P.S.

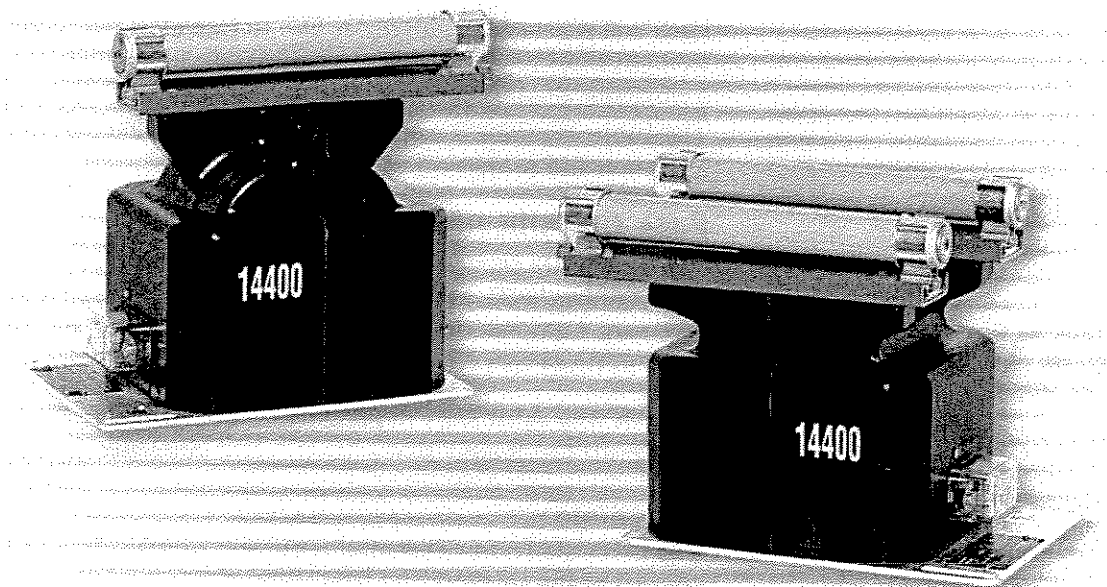


Manufacturer Cut Sheets

Types VIZ-75 and VIZ-11 Voltage Transformers

8.7 and 15 kV, 75 and 110 kV BIL, Indoor

Product Bulletin 1VAP429551-DB



ABB

Product Features

- 8.7 and 15 kV Indoor
- 75 and 110 kV BIL
- 60 Hertz
- Primary Volts: 2400 - 14400
- Thermal Rating:
 - 1500 VA @ 30° C ambient
 - 1000 VA @ 55° C ambient
- IEEE Metering Accuracy at 60 Hertz:
 - 0.3 W, X, Y, Z, & 0.6 ZZ @ 120 volts
 - 0.3 W, X, M, Y, & 1.2 Z @ 69.3 volts
- UL Recognized Component; File No. E148620



UL Recognized Component

Application

The VIZ-75 and VIZ-11 indoor voltage transformers are designed for service in metalclad switchgear and are used for metering, relaying, or control power. Both units are available in single, double, and tapped secondary designs with two accuracy and thermal rating options.

Construction Features

The primary and secondary coils are wound using special winding and shielding techniques for improved voltage stress distribution. The coils are designed to withstand continuous operation at either 1.1 or 1.25 times the line-to-line voltage level for Z burden units and the line-to-ground voltage level for Y burden units. For some line-to-ground voltage units, a short-time withstand voltage of 1.9 is available upon request.

Each coil is insulated with mylar film to provide a high dielectric strength between layers. The coils and core are combined to create a complete winding structure that is assembled to a support frame. The entire assembly is vacuum cast in polyurethane for added insulation and protection.

Fuse Classifications

These units are provided with three fuse classifications: mounted fuse with hardware, unfused with hardware, or unfused without hardware. Optional fuse kits are offered to convert some unfused styles to fused styles.

Consult your ABB Sales Representative concerning overvoltage conditions for designs above the standard rated voltage factor of 1.25.

Baseplate

The baseplate is constructed of corrosion-resistant aluminum and is secured to the encapsulated base support.

Mounting

The VIZ-75 and VIZ-11 can be mounted in upright, cantilever, or upside-down positions.

Curves

Type curves are available upon request.

Test Reports

IEEE test reports are stored electronically and can be e-mailed in various formats at the time of shipment.

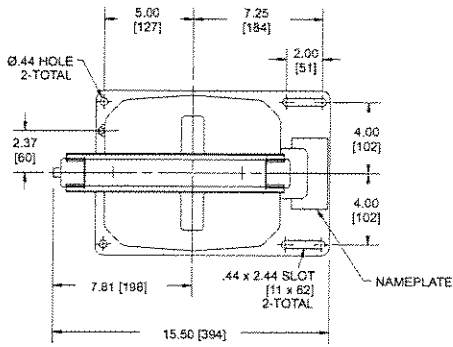
Standards

These units meet all applicable IEEE and NEMA standards and are UL Recognized Components.

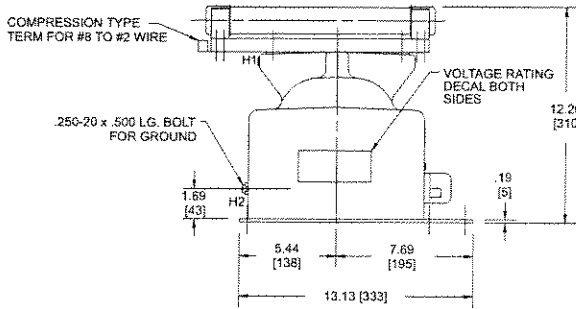
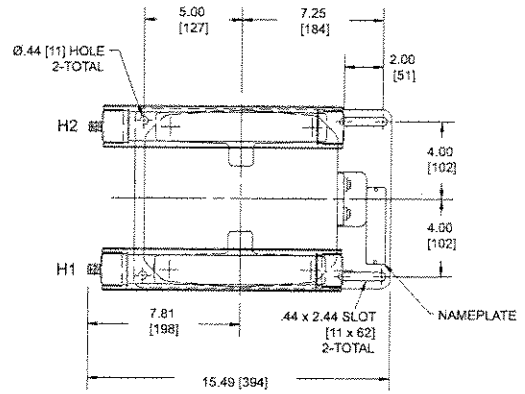
Units pictured on front cover, left to right: line-to-ground fused and line-to-line fused

Types VIZ-75 and VIZ-11 Unit Dimensions

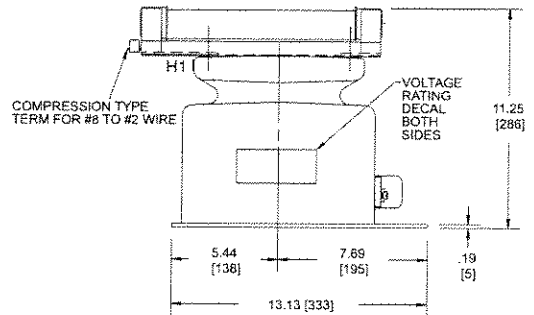
Fused (one fuse)



Fused (two fuses)

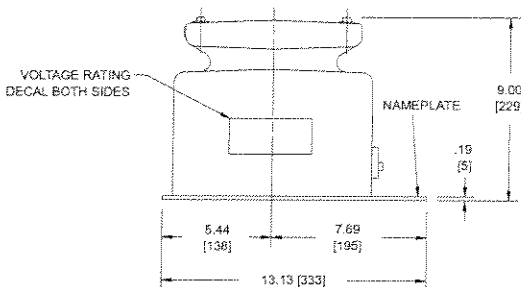
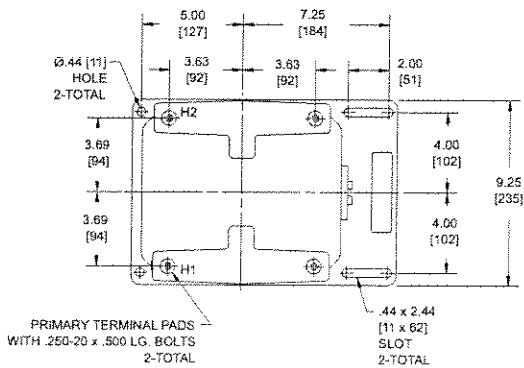


Approximate weight is 67 lbs.



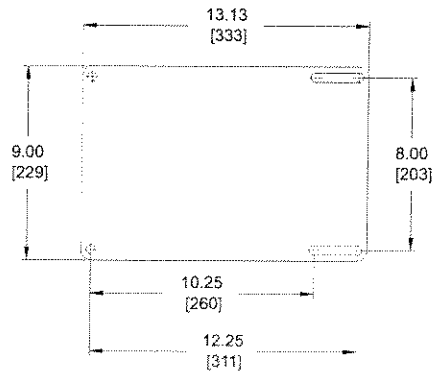
Approximate weight is 69 lbs.

Unfused



Approximate weight is 65 lbs.

Baseplate Dimensions



Note: Metric dimensions are displayed in [mm].

Selection Guide for Line-to-Line Units

Primary Voltage	Secondary Voltage	Winding Ratio	Rated Voltage Factor	Frequency (Hz)	Style Number		
					Unfused with no provision for fuse mounting	Two Fuses	Unfused with provision for fuse mounting
VIZ-75 (Line-to-Line)							
2400/4160Y	120	20:1	1.1	60	7525A66G01	7525A67G01	7525A70G01
4200/7280Y	120	35:1	1.1	60	7525A66G02	7525A67G02	7525A70G02
4800/8320Y	120	40:1	1.1	60	7525A66G03	7525A67G03	7525A70G03
7200/7200Y	120	60:1	1.1	50	-	7525A67G18	7525A70G18
7200/7200Y	120	60:1	1.1	60	7525A66G04	7525A67G04	7525A70G04
VIZ-11 (Line-to-Line)							
2400/4160Y	120	20:1	1.1	60	-	7525A67G17	7525A70G17
7200/12470Y	120	60:1	1.1	60	7525A66G05	7525A67G05	7525A70G05
7620/13200Y	120	63.5:1	1.1	60	7525A66G06	7525A67G06	7525A70G06
8400/14560Y	120	70:1	1.1	60	7525A66G07	7525A67G07	7525A70G07
10000/10000Y	120	83.33:1	1.1	60	-	7525A67G35	7525A70G28
11000/11000Y	110	100:1	1.1	50	-	7525A67G11	-
12000/12000Y	120	100:1	1.1	50	7525A66G13	7525A67G15	7525A70G15
12000/12000Y	120	100:1	1.1	60	7525A66G08	7525A67G08	7525A70G08
12470/12470Y	120	103.9:1	1.1	60	7525A66G15	7525A67G38	7525A70G27
13200/13200Y	120	110:1	1.1	60	7525A66G09	7525A67G09	7525A70G09
13800/13800Y	120	115:1	1.1	60	-	7525A67G43	7525A70G37
13800/13800Y	115	120:1	1.1	60	7525A66G11	7525A67G58	-
14400/14400Y	120	120:1	1.1	50	-	7525A67G34	7525A70G14
14400/14400Y	120	120:1	1.1	60	7525A66G10	7525A67G10	7525A70G10

Additional styles available upon request. Contact your ABB Sales Representative or call +1-252-827-3212 for more information.

Optional Accessories for Line-to-Line Units

Fuse kits to convert unfused VIZ-75 or VIZ-11 to fused style:

- Fuse kit (two fuses and hardware) 7527A98G01

Selection Guide for Line-to-Ground Units

Primary Voltage	Secondary Voltage	Winding Ratio	Rated Voltage Factor	Frequency (Hz)	Style Number	
					One Fuse	Switchgear
VIZ-75 (Line-to-Ground)						
2400/4160GY	120	20:1	1.1	60	7525A68G01	7525A71G01
4200/7280GY	120	35:1	1.1	50	7525A68G26	-
4200/7280GY	120	35:1	1.1	60	7525A68G02	7525A71G02
4800/8320GY	120	40:1	1.1	60	7525A68G03	7525A71G03
7200/7200GY	120	60:1	1.1	50	7525A68G34	-
7200/7200GY	120	60:1	1.1	60	7525A68G04	7525A71G04
VIZ-11 (Line-to-Ground)						
2400/4160GY	120	20:1	1.1	60	7525A68G55	-
4200/7280GY	120	35:1	1.1	60	7525A68G31	-
7200/12470GY	120	60:1	1.1	50	7525A68G63	7525A71G12
7200/12470GY	120	60:1	1.1	60	7525A68G05	7525A71G05
7620/13200GY	120	63.5:1	1.1	60	7525A68G06	7525A71G06
7620/13200GY	208.75	63.5:1	1.1	60	7525A68G50	-
8400/14560GY	120	70:1	1.1	50	7525A68G15	7525A71G18
8400/14560GY	120	70:1	1.1	60	7525A68G07	7525A71G07
10000/10000GY	120	83.33:1	1.1	50	7525A68G37	-
10000/10000GY	120	83.33:1	1.1	60	7525A68G36	-
11000/11000GY	120	91.67:1	1.1	50	7525A68G42	-
12000/12000GY	120	100:1	1.1	50	7525A68G17	7525A71G13
12000/12000GY	120	100:1	1.1	60	7525A68G08	7525A71G08
13200/13200GY	120	110:1	1.1	60	7525A68G09	7525A71G09
13800/13800GY	120	115:1	1.1	60	7525A68G61	-
13800/13800GY	115	120:1	1.1	60	7525A68G44	-
14400/14400GY	120	120:1	1.1	50	7525A68G14	7525A71G15
14400/14400GY	120	120:1	1.1	60	7525A68G10	7525A71G10
15000/15000GY	120	125:1	1.1	60	7525A68G21	-

Additional styles available upon request. Contact your ABB Sales Representative or call +1-252-827-3212 for more information.

Optional Accessories for Line-to-Ground Units

Fuse kits to convert unfused VIZ-75 or VIZ-11 to fused style:

- Fuse kit (one fuse and hardware) 7527A98G02

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

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dimensions, fabrication process, techniques of
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REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

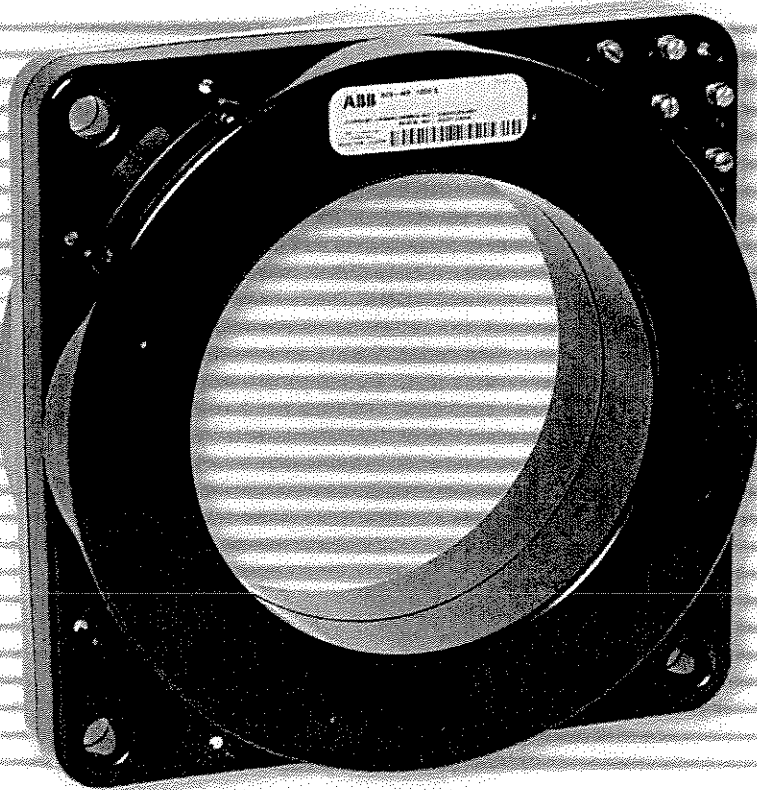
Project No. 79538-2.31-16

Date: June 21, 2016 By: [Signature]

Type SCV Current Transformer

600 Volt, 10 kV BIL, Indoor

Product Bulletin 1VAP428601-DB



ABB

Product Features

- 600 Volt Indoor
- 10 kV BIL
- 25 through 400 Hertz
- Primary Amperes 75-4000
- Mechanical Rating:
180 x rated current
- Thermal Rating:
80 x rated current, one second
- Continuous Current Rating Factor:
2.0 @ 30°C ambient
1.5 @ 55°C ambient
- UL Recognized Component;
File No. E96461



UL Recognized Component

Application

The SCV current transformer is used as the source of current for relaying and metering.

Construction Features

The ring-type core is insulated and toroidally wound with a fully distributed secondary winding. The protective case, made of an impact-resistant polycarbonate, is assembled using self-tapping screws.

Secondary Terminals

Secondary terminals are 10-32 brass terminal screws with hardware. Space is available for a maximum of five terminals to accommodate multi-ratio designs.

Curves

Saturation, overcurrent, ratio correction factor, and phase-angle curves are available upon request.

Test Reports

IEEE test reports are stored electronically and can be e-mailed in various formats at the time of shipment.

Standards

This unit meets all applicable IEEE and NEMA standards and is a UL Recognized Component.

Selection Guide

Primary Ampere Rating	IEEE Metering Accuracy					IEEE Relaying Accuracy	Style Number
	B-0.1	B-0.2	B-0.5	B-0.9	B-1.8		
Type SCV (6.5" window)							
75	2.4	2.4	-	-	-	C10	6353C88H20
100	1.2	2.4	-	-	-	C10	6353C88H01
150	0.6	1.2	2.4	-	-	C20	6353C88H02
200	0.6	0.6	1.2	-	-	C20	6353C88H03
250	0.6	0.6	1.2	2.4	-	C20	6353C88H04
300	0.3	0.6	1.2	1.2	2.4	C20	6353C88H05
400	0.3	0.3	0.6	1.2	1.2	C50	6353C88H06
500	0.3	0.3	0.3	0.6	1.2	C50	6353C88H07
600	0.3	0.3	0.3	0.6	0.6	C100	6353C88H08
800	0.3	0.3	0.3	0.3	0.6	C100	6353C88H09
1000	0.3	0.3	0.3	0.3	0.3	C100	6353C88H10
1200	0.3	0.3	0.3	0.3	0.3	C200	6353C88H11
1500	0.3	0.3	0.3	0.3	0.3	C200	6353C88H12
2000	0.3	0.3	0.3	0.3	0.3	C200	6353C88H13
2500	0.3	0.3	0.3	0.3	0.3	C200	6353C88H14
3000	0.3	0.3	0.3	0.3	0.3	C200	6353C88H15
4000	0.3	0.3	0.3	0.3	0.3	C200	6353C88H16
Multi-Ratio, IEEE, 5 Terminals							
600	0.3	0.3	0.3	0.6	0.6	C100	6350C23H01
1200	0.3	0.3	0.3	0.3	0.3	C200	6350C24H01
2000	0.3	0.3	0.3	0.3	0.3	C200	6350C25H01
3000	0.3	0.3	0.3	0.3	0.3	C200	6350C26H01
4000	0.3	0.3	0.3	0.3	0.3	C200	6350C27H01

Additional styles available upon request. Contact your ABB Sales Representative or call +1-252-827-3212 for more information.

6 NGR

Which CT for the NGR?

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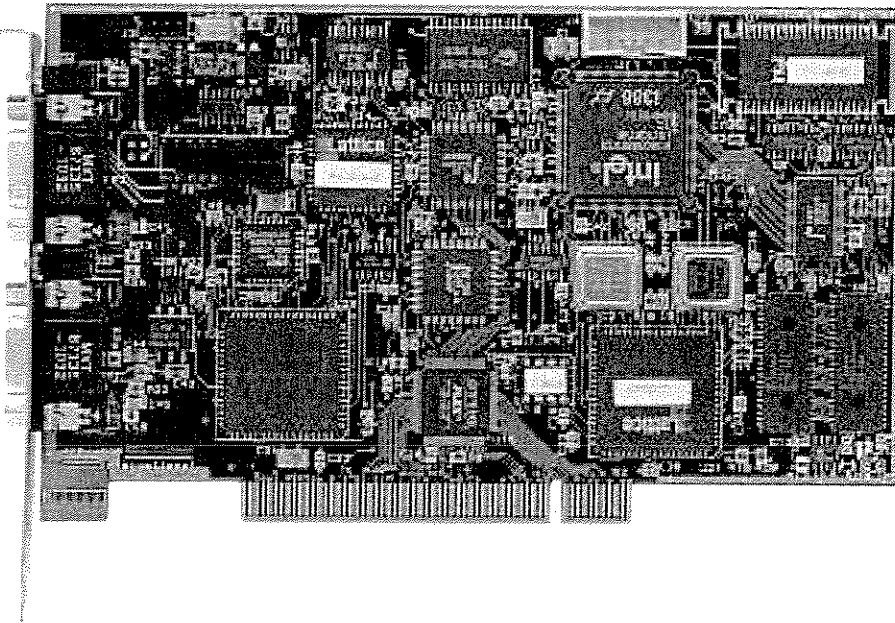
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Project No. 19538-C-16
 Date: June 24, 2004 By: P. S. [Signature]



ABB Inc.
 3022 NC 43 North
 Pinetops, NC 27864
 Tel: +1-252-827-3212
 www.abb.com/mediumvoltage

applicom® PCI2000MBP



Based on a unique industrial communications concept, applicom® is the fastest, open, trouble-free approach for interfacing PC-based applications (HMI, SCADA, MES, RDBM, spreadsheets, custom applications) and devices (PLCs, I/O modules, etc.) on fieldbuses and industrial networks.

The applicom® software package includes:

- Configuration software.
- Powerful test and diagnostic tools.
- Data servers (OPC, ActiveX, DDE, FastDDE, SuiteLink).
- Development libraries for programming languages such as Visual C/C++, Visual Basic, Delphi, Borland, Windev, Labwindows CVI, LabVIEW...

June 2003

1 page 2/8

Thanks to smart technology, all applicom® communications processors are able to execute all management and the processing (polling, frame management, etc.) of communications protocols, resulting in extremely fast, efficient application performance.

Particularly, the applicom® **PCI2000MBP** board is equipped with **1 Modbus Plus** and **1 Serial port** or with **2 Modbus Plus** redundant ports.

applicom international is a member of Schneider Alliances association

Compatibles platforms

- Windows 32-bits (XP, 2000, NT 4, 98)
- Windows Embedded (XPe)
- VenturCom RTX
- VxWorks
- QNX
- Linux
- Dos

Protocols

Modbus Plus Protocol	Device
Modbus Plus	All Modbus Plus Client/Server devices

Compatible serial protocols ^[1]	Devices
3964/3964R (free messaging or RK512)	Siemens S5 series
AS511	Siemens S5 series (programming port)
Batibus	Merlin Gerin (building automation)
Data Link	Elsag Bailey
DF1 ^[2] , DH, DH+, DH-485	Allen Bradley (programming port)
Jbus/Modbus	All Modbus & Jbus devices
PPI+, PPI	Siemens S7-200 (programming port)
Saia Bus	Saia
SNP-X	GE-Fanuc/Cegelec
SucomA	Moeller Group
Sysmac Way	Omron
TI-Dir	Siemens TI series 505 (programming port)
Uni-Telway	Schneider Electric
Kit4000TD	Development toolkit for serial protocols

[1] : Available only if you don't use the MBP redundant port

[2] : DF1 : for DH and DH+ via 1770-KF2. For DH-485 via 1770-KF3 (1770-KF2 and 1770-KF3 not included)

Technical Data

Unit	PCI PC board, 5V
Processor	Intel 80386EX -32 MHz
Memory	4 Mbytes dynamic RAM
Flash memory	512 Kbytes flash memory
Supported Interrupts	Hardware Plug&Play
DPRAM Address	Hardware Plug&Play (8 Kbytes used by board)
Discrete Input*	Opto-coupled discrete input Voltage -> DC +10 to +30 or AC 24 V (50 to 60 Hz)
Discrete Output*	"WatchDog" contact output LED ; contact free from potential (floating) (24V DC, 0.25 A)
Technology	SMC technology, Complies with EMC for both Industrial and office use
Dimensions (L x W)	175mm x 107mm (6.88" x 4.17")
Consumption	4 W (max. 0.8A)
Operating Temperature	0° C (32° F) up to +65° C (149° F)
Storage Temperature	-40° C (-92° F) up to +80° C (176° F)

* The discrete I/O's are mounted on a special bracket (ref. IOSPKIT), and require an additional rear panel slot.

Modbus Plus Port

Interface type	1 Modbus Plus port
Connector Type	Modbus Plus standard 9-pin Sub-D female
Speed	1 Mbps (Token Ring)
Status LEDs	1 Network state/1 error indicator

Modbus Plus redundant port or serial port

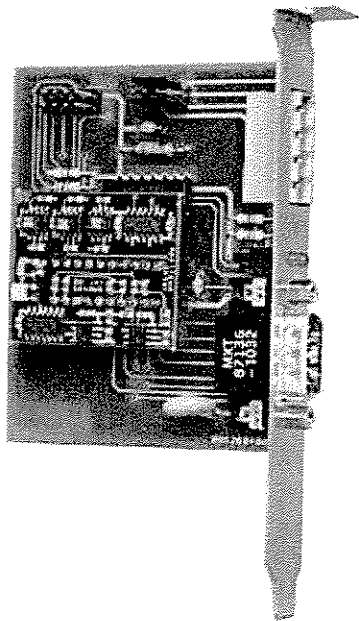
Interface type	1 Modbus Plus redundant port
Connector Type	Modbus Plus standard 9-pin Sub-D female
Speed	1 Mbps (Token Ring)
Status LEDs	1 Network state/1 error indicator

Port Type	1 asynchronous serial port
Connector Type	9-pin Sub-D female
Transmission LEDs	1 Transmit LED / 1 Receive LED
Electrical Interface	<p>Plugged on board:</p> <ul style="list-style-type: none"> • RS232C (2 or 6 signals) interface with or without galvanic insulation (500 Volts) • RS485/RS422 interface with or without galvanic insulation (500 Volts) • 20mA current loop interface • Batibus interface
Baud Rate	<p>from 50 to 38400 bps</p> <p>Supported Format :</p> <ul style="list-style-type: none"> • 7 or 8 data bits • 1 or 2 stop bits • odd, even or no parity

Add-on

Brackets

- Discrete I/O's bracket



Line interfaces

- RS232C (2 or 6 signals) with or without galvanic insulation (500 Volts)
- RS422/RS485 with or without galvanic insulation (500 Volts)
- 20mA current loop
- Profibus module
- Profibus module with galvanic insulation
- Batibus module
- Modbus Plus module for the redundant port

References

	Reference
applicom® on PCI2000MBP board under Windows XP, 2000, NT4, 95/98	PCI2000MBP/W32

Bracket	Reference
Discrete I/O's and serial port bracket	IOSPKIT

Electrical Interface	Reference
RS232C	5RS232
RS232C with galvanic insulation (500 volts)	6RS232
RS485/RS422	5RS485
RS485/RS422 with galvanic insulation (500 volts)	6RS485
20mA current loop	5BC20
Module Profibus	5PFB485
Profibus module with galvanic insulation	6PFB485
Batibus module	5BCBAT
Modbus Plus redundancy module	5MBP

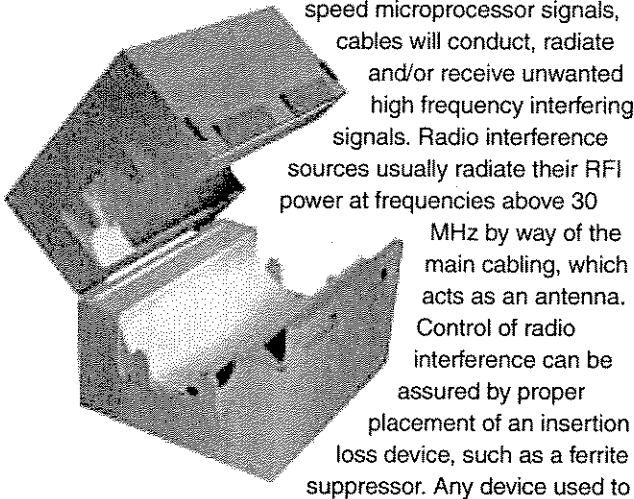
Modbus Plus Protocol	Device	Reference
Modbus Plus	All Modbus Plus Client/Server devices	PC/MBP

Serial Protocols (single station licence)	Device	Reference
3964/3964R	Siemens Simatic S5	PC/39
AS511	Siemens Simatic S5	PC/AS
Batibus	Merlin Gerin	PC/BAT
Data Link	Elsag Bailey	PC/DA
DF1	Allen Bradley	PC/DF
Jbus/Modbus	All Jbus or Modbus devices	PC/MB
PPI+, PPI	Siemens Simatic S7-200	PC/PPI
Saia Bus	Saia	PC/SB
SNP-X	GE-Fanuc/Cegelec	PC/SNP
SucomA	Moeller Group	PC/SU
Symac Way	Omron	PC/SW
TI-Dir	Siemens Simatic TI-505	PC/TI
Uni-Telway	Schneider Electric	PC/TE
Kit4000TD	Development toolkit for serial protocols	KIT4000TD

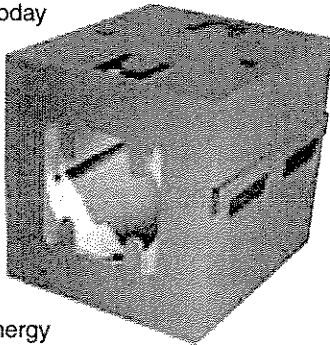
BF Series

Split Ferrite Suppressors for Round Cables

Electronic cables and wires, by virtue of their length-to-width ratios, are perfect natural antennas. In the presence of high speed microprocessor signals, cables will conduct, radiate and/or receive unwanted high frequency interfering signals. Radio interference sources usually radiate their RFI power at frequencies above 30 MHz by way of the main cabling, which acts as an antenna. Control of radio interference can be assured by proper placement of an insertion loss device, such as a ferrite suppressor. Any device used to block an RFI signal between its source and a receiver is an electromagnetic interference (EMI) shield. The measure of this ability to attenuate RFI is shielding effectiveness, "SE", which is expressed in decibels, "dB", the ratio of field strength on one side of the shield to the other side.



One of the most versatile and cost effective shielding methods that can be used today is the API Delevan bisected ferrite cable snap assembly. The bisected styling, or familiar clamshell enclosure design offers the ultimate in adaptability. The RF absorbing material interacts directly with unwanted high frequency energy and dissipates it effectively while allowing data signals to pass unimpeded.

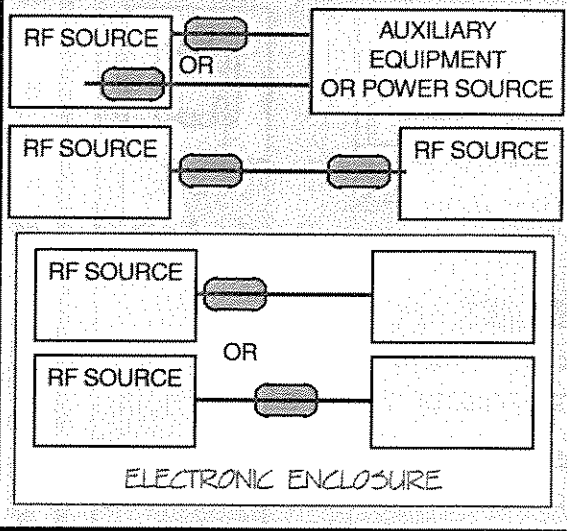


Bisected ferrites have a concentrated, homogeneous magnetic structure with high permeability. These are consistently stable at +20°C to +60°C and provide RF suppression without eddy current losses.

AIR GAP EFFECT

The air gap in bisected ferrites actually extends current carrying capabilities with only an extremely small reduction in impedance versus solid ferrites of the same size. The gap is magnetically insignificant while it is electrically significant as a discontinuation, thereby accommodating more current.

POSITION OF SUPPRESSOR



POSITION OF SUPPRESSOR The suppressor should normally be located close to the cable termination where it exits the enclosure. Where a cable connects two enclosures containing RF sources, a suppressor on each end may be required. For circuits within an enclosure, a position close to the RF is best. However, other locations along the circuit may work as well.

Material and U.L. Data API-1 Material, see characteristics and information on page 121.

Continued on next page

BF Series

Suppressors for Round Cables

DIMENSIONS
Inches ± 0.04; mm ± 1.0

IMPEDANCE
(OHMS) *

25 MHz
100 MHz

PART NUMBER
UNITS

BODY TYPE

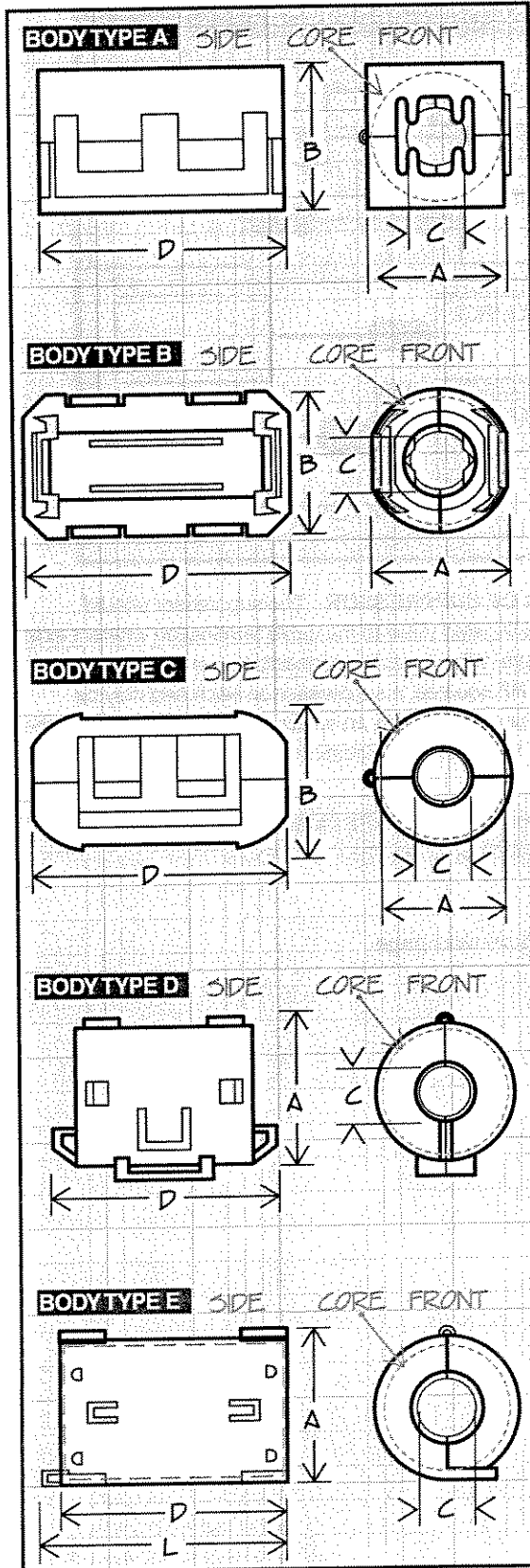
A

B

C

D

L



SERIES BF - FOR ROUND CABLES									
PART NUMBER	UNITS	BODY TYPE	A	B	C	D	L	25 MHz	100 MHz
BF2930	in. mm	A	1.16 29.6	1.20 30.5	0.51 13.0	1.30 33.0	—	155	257
BF2223	in. mm	A	0.87 22.3	0.91 23.3	0.39 10.0	1.28 32.6	—	136	250
BF1719	in. mm	A	0.70 17.8	0.76 19.5	0.25 6.5	1.28 32.5	—	171	325
BF1835	in. mm	B	0.70 18.0	0.77 19.7	0.35 9.0	1.37 35.0	—	112	172
BF1125-5	in. mm	B	0.46 11.7	0.51 13.0	0.19 5.0	0.98 25.0	—	96	154
BF1125-3	in. mm	B	0.46 11.7	0.51 13.0	0.13 3.5	0.98 25.0	—	139	191
BF1429	in. mm	C	0.57 14.5	0.61 15.7	0.22 5.6	1.14 29.0	—	85	157
BF1225	in. mm	C	0.50 12.8	0.57 14.7	0.15 4.0	0.98 25.0	—	82	146
BF3024	in. mm	D	1.20 30.5	—	0.45 11.4	0.69 17.7	0.94 24.0	51	103
BF2125	in. mm	D	0.84 21.5	—	0.32 8.15	0.77 19.7	1.01 25.8	50	107
BF2123	in. mm	D	0.84 21.5	—	0.32 8.15	0.66 16.8	0.90 23.0	42	94
BF1835-9	in. mm	E	0.73 18.6	—	0.35 9.0	1.22 31.0	1.38 35.2	126	174
BF3121	in. mm	D	1.24 31.5	—	0.59 15.0	0.60 15.2	0.84 21.5	41	95

Physical Parameters

Material and U.L. Data API-1 Material, see characteristics and information on page 121.

* **Note** Impedance is typical, based on 1/2 turn (4.0") 18 AWG wire. Impedance measurement using HP4191A.

Color Black; Special colors Available for bases on a non-cancellable, non returnable basis C = Cream; W = White; Gr = Grey

U.L. Recognized

All plastic and adhesive components use U.L. Recognized materials with Flammability Ratings of UL94V-0, UL-510 or UL-746C

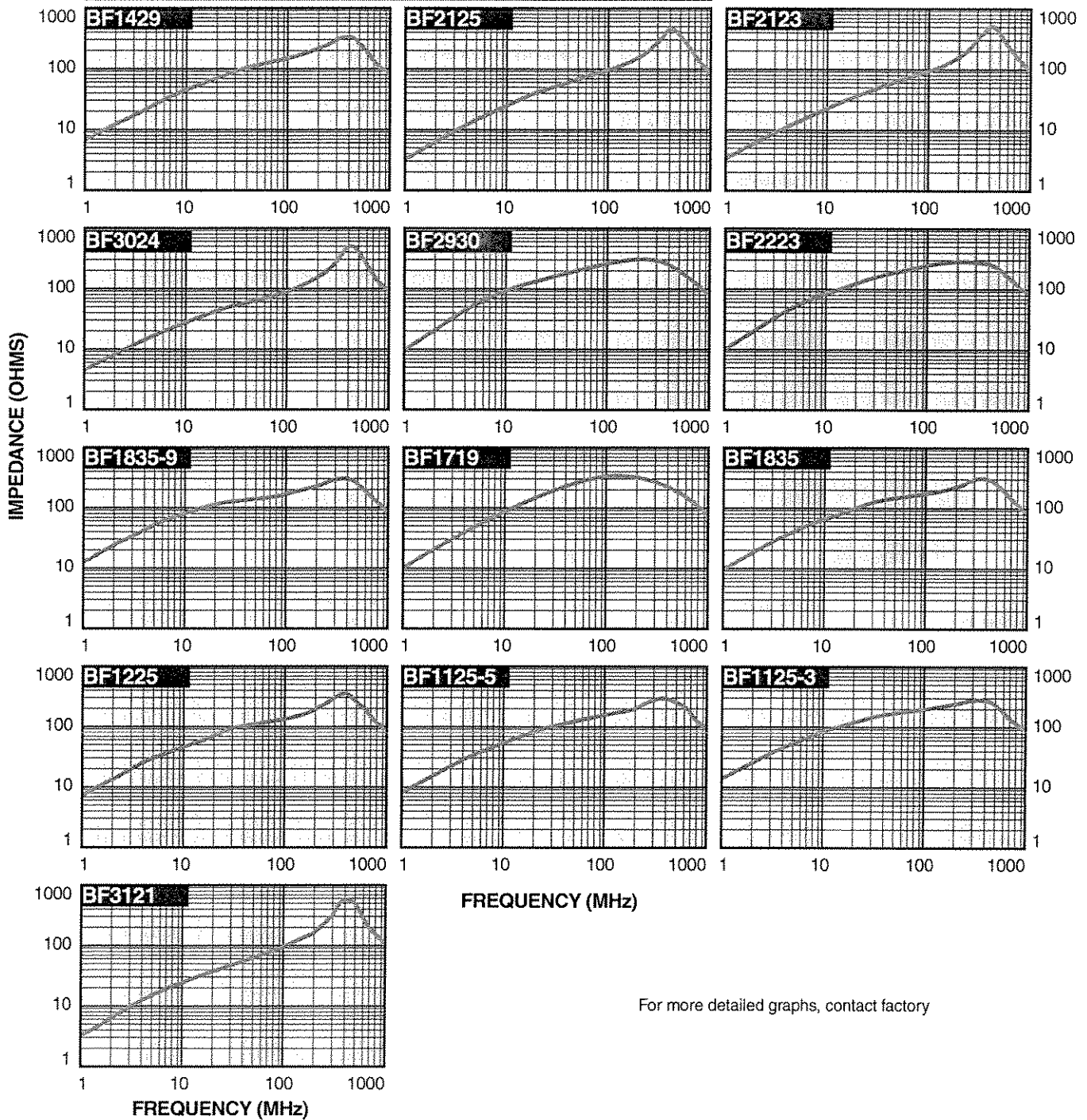
SEE Z vs. f GRAPHS ON NEXT PAGE

SUPPRESSORS

BF Series

Split Ferrite Suppressors for Round Cables

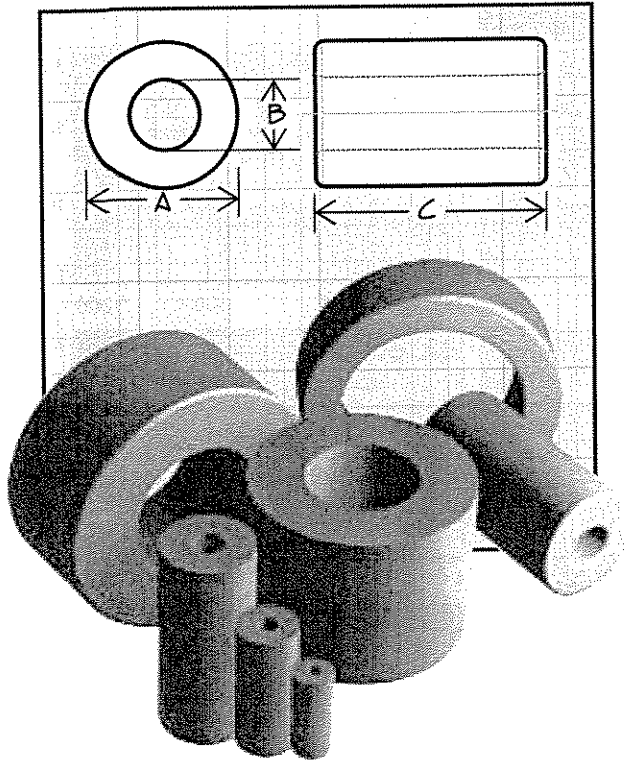
IMPEDANCE vs. FREQUENCY



Additional Information on Preceding Pages

Note Impedance is typical, based on 1/2 turn (4.0") 18 AWG wire.
Impedance measurement using HP4191A

Cylindrical EMI Suppression Ferrites



API's Cylindrical EMI Suppression ferrites provide a cost effective means of reducing common and differential mode EMI. Used to suppress common mode EMI on the internal and external cable assemblies of electronic equipment.

Select a ferrite with an inner diameter most closely matching the outer diameter of the wires to be filtered.

Features

- Wide range of sizes with inner diameters from 1.5 mm (0.059 inches) to 23 mm (0.905 inches)
- Precision formed smooth surfaces prevent damage to wire insulation
- Available in API-1 and API-2 material. See page 121.
- Custom designs available

Applications

- Internal and external computer data and power cables.

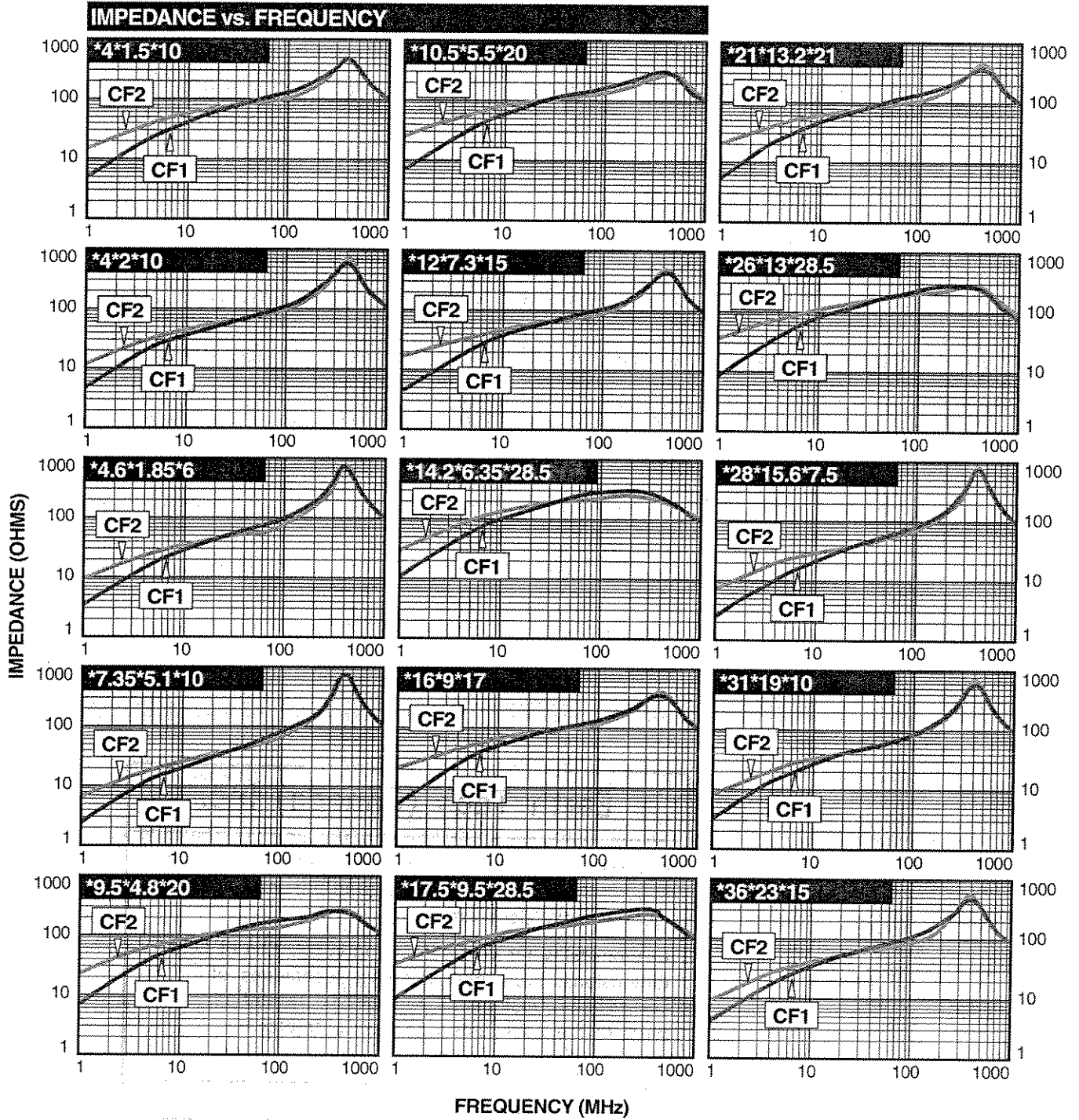
****Note – Impedance Testing** Impedance is typical, measurement using HP4191A. For CF1-4*1.5*10 through CF2-4.6*1.85*6, based on 1/2 turn (4.0") 32 AWG wire. For CF1-7.35*5.1*10 and above, based on 1/2 turn (4.0") 19 AWG wire.

PART NUMBER	IMPEDANCE**			DIMENSION A		DIMENSION B		DIMENSION C	
	@ 25 MHz (Min.)	@ 100 MHz (Typ.)	@ 300 MHz (Typ.)	INCHES	mm	INCHES	mm	INCHES	mm
CF1-4*1.5*10	50	135	300	0.157±.007	4.0±0.2	0.059±.005	1.5±0.15	0.393±.015	10.0±0.4
CF2-4*1.5*10	55	116	269	0.157±.007	4.0±0.2	0.059±.005	1.5±0.15	0.393±.015	10.0±0.4
CF1-4*2*10	40	102	282	0.157±.007	4.0±0.2	0.078±.007	2.0±0.2	0.393±.015	10.0±0.4
CF2-4*2*10	40	86	255	0.157±.007	4.0±0.2	0.078±.007	2.0±0.2	0.393±.015	10.0±0.4
CF1-4.6*1.85*6	35	89	261	0.181±.007	4.6±0.2	0.072±.007	1.85±0.2	0.236±.011	6.0±0.3
CF2-4.6*1.85*6	35	77	237	0.181±.007	4.6±0.2	0.072±.007	1.85±0.2	0.236±.011	6.0±0.3
CF1-7.35*5.1*10	23	68	217	0.289±.011	7.35±0.3	0.200±.007	5.1±0.2	0.393±.015	10.0±0.4
CF2-7.35*5.1*10	23	63	214	0.289±.011	7.35±0.3	0.200±.007	5.1±0.2	0.393±.015	10.0±0.4
CF1-9.5*4.8*20	70	171	263	0.374±.011	9.5±0.3	0.188±.007	4.8±0.2	0.787±.023	20.0±0.6
CF2-9.5*4.8*20	80	142	251	0.374±.011	9.5±0.3	0.188±.007	4.8±0.2	0.787±.023	20.0±0.6
CF1-10.5*5.5*20	65	161	273	0.413±.015	10.5±0.4	0.216±.007	5.5±0.2	0.787±.023	20.0±0.6
CF2-10.5*5.5*20	70	134	261	0.413±.015	10.5±0.4	0.216±.007	5.5±0.2	0.787±.023	20.0±0.6
CF1-12*7.3*15	40	107	273	0.472±.019	12.0±0.5	0.287±.011	7.3±0.3	0.590±.019	15.0±0.5
CF2-12*7.3*15	40	89	242	0.472±.019	12.0±0.5	0.287±.011	7.3±0.3	0.590±.019	15.0±0.5
CF1-14.2*6.35*28.5	115	280	302	0.559±.019	14.2±0.5	0.250±.011	6.35±0.3	1.122±.031	28.5±0.8
CF2-14.2*6.35*28.5	125	230	210	0.559±.019	14.2±0.5	0.250±.011	6.35±0.3	1.122±.031	28.5±0.8
CF1-16*9*17	50	130	281	0.629±.019	16.0±0.5	0.354±.011	9.0±0.3	0.669±.023	17.0±0.6
CF2-16*9*17	55	109	257	0.629±.019	16.0±0.5	0.354±.011	9.0±0.3	0.669±.023	17.0±0.6
CF1-17.5*9.5*28.5	95	217	310	0.688±.023	17.5±0.6	0.374±.011	9.5±0.3	1.122±.031	28.5±0.8
CF2-17.5*9.5*28.5	95	172	296	0.688±.023	17.5±0.6	0.374±.011	9.5±0.3	1.122±.031	28.5±0.8
CF1-21*13.2*21	55	136	309	0.826±.023	21.0±0.6	0.519±.019	13.2±0.5	0.826±.023	21.0±0.6
CF2-21*13.2*21	55	115	305	0.826±.023	21.0±0.6	0.519±.019	13.2±0.5	0.826±.023	21.0±0.6
CF1-26*13*28.5	100	235	325	1.023±.027	26.0±0.7	0.511±.019	13.0±0.5	1.122±.031	28.5±0.8
CF2-26*13*28.5	110	198	316	1.023±.027	26.0±0.7	0.511±.019	13.0±0.5	1.122±.031	28.5±0.8
CF1-28*15.6*7.5	28	85	313	1.102±.031	28.0±0.8	0.614±.019	15.6±0.5	0.295±.011	7.50±0.3
CF2-28*15.6*7.5	28	76	286	1.102±.031	28.0±0.8	0.614±.019	15.6±0.5	0.295±.011	7.50±0.3
CF1-31*19*10	30	91	232	1.220±.031	31.0±0.8	0.748±.023	19.0±0.6	0.393±.015	10.0±0.4
CF2-31*19*10	30	83	320	1.220±.031	31.0±0.8	0.748±.023	19.0±0.6	0.393±.015	10.0±0.4
CF1-36*23*15	40	113	384	1.417±.031	36.0±0.8	0.905±.023	23.0±0.6	0.590±.019	15.0±0.5
CF2-36*23*15	40	101	369	1.417±.031	36.0±0.8	0.905±.023	23.0±0.6	0.590±.019	15.0±0.5

CF Series

Cylindrical EMI Suppression Ferrites

SUPPRESS IS



For more detailed graphs, contact factory

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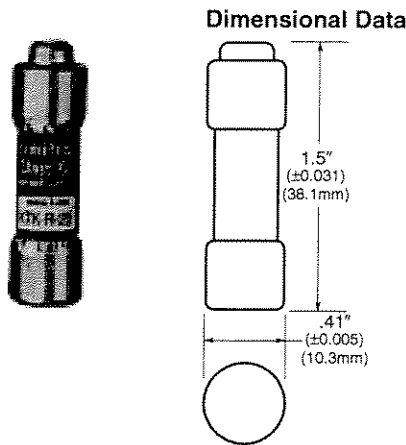
Date: 5/21/06 By: P.S. [Signature]

LIMITRON®

KTK-R

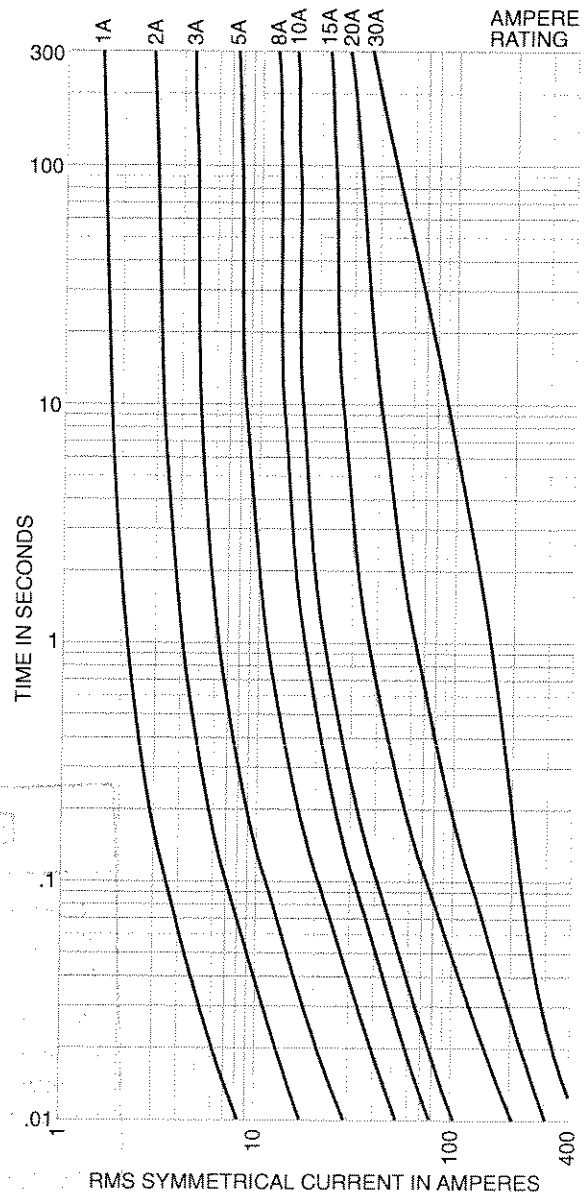
Fast-Acting Fuses

13/32" x 1-1/2", Class CC - 600 Volt, 1/10 - 30 Amps



- LIMITRON® fast-acting fuse.
- Melamine tube. Nickel-plated brass endcaps.
- U.L. Listed for branch circuit protection.
- Rejection type; for both standard holders or those which reject other type fuses.

Time-Current Characteristic Curves—Average Melt



CATALOG SYMBOL: KTK-R
 FAST-ACTING BRANCH CIRCUIT FUSE
 1/10 TO 30 AMPERES
 600 VOLTS AC (OR LESS)†
 INTERRUPTING RATING—200,000A RMS SYM. (U.L.)
 UL LISTED, STD. 248-4, CLASS CC,
 (GUIDE #JDDZ, FILE #E4273)
 CSA CERTIFIED, C22.2 NO. 248.4, (FILE #53787—CLASS
 #1422-02)
 †12-30A RATED 300 VDC AND 10 KAIC.

Electrical Ratings (Catalog Symbol and Amperes)

600 Volts AC - U.L. Listed & C.S.A.			
KTK-R-1/10	KTK-R-6/10	KTK-R-3-1/2	KTK-R-10
KTK-R-1/8	KTK-R-3/4	KTK-R-4	KTK-R-12
KTK-R-2/10	KTK-R-1	KTK-R-5	KTK-R-15
KTK-R-1/4	KTK-R-1-1/2	KTK-R-6	KTK-R-20
KTK-R-3/10	KTK-R-2	KTK-R-7	KTK-R-25
KTK-R-4/10	KTK-R-2-1/2	KTK-R-8	KTK-R-30†
KTK-R-1/2	KTK-R-3	KTK-R-9	

Carton Quantity and Weight

Ampere Ratings	Carton Qty.	Weight*	
		Lbs.	Kg.
1/10-30	10	.180	.082

*Weight per carton.

Fuseblock Catalog Numbers

No. of Poles	Screw Terminal	Pressure Plate	Box Terminal	Screw Quick-Connect	Pressure Quick-Connect
1	BC6031S	BC6031P	BC6031B	BC6031SQ	BC6031PQ
2	BC6032S	BC6032P	BC6032B	BC6032SQ	BC6032PQ
3	BC6033S	BC6033P	BC6033B	BC6033SQ	BC6033PQ

CE logo denotes compliance with European Union Low Voltage Directive (50-1000 VAC, 75-1500 VDC). Refer to BIF document #8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

See Also OPTIMA - Overcurrent Protection Modules

Catalog Number		BIF Document No.
OPM-SW	Fuse Switch with indication	1101
OPM-CC	Fuse Module with indication	1100

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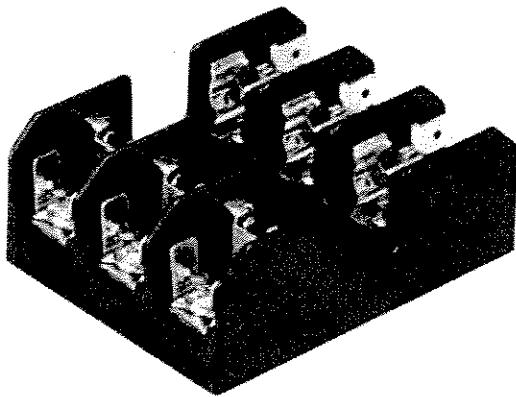
Date: June 21/06

By: [Signature]

Class CC Fuseblocks

600 Volt AC, 1/10 to 30 Amps

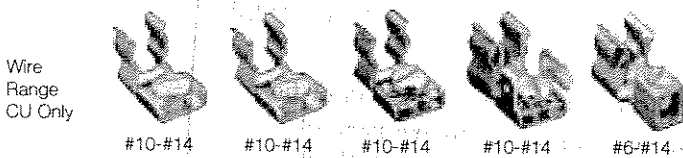
BC Series



Catalog Symbol: BC Series
Class CC Fuseblocks
Ampere Rating: 1/10 to 30 Amperes
Voltage Rating: 600 Volts AC
Withstand Rating: 200,000 Amps, RMS Sym.
Agency Information:
 U.L. Listed, U.L. 512, Guide IZLT, File E14853
 CSA Certified, C22.2 No. 39, Class 6225-01, File 47235
 For use with Class CC Fuses (Bussmann LP-CC, KTK-R, and FRQ-R)
U.L. Flammability: 94 VO
Materials: Base - Thermoplastic
 Clips - Bright tin-plated bronze

Catalog Data (600 Vac)

Amps	Poles	Terminal Type				
		Screw	Screw with Quick Connect*	Pressure Plate	Pressure Plate w/ Quick Connect*	Box Lug
1/10	1	BC6031S	BC6031SQ	BC6031P	BC6031PQ	BC6031B
to	2	BC6032S	BC6032SQ	BC6032P	BC6032PQ	BC6032B
30	3	BC6033S	BC6033SQ	BC6033P	BC6033PQ	BC6033B

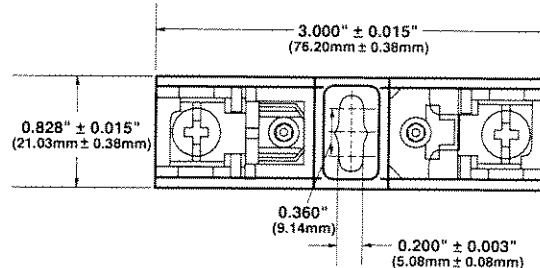


* QUICK CONNECT RATED FOR 20A MAXIMUM.

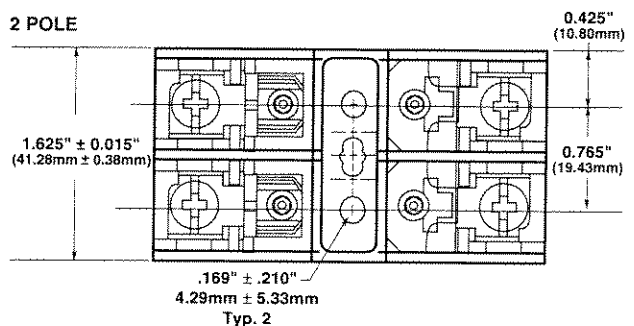
CE CE logo denotes compliance with European Union Low Voltage Directive (50-1000 Vac, 75-1500 Vdc). Refer to BIF document #8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

Dimensional Data

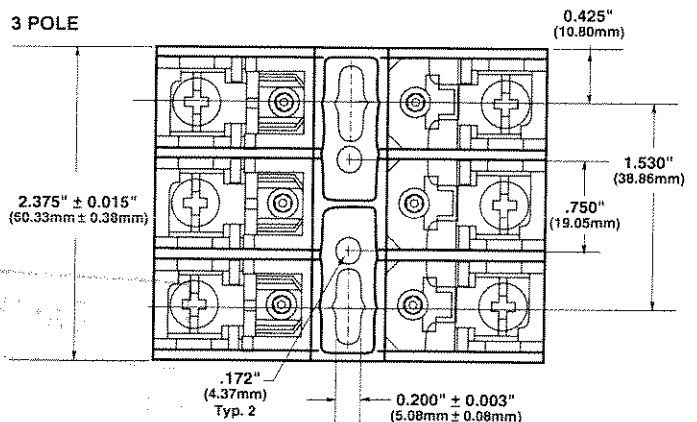
1 POLE



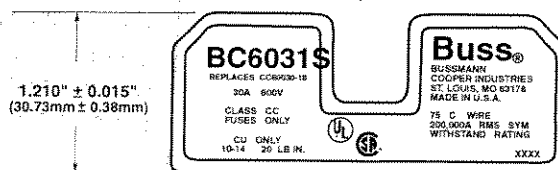
2 POLE



3 POLE



FUSEBLOCK LABEL (EXAMPLE SHOWN)



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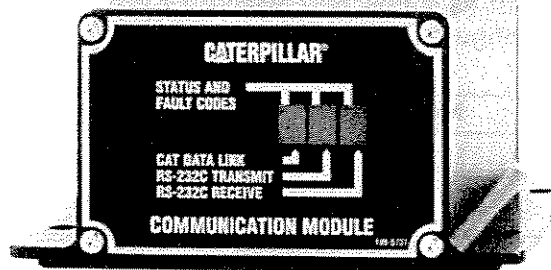
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Project No. 79538-03-16

Date: 11/21/01 By: [Signature]



Shown with
Optional Equipment

FEATURES

CUSTOMER COMMUNICATION MODULE

- CCM converts EMCP II and EMCP II+ proprietary Cat® high speed serial data link to an industry standard RS-232C serial data link. Number of packaged generator sets that can be linked at a common site:
 - Up to eight generator sets with MUI engines, CCM, and EMCP II or EMCP II+*
 - One generator set with 3500B Series engine, CCM, and EMCP II
 - Up to four generator sets with 3500B Series engines, CCM, and EMCP II+
 - Up to eight generator sets with 3500B engines, CCM, and EMCP II+*
 - One generator set with 3406E engine, CCM, and EMCP II or EMCP II+
 - Up to eight generator sets with 3406E engines, CCM, and EMCP II+*
 - One generator set with G3500B Series engine, CCM, and EMCP II+*
 - Up to eight generator sets with G3400 Series engine, CCM, and EMCP II or EMCP II+*
- When combining MUI, 3500B Series, and 3406E engines, or connecting multiple packaged generator sets, consult the latest version of the Operation and Maintenance Manual (SEBU6874).

* Engine data limited to parameters monitored by EMCP II and EMCP II+.

REMOTE COMMUNICATION

- CCM allows communication with a remote customer PC via direct connection or Hayes compatible modem:
 - Remote monitoring of all “real time” engine and generator parameters
 - Remote monitoring of all alarms, shutdowns, and diagnostic codes
 - Remote start/stop
 - Remote fault set
 - Remote control of low/high idle relay, fault relay
 - Cooldown timer override

WINDOWS-BASED PC SOFTWARE

- Software provided with the CCM can be used for all control and monitoring functions available on the EMCP II and EMCP II+ control panels.

CUSTOMER COMMUNICATION MODULE (CCM)

Applied to packaged generator sets equipped with EMCP II family of control panels

The Customer Communication Module (CCM) provides a means to remotely control and monitor single or multiple Packaged Generator Sets (PGS) at a common site. By accessing the CCM from a personal computer (PC) or other RS-232C device, each PGS can be remotely started and stopped, and all engine and generator parameters can be monitored on a “real time” basis.

SPECIFICATIONS

PHYSICAL DATA

Length — mm (in)	145 (5.7)
Width — mm (in)	149 (5.9)
	includes 21 mm flange on each side
Height — mm (in)	73 (2.9)
Weight — kg (lb)	approx. 0.5 (1.10)

ENVIRONMENTAL

Ambient temperature range
— °C (°F).....-40 to +70 (-40 to 158)

POWER REQUIREMENTS

3.0 watts at 24 vdc (nominal)
Voltage range — vdc

MODEM REQUIREMENTS

(not required for direct connected systems)

- Hayes compatible
- Minimum recommended baud rate of 9600

CABLE REQUIREMENTS

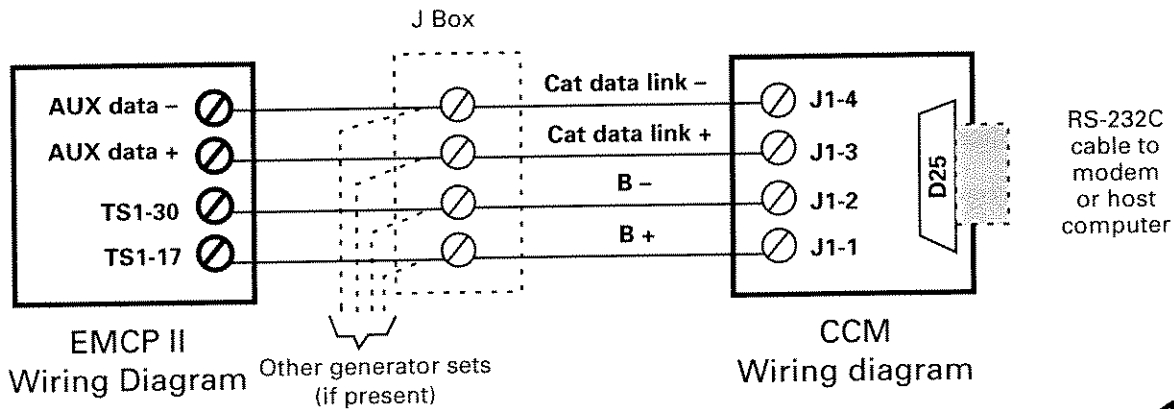
- Boosted Cat data link and CCM power via four-point terminal strip:
 - Boosted Cat data link ±: Belden 8719 (or equivalent), shielded twisted pair, 16 AWG minimum, 458 m (1500 ft) maximum (total cable length)
 - B ±: 16 AWG minimum
- RS-232 data link:
 - Standard 25-pin “D” type connector 15 m (50 ft) maximum cable length — cable must include transmit, receive, DTR, DCD, and ground conductors
- Null modem required for direct connected systems

CCM OPERATING MODES

The CCM provides a system to control the generator set, monitor its status, and establish a hierarchy for administration (control, control/monitor, control/monitor/configure). CCM allows remote PC to perform the following:

	CONTROL	MONITOR	
		Operating Parameters:	Status Parameters:
EMCP II	Remote start or stop	Engine rpm	Position of engine control switch
	Emergency stop	Oil pressure	All alarms
	Fault reset	Coolant temperature	All shutdowns
	Activate idle/rated speed constant	Service meter hours	All EMCP II relays
	Activate circuit breaker shunt trip	DC battery voltage	All spare inputs
	Override cooldown timer	Generator frequency, AC volts, AC amps	All diagnostic codes
			GSC programmable parameters
Additional EMCP II+ Modes	Relay driver module	Power metering ekW kVAR kVA kW/hr kVAR/hr percent rated power power factor	Load demand relay
	Spare output relay		

CCM CONNECTION DIAGRAM



www.CAT-ElectricPower.com

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U.S./European sourced

LEHE1663 (7-01)
Replaces: LEHX7046-02

Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
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Project No. 79538-C31-16

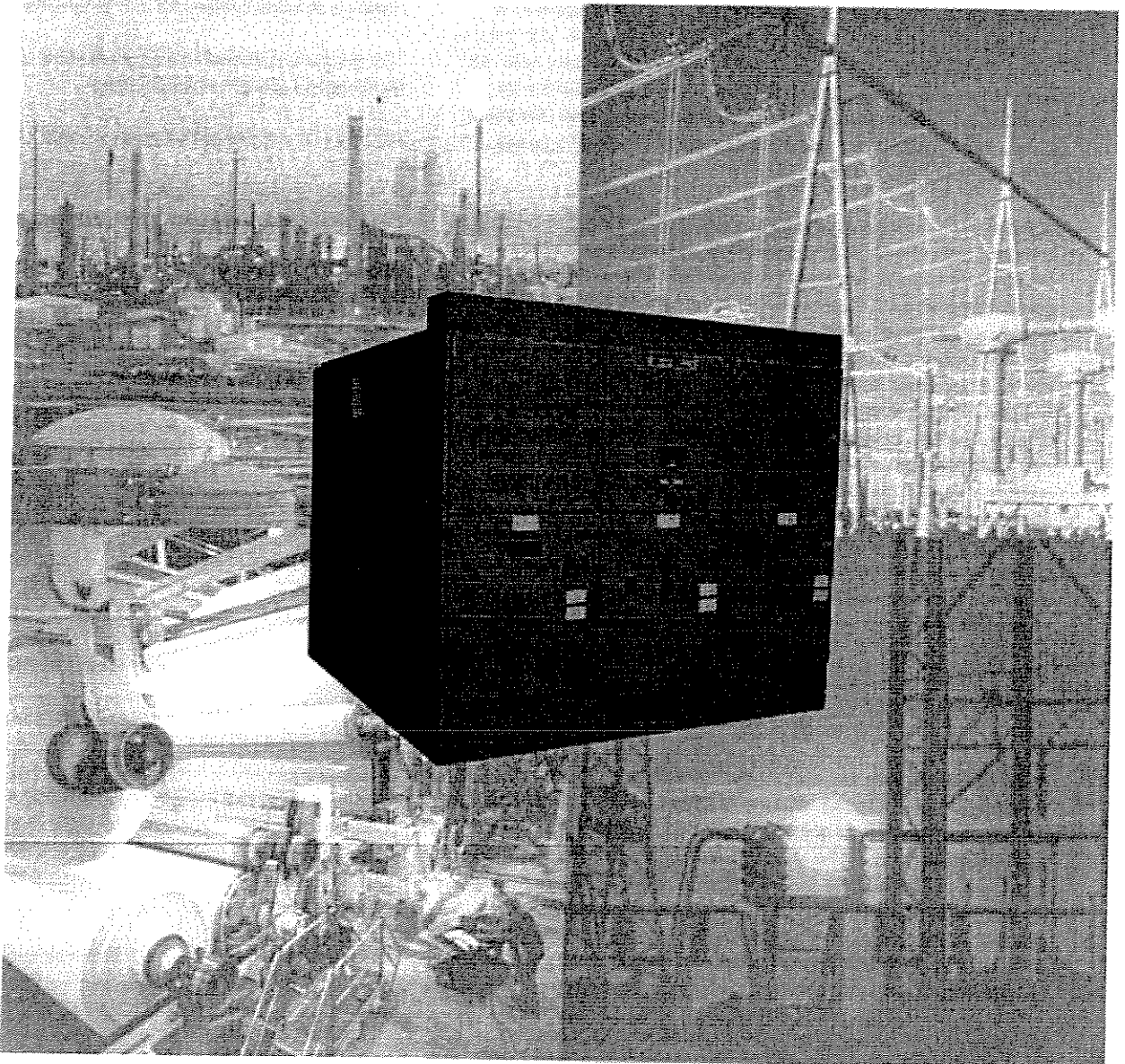
Date: June 21/06 By: M

Cutler-Hammer VacClad-W Arc Resistant Switchgear

The Result of Innovative Technology

Hugo Sulzer
Switchgear Application Specialist

April 1996



Cutler-Hammer

EAT•N

TRADITIONAL METALCLAD SWITCHGEAR CONCEPTS

Developments in Technology for medium voltage metalclad switchgear in recent years have greatly improved the reliability of the distribution systems from 2.4KV to 38KV. Vacuum breakers have fewer moving parts with lower inertia mechanisms resulting from smaller contact gap requirements. The net result has increased the reliability factors two fold. Improved insulation materials on breakers along with bed fluidized epoxy insulation bonded to bus bars have not only increased the performance reliability but has extended the life expectancy of current designed metalclad switchgear to 40 plus years. Distribution systems have also moved to higher interrupting ratings such as 750, 1000, 1500MVA.

With the trend to higher interrupting ratings, the metalclad switchgear design is recommended rather than metal enclosed and is the first choice design of most consultants and utilities. The metalclad design concentrates on a structure design which reduces the possibility of arcing faults within the enclosure. For instance, all primary elements such as breakers, voltage transformers and control power transformers have disconnect means with isolating shutters establishing isolation from the high voltage source. The enclosures containing primary elements have been compartmentalized and grounded for maximum isolation and confinement such as the breaker compartment, main bus compartment and cable compartment. Within these compartments all live parts where possible are fully insulated reducing the possibility of an arcing fault to occur. This primary directive to attempt to eliminate the possibility of an arcing fault has driven the design development to metalclad switchgear construction for many years. The design has proven itself to be a reliable switchgear design in most applications. Structural containment due to arcing faults were never considered by the traditional standards such as ANSI, IEEE, NEMA, UL, CSA because of the design criteria established to prevent arcing faults within the switchgear structure design.

Although arcing faults are rare, injuries from arcing faults in switchgear have continued. When it does occur, the results can be very destructive because of the energy levels reached within a confined compartment. The structural containment proves inadequate to prevent arcing products and hot gases escaping the faulted compartment. Burns could result if operating personnel are in close proximity to the faulted switchgear. Present regulatory organizations such as NEC, OSHA recognize the hazards of electric arc propagation and stipulates the use of protective clothing for operating personnel.

REASONS FOR DEVELOPMENT OF AN ARC RESISTANT SWITCHGEAR

ARCING FAULT PHENOMENA

Arcing faults can occur within a compartment as a result of insulation failure or human error. The pressure from an electric arc is developed from two sources: the expansion of the metal in boiling, and the heating of air by the arc energy. Copper expands by a factor of 67,000 times in vaporizing. This accounts for the expulsion of near-vaporized droplets of molten metal from the arc; one of the tests showed that

droplets could be propelled up to 10 feet. The pressure also generates plasma outward from the arc for distances proportional to the arc energy. One cubic inch of copper vaporizes into 1.44 cubic yards of vapor. The air in the arc stream expands in warming up from its ambient temperature to that of the arc temperature (approx. 35,000 degrees F). All this happens within the first half cycle of the fault and results in a sudden, large rise in pressure inside of the compartment.

The structure of the switchgear offers some containment but may not be enough to prevent personal injury.

HISTORY OF ARC RESISTANT SWITCHGEAR IN EUROPE

In Europe, concern for internal arcing within the enclosure of switchgears had existed for a number of years and in April 1969, work in Germany led to the publication of "Pehla Recommendation no. 2" which described the method for testing switchgear under conditions of internal arcing and gave the criteria for accepting an arc resistant construction. Some years later an IEC working group was formed to study a German proposal for amending the switchgear specification publication 298 to include a section on non-mandatory internal arc test and in December 1978, Amendment no. 2 to IEC publication 298 was adopted.[1] This Amendment and subsequent updates are considered as the basis for arc resistant testing of metalclad switchgear in Europe. It gives the locations where internal faults are more likely to occur, types of accessibility for a switchgear, test arrangements, test current and voltage to be applied, test procedure and the criteria for assessing the test results. This IEC standard was also used as the base standard in the development of the EEMAC Standard G14-1 1987 in Canada.

CANADIAN DEVELOPMENT OF ARC RESISTANT SWITCHGEAR

To provide some background in Canada as to how the EEMAC Standard was developed, the following events took place before the Standard was written. A failure took place in a substation in the City of Toronto. The racking mechanism for the incoming circuit breaker was designed such that the circuit breaker could pivot slightly out of alignment and still satisfy interlocking requirements. This resulted in a poor connection in one of the outer phases at the circuit breaker upper primary disconnect.

The disconnect overheated, resulting eventually in thermal breakdown of the circuit breaker bushing, and a flashover to the wall of the circuit breaker cubicle. The resulting explosion in the circuit breaker compartment caused the front door to bow, fractured its upper and lower fastenings, and swung the door open, ejecting hot arc products into the station building. Nobody was close to the equipment at the time and there were no injuries.

In another event in Ontario's Niagara Region, due to changes in metering requirements in the Region, some current transformers were removed from a circuit breaker cell and replaced by epoxy insulated copper bars. One of the bolted connections was not properly torqued and in the course of about a week, the heat generated at the poor connection caused the insulation to deteriorate to the point of failure.

The flashover resulted in a cable compartment cover being blown off, shearing eleven fastening bolts. Again, nobody was close to the equipment and there were no injuries.

The third event had two explosive failures in adjacent cable compartments in a metalclad switchgear in a Hamilton transformer station. The primary cause of both failures was attributed to snow blowing into the cubicles via a ventilation louvre under the building eaves, resulting in the eventual failure of two cable potheads.

The first fault was interrupted by the feeder breaker but resulted in the doors of the cable compartment being blown open. Five workmen including supervisors were dispatched from Ontario Hydro and Hamilton Hydro to examine the failed equipment and to start the repair procedures. As they gathered around the failed cell, the second fault in the adjacent compartment took place. Because of a faulty feeder circuit breaker, the second fault persisted for a longer period of time, with the result that the doors were completely torn off and the hot arc products spilled into the aisleway. Four of the workmen were seriously injured. [2]

Following this last failure, it was decided future metalclad bought by Ontario Hydro must be able to withstand the explosive forces generated by faults inside metalclad cells i.e., the design must be arc resistant. Prior to these failures, Ontario Hydro had been made aware of European developments in this area, particularly in Germany. At the time of Ontario Hydro's decision, the International Electrotechnical Commissions (IEC) were in the process of establishing criteria for successful type testing of an arc resistant design. These were later published in Amendment No. 2 to IEC Standard 298 as previously stated.

Ontario Hydro directed the members of the Electronic & Electrical Manufacturers Association (EEMAC) to form a working group to write a similar Canadian specification to deal with the proper procedure for testing a switchgear design which would prevent explosive forces from escaping due to the failure of the structure containment during the severe overpressure phase of a fault.

The specification was completed in 1987 heavily influenced by Ontario Hydro. The basis for the EEMAC G14-1 test procedure has similar criteria as established by IEC but strengthened in areas where Ontario Hydro felt the procedure for testing needed improvement from the European design criteria at the time it was written. To date, IEC has made modifications to their specifications to improve the safety of control gear manufactured in Europe.

DESIGN LEVELS FOR ARC RESISTANT SWITCHGEAR

The EEMAC G14-1 although a test procedure, does define three distinct levels of arc resistant design corresponding to the test conditions stipulated within the test procedure.

Accessibility Type A: Switchgear with arc resistant construction at the front only.

Accessibility Type B: Switchgear with arc resistant construction at front, back and sides.

Accessibility Type C: Switchgear with arc resistant construction at front, back and sides and between compartments within the same cell or adjacent cells.
(Utility Requirement)

Note to Type C: The only exception is that a fault in a bus bar compartment of a feeder cell is allowed to break into the bus bar compartment of an adjacent feeder cell. (This recognizes the fact that most bus compartments have very little volume for gas expansion and that the pressure relief in breaking into the adjacent main bus compartment is acceptable, according to EEMAC G14-1 1987.)

EVALUATION CRITERIA OF A SUCCESSFUL TEST

The test procedure outlines the following stipulations which must be met for evaluating an acceptable arc resistant design.

Criteria No. 1

That properly secured doors, covers, etc., do not open.

Criteria No. 2

That parts which may cause a hazard do not fly off. This includes large parts or those with sharp edges, for example, inspection windows, doors, pressure relief flaps, cover plates, etc. made of metal or plastic.

Criteria No. 3

Accessibility Type A: That arcing does not cause holes to develop in the accessible front of the switchgear.

Accessibility Type B: That arcing does not cause holes in the freely accessible front, sides and rear of the enclosure.

Accessibility Type C: That arcing does not cause holes in the freely accessible front sides and rear of the enclosure or in the walls separating the cells in an assembly (except for main bus bar barriers) or between compartments of a cell.

Criteria No. 4

That the cotton indicators fitted as per test specification do not ignite. Indicators ignited as a result of the burning of paint, labels, etc. are excluded from this assessment.

EEMAC standard requires the cotton indicators to be 150g per square meter density and must be 10.2 cm from the test surface.

IEC standard requires 150g per square meter density and must be 30 cm from test surface.

Criteria No. 5

That all the grounding connections remain effective.[3]

With the above five criteria having been tested and assessed by an independent high voltage test station, a manufacturer is deemed to have an arc resistant design.

At this point in time, it must be emphasized that failure within the switchgear enclosure due either to a defect, an exceptional service condition as an example, corrosive atmosphere or mal-operation may initiate an internal arc.

There is little probability of such an event occurring in equipment meeting the requirements of ANSI, IEEE, EEMAC but it cannot be completely disregarded. Such an event may lead to the risk of injury, if persons are present in the vicinity of the equipment.

It is desirable that system designers and purchasers provide the highest appropriate degree of protection to persons. The principal objective is to avoid internal arcs or to limit their duration and consequences.

Experience has shown that faults are more likely to occur in some locations inside an enclosure than in others. Special attention should be paid in such areas. For guidance, a list of such locations and causes is given in Columns 1 and 2 of **Table 1** of EEMAC G14-1. Measures to decrease the probability of internal faults or to reduce the risk are recommended but not limited to examples in column 3.

If the measures described above are considered to be insufficient, then, to cover the case of an arc occurring entirely in air within the switchgear enclosure, a test in accordance with EEMAC G14-1, 1987 may be agreed between the manufacturer and user. The tests required make allowance for internal overpressure acting on covers, doors, inspection windows, etc. and also takes into consideration the thermal effects of the arc or its roots on the enclosure and of ejected hot gases directly from the switchgear and damage to partitions which would endanger operating personnel doing maintenance inside adjacent compartments.

It does not cover all effects which may constitute a risk, such as toxic gas nor the location of the equipment within a building.

Table 1 Locations, causes and examples of measures decreasing the probability of internal faults or reducing the risk [3]

Locations where internal faults are more likely to occur 1	Possible causes of internal faults 2	Examples of Measures 3
Cable Termination Compartments	Inadequate design	Selection of adequate dimensions
	Faulty installation	Avoidance of crossed cable connections. Checking of workmanship on site.
	Failure of solid or liquid insulation (defective or missing)	Check of workmanship and/or dielectric test on site. Regular checking of liquid levels.
Disconnectors Switches Grounding Switches	Mal-operation	Interlocks. Delays re-opening. Independent manual operation. Making capacity for switches and grounding switches. Instructions to personnel
Bolted Connections and Contacts	Corrosion	Use of corrosion inhibiting coatings and/or greases. Encapsulation where possible.
	Faulty assembly	Checking of workmanship by suitable means.
Instrument Transformers	Ferroresonance	Avoidance of these electrical influences by suitable design of the circuit.
Circuit Breakers	Insufficient maintenance	Regular programmed maintenance. Instructions to personnel.
All Locations	Error by personnel	Limitation of access by compartmentation. Insulation embedded live parts. Instructions to personnel.
	Aging under electric stresses	Partial discharge routine tests.
	Pollution, moisture, dust vermin etc.	Measures to ensure that the ingress specified service conditions are achieved.

CUTLER-HAMMER VacClad-W ARC RESISTANT SWITCHGEAR DEVELOPMENT

The new Cutler-Hammer using the Westinghouse VacClad-W medium voltage arc resistant switchgear design provides more advanced technology and more flexibility by incorporating into the basic steel structure all requirements of containment during an arcing fault.

During the many studies and tests conducted by Cutler-Hammer, it was found that the internal arcing phenomenon consists of two stages initially, the dynamic phase and a thermal phase. See Figure 1.

THE DYNAMIC PHASE

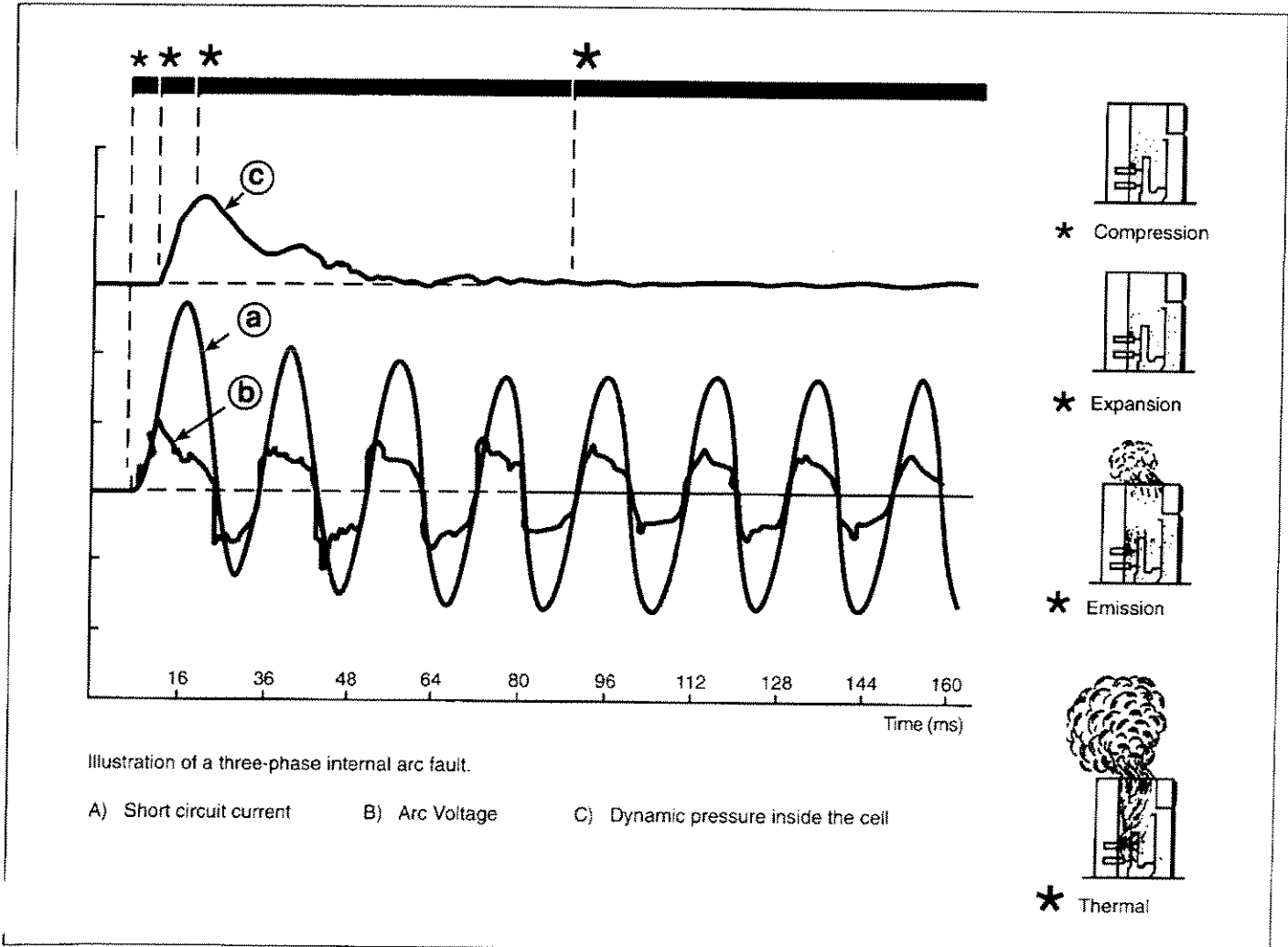
At the start of arc initiation within 10 milliseconds, the absolute pressure inside a switchgear enclosure could reach a pressure level of 4232 lbs/square foot in some instances but this value is a function of the fault current magnitude. With such a rate of rise of pressure, containment cannot be accomplished within the compartment.

The overpressure and the magnitude of arcing current and the volume of the compartment are all interrelated. There are many differential equations which have been developed but the geometry of each switchgear compartment are subtly different making actual testing the only ultimate way to prove an arc resistant design. The issue here is to design a pressure relief vent into the switchgear compartment design to allow the dynamic phase to dissipate without losing the integrity of the fastening devices.[4]

THE THERMAL PHASE

While the arc is burning and expanding, part of the compartment bus bars will vaporize, insulation will melt and disintegrate and burning of paint results in smoke and fumes. The longer the fault is allowed to persist beyond 30 cycles, the arc could burn through steel. This is why relay coordination settings are very important to clear the fault before burn through during the thermal phase takes place. Understanding the dynamics of an arc fault and energy levels attained allowed Cutler-Hammer to achieve the design goals required for arc resistant switchgear.

Figure 1 Pressure in a cell/compartment during arc.



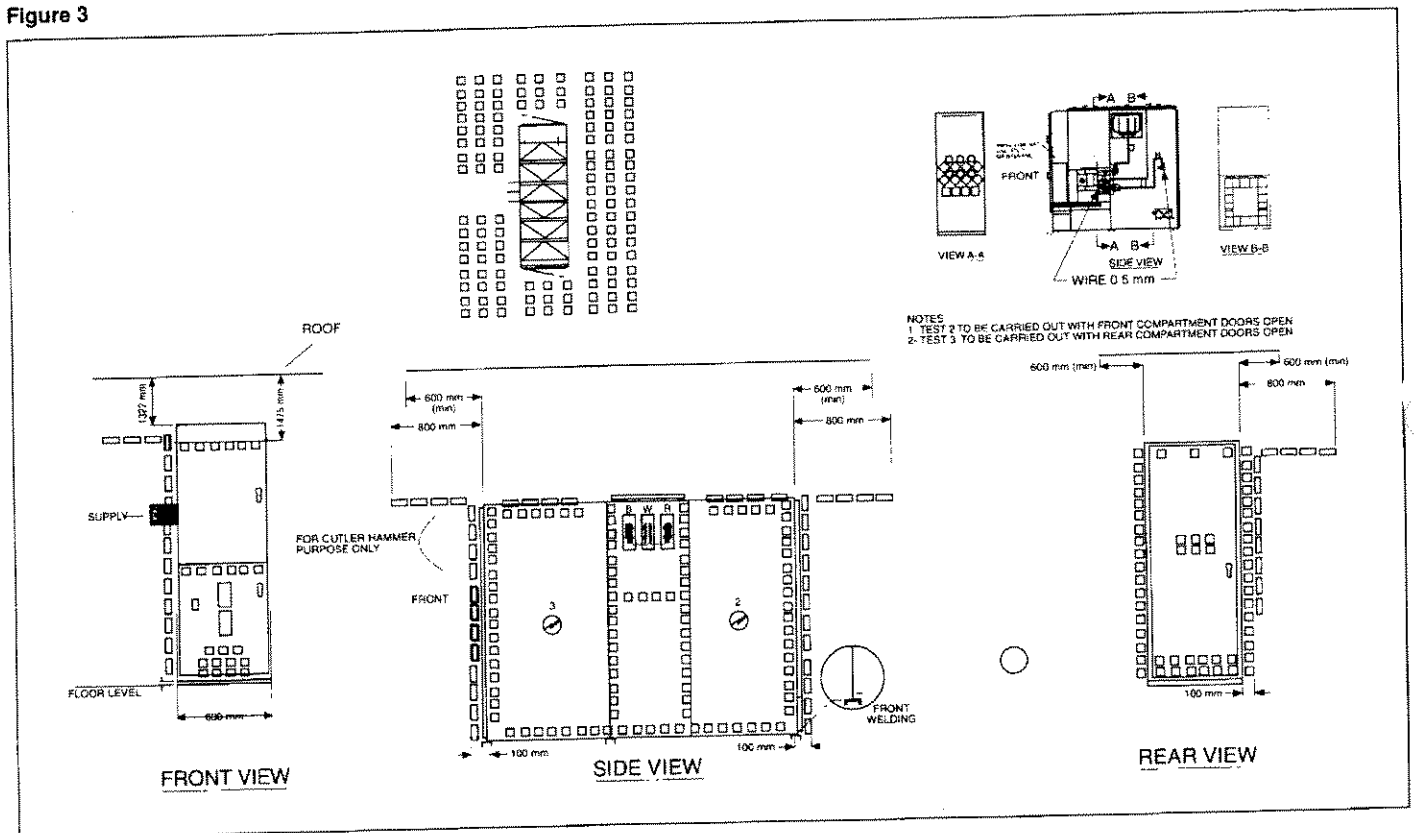
TESTING PROGRAM

Cutler-Hammer designed pressure relief vents in sufficient cross section areas on the roof of each metal clad compartment to effectively relieve the stresses within each compartment. The critical design of course are the hinges and latches which must hold together while pressure relief is accomplished. The overlaps of steel flanges had to seal off hot gases so that the cotton indicators outside the switchgear would not ignite. Cotton indicators representing bare skin in close proximity to switchgear compartments in a typical test are shown in **Figure 3**. The squares represent cotton indicators strategically placed in vulnerable areas of the switchgear design. Establishing a clear area

above the switchgear must be considered since the arc energy is now being focused through the tops of the switchgear. Compartment to compartment as defined by EEMAC G14-1 had to be tested so that the design levels A, B and C were proven to be safe. The pressure relief vents on top of the switchgear had to be of suitable thickness to ensure a walkable roof. During the installation of the switchgear, construction crews quite often walk on top of enclosures during offloading and placing into final position on the switchgear floor.

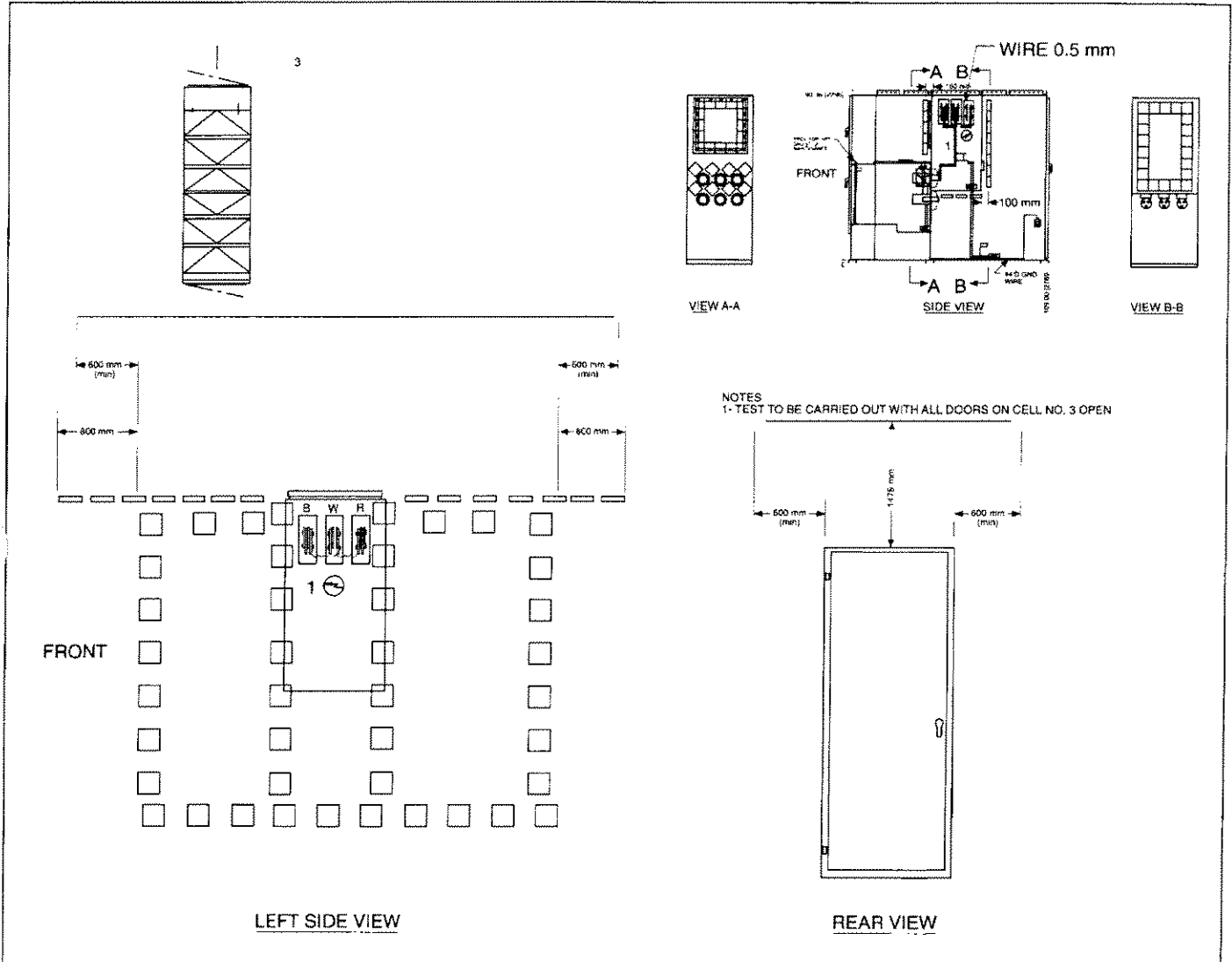
The Cutler-Hammer design not only has a walkable roof but the unique raised flange provides automatic driproof construction with every arc resistant design.

Figure 3



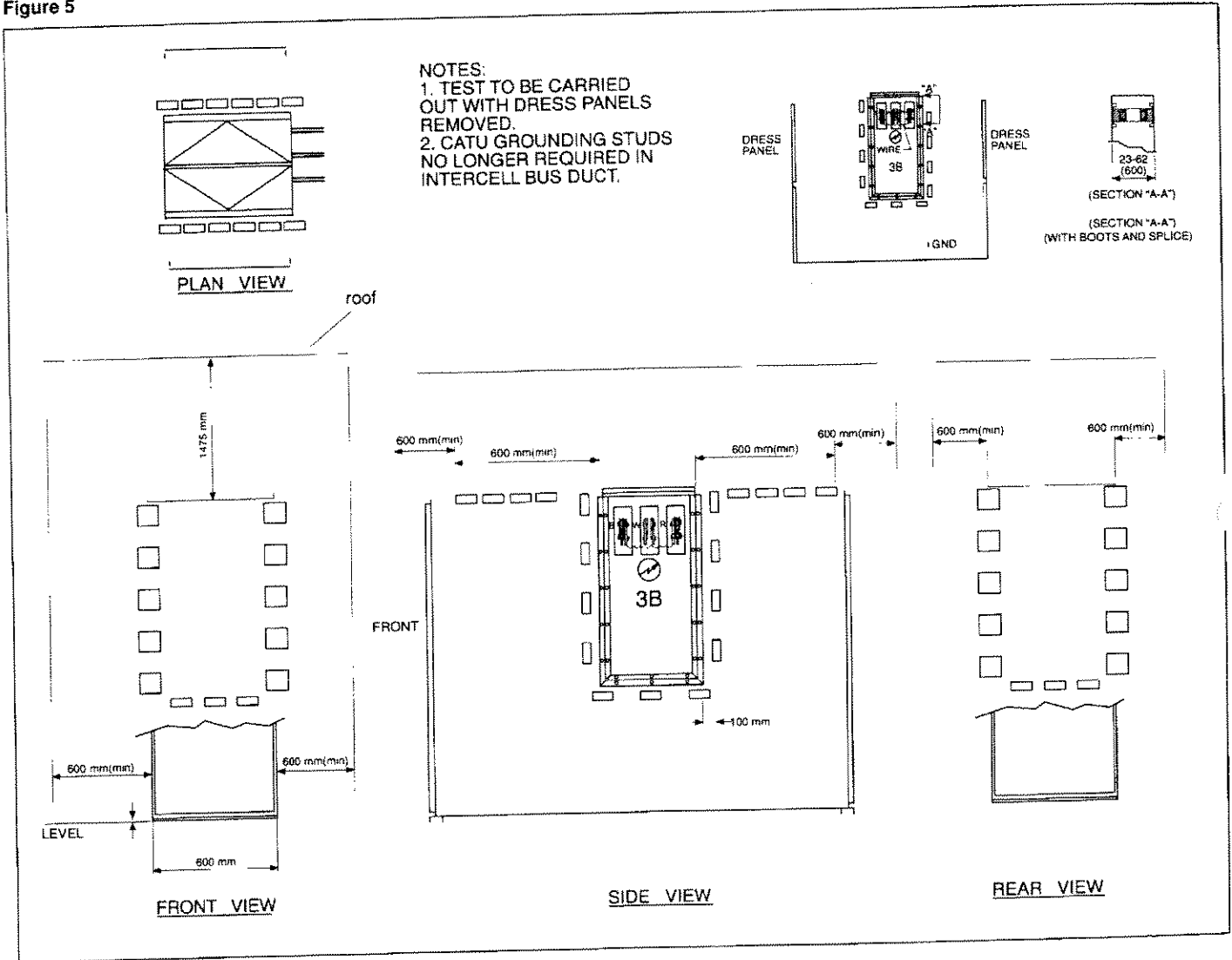
The test shown in **Figure 4** shows the set up of cotton indicator locations. The main bus compartment will be shorted with a copper wire having 0.5mm diameter sufficient to initiate the arc. These test sequences were performed with type c arc resistant construction.

Figure 4



The design in **Figure 5** is an internal bus duct rated 3000A. Bus duct connections will be necessary in some form and testing to validate the arc resistant design is necessary. Outside the compartment bus duct location of cotton indicators to detect any leakage of hot gases is critical even to extend beyond the roof line where the pressure vents are located.

Figure 5



FAULT LEVELS AVAILABLE

The procedure for testing as written in EEMAC G14-1 states that the fault levels tested must be agreed between the manufacturer and end user. The actual fault level is not stipulated. To provide improved operator safety, the Cutler-Hammer design was tested to match the interrupting rating of the breaker. This ensures a coordinated design

between arc resistant ratings and breaker ratings for the life of the switchgear design. It is common practice to add more feeder load on distribution switchgear including motor feeders. Motor contribution will increase the fault capacity of the distribution system. The allowed increase of course must not exceed the interrupting capacity of the breaker and for this reason, arc resistant tests were performed matching the breaker ratings. See **Table 2**.

Table 2

Circuit Breaker Type and Impulse Level	Nominal Voltage Class	Nominal 3-Phase MVA Class	Rated Maximum Voltage	Rated Voltage Range Factor K	Rated Continuous Current at 60 Hz	Rated Short Circuit at Rated Maximum Voltage	Maximum Symmetrical Interrupting Capacity	Arc Resistant Short Circuit Current Level at 60 Hz
50 VCP—W250 60kV B.I.L.	4.16	250	4.76	1.24	1200 2000 3000	29	36	36
50 VCP—W350 60kV B.I.L.	4.16	350	4.76	1.19	1200 2000 3000	41	49	49
75 VCP—W500 95kV B.I.L.	7.2	500	8.25	1.25	1200 2000 3000	33	41	41
150 VCP—W500 95kV B.I.L.	13.8	500	15	1.3	1200 2000 3000	18	23	23
150 VCP—W750 95kV B.I.L.	13.8	750	15	1.3	1200 2000 3000	28	36	36
150 VCP—W1000 95kV B.I.L.	13.8	1000	15	1.3	1200 2000 3000	37	48	48
270 VCP—W25 125kV B.I.L.	27	1170	28.5	1	630 1200 2000	25	25	25

CONSTRUCTION DETAIL HIGHLIGHTS AND DIMENSIONS

All operations performed on breakers, potential transformers and control power transformers, engagement/isolation/test are with the compartment doors closed for operator safety. The front door is interlocked with the shutter assembly to reduce the chance of accidental opening of the front door during even partial levering-in of the breaker/potential transformer/control power transformer drawout element. Viewing windows are provided so that the operator is able to see at all times what position the drawout element has reached such as the connected position or test/isolated position. In any breaker position, the status indicators on the breaker can be seen through the viewing windows which include breaker open and closed indicator flag, stored energy mechanism charged or discharged flag. All functions such as levering-in, manual trip, manual close, manual

charging of stored energy mechanisms are done with the front door closed in full view through the Lexan viewing windows. For typical dimensions, see **Table 3**.

A cautionary note must be made that all doors and panels must be properly closed and fastened for the arc resistant feature of the switchgear to be operative.

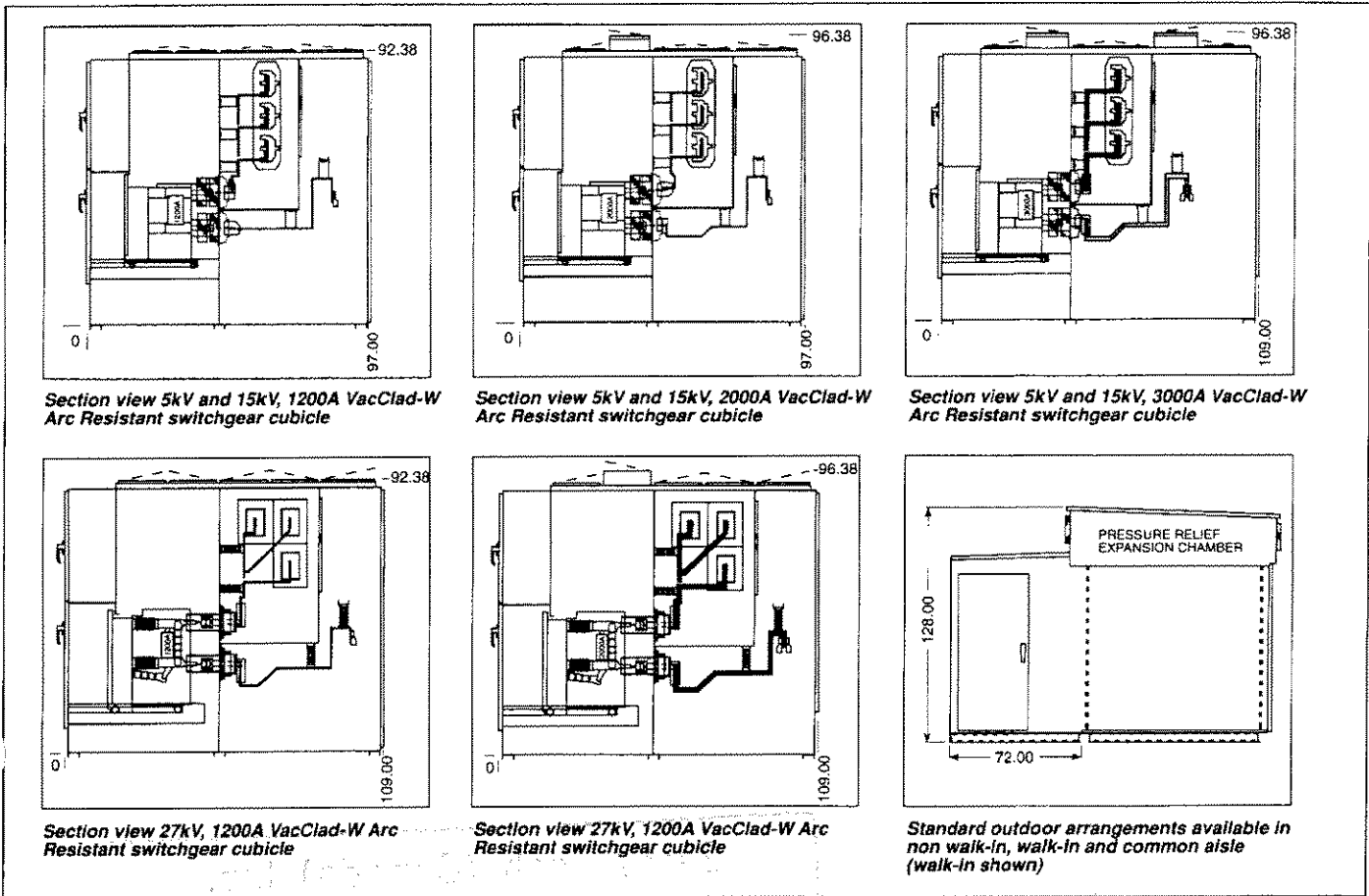
The rear cable compartment has two designs available; an all bolted back panel or a rear door with an 8 point latching handle mechanism which requires no bolting.

The walkable roof combined with the inherent dripproof construction provides the highest degree of equipment protection during installation and commissioning.

Table 3 Typical Dimensions Indoor and Outdoor VacClad-W Arc Resistant Switchgear

Circuit Breaker Type and Impulse Level	Nominal Voltage Class	Nominal 3-Phase MVA Class	Rated Continuous Current at 60 Hz	Indoor				Outdoor			
				Height	Width	Bottom Entry Depth	Top Entry Depth	Height	Width	Bottom Entry Depth	Top Entry Depth
50 VCP—W250 60kV B.I.L.	4.16	250	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
50 VCP—W350 60kV B.I.L.	4.16	350	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
75 VCP—W500 95kV B.I.L.	7.2	500	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
150 VCP—W500 95kV B.I.L.	13.8	500	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
150 VCP—W750 95kV B.I.L.	13.8	750	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
150 VCP—W1000 95kV B.I.L.	13.8	1000	1200 2000 3000	92.38" 96.38" 96.38"	36"	97" 97" 109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"
270 VCP—W25 125kV B.I.L.	27	1170	630 1200 2000	92.38" 96.38" 96.38"	42"	109"	Add 3" plus Top Cable Space	128"	Add 4" per Cell to Indoor Dimension	Add 10" to Indoor Dimension	Add 70"

Table 4 Section Views



CONCLUSION

The reliability of Westinghouse switchgear and circuit breakers, now Cutler-Hammer, has been proven by over 25 years of vacuum interrupter design and manufacturing experience. The ongoing research and development program has resulted in many significant advances in vacuum interrupter technology. These advances have been incorporated into the Cutler-Hammer VacClad-W Arc-Resistant Switchgear and VCP-W Circuit Breakers to provide enhanced dependability, reliability, and safety.

Extensive design and development taking into account all critical mechanical criteria of impact under overpressure makes the Cutler-Hammer VacClad-W Arc Resistant switchgear the best design available in the marketplace. Cutler-Hammer provides VacClad-W Arc Resistant switchgear which meets most utility design requirements. Multiple bolting, reinforced steel, heavier gauge material does not provide a better design or longer life expectancy; it only adds more weight to the switchgear assembly and more complexity to servicing. The Cutler-Hammer VacClad-W Arc Resistant design is not a retrofitted general purpose switchgear cubicle. Compartment formed steel design achieves panel against panel interfacing, providing a sealed joint under fault conditions which prevents smoke and gas escaping to other compartments, instead of conventional flat bolted panels which are not necessarily smoke or gas tight.

The switchgear cubicle can be easily removed even after a major fault occurrence without disturbing the adjacent cubicle, even in cases which have inaccessible locations. The enclosure can be dismantled inwardly with minimal unbolting.

Greater life expectancy is achievable with the Cutler-Hammer design with minimum down time if replacement or repair is ever necessary.

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- [3] "Procedure for Testing the Resistance of Metal-Clad Switchgear Under Conditions of Arcing due to an Internal Fault" EEMAC G14-1, 1987.
- [4] Michel G. Drouet, Francois Nadeau "Pressure Waves due to Arcing Faults in a Substation" IEEE transactions on power apparatus and systems, Vol. PAS-98, No 5, Sept/Oct 1979.

ABOUT THE AUTHOR

Hugo Sulzer received the Engineering Technologist degree in Electrical/Electronics from the Hamilton Institute of Technology in Hamilton, Ontario, Canada. He is a Switchgear Application Specialist working in the Cutler-Hammer Sales Department in Canada. Hugo is also a national resource for applications with vacuum devices in Canada and is an associate member of IEEE. Hugo has been involved with the development of Arc Resistant Switchgear for Cutler-Hammer, Canada from its early design to the present.

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New Information

MV Metal-Clad Vacuum Switchgear

Application

Cutler-Hammer VacClad-W metal-clad switchgear with type VCP-W vacuum breakers provides centralized control and protection of medium-voltage power equipment and circuits in industrial, commercial, and utility installations involving generators, motors, feeder circuits, and transmission and distribution lines.

VacClad-W switchgear is available in maximum voltage ratings from 4.76 kV through 38 kV, and interrupting ratings as shown below. VacClad-W offers a total design concept of cell, breaker, and auxiliary equipment, which can be assembled in various combinations to satisfy user application requirements. Two-high breaker arrangements are standard up to 15 kV. One-high arrangements can be furnished when required.

Ratings

Maximum Voltages:

4.76 kV, 8.25 kV, 15 kV, 27 kV, 38 kV

Interrupting Ratings:

4.76 kV: 250 MVA (29 kA)
 4.76 kV: 350 MVA (41 kA)
 500 MVA (63 kA)
 8.25 kV: 500 MVA (33 kA)
 15 kV: 500 MVA (18 kA)
 750 MVA (28 kA)
 1000 MVA (37 kA)
 1500 MVA (63 kA)
 27 kV: 16 kA, 22 kA, 25 kA, 40 kA
 38 kV: 16 kA, 25 kA, 31.5 kA, 40 kA
 : 2300 MVA (35 kA)

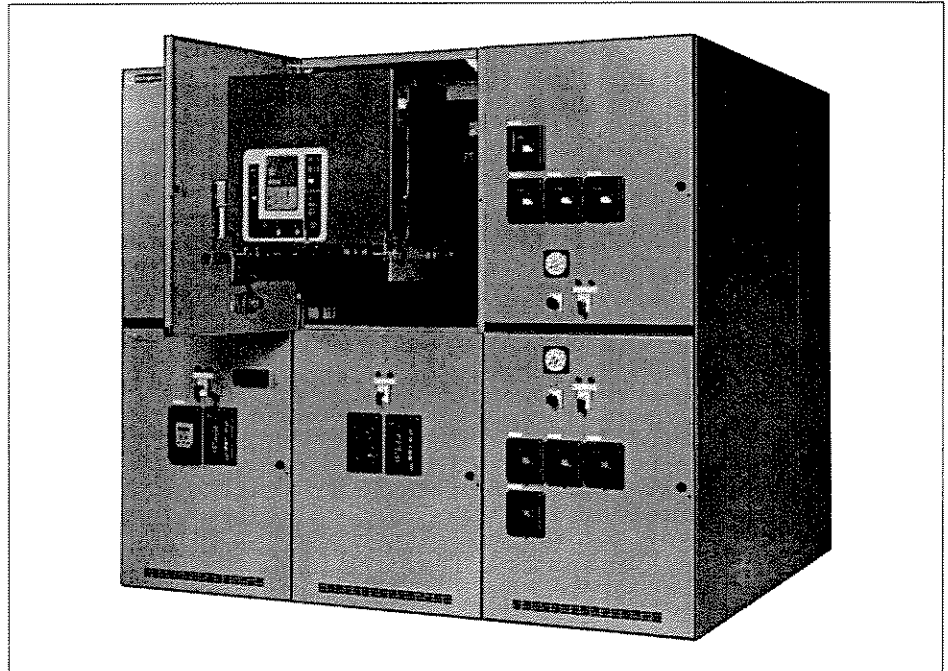
Continuous Current:

1200A, 2000A, 3000A (5 and 15 kV)
 4000A Forced cooled (5 and 15 kV)
 1200A, 2000A, (27 kV)
 3000A Forced cooled (27 kV)
 600A, 1200A, 1600A, 2000A, 2500A (38 kV)
 3000A Forced cooled (38 kV)

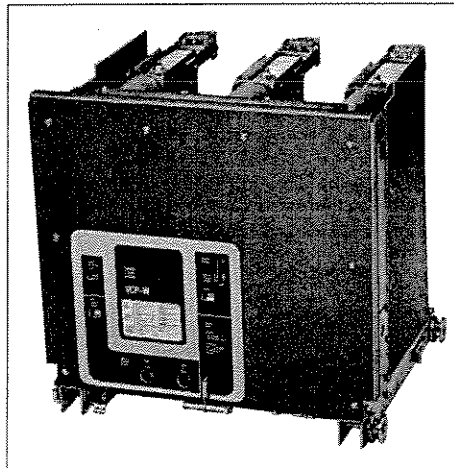
Advantages

Cutler-Hammer has been manufacturing metal-clad switchgear for over 50 years, and vacuum circuit breakers for over 30 years. Tens of thousands of Cutler-Hammer vacuum circuit breakers, used in a wide variety of applications, have been setting industry performance standards for years.

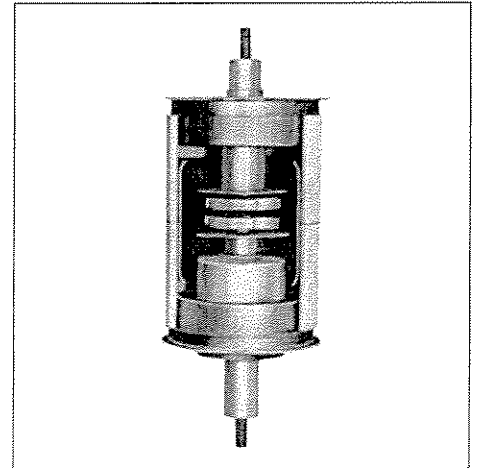
With reliability as a fundamental goal, Cutler-Hammer engineers have simplified the VacClad-W switchgear design to minimize problems and gain trouble-free performance. Special attention was given to material quality and maximum possible use was made of



Typical Indoor Assembly with a Breaker Withdrawn on Rails



VCP-W Breaker Element



Cut-away View of Vacuum Interrupter (Enlarged to Show Detail)

components proven over the years in Cutler-Hammer switchgear.

Maintenance requirements are minimized by the use of enclosed long-life vacuum interrupters. When maintenance or inspection is required, the component arrangements and drawers allow easy access. VacClad-W's light weight simplifies handling and relocation of the breakers.

VacClad-W meets or exceeds all applicable ANSI, NEMA, and IEEE design standards, and additionally offers many outstanding safety features. To ensure reliability and quality, the testing of VacClad-W switchgears has been extensive. UL and CSA listed switchgear is also available.

Features

Endurance

High power laboratory tests prove VCP-W breakers are capable of 50 to 200 full fault current interruptions.

Space Savings

Up to 50% floor space reduction over previous designs.

Vacuum Interrupter, Current Transfer Conductor

The Cutler-Hammer stiff-flexible design eliminates sliding/rolling contacts in the main conductor which provides excellent electrical and thermal transfer and long vacuum interrupter life.

Grounded Steel Safety Shutters

Prevents accidental contact with live primary voltage connections when breaker is withdrawn.

Breaker Rails

On 5-27 kV units the breaker can be withdrawn on rails for inspection and maintenance without the need for a separate lifting device.

Roll-on-the-Floor

38 kV breaker is designed to roll directly on the floor.

Reduced Breaker Weight

525 lbs. maximum through 27 kV vs. 2450 lbs. in a comparable air-magnetic design for ease of handling.

Reduced Breaker Maintenance

Vacuum interrupter requires only periodic check for contact erosion. Integral wear indicator provided. No contact adjustments are required.

Front Accessible Mechanism

Front accessible mechanism is standard on all VCP-W breakers.

Front Accessible CTs (5-27 kV)

Up to 12 CTs per breaker can be mounted for easy access.

Drawout Auxiliary Compartments

Up to 4 drawers per vertical section can be equipped with CPTs or VTs up to 15 kV. Primary isolation shutters are standard.

Fluidized Bed Epoxy Bus Insulation

Excellent track resistant and flame retardant properties.

Standardized Functional Designs

Shortens order cycle time.

Protective Relays

A full scope of protective relays designed to meet all application requirements is available to provide the utmost in system and component protection. One such multi-purpose relay system is the Cutler-Hammer Digitrip 3000. This microprocessor-based circuit protective, control and monitoring relay system includes devices 50, 51, 50N, 51N, 50G, 51G and 86, plus cause and magnitude of trip, integral test and programming, ampere demand, high load alarm, non-volatile set-points, self-testing and communications capabilities. The Digitrip 3000 is capable of being monitored and controlled through the Cutler-Hammer PowerNet System and other monitoring/control packages. The Digitrip 3000 is further discussed elsewhere in this publication. Refer to section B2 of CAT.71.01.T.E for further information.

PowerNet- Integrated Monitoring Protection and Control Communications System

Medium-voltage VacClad-W switchgear is ideally suited for the unique Cutler-Hammer PowerNet System.

PowerNet is the unique system that, for the first time, ties together multiple devices in electrical distribution systems in a wide variety of buildings and plants.

PowerNet utilizes the proven, INCOM chip for highly reliable, two-way communications (even in noisy industrial environments) between the master control unit and system devices via a twisted pair of conductors. Communications wires can be extended up to 10,000 feet from the master control unit without repeaters...and as many as 1,000 compatible devices, installed in various assemblies, can be on the PowerNet System.

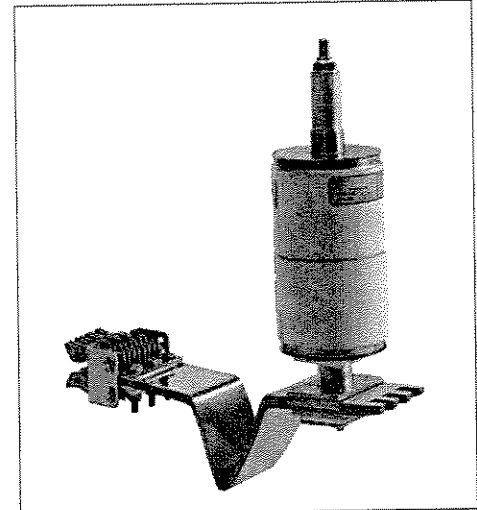
Easy Installation

Installation is uncomplicated and devices are connected, daisy chain style, via the twisted pair conductors. All assemblies and devices are standard Cutler-Hammer equipment when PowerNet compatible devices are ordered as part of an assembly. The assemblies (with compatible devices built in) are prewired, pretested and delivered complete.

Flexibility

PowerNet is flexible in that it can include those assemblies, such as VacClad-W switchgear, that are desired in a distribution system...but IMPACC/PowerNet can be easily upgraded as new assemblies are added. In essence, a customer determines the requirements for a building's electrical distribution system, and Cutler-Hammer provides the PowerNet System to fit those specific requirements.

Refer to section B5 of CAT.71.01.T.E for more information on PowerNet.



World Class VCP-W Vacuum Circuit Breakers Designed with a Patented V-Flex Nonsliding Current Transfer System

Supplemental Devices

Ground and Test Device

The ground and test device is a drawout element that may be inserted into a metal-clad switchgear housing in place of a circuit breaker to provide access to the primary circuits to permit the temporary connection of grounds or testing equipment to the high-voltage circuits. High potential testing of cable or phase checking of circuits are typical tests which may be performed. The devices are insulated to suit the voltage rating of the switchgear and will carry required levels of short-circuit current.

Before using ground and test devices it is recommended that each user develop detailed operating procedures consistent with safe operating practices. Only qualified personnel should be authorized to use ground and test devices.

Manual and electrical ground and test devices are available. These devices include six studs for connection to primary circuits. On the manual device, selection and grounding is accomplished by cable connection. On electrical-type device, grounding is accomplished by electrically operated grounding switch.

Standard Accessories:

- 1 - test jumper
- 1 - levering crank
- 1 - maintenance tool
- 1 - lifting yoke (5-27 kV)
- 2 - set of rails (5-27 kV)
- 1 - set of rail clamps (5-27 kV)
- 1 - turning handle (5th wheel, 38 kV)

Optional Accessories:

- 1 - transport dolly (5-27 kV)
- 1 - portable lifter (5-27 kV)
- 1 - test cabinet
- 1 - electrical levering device (5-27 kV)
- 1 - ramp for lower breaker (5-27 kV)
- 1 - manual or electrical ground and test device
- 1 - hi-pot tester

26-inch Wide 5 kV 250 MVA 1200A Switchgear

Application

This new member of the VacClad-W MV Metal-Clad switchgear family was designed for use in instances where floor space requirements would not allow the industry standard 36-inch wide switchgear. Typical applications include not only new construction but also replacement switchgear for installations previously equipped with 26-inch wide airbreak devices. This new line of switchgear has also proven very popular among Generator Control manufacturers where 5 kV, 1200A, 250 MVA applications are commonplace.

Ratings

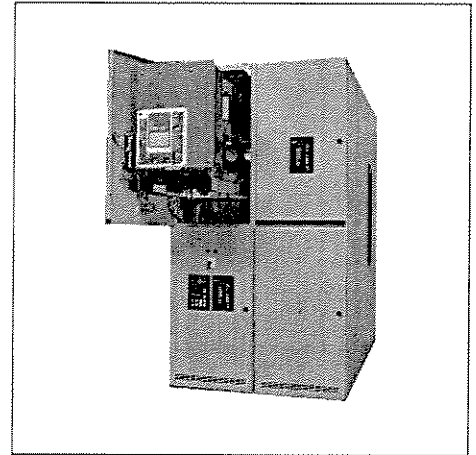
At the heart of the new switchgear line is the World-Class Cutler-Hammer VCPW-ND "Narrow Design" vacuum circuit breaker. The 26-inch wide offering includes breakers and gear that are rated for use on 5 kV, 250 MVA, 1200A, 60 kV BIL maximum systems. Main bus ratings of up to 3000A are available.

Configurations

Functionality is the name of the game. Available configurations include breaker over breaker, one or two auxiliaries over breaker, breaker over one or two auxiliaries or up to four auxiliaries in one vertical section.

In addition to the tremendous floor space saving offered by the 26-inch wide design, a savings in the height of the switchgear is also available. Where height is an issue, such as an outdoor powerhouse or in a mobile power container, the standard 95-inch height can be reduced to an 80-inch tall model with a single high breaker with one auxiliary and/or control cubical. In addition, the low-profile structure is designed to accommodate Voltage Transformers which may be front or rear mounted. Shallow-depth versions are also available for applications where depth is an issue. Contact your local Cutler-Hammer representative for more information on special dimensional requirements.

For installations requiring 2000A main breakers with 1200A feeders, lineups can be built with standard 36-inch wide main breaker cubicals and 26-inch wide feeders. The main bus connections are 100% compatible with standard 36-inch wide vertical sections. As a result, add-ons to existing installations can be simply and rapidly performed without costly system modifications and transition sections.



38 kV Metal-Clad Switchgear

Application

This new member of the VacClad Switchgear family was designed for use in applications with distribution voltages at 38 kV maximum. Typical applications include not only new construction but also replacement for older airbreak, minimum oil or SF6 switchgear. This new line is available in two basic versions: one designed specifically for domestic and export ANSI applications (VacClad-W), with a continuous current range of 600-2000A; and one built for export only IEC applications (W-VAC) for continuous current ranges of 630-2000A.

Ratings and Configurations

Both ANSI and IEC versions offer 31.5 kA RMS SYM momentary short circuit, 80 kV 1 minute withstand, 170 V BIL ratings as standard and both feature a revolutionary interface design that permits crossover and transition bus connections to adjacent sections without the need for a transition section. Standard dimensions of this 170 kV gear is 42 inches wide x 100 inches tall x 128.75 inches deep, making the VacClad-W offering the smallest in its class.

Features and Benefits

Safety has been thoroughly addressed in the design of the 38 kV VacClad-W. Both ANSI and IEC designs are designed and tested at the factory to be Corona-Free. In addition, optional Arc-Resistant designs can be specified to comply with EEMAC G-14-1 for Accessibility Types A, B and C. On all standard units, shutters can be independently padlocked to prevent inadvertent energizing during maintenance. Where needed, fully rated feeder and main bus earthing switches are also available.

Ease of service is another benefit. All 38 kV switchgear units are equipped with roll-on-the-floor vacuum circuit breakers that provide both unprecedented mobility and ready accessibility to the breaker cell. Levering-in mechanisms for breaker installation employ an innovative ball-screw bearing drive that can be operated by a single technician. A motor-driven levering system is also available.

Like the Cutler-Hammer VacClad-W Metal-clad switchgear products, the 38 kV line can be equipped with a variety of optional

features to enhance system protection and monitoring. The Cutler-Hammer Digitrip 3000 microprocessor-based trip system, IQ Analyzer and the PowerNet communications system are all available with the 38 kV metal-clad switchgear.

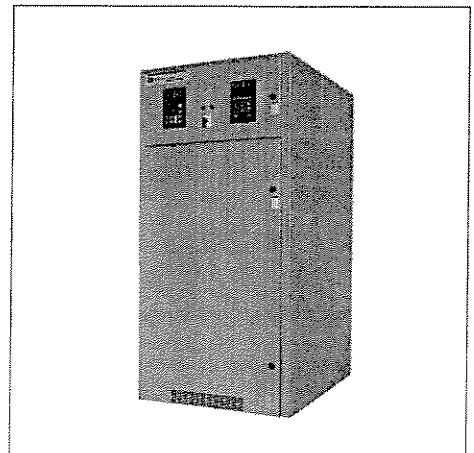


Table 1: Available VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards^①

Identification Circuit Breaker Type	Nominal Voltage Class kV Class	Nominal 3-Phase MVA Class MVA Class	Rated Values										Related Required Capabilities ^②					Asymmetry Factor for VCP-W Breakers S	
			Voltage		Insulation Level		Current		Rated Transient Recovery Voltage		Rated interrupting Time Cycles	Rated Permissible Tripping Delay Y Sec.	Rated Re-closing Time Cycles	Rated Maximum Voltage Divided By K V/K kV rms	Current Values				
			Rated Maximum Voltage V kV rms	Rated Voltage Range Factor K	Rated Withstand Test Voltage kV rms	Normal Frequency kV Crest	1.2 x 50 μsec. impulse kV Crest	Rated Continuous Current at 60 Hz Amperes	Rated Short-Circuit Current (at Rated Max. kV) kA rms	Rated Crest Voltage E2 kV Crest					Rated Time To Crest T2 Micro-sec	Maximum Sym. Interrupting Capability kA rms	3 Sec. Short-Time Current Carrying Capability kA rms		Closing and Latching Capability (Momentary) ^③ kA Crest
			④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮					
50 VCP-WND 250	4.16	250	4.76	1.24	19	60	1200	29	8.9	50	5	2	30	3.85	36	36	97	58	1.2
50 VCP-W 250	4.16	250	4.76	1.24	19	60	1200 2900 3000	29	8.9	50	5	2	30	3.85	36	36	97 132 ^③	58 78 ^③	1.2
50 VCP-W 350	4.16	350	4.76	1.19	19	60	1200 2600 3000	41	8.9	50	5	2	30	4.0	49	49	132	78	1.2
50 VCP-W 500	4.16	500	4.76	1.0	19	60	1200 2000 3000	63	8.9	50	5	2	30	4.76	63	63	170	100.8	1.27
75 VCP-W 500	7.2	500	8.25	1.25	36	95	1200 2000 3000	33	15.5	60	5	2	30	6.6	41	41	111	66	1.2
150 VCP-W 500	13.8	500	15	1.30	36	95	1200 2000 3000	18	28	75	5	2	30	11.5	23	23	62 97 ^③	37 58 ^③	1.2
150 VCP-W 750	13.8	750	15	1.30	36	95	1200 2000 3000	28	28	75	5	2	30	11.5	36	36	97 130 ^③	58 77 ^③	1.2
150 VCP-W 1000	13.8	1000	15	1.30	36	95	1200 2000 3000	37	28	75	5	2	30	11.5	48	48	130	77	1.2
150 VCP-W 1500	13.8	1500	15	1.0	36	95	1200 2000 3000	63	28	75	5	2	30	15	63	63	170	100.8	1.27
270 VCP-W 750	27	---	27	1.0	60	125	600 1200 2000	16	51	105	5	2	30	27	16	16	43	26	1.2
270 VCP-W 1000	27	---	27	1.0	60	125	600 1200 2000	22	51	105	5	2	30	27	22	22	60	35	1.2
270 VCP-W 1250	27	---	27	1.0	60	125	600 1200 2000	25	51	105	5	2	30	27	25	25	68	40	1.2
270 VCP-W 40	27	---	27	1.0	60	125	1200 2000	40	51	105	5	2	30	27	40	40	108	64	1.2
380 VCP-W 16	34.5	---	38	1.0	80	170 ^⑥	600 1200 1600 2000	16	71	125	5	2	30	38	16	16	43	26	1.2
380 VCP-W 21	34.5	---	38	1.65	80	170 ^⑥	1200 2000	21	71	125	5	2	30	23	35	35	95	56	1.2
380 VCP-W 25	34.5	---	38	1.0	80	170 ^⑥	600 1200 1600 2000	25	71	125	5	2	30	38	25	25	68	40	1.2
380 VCP-W 32	34.5	---	38	1.0	80	170 ^⑥	600 1200 1600 2000	31.5	71	125	5	2	30	38	31.5	31.5	85	51	1.2
380 VCP-W 40	34.5	---	38	1.0	80	170 ^⑥	600 1200 1600 2000 2500	40	71	125	5	2	30	38	40	40	108	64	1.2

- ① Contact Cutler-Hammer for capacitor switching, low inductive switching, and cable charging ratings.
- ② For reclosing service, there is **No De-Rating** necessary for the Cutler-Hammer VCP-W family of circuit breakers. **R = 100%**. Type VCP-W breaker can perform the O-C-O per ANSI C37.09; O-0.3s-CO-15s-CO per IEC 56; and some VCP-Ws have performed O-0.3s-CO-15s-CO-15s-CO-15s-CO; **all with no derating**. Contact Cutler-Hammer for special reclosing requirements.
- ③ For 3-phase and line-to-line faults, the sym. interrupting capability at an operating voltage, V_o

$$= \frac{V}{V_o} \text{ (Rated Short-Circuit Current)}$$

But not to exceed KI.

Single line-to-ground fault capability at an operating voltage, V_o

$$= 1.15 \frac{V}{V_o} \text{ (Rated Short-Circuit Current)}$$

But not to exceed KI.

The above apply on predominately inductive or resistive 3-phase circuits with normal-frequency line-to-line recovery voltage equal to the operating voltage.

- ④ 4000A continuous rating is available for 5/15 kV. 3000A continuous rating is available for 27/38 kV. Contact Cutler-Hammer for details.
- ⑤ 3-cycle rating available.
- ⑥ Tripping may be delayed beyond the rated permissible tripping delay at lower values of

current in accordance with the following formula:

$$T \text{ (seconds)} = \sqrt{\frac{[K \text{ Times Rated Short-Circuit Current}]^2}{\text{Short-Circuit Current Through Breaker}}}$$

The aggregate tripping delay on all operations within any 30-minute period must not exceed the time obtained from the above formula.

- ⑦ Non-standard breakers with high momentary rating available for special applications.
- ⑧ Included for reference only.
- ⑨ Asymmetrical interrupting capability = "S" times symmetrical interrupting capability, both at specified operating voltage.
- ⑩ ANSI standard requires 150 kV BIL. All 38 kV ratings are tested to 170 kV BIL.

Application Quick Check

See Table 2 for application of circuit breakers in a radial system supplied from a single source transformer. Short-circuit duty was determined using E/X amperes and 1.0 multiplying factor for X/R ratios in the range of 15 to 40.

Applications Above 3300 Feet [1000 m]

The rated one-minute power frequency withstand voltage, the impulse withstand voltage, the continuous current rating and the maximum voltage rating must be multiplied by the appropriate correction factor in Table 3 to obtain modified ratings which most equal or exceed the application requirements. Note that intermediate values may be obtained by interpolation.

Load Current Switching

Table 4 showing number of operations is a guide to normal maintenance for circuit breakers operated under usual service conditions for most repetitive duty applications including isolated capacitor bank switching and shunt reactor switching, but not for arc furnace switching. The numbers in the table are equal to or in excess of those required by ANSI C37.06.

Maintenance shall consist of adjusting, cleaning, lubricating, tightening, etc., as recommended by the circuit breaker instruction book.

Continuous current switching assumes opening and closing rated continuous current at rated maximum voltage with power factor between 80% leading and 80% lagging.

Inrush current switching assures a closing current equal to 600% of rated continuous current at rated maximum voltage with power factor of 30% lagging or less, and an opening current equal to rated continuous current at rated maximum voltage with power factor between 80% leading and 80% lagging.

In accordance with ANSI C37.06, if a short-circuit operation occurs before the completion of the listed switching operations, maintenance is recommended and possible functional part replacement may be necessary, depending on previous accumulated duty, fault magnitude and expected future operations.

Applications Above or Below 40°C Ambient

Refer to ANSI C37.20.2, section 7.4 for load current-carrying capabilities under various conditions of ambient temperature and load.

Table 2

Source Transformer MVA Rating		Operating Voltage kV					
Motor Load		2.4	4.16	6.6	12	13.8	27
100%	0%						
Up to 5	Up to 7.5	50 VCP-W 250 ^① (36 kA)	50 VCP-W 250 ^① (33.2 kA)	150 VCP-W 500 (23 kA)	150 VCP-W 500 (22.5 kA)	150 VCP-W 500 (19.6 kA)	270 VCP-W 750 (16 kA)
7.5 10 ^①	10 10	50 VCP-W 350 (49 kA)					
10	12 ^②						
12	15		50 VCP-W 350 (46.9 kA)	75 VCP-W 500 (41.3 kA)			
15	20						
20 ^②					150 VCP-W 750 (35 kA)	150 VCP-W 750 (30.4 kA)	
	25 30 50 ^②	Breaker Type and Sym. Interrupting Capability at the Operating Voltage			150 VCP-W 1000 (46.3 kA)	150 VCP-W 1000 (40.2 kA)	270 VCP-W 1000 (22 kA)
25	50						
30							270 VCP-W 1250 (25 kA)

Table 3

Altitude Above Sea Level in Feet [m]	Altitude Correction Factor to be Applied to	
	Voltage	Rated Continuous Current
3300 [1000] (and Below)	1.0	1.0
4000 [1200]	0.98	0.995
5000 [1500]	0.95	0.99
6000 [1800]	0.92	0.99
6600 [2000]	0.91	0.985
7000 [2100]	0.89	0.98
8000 [2400]	0.86	0.97
9000 [2700]	0.83	0.965
10000 [3000]	0.80	0.96
12000 [3600]	0.75	0.95
13200 [4000]	0.72	0.94
14000 [4300]	0.70	0.935
16000 [4900]	0.65	0.925
16400 [5000]	0.64	0.92
18000 [5500]	0.61	0.91
20000 [6100]	0.56	0.90

Table 4

Circuit Breaker Ratings		Maximum Number of Operations ^③				
Rated Maximum Voltage kV rms	Rated Continuous Current Ampere	Rated Short Circuit Current kA rms	Between Servicing	No-Load Mechanical	Rated Continuous Current Switching	Inrush Current Switching
4.76, 8.25, 15	1200, 2000	33 kA and below	2000	10000	10000	750
4.76, 8.25, 15	3000	All	1000	5000	5000	400
4.76, 15	All	37 kA and above	1000	5000	5000	400
27	All	All	500	2500	2500	100
38	All	All	250	1500	1500	100

① Also includes 50VCPW-ND250.

② Transformer impedance 6.5% or more. All other transformer impedances are 5.5% or more.

③ Each operation is comprised of one closing plus one opening.

Surge Protection

VacClad-W metal-clad switchgear is applied over a broad range of circuits, and is one of the many types of equipment in the total system. The distribution system can be subject to voltage transients caused by lighting or switching surges.

Recognizing this phenomenon, the industry has developed standards to provide guidelines for application of electrical equipment, which should be used in the design of distribution systems independent of the breaker interrupting medium. These standards are:

- ANSI C62 – Guides and Standards for Surge Protection
- IEEE 242 – Buff Book
IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- IEEE 141 – Red Book
Recommended Practice for Electric Power Distribution for Industrial Plants
- ANSI C37.20.2
Metal-Clad Switchgear

In general, if the BIL of the system is equal to the BIL of VacClad-W metal-clad switchgear, no protection is required against switching surges; however, standard BIL dry-type transformers and rotating apparatus rarely meet this criteria. For circuits exposed to lightning, protection is recommended in line with standard practices.

In a wide range of applications, not all circuits require surge protection. Therefore, VacClad-W metal-clad switchgear does not include any surge protection as standard. The user exercises the options as to the type of protection deemed necessary, depending on the individual circuit characteristics and cost considerations.

The following recommendations are outlined to provide guidelines of minimum surge protection for metal-clad switchgear and the associated system equipment:

1. Lightning – Provide standard lightning protection.
2. Switching surge protection:
 - a. Liquid-filled transformer — **no surge protection required.**
 - b. Dry-type transformers:
 - 38 kV - 170 kV BIL — **no surge protection required.**
 - 27 kV - 125 kV BIL — **no surge protection required.**
 - 15 kV - 95 kV BIL — **no surge protection required.**
 - 7.5 kV - 95 kV BIL — **no surge protection required.**
 - 5 kV - 60 kV BIL — **no surge protection required.**

Turn-to-turn insulation protection: Surge capacitors may be required on some systems where a steep rate of rise is expected which may damage turn-to-turn insulation.

For all other voltage/BIL ratings for dry-type transformers, surge protection (arresters or capacitors) is recommended at the transformer terminals, in line with established practices. Metal oxide surge arresters can be supplied in VacClad-W switchgear as an alternate to above.

- c. Motors — Surge capacitors at the motor terminals (and surge arresters where appropriate).
- d. Generators — Surge capacitors and station class surge arresters at machine terminals.
- e. Switching overhead lines and underground cables — No surge protection required.
- f. Capacitor switching — No surge protection required.
- g. Shunt reactor switching — Three-phase 15 kV dry-type reactors less than 9 MVA require surge protection at the reactor's terminals.

These application guidelines for VacClad-W metal-clad switchgear were established after extensive analysis of medium-voltage power systems.

Surge Arresters

The modern metal-oxide surge arresters are recommended because this latest advance in arrester design ensures better performance and high reliability of surge protection schemes. Manufacturer's technical data must be consulted for correct application of a given type of arresters. Notice that published arrester MCOV (maximum continuous operating voltage) ratings are based on 40-45°C ambient temperature range. In general, the following guidelines are recommended for arrester selections, when installed inside the VCP-W metal-clad switchgear:

- a. Solidly Grounded System – Minimum arrester MCOV rating should be equal to $1.05 \times V_{LL} / (1.732 \times T)$, where V_{LL} is nominal line-to-line service voltage, 1.05 factor allows for +5% voltage variation above the nominal voltage according to ANSI C84.1, and T is derating factor to allow for operation at 55°C switchgear ambient, which should be obtained from the arrester manufacturer for the type of arrester under consideration. Typical values of T are: 0.946 to 1.0.
- b. Low Resistance Grounded Systems (systems grounded through resistor rated 10 seconds) – Arrester 10-second MCOV capability at 60°C, which is obtained from manufacturer's data, should be equal to $1.05 V_{LL}$, where V_{LL} is nominal line-to-line

service voltage, and 1.05 factor allows for +5% voltage variation above the nominal voltage.

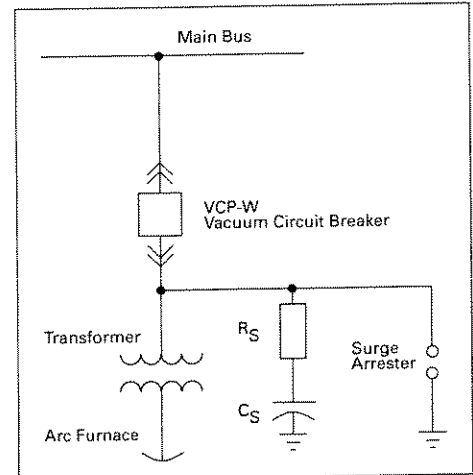
- c. Ungrounded Systems or Systems Grounded through impedance other than 10-second resistor – The arrester minimum MCOV rating should be equal to $1.05 V_{LL} / T$, where V_{LL} and T are as defined above.

Surge Capacitors

Metal-oxide surge arresters limit the magnitude of prospective surge overvoltage, but are ineffective in controlling its rate of rise. Specially designed capacitors with low internal inductance are used to limit the rate of rise of this surge overvoltage to protect turn-to-turn insulation. Recommended values for surge capacitors are: 0.5 µf on 5 kV and 7.5 kV, 0.25 µf on 15 kV, and 0.13 µf on 24 kV and higher systems.

Arc Furnace Transformer Protection

For arc furnace transformer protection, recommended RC network and arresters are shown below. For values of C_S and R_S , see Table 5. The resistor is important to limit capacitive current in the event of a re-ignition. This is especially important when large power-factor correction capacitor banks are used.



Resistor-Capacitor Protection for Arc Furnace

Instrument Transformers

Instrument transformers are used to protect personnel and secondary devices from high voltage and permit use of reasonable insulation levels for relays, meters and instruments. The secondaries of standard instrument transformers are rated at 5 amperes and/or 120 volts, 60 Hertz.

Voltage Transformers

Selection of the ratio for voltage transformers is seldom a question since the primary rating should be equal to or higher than the system line-to-line voltage. The number of potential transformers per set and their connection is determined by the type of system and the relaying and metering required.

The 3-phase, 3-wire system with 2-element watt-hour meters would require a set of two line-to-line voltage transformers. If line-to-ground potential is also required for a directional ground relay, then a set of three line-to-ground voltage transformers could be used to provide both line-to-line potential for the 2-element watt-hour meter and line-to-ground potential for the ground relay.

Ground detection lights or relays for the ungrounded system requires three line-to-ground voltage transformers and a separate set is usually recommended for this purpose.

The 3-phase, 4-wire, solidly grounded system usually requires three line-to-ground voltage transformers for 2 1/2- or 3-element metering.

Where synchronizing of generators or systems is involved, it is recommended that only line-to-line potential be used.

Current Transformers

The current transformer ratio is generally selected so that the maximum load current will read about 70 percent full scale on a standard 5-ampere coil ammeter. Therefore, the current transformer primary rating should be 140 to 150 percent of the maximum load current.

Maximum system fault current can sometimes influence the current transformer ratio selection since the connected secondary devices have published one-second ratings.

The zero-sequence current transformer is used for sensitive ground fault relaying or self-balancing primary current type machine differential protection. The zero-sequence current transformer is available with a nominal ratio of 50/5 or 100/5 and available opening size for power cables of 7.25 inches, special zero-sequence transformers with larger windows are also available.

The minimum number of current transformers for circuit relaying and instruments is three current transformers, one for each phase or two-phase connected current transformers and one zero-sequence current transformer. Separate sets of current transformers are required for differential relays.

The minimum pickup of a ground relay in the residual of three-phase connected current transformers is primarily determined by the current transformer ratio. The relay pickup can be reduced by adding one residual connected auxiliary current transformer. This connection is very desirable on main incoming and tie circuits of low resistance grounded circuits.

Standard accuracy current transformers are normally more than adequate for most standard applications of microprocessor-based

Table 5: Characteristics of Transformers for Arc Furnaces and Protection

Arc Furnace Transformer						R-C Protection						
Voltage kV	MVA	Continuous Current A	Short Circuit %	Magnetizing Current		Cap. Cs Microf.	RES. R _s Ohm					
				%	A		50 Ft. Cable ^①		100 Ft. Cable ^③		1000 Ft. Cable ^④	
							ohm	watt	ohm	watt	ohm	watt
25.5	50	1130	2.4	0.155	1.75	0.018	15.47	0.15	21.87	0.21	69.16	0.66
23	35	878	3.5	0.16	1.4	0.016	16.41	0.10	23.21	0.14	73.39	0.45
13.2	30	1312	3	0.796	10.4	0.204	4.56	1.54	6.45	2.18	20.40	6.90
13.2	50	2000	2.4	0.765	15.30	0.326	3.60	3.13	5.10	4.43	16.12	14.00

Table 6: Standard Voltage Transformer, 60 Hertz

Rating-Volts	2400	4200	4800	7200	8400	10800	12000	14400	15600	18000	21000	24000	27000	36000
Ratio	20-1	35-1	40-1	60-1	70-1	90-1	100-1	120-1	130-1	150-1	175-1	200-1	225-1	300-1
Switchgear		Voltage Transformer - ANSI Accuracy												
kV Class	kV Bil	Maximum Number Per Set and Connection	Standard Ratio's	Burdens at 120 Volts				Burdens at 69.3 Volts				Thermal Rating 55°C Conn.	Volt-amp	
				W, X, Y	Z	M	ZZ	W, X	Y	M	Z			
5	60	2LL or 3LG	20, 35, 40	0.3	1.2			0.3					LL LG LG ^③	700 400 700
7.5 and 15	95	2LL or 3LG	35, 40, 60, 70, 100, 120	0.3	0.3	0.3	0.6	0.3	0.3	0.3	1.2		LL LG LG ^③	1000 550 1000
27	125	2LL or 3LG	90, 100, 120, 130, 150, 175, 200, 225	0.3	0.3	0.3	1.2	0.3	0.3	0.3	1.2		LL LG LG ^③	1000 550 1000
38	170	2LL or 3LG	175, 300	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		LL LG LG ^③	1000 550 1000

LL = Line-to-line connection.
LG = Line-to-ground connection.

Table 7: Current Transformers, 55°C Ambient

CT Ratio (MR= Multi-Ratio)	Metering Accuracy Classification			Relaying Accuracy Classification		
	at 60 Hz Standard Burden B 0.1	at 60 Hz Standard Burden B 0.5	at 60 Hz Standard Burden B 1.8	Minimum Accuracy Required per IEEE C37.20.2	Standard Accuracy Supplied in VCP-W Switchgear	Optional High Accuracy Available in VCP-W Switchgear
50:5	1.2			C10	C10	—
75:5	1.2	2.4		C10	C20	—
100:5	1.2	2.4		C10	C20	—
150:5	0.6	2.4		C20	C20	C50
200:5	0.6	2.4		C20	C20	C50
250:5	0.6	2.4		C20	C20	C50
300:5	0.6	2.4	2.4	C20	C50	C100
400:5	0.3	1.2	2.4	C50	C50	C100
500:5	0.3	0.3	2.4	④	C50	C100
600:5	0.3	0.3	2.4	C50	C100	C200
800:5	0.3	0.3	1.2	C100	C100	C200
1000:5	0.3	0.3	0.3	④	C100	C200
1200:5	0.3	0.3	0.3	C100	C200	C400
1500:5	0.3	0.3	0.3	C100	C200	C400
2000:5	0.3	0.3	0.3	C100	C200	C400
2500:5	0.3	0.3	0.3	④	C200	C400
3000:5	0.3	0.3	0.3	C100	C200	C400
4000:5	0.3	0.3	0.3	C100	C200	C400
600:5 MR	0.3	0.3	2.4	④	C100	C200
1200:5 MR	0.3	0.3	0.3	④	C200	C400
2000:5 MR	0.3	0.3	0.3	④	C200	C400
3000:5 MR	0.3	0.3	0.3	④	C200	C400
50:5 Zero Seq				④	C20	
100:5 Zero Seq					C20	

① Cable surge impedance 37Ω.

② For solidly grounded 4160 volt system only or any type 2400 volt system.

③ For solidly grounded system only.

④ Not listed in C37.20.2.

Control Equipment

Circuit Breaker Control

The VCP-W circuit breaker has a motor charged spring type stored energy closing mechanism. Closing the breaker charges accelerating springs. Protective relays or the control switch will energize a shunt trip coil to release the accelerating springs and open the breaker. This requires a reliable source of control power for the breaker to function as a protective device.

For ac control, a capacitor trip device is used with each circuit breaker shunt trip to ensure that energy will be available for tripping during fault conditions. A control power transformer is required on the source side of each incoming line breaker. Closing bus tie or bus sectionalizing breakers will require automatic transfer of control power. This control power transformer may also supply other ac auxiliary power requirements for the switchgear.

Dc control would require a dc control battery, battery charger and an ac auxiliary power source for the battery charger. The battery provides a very reliable dc control source, since it is isolated from the ac power system by the battery charger. However, the battery will require periodic routine maintenance and battery capacity is reduced by low ambient temperature.

Any economic comparison of ac and dc control for switchgear should consider that the ac capacitor trip is a static device with negligible maintenance and long life, while the dc battery will require maintenance and replacement at some time in the future.

Relays

Microprocessor-based or solid-state relays would generally require dc power or reliable uninterruptible ac supply for their logic circuits.

Auxiliary Switches

Optional circuit breaker and cell auxiliary switches are available where needed for interlocking or control of auxiliary devices. Typical applications and operation are described in Tables 8 and 9.

Auxiliary switch contacts from the circuit breaker mechanism are limited in number by the breaker control requirements usually to one "a" and two "b" contacts for ac control or two "a" and two "b" contacts for dc control.

When additional auxiliary contacts are needed, the optional auxiliary relay or mechanism operated cell (MOC) switch is used. Two types of MOC switches are available:

- a. operates with breaker in connected position only.
- b. operates with breaker in connected position and test position.

The optional truck operated cell (TOC) switch operates when the circuit breaker is levered into or out of the operating position.

MOC and TOC switch contacts are not field convertible from "a" to "b" or "b" to "a". Up to 3 MOC switches, each with 5a and 4b contacts, and 1 TOC with 4a and 5b contacts can be provided in each breaker compartment.

Auxiliary switch contacts are primarily used to provide interlocking in control circuits, switch indicating lights, auxiliary relays or other small loads. Suitability for switching remote auxiliary devices, such as motor heaters or solenoids, may be checked with the interrupting capacity listed in Table 9. Where higher interrupting capacities are required, an interposing contactor should be specified.

Table 8: Breaker Auxiliary Switch Operating Times

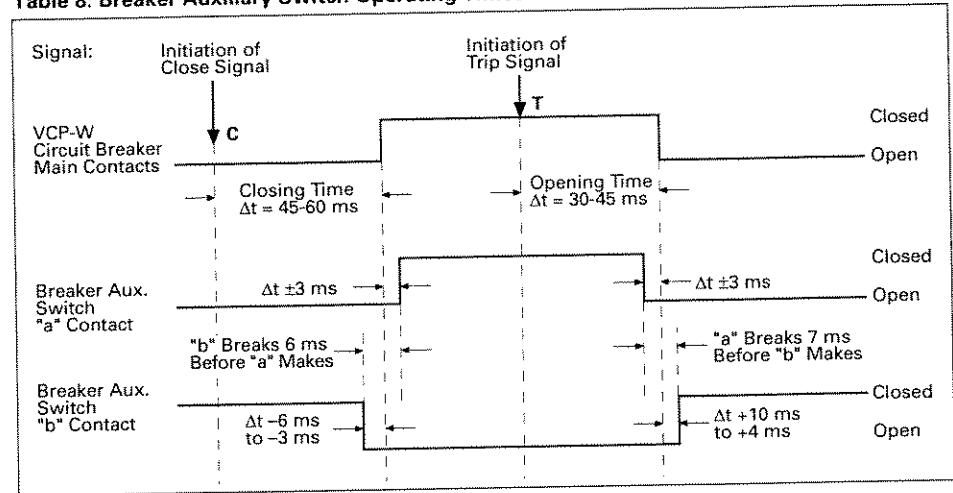


Table 9: Auxiliary Switch Contacts Interrupting Capacities

Type Auxiliary Switch	Continuous Current Amperes	Control Circuit Voltage				
		120 Ac	240 Ac	48 Dc	125 Dc	250 Dc
Non-inductive circuit interrupting capacity in amperes						
Breaker Auxiliary Switch	20	15	10	16	10	5
TOC	20	15	10	16	10	5
MOC Auxiliary Switch	20	15	10	16	10	5
Inductive circuit interrupting capacity in amperes						
Breaker Auxiliary Switch	20	15	10	16	10	5
TOC	20	15	10	16	10	5
MOC Auxiliary Switch	20	15	10	16	10	5

Table 10: VCP-W Breaker Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Charge Motor			UV Trip mA (Max.)	Voltage Range		Ind. Light Amperes
	Run Amperes	Time Seconds	Close or Trip Amperes		Close	Trip	
48 Vdc	9.0	6	16	200	38-56	28-56	.035
125 Vdc	4.0	6	7	80	100-140	70-140	.035
250 Vdc	2.0	6	4	40	200-280	140-280	.035
120 Vac	4.0	6	6		104-127	104-127	.035
240 Vac	2.0	6	3		208-254	208-254	.035

Table 11: Control Power Transformers, 1 Phase, 60 Hertz^{①②}

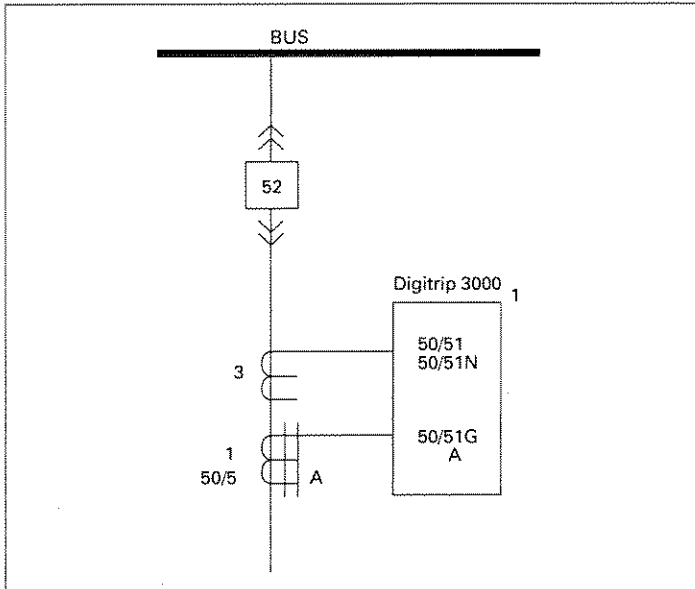
Taps	Secondary Volts		kVA	kV Class
	+7½%	-7½%		
2580	2400	2220	240/120	5, 10, 15
4470	4160	3850	240/120	5, 10, 15
5160	4800	4400	240/120	5, 10, 15
7740	7200	6680	240/120	5, 10, 15
9030	8400	7770	240/120	5, 10, 15
13405	12470	11535	240/120	5, 10, 15
14190	13200	12210	240/120	5, 10, 15
14835	13800	12765	240/120	5, 10, 15
24725	23000	21275	240/120	5, 10, 15
37088	34500	31913	240/120	15, 25

① Line-to-line connection only available.

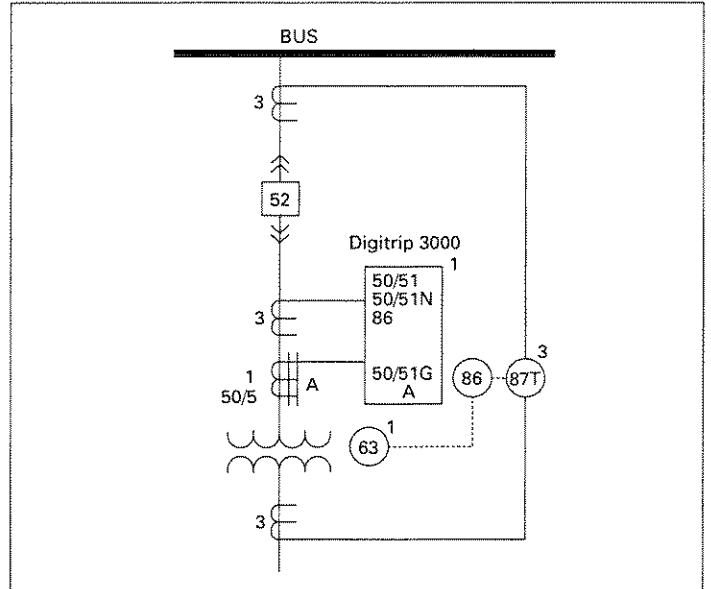
② Refer to Cutler-Hammer for other voltages and kVA ratings.

③ 150 kV BIL.

For AC Generator, Transformer and AC Motor Protection Industrial and Commercial Power System Applications

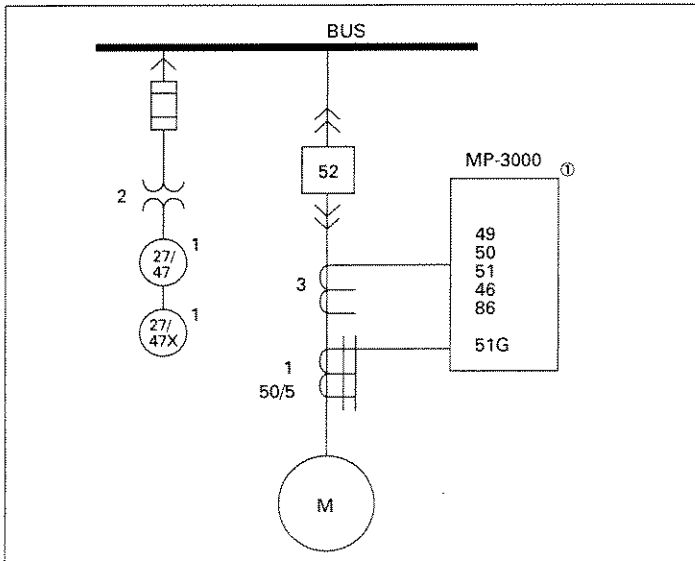


Ct Rating = 200% Feeder Full Load
Digitrip 3000 Multifunction Microprocessor Overcurrent Trip Unit
A - Alternate to 50/51N



Ct Rating = 200% Full Load
Digitrip 3000 Multifunction Microprocessor Overcurrent Trip Unit
87T - Transformer Differential Relay (Above 5 MVA)
86 - Lockout Relay
63 - Sudden Pressure Relay (Liquid Above 5 MVA)
A - Alternate to 50/51N

Protective Relays - Feeder Circuit

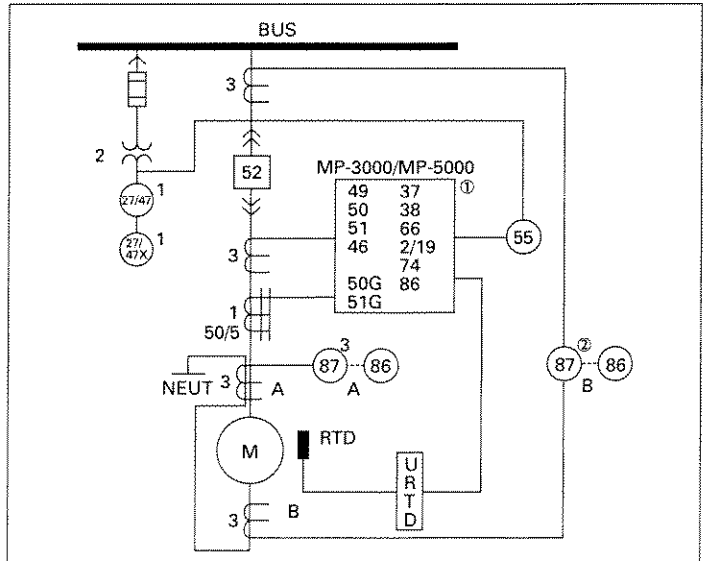


Phase Ct Rating = 150% Full Load
MP-3000 Multifunction Motor Protection Unit
27/47 - Undervoltage, Phase Sequence, and Unbalanced Voltage Relay (One Per Bus)
27/47x - Auxiliary Relay for Multimotor System

Protective Relays - Induction Motors Below 1500 Hp
Minimum Adequate Protection①

① For additional backup overcurrent/short circuit protection a Digitrip 3000 Relay can be added in addition to the MP-3000.

Protective Relays - Transformer Feeder



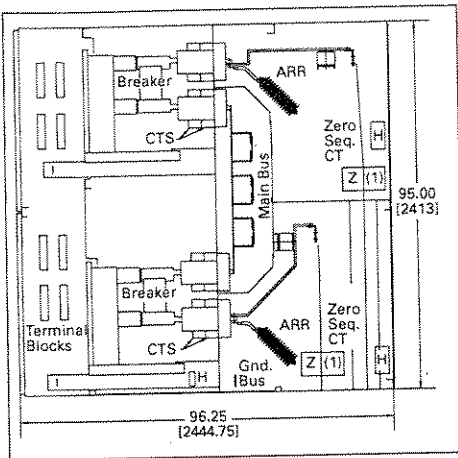
Phase Ct Rating = 150% Full Load
A - Preferred Scheme
B - Alternate Scheme
IQ-1000-II - Multifunction Motor Protection Unit
87 - Motor Differential Relay
86 - Lockout Relay
27/47 - Undervoltage, Phase Sequence, and Unbalanced Voltage Relay (One Per Bus)
27/47x - Auxiliary Relay for Multi-motor System
55 - Loss of Synchronism (Synchronous Motors Only)
URTD - Universal RTD Interface Module

Protective Relays - Induction Motors Above 1500 Hp
and Synchronous Motors①

② Optional for MP-5000.

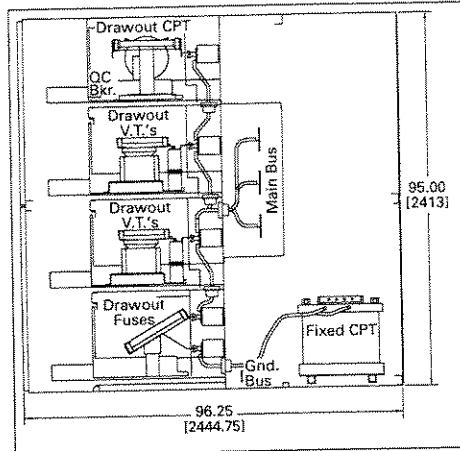
Layout Dimensions ① – 5 and 15 kV

Typical Units



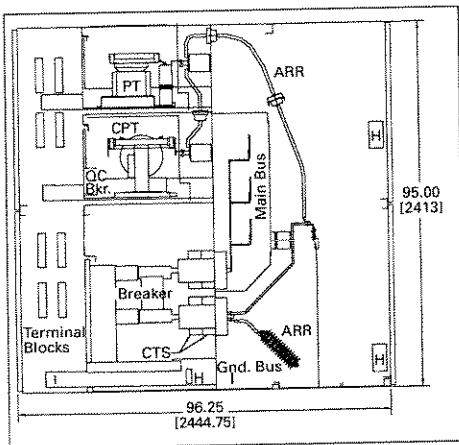
36-inch [914.4] Wide Typical Breaker/
Breaker Vertical Section

- 1 - 1200/2000/3000-ampere main bus.
- 2 - Type VCP-W breakers 1200/2000-ampere in 2-high configuration.
- 4 - Current transformers per phase, standard accuracy.
- Surge arresters, if desired.
- Zero sequence current transformer (ZST).



36-inch [914.4] Wide Typical Auxiliary/
Auxiliary Vertical Section

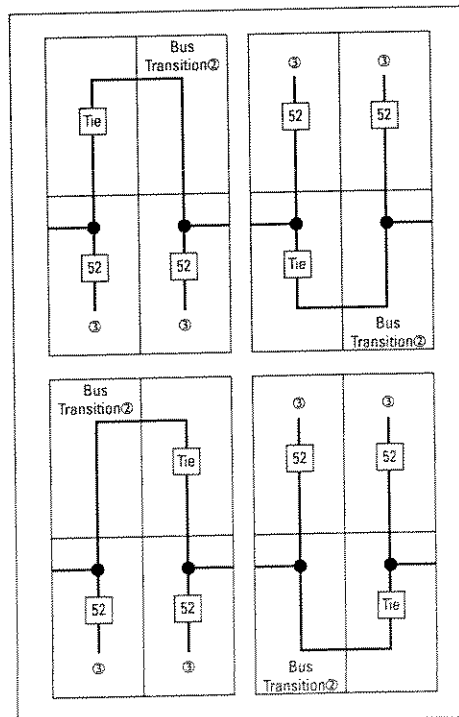
- 1 - 1200/2000/3000-ampere main bus.
- Illustrating maximum utilization of auxiliary compartment with 4-high draw-out auxiliaries and fixed mounted control power transformer.



36-inch [914.4] Wide Typical Auxiliary/Breaker
Vertical Section

- 1 - 1200/2000/3000-ampere main bus.
- 1 - Type VCP-W breaker 1200/2000-ampere in lower position.
- 1 - Drawout voltage transformer drawer.
- 2 - L-L with fuses.
- 3 - L-G with fuses.
- 1 - Drawout control power transformer drawer CPT - 15 kVA max. - single phase.
- Surge arresters, if desired.

Tie Breaker Bus Transition
Requirements



[] = Dimensions in mm.

- ① For 4000A force cooled application, refer to Cutler-Hammer.
- ② Breakers cannot be located in bus transition compartment.
- ③ Breakers can be located in these compartments.

Available Configurations

1200-Amp Breaker	1200-Amp Breaker	1200-Amp Breaker
1200-Amp Breaker	2000-Amp Breaker	Drawout Auxiliary
Drawout Auxiliary	2000-Amp Breaker	Drawout Auxiliary
1200-Amp Breaker	Drawout Auxiliary	2000-Amp Breaker
Vented Auxiliary Compartment (Non-Draw-out)	Drawout Auxiliary	2000-Amp Breaker
3000-Amp Breaker	Draw-out Auxiliary	1200-Amp Breaker
① 3000-Amp Breaker		
Vent Area		
Drawout Auxiliary		

Dimensions for Estimating Purposes Only.

Typical Weights, Lbs. (kg)

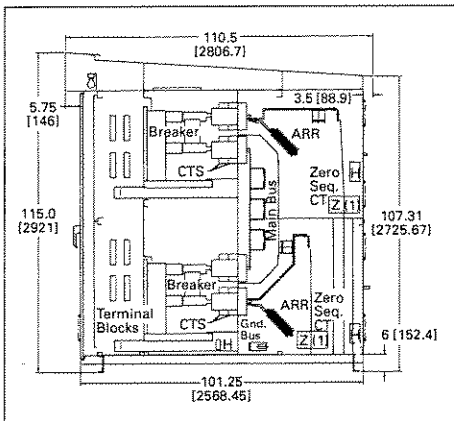
Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor		Aisleless		Sheltered-Aisle Including Aisle	
						Single Row	Double Row
B/B	1200	2400 (1090)	3000 (1365)	4200 (1910)	7200 (3270)		
	2000	2500 (1135)	3100 (1410)	4300 (1955)	7400 (3365)		
	3000	2600 (1180)	3200 (1455)	4400 (2000)	7600 (3455)		
B/A or A/B	1200	2300 (1045)	2900 (1320)	4100 (1865)	7000 (3180)		
	2000	2400 (1090)	3000 (1365)	4200 (1910)	7200 (3270)		
	3000	2500 (1135)	3100 (1410)	4300 (1955)	7400 (3365)		
A/A	1200	2000 (910)	2600 (1180)	3800 (1730)	6400 (2910)		
	2000	2100 (955)	2700 (1230)	3900 (1770)	6600 (3000)		
	3000	2200 (1000)	2800 (1275)	4000 (1820)	6800 (3090)		
B	1200	2200 (1000)	2800 (1275)	4000 (1820)	6800 (3090)		
	2000	2300 (1045)	2900 (1320)	4100 (1865)	7000 (3180)		
	3000	2400 (1090)	3000 (1365)	4200 (1910)	7200 (3270)		

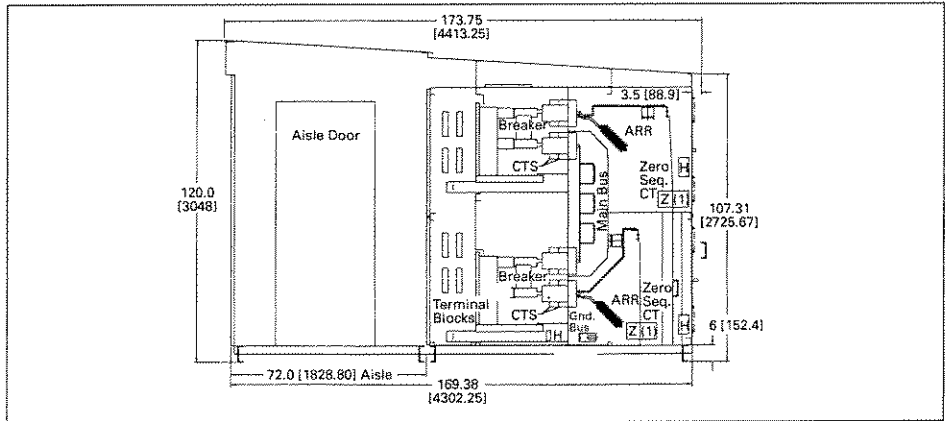
Breakers Weights

Type of Breaker	Current Rating, Amperes		
	1200	2000	3000
	Approximate Weight, Lbs. (kg)		
50 VCP-W 250	350 (160)	410 (190)	525 (240)
50 VCP-W 350	460 (210)	490 (225)	525 (240)
50 VCP-W 500	575 (261)	575 (261)	575 (261)
75 VCP-W 500	375 (170)	410 (190)	525 (240)
150 VCP-W 500	350 (160)	410 (190)	525 (240)
150 VCP-W 750	350 (160)	410 (190)	525 (240)
150 VCP-W 1000	460 (210)	490 (225)	525 (240)
150 VCP-W 1500	575 (261)	575 (261)	575 (261)

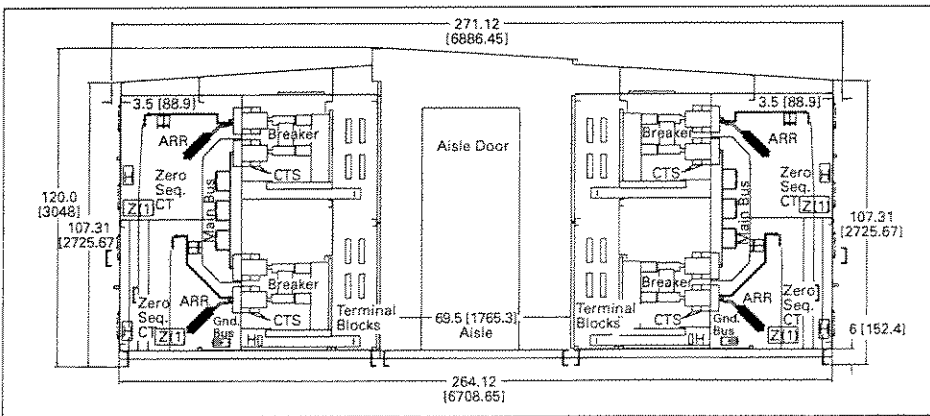
Dimensions, Inches



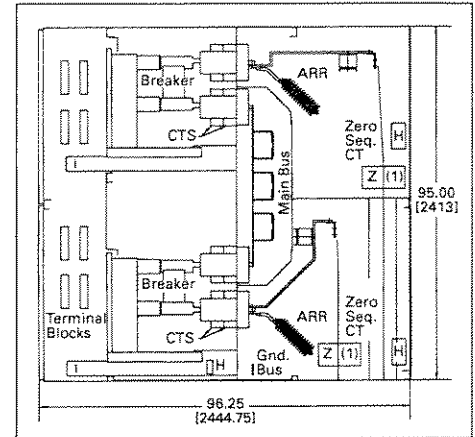
Outdoor Aisleless



Outdoor Sheltered Aisle Single Row



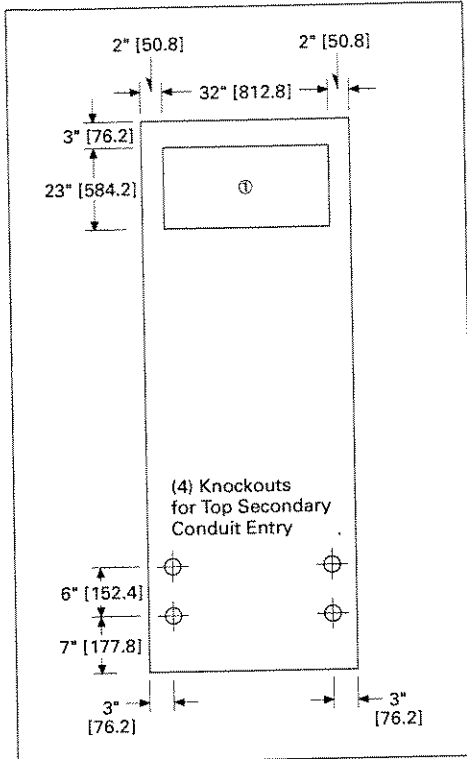
Outdoor Sheltered Aisle Double Row



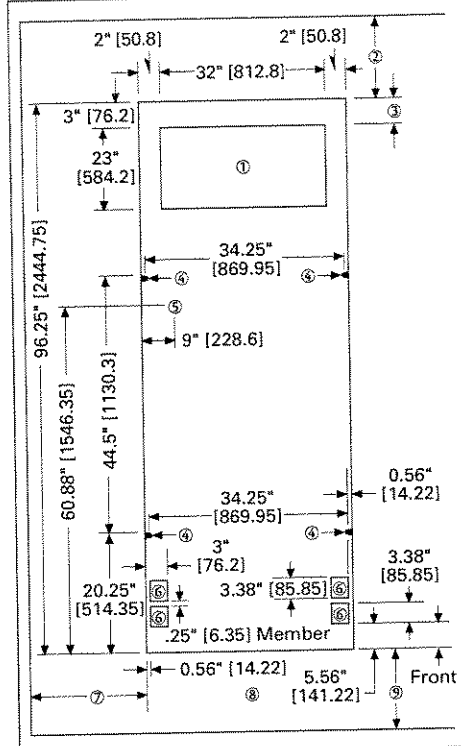
Indoor

[] = Dimensions in mm.

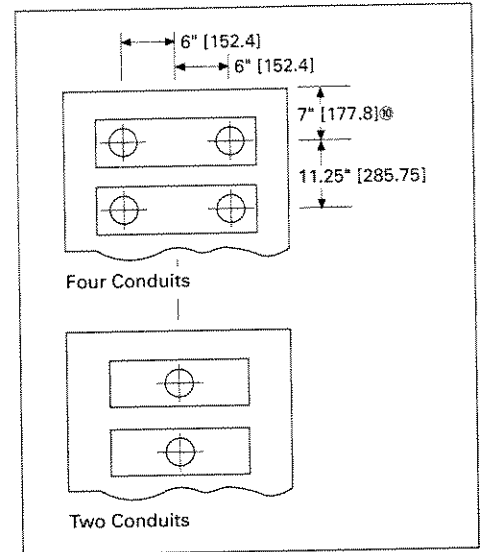
Dimensions and Weights for Estimating Purposes Only.



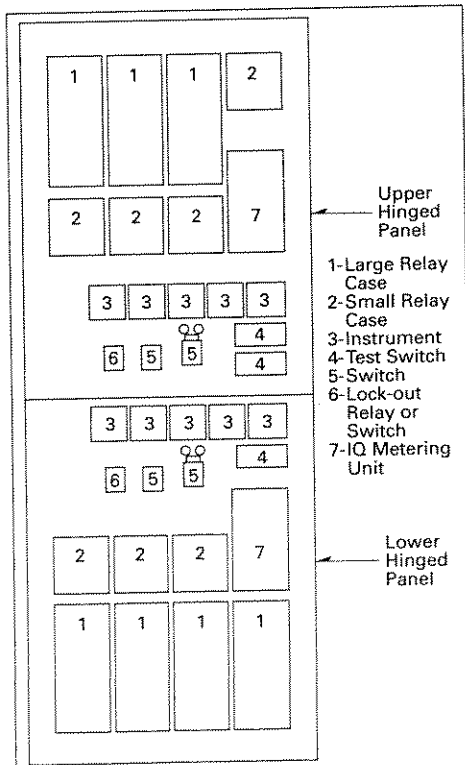
Top View of Typical Indoor Breaker and Auxiliary Structures



Base Plan of a Typical Indoor Breaker or Auxiliary Structure



Primary Conduit Locations for Top or Bottom Entry



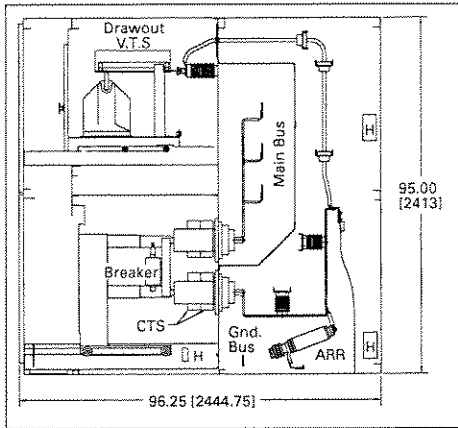
MAXIMUM Hinged Panel Equipment^{①②}

[] = Dimensions in mm.

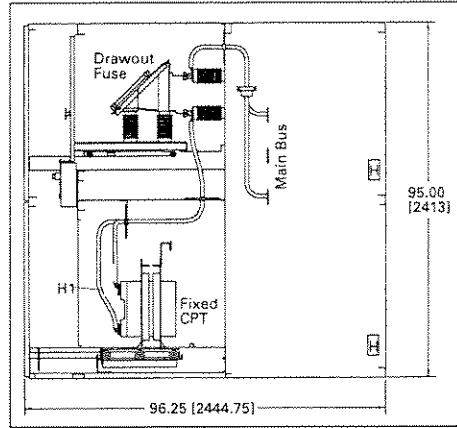
- ① Primary conduit locations for top or bottom entry.
- ② Recommended minimum clearance to rear of VacClad-W: 36 inches [914.4].
- ③ Floor steel, if used, must not exceed 3.25 inches [82.55] under VacClad-W.
- ④ Anchor locations: indoor - 0.5-inch [13] bolts or weld, outdoor - 0.5-inch [13] bolts.
- ⑤ Station ground connection provision.
- ⑥ Secondary conduit space: All - maximum of 1-inch [25.4] projection.
- ⑦ Minimum clearance to LH side of VacClad-W: 32 inches [812.8].
- ⑧ Finished foundation surface (including floor steel) must be flat and level and in true plane.
- ⑨ Minimum clearance to front of VacClad-W: 70 inches [1778].
- ⑩ Changes to 8.25 [209.55] if optional hinged rear doors are required.
- ⑪ Note that the figure above shows that the arrangement of components differs between upper and lower panels. The figure may also be used to select custom arrangements of hinged panel components.
- ⑫ Use of multipurpose solid-state relays such as the Cutler-Hammer Digitrip 3000 (same size as 7) will significantly reduce consumption of panel space.

Dimensions for Estimating Purposes Only.

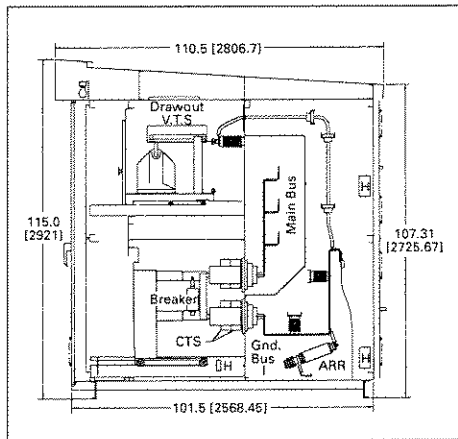
Typical Units



Indoor
36-inch [914.4] Wide Typical
Auxiliary/Breaker Vertical Section



Indoor
36-inch [914.4] Wide Typical
Auxiliary/Auxiliary Vertical Section



Outdoor Aisleless
Typical Auxiliary/Breaker Vertical Section

Typical Weights, Lbs. (kg.)

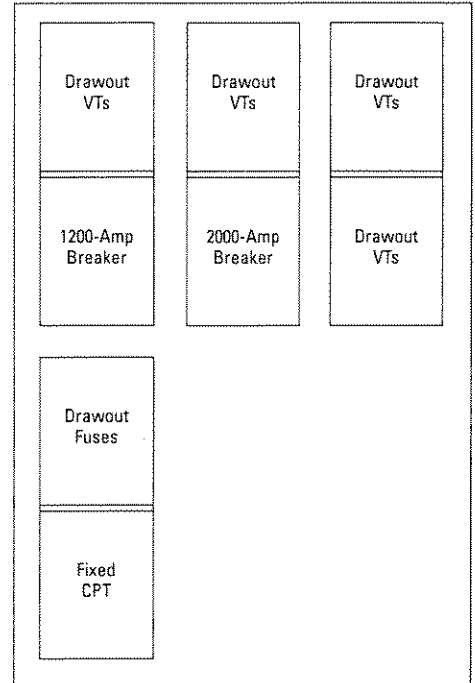
Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor	Outdoor Aisleless
A/B	1200	2500 (1135)	3100 (1410)
	2000	2600 (1180)	3200 (1455)
A/A	1200	2100 (955)	2700 (1230)
	2000	2200 (1000)	2800 (1275)

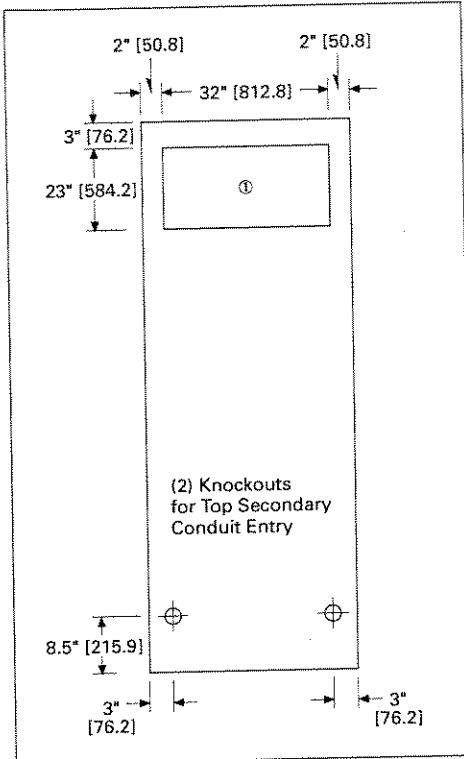
Breaker Weights

Type of Breaker	Current Rating, Amperes	
	1200	2000
270 VCPW 750	415 (188)	475 (216)
270 VCPW 1000	415 (188)	475 (216)
270 VCPW 1250	415 (188)	475 (216)
270 VCPW 40	415 (188)	475 (216)

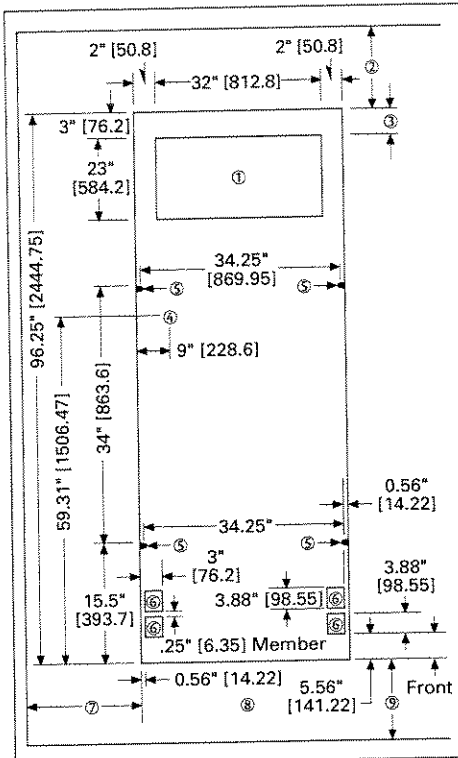
Available Configurations



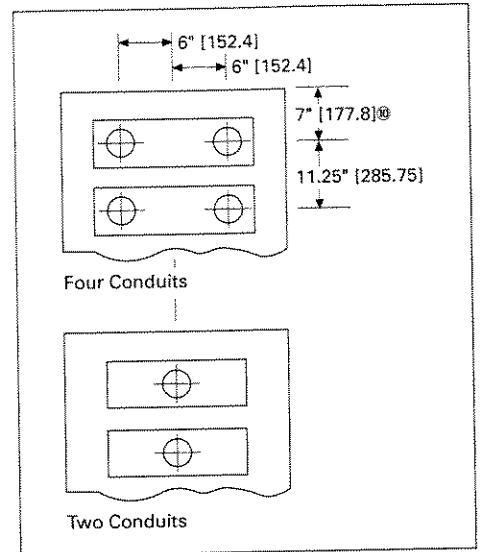
Dimensions for Estimating Purposes Only. [] = Dimensions in mm.



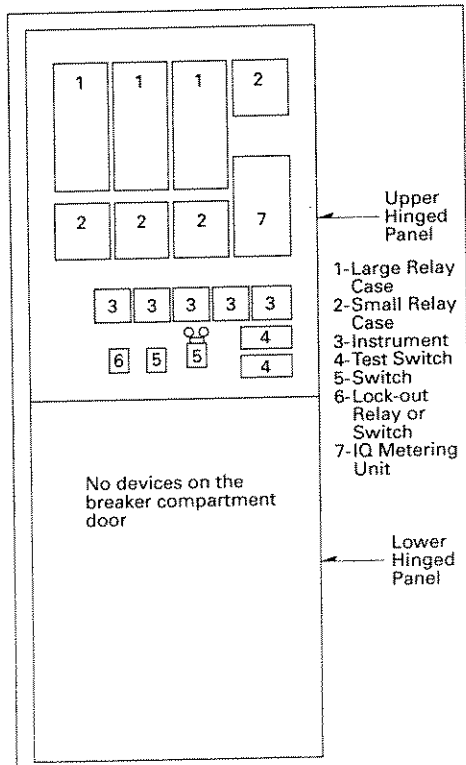
Top View of Typical Indoor Breaker and Auxiliary Structures



Base Plan of a Typical Indoor Breaker or Auxiliary Structure



Primary Conduit Locations for Top or Bottom Entry

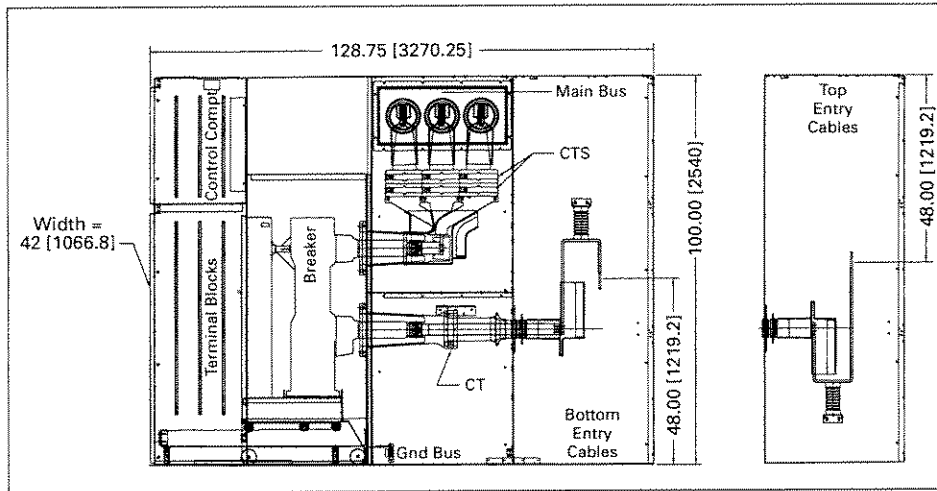


MAXIMUM Hinged Panel Equipment^{①②}

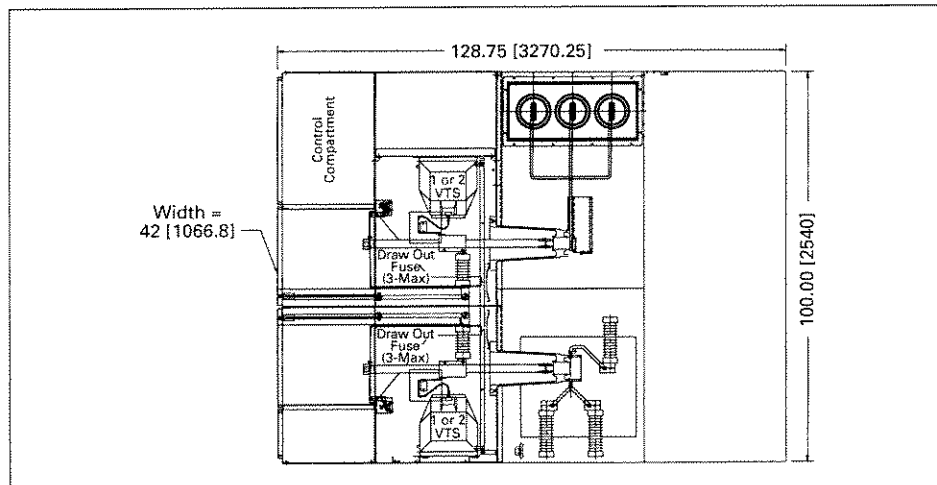
[] = Dimensions in mm.

- ① Primary conduit locations for top or bottom entry.
- ② Recommended minimum clearance to rear of VacClad-W: 36 inches [914.4].
- ③ Floor steel, if used, must not exceed 3.25 inches [82.55] under VacClad-W.
- ④ Anchor locations: indoor - 0.5-inch [13] bolts or weld, outdoor - 0.5-inch [13] bolts.
- ⑤ Station ground connection provision.
- ⑥ Secondary conduit space: All - maximum of 1-inch [25.4] projection.
- ⑦ Minimum clearance to LH side of VacClad-W: 32 inches [812.8].
- ⑧ Finished foundation surface (including floor steel) must be flat and level and in true plane.
- ⑨ Minimum clearance to front of VacClad-W: 70 inches [1778].
- ⑩ Changes to 8.25 [209.55] if optional hinged rear doors are required.
- ⑪ Note that the figure above shows that the arrangement of components differs between upper and lower panels. The figure may also be used to select custom arrangements of hinged panel components.
- ⑫ Use of multipurpose solid-state relays such as the Cutler-Hammer Digitrip 3000 (same size as device 7) will significantly reduce consumption of panel space.

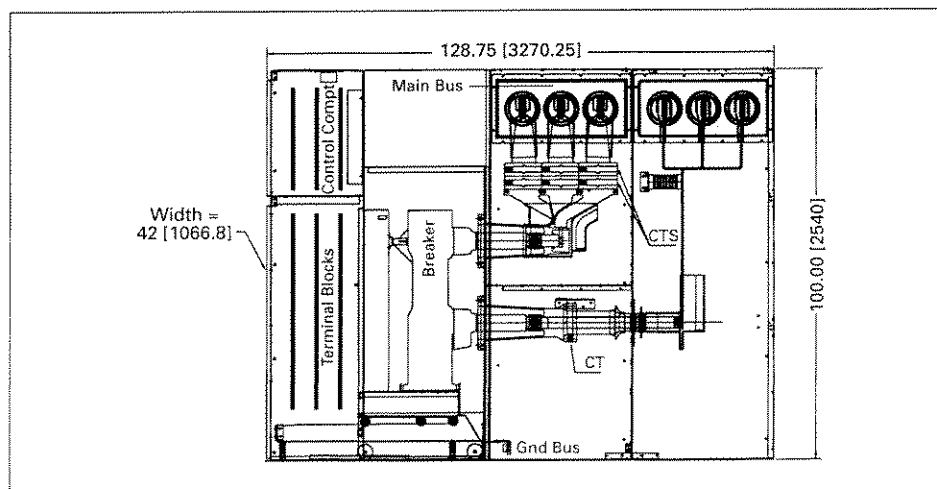
Dimensions for Estimating Purposes Only.



Indoor
Typical Breaker, Vertical Section, Bottom Cable Exit



Indoor
Typical, Auxiliary/Auxiliary



Indoor
Typical Tie Breaker, Vertical Section

Typical Weights, Lbs. (kg.)

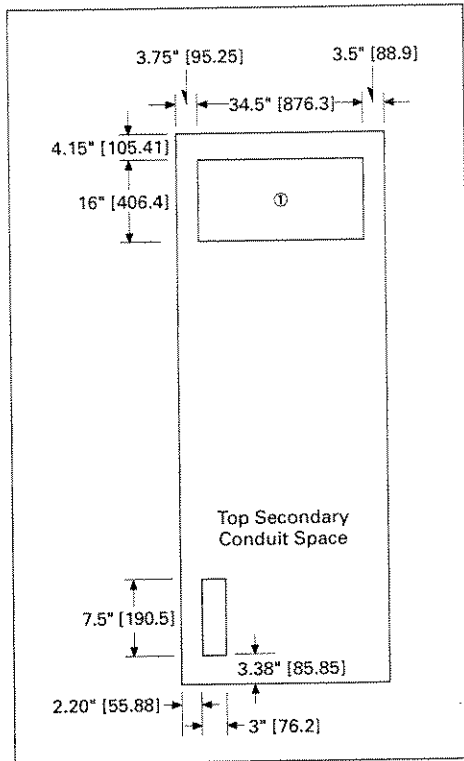
Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor
Breaker	1200	2400 [1090]
	2000	2500 [1135]
Auxiliary	1200	2300 [1044]
	2000	2400 [1090]

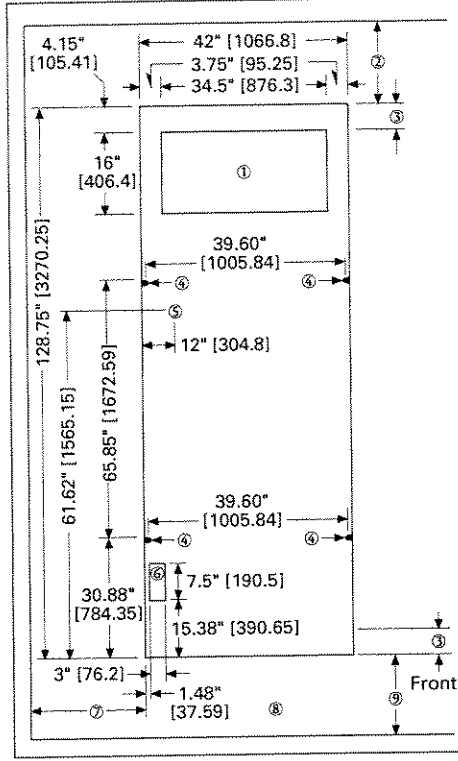
Breaker Weights

Type of Breaker	Current Rating, Amperes	
	1200	2000
380 VCPW-16	1080 (490)	1140 (518)
380 VCPW-25	1080 (490)	1140 (518)
380 VCPW-32	1080 (490)	1140 (518)
380 VCPW-21	1080 (490)	1140 (518)

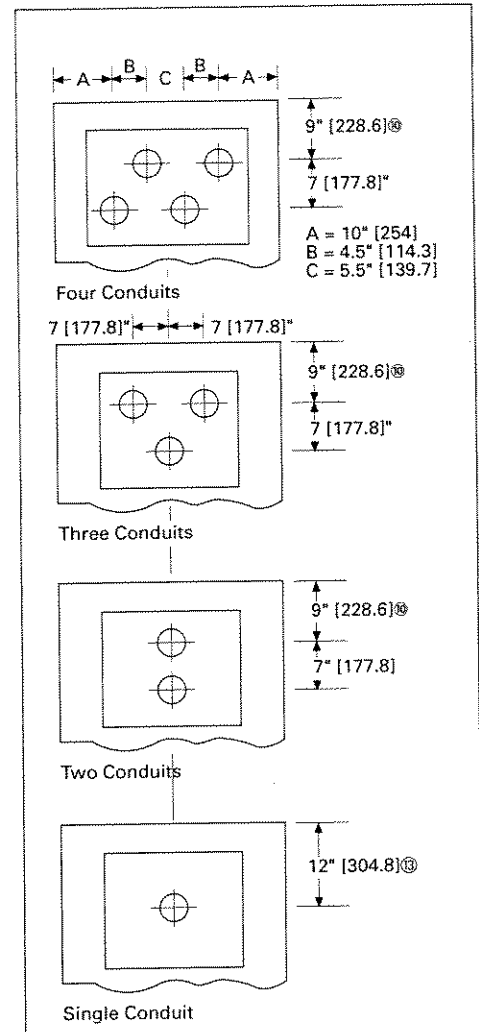
Dimensions for Estimating Purposes Only. [] = Dimensions in mm.



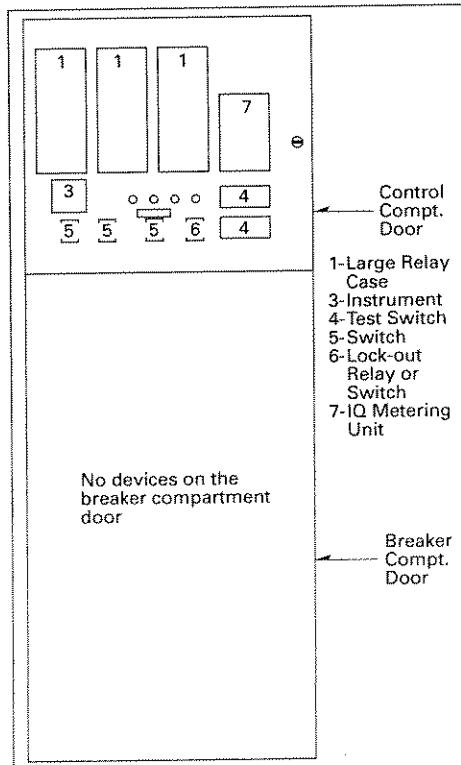
Top View of Typical Indoor Breaker and Auxiliary Structures



Base Plan of a Typical Indoor Breaker or Auxiliary Structure



Primary Conduit Locations for Top or Bottom Entry



MAXIMUM Hinged Panel Equipment

[] = Dimensions in mm.

- ① Primary conduit locations for top or bottom entry.
- ② Recommended minimum clearance to rear of VacClad-W: 42 inches [1066.8].
- ③ Floor steel, if used, must not exceed 3.25 inches [82.55] under VacClad-W.
- ④ Anchor locations: indoor - 0.5-inch [13] bolts or weld, outdoor - 0.5-inch [13] bolts.
- ⑤ Station ground connection provision.
- ⑥ Secondary conduit space: All - maximum of 1-inch [25.4] projection.
- ⑦ Minimum clearance to LH side of VacClad-W: 38 inches [965.2].
- ⑧ Finished foundation surface (including floor steel) must be flat and level and in true plane.
- ⑨ Minimum clearance to front of VacClad-W: 84 inches [2133.6].
- ⑩ Changes to 10.25 inches [260.35] if optional hinged rear doors are required.
- ⑪ Note that the figure above shows that the arrangement of components. The figure may also be used to select custom arrangements of hinged panel components.
- ⑫ Use of multipurpose solid-state relays such as the Cutler-Hammer Digitrip 3000 (same size as device 7) will significantly reduce consumption of panel space. Changes to 13.25 inches [336.55] if optional hinged rear doors are required.

Dimensions for Estimating Purposes Only.

Ratings

- A. The switchgear described in this specification shall be designed for operation on a _____ kV, three-phase, _____ wire, [solidly grounded] [ungrounded] [impedance grounded] [high impedance grounded], 60-hertz system.
- B. Each circuit breaker shall have the following ratings:
- | | |
|-----------------------|----------------------|
| Maximum Voltage | _____ kV |
| BIL Rated | _____ kV |
| Continuous Current | _____ Amperes |
| | [1200] [2000] [3000] |
| Short-Circuit Current | _____ kA |
| At Rated Maximum kV | |
| Closing and | |
| Latching Capability | _____ kA Crest |
| Three Second Rating | _____ kA |
| Nominal 3-Phase | |
| MVA Class | _____ MVA |
| Rated Interrupting | |
| Time | Five cycles |

Construction

- A. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. [Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling.] [Hinged rear doors, complete with provisions for padlocking, shall be provided.]
- B. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each 5-, 15-, and 27-kV circuit breaker for inspection and maintenance without the use of a separate lifting device. The 38-kV circuit breaker shall be roll-out design.

Bus

- A. The main bus shall be copper and have fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, [glass polyester for 5- and 15-kV class] [cycloaliphatic epoxy supports for 27- and 38-kV class]. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. A set of [1200-] [2000-] [3000-] ampere insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be

silver-plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

- B. A copper ground bus shall extend the entire length of the switchgear.
- C. A [bare] [insulated] fully rated neutral bus shall extend the entire length of the switchgear.

Wiring/Terminations

- A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminal connections shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

- B. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

Circuit Breakers

- A. The circuit breakers shall be horizontal drawout type, capable of being withdrawn on rails for 5-27 kV and roll-out type for 38 kV. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.
- B. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole unit shall be mounted on [glass polyester supports for 5- and 15-kV class] [cycloaliphatic epoxy supports for 27- and 38-kV class]. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the 5/15/27 kV breaker is removed from its compartment. It shall be visible when opening the compartment door of the 38 kV breaker. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

- C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

- D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

- E. The breakers shall be electrically operated by the following control voltages:

[120-] [240-] volt AC close and AC capacitor trip.

— OR —

[48-] [125-] [250-] volt DC close and [48-] [125-] [250-] volt DC trip.

Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

- F. The control voltage shall be [derived from a control power transformer mounted in the switchgear] [as indicated on the drawings].

Protective Relays

- A. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.

Select one of the following for overcurrent protection:

- Microprocessor-based three-phase relay
- Induction-disk type single-phase overcurrent relays

- B. Microprocessor Three-Phase Protective Relay

1. Relays for phase time overcurrent, instantaneous overcurrent and ground fault protection, ANSI 50/51, 50/51G, or 50/51N, shall be incorporated into a single device and shall be Cutler-Hammer type Digitrip-3000 or approved equal. Refer to page _____ for more details.

— OR —

- B. Induction-Disk Overcurrent Relay

1. Provide an induction-disk type overcurrent relay mounted in a semi-flush drawout case.
2. Where shown on drawings, induction-disk relays shall be equipped with ANSI

Device 50 adjustable pickup instantaneous coils.

- 3. Induction-disk relay shall be furnished with targets to indicate relay operation.

Auxiliary Devices

- A. Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the 5-, 15-, and 27-kV breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.
- B. Voltage and control power transformers of the quantity and ratings indicated in the detail specification shall be supplied. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in drawout drawers. Control power transformers for 27-kV class and voltage and control power transformers for 38-kV class switchgear shall be fixed mounted with primary fuses in drawout drawers. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.
- C. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

Utility Metering

- A. Where shown on drawings, provide separate barriered-off utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements.

Customer Metering

- A. Provide customer metering devices where shown on the drawings. Where indicated provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.

- B. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.
- C. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

Select devices as required for item D. Refer to page indicated for detailed specification.

D. Microprocessor-Based Metering System

IQ Analyzer	(sect. B1, CAT.71.01.T.E)
IQ DP-4000	(sect. B1, CAT.71.01.T.E)
IQ Generator	(sect. B1, CAT.71.01.T.E)
IQ Data	(sect. B1, CAT.71.01.T.E)

Enclosures

- A. The switchgear described in these specifications shall be indoor construction, with devices arranged as shown on contract drawings.

— OR —

- A. The switchgear described in these specifications shall be weatherproof, aisleless construction for outdoor service. Each shipping group shall be mounted upon an integral base frame with a weatherproof enclosure for assembly in the field into a complete metal-enclosed switchgear assembly with a weatherproof door provided on the breaker drawout side of each vertical section.

— OR —

- A. The switchgear described in these specifications shall be weatherproof, sheltered-aisle construction for outdoor service. Each shipping group shall be mounted upon an integral base frame with a weatherproof enclosure assembly in the field into a complete metal enclosed switchgear assembly. The enclosure shall be extended on the breaker drawout side to form an operating and/or maintenance aisle large enough to permit interchange of circuit breakers. A weatherproof door with an inside quick release latch mechanism shall be located at each end of the inside even when locked on the outside. Interior lights, light switches and duplex ground fault receptacles shall be furnished in the aisle.
- B. Where outdoor switchgear is shown, each vertical section of outdoor switchgear shall be provided with space heaters. Tubular type heaters operated at half voltage for long life shall be supplied. 500-volt or 250-volt rated heaters shall be used at 240 or 120 volts, respectively. Power for space heaters shall be furnished [as indicated on the drawings]

[from a control power transformer mounted in the switchgear].

- C. Heaters shall be wired to provide temporary heating during storage.

Nameplates

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.
- B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

Finish

- A. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray. Prior to shipment, the complete assemblies, indoor as well as outdoor, shall be given 1.5 to 2.0 mil thick exterior finish spray coat of air drying high-gloss gray enamel.

Accessories

- A. The switchgear manufacturer shall furnish accessories for test, inspection, maintenance, and operation, including:
 1. One — Maintenance tool for manually charging the breaker closing spring and manually opening the shutter
 2. One — Levering crank for moving the breaker between test and connected positions
 3. One — Test jumper for electrically operating the breaker while out of its compartment
 4. One — Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails^①
 5. One — Set of rail extensions and rail clamps^①
 6. One — (Optional) Portable lifting device for lifting the breaker on or off the rails^①

^① Applicable to 5-, 15- and 27-kV switchgear only.

- 7. One — (Optional) Ramp for rolling breaker mounted in lower compartment directly onto the floor^①
- 8. One — (Optional) Test cabinet for testing electrically operated breakers outside housing
- 9. One — (Optional) "Dockable" transport dolly for moving breaker about outside its compartment^①
- 10. One — (Optional) Electrical levering device.

Bills of Material

A. The metal-clad switchgear auxiliary section for control and instrumentation shall include the following:

- 1. [Two — Line-to-line] [Three — Line-to-ground] voltage transformers
- 2. Three — Current transformers
- 3. One — ____ kVA [Single-phase] [Three-phase] control power transformer
- 4. One — Microprocessor-based metering system
- 5. Additional requirements as shown on the plans.

B. The metal-clad switchgear main circuit breaker section for control of a main circuit breaker shall include the following:

- 1. One — Drawout power circuit breaker rated ____ amperes
- 2. Three — Current transformers, single secondary

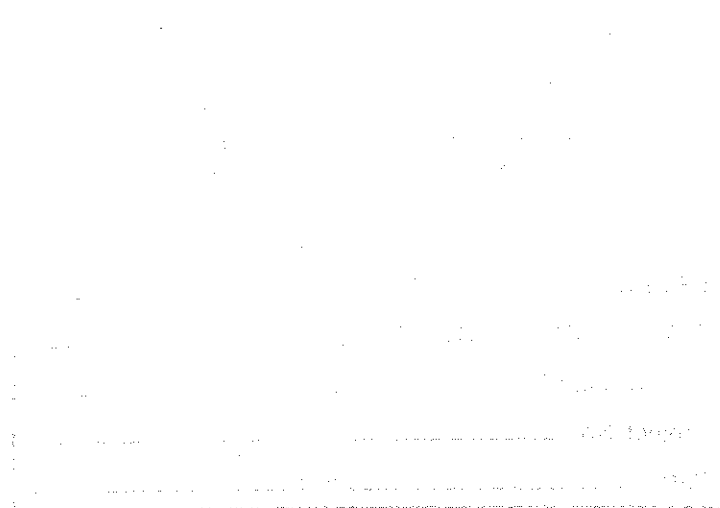
- 3. One — Circuit breaker control switch with red and green indicating lights
- 4. [One — Microprocessor-based three-phase and ground overcurrent relay, ANSI device number 51/50, 51/50N] [Three — Single-phase overcurrent relays, induction-disk type ANSI device number 51/50 and One — Single ground overcurrent relay, ANSI device number 51/50N]

- 5. One — Nameplate
- 6. One — Microprocessor-based metering system
- 7. One — Set of cable lugs.

C. The metal-clad switchgear tie breaker section for control of a tie breaker shall include the following:

- 1. One — Drawout power circuit breaker rated ____ amperes
- 2. Three — Current transformers, single secondary
- 3. One — Circuit breaker control switch with red and green indicating lights
- 4. [One — Microprocessor-based three-phase and ground overcurrent relay, ANSI device number 51/50, 51/50/N] [Three — Single-phase overcurrent relays, induction-disk type ANSI device number 51/50 and One — Single ground overcurrent relay, ANSI device number 51/50, 50/51N]

- 5. One — Nameplate
 - 6. One — Microprocessor-based metering system.
- D. Each metal-clad switchgear feeder breaker section for control of a feeder circuit breaker shall include the following:
- 1. One — Drawout power circuit breaker rated ____ amperes
 - 2. Three — Current transformers, single secondary
 - 3. One — Circuit breaker control switch with red and green indicating lights
 - 4. [One — Microprocessor-based 3-phase and ground relay, ANSI device number 51/50, 50/51G] [Three — Single-phase overcurrent relays, induction-disk type ANSI device number 51/50 and One — Single ground overcurrent relay, ANSI device number 51/50G]
 - 5. One — Nameplate
 - 6. One — Microprocessor-based metering system
 - 7. One — Set of cable lugs
 - 8. One — Zero sequence current transformer.



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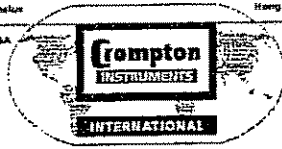
For a complete product specification in CSI format, see **Cutler-Hammer Product Specification Guide**, section 16346.

^① Applicable to 5-, 15- and 27-kV switchgear only.



TD4601ATE

Earth Tech (Contractor), Inc.	
Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.	
Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.	
REVIEWED	_____
REVIEWED AS MODIFIED	_____
REVISE AND RE-SUBMIT	_____
NOT REVIEWED	_____
Project No.	79538-C31-16
Date:	June 21/06 By: <i>[Signature]</i>



Protector Trip Relays Wall Mounted Synchro-Check (Paralleling)

Application

The Crompton Paralleling Protector provides manual/automatic switching of generator to busbar without damage or disturbance to the system.

The volt-free relay contacts change state when the voltage level, phase relationship and frequency are within the selected synchronising limits.

Model 256-PLD

This model operates in the same way as type 256-PLL, with the addition of the 'dead bus' facility. This extra feature enables the relay to energize with a generator supply only. Thus type 256-PLD will allow the generator to power the busbar during mains failure.

Specification

This model is U.L. recognized up to 300V.

Nominal Voltage : 100, 110, 120, 208, 220, 230, 240, 277, 380, 400, 415, 440 & 480V
 Voltage tolerance: -25% to +30% of the nominal voltage
 Frequency: 45 or 50 or 55 or 60 or 65Hz
 Burden maximum: Bus 2VA, Generator 4VA

Setpoint Synchronising
 Set point: 10% to 30% of the nominal voltage
 (6° to 20° electrical)
 Adjustment: Approximately 0.85kg
 Weight:

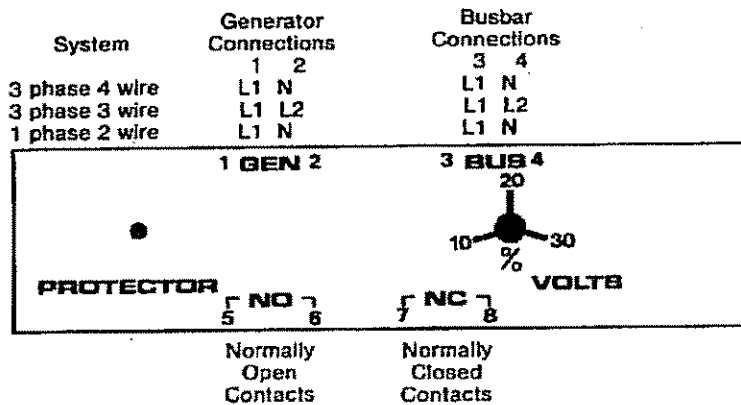
Output Relay
 Relay contacts: 1 pair NO*, 1 pair NC*

*2 pair NO and 2 pair NC available on request

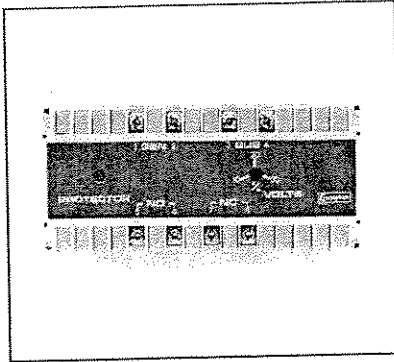
For full specification see page H2

SYSTEM	INPUT	PROTECTION	ANSI N°	BUS	CATALOG NUMBER
PARALLELLING (SYNCHRO-CHECK RELAY)					
Single Phase or 3 Phase 3 or 4 Wire	120V, 60Hz 120V, 60Hz	Phase Angle & Voltage	25 25	Live bus Dead Bus	256-PLLU-PQBX-C6 256-PLDU-PQBX-C6

Connection Diagram 256-PLLU, 256-PLDU



250 Series DIN Rail and Wall Mounted Relays



Synchro-Check (paralleling)

The synchro-check relay can be used to assist in the semi-automatic paralleling of two AC power systems. The volt-free relay contacts change state when the voltage level, phase relationship and frequency are within the selected synchronizing limits. Connecting two electrical systems that are not closely matched can cause expensive damage and disturbance to the electrical system. Using this relay will ensure that damage will not occur.

Operation

As part of a manual control system, the operator will make adjustments to the generator voltage (excitation) and frequency (engine speed) using a synchroscope or lamps, and will then attempt to manually close the breaker. This synchro check protector will qualify that the two systems are closely matched before permitting the breaker to close. As part of an automatic synchronizing arrangement, this relay can be used as an independent backup or checking device to ensure the two systems are suitably matched before the breaker can close.

Features

- Single phase or three phase, 3 or 4 wire
- Live and dead bus versions
- Adjustable setpoint
- LED trip indication
- Volt free relay contacts

Benefits

- Monitors voltage phase displacement and frequency of 2 supplies
- Frequency matching
- Voltage matching
- Phase angle matching
- Synchronization of Gen-Bus and Bus-Bus
- Monitors auto synchronizing systems
- Assists in manual synchronization

Applications

- Marine panels
- Switchgear
- Distribution systems
- Generator sets
- Co-generation
- Control panels

Approvals

- UL, BV and ABS

Model 256-PLL

The relay continuously monitors the voltage, phase displacement and frequency of two supplies. A single setpoint adjustment permits selection of suitable matching, and a red LED illuminates when the relay is energized, indicating that the two supplies are well matched and it is safe to close the breaker.

Model- 256-PLD

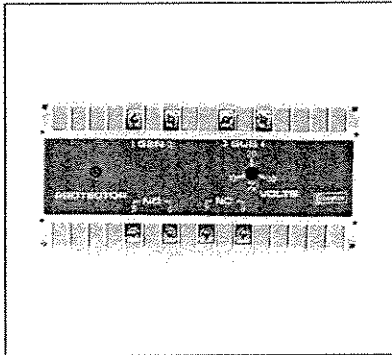
This version operates in the same way as model 256-PLL, but includes an additional dead bus detection function. If there is a requirement for a continuous supply or emergency power, then the generator can be connected without synchronizing, thus ensuring continuity of supply. The absence of bus voltage will cause the relay to energize.

Product Codes

Relay	Protection	ANSI No.	Catalog No.
Single phase, or 3 phase 3 or 4 wire	Phase angle and voltage	25	256-PLL
Single phase, or 3 phase 3 or 4 wire	Phase angle and voltage Dead bus	25	256-PLD

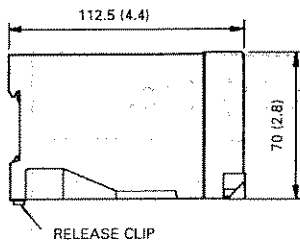
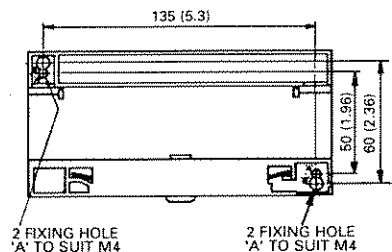
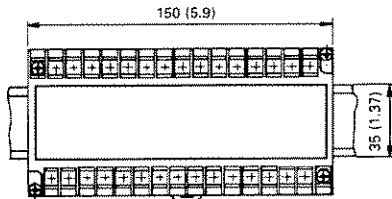
Specify system voltage, frequency and required options at time of ordering.

250 Series DIN Rail and Wall Mounted Relays



Dimensions

Model 256



Specification – Synchro-Check (paralleling)

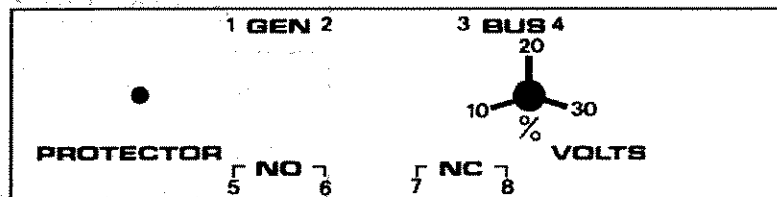
Nominal Voltage	100V, 110V, 120V, 208V, 220V, 230V, 240V, 277V, 380V, 400V, 415V, 440V or 480V
System Frequency	45, 50, 55, 60 or 65Hz
Burden	Bus: 2VA Generator: 4VA
Overload	-25 to +30% of the nominal voltage
Set Point Repeatability	>0.5% of full span
Differential (Hysteresis)	Preset at 1%. Values 1% to 10% available on request
Trip Level	10 to 30% of the nominal voltage. 6° to 20° electrical adjustment
Output Relay	1 pair NO (normally open), 1 pair NC (normally closed) 2 pair NO and 2 pair NC available on request
Relay Contact Rating	AC: 240V 5A, non inductive DC: 24V, 5A resistive
Relay Mechanical Life	0.2 million operations at rated loads
Relay Reset	Automatic
Operating Temperature	0°C to +60°C (0°C to +40°C for UL models)
Storage Temperature	-20°C to +70°C
Temperature Co-efficient	0.05% per °C
Interference Immunity	Electrical stress surge withstand and non-function to ANSI/IEEE C37 90a
Enclosure Style	DIN rail with wall mounting facility
Material	Flame retardant polycarbonate/ABS
Enclosure Integrity	IP50
Compliant With	EMC, LVD, Safety Standard IEC 414 UL File No: E113067 recognized up to 600V BV File No: 2650H-07427-AO PRSO BV ABS File No: 93-LD 17806-X
Dimensions	150mm (5.9") wide x 70mm (2.8") high x 112mm (4.4") deep
Weight	1.0kg approx.

Connections

256-PLL

256-PLD

System	Generator Connections	Busbar Connections
3 phase 4 wire	1 2 L1 N	3 4 L1 N
3 phase 3 wire	L1 L2	L1 L2
1 phase 2 wire	L1 N	L1 N



Normally Open Contacts

Normally Closed Contacts

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 79533-C3116 *P.S. H.C.*

Date: June 21/06 By: _____



Military Purpose Toggle Switches (continued)

AC Rated (Heavy Duty) Military (Jan-S-23 Equivalents) with Unsealed Lever

AC RATED (HEAVY DUTY) MILITARY JAN-S-23 EQUIVALENTS SELECTION TABLE (BOLD FACE TYPE INDICATES ITEMS NORMALLY IN DISTRIBUTOR STOCK)

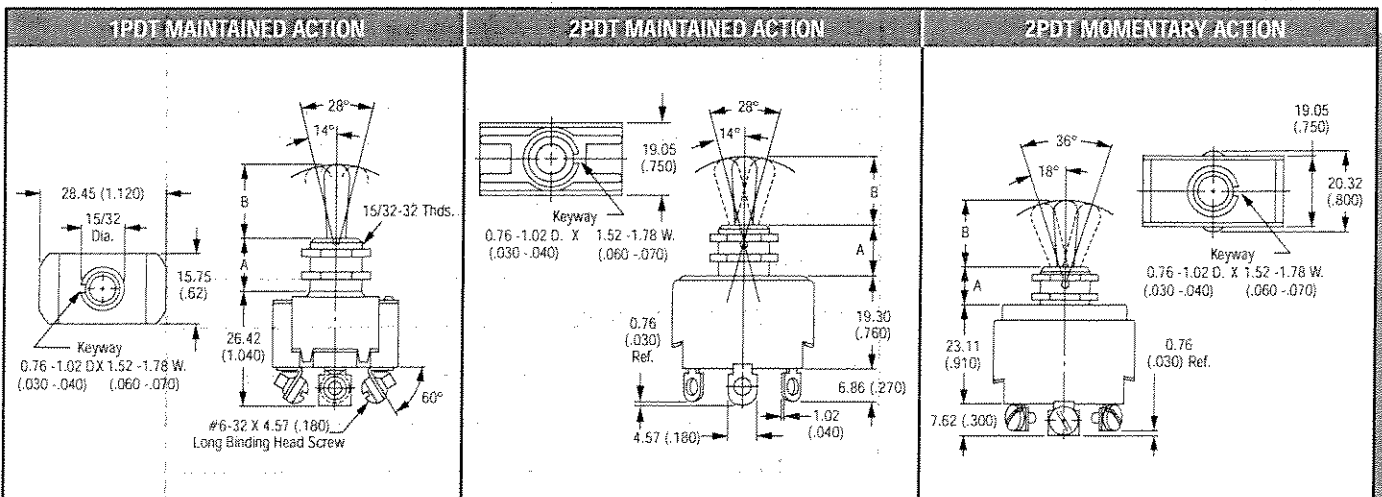
Rating	Poles and Throw	Circuit with Toggle in			BASE CIRCUIT SEE PAGE 4.28	Bushing Length "A" mm (inches)	Bushing Length "B" mm (inches)	CATALOG NUMBERS			
		UP Position	CENTER Position	DOWN Position (Keyway)				Solder Lug Terminals		Screw Terminals	
								Former Jan-S-23 with Unsealed Lever	Catalog Number	Former Jan-S-23 with Unsealed Lever	Catalog Number
ONE POLE											
① ②	1 P.S.T.	ON	NONE	OFF	A	11.89 (.468)	17.45 (.688)	ST-42A	7300K38	ST-40A	7300K36
		ON	NONE	OFF*				ST-42B	7304K38	ST-40B	7304K36
		OFF	NONE	ON*				ST-42C	7303K38	ST-40C	7303K36
① ② ③ ④ ⑤	1 P.D.T.	ON	OFF	ON	B	11.89 (.468)	17.45 (.688)	ST-42E	7301K38	ST-40E	7301K36
		ON	NONE	ON				ST-42D	7302K38	ST-40D	7302K36
		ON	NONE	ON*				ST-42F	7307K38	ST-40F	7307K36
		ON*	OFF	ON*				ST-42G	7306K38	ST-40G	7306K36
		ON	OFF	ON*				ST-42H	7305K38	ST-40H	7305K36
TWO POLE											
① ② ③	2 P.S.T.	ON	NONE	OFF	C	11.89 (.468)	17.45 (.688)	ST-52K	7310K38	ST-50K	7310K36
		ON	NONE	OFF*				ST-52L	7314K38	ST-50L	7314K36
		OFF	NONE	ON*				ST-52M	7313K38	ST-50M	7313K36
② ③ ④ ⑤ ⑥	2 P.D.T.	ON	OFF	ON	D	11.89 (.468)	17.45 (.688)	ST-52P	7311K38	ST-50P	7311K36
		ON	NONE	ON				ST-52N	7312K38	ST-50N	7312K36
		ON	NONE	ON*				ST-52R	7317K38	ST-50R	7317K36
		ON*	OFF	ON*				ST-52S	7316K38	ST-50S	7316K36
		ON	OFF	ON*				ST-52T	7315K38	ST-50T	7315K36

* Momentary Contact.

CURRENT RATINGS

Code From Selection Table	Type of Operation	CURRENT CAPACITY IN AMPERES PER POLE								
		30V dc			125V ac, 60 Hz			250V ac, 60 Hz		
		Lamp Load	Resistive Load	Inductive Load	Resistive Load	Inductive Load	Horse Power	Resistive Load	Inductive Load	Horse Power
ONE POLE										
① ②	Maintained	5	20	15	15	—	—	6	—	—
		4	15	10	15	—	—	6	—	—
TWO POLE										
③ ④	Maintained	7	30	15	25	—	—	9	—	—
		5	20	10	15	—	—	6	—	—

DIMENSIONS APPROXIMATE IN MM (INCHES)



Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED



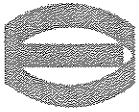
REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79533-C31-16

Date: June 21/06 By: [Signature]



NEW PRODUCT

SERIES 24 LOR

With Lighted Target Nameplate

Lighted Target Nameplates Save Panel Space and Reduce Costs

The Electroswitch Series 24 Lock-Out Relay, the Utility Industry Standard for Quality and Reliability, is now available with:

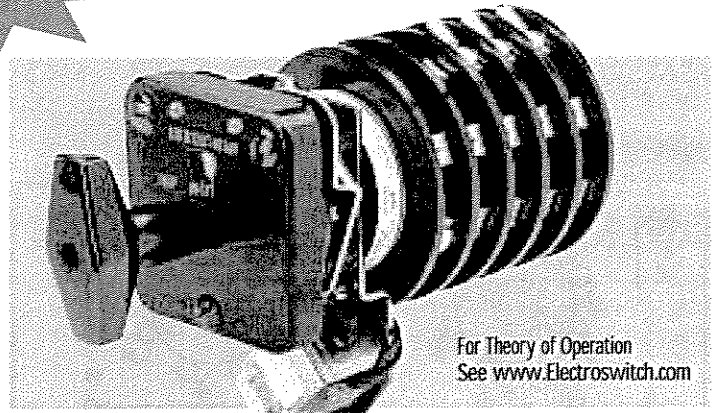
- Integral Coil Monitoring with LED Display and SCADA Feedback.
- LED Indication of Existing Fault Signal.

The Lock-Out Relay fills one of the most critical needs in the utility industry protection scheme. A fast, reliable Lock-Out Relay can mean the difference between a routine fault clearance and a disastrous loss of service, maintenance time and expensive equipment damage.

To assure that this crucial device is functioning and ready to operate, many utilities install pilot lamps on the panel to monitor the integrity of the LOR coil. This can involve expensive inter-wiring and use precious panel space. Because of this, Electroswitch has integrated these monitoring functions and more on a new electronic nameplate for the LOR.

Features

- Cost-effective Elimination of Additional Wiring and Lamps Needed to Perform this Function. Just Attach the Pre-wired Leads per the Enclosed Instructions.
- Save Valuable Panel Space. The Entire Package Fits in the Same Space as a Standard Mechanical LOR Nameplate.
- Both LOCAL (LED) and REMOTE (SCADA Signal) Indication is Provided; Reliable Protection for Unmanned Stations.
- Green LED indicates LOR Coil is Intact and Ready to Operate.
- Red LED Warns Against Resetting into an Existing Fault Signal and Possibly Damaging LOR Coils.
- Bright LEDs Visible Through 135°, > 11 Year Life (Typical).
- LEDs are Field Replaceable From the Front of Panel.
- LEDs are Available in Different Colors (Red, Amber, Green, Blue, and White).
- DC Unit Covers IEEE 24VDC and 48V/125V Ranges (38 to 140VDC).
- The Monitoring Package can be Implemented with Little or no Operator Training.
- A Retrofit Kit is Available to Provide this Enhanced Protection Package to Series 24 Lock-Out Relays Already in the Field.
- This Product is Designed and Manufactured by Electroswitch to Work Flawlessly with the Ultra-reliable, High Speed Series 24 Lock-Out Relay.



For Theory of Operation See www.Electroswitch.com

Benefits

- Provides Local and Remote (SCADA) Annunciation of an LOR Trip Coil Failure.
- Provides Clear Warning Against Closing into a Fault.
- Saves Panel Space.
- Reduces Purchase and Installation Cost.
- Easy to Use... No Special Operator Training.

How it Works

When the LOR is in the RESET position, one high visibility LED on the nameplate glows a continuous GREEN, giving local indication that coil continuity is intact and the Lock-Out Relay is ready to respond to a trip signal. Should the coil fail, the LED extinguishes and a built-in solid state contact closes, sending a warning signal to SCADA.

In the TRIP position, the red LED functions as a Trip Signal Monitor. As long as the Trip Signal is present on the LOR coil, the LED glows a continuous RED as a warning against resetting into a fault and possibly damaging the LOR coil. Other LED colors available (Amber, Blue and White).

The new design also retains the proven mechanical orange/black flag to indicate a trip. Contact your local Electroswitch Representative or call us directly for more details on how we can put the Electroswitch tradition of value and innovation to work for you.

Ordering Information

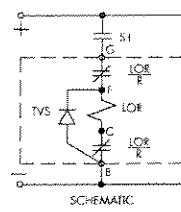
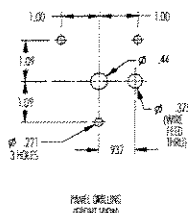
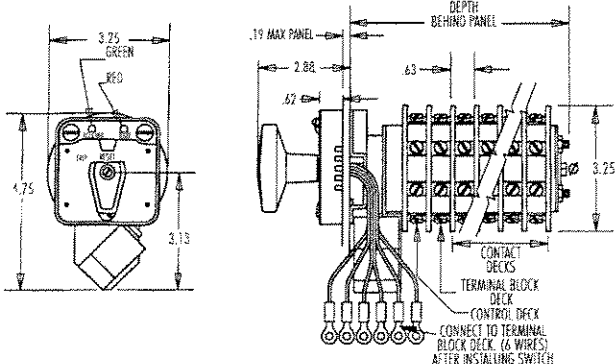
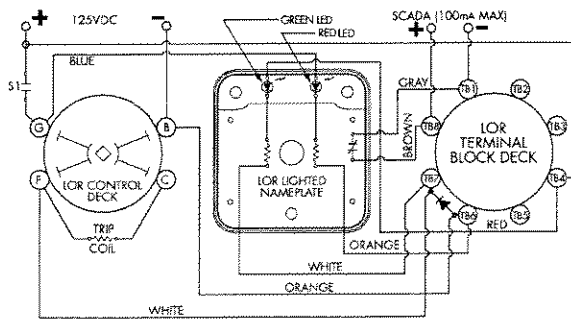
Part Numbers for the Series 24 LORs with Lighted Target Nameplate are fairly simple. Find the part number of the product you wish to order in the Electroswitch catalog, then simply add a two letter code after the second digit in its part number. The first letter of the two letter code will always be "P" indicating a Lighted Target Nameplate. The second letter of the code will change depending on the other options as follows.

A = One LED, 48/125VDC B = Two LEDs, 48/125VDC K = Two LEDs, 24VDC
Please Specify LED Colors. Color Options - Red, Green, Amber, Blue and White.

Example:

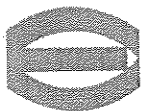
A Series 24 Manual Reset Lock-Out Relay with one deck and Trip Coil 'D' is part number 7801D. The same Lock-Out Relay with a Lighted Target Nameplate, Two LEDs, and 48/125VDC LED voltage would become part number 78PB01D.

Consult factory for information on retrofit kits.



Depth Behind Panel

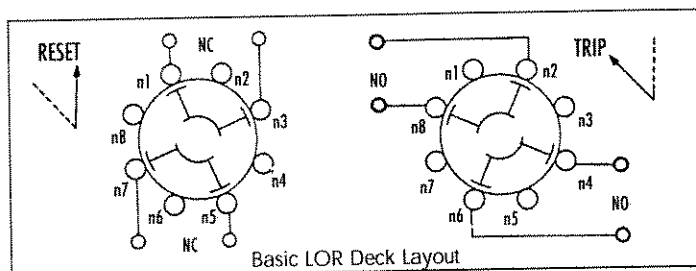
Decks	Depth
1	4.28
2	5.03
3	5.40
4	6.15
5	6.90
6	8.15
7	8.78
8	9.15
10	10.28



SERIES 24 LOCK-OUT RELAYS

FEATURES

Typical Contact Deck Arrangement



The blade and terminal configuration enables the use of multiple contacts in the same deck, and simple stacking procedures enable the fabrication of many independent contacts in one relay. Specifically, two N/O contacts and two N/C contacts are provided in each deck, and up to ten decks can be stacked, resulting in a relay with up to forty contacts (twenty N/O and twenty N/C). For good practice, however, it is suggested that polarized voltages should not be used on adjacent contacts. This is because of the remote possibility of flashover during transition between adjacent contacts -- especially at the higher DC ratings, or in highly inductive circuits. The illustration shows a single deck. For multideck units the second digit of the terminal number is the same as shown, but the first digit changes to denote the deck number. As an example, terminal 82 is in the eighth deck, directly under terminal 12 and is connected to terminal 88 in the trip position.

DECKS	CONTACTS	TRIP	RESET
1	11 — — — — 13	X	X
	12 — — — — 18	X	X
	15 — — — — 17	X	X
	16 — — — — 14	X	X
2	21 — — — — 23	X	X
	22 — — — — 28	X	X
	25 — — — — 27	X	X
	26 — — — — 24	X	X

Contact Charts

The illustration shows decks one and two of a typical Series 24 LOR and graphically describes the operation of the contacts.

Target Used with Lock-out Relays

All the Lock-out Relays have a mechanical target as part of the nameplate — BLACK for RESET and ORANGE for TRIP. This indicates the condition of the LOR. The target resets when the LOR resets (with the exception of the high-speed trip electric-reset LOR/ER and self-reset LOR/SR where the memory target is manually reset).

Contact Ratings

Contact ratings for two contacts/deck design

Contact Circuit Volts	Interrupting Rating (AMPS)				Short Time Rating** (AMPS)	Continuous Rating (AMPS)
	Resistive		Inductive*			
	Single Contact	Double Contact	Single Contact	Double Contact		
125VDC	5	10	2	5	60	30
250VDC	3	5	1	2	60	30
120VAC	20	30	20	30	60	30
240VAC	15	20	10	15	60	30
480VAC	7.5	10	5	5	60	30
600VAC	6	6	5	5	60	30

Contact ratings for tap switch contact design

Contact Circuit Volts	Interrupting Rating (AMPS)				Short Time Rating** (AMPS)	Continuous Rating (AMPS)
	Resistive		Inductive*			
	Single Contact	Double Contact	Single Contact	Double Contact		
125VDC	3	5	2	5	60	30
250VDC	3	3	1	2	60	30
120VAC	20	25	20	30	60	30
240VAC	15	20	10	15	60	30
480VAC	7.5	10	5	5	60	30
600VAC	6	6	5	5	60	30

* AC PF = 0.4; DC L/R = 0.04 ** Short time current is for one minute

The interrupting ratings are based on a 10,000 operation life at rated voltage with no extensive burning of contacts. Short time and continuous ratings are based on temperature rise in contact members and supporting parts not to exceed 50° above ambient.

UL file No. E80080

• IEEE Std. 323 - 1984
• IEEE Std. 344 - 1987

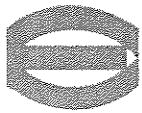


Trip Speed in Lock-out Relays

The manual reset Series 24 LOR has a nominal trip speed of less than 8 milliseconds at rated voltage as tested on 10 deck units. There is very little difference in LORs with fewer decks.

Both the Electric Reset and the Self Reset LORs are available in Standard Trip and High-Speed Trip configurations.

- Standard Trip models operate in approximately 12–15 mSec and come equipped with the standard LOR target nameplate or the optional LOR Monitor Nameplate.
- High Speed Trip LOR/ER models have the same 8 mSec trip speed as the Manual Reset LOR and come equipped with the Memory Target which displays an orange flag until it is manually reset. The LOR Monitor Nameplate is not available for the High Speed versions of LOR/ER and LOR/SR.

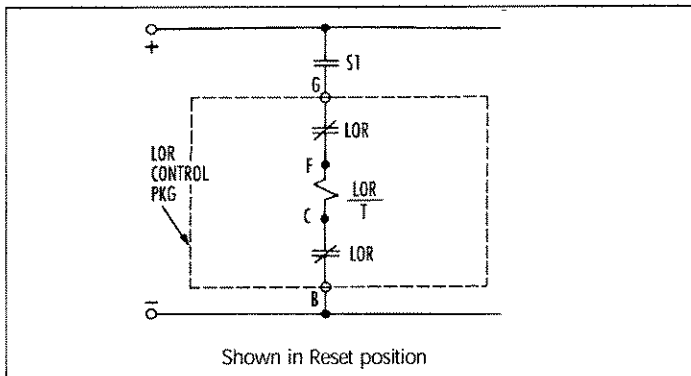


SERIES 24 LOCK-OUT RELAYS

OPTIONS

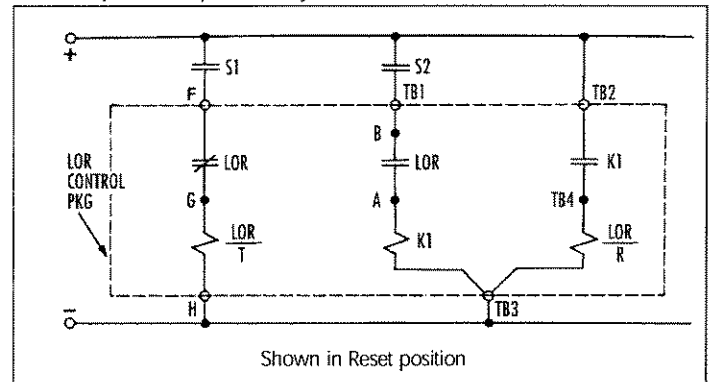
Manual Reset LOR

Closing S1 energizes the linear solenoid $\frac{LOR}{T}$ which releases the trigger mechanism and causes the LOR to snap to the Trip position. The control deck blades rotate to interrupt current flow to the coil.



Electric Reset LOR

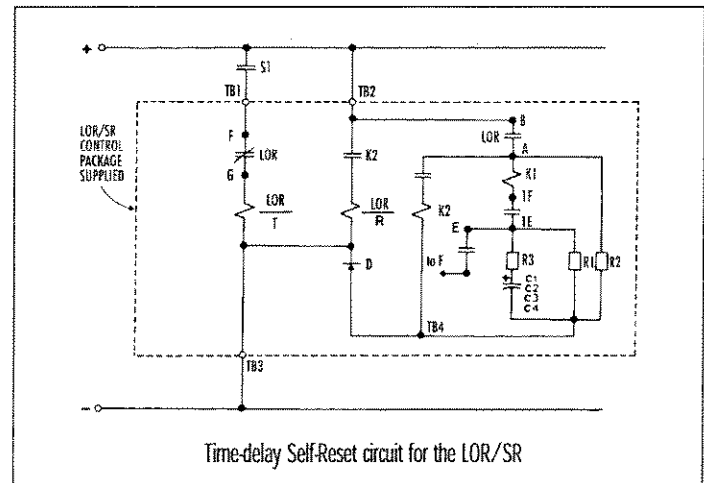
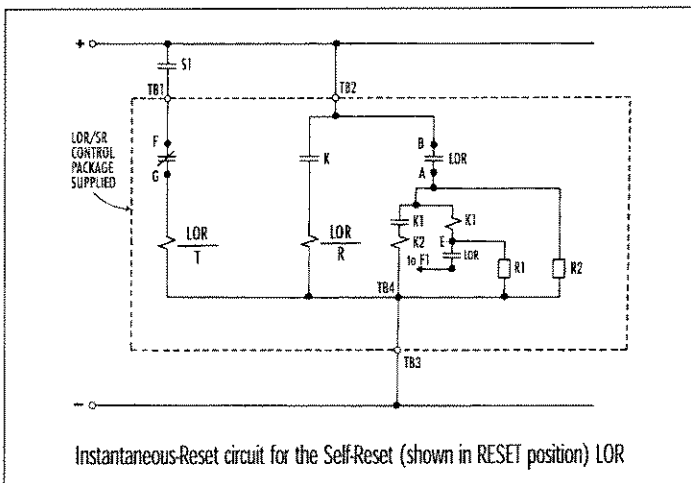
The Electric Reset LOR is tripped by the same method as the Manual Reset LOR. In the Trip position, closing S2 operates relay K1 which closes relay contact K1. The current then flows through solenoid $\frac{LOR}{R}$ which rotates the LOR/ER back into the reset position, while at the same time terminals A-B open to interrupt the K1 relay. Transition time is 80mSec.



Self Reset LOR

The Self Reset LOR is a special Electric Reset LOR which can be both TRIPPED and RESET from a single command contact. In both diagrams below, closing S1 will cause the LOR/SR to snap to the TRIP position. The unit will remain in TRIP as long as S1 remains closed. When S1 is opened, K1 is picked up and the LOR/SR returns to the reset position. The Instant Reset

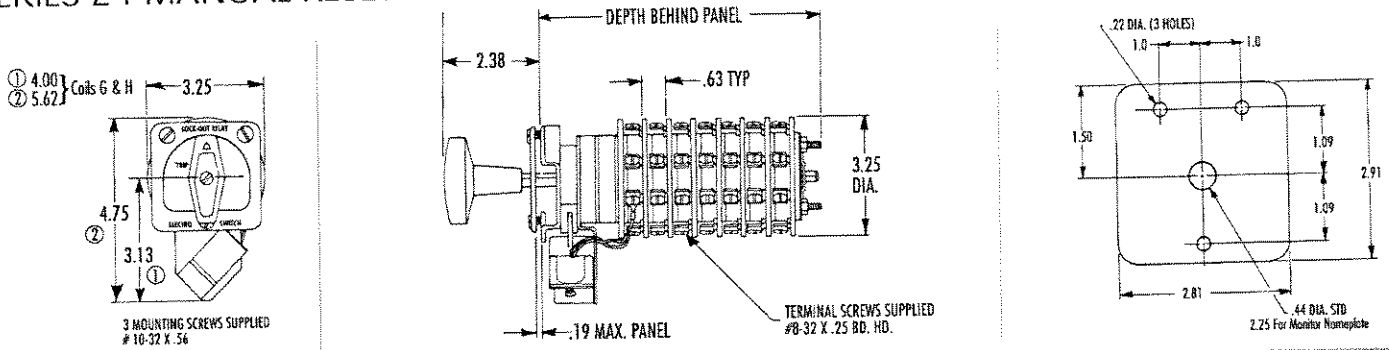
LOR/SR will reset itself within 80mS of the opening of S1. The Time Delay LOR/SR has factory preset circuitry which causes a time delay of .3 to .6 seconds from the time S1 opens until the LOR/SR contacts reclose.



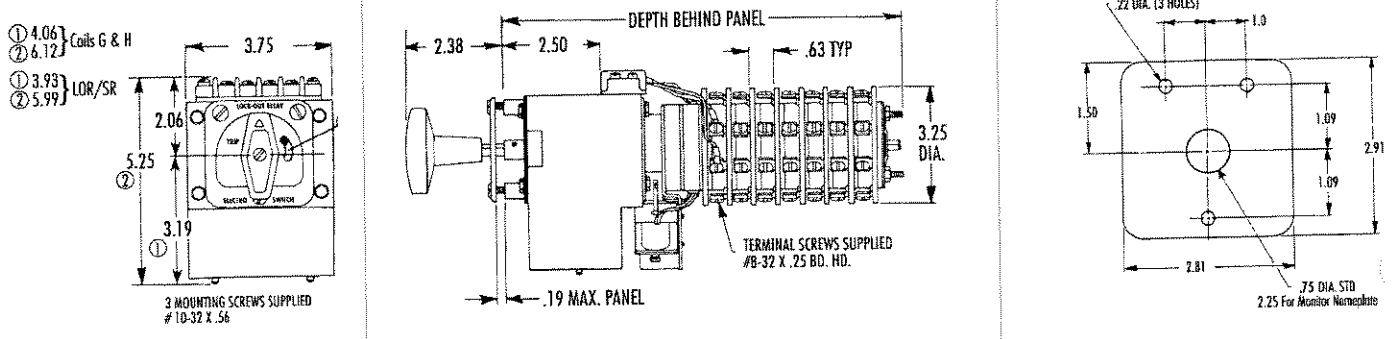


SERIES 24 LOCK-OUT RELAYS

SERIES 24 MANUAL RESET LOR



SERIES 24 LOR/ER, LOR/SR ELECTRIC RESET & SELF-RESET



DEPTH BEHIND PANEL

NO. OF DECKS	MAN. RESET LOR	HI SPEED TRIP LOR/ER	LOR/ER AND INSTANT LOR/SR TIME DELAY	RESET LOR/SR
1	3.63	-	-	-
2	4.38	-	-	-
3	4.75	8.00	8.00	8.63
4	5.50	-	-	-
5	6.25	9.75	9.75	10.38
6	7.50	-	-	-
7	8.13	-	-	11.63
8	8.50	11.63	11.63	-
10	9.63	12.90	-	-

COIL BURDEN DATA

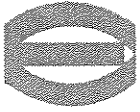
COIL	COIL CIRCUIT VOLTS	TRIP COIL		RESET COIL	
		COIL CIRCUIT DC OHMS @ 25°C	BURDEN (AMPS) AT RATED VOLTAGE	COIL CIRCUIT DC OHMS @ 25°C	BURDEN (AMPS) AT RATED VOLTAGE
A	24VDC	3.3	7.3	.7	33.8
B	24VDC	7.7	3.1	-	-
C	48VDC	13.0	3.7	3.0	15.9
D	125VDC	27.0	4.6	12.4	10.1
E	125VDC	50.0	2.5	-	-
F	250VDC	104.0	2.4	80.6	3.1
G	125VDC	27.0	4.6	-	-
H	250VDC	104.0	2.4	-	-
K	125VDC	27.0	4.6	-	-

TRIP COIL VOLTAGE DATA

Coil	Nominal Voltage	Threshold Voltage	Operating Range
A	24VDC	6VDC	10 - 40VDC
B	24VDC	9VDC	18 - 50VDC
C	48VDC	12VDC	24 - 70VDC
D	125VDC	16VDC	30 - 140VDC
	120VAC	20VAC	30 - 140VAC
E	125VDC	23VDC	45 - 140VDC
F	250VDC	33VDC	70 - 280VDC
	240VAC	40VAC	60 - 280VAC
G	125VDC	70VDC	90 - 140VDC
H	250VDC	140VDC	180 - 280VDC
K	125VDC	16VDC	100-150VDC

RESET COIL VOLTAGE DATA

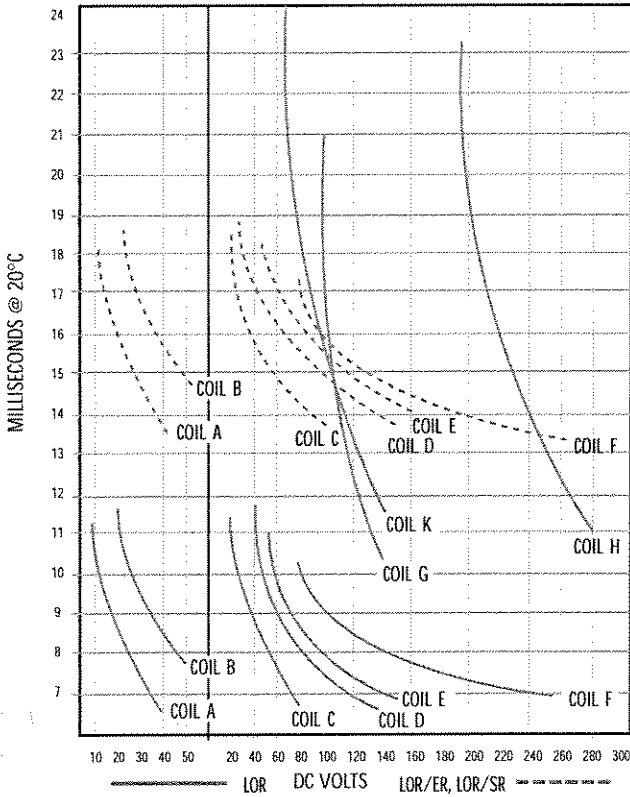
Coil	Nominal Voltage	Normal Voltage Operating Range
A	24VDC	19.2 to 28VDC
C	48VDC	38.4 to 57.6VDC
D	125VDC	100 to 150VDC
F	250VDC	200 to 275VDC



SERIES 24 LOCK-OUT RELAYS

LOR RESPONSE TIMES*

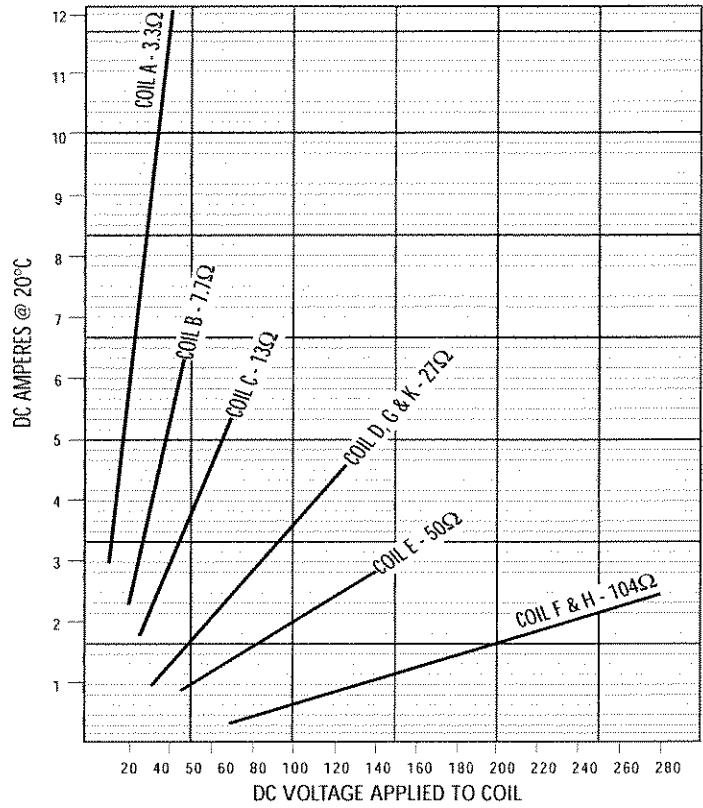
Time to Close Normally Open Contacts



*For AC Applications refer to Trip Coil Voltage Data on page 47

LOR CURRENT

Voltage Characteristics Of The Trip Coils



ORDERING INFORMATION

Selecting a Series 24 Lock-Out Relay:

1. Select type of LOR (Manual Reset, Electric Reset or Self Reset).
2. Fill out appropriate ordering matrix.
3. When selecting Trip and Reset Coils use information from tables below.
4. Contact factory for custom features and nonstandard configurations.

Manual Reset LOR

78	03	B
Model	No. of Decks	Trip Coil (See Page 47)
78 = LOR	03 = 3 08 = 8 05 = 5 10 = 10	A = Coil A D = Coil D G = Coil G B = Coil B E = Coil E H = Coil H C = Coil C F = Coil F K = Coil K

Electric Reset LOR/ER

78	□	□	□	□
Model				Reset Coil
78 = LOR				A = 24VDC D = 125VDC C = 48VDC F = 250VDC
Configuration				Trip Coil (See Page 47)
2 = Std. Trip LOR/ER 3 = Hi-Spd. Trip LOR/ER				A = Coil A F = Coil F B = Coil B G = Coil G C = Coil C H = Coil H D = Coil D K = Coil K E = Coil E
	No. of Decks			
	3 = 3 5 = 5 8 = 8 (10 Consult Factory)			

Self Reset LOR/SR

78	□	□	□	D
Model				Reset Coil
78 = LOR				D = 125VDC
Configuration				Trip Coil
4 = Std. Trip, Instant Reset, LOR/SR 5 = Std. Trip, Time Delay Reset, LOR/SR 6 = Hi-Spd. Trip, Instant Reset, LOR/SR 7 = Hi-Spd. Trip, Time Delay Reset, LOR/SR				D, E, F, G Available for Std. Trip LOR/SR D, E, F Available for Hi-Spd. Trip LOR/SR
	No. of Decks			
	3 = 3 5 = 5 7 = 7 (time delay units only) 8 = 8 (instant reset units only)			

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

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Project No. 79538-C31-16

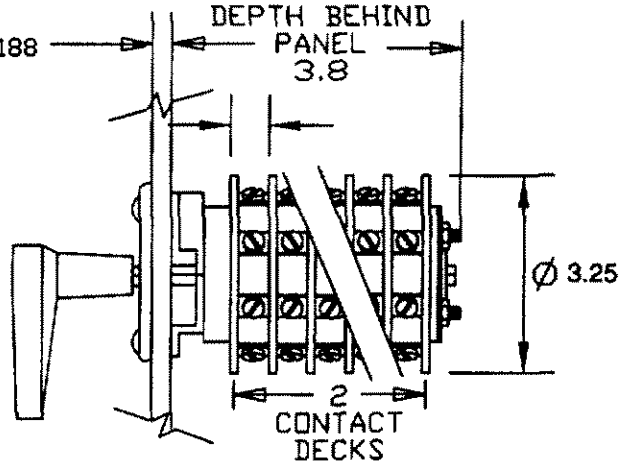
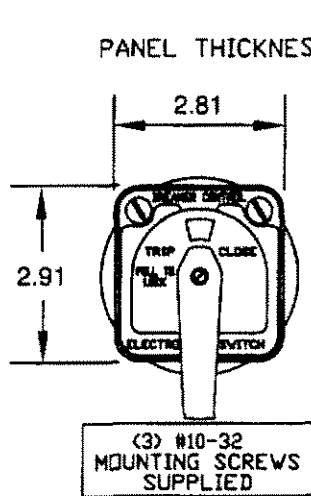
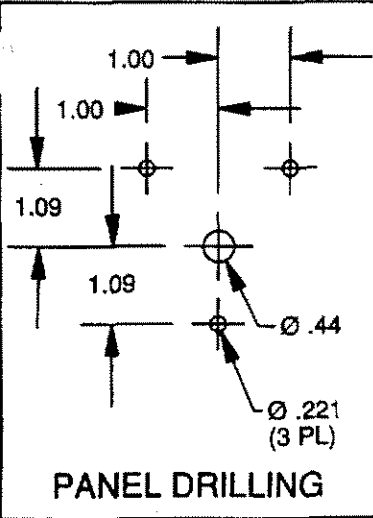
Date: June 21/06 By: [Signature]



ELECTRO SWITCH
 UNIT OF ELECTRO SWITCH CORP.
 WYOMOUTH MASSACHUSETTS 02188
 TEL(781)335-5200 FAX(781)335-4253

**SERIES 24
 CONTROL SWITCH**

74902QF



**# 8-32
 BD.HD. TERMINAL SCREWS
 SUPPLIED UN-ASSEMBLED.**

AI 20A-120VAC
 15A-240VAC
 6A-600VAC
 FILE NO. 3A-125VDC
 E18174 1A-250VDC

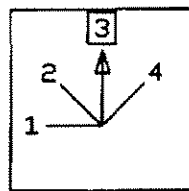


20A-600VAC res
 15A-600VAC ind
 2A-125VDC
 2HP-240/480VAC

TITLE: BREAKER CONTROL

DECK	CONTACTS	POSITION				
		PULL TO LOCK	TRIP	(NAT)	(NAC)	CLOSE
				3 FROM		
		1	2	2	4	4
1	11 ○ — — ○ 18	X	X			
2	27 ○ — — ○ 28	X				
	22 ○ — — ○ 23					X

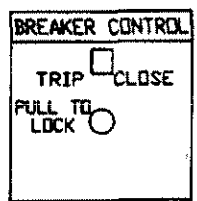
HANDLE POSITIONS



**ACTION: SPRING RETURN TO POS. 3
 PULL TO LOCK IN POSITION 1**

11	12	13	14	15	16	17	18
●	○	○	○	○	○	○	●
21	22	23	24	25	26	27	28
○	●	●	○	○	○	●	●

**JUMPERS AND
 TERMINALS SUPPLIED
 AS SHOWN**



**NAMEPLATE
 CODE 19C-3B33**

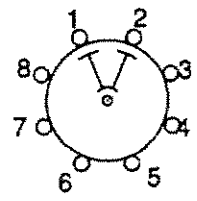
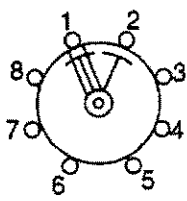
Earth Tech (Canada) Inc.

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Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

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 REVIEWED AS MODIFIED _____
 REVISE AND RE-SUBMIT _____
 NOT REVIEWED _____

Project No. 79538-CB1-16



MADE BY: WCK DATE: 09-08-05
 APPR BY: WCK DATE: 09-08-05

Date: June 2006 DWG. NO. By: [Signature]
 SHEET 1 OF 1

REVISIONS

2

2

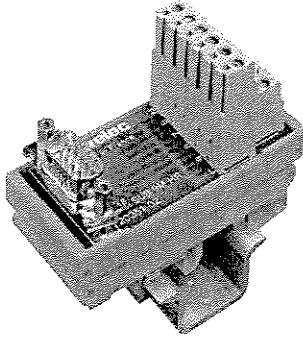
Handwritten notes in a rectangular box, possibly containing a list or a set of instructions. The text is very faint and difficult to read, but appears to be organized into several lines or sections.

Connector interfaces

Screw-clamp modules - Sub. D

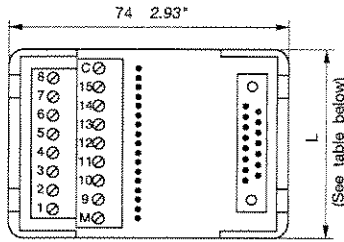
Series 20 000

DIN 1 - 3



Note: See Section 6, PLC Wiring Systems, for additional connection interfaces.

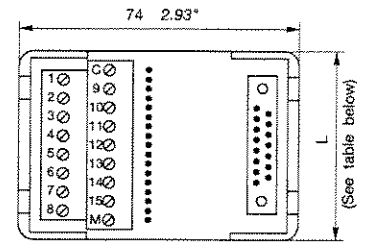
BFM SUB...M HR



(Example of Sub D, 15 points)

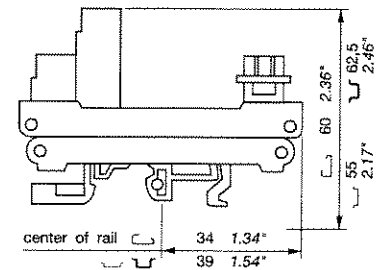
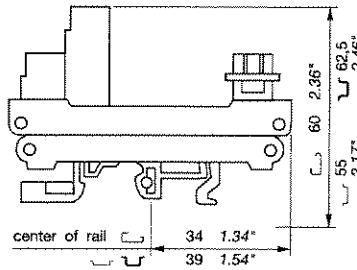
Compression clamp terminal blocks - Male SUB.D connector. As per DIN 41 652 standard.

BFM SUB...F HR



(Example of Sub D, 15 points)

Compression clamp terminal blocks - Female SUB.D connector. As per DIN 41 652 standard.



Easy interface of electronic cable with field wiring. Error-proof connection reduces wiring time. For ground connection of connector. UNC 4-40 locking screws.

Part numbers

- 9 points
- 15 points
- 25 points
- 37 points
- 50 points

Type	P/N	Length L. mm	Length L. inch.
BFM SUB 9 M HR	0020 351.02	33	1.30"
BFM SUB 15 M HR	0020 352.03	48.3	1.90"
BFM SUB 25 M HR	0020 353.04	73.7	2.90"
BFM SUB 37 M HR	0020 354.05	101.6	4.00"
BFM SUB 50 M HR	0020 355.06	137.2	5.40"

Type	P/N	Length L. mm	Length L. inch.
BFM SUB 9 F HR	0020 356.07	33	1.30"
BFM SUB 15 F HR	0020 357.00	48.3	1.90"
BFM SUB 25 F HR	0020 358.11	71.1	2.80"
BFM SUB 37 F HR	0020 359.12	104.1	4.10"
BFM SUB 50 F HR	0020 360.17	137.2	5.40"

Approvals (Contact Entrelec)



Characteristics

Wire size	Screw-clamp block Connector	DIN-VDE				UL				CSA				NFC-UTE			
		0 - 2.5 mm ²	14 AWG	14 AWG	0 - 2.5 mm ²	0 - 2.5 mm ²	14 AWG	14 AWG	0 - 2.5 mm ²	0 - 2.5 mm ²	14 AWG	14 AWG	0 - 2.5 mm ²	0 - 2.5 mm ²			
Voltage	V AC ~ DC =	60 (1)			60 (2)	60 (1)			60 (1)			60 (2)	60 (2)				
Test voltage	KV	1			1	1			1			1	1				
Current	A	1			1	1			1			1	1				

Self-extinguishing polyamide base - UL94V2 Ultramid - Epoxy PCB 1.6 mm .063" 35 µm CU with conformal coating

(1) Values as per VDE 0110 group C - (2) Values as per NFC 20040 category C

Accessories, marking, wire size : see Accessories section.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: Sept 21/06 By: [Signature]

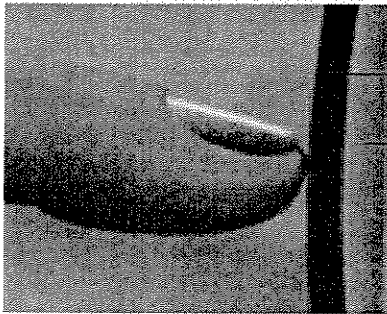


IntelliTouch® Surface-Wave Touchscreens

The Picture-Perfect, Precision Touch Solution

Benefits of IntelliTouch

- Smart, fast touch response with finger, gloved-hand, and soft stylus
- Superior image clarity, resolution and light transmission
- Stable, drift-free operation
- Durable, scratch-resistant glass surface—continues to work even if scratched
- Sealable against contaminants



Glass touchscreen

CRT or flat panel

IntelliTouch Surface-Wave Technology

The IntelliTouch system has three main components: a clear solid-glass screen formed to match the shape of a display, an electronic controller, and a software driver.

The controller uses ultrasonic waves on the glass to develop a digital map of the touchscreen surface. When you touch the screen, you absorb a portion of the wave traveling across it. The received signal is then compared to the stored digital map, the change recognized, and a coordinate calculated. The digitized coordinates are transmitted to the computer for processing.

The Clearest, Most Reliable Touchscreens

Solid glass and Elo's patented surface-wave technology are the keys to the unsurpassed stability, clarity and durability of the IntelliTouch product line. The only solid-glass touchscreen in the industry with no coatings or front layers, IntelliTouch touchscreens deliver the clearest image possible. For today's highly graphical presentations—in multimedia kiosks, interactive training programs, and self-service catalogs—IntelliTouch touchscreens attract attention and invite use.

IntelliTouch touchscreens also offer unmatched reliability. Tested to function perfectly even after more than 50 million touches in one location, IntelliTouch touchscreens have no known wear mechanism.

Fast and Sensitive

Elo's touchscreen controller is highly sensitive—it responds accurately to the lightest touch.

IntelliTouch touchscreens can register more information than simply touch location on the X and Y axes. When you touch an IntelliTouch touchscreen, it also recognizes the amount of

pressure applied—the Z axis. IntelliTouch is the only technology to provide this capability.

Smarter Than the Average Touchscreen

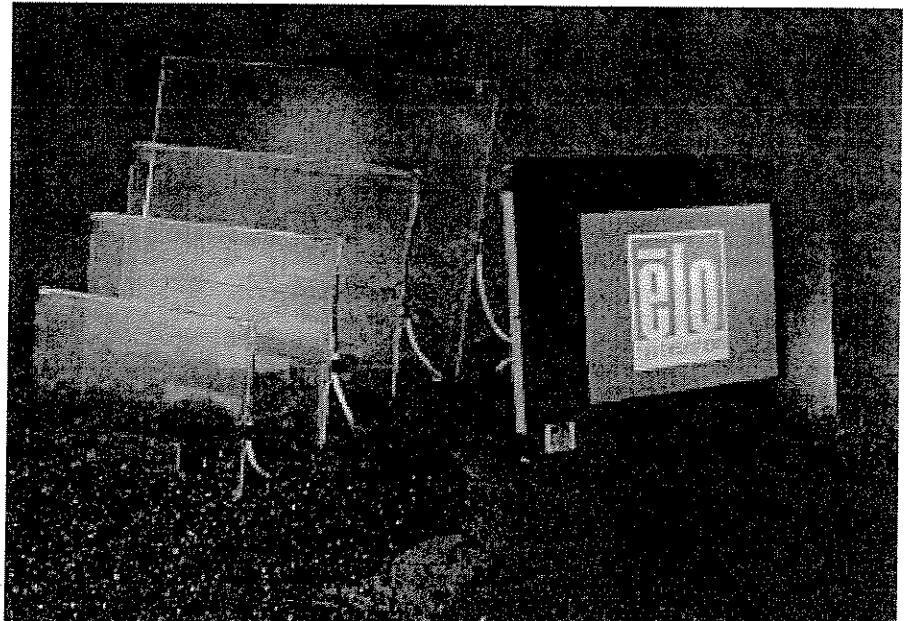
The IntelliTouch controller has the smarts to reprogram or “learn around” contamination—including grease, dirt, bits of food, gum and other substances—and respond immediately to the next touch. It does not register contaminants as touches, and its smart touch response virtually eliminates false touch activation.

An Inherently Stable Technology

IntelliTouch is inherently stable, and our patented surface-wave technology simply won't lose its accuracy.

The stability and accuracy of IntelliTouch touchscreens derives from the consistent velocity of the ultrasonic waves traveling across the surface of the glass screen and the system's ability to measure intervals of time very accurately. These two factors are not affected by environmental conditions, so the touchscreen's calibration remains true over the widest range of application settings and over time.

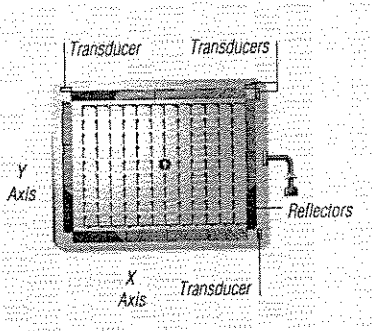
IntelliTouch pure-glass touchscreens provide superior image quality, durability and scratch resistance



IntelliTouch Surface-Wave Touchscreens

Typical Applications

- Point-of-information kiosks
- Electronic catalogs
- In-store locators
- Multimedia demos and marketing
- Ticket sales, vending, and gift registries
- Gaming, lottery and amusement
- Interactive education
- Banking/financial transaction
- Industrial control rooms
- Interactive pay phones
- Computer-based training



Piezoelectric elements located at the corners of the IntelliTouch touchscreen generate an ultrasonic wave. A sophisticated border pattern reflects the wave across the glass, creating a digital map of the touchscreen surface.

Durability

The solid-glass construction of an IntelliTouch touchscreen not only resists scratches and abrasions, but continues to operate even with deep scratches. Elo is a favorite with developers of public access systems such as kiosks and gaming machines because even with severe abuse, IntelliTouch solutions keep working.

Our new sealing capability further enhances durability, offering increased protection from dust, splashing of liquids, and other external contaminants.

Visual Resolution

4096 x 4096 resolution—the highest touchpoint density in the industry—

allows developers flexibility in designing their application, without being restricted to large, screen-consuming touch targets.

Light Transmission

Ninety percent light transmission provides optimized brightness and contrast.

Choose Your Solutions

Elo has the touchscreen solution for your application.

Choice of Touchscreen Size

- Flat touchscreens are available in sizes from 8.4 inches to 17 inches
- Spherical and cylindrical screens are also available from 13 inches to 21 inches
- Custom sizes for OEM quantities

Choice of Surface Treatment

- Clear
- Antiglare
- Privacy filter available for applications involving sensitive information, such as ATM transactions

Choice of Controller

- Internal serial
- External serial
- PC bus

Available Software Drivers

- MonitorMouse mouse-emulation software, available for multiple platforms

- MonitorMice extension, which allows multiple-monitor operation with one PC

Unbeatable Service and Support

- Shipment within 24 hours of order for most standard products in limited quantities
- Product information (1-800-ELO-TOUCH)
- In-depth technical assistance for developers of touch systems (1-800-489-9935)
- Longest warranties in the industry (10 years touchscreen, 5 years touch controller)
- Agency approvals for all components
- Evaluation units for 30-day trial
- Elo's On-line Virtual Tech Support Technician: www.elotouch.com/tech.html

For complete touchscreen specification details, visit our Web site at www.elotouch.com.

For a comparison of touchscreen technologies, and to find out more about Elo's extensive range of touch solutions, visit our Web site at www.elotouch.com. Or, simply call the office nearest you:

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Elo TouchSystems, Inc.

To have Elo product information faxed to you, call 1-888-FAX-ME-ELO (1-888-329-6335) or 1-650-556-8462.

IntelliTouch, MonitorMice and MonitorMouse are trademarks of Elo TouchSystems. All other trademarks are the property of their respective owners.

www.elotouch.com

Earth Tech (Canada) Inc.

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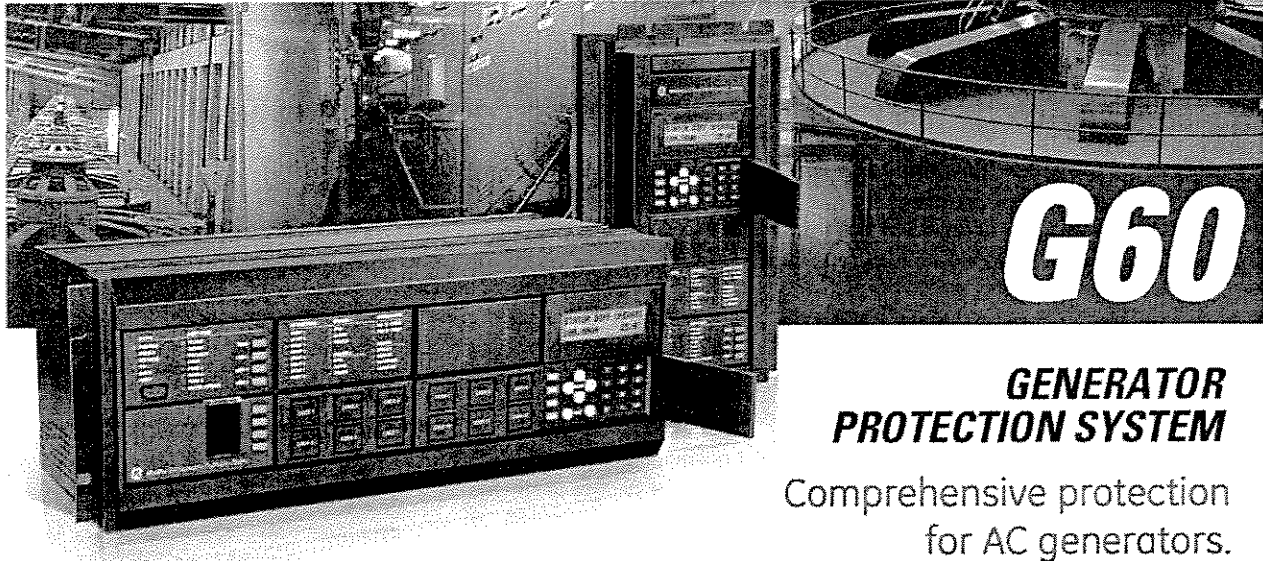
Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

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G60

GENERATOR PROTECTION SYSTEM

Comprehensive protection for AC generators.

KEY BENEFITS

- Full featured generator protection that satisfies any application
- Advanced automation capabilities
- Increase the reliability of the protection & control system with dual power supply option
- Complete support of multiple breaker applications (eg. Ring Bus, Breaker-and-a-half) - Fitted with the features needed to provide secure operation during external faults
- Cost effective and flexible access to information - Multiple communication options and protocols
- Reduce installation space requirements through compact design - Multifunction device that integrates protection and control functions, programmable pushbuttons and status LEDs, and communication interfaces
- Use high speed communications to reduce wiring and installation costs - Exchange inputs and outputs between relays to achieve relay-to-relay interaction
- Maintenance cost savings and simplification - Modular construction, common hardware, reduced stock of spare parts, plug & play modules
- Application flexibility - Multiple I/O options, programmable logic (FlexLogic™), modularity, customize to specific requirements
- Reduce system event analyzing time and cost - Sequence of event reports, oscillography, datalogging, IRIG-B time synchronization
- Embedded IEC 61850 Protocol - No external protocol converter required

APPLICATIONS

- Any size of AC generator typically driven by steam, gas or hydraulic turbine
- Stand-alone or component in automated substation control system

FEATURES

Protection and Control

- Stator differential
- 100% stator ground differential
- Backup distance
- Power swing blocking and tripping
- Synchronism Check
- Restricted Ground Fault
- Split phase protection
- Loss of excitation, Overexcitation
- Reverse and low forward power
- Generator unbalance

Communications

- Networking options - Ethernet-fiber (optional redundancy), RS485, RS422, G.703, C37.94
- Multiple protocols - IEC 61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC 60870-5-104, Ethernet Global Data (EGD)
- Direct I/O - Exchange of binary data between URs

Monitoring and Metering

- Metering - current, voltage, power, energy, frequency
- Oscillography - 64 samples/cycle, up to 64 records
- Event Recorder - 1024 time tagged events, with 0.5ms scan of digital inputs
- DataLogger - Up to 16 channels with user selectable sampling rate
- User Programmable Fault Reports

User Interface and Programming

- Front panel display and keypad for local direct access, with an RS232 port for local PC access
- User programmable local display, LEDs and pushbuttons
- Customize protection and control functions with FlexLogic™, FlexCurves™, and FlexElements™
- Includes EnerVista LaunchPad - Simple relay setup and programming
- Multi-language support - French, Chinese, Russian option



GE Consumer & Industrial
Multilin



Protection and Control

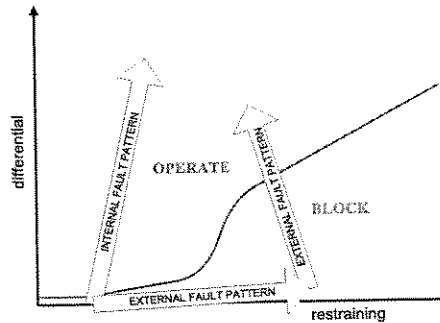
The G60 Generator Protection System provides comprehensive generator protection to satisfy any application. The G60 is the standard protection offering on GE generators, protecting machines up to 1000MW. The G60 includes advanced automation capabilities, extensive I/O options and configurations, and features that can minimize generator downtime. As part of the Universal Relay (UR) Family, the G60 provides superior protection and control that includes:

Stator Differential

High speed Stator Differential protection is provided for fast clearance of stator phase faults. Advanced CT saturation detection algorithms as well as dual slope characteristic are incorporated for increased security during heavy external fault/disturbances.

100% Stator Ground

100% stator ground fault protection is provided by an adaptive voltage differential feature responding to the unbalance of



Percent differential restraint operating characteristics

the third harmonic at the machine terminals and at the neutral point. The protection can be supplemented or replaced by a third harmonic undervoltage function responding to the voltage at the neutral side of the machine.

Backup Distance

This function provides time-delayed protection for system faults that have not been cleared by system protections and to provide backup protection for stator faults. Three zones of phase Distance protection are available. Transformer compensation is included to ensure correct reach for faults on the high side of the step up transformer.

Power Swing Detect

Integrated out-of-step tripping and power swing blocking functions use either two or three characteristics to trace the positive sequence impedance trajectory to detect an out-of-step condition. The element also incorporates an adaptive disturbance detector and the trip action is programmable (instantaneous or delayed).

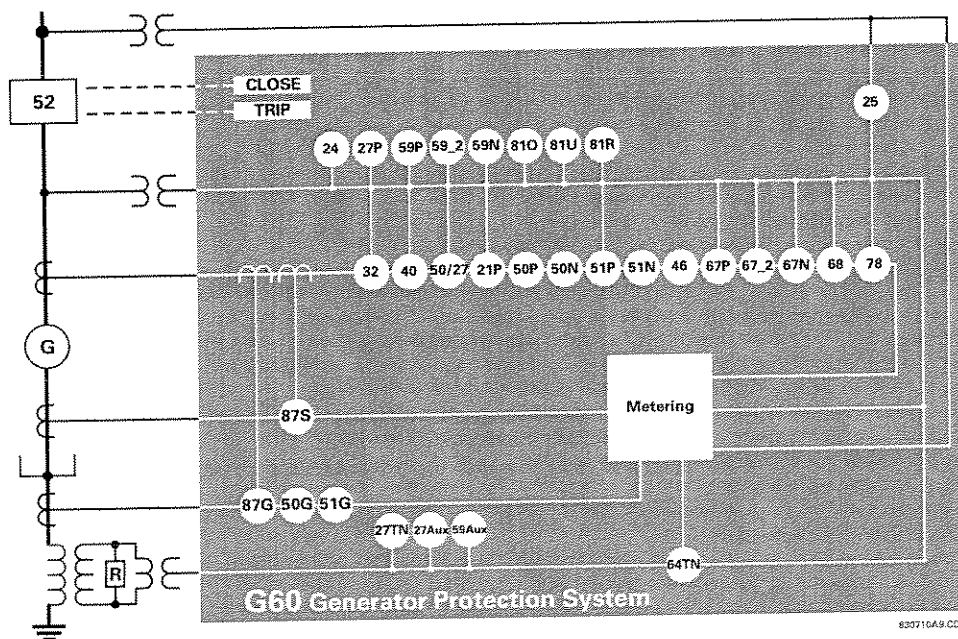
Restricted Ground Fault (RGF)

RGF (also known as zero sequence differential) provides sensitive ground fault detection for low-magnitude fault currents. The G60 incorporates low-impedance RGF protection and uses novel algorithms to provide fast and sensitive protection while overcoming stability problems and CT saturation.

Split Phase Protection

Split phase protection can be applied to detect inter-turn faults in cases where the generator is wound with two three-phase windings, each brought separately out of the machine and connected in parallel. This is a particularly popular winding

Functional Block Diagram



ANSI DEVICE NUMBERS AND FUNCTIONS

DEVICE NUMBER	FUNCTION
21P	Phase Distance Backup
24	Volts Per Hertz
25	Synchrocheck
27P	Phase Undervoltage
27TN	Third Harmonic Neutral Undervoltage
27X	Auxiliary Undervoltage
32	Sensitive Directional Power
40	Loss of Excitation
46	Generator Unbalance
50G	Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50P	Neutral Instantaneous Overcurrent
50SP	Split Phase Protection
50/27	Accidental Energization
51G	Ground Time Overcurrent

DEVICE NUMBER	FUNCTION
51P	Phase Time Overcurrent
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
64TN	100% Stator Ground
67_2	Negative Sequence Directional Overcurrent
67N	Neutral Directional Overcurrent
67P	Phase Directional Overcurrent
68/78	Power Swing Detection
81O	Overfrequency
81R	Rate of Change of Frequency
81U	Underfrequency
87G	Restricted Ground Fault
87S	Stator Differential

design on hydro generators. The currents in the two windings are compared with any difference indicating an inter-turn fault. These faults cannot be detected by differential protection.

Loss of Excitation

Use the G60 for the detection of the loss of excitation of synchronous generators, and to automatically remove the generator from service. Loss of excitation can be damaging to the machine, and/or detrimental to the operation of the system. It is recommended that loss-of- excitation protection be considered for all synchronous generators. Protective relays are applied as backup protection for excitation systems, which in most cases include minimum-excitation limiters to prevent under-excitation. An offset mho characteristic was chosen to provide selectivity between loss of excitation and other normal or abnormal conditions that may exist on the system. The element provides two-stage impedance based protection and responds to the positive sequence voltage and current.

Sensitive Directional Power

The Directional Power element responds to three-phase active power and is designed for reverse power and low forward power applications for synchronous machines or interconnections involving co-generation. The relay measures the three-phase power from either full set of wye-connected VTs or full-set of delta-connected VTs.

Generator Unbalance

The negative sequence components of unbalance currents cause second harmonic currents to flow in the rotor that can lead to undetected overheating and consequently severe machine damage. The G60 meets ANSI standards to minimize risk of heat damage caused by unbalance in the generator.

Overcurrent Protection

IOC and TOC functions are available for phase, ground, and neutral. Time curves provided include three IEEE, four IEC, four GE IAC, I^2t , definite time and four user-programmable curves. Phase TOC functions use voltage restraint.

Overexcitation Protection

Provided through a Volts/Hertz function with programmable inverse time characteristic.

Abnormal Voltage Frequency Protection

Over and underfrequency protection, and over and undervoltage protection are available.

Frequency Rate of Change Protection

Use the four frequency rate of change (df/dt) elements included in the G60 to provide protection against system disturbances through load shedding and to provide anti-islanding protection. These elements monitor the speed by which the frequency changes in any direction, through voltage, current and frequency supervision.

Thermal protection via RTDs

Use the G60 to provide over-temperature protection, a unique feature not normally found on Generator Protection Relays. The G60 is designed to receive signals from any type of external Resistance Temperature Detectors (RTDs), and convert these signals into a digital format for use as required. Actions based on RTD over temperature, such as trips or alarms, are done in conjunction with the FlexElements™ feature. FlexElements™ operands are available to FlexLogic™ for further interlocking or to operate an output contact directly.

Minimize Downtime

The G60 incorporate many features that can minimize generator downtime. These include:

- Dual hot swappable power supplies
- Quick troubleshooting and repair with withdrawable modules
- Comprehensive self-test features
- Extensively tested to ANSI and IEC specifications

The G60 is built on a generic hardware platform that has over 7 years of proven field experience

Synchronism Check

The synchrocheck elements are typically used at locations where the two parts of the system are interconnected through at least one other point in the system, which are to be joined by the closure of one or more circuit breakers. The G60 provides the required voltage source inputs, digital inputs and outputs, and elements to monitor differences in voltage magnitudes, phase angles, and frequencies to perform synchronism check across two breakers. Use the G60 to carry out full independent control over the associated breakers. When used in conjunction with an automated system, use the G60 to aid the restoration process as an independent check of the synchronizer.

Advanced Automation

The G60 incorporates advanced automation features including powerful FlexLogic™ programmable logic, communication, and SCADA capabilities that far surpass what is found in the average generator relay. The G60 integrates seamlessly with other URs for complete system protection, including the generator service unit, and balance of plant protection.

The G60 is available with a multitude of I/O configurations to suit the most demanding needs. The expandable modular design allows for easy configuration and future upgrade.

Multiple CT/VT configurations allow for implementation of traditional voltage balance schemes (with 2 CTs & 2 VTs) or for schemes that require differential assigned to a dedicated CTs.

Up to 80 digital inputs (with utility voltage rating up to 250V) and up to 56 digital outputs are available and can be used to monitor and control a wide range of auxiliary equipment found within a generation application. Types of digital I/O cards include Trip rated Form-A, Form-C, Fast Form C, Latching and Solid State with or without dc voltage and current monitoring. Mechanically latching outputs can be used to develop secure interlocking applications and replace mechanical switches.

RTDs and dcMA cards are available to monitor system parameters such as temperature, vibration, pressure, wind speed, and flow. Analog outputs can be used for hardwired connections from the relay to a SCADA system or other user interface device (eg. panel display).

The remote I/O and direct I/O features provide a means of sharing digital point state information between URs or other IEC 61850 compliant IEDs. This can be used for distributed protection and control schemes with other transformer, bus, feeder, and motor relays.

Monitoring and Metering

The G60 includes high accuracy metering and recording for all ac signals. Voltage, current, and power metering are built into the relay as a standard feature. Current parameters are available as total waveform RMS magnitude, or as fundamental frequency RMS magnitude and angle (phasor).

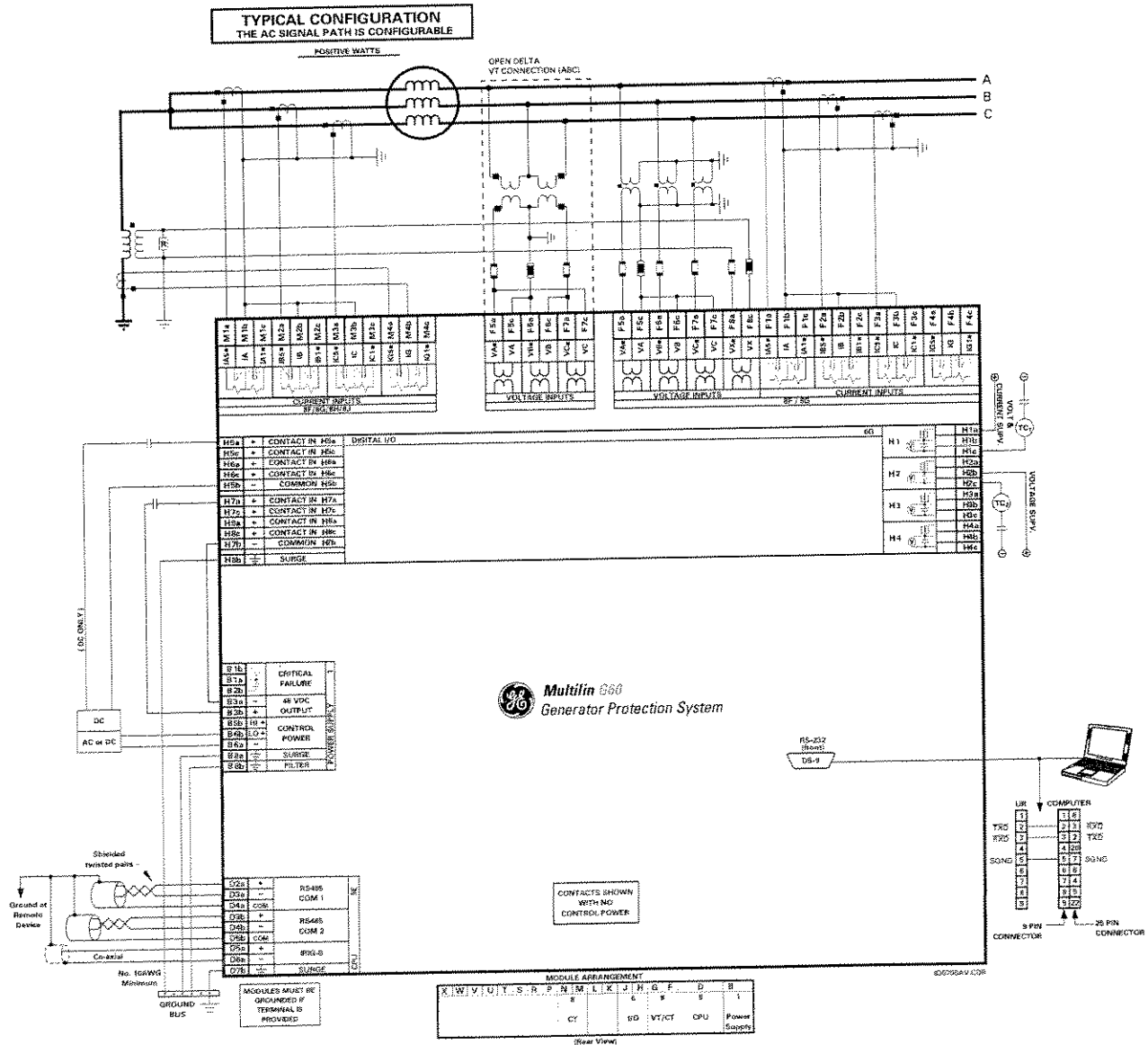
Diagnostics features such as oscillography, event recording, and data logger, combined with EnerVista software tools,

significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

Oscillography

Configure up to 64 oscillography channels to monitor any physical I/O point or internal digital and analog variables. The waveform traces and digital states provide a visual display of power system and operational data captured during specified triggered events. Sampling rates are up to 64 samples/cycle and 64 fault records can be stored on the unit.

Typical Wiring



Event Recorder

Capture the last 1024 events, with 0.5ms scan of digital inputs, to provide SOE recorder functionality. Consolidate the event records from multiple devices using EnerVista software tools and use the IRIG_B time synchronization feature to synchronize all events across a system of URs for even more accurate analysis and troubleshooting.

DataLogger

Profile operational data with up to 16 data logger channels with a user configurable sampling rate, ranging from 1 second to 1 hour. All data is stored in non-volatile memory so that information is retained even when power to the unit is lost. All recorded data can be easily retrieved via EnerVista for viewing and analysis.

User Interface and Programming

The G60 front panel provides extensive local HMI capabilities. The local display is used for monitoring, status messages, fault diagnosis, and controller configuration. User configurable messages that combine text with live data, can be displayed when user defined conditions are met. A keypad is also provided for easy access and changes to relay settings.

Replace external indicator lights with the 48 user programmable LEDs to display key status information. An additional 14 pre-programmed LEDs and custom LED labeling are available.

An RS232 port for local PC access is provided on the front panel for convenient access to the relay through EnerVista LaunchPod. The Ethernet port allows for even easier access to the relay over the network.

User-Programmable Push Buttons

Perform manual control, operate breakers, or lock out functions, with the user-programmable pushbuttons. Replace external switches and bi-stable relays by using mechanically latching outputs controlled from the pushbuttons. The G60 can be ordered with 7 user programmable control pushbuttons (3 standard, 4 optional) and 12 large user-programmable

push buttons (optional). The control action of each push button is fully programmable and its operation can be logged directly in the Sequence of Events recorder to enhance troubleshooting. The push buttons can be easily labeled for added clarity of functionality.

Multi-Language

The G60 supports multiple languages. French, Chinese, Russian language options are available on the local display, front panel, and EnerVista setup software, as well as the product instruction manual. Easily switch between English and an additional user selectable language on the local display.

FlexLogic™, FlexElements™, FlexCurves™

The G60 comes with powerful configuration and programming tools. These include:

- FlexLogic™: simplifies the programming and use of the G60 and enables powerful but flexible protection and control solutions
- FlexElements™: user-definable protection functions
- FlexCurves™: define additional custom curve shapes

Multiple Settings Groups

Six separate setting groups can be stored in the G60's non-volatile memory. An easy to use and fully programmable mechanism is provided to instantly switch the active settings. Multiple settings groups apply to all the protection elements.

Communications

The G60 supports a wide range of communication mediums and protocols compatible with new and existing communication infrastructures.

Networking options include Ethernet-Fiber, with optional redundancy, and RS485 interfaces. With the advent of high-speed relay-to-relay communication LANs, performing inter-device control signaling via remote I/O over the LAN can eliminate a great deal of inter-device control wiring.

Protocols supported by the G60 include IEC61850, DNP 3.0, Modbus RTU, Modbus TCP/IP, and IEC60870-5-104. These

protocols make it easy to connect to a utility automation system and are integrated into the G60, removing the need for external protocol converter devices.

Interoperability with Embedded IEC 61850 Protocol

IEC 61850 is the new international standard for information exchange and interoperability between intelligent devices within a substation. Use the G60 with IEC 61850 to lower the costs and simplify the engineering, commissioning, operating, and maintenance associated with substation protection and control applications. IEC 61850 is built on over 7 years of GE leadership in UCA 2.0 implementation.

IEC 61850 allows for the seamless connection of IEDs from multiple vendors. In addition to device interoperability, these protocols are designed to control the substation via a LAN instead of through discrete wiring to an RTU. Peer-to-peer communication over Ethernet enables distributed control with several IEDs and eliminates the need for an RTU to remote SCADA master. High-speed message transfer eliminates the need for large and costly hard-wired interconnection.

Direct I/O Messaging

This feature allows for the exchange of binary information (FlexLogic™ operands) between a number of UR IEDs over a dedicated fiber (single or multimode), RS422, G.703 or C37.94 interface. No switching equipment is required as the IEDs are connected directly in a ring or redundant (dual) ring configuration.

EnerVista™

The EnerVista™ Suite is an industry leading set of software programs that will simplify every aspect of using the G60 relay. Tools to instantly monitor the status of the Generator and view the magnitude of any power quantities measured by the G60 relay are available. Also, the ability to analyze the cause of any faults using the powerful COMTRADE and the Sequence of Event viewers in the EnerVista UR Setup program is included with each relay.

EnerVista™ LaunchPad

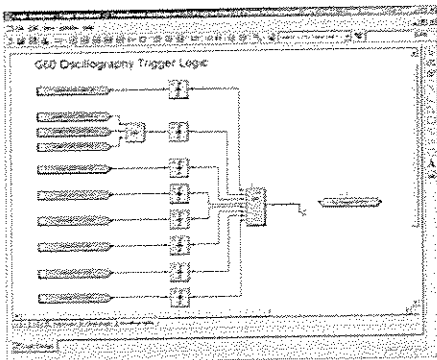
EnerVista™ LaunchPad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining all GE Multilin products. Also included is a document archiving system that will ensure that all manuals, application notes, and other necessary documentation are always up-to-date and available when needed.

Viewpoint Monitoring

Viewpoint Monitoring is a software application that will provide Monitoring, Control, Trending, Alarming and Fault Data Recording functionality needed for substation applications. This easy to use program can be configured to give complete visibility, control, and automated retrieving and archiving of all Event Records and Waveforms files from GE Multilin devices in minutes.

Viewpoint Engineer

Viewpoint Engineer is a set of tools that will reduce the amount of time required to program, test and commission UR relays. The Graphical FlexLogic™ Editor will improve efficiency in programming UR's by combining the creating of control diagrams, documenting of logic, and programming of relays into one easy step. The Real-Time FlexLogic™ Analyzer will then simply commissioning and troubleshooting by displaying the status of each part of the equations as they change state.



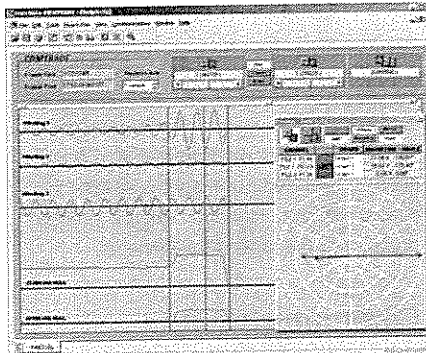
Create your control and automation logic in our IEC1131 graphical logic editor

Viewpoint Maintenance

Viewpoint Maintenance is a set of tools designed specifically for individuals responsible for diagnosing faults, maintaining and troubleshooting GE Multilin devices after commissioning. With a single click of the mouse, this software provides users with a simplified report that shows the cause of any power system faults or problems. This software will also enhance the security of the relay by providing reports that will document any changes have been made to the configuration of the devices.

EnerVista™ Integrator

EnerVista™ Integrator is the tool to use to send data that is measured by GE Multilin devices to new or existing HMI, SCADA, or DCS system. This software can greatly reduce the time required to integrate GE Multilin devices with the Energy Management or Plant Operations Systems. Also included is a tool that will detect any new Events or Waveform files created by all the relays and automatically save them into a permanent historical archive, which will give a station wide Sequence of Event record.



Automatically retrieves and archives all Waveforms and Event Records from GE Multilin devices

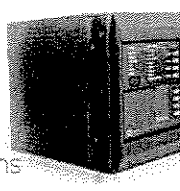
G60 Guideform Specifications

For an electronic version of the G60 guideform specifications, please visit: www.GEMultilin.com/specs, fax your request to 905-201-2098 or email to literature.multilin@ge.com.

Guideform Specifications Available Online or from your Sales Representative.

www.GEMultilin.com

Refer to the **UR Family** section for more details on features and specifications



Accessorize your G60



www.GEMultilin.com

Ordering

G60-N00-HCH-F8L-M67-M6D-PXX-UXX-W/XX

Base Unit	G60	*00	-H*	*-F**	H**	-M**	-P**	-U**	-W/X	**
CPU		*00	-V F	*-F**	H**	-M**	-P**	-U**	-W/X	**
Software Options		00								
Mount / Coating		01								
User interface		03								
*Power Supply		04								
CT/VT DSP										
Digital I/O										
Transducer I/O										
Inter-Relay Communications										

Base Unit	RS485 + RS485
RS485 + Multi-mode ST 10BaseF	
RS485 + Multi-mode ST Redundant 10BaseF	
RS485 + Multi-mode ST 100BaseFX	
RS485 + Multi-mode ST Redundant 100BaseFX	
RS485 + Single-mode SC 100BaseFX	
RS485 + Single-mode SC Redundant 100BaseFX	
RS485 + 10/100 BaseT	
RS485 + Single-mode ST 100BaseFX	
RS485 + Single-mode ST Redundant 100BaseFX	
No Software Options	
Ethernet Global Data (EGD)	
EC 61850	
Ethernet Global Data (EGD) + IEC 61850	
Horizontal (19" rack) - Standard	
Horizontal (19" rack) - Harsh Environment Coating	
Vertical (3/4 size) - Standard	
Vertical (3/4 size) - Harsh Environment Coating	
English	
English with additional 4 small and 12 large programmable pushbuttons	
Chinese	
Chinese with additional 4 small and 12 large programmable pushbuttons	
French	
French with additional 4 small and 12 large programmable pushbuttons	
Russian	
Russian with additional 4 small and 12 large programmable pushbuttons	
125 / 250 V AC/DC	
125/250 V AC/DC with redundant 125/250 V AC/DC	
24 - 48 V (DC only)	
24 - 48 V (DC only) with redundant 24 - 48 V (DC only)	
Standard 4CT/4VT	
Sensitive Ground 4CT/4VT	
Standard 8CT	
Sensitive Ground 8CT	
No module	
4 Solid State (No Monitoring) MOSFET Outputs	
4 Solid State (Voltage w/opt Current) MOSFET Outputs	
4 Solid State (Current w/opt Voltage) MOSFET Outputs	
16 Digital Inputs with Auto-Burnish	
14 Form-A (No Monitoring) Latchable Outputs	
8 Form-A (No Monitoring) Outputs	
2 Form-A (Voltage w/ opt Current) & 2 Form-C Outputs, 8 Digital Inputs	
2 Form-A (Voltage w/ opt Current) & 4 Form-C Outputs, 4 Digital Inputs	
8 Form-C Outputs	
16 Digital Inputs	
4 Form-C Outputs, 8 Digital inputs	
8 Fast Form-C Outputs	
4 Form-A (Voltage w/ opt Current) Outputs, 8 Digital Inputs	
6 Form-A (Voltage w/ opt Current) Outputs, 4 Digital Inputs	
4 Form-C & 4 Fast Form-C Outputs	
2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs	
2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs	
4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs	
6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs	
2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs	
2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs	
4 Form-A (No Monitoring) Outputs, 8 Digital Inputs	
6 Form-A (No Monitoring) Outputs, 4 Digital Inputs	
4 dcmA Inputs, 4 dcmA Outputs	
8 RTD Inputs	
4 RTD Inputs, 4 dcmA Outputs	
4 dcmA Inputs, 4 RTD Inputs	
8 dcmA Inputs	
820 nm, multi-mode, LED, 1 Channel	
1300 nm, multi-mode, LED, 1 Channel	
1300 nm, single-mode, ELED, 1 Channel	
1300 nm, single-mode, LASER, 1 Channel	
Channel 1 - G.703, Channel 2 - 820 nm, multi-mode	
Channel 1 - G.703, Channel 2 - 1300 nm, multi-mode	
Channel 1 - G.703, Channel 2 - 1300 nm, single-mode ELED	
820 nm, multi-mode, LED, 2 Channels	
1300 nm, multi-mode, LED, 2 Channels	
1300 nm, single-mode, ELED, 2 Channels	
1300 nm, single-mode, LASER, 2 Channels	
Channel 1 - RS422; Channel 2 - 820 nm, multi-mode, LED	
Channel 1 - RS422; Channel 2 - 1300 nm, multi-mode, LED	
Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, ELED	
Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, LASER	
Channel 1 - G.703, Channel 2 - 1300 nm, single-mode Laser	
G.703, 1 Channel	
G.703, 2 Channels	
RS422, 1 Channel	
RS422, 2 Channels	
1550 nm, single-mode, LASER, 1 Channel	
1550 nm, single-mode, LASER, 2 Channels	
Channel 1 - RS422; Channel 2 - 1550 nm, single-mode, LASER	
Channel 1 - G.703, Channel 2 - 1550 nm, Single-mode Laser	
IEEE C37.94, 820 nm, multimode, LED, 1 Channel	
IEEE C37.94, 820 nm, multimode, LED, 2 Channel	
C37.94SM, 1300nm Singlemode, ELED, 1 Channel Single mode	
C37.94SM, 1300nm Singlemode, ELED, 2 Channel Single mode	
Biphase, 1 Channel	
Biphase, 2 Channel	

*redundant power supply only available in horizontal unit
 *if redundant chosen, must be same type Maximum 2 per chassis

Accessories: Interactive UR Training CD-ROM available. Visit www.GEMultilin.com/trainingcd to order.

Ordering Note: This order code is valid for the latest version of UR hardware and firmware version 4.0 and later. The older hardware and previous firmware versions are still available and may be ordered through the usual channels. In addition, upgrade kits are available for users who wish to take advantage of the features in the newer models.
 Please see the GE Multilin On-Line Store (www.GEMultilin.com/onlinestore) for the most up to date ordering information.

Protocol Note: IEC 61850 replaces UCA 2.0 as of UR firmware version 4.4. For applications requiring the original UCA 2.0 protocol, please specify the pre-v4.4 UR firmware version at the time of ordering.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 74538-C31-16

Date: Sun: 21/06 By: _____



Feeder protection, control, monitoring and metering in one integrated package.

KEY BENEFITS

- Unparalleled security/safety - Downed conductor detection
- Reliable Distributed Generation interconnection protection
- Dependable and Secure - Performance backed up by many years of field experience
- Cost effective and flexible access to information - Multiple communication options and protocols
- Breaker monitoring - Monitor breaker conditioning through analog I/O, rich metering, breaking arcing current, and trip counters
- Use high speed communications to reduce wiring and installation costs - Exchange inputs and outputs between relays to achieve relay-to-relay interaction
- Reduce installation space requirements through compact design - Multifunction device that integrates protection and control functions, programmable pushbuttons and status LEDs, and communication interfaces
- Maintenance cost savings and simplification - Modular construction, common hardware, reduced stock of spare parts, plug & play modules
- Application flexibility - Multiple I/O options, programmable logic (FlexLogic™), modularity, customize to specific requirements
- Reduce system event analyzing time and cost - Sequence of event reports, oscillography, datalogging, IRIG-B time synchronization
- Embedded IEC 61850 Protocol -No external protocol converter required

APPLICATIONS

- Primary protection for distribution feeders
- Stand-alone or component in automated substation control system
- Interlocking scheme on distribution level by means of Remote I/O features
- Throw over schemes (bus transfer scheme)
- Load shedding scheme based on frequency elements

FEATURES

Protection and Control

- Downed conductor detection - High impedance faults
- Phase, neutral, ground or sensitive ground and negative sequence IOCs and TOCs with directional control
- Sensitive directional power
- Breaker failure
- Breaker control
- Four-shot autorecloser with synchronism check
- Up to 80 digital input and 56 digital outputs
- Transducer I/Os (RTD, dcmA)
- Wattmetric zero-sequence directional function

Communications

- Networking options - Ethernet-fiber (optional redundancy), RS485, RS422, G.703, C37.94
- Multiple protocols - IEC 61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC 60870-5-104, Ethernet Global Data (EGD)
- Direct exchange of inputs/Outputs - Exchange of binary data between URs

Monitoring and Metering

- Metering - current, voltage, power, energy, frequency, voltage and current harmonics, demand (current, power)
- Oscillography - 64 samples/cycle, up to 64 records
- Event Recorder - 1024 time tagged events, with 0.5ms scan of digital inputs
- DataLogger - Up to 16 channels with user selectable sampling rate
- Fault Locator

User Interfaces and Programming

- Front panel display and keypad for local direct access, with an RS232 port for local PC access
- User programmable local display, LEDs and pushbuttons
- Customize protection and control functions with FlexLogic™, FlexCurves™, and FlexElements™
- Includes EnerVista LaunchPad - Simple relay setup and programming
- Multi-language support - French, Chinese, Russian option



GE Consumer & Industrial
Multilin

Protection and Control

The F60 Feeder Protection System provides feeder protection, control, monitoring and metering in an integrated, economical, and compact package. As part of the Universal Relay (UR) Family, the F60 features high performance protection, expandable I/O options, integrated monitoring and metering, high-speed communications, and extensive programming and configuration capabilities.

The F60 provides fast and deterministic execution of programmable logic necessary for substation automation applications. Graphical programming tools, supported by a library of logic components, make the F60 simple to use and configure.

Protection and control applications ideally suited for the F60 include:

- Primary protection for distribution feeders
- Automatic bus transfer schemes
- Load shedding scheme on distribution level
- High impedance fault detection in distribution systems.

The F60 has a wide range of protection elements that have many years of proven field experience. Protection and control features includes:

Downed Conductor (HI-Z) Protection

The HI-Z element, unique to GE Multilin, provides fast and reliable detection of faults caused by downed conductors. These types of faults cannot be detected by traditional overcurrent protection due to the low level of fault current. Unique field proven algorithms that incorporate artificial intelligence ensures dependable and secure operation, while also improving safety through faster detection of hazardous situations. This protection feature can also be used to detect arcing faults. Through testing and based on field data, the F60 has shown a high degree of security (90% of correctly declared high-impedance faults) and considerable dependability (60% detection rate).

Overcurrent Protection

IOC and TOC functions are available for phase, neutral and ground/sensitive ground currents. A variety of standard time curves are provided plus four user-programmable curves. The phase TOC elements also have a voltage-restrained feature, which can be used if necessary.

Sensitive Ground Input

The F60 CT/VT modules may be ordered with a sensitive ground current input, which provides ground fault protection on

high impedance grounded systems. This can be especially important when using a residual CT connection to detect ground faults.

Voltage Elements

The F60 includes the following voltage and frequency elements:

- Phase undervoltage/overvoltage elements (each element has three individual phase undervoltage/overvoltage components)
- Auxiliary undervoltage/overvoltage element
- Neutral overvoltage element

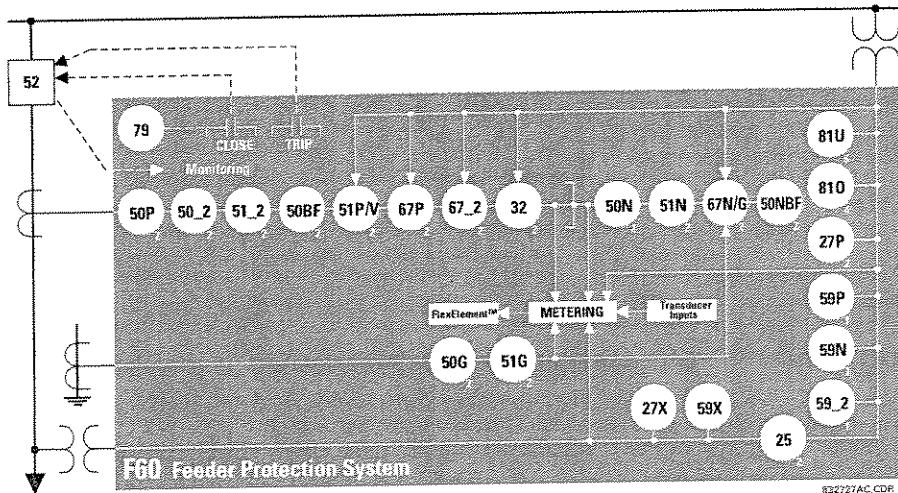
Frequency Elements

The F60 offers four overfrequency elements and six identical underfrequency elements that can be used for load-shedding.

Frequency Rate of Change Protection

Use the four frequency rate of change (df/dt) elements included in the F60 to provide protection against system disturbances through load shedding and to provide anti-islanding protection. These elements monitor the speed by which the frequency changes in any direction, through voltage, current and frequency supervision.

Functional Block Diagram



ANSI DEVICE NUMBERS AND FUNCTIONS

DEVICE NUMBER	FUNCTION
25 (2)	Synchrocheck
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Sensitive Directional Power Breaker Failure
50BF/50BN/51	Disturbance Detector
50G (2)	Ground Instantaneous Overcurrent
50N (2)	Neutral Instantaneous Overcurrent
50P (2)	Phase Instantaneous Overcurrent
50_2 (2)	Negative Sequence Instantaneous Overcurrent
51G (2)	Ground Time Overcurrent
51N (2)	Neutral Time Overcurrent
51P (2)	Phase Time Overcurrent
51_2 (2)	Negative Sequence Time Overcurrent
52	AC Circuit Breaker
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
67N (2)	Neutral Directional Overcurrent
67P (2)	Phase Directional Overcurrent
67_2 (2)	Negative Sequence Directional Overcurrent
79	Automatic Recloser
81O (4)	Overfrequency
81U (6)	Underfrequency

Sensitive Directional Power

The two-stage element responds to three-phase active power and is designed for reverse power and low forward power applications for synchronous machines or interconnections involving co-generation. Adjustable characteristic angles and minimum operating power offer a variety of operating characteristics.

Cold Load Pickup

This feature can change protection element setting groups when a cold load condition is expected to occur. A cold load condition can be caused by a prolonged outage of the load, by opening of the circuit breaker, or by a loss of supply even if the breaker remains closed. Two identical cold load pickup elements are provided in the F60.

Autorecloser

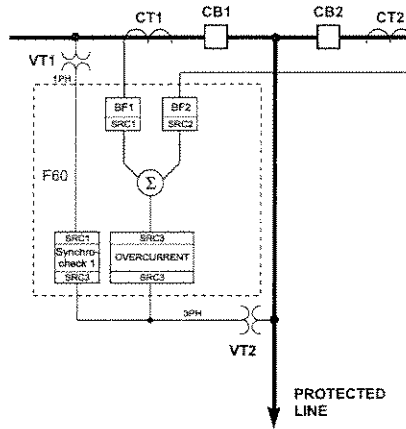
An autorecloser is provided for use with distribution lines in three-pole tripping schemes. Up to four selectable recloser "shots" are possible prior to locking out.

Breaker Failure

The breaker failure function determines if a breaker that was signaled to trip has not cleared a fault within a definite time, so further tripping action must be performed. The F60 provides the required current source inputs, digital inputs and outputs, and elements to perform two independent breaker failure functions. Initiation and blocking is done via input contacts or external communications. Use the F60 to carry out full independent breaker failure protection over the breakers associated to the line when connected to a substation with a breaker-and-a-half or ring bus arrangement.

Multi-Breaker Configurations

The F60 supports multi-breaker busbar configurations such as breaker-and-a-half or ring bus arrangements. Up to 2 CTs can be brought in individually and summed up at each terminal. The design provides secure operation during external faults with possible CT saturation.



F60 breaker-and-a-half scheme example

Synchronism Check

The synchrocheck elements are typically used at locations where the two parts of the system are interconnected through at least one other point in the system, which are to be joined by the closure of one or more circuit breakers. The F60 provides the required voltage source inputs, digital inputs and outputs, and elements to monitor differences in voltage magnitudes, phase angles, and frequencies to perform synchronism check across two breakers. Use the F60 to carry out full independent control over the breakers associated to the line, when connected to a substation with a breaker-and-a-half or ring bus arrangement.

Breaker Control

The relay provides for control of one or two breakers from faceplate pushbuttons, remote communications or contact inputs. A breaker pole discrepancy is included in the breaker control scheme. Breaker position is indicated by LEDs on the faceplate.

User-Definable Protection Functions

Sixteen FlexElements™ can be programmed to respond to any quantity measured by the relay (phase, ground and sequence currents and voltages, power, frequency, power factor, etc.). The element responds to variations in its input signal. Applications could include: positive/negative sequence overcurrent, negative sequence overvoltage, overpower, low power factor, temperature differential, frequency rate-of-change and more.

CTs and VTs

The F60 is configurable to accommodate various breaker protection applications. A CT module with sensitive ground input is also available to provide ground fault protection on high-impedance grounded systems. A high impedance fault detection module is also available to provide fast and reliable detection of faults caused by downed conductors.

Digital I/O

Up to 80 digital inputs (with utility voltage rating up to 250V), and up to 56 digital outputs, are available and can be used to monitor and control a wide range of auxiliary equipment found within a substation or other protection application. Types of digital I/O cards include Trip rated Form-A, Form-C, Fast Form C, Latching and Solid State with or without dc voltage and current monitoring. Mechanically latching outputs can be used to develop secure interlocking applications and replace mechanical switches. All digital I/O have activation speeds of less than 4ms and both wet and dry contacts are supported.

Transducer I/O

RTDs and dcmA cards are available to monitor system parameters such as temperature, vibration, pressure, wind speed, and flow. Analog outputs can be used for hardwired connections from the Controller to a SCADA system, to a programmable logic controller (PLC), or to other user interface devices (eg. panel display).

Remote I/O

The remote I/O feature provides a means of sharing digital point state information between URs or other IEC 61850 compliant IEDs or controllers. The remote outputs interface seamlessly to the remote inputs of other UR devices via the IEC 61850 GSSE and GOOSE messaging (or UCA 2.0 protocol in earlier versions of the UR). Use secure peer-to-peer communications in dual-token-ring arrangements to develop complex schemes in distributed logic and I/Os.

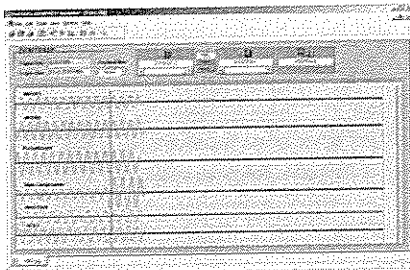
Monitoring and Metering

The F60 includes high accuracy metering and recording for all ac signals. Voltage, current, power, frequency, power factor, energy, harmonics and THD metering are built into the relay as a standard feature. Current parameters are available as total waveform RMS magnitude, or as fundamental frequency RMS magnitude and angle (phasor).

Diagnostics features such as oscillography, event recording, and data logger, combined with EnerVista software tools, significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

Oscillography

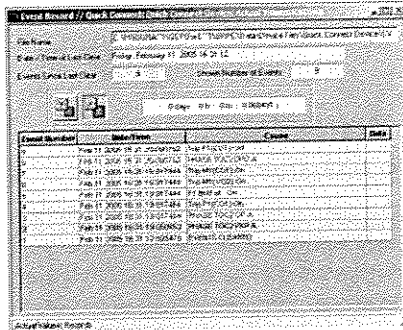
Configure up to 64 oscillography channels to monitor any physical I/O point or internal digital and analog variables. The waveform traces and digital states provide a visual display of power system and operational data captured during specified triggered events. Sampling rates are up to 64 samples/cycle and 64 fault records can be stored on the unit.



Analyze faults using Waveforms with both Analog and Digital status information

Event Recorder

Capture the last 1024 events, with 0.5ms scan of digital inputs, to provide SOE recorder functionality. Consolidate the event records from multiple devices using EnerVista software tools and use the IRIG-B time synchronization feature to synchronize all events across a system of URs for even more accurate analysis and troubleshooting.



Determine the Tripping Sequence of your entire Protection Scheme

DataLogger

Profile operational data with up to 16 data logger channels with a user configurable sampling rate, ranging from 1 second to 1 hour. All data is stored in non-volatile memory so that information is retained even when power to the unit is lost. All recorded data can be easily retrieved via EnerVista for viewing and analysis.

Breaker Condition Monitoring

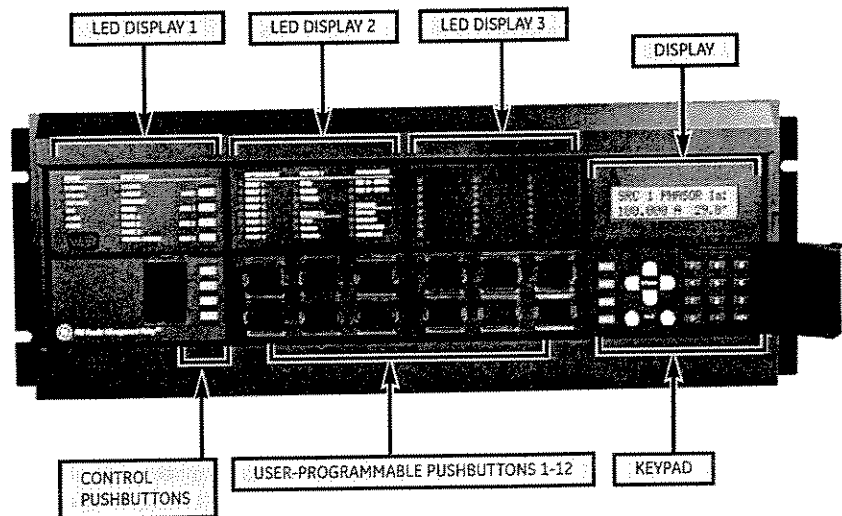
With the ability to track the per-phase wear (arc) on the breaker contacts, available per CT bank, monitor breaker auxiliary systems through analog I/O, and monitor breaker operations through digital counters, you can use the F60 to perform basic breaker conditioning monitoring functions. The F60 can issue early warnings, or even perform operations based on maximum thresholds, as dictated by the breaker manufacturer. In particular, the breaker arcing current (I2t) measurement for each phase is available locally and remotely, and can be stored in an oscillography file or data logger.

Trip Circuit Monitoring

DC battery voltage can be monitored across open output contacts, triggering an alarm when the voltage becomes virtually zero. A FlexLogic™ flag is set when the supervised circuit is interrupted. Current sensors in series with each trip contact can provide a series seal-in function.

Fault Reports and Locator

The F60 relay supports one fault report and an associated fault locator per CT bank to a maximum of 5. The fault report stores data pertinent to an event that is triggered. Both the signal source and trigger condition are user-definable. The fault locator feature provides the distance to the fault location.



Best in class human machine interface (HMI), with display, full numerical keypad, and user-programmable pushbuttons

User Interface and Programming

The F60 front panel provides extensive local HMI capabilities. The local display is used for monitoring, status messages, fault diagnosis, and controller configuration. User configurable messages that combine text with live data, can be displayed when user defined conditions are met. A keypad is also provided for easy access and changes to the relay settings.

Replace external indicator lights with the 48 user programmable LEDs to display key status information. An additional 14 pre-programmed LEDs and custom LED labeling are available.

An RS232 port for local PC access is provided on the front panel for convenient access to the relay through EnerVista LaunchPad. The Ethernet port allows for even easier access to the relay over the network.

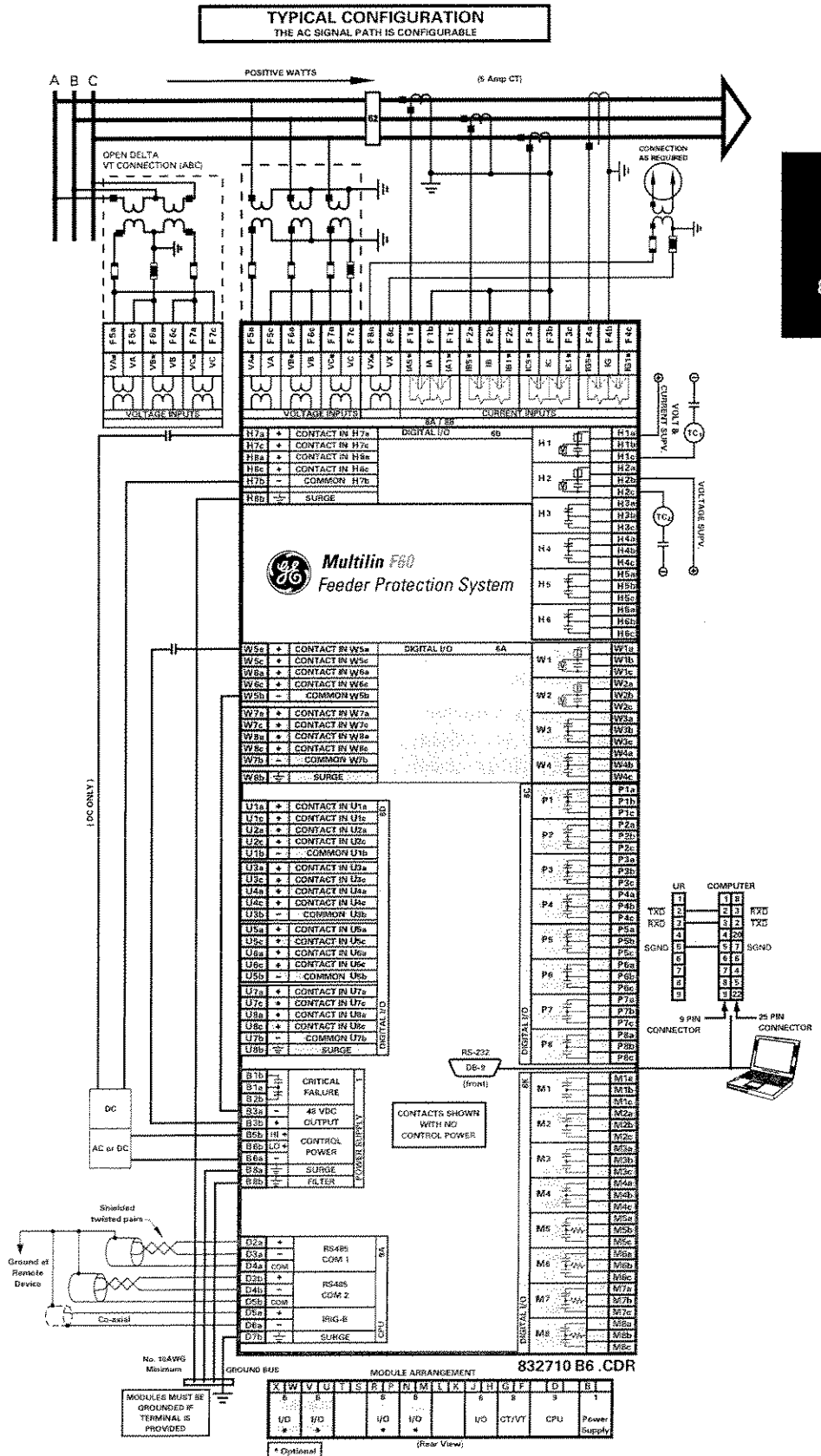
User-Programmable Push Buttons

Perform manual control, operate breakers, or lock out functions, with the user-programmable pushbuttons. Replace external switches and bi-stable relays by using mechanically latching outputs controlled from the pushbuttons. The F60 can be ordered with 7 user programmable control pushbuttons (3 standard, 4 optional) and 12 large user-programmable push buttons (optional). The control action of each push button is fully programmable and its operation can be logged directly in the Sequence of Events recorder to enhance troubleshooting. The push buttons can be easily labeled for added clarity of functionality.

Multi-Language

The F60 supports multiple languages. French, Chinese, Russian language options are available on the local display, front panel, and EnerVista setup software, as well as the product instruction manual. Easily switch between English and an additional user selectable language on the local display.

Typical Wiring



FlexLogic™, FlexElements™, FlexCurves™

The F60 comes with powerful configuration and programming tools. These include:

- FlexLogic™: simplifies the programming and use of the F60 and enables powerful but flexible protection and control solutions
- FlexElements™: user-definable protection functions
- FlexCurves™: define additional custom curve shapes

Multiple Settings Groups

Six separate setting groups can be stored in the F60's non-volatile memory. An easy to use and fully programmable mechanism is provided to instantly switch the active settings. Multiple settings groups apply to all the protection elements.

Communications

The F60 supports a wide range of communication mediums and protocols compatible with new and existing communication infrastructures.

Networking options include Ethernet-Fiber, with optional redundancy, and RS485 interfaces. With the advent of high-speed relay-to-relay communication LANs, performing inter-device control signaling via remote I/O over the LAN can eliminate a great deal of inter-device control wiring.

Protocols supported by the F60 include IEC61850, DNP 3.0, Modbus RTU, Modbus TCP/IP, and IEC60870-5-104. These protocols make it easy to connect to a utility automation system and are integrated into the F60, removing the need for external protocol converter devices.

Interoperability With Embedded IEC 61850 Protocol

IEC 61850 is the new international standard for information exchange and interoperability between intelligent devices within a substation. Use the F60 with IEC 61850 to lower the costs and simplify the engineering, commissioning, operating, and maintenance associated with substation protection and control applications. IEC61850 is built on over 7 years of GE leadership in UCA 2.0 implementation.

IEC 61850 allows for the seamless connection of IEDs from multiple vendors. In addition to device interoperability, these protocols are designed to control the substation via a LAN instead of through discrete wiring to an RTU. Peer-to-peer communication over Ethernet enables distributed control with several IEDs and eliminates the need for an RTU to remote SCADA master. High-speed message transfer eliminates the need for large and costly hard-wired interconnection.

Direct I/O Messaging

This feature allows for the exchange of binary information between a number of UR IEDs over a dedicated fiber (single or multimode), RS422, G.703 or C37.94 interface. No switching equipment is required as the IEDs are connected directly in a ring or redundant (dual) ring configuration.

EnerVista™

The EnerVista™ Suite is an industry leading set of software programs that will simplify every aspect of using the F60 relay. Tools to instantly monitor the status of the substation equipment and view the magnitude of any power quantities measured by the F60 relay are available. Also, the ability to analyze the cause of any faults using the powerful COMTRADE and the Sequence of Event viewers in the EnerVista UR Setup program is included with each relay.

EnerVista™ LaunchPad

EnerVista™ LaunchPad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining all GE Multilin products. Also included is a document archiving system that will ensure that all manuals, application notes, and other necessary documentation are always up-to-date and available when needed.

Viewpoint Monitoring

Viewpoint Monitoring is a software application that will provide Monitoring, Control, Trending, Alarming and Fault Data Recording functionality needed for substation applications. This easy to use program can be configured to give complete visibility, control, and automated retrieving and

archiving of all Event Records and Waveforms files from GE Multilin devices in minutes.

Viewpoint Engineer

Viewpoint Engineer is a set of tools that will reduce the amount of time required to program, test and commission UR relays. The Graphical FlexLogic™ Editor will improve efficiency in programming UR's by combining the creating of control diagrams, documenting of logic, and programming of relays into one easy step. The Real-Time FlexLogic™ Analyzer will then simply commissioning and troubleshooting by displaying the status of each part of the equations as they change state.

Viewpoint Maintenance

Viewpoint Maintenance is a set of tools designed specifically for individuals responsible for diagnosing faults, maintaining and troubleshooting GE Multilin devices after commissioning. With a single click of the mouse, this software provides users with a simplified report that shows the cause of any power system faults or problems. This software will also enhance the security of the relay by providing reports that will document any changes have been made to the configuration of the devices.

EnerVista™ Integrator

EnerVista™ Integrator is the tool to use to send data that is measured by GE Multilin devices to new or existing HMI, SCADA, or DCS system. This software can greatly reduce the time required to integrate GE Multilin devices with the Energy Management or Plant Operations Systems. Also included is a tool that will detect any new Events or Waveform files created by all the relays and automatically save them into a permanent historical archive, which will give a station wide Sequence of Event record.

F60 Guideform Specifications

For an electronic version of the F60 guideform specifications, please visit: www.GEMultilin.com/specs, fax your request to 905-201-2098 or email to literature.multilin@ge.com.

www.GEMultilin.com

Ordering

HCH
F60 - NDO - HCH - FBG - HLT - MGD - PXX - UXX - WXX

Base Unit CPU	Software Options	Mount / Coating	User Interface	Power Supply (redundant power supply only available in horizontal units)	CT/VT DSP	Digital I/O	Transducer I/O (select a maximum of 3)	Inter-Relay Communications (use U slot if redundant power supply option is chosen)
F60	00 01 03 04	H A V B	C P A B D G R S	H H L L	BF 8G 8H 8J	XX 4A 4B 4C 4D 4L 67 6A 6B 6C 6D 6E 6F 6G 6H 6K 6L 6M 6N 6P 6R 6S 6T 6U 5A 5C 5D 5E 5F	5A 5C 5D 5E 5F	7A 7B 7C 7D 7E 7F 7G 7H 7I 7J 7K 7M 7N 7P 7Q 7R 7S 7T 7W 73 74 75 76 77 2A 2B 2E 2F

For Full Sized Horizontal Mount
 For Reduced Size Vertical Mount

Base Unit
 RS485 + RS485
 RS485 + Multi-mode ST 10BaseF
 RS485 + Multi-mode ST Redundant 10BaseF
 RS485 + Multi-mode ST 100BaseFX
 RS485 + Multi-mode ST Redundant 100BaseFX
 RS485 + Single-mode SC 100BaseFX
 RS485 + Single-mode SC Redundant 100BaseFX
 RS485 + 10/100 BaseT
 RS485 + Single-mode ST 100BaseFX
 RS485 + Single-mode ST Redundant 100BaseFX
 No Software Options
 Ethernet Global Data
 IEC 61850
 Ethernet Global Data (EGD) + IEC 61850
 Horizontal (19" rack) - Standard
 Horizontal (19" rack) - Harsh Environment Coating
 Vertical (3/4 size) - Standard
 Vertical (3/4 size) - Harsh Environment Coating

English
 English with additional 4 small and 12 large programmable pushbuttons
 Chinese
 Chinese with additional 4 small and 12 large programmable pushbuttons
 French
 French with additional 4 small and 12 large programmable pushbuttons
 Russian
 Russian with additional 4 small and 12 large programmable pushbuttons
 125 / 250 V AC/DC
 125/250 V AC/DC with redundant 125/250 V AC/DC power supply
 24 - 48 V (DC only)
 24 - 48 V (DC only) with redundant 24 - 48 V (DC only)
 Standard 4CT/4VT
 4CT/4VT (1 Sensitive Ground)
 Standard 8CT
 8CT (2 Sensitive Ground)
 HI-Z 4CT (high impedance fault detection)
 No module
 4 Solid State (No Monitoring) MOSFET Outputs
 4 Solid State (Voltage w/opt Current) MOSFET Outputs
 4 Solid State (Current w/opt Voltage) MOSFET Outputs
 16 Digital Inputs with Auto-Burnish
 14 Form-A (No Monitoring) Latchable Outputs
 8 Form-A (No Monitoring) Outputs
 2 Form-A (Voltage w/ opt Current) & 2 Form-C Outputs, 8 Digital Inputs
 2 Form-A (Voltage w/ opt Current) & 4 Form-C Outputs, 4 Digital Inputs
 8 Form-C Outputs
 16 Digital Inputs
 4 Form-C Outputs, 8 Digital inputs
 8 Fast Form-C Outputs
 4 Form-A (Voltage w/ opt Current) Outputs, 8 Digital inputs
 6 Form-A (Voltage w/ opt Current) Outputs, 4 Digital inputs
 4 Form-C & 4 Fast Form-C Outputs
 2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs
 2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs
 4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs
 6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital inputs
 2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs
 2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs
 4 Form-A (No Monitoring) Outputs, 8 Digital Inputs
 6 Form-A (No Monitoring) Outputs, 4 Digital Inputs
 4 dcmA Inputs, 4 dcmA Outputs
 8 RTD Inputs
 4 RTD inputs, 4 dcmA Outputs
 4 dcmA Inputs, 4 RTD Inputs
 8 dcmA Inputs
 820 nm, multi-mode, LED, 1 Channel
 1300 nm, multi-mode, LED, 1 Channel
 1300 nm, single-mode, ELED, 1 Channel
 1300 nm, single-mode, LASER, 1 Channel
 Channel 1 - G.703, Channel 2 - 820 nm, multi-mode
 Channel 1 - G.703, Channel 2 - 1300 nm, multi-mode
 Channel 1 - G.703, Channel 2 - 1300 nm, single-mode ELED
 820 nm, multi-mode, LED, 2 Channels
 1300 nm, multi-mode, LED, 2 Channels
 1300 nm, single-mode, ELED, 2 Channels
 1300 nm, single-mode, LASER, 2 Channels
 Channel 1 - RS422; Channel 2 - 1300 nm, multi-mode, LED
 Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, ELED
 Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, LASER
 Channel 1 - G.703, Channel 2 - 1300 nm, single-mode Laser
 G.703, 1 Channel
 G.703, 2 Channels
 RS422, 1 Channel
 RS422, 2 Channels
 1550 nm, single-mode, LASER, 2 Channels
 Channel 1 - RS422, Channel 2 - 1550 nm, single-mode, LASER
 Channel 1 - G.703; Channel 2 - 1550nm, Single-mode LASER
 IEEE C37.94, 820 nm, multimode, LED, 1 Channel
 IEEE C37.94, 820 nm, multimode, LED, 2 Channel
 C37.94SM, 1300nm single-mode, ELED, 1 channel single-mode
 C37.94SM, 1300nm single-mode, ELED, 2 channel single-mode
 Biphase, 1 Channel
 Biphase, 2 Channel

Ordering Note: This order code is valid for the latest version of UR hardware and firmware version 4.0 and later. The older hardware and previous firmware versions are still available and may be ordered through the usual channels. In addition, upgrade kits are available for users who wish to take advantage of the features in the newer models.

Please see the GE Multilin On-Line Store (www.GEMultilin.com/onlinestore) for the most up to date ordering information.

Protocol Note: IEC 61850 replaces UCA 2.0 as of UR firmware version 4.4. For applications requiring the original UCA 2.0 protocol, please specify the pre-v4.4 UR firmware version at the time of ordering.

available since version 2.4
 available since version 2.4
 available since version 2.4

available since version 2.4
 available since version 2.4
 available since version 2.4

available since version 2.60

available since version 3.4
 available since version 3.4

Accessories: Interactive UR Training CD-ROM available. Visit www.GEMultilin.com/trainingcd to order.



Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED _____

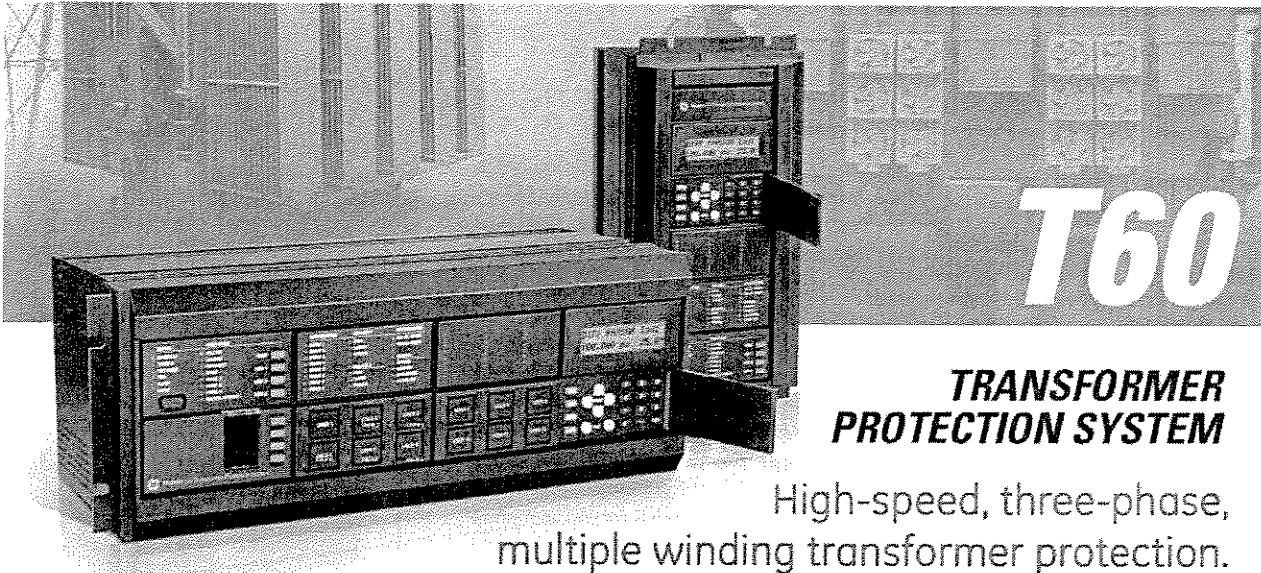
REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 710538-031-16

Date: June 21/06 By: [Signature]



T60

TRANSFORMER PROTECTION SYSTEM

High-speed, three-phase, multiple winding transformer protection.

KEY BENEFITS

- Comprehensive transformer protection - Monitor analog and RTD inputs, and up to 4 three-phase current inputs (four restraints); secure operation with multiple breaker applications
- Enhanced security by applying dual-principle (differential and directional) and CT saturation detection
- Dependable - Best in class patented solution, works with only 2ms of saturation-free currents
- Reduce installation space requirements through compact design - Multifunction device that integrates protection and control functions, programmable pushbuttons and status LEDs, and communication interfaces
- Maintenance cost savings and simplification - Modular construction, common hardware, reduced stock of spare parts, plug & play modules
- Use high speed communications to reduce wiring and installation costs - Exchange inputs and outputs between relays to achieve relay-to-relay interaction
- Cost effective and flexible access to information - Multiple communication options and protocols
- Application flexibility - Multiple I/O options, programmable logic (FlexLogic™), modularity, customize to specific requirements
- Breaker monitoring - Monitor breaker conditioning through analog I/O, rich metering, breaking arcing current, and trip counters
- Reduce system event analyzing time and cost - Sequence of event reports, oscillography, datalogging, IRIG-B time synchronization
- Embedded IEC 61850 Protocol - No external protocol converter required

APPLICATIONS

- Reliable primary and backup protection for small to large three-phase transformers and autotransformers
- Reactors, split phase and phase angle regulating
- Transformers with windings in a ring bus or breaker-and-a-half configuration
- Stand-alone or component in automated substation control system

FEATURES

Protection and Control

- Dual slope, dual breakpoint differential restraint characteristic
- Percent and Instantaneous differential protection
- 2nd harmonic inrush inhibit
- Overexcitation
- Restricted ground fault
- Up to 80 digital input and 56 digital outputs
- Transducer I/Os (RTD, dc mA)

Communications

- Networking options - Ethernet-fiber (optional redundancy), RS485, RS422, G.703, C37.94
- Multiple protocols - IEC 61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC 60870-5-104, Ethernet Global Data (EGD)
- Direct I/O - Exchange of binary data between URs

Monitoring and Metering

- 2nd to 25th harmonic on phase currents and THD
- Metering - current, voltage, power, energy, frequency, current harmonics, demand
- Oscillography - 64 samples/cycle, up to 64 records
- Event Recorder - 1024 time tagged events, with 0.5ms scan of digital inputs
- DataLogger - Up to 16 channels with user selectable sampling rate
- User Programmable Fault Reports

User Interface and Programming

- Front panel display and keypad for local direct access, with an RS232 port for local PC access
- User programmable local display, LEDs and pushbuttons
- Customize protection and control functions with FlexLogic™, FlexCurves™, and FlexElements™
- Includes EnerVista LaunchPad - Simple relay setup and programming
- Multi-language support - French, Chinese, Russian options



GE Consumer & Industrial
Multilin

Protection and Control

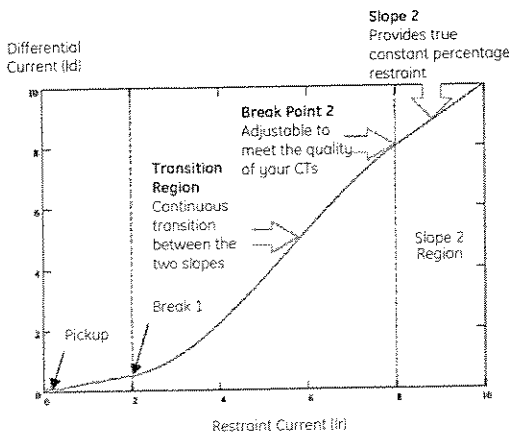
The T60 Transformer Protection System is a three-phase, multiple winding transformer relay for the primary protection and management of any size power transformer. The T60 includes advanced features such as automatic or user definable magnitude reference winding selection for CT ratio matching, and automatic phase shift compensation for any transformer windings configuration. Advanced algorithms enable application of the relay to transformers with in-zone cable connections or other in-zone grounded devices.

As part of the Universal Relay (UR) Family, the T60 provides superior protection and control that includes:

Percent Differential Protection

The T60 provides enhanced security by including both restrained and unrestrained (instantaneous) differential protection. The Percent Differential element is based on a configurable dual-breakpoint / dual-slope differential restraint characteristic with true percentage slope and smooth transition between slopes, with inrush and overexcitation inhibits. Maximum winding current is used as a restraining signal for better through fault stability under CT saturation conditions. Due to its extreme flexibility, which includes automatic or manual selection of the reference winding, forced zero-sequence removal for in-zone grounding points, and a CT ratio mismatch of up to 32:1 between terminals, the T60 is the ideal solution in a wide variety of transformer differential applications.

Operating Characteristic (I_d vs. I_r)



Dual Slope Percent Differential Characteristic

Harmonic Inrush Inhibit

The T60 provides excellent filtering capabilities for fundamental, 2nd, and 5th harmonics for differential currents. Used during magnetizing inrush conditions, the 2nd harmonic inhibit function is selectable in order to cover energization of different types of transformers. The percent second harmonic level is user definable and its function can be set to either traditional or adaptive mode. The adaptive mode maximizes the performance on internal faults and ensures security during inrush conditions even with weak second harmonics. With regards to harmonic inhibit, the T60 provides the following advanced features:

- A patented adaptive second harmonic inrush inhibit,
- Addresses applications with low level of the 2nd harmonic by applying per-phase, cross-phase or average harmonic inhibit (settable)
- Flexible application with customizable inhibit and supervision (FlexElements™, FlexLogic™)
- Unique equation for the restraining currents to ensure good performance on through faults

Overexcitation Inhibit

A fifth harmonic inhibit is integrated into percent differential function to protect for overexcitation conditions resulting from an increased V/Hz ratio. The overexcitation inhibit works on a per-phase basis and is user definable.

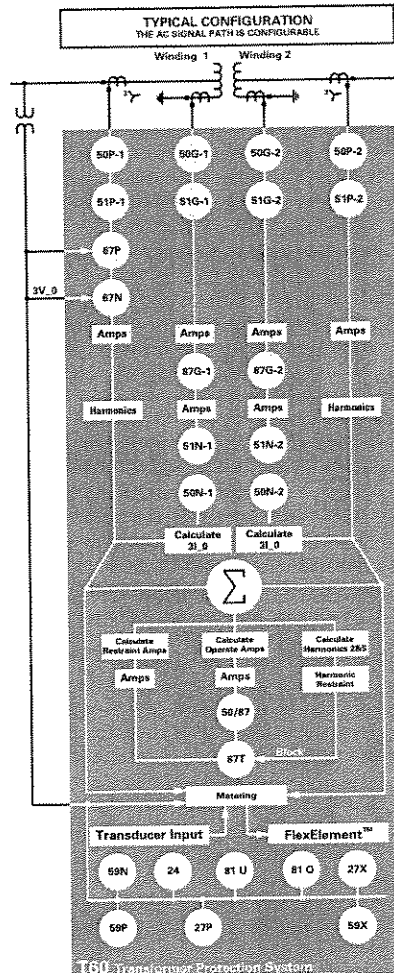
Instantaneous Differential

The Instantaneous Differential element acts as an instantaneous overcurrent element responding to the measured differential current magnitude (filtered fundamental frequency component) and applying a user-selectable pickup threshold. This element provides fast tripping on heavy internal faults.

Restricted Ground Fault (RGF)

RGF (also known as zero sequence differential) provides sensitive ground fault detection for low-magnitude fault currents. The T60 incorporates low-impedance RGF protection and uses novel algorithms to provide fast and sensitive protection while overcoming stability problems. Use the RGF to protect against ground faults close to the neutral and below sensitivity of the main differential protection.

Functional Block Diagram



ANSI DEVICE NUMBERS AND FUNCTIONS

DEVICE NUMBER	FUNCTION
24	Volts Per Hertz
27	Phase Undervoltage
27X	Auxiliary Undervoltage
50/87	Instantaneous Differential Overcurrent
50G	Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50P	Phase Instantaneous Overcurrent
51G	Ground Time Overcurrent
51N	Neutral Time Overcurrent
51P	Phase Time Overcurrent
59N	Neutral Overvoltage
59P	Phase Overvoltage
59C	Auxiliary Overvoltage
67N	Neutral Directional Overcurrent
67P	Phase Directional Overcurrent
81O	Overfrequency
81U	Underfrequency
87G	Restricted Ground Fault
87T	Transformer Differential

Backup Protection

In addition to current differential protection, the relay provides backup protection functions for phase and ground faults, as listed below:

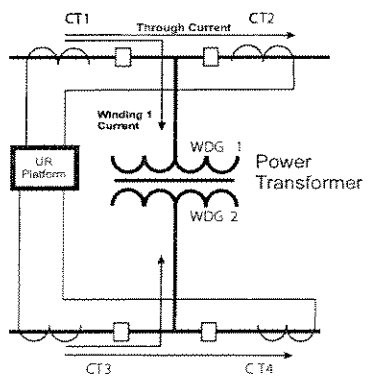
- **Overcurrent:** Instantaneous sub-cycle and time protection functions are provided for phase, ground, and neutral currents. A variety of standard time

curves including three IEEE, four IEC, four GEIAC, I^2t , definite time are provided plus four user-programmable curves.

- **Directional Overcurrent:** Phase directional elements use memory polarization. Neutral directional elements can work under zero-sequence voltage, ground current or dual polarization.
- **Voltage Protection:** The following voltage protection functions are included - undervoltage, overvoltage, neutral voltage, auxiliary undervoltage, auxiliary overvoltage and volts per hertz.
- **Frequency Elements:** Overfrequency and underfrequency elements are provided for high frequency or load shedding protection.
- **Remote Backup:** If a remote T60 relay issues a trip from one of its backup functions, it can send a transfer trip signal to another UR relays if such option is designated, through the unique Direct I/O functionality offered by the UR Family of products.
- **Dual Power Supply (Optional):** The T60 can be equipped with an optional redundant dual power supply for increased reliability in all critical protection applications.

Multi-Breaker Configurations

The T60 supports multi-breaker busbar configurations such as breaker-and-a-half or ring bus arrangements. The design provides secure operation during external faults with possible CT saturation.



Multi-Breaker application example

Monitoring and Metering

The metering functions of the T60 include true RMS and phasors for currents and voltages, symmetrical components, frequency, power, power factor, and energy.

The T60 also provides monitoring and metering of the differential and restraining currents, second and fifth harmonic content of the differential currents V/Hz ratio, harmonics from second to twenty-fifth, Total Harmonic Distortion (THD) and ground differential and restraint currents.

Use spare I/Os as SCADA interface for the monitoring of gas and oil relays, associated breakers and isolators, tap changer operation and more.

Diagnostics features such as oscillography, event recording, and data logger, combined with EnerVista software tools, significantly reduce analyzing time and simplify report generation in the event of a system fault.

Oscillography

Configure up to 64 oscillography channels to monitor any physical I/O point or internal digital and analog variables. The waveform traces and digital states provide a visual display of power system and operational data captured during specified triggered events. Sampling rates are up to 64 samples/cycle and 64 fault records can be stored on the unit.

Event Recorder

Capture the last 1024 events, with 0.5ms scan time of digital inputs, to provide SOE recorder functionality. Consolidate the event records from multiple devices using EnerVista software tools and use the IRIG-B time synchronization feature to synchronize all events across a system of URs for even more accurate analysis and troubleshooting.

DataLogger

Profile operational data with up to 16 data logger channels with a user configurable sampling rate, ranging from 1 second to 1 hour. All data is stored in non-volatile memory so that information is retained even when power to the unit is lost. All recorded data can be easily retrieved via EnerVista for viewing and analysis.

Transformer Condition Monitoring

Use the T60 as a tool for the implementation of a loss-of-life driven maintenance and emergency loading program. Take advantage of the following advanced features:

- Ability to monitor the hottest spot temperature
- Built in IEEE C37.92 compliant thermal model
- Aging factor and loss of life calculation
- Digital counters

The T60 can issue early warnings, or even perform operations based on maximum thresholds, as dictated by the transformer manufacturer.

User Interface and Programming

The T60 front panel provides extensive local HMI capabilities. The local display is used for monitoring, status messages, fault diagnosis, and controller configuration. User configurable messages that combine text with live data, can be displayed when user defined conditions are met. A keypad is also provided for easy access and changes to relay settings.

Replace external indicator lights with the 48 user programmable LEDs to display key status information. An additional 14 pre-programmed LEDs and custom LED labeling are available.

An RS232 port for local PC access is provided on the front panel for convenient access to the relay through EnerVista LaunchPad. The Ethernet port allows for even easier access to the relay over the network.

User-Programmable Push Buttons

Perform manual control, operate breakers, or lock out functions, with the user-programmable pushbuttons. Replace external switches and bi-stable relays by using mechanically latching outputs controlled from the pushbuttons. The T60 can be ordered with 7 user programmable control pushbuttons (3 standard, 4 optional) and 12 large user-programmable push buttons (optional). The control action of each push button is fully programmable and its operation can be logged directly in the Sequence of Events recorder to enhance troubleshooting. The push buttons can be easily labeled for added clarity of functionality.

Multi-Language

The T60 supports multiple languages. French, Chinese, Russian language options are available on the local display, front panel, and EnerVista setup software, as well as the product instruction manual. Easily switch between English and an additional user selectable language on the local display.

FlexLogic™, FlexElements™, FlexCurves™

The T60 comes with powerful configuration and programming tools. These include:

- FlexLogic™: simplifies the programming and use of the T60 and enables powerful but flexible protection and control solutions
- FlexElements™: user-definable protection functions
- FlexCurves™: define additional custom curve shapes

Multiple Settings Groups

Six separate setting groups can be stored in the T60's non-volatile memory. An easy to use and fully programmable mechanism is provided to instantly switch the active settings. Multiple settings groups apply to all the protection elements.

Communications

The T60 supports a wide range of communication mediums and protocols compatible with new and existing communication infrastructures.

Networking options include Ethernet-Fiber, with optional redundancy, and RS485 interfaces. With the advent of high-speed relay-to-relay communication LANs, performing inter-device control signaling via remote I/O over the LAN can eliminate a great deal of inter-device control wiring.

Protocols supported by the T60 include IEC61850, DNP 3.0, Modbus RTU, Modbus TCP/IP, and IEC60870-5-104. These protocols make it easy to connect to a utility automation system and are integrated into the T60, removing the need for external protocol converter devices.

Interoperability With Embedded IEC 61850 Protocol

IEC 61850 is the new international standard for information exchange and interoperability between intelligent devices within a substation. Use the T60 with IEC 61850 to lower the costs and simplify the engineering, commissioning, operating, and maintenance associated with substation protection and control applications. IEC61850 is built on over 7 years of GE leadership in IEC 61850.

IEC 61850 allows for the seamless connection of IEDs from multiple vendors. In addition to device interoperability, these protocols are designed to control the substation via a LAN instead of through discrete wiring to an RTU. Peer-to-peer communication over Ethernet enables distributed control with several IEDs and eliminates the need for an RTU to remote SCADA master. High-speed message transfer eliminates the need for large and costly hard-wired interconnection.

Direct I/O Messaging

This feature allows for the exchange of binary information between a number of UR IEDs over a dedicated fiber (single or multimode), RS422, G.703 or C37.94 interface. No switching equipment is required as the IEDs are connected directly in a ring or redundant (dual) ring configuration.

EnerVista™

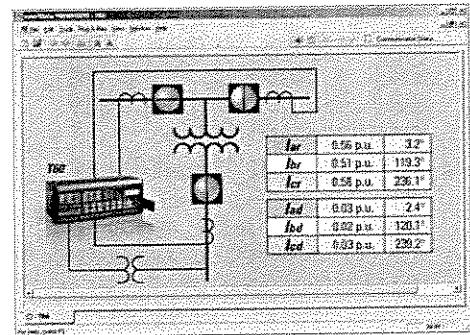
The EnerVista™ Suite is an industry leading set of software programs that will simplify every aspect of using the T60 relay. Tools to instantly monitor the status of the Transformer and view the magnitude of any power quantities measured by the T60 relay are available. Also, the ability to analyze the cause of any faults using the powerful COMTRADE and the Sequence of Event viewers in the EnerVista UR Setup program is included with each relay.

EnerVista™ LaunchPad

EnerVista™ LaunchPad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining all GE Multilin products. Also included is an archiving system that will ensure that all manuals, application notes, and other necessary documentation are always up-to-date and available when needed.

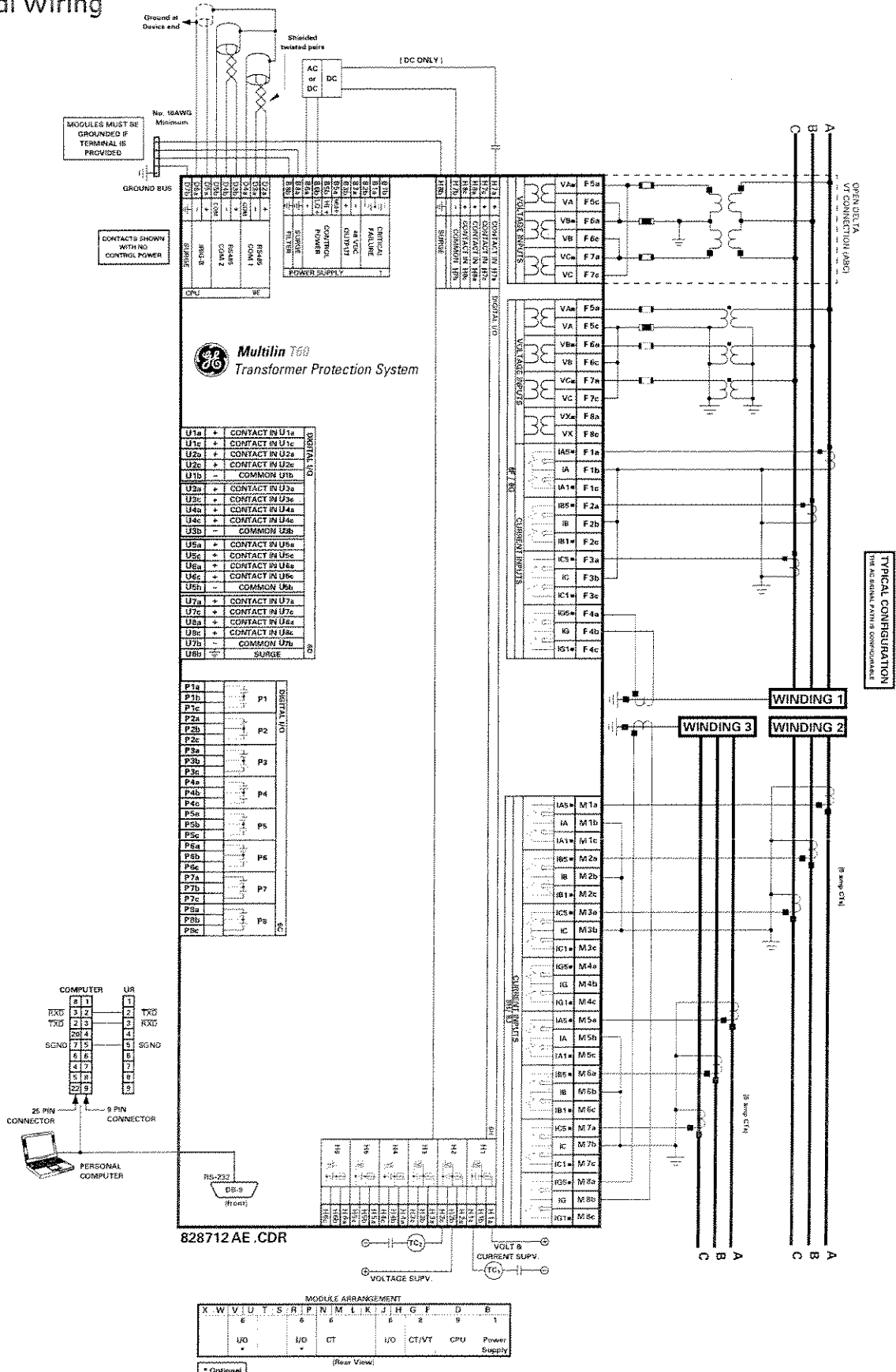
Viewpoint Monitoring

Viewpoint Monitoring is a software application that will provide Monitoring, Control, Trending, Alarming and Fault Data Recording functionality needed for substation applications. This easy to use program can be configured to give complete visibility, control, and automated retrieving and archiving of all Event Records and Waveforms files from GE Multilin devices in minutes.



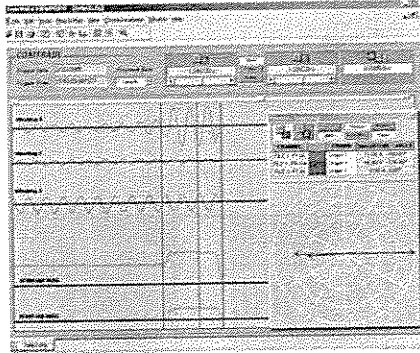
Identify the status of the transformer and monitor all measured power levels

Typical Wiring



Viewpoint Engineer

Viewpoint Engineer is a set of tools that will reduce the amount of time required to program, test and commission UR relays. The Graphical FlexLogic™ Editor will improve efficiency in programming UR's by combining the creating of control diagrams, documenting of logic, and programming of relays into one easy step. The Real-Time FlexLogic™ Analyzer will then simply commissioning and troubleshooting by displaying the status of each part of the equations as they change state.



Automatically retrieves and archives all Waveforms and Event Records from GE Multilin devices

T60 Guideform Specifications

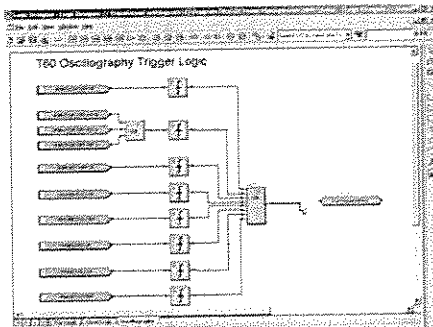
For an electronic version of the T60 guideform specifications, please visit: www.GEMultilin.com/specs, fax your request to 905-201-2098 or email to literature.multilin@ge.com.

Guideform Specifications
 Available Online or
 from your Sales
 Representative.
www.GEMultilin.com

Refer to the
UR Family
 section
 for more details
 on features
 and specifications

Accessorize your T60

www.GEMultilin.com



Create the control and automation logic in the IEC1131 graphical logic editor

Viewpoint Maintenance

Viewpoint Maintenance is a set of tools designed specifically for individuals responsible for diagnosing faults, maintaining and troubleshooting GE Multilin devices after commissioning. With a single click of the mouse, this software provides users with a simplified report that shows the cause of any power system faults or problems. This software will also enhance the security of the relay by providing reports that will document any changes have been made to the configuration of the devices.

EnerVista™ Integrator

EnerVista™ Integrator is the tool to use to send data that is measured by GE Multilin devices to new or existing HMI, SCADA, or DCS system. This software can greatly reduce the time required to integrate GE Multilin devices with the Energy Management or Plant Operations Systems. Also included is a tool that will detect any new Events or Waveform files created by all the relays and automatically save them into a permanent historical archive, which will give a station wide Sequence of Event record.

Ordering T60-N00-HCH-FEG-M67-M6D-FXX-WXX-W/XXX

Base Unit	T60	*00	*00	-H	*F	*F	*F	*H	*M	*P	*U	-W/X	**
CPU	E	G	H	J	K	L	M	N	P	R			
Software Options		00	01	03	04								
Mount / Coating				H	A	V	B						
User Interface				C	P	A	B	D	G	R	S		
Power Supply				H	L	L							
CT/VT DSP					8F	8G	8H	8J					
Digital I/O				XX	4A	4A	4A	4A	4A	4A	4A	4A	4A
Transducer I/O				5A	5A	5A	5A	5A	5A	5A	5A	5A	5A
Inter-Relay Communications				7A	7A	7A	7A	7A	7A	7A	7A	7A	7A

For Full Sized Horizontal Mount
For Reduced Size Vertical Mount

Base Unit	RS485 + RS485	RS485 + Multi-mode ST 10BaseF	RS485 + Multi-mode ST Redundant 10BaseF	RS485 + Multi-mode ST 100BaseFX	RS485 + Multi-mode ST Redundant 100BaseFX	RS485 + Single-mode SC 100BaseFX	RS485 + Single-mode SC Redundant 100BaseFX	RS485 + 10/100 BaseT	RS485 + Single-mode ST 100BaseFX	RS485 + Single-mode ST Redundant 100BaseFX	No Software Options	Ethernet Global Data (EGD)	IEC 61850	Ethernet Global Data (EGD) + IEC 61850	Horizontal (19" rack) - Standard	Horizontal (19" rack) - Harsh Environment Coating	Vertical (3/4 size) - Standard	Vertical (3/4 size) - Harsh Environment Coating	English	English with additional 4 small and 12 large programmable pushbuttons	Chinese	Chinese with additional 4 small and 12 large programmable pushbuttons	French	French with additional 4 small and 12 large programmable pushbuttons	Russian	Russian with additional 4 small and 12 large programmable pushbuttons	125 / 250 V AC/DC	125/250 V AC/DC with redundant 125/250 V AC/DC	24 - 48 V (DC only)	24 - 48 V (DC only) with redundant 24 - 48 V (DC only)	Standard 4CT/4VT	Sensitive ground 4CT/4VT	Standard 8CT	Sensitive ground 8CT	No Module	4 Solid State (No Monitoring) MOSFET Outputs	4 Solid State (Voltage w/opt Current) MOSFET Outputs	4 Solid State (Current w/opt Voltage) MOSFET Outputs	16 Digital Inputs with Auto-Burnish	14 Form-A (No Monitoring) Latchable Outputs	8 Form-A (No Monitoring) Outputs	2 Form-A (Voltage w/ opt Current) & 2 Form-C Outputs, 8 Digital Inputs	2 Form-A (Voltage w/ opt Current) & 4 Form-C Outputs, 4 Digital Inputs	8 Form-C Outputs	16 Digital Inputs	4 Form-C Outputs, 8 Digital Inputs	8 Fast Form-C Outputs	4 Form-A (Voltage w/ opt Current) Outputs, 8 Digital Inputs	6 Form-A (Voltage w/ opt Current) Outputs, 4 Digital Inputs	4 Form-C & 4 Fast Form-C Outputs	2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs	2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs	4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs	6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs	2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs	2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs	4 Form-A (No Monitoring) Outputs, 8 Digital Inputs	6 Form-A (No Monitoring) Outputs, 4 Digital Inputs	4 dcmA Inputs, 4 dcmA Outputs	8 RTD Inputs	4 RTD Inputs, 4 dcmA Outputs	4 dcmA Inputs, 4 RTD Inputs	8 dcmA Inputs	820 nm, multi-mode, LED, 1 Channel	1300 nm, multi-mode, LED, 1 Channel	1300 nm, single-mode, ELED, 1 Channel	1300 nm, single-mode, LASER, 1 Channel	Channel 1 - G.703, Channel 2 - 820 nm, multi-mode	Channel 1 - G.703, Channel 2 - 1300 nm, multi-mode	Channel 1 - G.703, Channel 2 - 1300 nm, single-mode ELED	820 nm, multi-mode, LED, 2 Channels	1300 nm, multi-mode, LED, 2 Channels	1300 nm, single-mode, ELED, 2 Channels	1300 nm, single-mode, LASER, 2 Channels	Channel 1 - RS422; Channel 2 - 820 nm, multi-mode, LED	Channel 1 - RS422; Channel 2 - 1300 nm, multi-mode, LED	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, ELED	Channel 1 - RS422; Channel 2 - 1300 nm, single-mode, LASER	Channel 1 - G.703, Channel 2 - 1300 nm, single-mode Laser	G.703, 1 Channel	G.703, 2 Channels	RS422, 1 Channel	RS422, 2 Channels	1550 nm, single-mode, LASER, 1 Channel	1550 nm, single-mode, LASER, 2 Channels	Channel 1 - RS422; Channel 2 - 1550 nm, single-mode, LASER	Channel 1 - G.703, Channel 2 - 1550 nm, single-mode Laser	IEEE C37.94, 820 nm, multimode, LED, 1 Channel	IEEE C37.94, 820 nm, multimode, LED, 2 Channel	C37.94SM, 1300nm Singlemode, ELED, 1 Channel Single mode	C37.94SM, 1300nm Singlemode, ELED, 2 Channel Single mode	Biphase, 1 Channel	Biphase, 2 Channel
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*redundant power supply only available in horizontal unit
 **if redundant chosen, must be same type Maximum 2 per chassis

Accessories: Interactive UR Training CD-ROM available. Visit www.GEMultilin.com/trainingcd to order.

Ordering Note: This order code is valid for the latest version of UR hardware and firmware version 4.0 and later. The older hardware and previous firmware versions are still available and may be ordered through the usual channels. In addition, upgrade kits are available for users who wish to take advantage of the features in the newer models. Please see the GE Multilin On-Line Store (www.GEMultilin.com/onlinestore) for the most up to date ordering information.

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Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED _____ ✓

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 795388-C31-16

Date: June 21/06 By: br

Battery Cabinet Required

Rack-Info

Number of elements
UP TO 4 x MARATHON, M12V40 - 70

Art.Nr., Racktype
PS1060, PGS 1-06

Rack dimensions
Length=23.62 inch
Width=11.42 inch
Height=7.28 inch

Part list
1 x PGS 1
0.5x 604

Battery-Weight
39.00 lbs each

Rack-Weight
15.32 lbs

Total-Weight
83.32 lbs

Projected surface load
3.64 lbf/ft²

Load per insulator
20.92 lbs

Earth Tech (Canada) Inc.	
Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.	
Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.	
REVIEWED	_____
REVIEWED AS MODIFIED	_____
REVISE AND RE-SUBMIT	_____ ✓
NOT REVIEWED	_____
Project No. 79538-C31-16	_____
Date: June 21/06	By: <i>β</i>

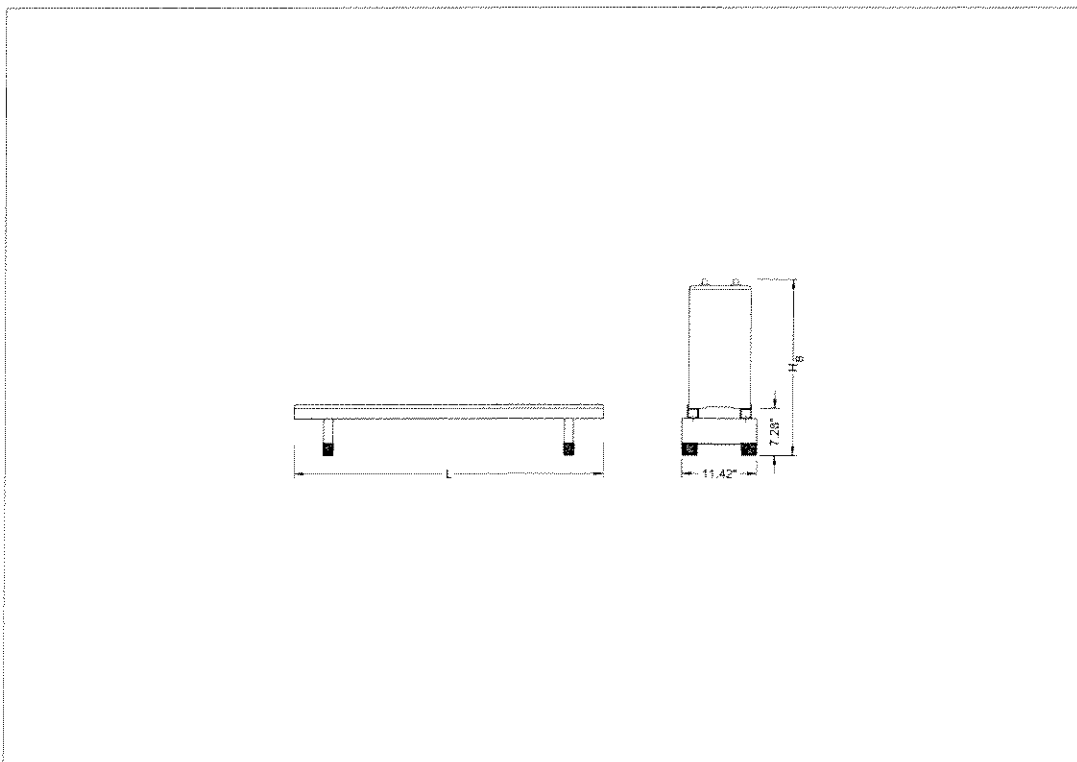
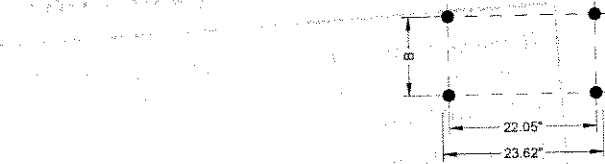


Table 1 (Cont'd)



...

...

MARATHON™

From the World Leader in VRLA Battery Technology

Designed for durability in Telecommunications and Electric Utility applications, the GNB TOP Terminal *MARATHON™* series provides high performance and reliability in long duration discharge applications. The *MARATHON™* family of batteries highlights another example of GNB's extensive experience and world wide leadership in VRLA technology.

"Designed in" Quality Manufacturing

Quality manufacturing processes for the *MARATHON™* series batteries incorporate the industry's most advanced technologies including: an automated helium leak detection system, a computer controlled "fill by weight" acid filler, and a temperature controlled water bath formation process. Each and every unit is capacity tested.

High Performance *MARATHON™* Series Features

- Standard: Reinforced polypropylene container and cover
- Optional: Flame-retardant reinforced container and cover compliant with UL94 V-0, 28% L.O.I.
- Integrated Flash-arrester ultrasonically welded into cover.
- Patented "Diamond Side-Wall" design to maintain structural integrity in higher operating temperatures
- Heat sealed case-to-cover bond to ensure a leak proof seal
- High-Compression Absorbent Glass Mat (AGM) technology for greater than 99% recombination efficiency
- High-tin, calcium, silver, lead positive plate design for maximum service float life; 10 year design life @ 25°C (77°F)
- Heavy duty copper alloy terminals for ease of assembly and reduced maintenance
- Reliable one-way, self-resealing safety vents
- Multicell design for faster installation and reduced maintenance
- Horizontal or vertical operation
- Removable carry handles for ease of installation.

Applications

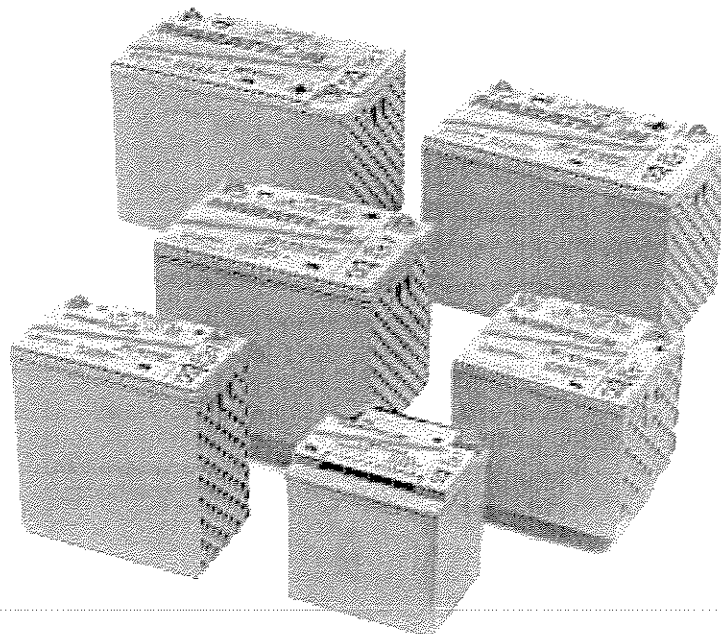
MARATHON™ series batteries incorporate GNB's advanced VRLA technology designed for long life and high performance in:

Telecommunications

- Distributed Power
- PCS
- Cellular
- Broadband

Electric Utility

- Switchgear Control Power
- Communications



MARATHON™

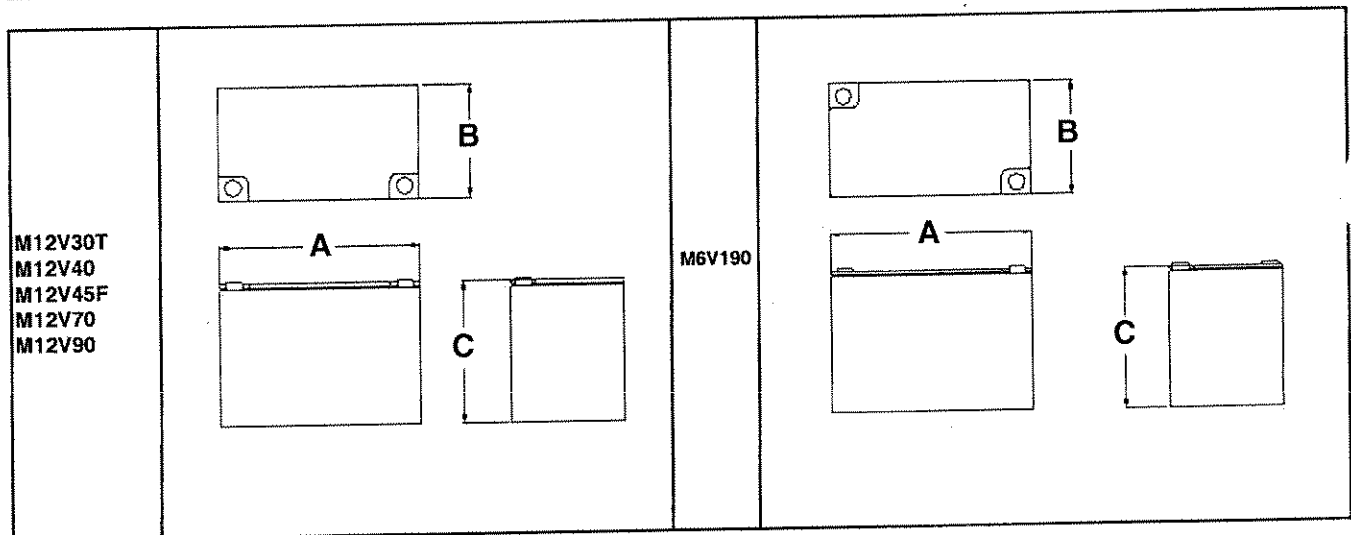
MARATHON™ Specifications

Model Number [#]	Voltage	Capacity (AH)		Nominal Dimensions						Nominal Weight	
		8 Hr To 1.75 VPC @ 25°C	10 hr To 1.80 VPC @ 20°C	Inches			Millimeters			lbs.	Kg
				A	B	*C	A	B	*C		
M12V30T [%]	12	28	28	6.75	5.13	6.90	171	130	175	24	10.7
M12V40	12	40	37	7.81	6.58	7.01	198	167	178	39	17.8
M12V45F [%]	12	46	45	8.68	4.78	9.58	220	121	243	38	17.5
M12V70	12	72	71	10.25	6.85	8.80	260	174	224	61	27.8
M12V90	12	90	88	12.05	6.85	8.80	306	174	224	72	32.8
M6V190	6	190	186	12.05	6.85	8.80	306	174	224	74	33.5

* Bolt, washer, and connector typically increase height by 0.45 in. (11 mm)

Add suffix "F" to model number for flame retardant version OPTION

% Available in flame retardant version ONLY



MARATHON™ Electrical Data

Model Number	Short Circuit Current (Amps)	Internal Resistance (mOhms)
M12V30T	1576	7.7
M12V40	2341	5.3
M12V45F	2162	5.4
M12V70	3271	3.7
M12V90	3365	3.7
M6V190	6343	1.0

Float Voltage & Charging

Constant Voltage charging is recommended

Recommended float voltage: 2.27 VPC @ 25°C (77°F)

Float Voltage Range: 2.25 to 2.30 VPC @ 25°C (77°F)

Equalize voltage: 2.35 VPC for 24 Hours

NOTE: Design and/or specifications subject to change without notice. If questions arise, contact your local GNB sales representative for clarification

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED

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REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: June 21/06 By: B

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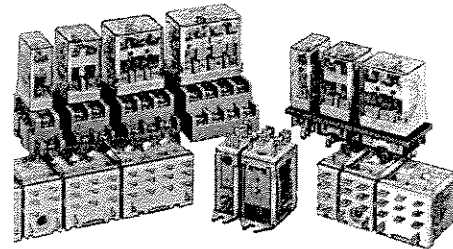
3

4

RH Series — General Purpose Midget Relays

Key features of the RH series include:

- Compact midget size saves space
- High switching capacity (10A)
- Choice of blade or PCB style terminals
- Relay options include indicator light, check button, and top mounting bracket
- DIN rail, surface, panel, and PCB type sockets available for a wide range of mounting applications



UL Recognized
Files No. E67770
E59804



CSA Certified
File No. LR35144



File No. BL951113332319



Contact Material	Silver cadmium oxide
Contact Resistance	50mΩ maximum (initial value)
Minimum Applicable Load	24V DC/30mA, 5V DC/100mA (reference value)
Operating Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Release Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
Drop-Out Voltage (AC)	30% or more of the rated voltage
Drop-Out Voltage (DC)	10% or more of the rated voltage
Power Consumption	SPDT (RH1): DC: 0.8W AC: 1.1VA (50Hz), 1VA (60Hz) DPDT (RH2): DC: 0.9W AC: 1.4VA (50Hz), 1.2VA (60Hz) 3PDT (RH3): DC: 1.5W AC: 2VA (50Hz), 1.7VA (60Hz) 4PDT (RH4): DC: 1.5W AC: 2.5VA (50Hz), 2VA (60Hz)
Insulation Resistance	100MΩ min (measured with a 500V DC megger)
Dielectric Strength	SPDT (RH1) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute DPDT (RH2), 3PDT (RH3), 4PDT (RH4) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contact circuits: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
Frequency Response	1,800 operations/hour
Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
Vibration Resistance	0 to 6G (55Hz maximum)
Shock Resistance	SPDT/DPDT: 200N (approximately 20G) 3PDT/4PDT: 100N (approximately 10G)
Life Expectancy	Electrical: over 500,000 operations at 120V AC, 10A; (over 200,000 operations at 120V AC, 10A for SPDT [RH1], 3PDT [RH3], 4PDT [RH4]) Mechanical: 50,000,000 operations
Operating Temperature	-30 to +70°C
Weight	SPDT: 24g, DPDT: 37g (approximately) 3PDT: 50g, 4PDT: 74g (approximately)

Specifications

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.	Coil Voltage:
<u>RH2B-U</u>	<u>AC110-120V</u>

Part Numbers

Part Numbers: RH Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Indicator Light and Check Button	Top Bracket
B (blade)	SPDT	RH1B-U	RH1B-L*	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (PCB 0.078" [2mm] wide)	SPDT	RH1V2-U	RH1V2-L*	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	—

* RH1B(V2)-L is not UL recognized.



Ratings

Coil Ratings

Rated Voltage	Rated Current ±15% at 20°C								Coil Resistance ±15% at 20°C				
	60Hz				50Hz				SPDT	DPDT	3PDT	4PDT	
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT					
AC	6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
	12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
	24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
	120V*	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7,680Ω	4,170Ω	2,770Ω	2,220Ω
	240V†	3.2mA	5.5mA	7.1mA	8.3mA	3.7mA	6.5mA	8.2mA	9.8mA	3,1200Ω	15,210Ω	12,100Ω	9,120Ω
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
DC	6V		128mA		150mA		240mA		250mA	47Ω	40Ω	25Ω	24Ω
	12V		64mA		75mA		120mA		125mA	188Ω	160Ω	100Ω	96Ω
	24V		32mA		36.9mA		60mA		62mA	750Ω	650Ω	400Ω	388Ω
	48V		18mA		18.5mA		30mA		31mA	2,660Ω	2,600Ω	1,600Ω	1,550Ω
	110V‡		8mA		9.1mA		12.8mA		15mA	13,800Ω	12,100Ω	8,600Ω	7,340Ω

* For RH2 relays = 110/120V AC.
 † For RH2 relays = 220/240V AC.
 ‡ For RH2 relays = 100/110V DC.



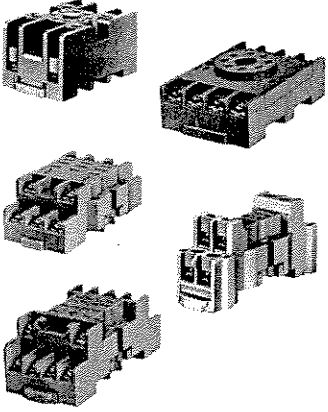
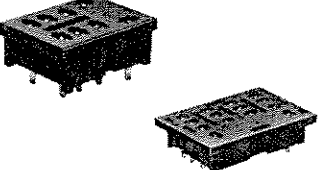

Rated Voltage	Coil Inrush				Coil Inductance								
					Energizing				De-Energizing				
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	
AC	6V	250mA	340mA	520mA	620mA	0.09H	0.08H	0.05H	0.05H	0.06H	0.04H	0.03H	0.02H
	12V	120mA	170mA	260mA	310mA	0.037H	0.30H	0.22H	0.18H	0.22H	0.16H	0.12H	0.10H
	24V	56mA	85mA	130mA	165mA	1.5H	1.2H	0.9H	0.73H	0.9H	0.63H	0.5H	0.36H
	120V*	12mA	16mA	26mA	33mA	37H	33H	21H	18H	22H	15H	12H	9H
	240V†	7mA	8mA	12mA	16mA	130H	130H	84H	73H	77H	62H	47H	36H
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
DC	6V												
	12V												
	24V	N/A		N/A		N/A		N/A		N/A		N/A	
	48V												
	110V‡												

* For RH2 relays = 110/120V AC.
 † For RH2 relays = 220/240V AC.
 ‡ For RH2 relays = 100/110V DC.





Relay and Timer Socket Selection Guide

Relay and Timer Sockets

Mounting	Series	Page	Part No.	No. of Poles	Receptacle	Terminal	Compatible IDEC Relay and Timer	
	SR	F-6	SR2P-05 SR2P-05C SR2P-06	2	8-Pin	M3.5 Screw	RR2P, GT5P, RTE-P1, GT3 (8-pin)	
			SR3P-05 SR3P-05C SR3P-06	3	11-Pin		RR3PA, RR2KP, RTE-P2 GT3 (11-pin)	
			SR3B-05	3	11-Blade		RR1BA, RR2BA, RR3B, RTE-B	
	SH	F-9	SH1B-05 SH1B-05C	1	5-Blade	M3.5 Screw Coil Terminal: M3	RH1B	
			SH2B-05 SH2B-05C	2	8-Blade	M3.5 Screw	RH2B	
			SH3B-05 SH3B-05C	3	11-Blade		RH3B, RH2LB	
			SH4B-05 SH4B-05C	4	14-Blade		RH4B	
	SY	F-13	SY2S-05 SY2S-05C	2	8-Blade	M3 Screw	RY2S, RY22S	
			SY4S-05 SY4S-05C	4	14-Blade		RU4S, RY4S, RY42S, RY2KS, RY2LS, RM2S, GT5Y	
	SM	F-15	SM2S-05 SM2S-05C				RU2S	
		SR	F-16	SR2P-51	2	8-Pin	Solder	RR2P, RAPP, RBPP, GT5P, RTE-P1, GT3 (8-pin)
				SR3P-51	3	11-Pin		RR3PA, RR2KP, RTE-P2, GT3 (11-pin)
SR3B-51				3	11-Blade	RR1BA, RR2BA, RR3B		
SH		F-17	SH1B-51	1	5-Blade	Solder	RH1B, RAHB, RBHB	
			SH2B-51	2	8-Blade		RH2B, RAMB, RBMB	
			SH3B-51	3	11-Blade		RH3B, RH2LB	
			SH4B-51	4	14-Blade		RH4B	
SY		F-19	SY2S-51	2	8-Blade	Solder	RY2S, RY22S	
			SY4S-51	4	14-Blade		RY4S, RY42S, RY2KS, RY2LS, RM2S, GT5Y	
		SH	F3-20	SH1B-62	1	5-Blade	PC Board	RH1B, RAHB, RBHB
	SH2B-62			2	8-Blade	RH2B, RAMB, RBMB		
	SH3B-62			3	11-Blade	RH3B, RH2LB		
	SH4B-62			4	14-Blade	RH4B		
	SY	F3-21	SY2S-61	2	8-Blade	PC Board	RY2S, RY22S	
			SY4S-61	4	14-Blade		RY4S, RY42S, RY2KS, RY2LS, RM2S, GT5Y	
			SY4S-62	4	14-Blade		RY4S, RY42S, RY2KS, RY2LS, RM2S, GT5Y	
	SH	F-23	SH2B-02	2	8-Blade	M3.5 Screw	RH2B, RAMB, RBMB	

For Panel Mounted Timers

	SR	F-23	SR6P-M08G	2	8-pin	M3.5 Screw	GE1A; RTE-P1; GT3A-1,-2,-3; GT3D-1,-2,-3; GT3W (8-pin); GT3S; GT3F
			SR6P-M11G		11-pin		RTE-P2; GT3A-4,-5,-6; GT3D-4,-8; GT3W (11-pin)

 For relay mounting accessories, see page F-24.

Specifications	Rated Insulation Voltage	300V; except SH1B and SY4S-62: 250V
	Rated Current	SR/SH/SM: 10A, SY: 7A (SH1B coil terminal 7A)
	Insulation Resistance	100MΩ minimum
	Dielectric Strength	2,000V AC, 1 minute
	Material Grade	UL94V-0



UL Recognized
File No. E64245, E62437



CSA Certified
File No. LR35144



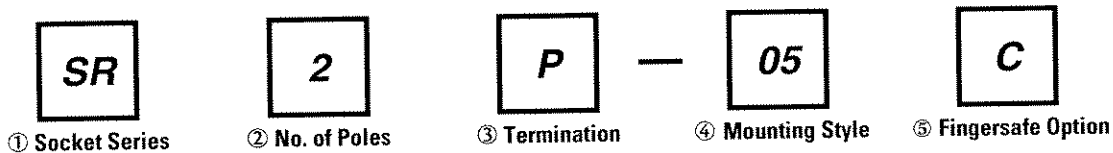
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1. *Applicable to DIN rail sockets only.

Relay Socket Part Numbering Guide

Relay socket part numbers are composed of 5 part number codes. When ordering a relay socket, select one code from each category.
Example: SR2P-05C



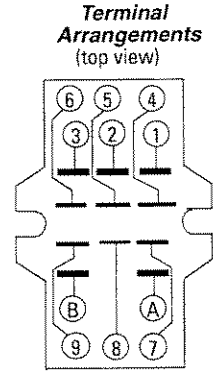
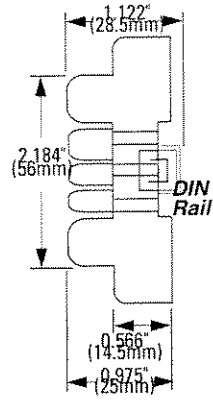
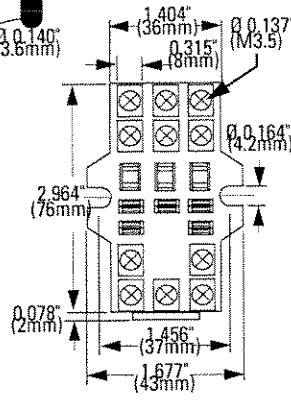
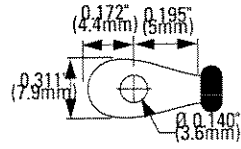
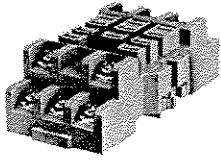
Part Numbers: Relay Sockets

	Description	Part Number Code	Remarks
① Socket Series	SR	SR	For use with RR series relays
	SH	SH	For use with RH series relays
	SY	SY	For use with RY series relays
	SM	SM	For use with RU2, RM2 series relays
② No. of Poles	1-pole	1	SH series
	2-pole	2	SR, SH, SM, and SY series
	3-pole	3	SR, and SH series
	4-pole	4	SH series
③ Termination	Tubular pin	P	SR series
	Blade	B	SH series
	Solder/blade	S	SY and SM series
④ Mounting Styles	DIN rail snap-mount	05	To decide between configuration 05 and 06, see pictures and schematics beginning on page F-6
		06	Model 05 is available as 05C with a fingersafe option; see ⑤ below
	PC board mount	51	
		61	
⑤ Fingersafe Option	With finger-protection terminals	C	Available only on SR, SH, SM, and SY series snap-mount sockets
	Without finger-protection terminals	Leave blank	



2. For hold-down springs and clips for DIN rail snap-mount, panel mount, and PC board mount, see page F-4.
3. For socket accessories, see page F-24.

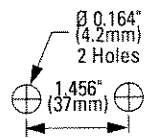
SR3B Sockets



SR3B-05

Style	11-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 15A (10A)* (*denotes CSA rating)
Compatible Relay	RR1BA, RR2BA, RR3B
Compatible Timer	RTE-B
Hold-Down Spring	SR3B-02F1 (relays)
Hold-Down Clip	SFA-202 (relays and timers)

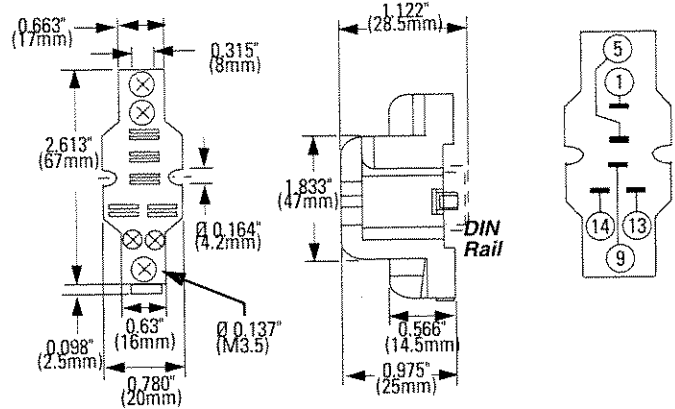
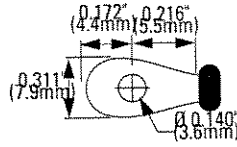
Panel Cutout for Surface Mounting →



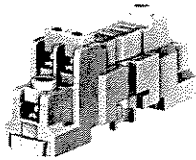
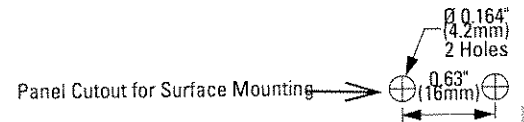
1. For socket mounting accessories, see page F-24.
2. For hold-down clip/spring selections, see page F-4.

SH Series: DIN Rail Snap-Mount Sockets

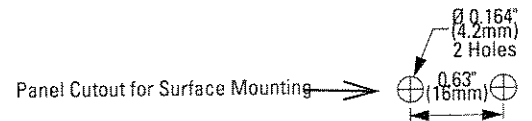
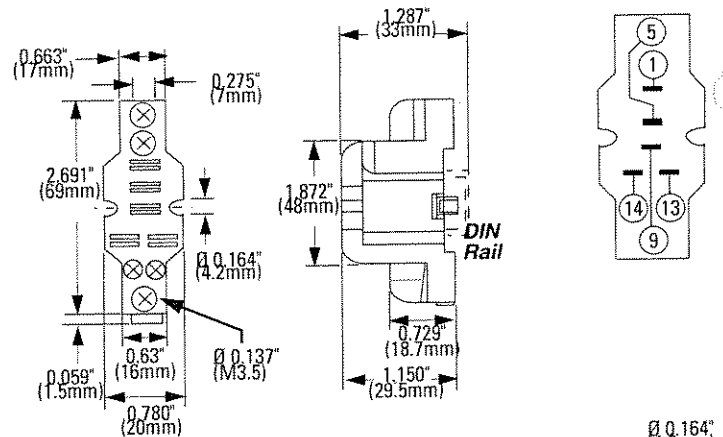
SH1B Sockets



SH1B-05	
Style	5-blade, snap-mount/surface mount
Terminal	(Coil) M3 screws/(contact) M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	250V, 10A
Compatible Relay	RH1B
Hold-Down Spring	SY2S-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

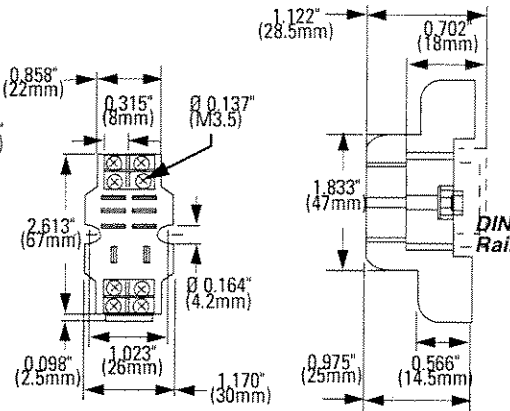
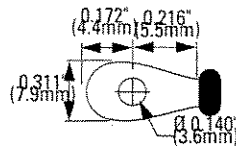
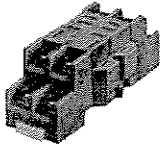


SH1B-05C Fingersafe	
Style	5-blade, snap-mount/surface mount
Terminal	(Coil) M3 screws/(contact) M3.5 screws with captive wire clamp, fingersafe
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	250V, 10A
Compatible Relay	RH1B
Hold-Down Spring	SY2S-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

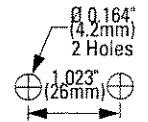
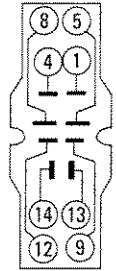


1. For socket mounting accessories, see page F-24.
2. For hold-down clip/spring selections, see page F-4.

SH2B Sockets



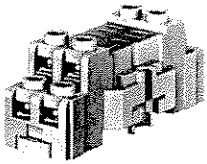
Terminal Arrangements (top view)



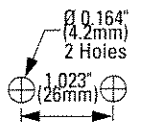
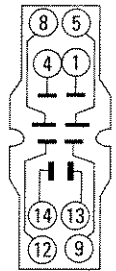
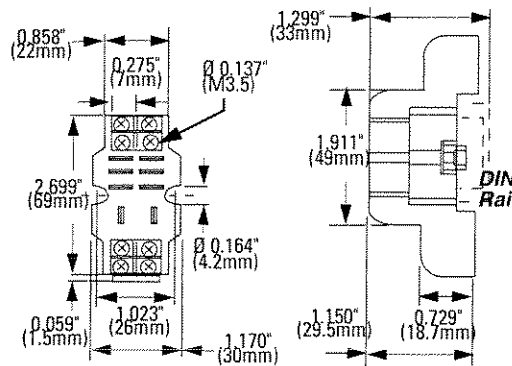
SH2B-05

Style	8-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH2B
Hold-Down Spring	SY4S-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

Panel Cutout for Surface Mounting →



F



SH2B-05C Fingersafe

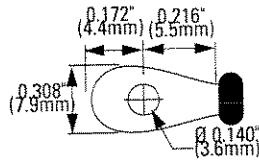
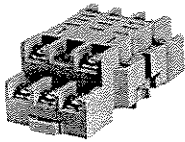
Style	8-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp, fingersafe
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH2B
Hold-Down Spring	SY4S-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

Panel Cutout for Surface Mounting →



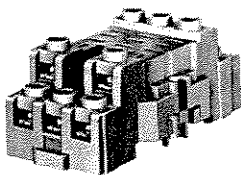
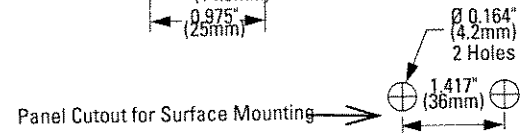
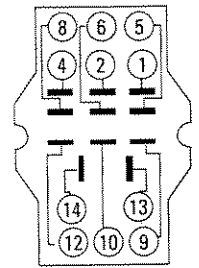
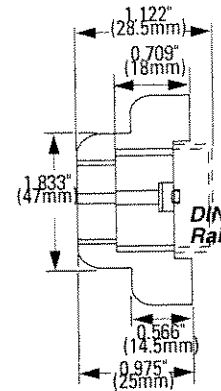
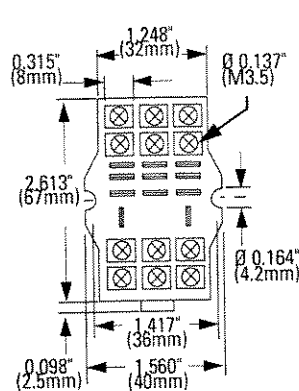
1. For socket mounting accessories, see page F-24.
2. For hold-down clip/spring selections, see page F-4.

SH3B Sockets



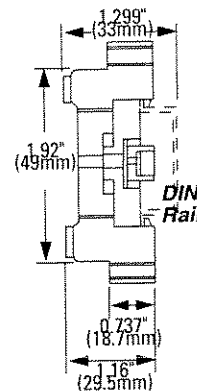
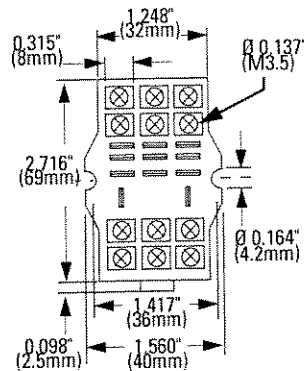
SH3B-05

Style	11-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH3B, RH2LB
Hold-Down Spring	SH3B-05F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

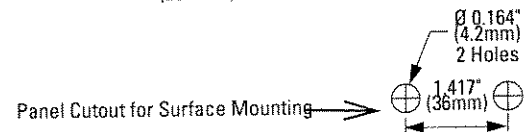
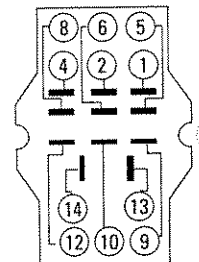


SH3B-05C Fingersafe

Style	11-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp, fingersafe
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH3B, RH2LB
Hold-Down Spring	SH3B-05F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

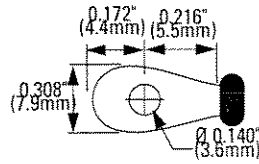
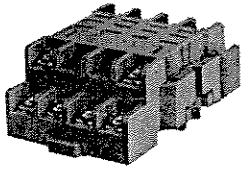


Terminal Arrangements (top view)



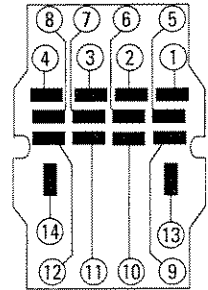
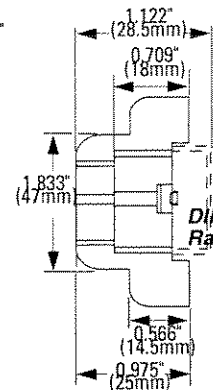
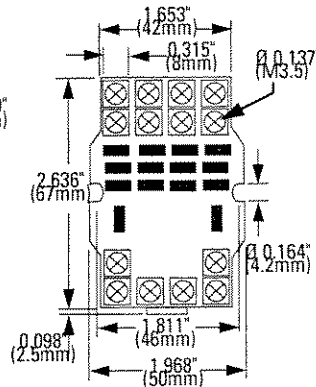
1. For socket mounting accessories, see page F-24.
2. For hold-down clip/spring selections, see page F-4.

SH4B Sockets

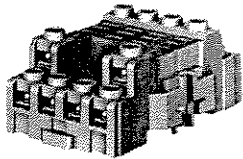
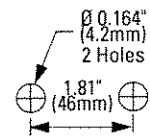


SH4B-05

Style	14-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH4B
Hold-Down Spring	SH4B-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)

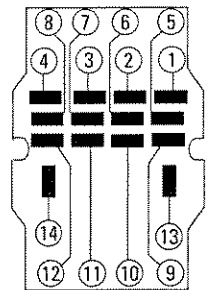
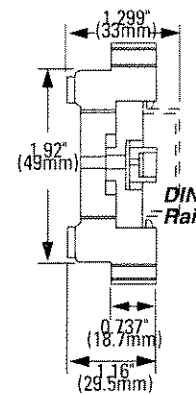
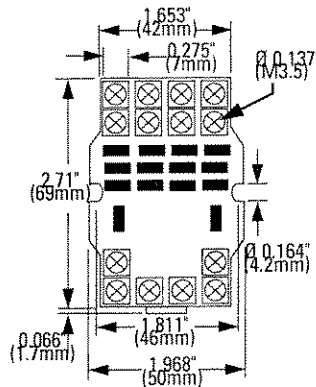


Panel Cutout for Surface Mounting →

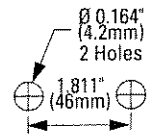


SH4B-05C Fingersafe

Style	14-blade, snap-mount/surface mount
Terminal	M3.5 screws with captive wire clamp, fingersafe
Wire Size	Maximum up to 2-#12AWG
Electrical Rating	300V, 10A
Compatible Relay	RH4B
Hold-Down Spring	SH4B-02F1
Hold-Down Clip	SFA-101 (top notch), SFA-202 (side notch)












Panel Cutout for Surface Mounting →



1. For socket mounting accessories, see page F-24.
2. For hold-down clip/spring selections, see page F-4.

Non-Illuminated Pushbuttons (Assembled) con't

Part Numbers: Non-illuminated Pushbuttons

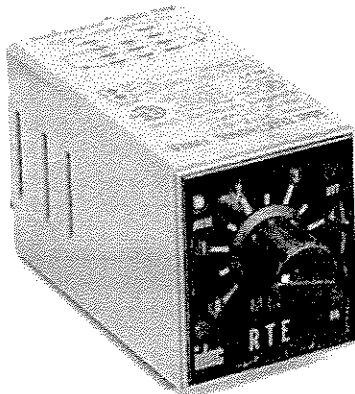
Style	Contacts	Part Numbers	
		Momentary Action	Maintained Action
Flush *  	1NO 1NC 1NO-1NC 2NO 2NC	ABW110-B,G,R ABW101-B,G,R ABW111-B,G,R ABW120-B,G,R ABW102-B,G,R	AOW110-B,G,R AOW101-B,G,R AOW111-B,G,R AOW120-B,G,R AOW102-B,G,R
Extended 	1NO 1NC 1NO-1NC 2NO 2NC	ABW210-① ABW201-① ABW211-① ABW220-① ABW202-①	AOW210-① AOW201-① AOW211-① AOW220-① AOW202-①
Recessed 	1NO 1NC 1NO-1NC 2NO 2NC	ABFW110-① ABFW101-① ABFW111-① ABFW120-① ABFW102-①	AOFW110-① AOFW101-① AOFW111-① AOFW120-① AOFW102-①
Extended with Full Shroud 	1NO 1NC 1NO-1NC 2NO 2NC	ABFW210-① ABFW201-① ABFW211-① ABFW220-① ABFW202-①	AOFW210-① AOFW201-① AOFW211-① AOFW220-① AOFW202-①
Ø 1-37/64" (40mm) Mushroom 	1NO 1NC 1NO-1NC 2NO 2NC	ABW410-① ABW401-① ABW411-① ABW420-① ABW402-①	AOW410-① AOW401-① AOW411-① AOW420-① AOW402-①
Ø 1-37/64" (40mm) Mushroom with Full Shroud 	1NO 1NC 1NO-1NC 2NO 2NC	ABGW410-① ABGW401-① ABGW411-① ABGW420-① ABGW402-①	AOGW410-① AOGW401-① AOGW411-① AOGW420-① AOGW402-①
Square Flush 	1NO 1NC 1NO-1NC 2NO 2NC	ABQW110-① ABQW101-① ABQW111-① ABQW120-① ABQW102-①	AQQW110-① AQQW101-① AQQW111-① AQQW120-① AQQW102-①
Square Extended 	1NO 1NC 1NO-1NC 2NO 2NC	ABQW210-① ABQW201-① ABQW211-① ABQW220-① ABQW202-①	AQQW210-① AQQW201-① AQQW211-① AQQW220-① AQQW202-①

A



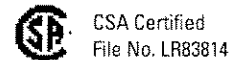
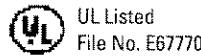
1. In place of ①, specify the button color code from table on next page.
 2. * Flush units include one each of Red, Green, and Black buttons.
 3. For sub-assembled part numbers, see page A-127.
 4. Small mushroom pushbutton Ø 1-5/32" (29mm) is available by ordering a button separately (part no. ABW3B-①).
 5. For accessories, see page A-154.
 6. For dimensions, see page A-156.

RTE Series — Analog Timers



Key features of the RTE series include:

- 16 time ranges and 4 timing functions
- ON-delay, interval, OFF-delay, one-shot
- Time delays up to 10 hours
- Space-saving package (1.63" x 1.42" x 3.03")
- High repeat accuracy of $\pm 0.25\%$
- Power saving 2.2VA consumption
- ON and timing OUT LED indicators
- Standard 8- or 11-pin and 11-blade termination
- 2 form C delayed output contacts
- 10A Contact Rating



Cert. No. E9950913332316 (EMC, RTE)
 Cert. No. BL960813332355 (LVD, RTE)

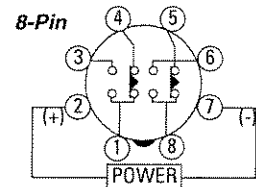
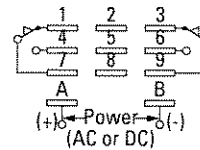


Internal Circuits

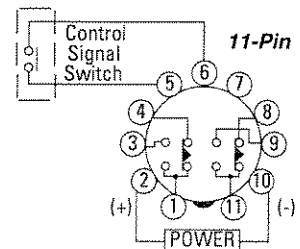
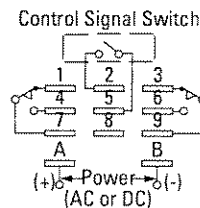
Blade Terminals

Pin Terminals

ON-Delay/Interval



OFF-Delay/One-Shot



Do not apply voltage to terminals 2 and 5.

Do not apply voltage to terminals 5 and 6.

Specifications

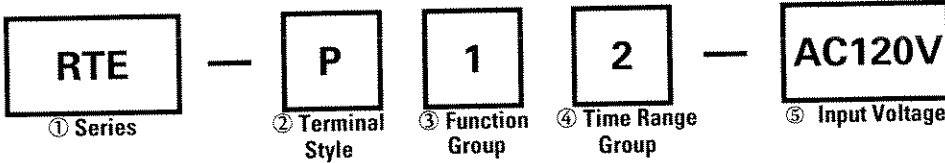
Contact Configuration	2 Form C, DPDT (delay outputs)
Input Voltage	120V AC, 50/60Hz 12V AC/DC 24V AC/DC
Contact Load Rating	10A resist. at 240V AC, 30V DC 7A induct. at 240V AC, 30V DC 1/6 HP at 120V AC 1/3 HP at 240V AC
Power Consumption	ON-delay/interval AC: 1.6VA to 2.2VA DC: 0.9W to 1.2W OFF-delay/single-shot AC: 1.6VA to 2.2VA DC: 0.9W to 1.2W
Repeat Accuracy	$\pm 0.25\%$ maximum, 10ms
Voltage Accuracy	$\pm 1\%$ maximum, ± 30 ms
Temperature Error	$\pm 2\%$ maximum, ± 30 ms
Setting Error	$\pm 10\%$ maximum
Reset Time	0.1s maximum
Insulation Resistance	100 M Ω minimum
Dielectric Strength	1500V AC, 1 minute (except between contacts of same pole)
Vibration Resistance	6N (approximate 6G)
Shock Resistance	500N (approximate 50G)
Operating Temperature	-20°C to +65°C
Operating Humidity	45 to 85% RH

RTE Table of Contents

- Part Number GuideG-9
- Part Number ListG-9
- RTE Timing DiagramsG-10
- RTE AccessoriesG-11
- Instructions: Setting TimerG-13
- RTE DimensionsG-14

Part Numbering Guide

RTE series part numbers are composed of 5 part number codes. When ordering a RTE series part, select one code from each category.
 Example: RTE-P12-AC120V



Part Numbers: RTE Series

	Description	Part Number Code	Remarks
① Series	RTE series	RTE	For internal circuits, see previous page.
② Terminal Style	Pin	P	Select one only.
	Blade	B	
③ Function Group	ON-delay/interval	1	Each function group has two timing functions. See page G-10.
	OFF-delay/one-shot	2	
④ Time Range Group	0.1s to 10 minutes	1	Each time group has 8 selectable ranges. See page G-13.
	0.1 minutes to 10 hours	2	
⑤ Input Voltage	120V AC, 50/60Hz	AC120V	
	12V AC/DC	12V	
	24V AC/DC	24V	

Part Number List

Part Numbers

Mode of Operation	Time Range	Part No.	
		Pin	Blade
ON-Delay/Interval	0.1 seconds to 10 minutes	RTE-P11	RTE-B11
	0.1 minutes to 10 hours	RTE-P12	RTE-B12
OFF-Delay/One-Shot	0.1s to 10 minutes	RTE-P21	RTE-B21
	0.1 minutes to 10 hours	RTE-P22	RTE-B22



1. After basic part number, insert input voltage.
2. For schematics, see page G-8.
3. For timing diagrams, see page G-10.
4. All timers have multiple time ranges. For a list of ranges, see page G-13.
5. For socket and accessory information, see page G-11.

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

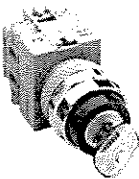
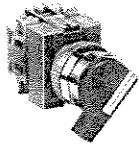
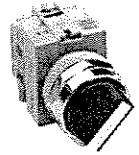
Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

Non-Illuminated Selector Switches (Assembled) con't

Part Numbers: 2-Position Selector Switches

Style		Operator Position		Part Number	Part Number	Part Number	
Contact	Mounting	L	R				
1NO	1	0	X	Knob Lever Key			
	2	0	0				
	ASW210 ASW2L10 ASW2K10	ASW2110 ASW21L10 ASW21K10	ASW2210 ASW22L10 ASW22K10				
1NC	1	X	0	Knob Lever Key			
	2	0	0				
	ASW201-116 ASW2L01-116 ASW2K01-116	ASW2101-116 ASW21L01-116 ASW21K01-116	ASW2201-116 ASW22L01-116 ASW22K01-116				
1NO 1NC	1	X	0	Knob Lever Key			
	2	0	X				
	ASW211 ASW2L11 ASW2K11	ASW2111 ASW21L11 ASW21K11	ASW2211 ASW22L11 ASW22K11				
2NO	1	0	X	Knob Lever Key			
	2	0	X				
	ASW220 ASW2L20 ASW2K20	ASW2120 ASW21L20 ASW21K20	ASW2220 ASW22L20 ASW22K20				
2NC	1	X	0	Knob Lever Key			
	2	X	0				
	ASW202-104 ASW2L02-104 ASW2K02-104	ASW2102-104 ASW21L02-104 ASW21K02-104	ASW2202-104 ASW22L02-104 ASW22K02-104				
2NO 2NC	1	0	X	Knob Lever Key			
	2	X	0				
	3	0	X				
	4	X	0				
2NO 2NC	1	0	X	Knob Lever Key			
	2	0	X				
	3	X	0				
	4	X	0				



Part Numbers: 3-Position Selector Switches

Style		Operator Position			Part Number	Part Number	
Contact	Mounting	L	C	R			
2NO	1	X	0	0	Knob Lever Key		
	2	0	0	X			
	ASW320 ASW3L20 ASW3K20	ASW3120 ASW31L20 ASW31K20					
2NC	1	0	X	X	Knob Lever Key		
	2	X	X	0			
	ASW302 ASW3L02 ASW3K02	ASW3102 ASW31L02 ASW31K02					
2NO 2NC	1	X	0	0	Knob Lever Key		
	2	0	0	X			
	3	0	X	X			
	4	X	X	0			
2NO 2NC	1	X	0	X	Knob Lever Key		
	2	X	X	0			
	3	0	X	0			
	4	0	0	X			
2NO 2NC	1	0	X	0	Knob Lever Key		
	2	0	0	X			
	3	0	X	0			
	4	0	0	X			
4NO	1	X	0	0	Knob Lever Key		
	2	0	0	X			
	3	X	0	0			
	4	0	0	X			
4NC	1	0	X	X	Knob Lever Key		
	2	X	X	0			
	3	0	X	X			
	4	X	X	0			

Operator Truth Tables

Use the following tables to build custom selector switches.

2 Position Selector Switches

Contact	Mounting Position	Operator Position	
		Left	Right
TW-C10 (NO)	L	0	X
	R	0	X
TW-C01 (NC)	L	X	0
	R	X	0
TW-C10R NO-(EM)	L	0	X
	R	0	X
TW-C01R NC-(LB)	L	X	0
	R	X	0

ASW200
ASLW200
ASW2K00

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: June 21/06 By: M

3 Position Selector Switches

Contact	Mounting Position	Operator Position		
		Left	Center	Right
TW-C10 (NO)	L	X	0	0
	R	0	0	X
TW-C01 (NC)	L	0	X	X
	R	X	X	0
TW-C10R NO-(EM)	L	X	0	0
	R	0	0	X
TW-C01R NC-(LB)	L	0	X	X
	R	X	X	0

ASW300-1
ASW3K00-1
ASLW300-1

Contact	Mounting Position	Operator Position		
		Left	Center	Right
TW-C10 (NO)	L	X	0	X
	R	0	0	X
TW-C01 (NC)	L	0	X	0
	R	X	X	0
TW-C10R NO-(EM)	L	X	0	X
	R	0	0	X
TW-C01R NC-(LB)	L	0	X	0
	R	X	X	0

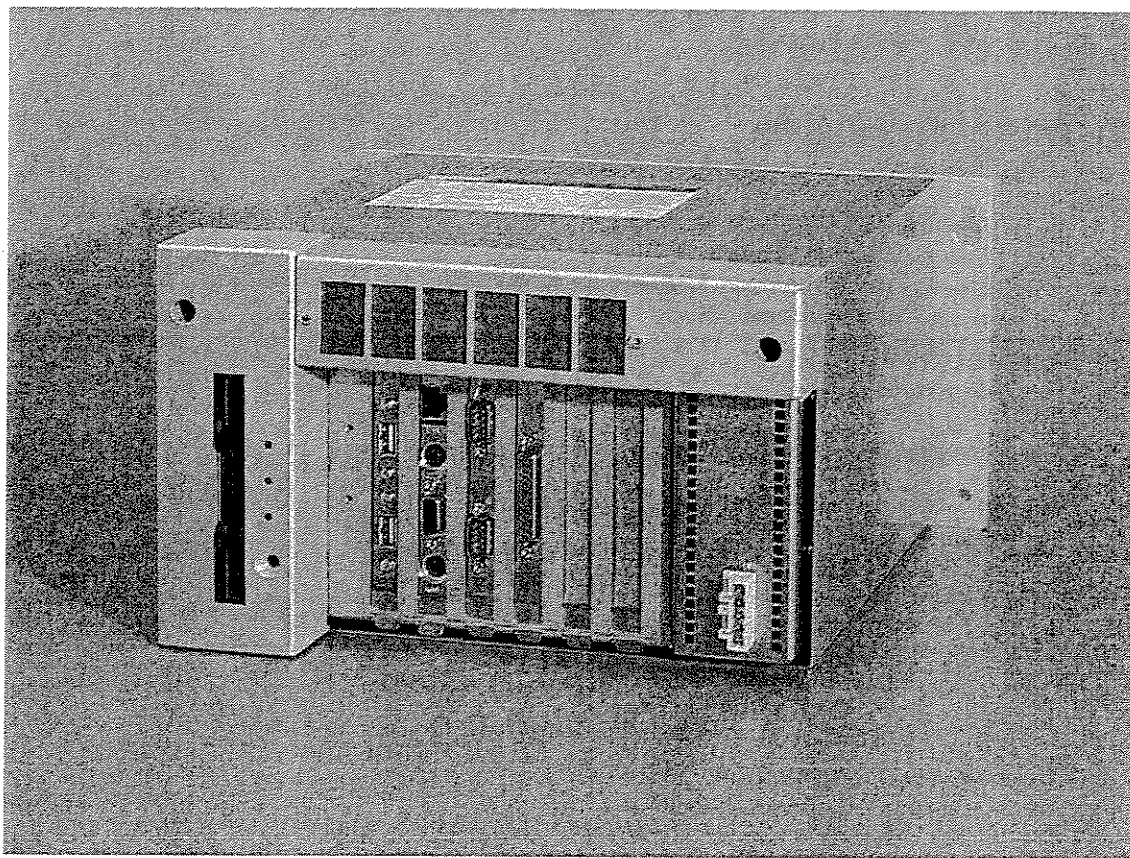
ASW300-2
ASW3K00-2
ASLW300-2

Contact	Mounting Position	Operator Position		
		Left	Center	Right
TW-C10 (NO)	L	X	0	0
	R	0	0	X
TW-C01 (NC)	L	0	X	0
	R	0	X	0
TW-C10R NO-(EM)	L	X	0	X
	R	X	0	X
TW-C01R NC-(LB)	L	0	X	X
	R	X	X	0

ASW300-3
ASW3K00-3
ASLW300-3



1. For Operator Truth Tables, see next page.
2. For examples of how to assemble selector switches, see A-106.



Operating instructions for
Control Cabinet PC C6220

Version: 1.1
Date: 30.09.2004

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Basic safety measures

Only switch the PC off after closing the software

Before the Industrial PC is switched off, software that is running must be properly closed.

Otherwise it is possible that data on the hard disk is lost. Please read the section on *Switching off*.



Warning

Switch off all parts of the equipment, then uncouple the fieldbus!
Before opening the housing of the PC, and whenever the PC is being used for purposes other than plant control, such as during functional tests following repair, all parts of the equipment must first be switched off, after which the Industrial PC can be uncoupled from the plant.

Pulling out the fieldbus connection plug uncouples the PC (optional).

Items of equipment that have been switched off must be secured against being switched on again.

The Industrial PC's power supply unit must be supplied with 100 V_{AC} - 240 V_{AC} or 24V_{DC} (optional).



Danger

Do not open the power supply unit while voltage is applied!

The supply voltage must be switched off before the power supply unit housing is opened.

Do not exchange any parts when under power!

When components are being fitted or removed, the supply voltage must be switched off.

Fitting work on the Industrial PC can result in damage:

- If metal objects such as screws or tools fall onto operating circuit boards.
- If connecting cables internal to the PC are removed or inserted during operation.
- If plug-in cards are removed or inserted when the PC is switched on.

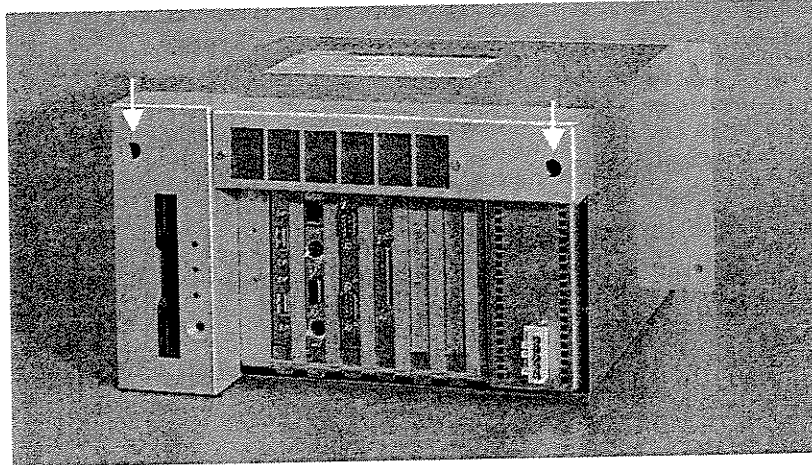
Product Description

Appropriate Use

The C6220 Industrial PC is designed for mounting in control cabinets in machine and plant engineering applications.

Structure

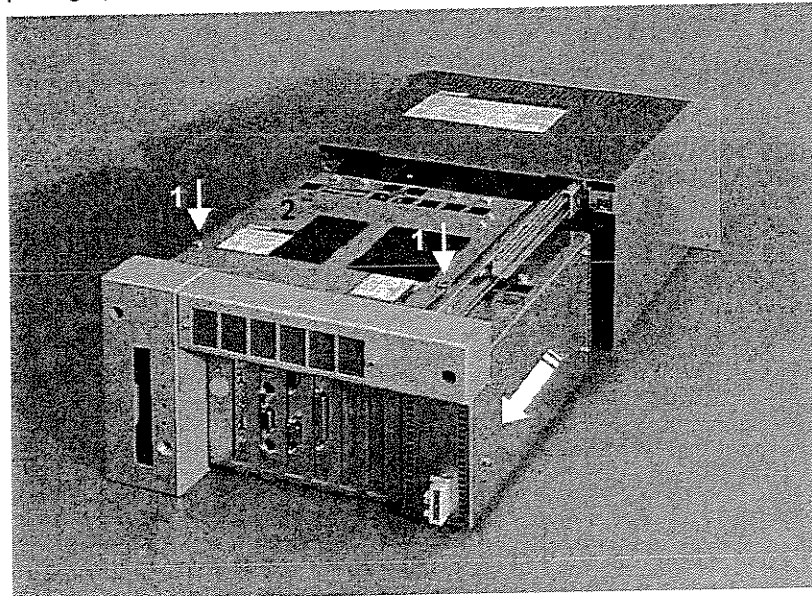
Front view of the C6220



Opening the housing

To open the PC housing, initially rotate the two fast closing screws (see photograph above) by 90 degrees in either direction using a screwdriver. The inner chassis can now be pulled out on telescopic guide supports (see photograph below).

Removable inner chassis



Undo the two screws (1) of the upper housing cover (2). The upper housing cover (1) can now be tilted upwards (see following photograph), thus providing access to the floppy disk drive, hard disk, processor, memory and plug-in cards.

Supplied mains power unit The Industrial PCs is either fitted with a 100-240 V, 50-60 Hz power supply unit (standard) or with a 24 V_{DC} power supply unit (with the option of an uninterruptible power supply, UPS).

Current carrying capacity of the 100-240 V power supply unit

Output voltages from the 100-240 V power supply unit	Current loading maximum
+3,3 V	14 A
+5 V stand by	1,5 A
+5 V	16 A
-5 V	0,2 A
+12 V	9 A
-12 V	0,7 A

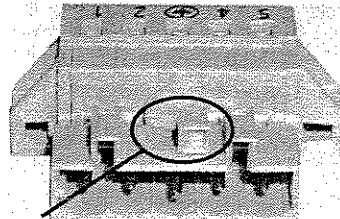
Current carrying capacity of the 24 V power supply unit

Output voltages from the 24 V power supply unit	Current loading maximum
+5 V	25 A
-5 V	1 A
+12 V	10 A
-12 V	1,5 A

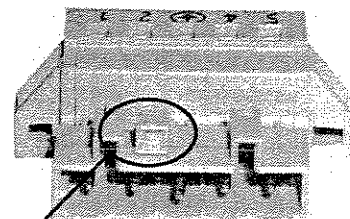
Coding pieces

Differently coded plug connectors

The connectors are coded differently at the factory, using snap-on coding pieces, according to the power supply unit that has been fitted.



Coding for the 100-240 V_{AC}, 50-60 Hz power supply unit

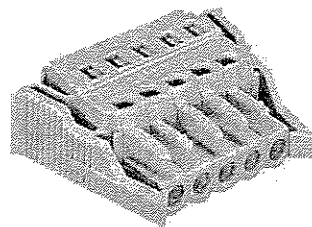


Coding for the 24 V_{DC} power supply unit

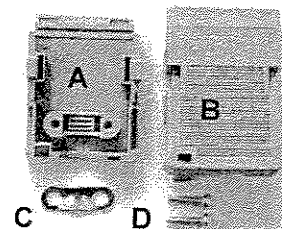
Fitting the Power Supply Cable

A 5-pin female plug connector with CAGE CLAMP connection and insertion catches is supplied along with a snap-on strain relief housing in order to assemble the PC power supply cable.

Materials for assembly of the connector



Female plug connector



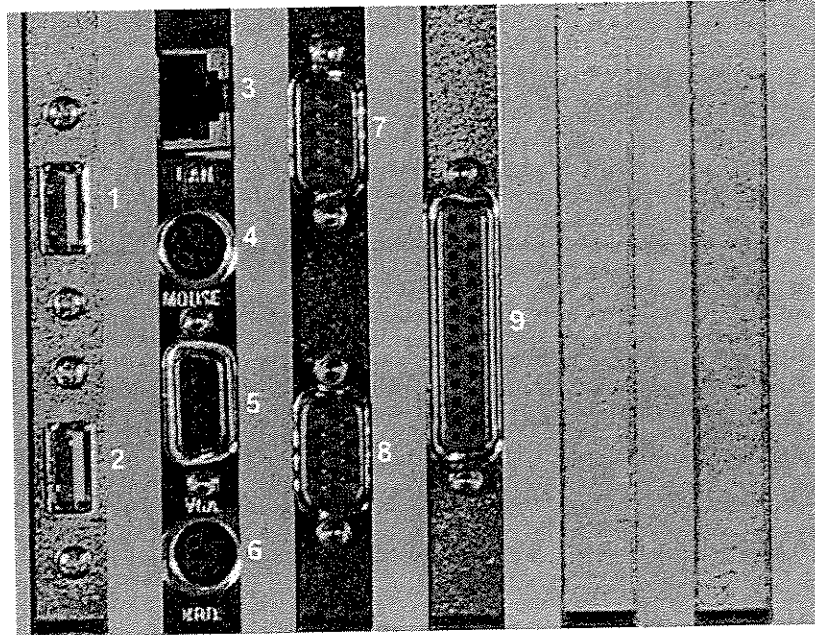
Strain relief housing

Female plug connector is correspondingly coded

This female plug connector is also coded at the factory, according to the type of power supply fitted, so that the plug, when assembled, will fit the Industrial PC's connecting socket.

Interfaces

*Interfaces to the C6220
Industrial PC*



USB1 – USB2

USB interfaces

Both USB interfaces (1) and (2) are used to connect peripheral devices with USB connections.

PS/2

PS/2 connections

The upper PS/2 connector (4) allows a PS/2 mouse to be used, while a PC keyboard can be connected to the lower PS/2 connector (6).

Network

Network connection

The RJ-45 connector (3) allows the 10/100 Base-T Ethernet adapter to be used to connect to a network.

VGA

VGA connection

A 15-pin SUB-D socket connector (5) allows a VGA monitor to be connected.

*RS 232
COM1 - COM2*

Serial interfaces

The basic version of the C6220 Industrial PC has two serial interfaces, COM1 (8) and COM2 (7), using the type RS232, which are brought to a 9 pin SUB-D plug connector.

*Printer
LPT1*

Parallel interface

The parallel interface (9) corresponds to the Centronics standard, and is addressed by the software as LPT1.

Type plate

Additional plug-in cards (optional)

There is a type plate on the top of the Industrial PC which provides information about the hardware configuration of the Industrial PC at the time it was supplied.



Connecting devices

The power supply plug must be withdrawn!

Please read the documentation for the external devices prior to connecting them.

During thunderstorms, plug connector must neither be inserted nor removed.

When disconnecting a plug connector, always handle it at the plug. Do not pull the cable!

Connecting cables

The connections are located on the front of the Industrial PC, and are documented in the section where the product is described.

When connecting the cables to the Industrial PC, proceed according to the following sequence:

- Switch off all the devices that are to be connected.
- Disconnect all the devices that are to be connected from the power supply.
- Connect all the cables between the Industrial PC and to the devices that are to be connected.
- Connect all data transfer cables (if present) to the appropriate plug-in receptacles of the data/telecommunication networks.
- Reconnect all devices to the power supply.

Check voltage rating and connect.

With compact 100-240 V_{AC} 50/60 Hz power supply:

1. Check that the mains voltage is correct.
2. Insert the power supply cable that you have assembled (see the section on *Fitting the Power Supply Cable*) into the Industrial PC's power supply socket. Then connect it to a power socket with a grounded earth connection.

When fitted with the (optional) 24 V_{DC} power supply unit:

1. Check that the external power supply is providing the correct voltage.
2. Insert the power supply cable that you have assembled (see the section on *Fitting the Power Supply Cable*) into the Industrial PC's power supply socket. Then connect it to your external 24 V power supply.



If a 24 V UPS is installed, the correct type of rechargeable battery must be used.

Maintenance

Please also refer to chapter *General instructions*.



Cleaning the Industrial PC

Switch off the Industrial PC and all connected devices, and disconnect the Industrial PC from the power supply.

The Industrial PC can be cleaned with a soft, damp cloth. Do not use any aggressive cleaning materials, thinners, scouring material or hard objects that could cause scratches.

Replacing the battery on the motherboard

A used battery on the motherboard has to be replaced according to the rules of the board manufacturer.



Danger of Explosion if battery is incorrectly replaced. Replace only with same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Servicing

The Industrial PC requires no maintenance.

Shutting down

Disposal

Dismantling the Industrial PC

The device must be fully dismantled in order to dispose of it. The housing can be sent for metal recycling.

Observe national electronics scrap regulations

Electronic parts such as disk drives and circuit boards must be disposed of in accordance with national electronics scrap regulations.

Service and Support

BECKHOFF and their partners around the world offer comprehensive service and support, making available fast and competent assistance with all questions related to BECKHOFF products and system solutions.

BECKHOFF Service

The BECKHOFF Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline: +49(0)5246/963-460
 Fax: +49(0)5246/963-479
 e-mail: service@beckhoff.com

Quote the project number

If servicing is required, please quote the **project number** of your Industrial PC.

BECKHOFF Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual BECKHOFF products, but also with other, wide-ranging services:

- world-wide support
- design, programming and commissioning of complex automation systems
- and extensive training program for BECKHOFF system components

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The addresses of BECKHOFF's branch offices and representatives round the world can be found on her internet pages:

<http://www.beckhoff.com>

You will also find further documentation for BECKHOFF components there.

2

Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings rests with the Contractor.

Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.

REVIEWED _____

REVIEWED AS MODIFIED _____

REVISE AND RE-SUBMIT _____

NOT REVIEWED _____

Project No. 79538-C31-16

Date: July 21/06 By: [Signature]

170AMM11030 Analog/Digital Momentum I/O Base

Overview

This document contains the following topics:

Topic	Page
Front Panel Components	3
Specifications	5
Internal Pin Connections	9
Field Wiring Guidelines	10
Wiring Diagrams	11
I/O Map	12
Register for Outputs	14
4x Registers	15
Register for Inputs	16
Analog Map	18
Discrete I/O Points and IEC Compliant Data Mapping	19
Input and Output Ranges	20
Interpreting the Error Bits	21

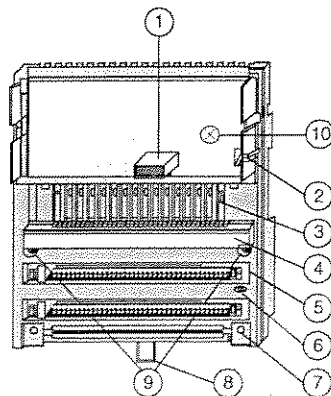
Front Panel Components

Overview

This section contains an illustration of the front panel of the 170AMM11030 I/O base and a description of the LEDs.

Front Panel Illustration

The illustration below shows the front panel of the I/O base.

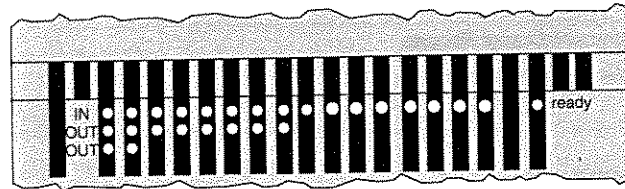


Components of the I/O Module:

Label	Description
1	Internal interface (ATI) connector
2	Locking and ground contact for the adapter
3	LED status display
4	Protective cover
5	Sockets for the terminal connectors
6	Grounding screw
7	Busbar mounting slot
8	Locking tab for DIN rail mount
9	Mounting holes for panel mount
10	Standoff -- ground nut

LED Illustration

The illustration below shows the LEDs.



LED Descriptions

The following table describes the LEDs.

LED	Color	Status	Meaning
Ready	Green	ON	I/O base is communicating with the comm adapter/CPU top hat. CPU must be in RUN state.
I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15, I16	Green	ON	Indicates the corresponding input point is ON.
O1, O2, O3, O4, O5, O6, O7, O8	Green	ON	Indicates the corresponding discrete output point is ON.
AO1, AO2	Green	ON	Indicates the corresponding analog output channel is active.

Specifications

Overview

This section contains specifications for the 170AMM11030 Momentum I/O base.

General Specifications

The following table contains general specifications for the I/O base. Each discrete output is protected against short-circuiting and overload.

External Power Requirement	
Normal Operating Voltage Range	16 to 42 VDC
Absolute Minimum Voltage	12 VDC
Absolute Maximum Voltage	45 VDC
Electrical	
Module Current	400 mA at 24 VDC
EMC for Industrial Environment	
Immunity	IEC 1131-2 Surge on auxiliary power supply 500 V
Emissions	EN 50081-2
ENV 50140	10 V/M
Agency Approvals	UL, CSA, CE, FM Class 1, Div. 2 (pending)
Isolation	
Discrete I/O point to discrete I/O point	None
Field to ground	500 VAC
Field to communication adapter	500 VAC
Analog output channel to channel	700 VDC
Environmental	
Storage Temperature	-40 to 85° C
Operating Temperature	0 to 60° C
Humidity Operating	95% RH @ 60° C
Humidity Non-Operating	95 RH @ 60° C
Vibration Operating	10 - 57 HZ 0.075 MMDA 57 - 150 HZ 1 G
Shock Non-Operating	15 G, 11 MS, 3 shocks/axis
Free Fall (Unpackaged)	0.1 meter

Analog Inputs

The following table contains specifications for analog inputs.

Number of Channels	2
Input Ranges	± 10 VDC
Input Type	Single-ended
Resolution	14 bit
Surge Tolerance	
Voltage Input	± 30 VDC
Over-range Tolerance	5% full scale
Protection	Polarity inversion
Common Mode Rejection	250 VAC @ 47 to 63 HZ or 250 VDC channel to ground
Cross Talk Between Channels	< lowest significant bit
Common Mode Rejection Ratio @ DC	< lowest significant bit
Common Mode Rejection Ratio @ 50/60	< lowest significant bit
Maximum Input Signal	15 VDC for voltage input
Filtering	Low pass with cutoff frequency 10 kHz
Conversion Times	0.75 ms maximum for 2 input channels
Sampling Period	1.5 ms per channel
Integration Time	100 μ sec
Range	± 10 VDC
Input Impedance	> 1 MOhm
Error @ 25°C	0.2% for full scale
Error @ 60°C	0.55% for full scale
Temperature Drift @ 60°C	100ppm full scale /°C

Analog Outputs

The following table contains specifications for analog outputs.

Number of Channels	2
Output Ranges	± 10 VDC
Resolution	14 Bit
Conversion Times	1.20 ms for all channels
Output Setting Time	3.2 ms to 0.1% of final value
Accuracy	Max. error @ 25°C $\pm 0.4\%$ for -10 to +10 VDC
Linearity	± 1 LSB, Guaranteed Monotonic
Max. Temperature Drift @ 60°C	± 100 ppm of full scale per °C
Data Format	Left justified
Crosstalk Between Channels	80 dB
Load	> 2K Ohms min @ ± 10 VDC
Channel to Channel Isolation	700 VDC

Discrete Inputs

The following table contains specifications for discrete inputs.

Operating Voltage	16 to 42 VDC
Absolute Minimum Voltage	12 VDC
Absolute Maximum Voltage	45 VDC
Number of Points	16
Number of Groups	1
Points per Group	16
Type of Signal	True high (sourcing)
IEC 1131 I/O Type	1+
Minimum ON Voltage	> 11 VDC
Maximum OFF Voltage	< 5 VDC
Input Operating Current	1.5 mA and lower, off, 3 to 15 mA, on
Input Voltage	
Range	16 to +42 VDC
Surge	75 volt peak for 10 ms
Response Time	2.2 ms OFF to ON @ 24 VDC 3.3 ms ON to OFF @ 24 VDC

Discrete Outputs The following table contains specifications for discrete outputs.

Description	Solid state switch
Operating Voltage	16 - 42 VDC
Absolute Minimum Voltage	12 VDC
Absolute Maximum Voltage	45 VDC
Maximum Voltage	50 VDC for 1 ms
Number of Points	8
Number of Groups	1
Points per Group	8
Current Capacity	250 mA per point 2 amps per module
Type of Signal	True high (sourcing)
Leakage Current	< 1 mA @ 42 VDC
Surge Current	5 amps for 1 ms
On State Voltage Drop	< 1.0 VDC max at 0.25 amp current
Fault Sensing	Overload and short circuit
Fault Reporting	System bit
Response Time	1.2 ms OFF to ON 1.1 ms ON to OFF



CAUTION

Discrete VDC outputs incorporate thermal shutdown and overload protection.

The output current of a shortened output is limited to a nondestructive value. The short circuit heats the output driver, and the output will switch off. The output will switch on again if the driver leaves the over temperature condition and the user resets the output under program control. If the short circuit still exists after the output point is reset, the driver will reach the over temperature condition again and will switch off again.

Failure to follow this precaution can result in injury or equipment damage.

Physical Dimensions

The following table outlines physical dimensions for the I/O base.

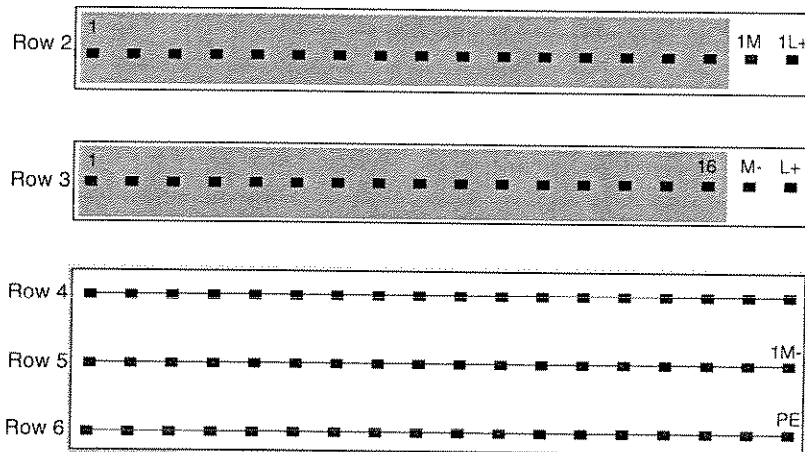
Width	125 mm (4.9 in)
Depth (with no adapter)	40 mm (1.54 in)
Length	141.5 mm (5.5 in) no or one busbar 159.5 mm (6.3 in) two busbars 171.5 mm (6.75 in) three busbars
Weight	220 g (0.49 lb)

Internal Pin Connections**Overview**

This section contains an illustration showing the internal connections between terminals on the I/O base and an optional busbar.

Illustration

The following illustration shows the internal connections between terminals.



Note: AGND and DGND are connected at a single point inside the module. External digital inputs must be returned to the DGND terminal. External analog circuits must be returned to AGND terminals.

Using Momentum I/O Bases

At a Glance

Purpose

This part describes how to assemble TSX Momentum I/O bases with other Momentum components, how to mount assembled modules and how to ground them.

What's in this Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
1	Introducing the TSX Momentum I/O Bases	3
2	Selecting Other TSX Momentum Components	9
3	Assembly	19
4	Dimensions and Mounting Instructions	37
5	Power and Grounding Guidelines	45

Introducing the TSX Momentum I/O Bases



1

At a Glance

Purpose

This chapter introduces the basic features and types of TSX Momentum I/O bases.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Basic Features of I/O Bases	4
Types of I/O Bases	6

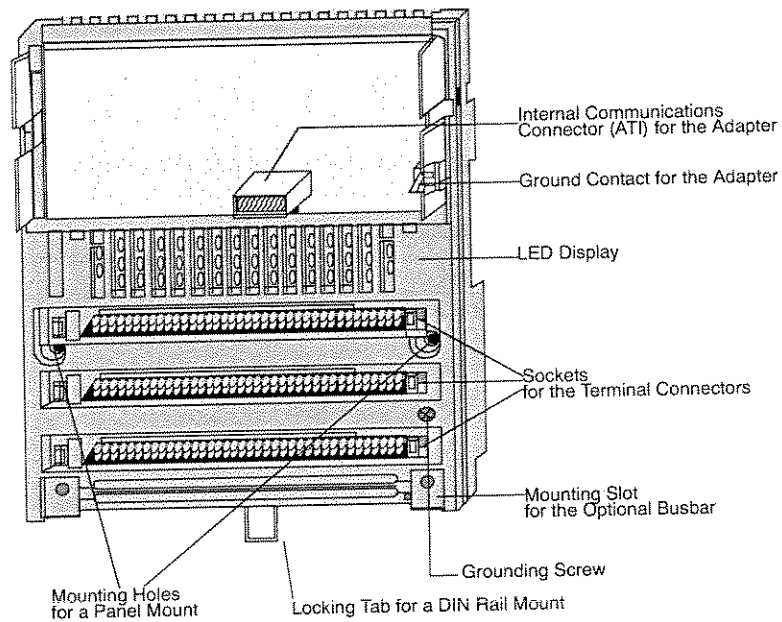
Basic Features of I/O Bases

Overview

This section provides a drawing of a typical I/O base and describes basic features of I/O bases.

Front View

The front panel components of a typical I/O base are shown in the illustration below



Internal Communications Connector

The internal communications connector on an I/O base provides automatic communication to any adapter mounted on the base.

LED Display

Each I/O base has a custom LED display, providing information about the status of input and output devices. Refer to the LED illustration and description for your I/O base for details.

Ground Contact

This contact provides an earth ground connection to any adapter mounted on the base.

Types of I/O Bases

Overview

This section provides part numbers and descriptions for the TSX Momentum I/O bases.

Analog

The following analog I/O bases are available

Part Number	Channels	Type	Details
170 AAI 030 00	8	Input	Broken wire detection
170 AAI 140 00	16	Input	Single-ended
170 AAI 520 40	4	Input	RTD/Thermocouple/mV
170 AAO 120 00	4	Output	0...20 mA
170 AAO 921 00	4	Output	4...20 mA

Combination

The following I/O bases support a combination of analog and discrete I/O

Part Number	Channels	Type	Details
170 AMM 090 00	4 analog in 2 analog out 4 discrete in 2 discrete out	Input/Output	24 VDC
170 ANR 120 90 Unipolar	6 analog in 4 analog out 8 discrete in 8 discrete out	Input/Output	24 VDC
170 ANR 120 91 Bipolar	6 analog in 4 analog out 8 discrete in 8 discrete out	Input/Output	24 VDC

Discrete

The following discrete I/O bases are available

Part Number	Points	Type	Details
170 ADI 340 00	16	Input	24 VDC
170 ADI 350 00	32	Input	24 VDC
170 ADI 540 50	16	Input	120 VAC
170 ADI 740 50	16	Input	230 VAC
170 ADM 350 10	16 in 16 out	Input Output	24 VDC, True High
170 ADM 350 11	16 in 16 out	Input Output	24 VDC, True High Fast Inputs
170 ADM 350 15	16 in 16 out	Input Output	24 VDC, True Low
170 ADM 370 10	16 in 8 out	Input Output	24 VDC @ 2 A
170 ADM 390 10	16 in 12 out	Input Output	24 VDC
170 ADM 390 30	10 in 8 relay out	Input Output	24 VDC
170 ADM 690 51	10 in 8 out	Input Output	120 VAC
170 ADO 340 00	16	Output	24 VDC
170 ADO 350 00	32	Output	24 VDC
170 ADO 530 50	8	Output	115 VAC @ 2A
170 ADO 540 50	16	Output	120 VAC
170 ADO 730 50	8	Output	230 VAC @ 2A
170 ADO 740 50	16	Output	230 VAC
170 ARM 370 30	10 in 8 out	Input Output	120 VAC Powered 24 VDC in

Note: The 170 ADM 690 50 has been replaced by the 170 ADM 690 51.

Specials

The following specialty I/O bases are available

Part Number	Points	Type	Details
170 AEC 920 00	2	Counter	24 VDC
170 ANM 050 10		Seriplex	
170 ADM 540 80	6 in/3 out	Modbus	120 VAC

Selecting Other TSX Momentum Components

2

At a Glance

Purpose

A TSX Momentum I/O base must be assembled with a Communication Adapter or Processor Adapter in order to function. If you choose a Processor Adapter, you may also use an Option Adapter.

This chapter describes:

- TSX Momentum adapters
- Terminal connectors
- Busbars.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Which Components Should I Use?	10
Communication Adapters	11
Processor Adapters	12
Option Adapters	14
Terminal Connectors	15
Busbars	16

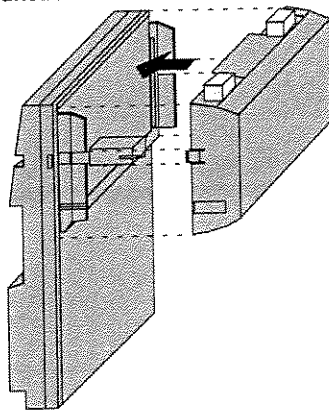
Which Components Should I Use?

Purpose

This section explains the choices you have in assembling a Momentum I/O device.

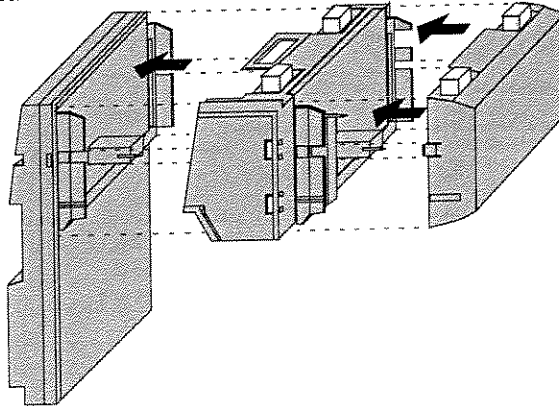
Primary Adapter

Each TSX Momentum I/O base must be assembled with a Communication Adapter or a Processor Adapter. Without one of these adapters, the I/O base will not function.



Option Adapter

If you use a Processor Adapter, you may add an Option Adapter. Option Adapters cannot be used with Communication Adapters.



Terminal Connectors

Terminal connectors must be used to connect I/O devices to the I/O base.

Busbars

Busbars may be used to support 3- and 4-wire field devices. They are optional.

Communication Adapters

Overview This section describes the function of Communication Adapters, the types available and where to get more information.

Function A Communication Adapter provides an interface between an I/O base and a number of industry standard open-communication networks.

Types The following Communication Adapters are available:

For This Network...	Order This Adapter...	And This Manual...
ControlNet	170 LNT 810 00	870 USE 007 00
DeviceNet	170 LNT 710 00	870 USE 104 00
Ethernet	170 ENT 110 01	870 USE 114 00
FIPI/O	170 FNT 110 00	870 USE 005 00
InterBus	170 INT 110 00 170 INT 110 01 170 INT 120 00	870 USE 009 00
Modbus Plus (IEC data format)	170 PNT 110 20 (Single Port) 170 PNT 160 20 (Dual Port)	870 USE 103 00
Modbus Plus (984 data format)	170 NEF 110 21 (Single Port) 170 NEF 160 21 (Dual Port)	870 USE 111 00
Profibus-DP	170 DNT 110 00	870 USE 004 00

For More Information

Refer to the manuals specified in the chart above.

Processor Adapters

Overview

This section describes the function of Processor Adapters, the types available and where to get more information.

Function

A Processor Adapter is a Programmable Logic Controller (PLC). It stores and executes a logic program and controls I/O points over a common communication bus. It is designed to mount on any Momentum I/O base and to control its points as local I/O.

12 TSX Momentum Processor Adapters are available.

Model	Internal Memory	Flash RAM	Clock Speed	Comm Ports
171 CCS 700 00	64K bytes	256K bytes	20 MHz	One Modbus RS-232 port
171 CCS 700 10	64K bytes	256K bytes	32 MHz	One Modbus RS-232 port
171 CCS 760 00	256K bytes	256K bytes	32 MHz	One Modbus RS-232 port
				One I/O Bus port
171 CCC 760 10	512K bytes	512K bytes	32 MHz	One Modbus RS-232 port
				One I/O Bus port
171 CCS 780 00	64K bytes	256K bytes	20 MHz	One Modbus RS-232 port
				One Modbus RS-485 port
171 CCC 780 10	512K bytes	512K bytes	32 MHz	One Modbus RS-232 port
				One Modbus RS-485 port
171 CCC 960 20	512K bytes	512K bytes	50 MHz	One Ethernet port
				One I/O Bus port
171 CCC 960 30	512K bytes	512K bytes	50 MHz	One Ethernet port
				One I/O Bus port
171 CCC 980 20	512K bytes	1 M bytes	50 MHz	One Ethernet port
				One Modbus RS-485 port

Model	Internal Memory	Flash RAM	Clock Speed	Comm Ports
171 CCC 980 30	512K bytes	1 M bytes	50 MHz	One Ethernet port
				One Modbus RS-485 port
171 CCC 960 91	512K bytes	512K bytes	50 MHz	One Ethernet port
				One I/O Bus port
171 CCC 980 91	512K bytes	1 M bytes	50 MHz	One Ethernet port
				One Modbus RS-485 port

For More Information

For detailed descriptions of all the Processor Adapters, refer to the *TSX Momentum Processor Adapter and Option Adapter User Guide* (870 USE 101 00).

Option Adapters

Overview	This section describes the function of Option Adapters, the types available and where to get more information.								
Function	An Option Adapter is used in conjunction with a Processor Adapter and an I/O base to provide: <ul style="list-style-type: none">• A time-of-day clock• A battery backup• One or more additional communication ports								
Types	The following Option Adapters are available <table border="1"><thead><tr><th>For These Communication Ports...</th><th>Order Adapter Part Number...</th></tr></thead><tbody><tr><td>One user-selectable RS-232/RS-485 port</td><td>172 JNN 210 32</td></tr><tr><td>One Modbus Plus port</td><td>172 PNN 210 22</td></tr><tr><td>Two (redundant) Modbus Plus ports</td><td>172 PNN 260 22</td></tr></tbody></table>	For These Communication Ports...	Order Adapter Part Number...	One user-selectable RS-232/RS-485 port	172 JNN 210 32	One Modbus Plus port	172 PNN 210 22	Two (redundant) Modbus Plus ports	172 PNN 260 22
For These Communication Ports...	Order Adapter Part Number...								
One user-selectable RS-232/RS-485 port	172 JNN 210 32								
One Modbus Plus port	172 PNN 210 22								
Two (redundant) Modbus Plus ports	172 PNN 260 22								
For More Information	For detailed descriptions of all the Option Adapters, refer to the <i>TSX Momentum Processor Adapter and Option Adapter User Guide</i> (870 USE 101 00).								

Terminal Connectors

Overview

This section describes:

- The function of terminal connectors
- The coding key feature
- Types of terminal connectors available
- How many are needed
- How to order them

Function

Terminal connectors are used to connect I/O field devices and the power supply to the I/O base. While busbars may also be used, terminal connectors are electrically connected to the module, busbars are not.

Coding Key Feature

Some I/O bases can be operated over dangerous voltage ranges (above 42.4 VAC and above 60 VDC). Coding keys shipped with the I/O base and coding tabs shipped with the terminal connector can be used to prevent the accidental insertion into an I/O base of a terminal connector wired for the wrong voltage range. For information on using coding keys, see *Using Terminal Connector Coding Keys*, p. 32.

Note: For maximum protection, key coding is required during installation.

Types

Terminal connectors are available in screw-in and spring-clip versions.



Screw-type terminal block



Spring-clip terminal block

How Many Do I Need?

One terminal connector is required for each row of terminals that you will connect to the module's operating voltages and field devices.

Ordering Information

Terminal connectors must be ordered separately. They are available in kits of three. They are not shipped with the Momentum I/O bases

Type	Kit Part Number	Wire Type	Wire Size
Screw-in (set of 3)	170 XTS 001 00	Solid or stranded	If one wire, use 12AWG (2.5mm ²) max. If two wires, use 14AWG (1.5mm ²) max.
Spring-clip (set of 3)	170 XTS 002 00	Solid only	

Busbars

Overview

This section describes:

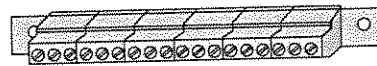
- The function of busbars
- Types of busbars
- How to choose a busbar
- How to order a busbar

Function

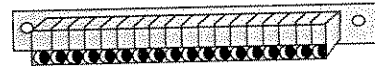
A busbar may be plugged into the fourth row of an I/O base. Busbars provide a common connection for the field devices and serve as protective distribution connectors, for instance to PE. Each row of terminals on the busbar is connected internally. There is no electrical connection to the I/O base.

Types

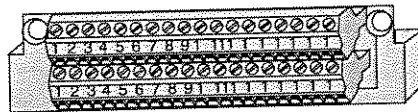
Depending on the I/O base and the type and number of field devices to which it is connected, a 1-, 2-, or 3-row busbar may be used. They are available in screw-in and spring-clip versions.



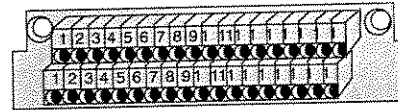
Screw-in 1-row busbar



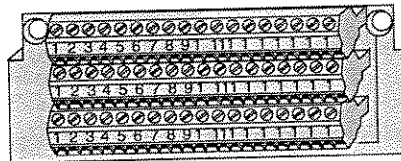
Spring-clip 1-row busbar



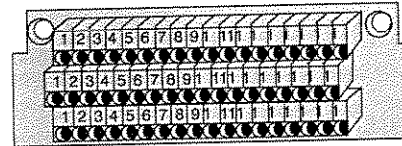
Screw-in 2-row busbar



Spring-clip 2-row busbar



Screw-in 3-row busbar



Spring-clip 3-row busbar

Specifications

Busbars have the following specifications:

Busbar type	Screw-in	Spring-clip
Max. load at 20 deg. C	250 V 14 A	250 V 17.5 A
Short circuit	100 A 30 s	100 A 30 s
Test voltage	2.2 kV	2.2 kV
Creepage / air dist.	per IEC 664A	per IEC 664A
Pollution	Degree 2	Degree 2
Contact derating at 70 deg. C	ca. 60% of nominal value	ca. 60% of nominal value

How to Choose a Busbar

See the internal pin connections and field wiring diagrams associated with your I/O base to determine whether or not you need a busbar and which busbar best suits your needs.

Ordering Information

Busbars should be ordered separately. They are not shipped with I/O bases.

Busbar Type	Part Number	# of Rows	Wire Size
Screw-in	170 XTS 006 01	1	If one wire, use 10AWG (4mm ²) max. If two wires, use 14AWG (2.5mm ²) max.
	170 XTS 005 01	2	One or two wires 14AWG (2.5mm ²) max.
	170 XTS 004 01	3	One or two wires 14AWG (2.5mm ²) max.
Spring-clip	170 XTS 007 01	1	If one wire, use 10AWG (4mm ²) max. If two wires, use 14AWG (2.5mm ²) max.
	170 XTS 008 01	2	One or two wires 14AWG (2.5mm ²) max.
	170 XTS 003 01	3	One or two wires 14AWG (2.5mm ²) max.

Selecting Other Components

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Project No. 79538-C3116

Date: June 21/06 By: [Signature]

- ⊕ Momentum M1 Processor Adapter and Option Adapter User Guide
 - ⊕ Getting Started with Momentum Components
 - ⊕ Overview of Momentum M1 Processor Adapters
 - ⊕ Features of Each M1 Processor Adapter
 - ⊕ **171 CCC 780 10 (M1 Processor Adapter)**

Overview

This section describes the 171 CCC 780 10 Processor Adapter, including key features, an illustration and specifications.

Key Features

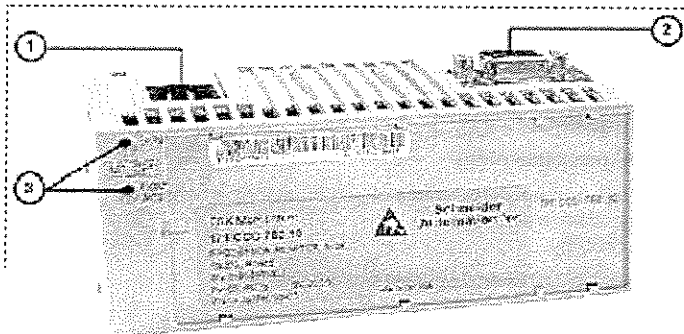
The key features of this Processor Adapter are:

- Modbus Port 1
- Modbus Port 2
- 512K bytes of internal memory
- 32 MHz clock speed

Note: The Modbus port connector looks like a Ethernet port connector. Do not attempt to use an Modbus adapter as an Ethernet unit. Do not attempt to place an Ethernet connector in a Modbus connector.

Illustration

The connector and LED indicators are shown in the following illustration:



Legend:

Label	Description
1	Modbus Port 1 connector
2	Modbus Port 2 connector
3	LED indicators

LED Indicators

This Processor Adapter has two LED indicators, RUN and COM ACT. Their functions are described in the table below:

LED	Status	Function
Start up	Both	Single flash. Indicates good health.
RUN	Green	On continuously when the CPU has received power and is solving logic.

		Flashes an error pattern if the CPU is in kernel mode. (See Run LED Flash Patterns and Error Codes)
	Off	CPU is not powered up or is not solving logic.
COM ACT	Green	May be on continuously or blinking. Indicates activity on Modbus port 1.
	Off	No activity on Modbus port 1.

Specifications

The following table contains specifications for the 171 CCC 780 10 Momentum M1 Processor Adapter:

Memory

Internal Memory	512K bytes
User Memory	18K words
Flash RAM	512K bytes
Clock Speed	32 MHz

Input and Output References

Registers	26032
Discretes	8192 0x references
	8192 1x references

I/O Servicing

Local I/O	Services all the points on any host Momentum I/O base
Watchdog timeout	262 ms
Logic solve time	0.16 ms/k ladder logic instructions

Mechanical

Weight	42.5 g (1.5 oz)
Dimensions (HxDxW)	25.9x61.02x125mm (1.01 x 2.37 x 4.86 in)
Material (Enclosures/bezels)	Lexan

Operating Conditions

Temperature	0 ... 60 degrees C
Humidity	5 ... 95% (noncondensing)
Chemical interactions	Enclosures and bezels are made of Lexan, a polycarbonate that can be damaged by strong alkaline solutions
Altitude, full operation	2000m (6500ft)
Vibration	10 ... 57Hz @ 0.075mm displacement amplitude 57...150Hz @ 1g
Shock	Ref. IEC 68-2-6 FC +/-15g peak, 11ms, half sine wave Ref. IEC 68-2-27 EA
RFI Susceptibility/ immunity	Meets CE mark requirements for open equipment. Open equipment should be installed in an industry-standard enclosure, with access restricted to qualified service personnel.

Storage Conditions

Temperature	-40 ... +85 degrees C
Humidity	5 ... 95% (noncondensing)

Safety Parameters

Degree of protection	Unintentional access (UL 508 Type 1, NEMA250 Type 1, IP20 conforming to IEC529)
Di-electric strength	RS232 and I/OBus are non-isolated from logic common
Ground continuity	30 A test on the exposed metal connector
Agency Approvals	UL 508, CSA, CUL, CE, FM class1, div2

- ⊕ Momentum M1 Processor Adapter and Option Adapter User Guide
 - ⊕ Getting Started with Momentum Components
 - ⊕ Overview of Momentum M1 Processor Adapters
 - ⊕ Features of Each M1 Processor Adapter
 - **171 CCS 760 00 (M1 Processor Adapter)**

Overview

This section describes the 171 CCS 760 00 Processor Adapter, including key features, an illustration and specifications.

Key Features

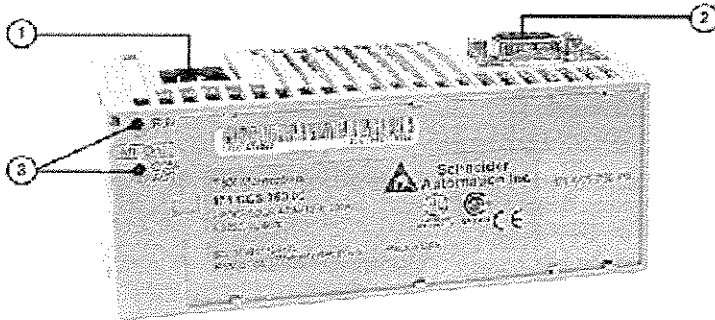
The key features of this Processor Adapter are:

- Modbus Port 1
- I/O Bus Port
- 256K bytes of internal memory
- 20 MHz clock speed

Note: The Modbus port connector looks like a Ethernet port connector. Do not attempt to use an Modbus adapter as an Ethernet unit. Do not attempt to place an Ethernet connector in a Modbus connector.

Illustration

The connector and LED indicators are shown in the following illustration:



Legend:

Label	Description
1	Modbus Port 1 connector
2	I/O Bus port connector
3	LED indicators

LED Indicators

This Processor Adapter has two LED indicators, RUN and COM ACT. Their functions are described in the table below:

LED	Status	Function
Start up	Both	Single flash. Indicates good health.

RUN	Green	On continuously when the CPU has received power and is solving logic. Flashes an error pattern if the CPU is in kernel mode. (See Run LED Flash Patterns and Error Codes)
	Off	CPU is not powered up or is not solving logic.
COM ACT	Green	May be on continuously or blinking. Indicates activity on Modbus port 1.
	Off	No activity on Modbus port 1.

Specifications

The following table contains specifications for the 171 CCS 760 00 Momentum M1 Processor Adapter:

Memory

Internal Memory	256K bytes
User Memory	12K words
Flash RAM	256K bytes
Clock Speed	20 MHz

Input and Output References

Registers	4096
Discretes	2048 (any combination of 0x and 1x references)

I/O Servicing

Local I/O	Services all the points on any host Momentum I/O base
Watchdog timeout	419 ms
Logic solve time	0.25 ms/k ladder logic instructions

Mechanical

Weight	42.5 g (1.5 oz)
Dimensions (HxDxW)	25.9x61.02x125mm (1.01 x 2.37 x 4.86 in)
Material (Enclosures/bezels)	Lexan

Operating Conditions

Temperature	0 ... 60 degrees C
Humidity	5 ... 95% (noncondensing)
Chemical interactions	Enclosures and bezels are made of Lexan, a polycarbonate that can be damaged by strong alkaline solutions
Altitude, full operation	2000m (6500ft)
Vibration	10 ... 57Hz @ 0.075mm displacement amplitude 57...150Hz @ 1g
Shock	Ref. IEC 68-2-6 FC +/-15g peak, 11ms, half sine wave
RFI Susceptibility/ immunity	Ref. IEC 68-2-27 EA Meets CE mark requirements for open equipment. Open equipment should be installed in an industry-standard enclosure, with access restricted to qualified service personnel.

Storage Conditions

Temperature	-40 ... +85 degrees C
Humidity	5 ... 95% (noncondensing)

Safety Parameters

Degree of protection	Unintentional access (UL 508 Type 1, NEMA250 Type 1, IP20 conforming to IEC529)
Di-electric strength	RS232 and I/OBus are non-isolated from logic common
Ground continuity	30 A test on the exposed metal connector
Agency Approvals	UL 508, CSA, CUL, CE; FM class1, div2

⊞ Momentum M1 Processor Adapter and Option Adapter User Guide

⊞ Getting Started with Momentum Components

⊞ Overview of Momentum Option Adapters

⊞ Modbus Plus Option Adapter

⊞ Front Panel Components of the Momentum Modbus Plus Option Adapter

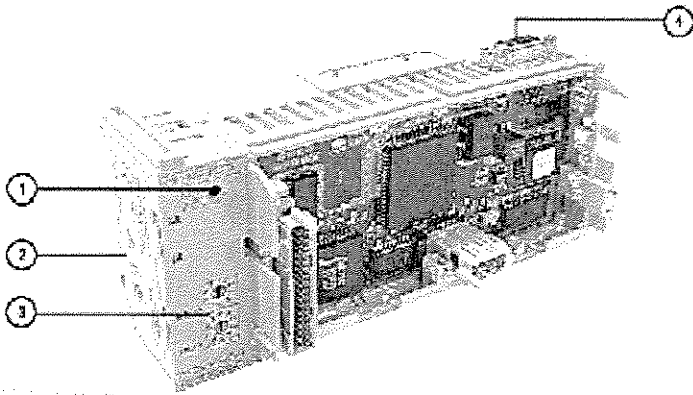
Overview

The front panel includes:

- An LED indicator
- Battery compartment
- Address switches
- 9-pin D-shell connector for Modbus Plus communications

Illustration

The illustration below shows the LED indicator, address switches, Modbus Plus connector, and battery compartment.



Legend:

Label	Description
1	LED indicator
2	Battery compartment door
3	Address switches for Modbus Plus
4	9-pin D-shell connector for Modbus Plus communications

LED Indicator

This Option Adapter has one LED indicator, the MB+ ACT indicator. This indicator flashes the following patterns, based on the status of the Modbus Plus node:

Pattern	Meaning
6 flashes/s	This is the normal operating state for the node. It is receiving and passing the network token. All nodes on a healthy network flash this pattern.
1 flash/s	The node is offline just after power-up or after exiting the 6 flashes/s mode. In this state, the node monitors the network and builds a table of active nodes. After being in this state for 5s, the node attempts to go to its normal operating state, indicated by 6 flashes/s.
2 flashes, then OFF for 2s	The node detects the token being passed among the other nodes, but never receives the token. Check the network for an open circuit or defective

3 flashes, then OFF for 1.7s

4 flashes, then OFF for 1.4s

ON

OFF

termination.

The node is not detecting any tokens being passed among the other nodes. It periodically claims the token but cannot find another node to which to pass it. Check the network for an open circuit or defective termination.

The node has detected a valid message from a node using a network address identical to its own address. The node remains in this state for as long as it continues to detect the duplicate address. If the duplicate address is not detected for 5s, the node changes to its 1 flash/s mode.

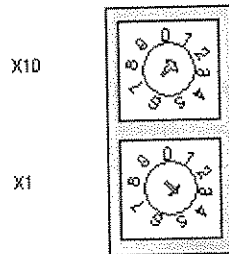
Indicates an invalid node address.

Possible fault with Modbus Plus Option Adapter.

Modbus Plus Address Switches

The two rotary switches on the Option Adapter are used to set a Modbus Plus node address for the CPU module. The switches are shown in the following illustration. Their usage is described in detail in Modbus Plus Addresses in Networks with Momentum Components.

The switches in this illustration are set to address 14.



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Project No. 790338-C31-16

Date: June 21/06 By: Mr

170 ADM 850 10 10 to 60 VDC Module Base

Doc ID: 170ADM85010

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Doc ID: 170ADM85010

Overview

Purpose

This chapter describes the 170 ADM 850 10 Module Base.

What's in this Chapter?

This chapter contains the following topics.

Topic	Page
Front Panel Components	4
Specifications	6
Internal Pin Connections	9
Field Wiring Guidelines	10
Wiring Diagrams	12
I/O Mapping	17

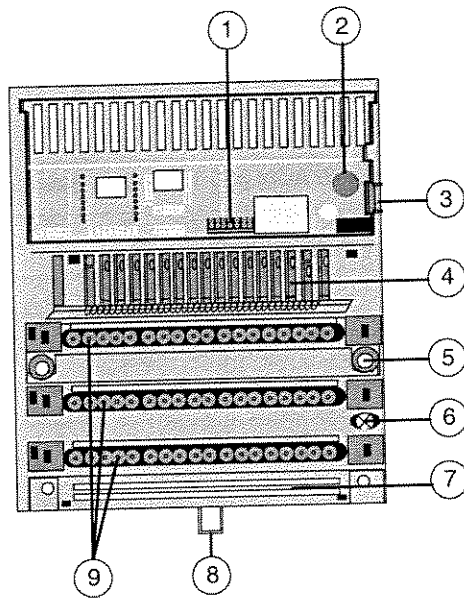
Front Panel Components

Overview

This section contains an illustration of the front panel of the 170 ADM 850 10 Momentum I/O base and a description of the LEDs.

Front Panel Illustration

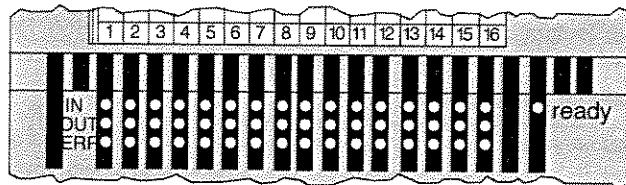
The front panel of the I/O base is shown in the illustration below.



Components of the I/O Module

Label	Description
1	Internal interface (ATI) connector
2	Ground nut standoff
3	Locking and ground contact for the adapter
4	LED status display
5	Mounting holes for panel mount
6	Grounding screw
7	Busbar Mounting Slot
8	Locking tab for DIN rail mount
9	Sockets for the terminal connectors

LED Illustration The LEDs are shown in the illustration below.



LED Descriptions

The LEDs are described in the table below.

Indicator	Condition	Message
Ready	Green	Module is ready to communicate. Operating voltage for internal logic (5 V) is present.
	Off	Module not ready.
Upper row IN 1...16	Green	Input status (an LED per input); Input point active, ie. input carries a 1 signal (logically ON)
	Off	Input point inactive, ie. input carries a 0 signal (logically OFF)
Middle row OUT 1...16	Green	Output status (an LED per output); Output point active, ie. output carries a 1 signal (logically ON)
	Off	Output point inactive, ie. Output carries a 0 signal (logically OFF)
Lower row ERR 1...16	Red	Output overload (an LED per output). Short circuit or overload on the corresponding output.
	Off	Outputs 1 ... 16 operating normally.

Specifications

Overview

This section contains specifications for the 170 ADM 850 10 Momentum I/O base.

General Specifications

General Specifications

Module type	16 discrete inputs in 1 group 16 discrete outputs in 1 group
Supply voltage	10-60 VDC
Supply voltage range	10-60 VDC
Supply current consumption max	500 mA at 12 VDC 250 mA at 24 VDC 125 mA at 48 VDC
Power dissipation	$6 \text{ W} + (\# \text{ of input points on } \times .144 \text{ W}) +$ $(\# \text{ of output points on } \times .25 \text{ W})$
I/O map	1 input word or 16 discrete inputs 1 output word or 16 discrete outputs

Isolation

Input to input	none
Output group to output group	none
Input to output	707 VDC
Logic to output	707 VDC
Field to protective earth	707 VDC
Input to output	707 VDC
Field to communication adapter	Defined by Communication Adapter type

Fuses

Internal	none
External: operating voltage (row 1)	12 VDC-630 mA fast-blow 24 VDC-315 mA fast-blow 48 VDC-200 mA fast-blow
External: input reference voltage (row 3)	315 mA fast-blow
External: output voltage (row 2)	According to the supply of the connected actuators—not to exceed 10 A fast-blow.

EMC

Immunity	IEC 1131-2 Surge on auxiliary power supply, 500V
Emissions	EN 50081-2 (limitation A)
Agency approvals	UL, CSA, CE, FM Class 1, Div. 2 pending

Physical dimensions

Width	125 mm (4.9 in)
Depth (with no adapter)	40 mm (1.54 in)
Length	141.5 mm (5.5 in) with or without one busbar 159.5mm (6.3in) two busbars 171.5 mm (6.75in) three busbars
Weight	200 g (0.44 lb)

Discrete Inputs

Number of points	16
Number of groups	1
Points per group	16
Signal type	True High
IEC 1131 type	1+ (See Appendix for definitions of IEC input types.)
Input Voltage Level	
12 VDC +20%,-15%	>7.5 VDC On, <2.5 VDC Off
24 VDC +25%,-20%	>11 VDC On, <5 VDC Off
48 VDC +25%,-20%	>30 VDC On, <10 VDC Off
OFF State Leakage Current	
12 VDC	1.5 mA and lower
24 VDC	1.5 mA and lower
48 VDC	1.5 mA and lower
Input Operating Current	
12 VDC ON Current	2.3 mA
24 VDC ON Current	2.7 mA
48 VDC ON Current	2.9 mA
Input voltage range	10-60 VDC
Input voltage surge	75 volts peak for 10ms
Response time	2.2 ms OFF to ON 3.3 ms ON to OFF

Note: Discrete 10-60 VDC inputs require an Input Voltage Reference (row 3 terminal block, terminals 17 and 18). The Input Voltage Reference must be the same voltage level as the voltage level as supplied to the inputs. This reference is required for the module to select the correct Turn On and Turn Off thresholds for the inputs.

Discrete Outputs

Output type	Solid state switch
Output supply voltage	10-60 VDC
Number of points	16
Number of groups	1
Current capacity	0.5 A/point maximum 8 A/module up to 50 degrees C 7 A/module from 50 degrees C to 60 degrees C
Signal type	True High (sourcing)
Leakage current (output out)	< 1 mA @ 60 VDC
Surge (inrush) current	5 A for 1 ms
On state voltage drop	< 1.0 VDC @ 0.5 A
Fault sensing (See Note Below)	Outputs are electronically safeguarded to assist in short circuit and overload protection
Fault reporting	1 red LED/point (row 3) ON when short current/overload occurs
Error indication	Output overload for at least one output (I/O-Error) to communication adapter
Response time (resistive load / 0.5 A)	< 2.5 ms OFF to ON < 2.5 ms ON to OFF
Maximum switching cycles	1000/h for 0.5 A inductive load 100/s for 0.5 A resistive load 8/s for 1.2 W Tungsten load

Note: Discrete 10-60 VDC outputs incorporate thermal shutdown and overload protection. The output current of a shortened output is limited to a nondestructive value. The short circuit heats the output driver and the output will switch off. The output will switch on again if the driver drops below the overtemperature threshold. If the short circuit still exists, the driver will reach the overtemperature condition again and will switch off again.

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Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

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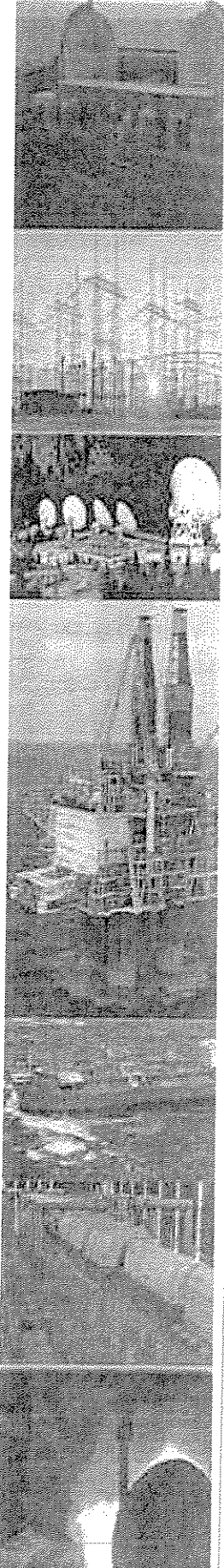
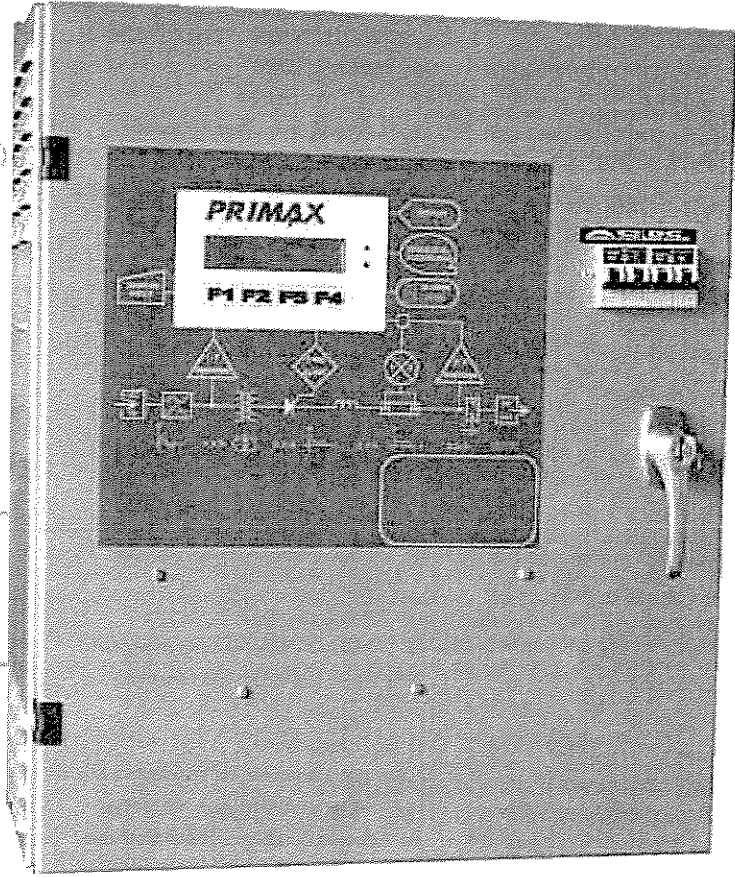
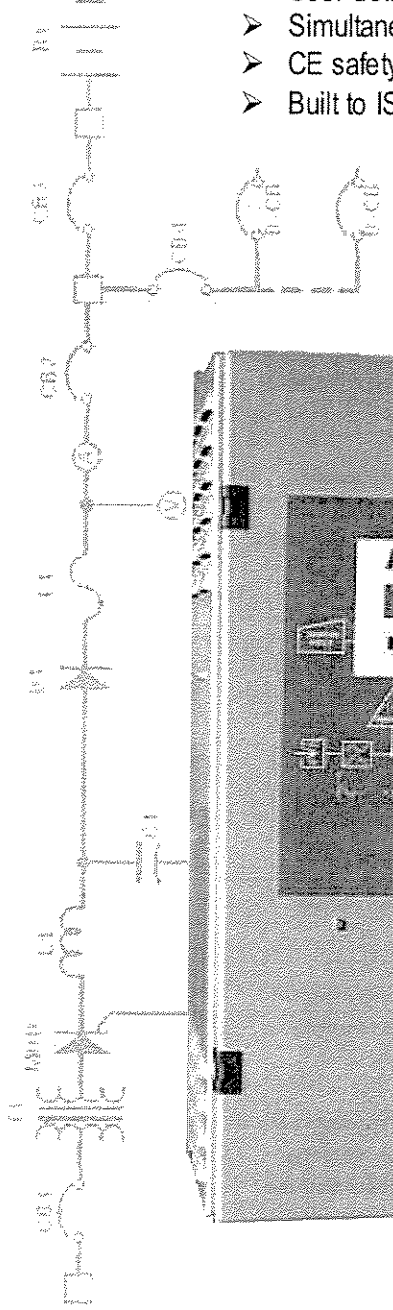
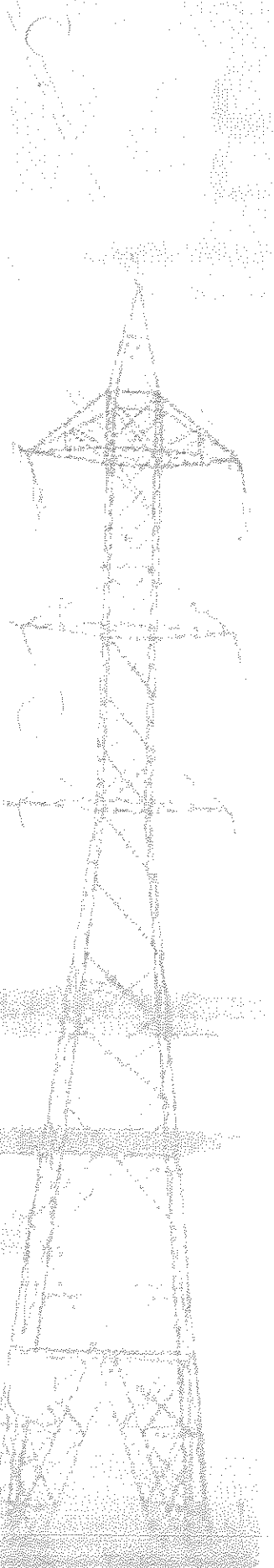
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P4500 Series

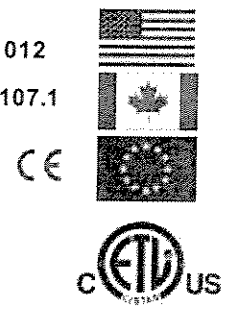
Stationary battery chargers & rectifiers

- Latest digital & power electronics technology
- Reliable industrial design
- User definable control and alarm set-points
- Simultaneous Voltage and current readings
- CE safety and EMC standards tested and compliant
- Built to ISO 9000 QA standards

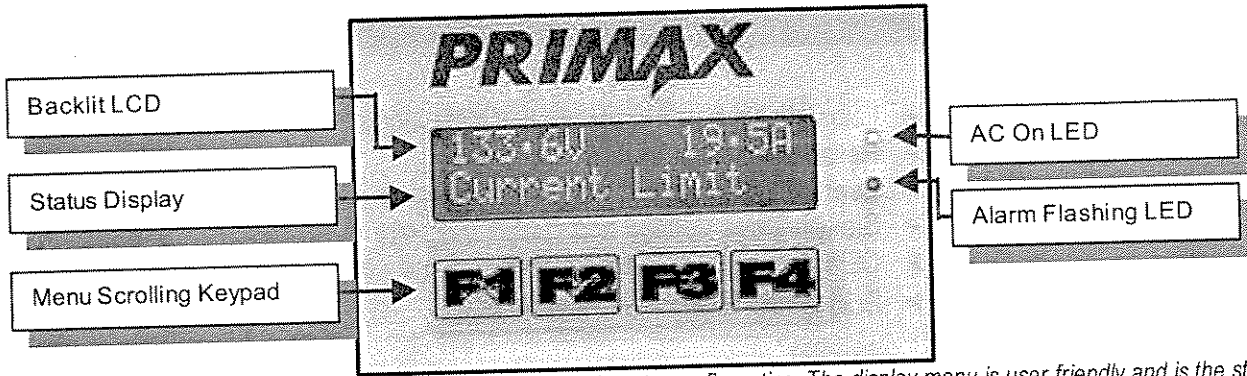


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 0100111107011000101001010011100101000111010
 1101010010101 www.primax-e.com 101001101110100
 1001110101011000011101

UL/ANSI1012
 CSA C22.2-107.1



Control Display:



The Digital Multilingual Display delivers all charger information at your fingertips. The display menu is user friendly and is the standard link between the operator and all monitoring control & alarms. All set points for control and alarm parameters are user-definable. The P4500 series design is solid state using SCR phase control to provide regulated DC output and limited current via a smoothing filter, it can operate with or without batteries.

Metering & control

Standard Features

Metering and timing:

- Simultaneous 0.5 % Accuracy DC voltage and current metering +/- 1 digit
- Remaining and elapsed equalize time

Control modes:

- Manual float / equalize toggle
- Negative slope regulation for equal redundant load sharing

Control adjustments (password protected):

- Float and equalize voltage
- Current limit
- Equalize period 0-100 hours
- Float period 0-100 days
- Equalize mode termination based on voltage, time and/or battery voltage event(s)
-

- Antidepressant charge for Ni-Cd

Indicating LEDs:

- AC On green LED
- Common alarm flashing red LED

Alarm menu indications:

- Charger failure based on low volts & low output DC current
- High DC volts
- Low DC volts
- Positive ground fault
- Negative ground fault
- AC fail
- End of discharge alarm
- Software high volts shutdown

Alarm menu functions (password protected):

- Adjustable alarm time delay
- Indications latch
- Alarm relays latch
- Alarm acknowledgment
- Alarm levels adjustment
- LED, LCD and relay test

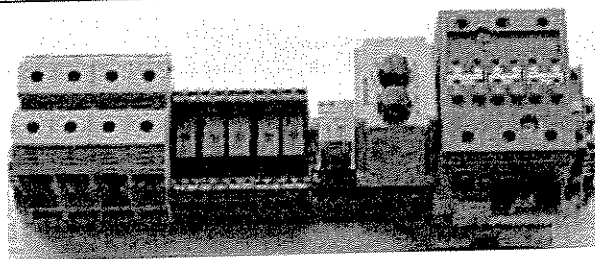
Remote indications:

- All alarms are wired to a common voltage free N.O. and N.C. (form "C") dry contacts

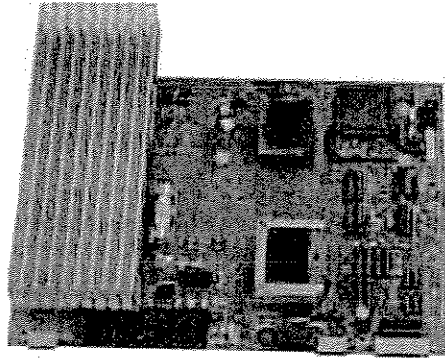
- Individual alarms form C contacts
- RS 232 / 485 communication ports
- Modbus on serial ports
- DNP3 communication protocol
- DC output circuit breaker
- Battery circuit breaker
- Distribution panel
- High capacity interrupting current CBs
- Negative temperature compensation
- High temperature alarm and shut-down
- High volts shutdown via the AC breaker trip
- AC input volts, amps and frequency readings
- High and low AC input voltage alarm

- Power factor correction to 0.95 lagging
- Tropicalization
- Remote voltage sensing terminals
- Remote shutdown and equalize control
- Audible alarm
- Input harmonic filter to comply with CE
- 50Hz or 400 Hz Input frequency
- Low DC volts load disconnect (load shedding)

- Battery high temperature alarm and shutdown
- Battery ammeter and voltmeter
- Ampere-hour meter reading battery capacity % or AH
- Oversized cabinets to fit batteries in separate compartments
- Special paint and NEMA / IP protection
- Seismic design
- Fungus proofing
- Special Wiring



Heavy duty terminal block strip with optional individual form C contacts and low volts disconnect



Combined Digital Control and Alarm Board

Standard Electrical Specifications:

Basic design features

- UL/ANSI 1012 Listed, CSA C22.2 107.1 Certified and applicable IEC standard compliant
- ISO 9002-1994 Quality control compliant
- SCR (Thyristor) based rectifier c/w double wound isolation transformer
- Electronic control, current limiting and voltage regulation
- Alarmlog, history and events
- Modular construction using the latest power and microelectronic devices
- Color coded PVC copper stranded wire for control and signals
- 30 year design, MTBF of 300 000 hours typical, MTTR less than 1 hour

Input:

Available voltages

Phases

Frequency

Power factor

Efficiency at full load

- 110, 120, 208, 220, 240, 380, 400, 480, 550, 575, and 600 VAC
- 1 and 3 phase
- 50 Hz or 60Hz
- 0.75 (1 phase), 0.85 (3 phase) at full load when tested on battery and resistive load
- Typical 90%

Output:

Standard nominal voltages

Power

AC ripple voltage

- Unfiltered units

- Filtered

- Eliminator

Static regulation

Dynamic regulation

Parallel operation

Emc*

- 12, 24, 36, 48, 72, 125, 250, 380, 480 and 600 VDC
- From 60 W to 200+ kW
- < 10% RMS typical (1 ph) and < 4% (3ph) when charger is connected to a battery capacity 4 times its current
- 1% RMS when charger connected to a battery capacity 4 times its current
- 30mVrms / 32dBmc weighted electrical voice band noise for up to 48VDC, 100mV for 125VDC and 200mV for 250VDC
- < 0.5% for simultaneous variations of +10/-12% input voltage, +/- 5% input frequency and 0-100% load
- +/-6% from 10%-90% and 90%-10% load variation (t< 300msec)
- Random: Similar chargers can be operated in random Parallel
- Conducted (150kHz-30MHz) and radiated (30MHz-1GHz): en55011 class A
- Electrostatic discharge EN61000 4-2 level 2/3 (4kV contact, 8kV air)
- Radiated susceptibility: EN61000-4-3 level 3 annex D (80MHz- 1GHz @ 10V/m)
- Electrical fast transient: EN61000-4-4 level 3 (2kV)
- Surge immunity: EN61000-4-5 level 3 (1kV I/I, 2 kV L/GND)
- Conducted susceptibility: EN61000-4-6 level 3 (150kHz to 80mHz, 10v)
- Voltage interrupt: EN61000-4-11 (30, 60&90%- 10-10&5000 ms)

Protection:

Over-current

Voltage transients

- Soft start
- Automatic current limiting circuit, adjustable from 20% to 120% of nominal rating
- Input thermal-magnetic circuit breaker and DC output fuse standard
- Surge suppression on input and output reverse polarity

* : CE Marked Units only

Standard mechanical specifications:

Mechanical and physical:

Enclosure

Finish

Cooling

- CEMA/NEMA1(IP20), 14GA (2mm) steel C/W hinged front access door
 - Standard powder baked ASA61, light gray
 - Natural convection cooling up to 130A output current
 - Forced air cooling assistance for units with over 130A output current
- N.B. Floor mounted models are provided with 3 in. (75mm) clearance at bottom to facilitate handling by lift truck, pallet truck or slings

Environmental

Audible noise

Operating temperature range

Temperature de-rating

Operating humidity

Altitude de-rating

- 45 to 65 dBA at 3ft (1 meter) rating dependant
- 32°F to +122°F (0°C to 50°C)/Storage -40°F to 185 oF (-40°C to 85°C)
- 0.83% /°F from 122°F to 140°F (1.5% /°C from 50°C to 60°C)
- Up to 95% (non condensing)
- 0% for 1st 3300ft (1000m), 7% per 3300ft (1000m) over 3300ft (1000m)

Charger standard adjustment range (VDC)

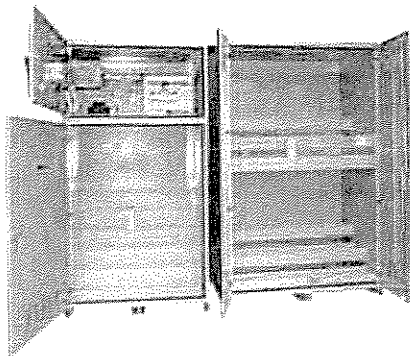
	12V	24V	48V	125V	250V
Float	10-15	20-30	40-60	100-145	200-290
Equalize	10-16	20-32	40-65	100-150	200-300
Single Level	10-16	20-32	40-65	100-150	200-300
Formation	10-16	20-32	40-65	100-150	200-300

Suggested battery voltages

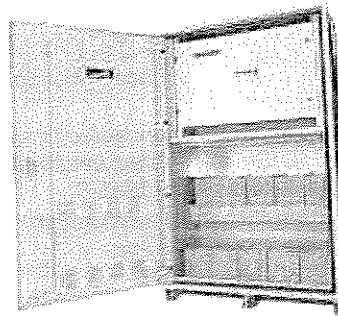
(May vary with manufacturer, type, duty and ambient)

Flooded L/A	Sealed L/A	Nickel Cadmium
2.15-2.25	2.25-2.35	1.35-1.45
2.3-2.5	2.3-2.4	1.45-1.55
2.23-2.3	2.25-2.4	1.42-1.55
2.5-2.7	2.5-2.7	1.55-1.65

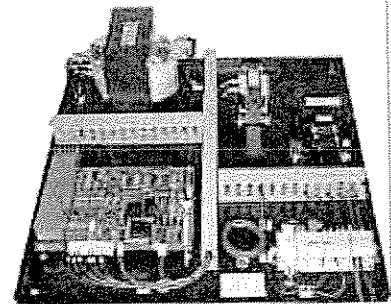
Other configurations



C/W DC panel, Ni-Cd battery compartment, stepped shelves and matching cabinet



NEMA3R charger cabinet c/w battery compartment and shelves



Open frame charger

Primax Technologies Inc.

133 Guthrie, Dorval, QC

Canada, H9P-2P1

Tel: ++514-631-3630

Fax: ++514-631-8389

Email: info @ primax-e.com

Web Site: www.primax-e.com

Distributed by:

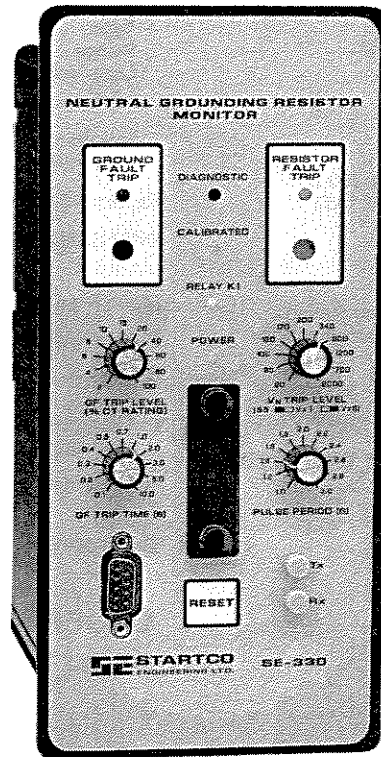
Battery cabinet required with load breakers

Earth Tech (Canada) Inc.	
Reviewed for general conformance with design intent. Responsibility for detailed design in the shop drawings rests with the Contractor.	
Responsibility for verification and correlation of field dimensions, fabrication process, techniques of construction, installation and coordination of all parts of the work rests with the Contractor.	
REVIEWED	_____
REVIEWED AS MODIFIED	_____
REVISE AND RE - SUBMIT	<input checked="" type="checkbox"/>
NOT REVIEWED	_____
Project No.	79538-C31-16
Date:	June 21/06 By: <i>B</i>

2

3

4



Additional information
available at
www.startco.ca

SE-330

NEUTRAL-GROUNDING-RESISTOR MONITOR

The SE-330 is a microprocessor-based neutral-grounding-resistor (NGR) monitor that detects NGR failures and ground faults in resistance-grounded systems. NGR resistance, NGR current, and transformer or generator neutral-to-ground voltage are measured using a current transformer (CT) and an ER-series sensing resistor. The SE-330 responds only to fundamental-frequency current and voltage, and it is not influenced by harmonics.

NGR resistance is continuously measured and a resistor-fault trip will occur if NGR resistance varies from its calibrated value. Ground-fault trip level is adjustable from 2 to 100% of the CT-primary rating and ground-fault trip time is adjustable from 0.1 to 10.0 seconds.

The SE-330 has four output relays—trip or pulsing, ground fault, resistor fault, and unit healthy. Additional features include LED and fluorescent-flag indication, trip memory, front-panel and remote reset, 4–20-mA analog output, RS-232 and optical local communications, and optional network communications with trip-record logging.

TECHNICAL SPECIFICATIONS

Supply	30 VA, 65 to 265 Vac, 40 to 400 Hz, 20W, 80 to 275 Vdc
Power-Up Time	250 ms at 120 Vac
AC Measurements	Discrete Fourier Transform. 16 samples per cycle, 50 or 60 Hz

Resistor-Fault Circuit:

Neutral-To-Ground Voltage Trip-Level Range:	
ER-600VC or ER-5KV	20 to 2,000 Vac
ER-15KV to ER-35KV	100 to 10,000 Vac
Accuracy	5% of setting
NGR Calibration Range:	
ER-600VC or ER-5KV	0 to 2 k Ω
ER-15KV to ER-35KV	0 to 10 k Ω
Trip Resistance, $V_R = 0$:	
ER-600VC or ER-5KV	500- Ω change \pm 200 Ω
ER-15KV to ER-35KV	2.5-k Ω change \pm 1 k Ω
DC-Voltage Rejection:	
ER-600VC or ER-5KV	25 Vdc
ER-15KV to ER-35KV	125 Vdc
Trip Time	12 \pm 1 s
Trip Hold-Off Level	5% of CT-Primary Rating
Operating Mode	Latching/Non-Latching

Ground-Fault Circuit:

Trip Level	2, 4, 6, 8, 10, 15, 20, 40, 60, 80, 100% of CT-Primary Rating
Trip Time	0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10.0 s
Trip-Level Accuracy	1% of CT-Primary Rating
Trip-Time Accuracy	10% of setting
CT-Input Burden:	
5-A Input	< 0.01 Ω
1-A Input	< 0.05 Ω
EFCT Input	< 10 Ω
Thermal Withstand:	
1-A and 5-A Input:	
Continuous	2 x CT Rating
1-Second	20 x CT Rating
EFCT Input:	
Continuous	10 x CT Rating
1-Second	25 x CT Rating
Measurement Range	25 x CT Rating
Operating Mode	Latching/Non-Latching

Pulsing Circuit:

Pulse Period	1.0 to 3.0 s in 0.2-s increments
Duty Cycle	50%
Time Accuracy	10% of setting

Trip/Pulsing Relay K1 Contacts:

Configuration	N.O. (Form A)
Operating Mode	Fail-Safe or Non-Fail-Safe
CSA/UL Contact Ratings	8 A resistive 250 Vac, 5 A resistive 30 Vdc

Supplemental Contact Ratings:

Make/Carry 0.2 s	30 A
Break:	
dc	75 W resistive, 35 W inductive (L/R = 0.04)
ac	2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
Subject to maximums of 8 A and 250 V (ac or dc).	

GF (K2) and RF (K3) Relay Contacts:

Configuration	N.O. and N.C. (Form C)
Operating Mode	Non-Fail-Safe
CSA/UL Contact Ratings	8 A resistive 250 Vac, 8 A resistive 30 Vdc

Supplemental Contact Ratings:

Make/Carry 0.2 s	20 A
Break:	
dc	50 W resistive, 25 W inductive (L/R = 0.04)
ac	2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
Subject to maximums of 8 A and 250 V (ac or dc).	

Unit-Healthy Output K4 (Option 00):

Configuration	N.O. (Form A)
Operating Mode	Closed when Healthy
Ratings	100 mA, 250 V (ac or dc)
Closed Resistance	30 Ω maximum

Unit-Healthy Output K4 (Option 01):

Configuration	N.C. (Form B)
Operating Mode	Open when Healthy
Ratings	100 mA, 250 V (ac or dc)
Closed Resistance	30 Ω maximum

4-20-mA Analog Output:

Type	Self Powered and Loop Powered
Range	4 to 22 mA
Loop Voltage	8 to 36 Vdc
Load	500 Ω (maximum with 24-Vdc supply)
Isolation	120 Vac
Parameter	NGR Current

Terminal-Block Ratings 10 A, 300 Vac, 12 AWG

PWB Conformal Coating MIL-1-46058 qualified,
UL QMJU2 recognized

Mounting Configurations Panel Mount and Surface Mount

Shipping Weight 2.0 kg (4.4 lbs)


Environment:

Operating Temperature	-40 to 60°C
Storage Temperature	-55 to 80°C
Humidity	85% Non-Condensing

Surge Withstand ANSI/IEEE C37.90.1-1989
(Oscillatory and Fast Transient)

Certification  LR 5342B 

ORDERING INFORMATION

SE-330-

Options:
00 N.O. UNIT HEALTHY Contact
01 N.C. UNIT HEALTHY Contact

Network Communications:

0 None
1 DeviceNet™
2 PROFIBUS®
3 Ethernet

Supply:

0 Universal ac/dc Supply

Sensing Resistors:

ER-600VC	1 kVac max. System Voltage
ER-5KV	5 kVac max. System Voltage
ER-15KV	15 kVac max. System Voltage
ER-25KV	25 kVac max. System Voltage
ER-35KV	35 kVac max. System Voltage

Current Sensors:

EFCT-26	5:0.05 A, 26 mm (1") Window
EFCT-1	5:0.05 A, 82 mm (3.2) Window
SE-CS30-26	30:0.05 A, 26 mm (1") Window
SE-CS30-70	30:0.05 A, 70 mm (2.7) Window

Accessories:

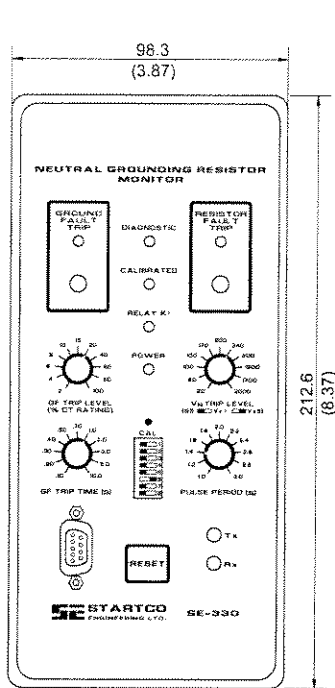
SE-OPT232 Port-Powered Fibre-Optic/
RS-232 Converter

Software: *

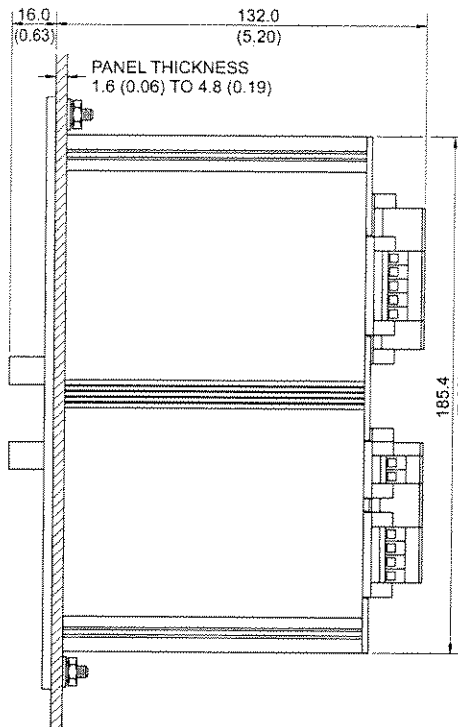
SE-FLASH Firmware Upgrade Program
SE-MON330 SE-330 Data-Display Program for
PC
SE-PDA330 SE-330 Data-Display Program for
PDA

* Available at www.startco.ca.

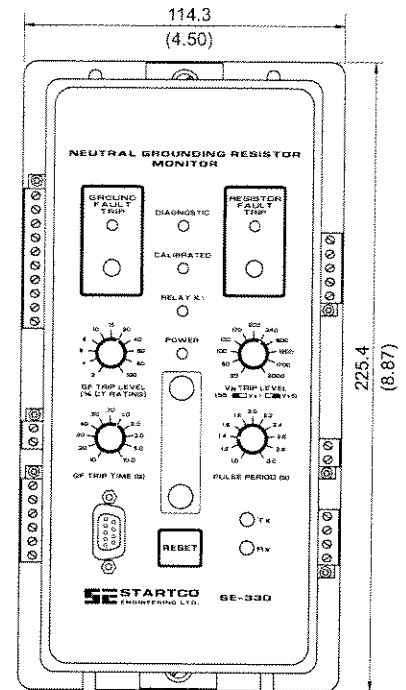
DIMENSIONS



SE-330
PANEL-MOUNT FRONT VIEW



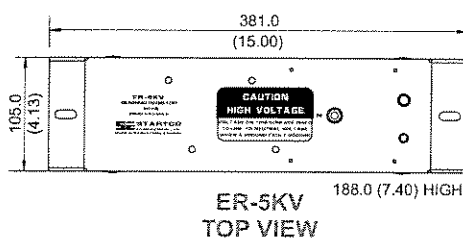
SE-330
PANEL-MOUNT SIDE VIEW



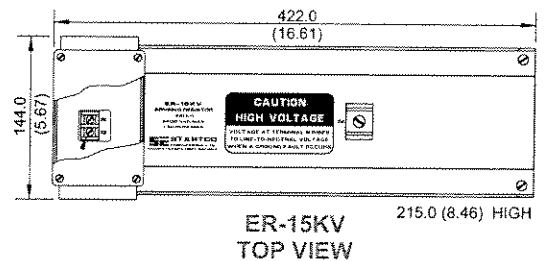
SE-330
SURFACE-MOUNT FRONT VIEW



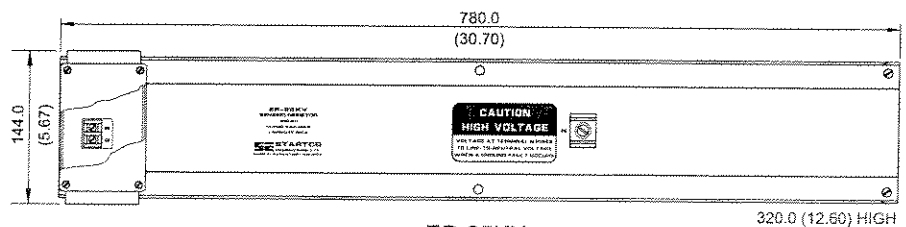
ER-600VC
TOP VIEW



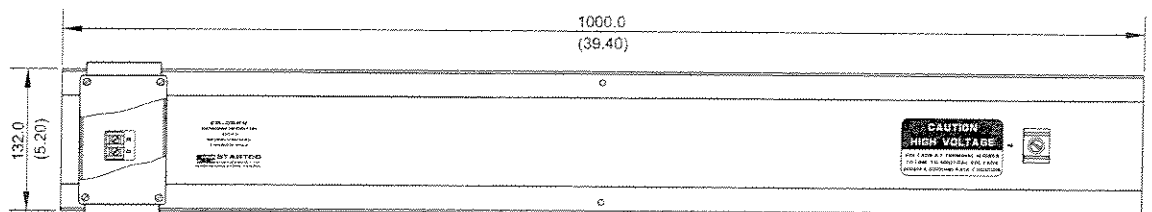
ER-5KV
TOP VIEW



ER-15KV
TOP VIEW



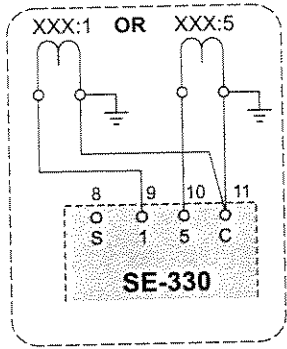
ER-25KV
TOP VIEW



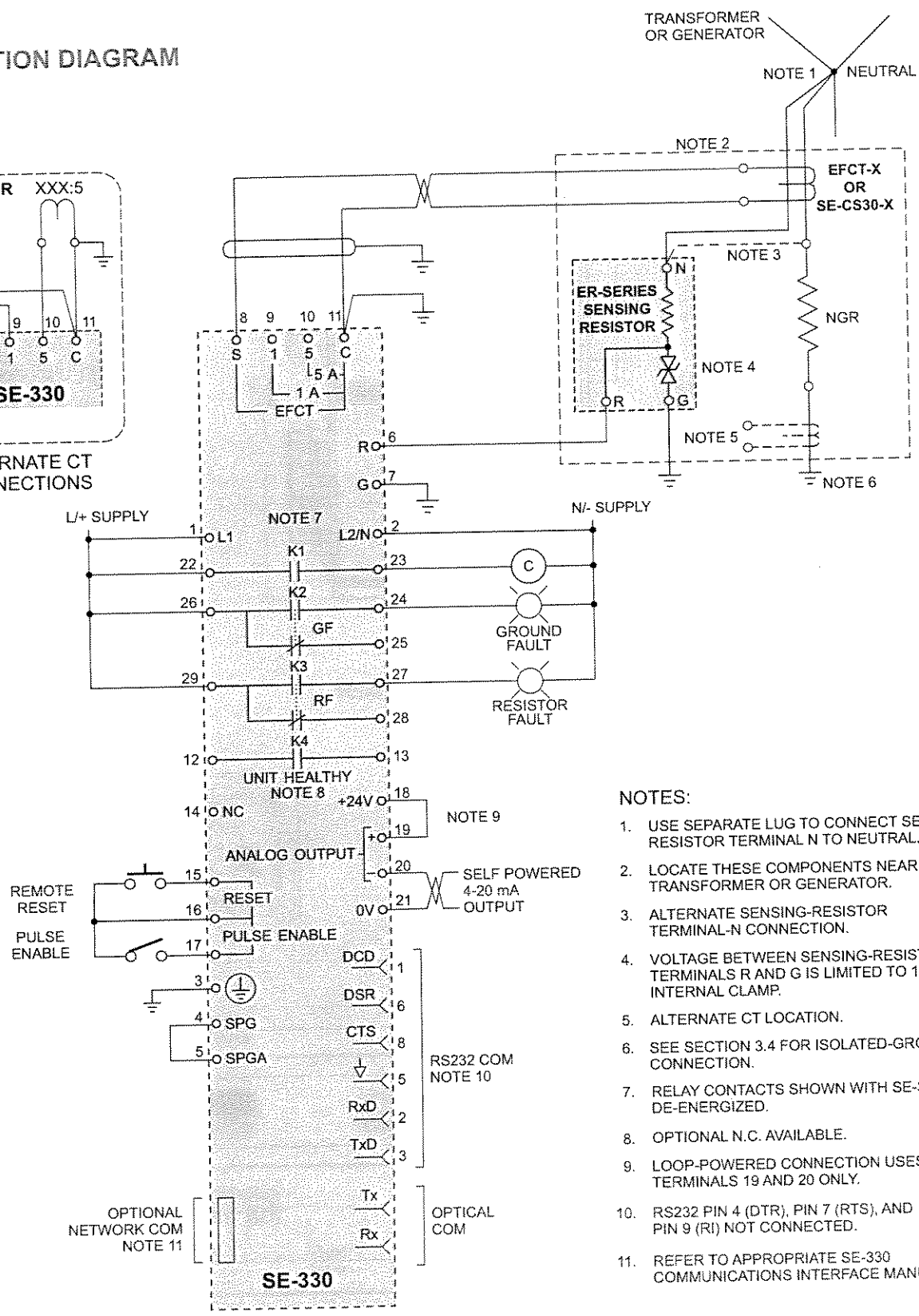
ER-35KV
TOP VIEW

- NOTES:
- FORWARD PROJECTION 138.0 (5.43).
 - DIMENSIONS IN MILLIMETRES (INCHES).
 - CAD DRAWINGS AVAILABLE AT www.startco.ca.

CONNECTION DIAGRAM



ALTERNATE CT CONNECTIONS



- NOTES:**
1. USE SEPARATE LUG TO CONNECT SENSING-RESISTOR TERMINAL N TO NEUTRAL.
 2. LOCATE THESE COMPONENTS NEAR TRANSFORMER OR GENERATOR.
 3. ALTERNATE SENSING-RESISTOR TERMINAL-N CONNECTION.
 4. VOLTAGE BETWEEN SENSING-RESISTOR TERMINALS R AND G IS LIMITED TO 100 V BY INTERNAL CLAMP.
 5. ALTERNATE CT LOCATION.
 6. SEE SECTION 3.4 FOR ISOLATED-GROUND CONNECTION.
 7. RELAY CONTACTS SHOWN WITH SE-330 DE-ENERGIZED.
 8. OPTIONAL N.C. AVAILABLE.
 9. LOOP-POWERED CONNECTION USES TERMINALS 19 AND 20 ONLY.
 10. RS232 PIN 4 (DTR), PIN 7 (RTS), AND PIN 9 (RI) NOT CONNECTED.
 11. REFER TO APPROPRIATE SE-330 COMMUNICATIONS INTERFACE MANUAL.

Specifications are subject to change without notice. Startco Engineering Ltd. is not liable for contingent or consequential damages, or for expenses sustained as a result of incorrect application, incorrect adjustment, or a malfunction. This product has a variety of applications. Those responsible for its application must take the necessary steps to assure that each installation meets all performance and safety requirements including any applicable laws, regulations, codes, and standards. Information provided by Startco is for purposes of example only. Startco does not assume responsibility for liability for use based upon the examples shown.



406 Jessop Avenue, Saskatoon, Saskatchewan, Canada S7N 2S5
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Earth Tech (Canada) Inc.

Reviewed for general conformance with design intent.
Responsibility for detailed design in the shop drawings
rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

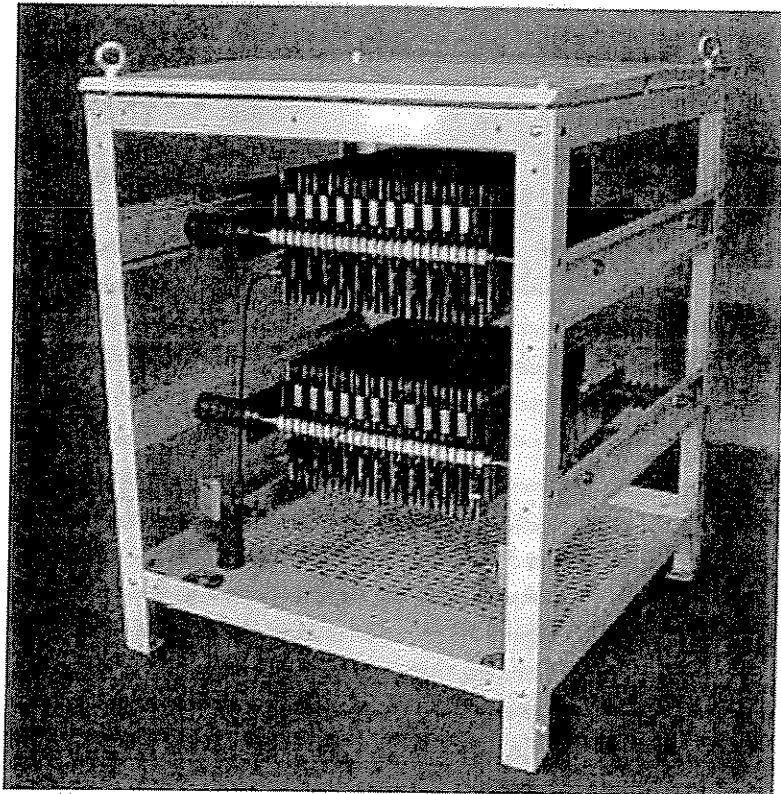
Date: June 21/06 By: BR



Telema & Berger Resistors, Inc.

Neutral Grounding Resistors

Neutral Grounding Resistors designed and manufactured by Telema & Berger Resistors, Inc. are set apart from other resistor manufacturers by one simple word, INNOVATION. Our design techniques utilize twenty first century technology to customize your resistor to the most efficient and economical solution. The punched stainless steel grid elements are computer designed evaluating a given power application confirming grid material, pattern, and thickness. These design programs incorporate numerous types of steel and grid element patterns to provide the best solution for thermal absorption and dissipation of energy in a neutral grounding application. Other resistor manufacturers take a dated approach to resistor design and manufacturing, limiting their element material options. These limitations prove to be costly and not the most effective solution. Telema & Berger Resistors, Inc. innovative and modern approach produces the most cost effective range of resistors from 120V to 72KV to be offered in the industry for over eighty years.





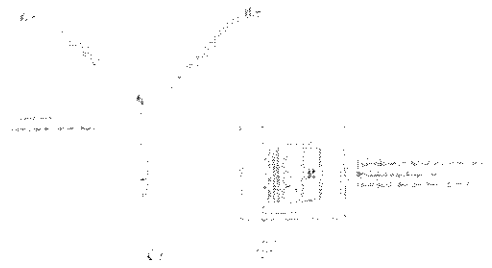
Telema & Berger Resistors, Inc.

NGR Resistor Model



TYPICAL LOW RESISTANCE NEUTRAL GROUNDING SYSTEM

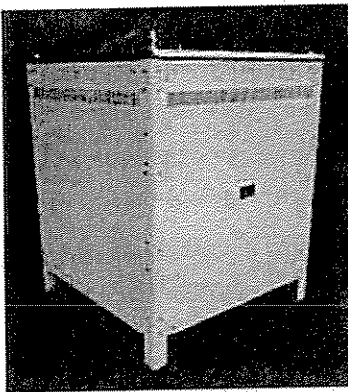
NGR Transformer Model



TYPICAL HIGH RESISTANCE TRANSFORMER NEUTRAL GROUNDING SYSTEM

Neutral Grounding Resistors Application:

Neutral grounding resistors or also called Earthing resistors, are a very important part of today's industrial power system protection. Their primary function is to limit single phase line fault currents to a

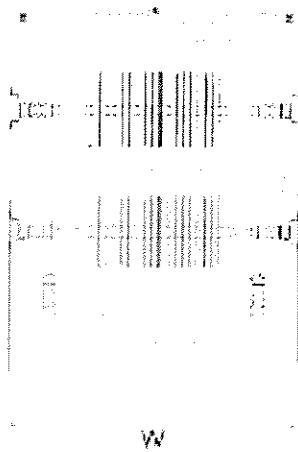


predetermined value. The grounding resistor is located between a transformer or generator neutral and earth ground on 3-phase wye (4 wire) system. (See Figure TYPICAL LOW RESISTANCE NEUTRAL GROUNDING SYSTEMS) If the system is a delta system (3 wire) transformers can be used to generated an artificial neutral which can be used to connect the grounding resistor. Three main neutral deriving transformer techniques are used. They are zig-zag transformer, three wye connected primary with delta connected secondary single phase transformers, or wye-broken delta connected single phase transformers. In some cases, typically medium voltage high resistance grounded systems, a single phase transformer is

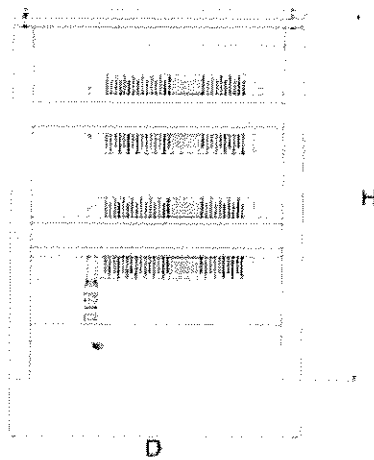
connected to the neutral and earth ground, with the secondary of the transformer connected to the resistor. (see figure TYPICAL HIGH RESISTANCE / TRANSFORMER NEUTRAL GROUNDING SYSTEM). For additional reference see IEEE Standard No. 142-1991 GREEN BOOK, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

There are large variations in the value of fault current levels depending on the application and system designer preferences. In process industry and mining applications where it is imperative to finish a process before shutting down for repairs, it is possible to use high resistance grounding and continue to run with a 5 to 25 amp ground fault until you can shut down for repairs. In other applications fault current limits can be set from 100 to 2,000 Amps. Typical time limits for the fault currents are 10 seconds, 1 minute, 10 minute, extended time, and continuous duty, as described in IEEE Standard 32-1972, Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices.

NGR Front View



NGR Side View



277 VOLTS L-N CONTINUOUS DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
5	10	13 x 11 x 4
10	15	13 x 11 x 8
25	25	12 x 26.5 x 14

3300 VOLTS L-N 10 SECOND DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
100-400	475-625	36 x 36 x 32
500-800	650-700	36 x 36 x 47
1000-1200	750-800	36 x 36 x 77

1390 VOLTS L-N 10 SECOND DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
100-800	200-325	36 x 36 x 32
1000-1200	450	36 x 36 x 47

6600 VOLTS L-N 10 SECOND DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
100-400	425-550	42 x 42 x 47
500-600	575-625	42 x 42 x 62
800	650	42 x 42 x 77
1000-1200	825-900	42 x 84 x 62

2400 VOLTS L-N 10 SECOND DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
100-600	250-375	36 x 36 x 32
800-1200	425-550	36 x 36 x 47

8000 VOLTS L-N 10 SECOND DUTY

INITIAL AMPS	APPROX WEIGHT	DIMENSIONS W" x D" x H"
100-300	550-650	42 x 42 x 47
400-600	675-775	42 x 42 x 62
800	825	42 x 42 x 77
1000-1200	875-975	42 x 84 x 62



Telema & Berger Resistors, Inc.

Neutral Grounding Resistor

QUICK-SPEC SHEET

Contact: _____
 Phone: _____
 Fax: _____

Company: _____
 Address: _____

VOLTAGE (system voltage/line-to-neutral voltage)

- | | | | |
|--------------------------------------|--------------------------------------|---------------------------------------|---|
| <input type="checkbox"/> 480/277 | <input type="checkbox"/> 4,160/2,400 | <input type="checkbox"/> 11,000/6,350 | <input type="checkbox"/> 34,500/19,200 |
| <input type="checkbox"/> 600/347 | <input type="checkbox"/> 6,600/3,810 | <input type="checkbox"/> 12,470/7,200 | <input type="checkbox"/> 34,500/20,000 |
| <input type="checkbox"/> 2,400/1,390 | <input type="checkbox"/> 7,200/4,160 | <input type="checkbox"/> 13,800/8,000 | <input type="checkbox"/> Other: ____/____ |

INITIAL CURRENT: 200 Amps

DUTY CYCLE (time on @ IEEE32-1972 specified element temperature limit):

- 10 seconds @ 760°C 60 seconds @ 760°C Extended Time (10 minutes) @ 610°C Continuous @ 385°C

ENCLOSURE CONSTRUCTION: Factory Standard Mill-Galvanized, or Hot-dipped galvanized
 Aluminum Stainless steel Painted (specify color) _____

NEUTRAL CONNECTION

- Bottom conduit bushing cable entry
 Top mounted neutral bushing
 Side mounted neutral bushing

GROUND CONNECTION

- Bottom conduit bushing cable entry
 Top mounted ground bushing
 Side mounted ground bushing

OPTIONS:

- Elevating Stand, 4ft. 6ft. 8ft. Other _____
 Donut Type Current Transformer for ground cable (specify ratio) _____
 Bar Type Current Transformer for neutral connection (specify ratio) 200:5
 Disconnect Switch (specify type) Manual Hook Stick or Motorized
 Potential Transformer (specify voltage / ratio) _____ / _____

For engineering assistance or
 a competitive quote contact:

Telema & Berger Resistors, Inc.
 1002 Ford Circle, Suite D
 Milford, OH 45150
 Ph: 513.831.7300
 Fax: 513.831.3444
 Web: www.tbresistors.com
 Email: sales@tbresistors.com



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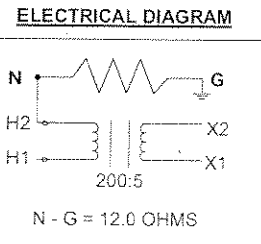
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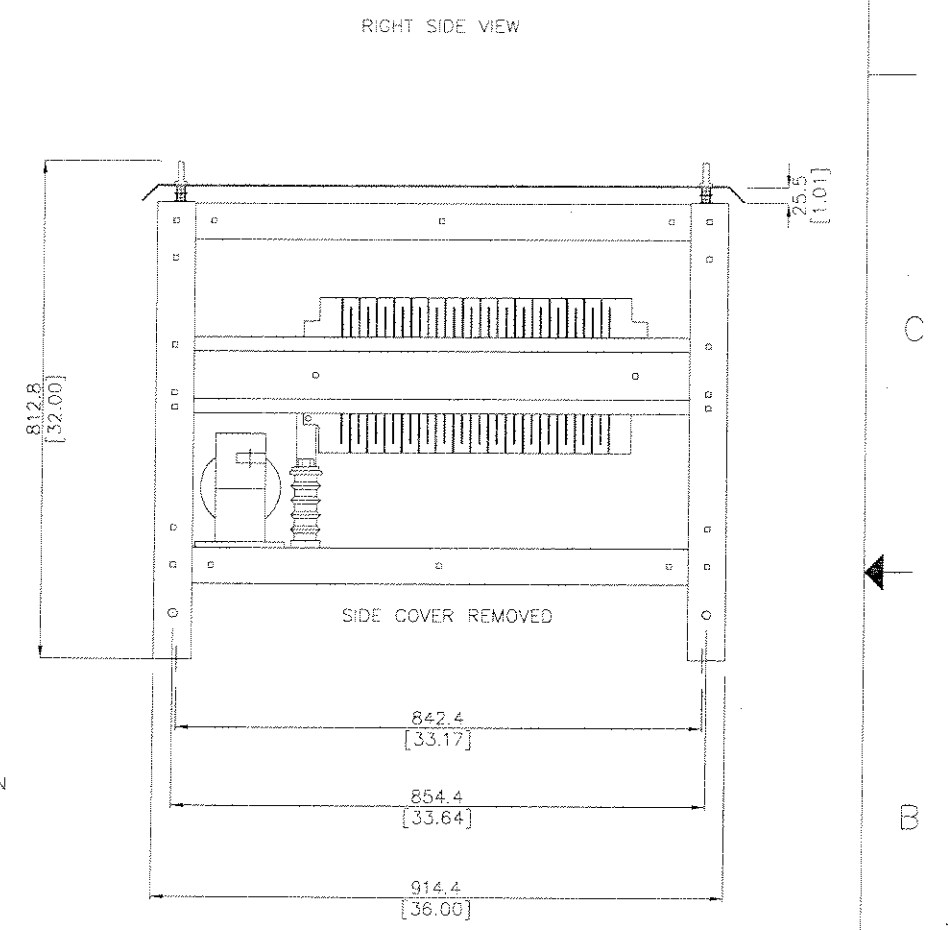
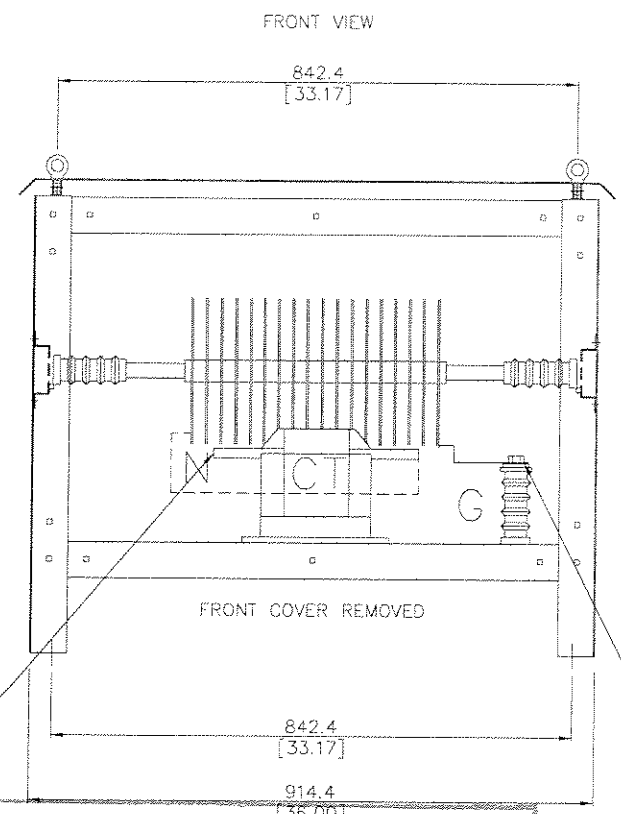
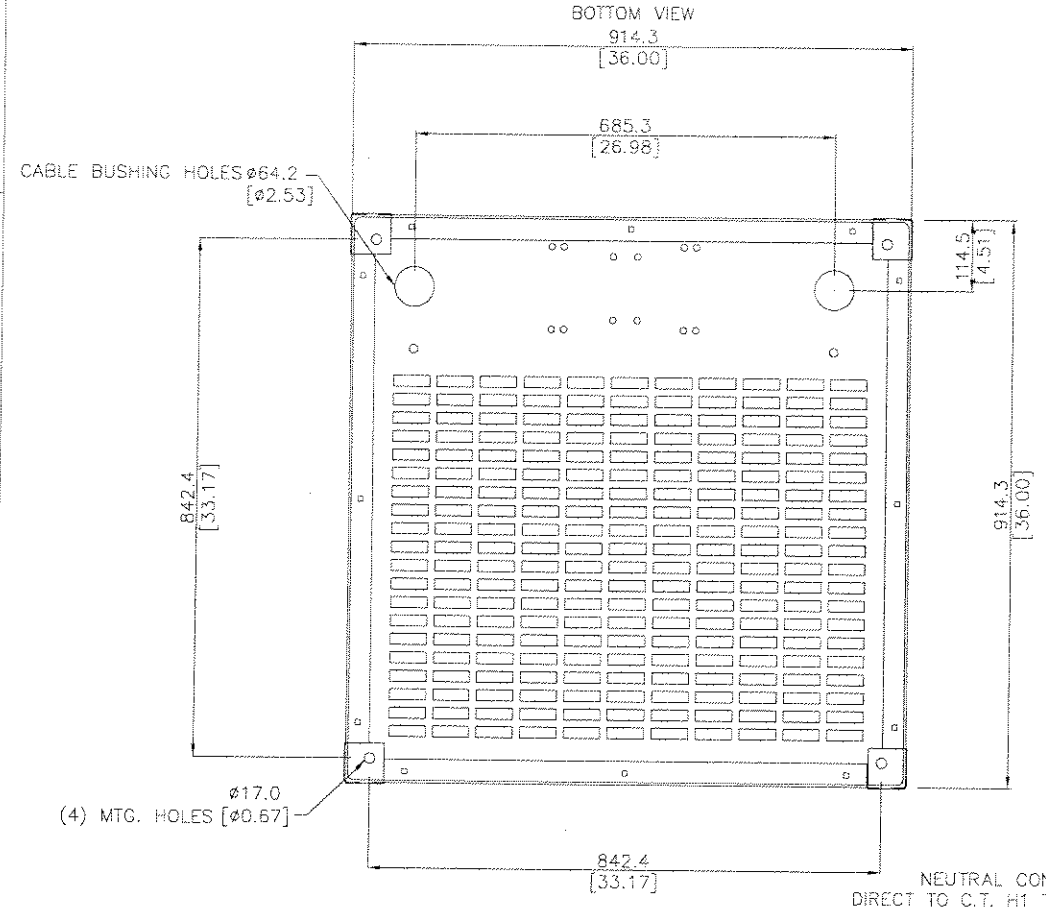
Project No. 79538-C31-16

Date: June 21/06 By: [Signature]



REPLACEMENT PARTS LIST

QTY	P/N	DESCRIPTION
1		GRID RESISTOR
1	EN0033-MG	MILL GALVANIZED ENCLOSURE
5	IG10	GLASTIC INSULATORS
1	CT052005	5KV @ 200:5 CURRENT TRANSFORMER MIN C50



NAMEPLATE INFORMATION

TELEMA & BERGER RESISTORS INC.
 1002 FORD CIRCLE, SUITE D
 MILFORD, OH 45150 PH. (513)831-7300

P/N NG24-2-10 UNIT NO. _____
 DRAWING NO. PRELIMINARY REV. _____
 OHMS @ 20°C 12.0 KW _____
 VOLTS 2400 AMPS 200
 CLASS/DUTY 10SEC. DATE _____

ASSEMBLY NOTES

- REQUIRES (1) BANK PER SET
- 12.0 OHM PER BANK
- USE P25 SPACING IN BANKS
- USE TRM12S THRU-ROD
- USE IG10 INSULATOR WITH 2-HOLE PAD ON GROUND CONNECTION
- USE IG 10 INSULATORS TO MOUNT BANKS
- ALL STAINLESS STEEL HARDWARE AND JUMPERS
- MILL GALVANIZED ENCLOSURE WITH LOUVERED SIDE COVERS
- ENCLOSURE FINISH: NATURAL
- TAG TERMINALS AS SHOWN
- 5KV@200:5 RATIO C.T. C50 MIN.

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 NOT REVIEWED _____

Project No. 79538-C31-16
 Date: June 21/06 By: B

REVISIONS

ZONE/REV	DESCRIPTION	DATE

PRELIMINARY_DRAWING

TESTING PROCEDURE

STANDARD	IEEE32
HIPOT VOLT	7400
RATED OHM	12.0
OHM -10%	10.8
OHM +10%	13.2
SIESMIC	Z4
WEIGHT	300

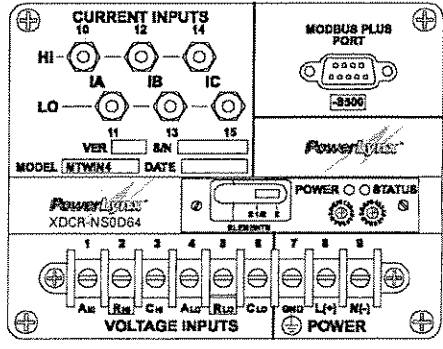


TELEMA & BERGER RESISTORS Inc.
 1002 Ford Circle Suite D
 Milford, OH 45150
 PH. 513-831-7300 FAX 513-831-3444

NEUTRAL GROUNDING RESISTOR
 2400V_L-N @ 200A_12.0_OHMS
 10 SECOND DUTY @ 760°C RISE

AWF
 6/19/03

SIZE B DWG NO Q#030507R02-R1
 APPROVED BY: _____ SCALE NONE SHEET 1 OF 1



MODBUS PLUS PORT

POWERLYNX SYNCHRONIZING POWER BLOCK

PowerLynx Synchronizing Power Block Transducer

Modbus Plus
3-phase
Utility Grade

MEASUREMENTS: Line and Reference Volts, Amps, Power (real, reactive, apparent), Power Factor, Energy, Line and Reference Frequency, phase difference between Line and Reference voltage. Includes many per-phase & total parameters.

SERIAL PORT: One(1) network-connection option. All parameters available in network-accessible registers.

ELEMENT SWITCH: Element-switch is field selectable for 3-wire and 4-wire systems within one instrument. (See Table.)

CURRENT INPUTS: Full transformer isolation. (See Table).

VOLTAGE INPUTS: Full transformer isolation. (See Table).

ENERGY SCALING: Scaling for primary-side energy values when connected to PTs and CTs is provided through CT and PT ratios written into registers over the network.

CERTIFICATION: Meets IEC1010 standards and is certified by Underwriters Laboratory to meet UL and CSA standards.

AUXILIARY POWER: Three(3) power supply options. Includes a universal power supply option which operates from either an ac or dc power source.

MECHANICAL: 5.3" x 5.3" Base x 5.6" high metal case.

QUANTITY & TYPE OF INPUTS TABLE

Electric System	3-Wire	4-Wire
Element Switch	2	2-1/2
Current Inputs	2 or 3	3
Voltage Inputs		
Line	2 (L-L)	2 (L-N)
Reference	1 (L-L)	1 (L-N)

BASE	MODEL
PowerLynx [®] Transducer Phase A as reference	XDCR-NS0D64

TABLES	OPTION CODES
1 Auxiliary Power 115V ac 230V ac 24-250V dc/115V ac	-VA5 -VA3 -VD10
2 Current Inputs 0-5A ac nominal 0-1A ac nominal	-X -CI1
3 Voltage Inputs 0-120V ac nominal	-X
4 Network-Connections Modbus Plus	-S500
5 Frequency 60Hz 50Hz	-X -F5
6 CT Ratio Default 5:5 Specify with order	-X -CT1
7 PT Ratio Default 1:1 Specify with order	-X -PT1

Intelligent Switchgear Organization LLC

4016 Hwy 9 & McFarland Drive
Alpharetta, GA 30004
Phone:(770) 442-9442
Fax: (770) 664-6302

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- NOT REVIEWED

Project No. 79538-C31-1b
Date: June 21/06 By: BC

1.3 Specifications

Input Signals

Amperes: 0 to 5* Aac (0.25* Aac minimum for PF), (7.5* Aac for Neutral Current), 400Aac for 2 seconds. 2500Vac isolation, minimum.

Volts: Range 0 to 150Vac, 120Vac nom., three phase. 2500Vac min isolation. Minimum input for PF, Frequency or Phase Angle = 20Vac.

Signal Burden

Amperes: 4 mVac at 5Aac input (0.02 VA).

Volts: <1 mAac at 120Vac input (0.1 VA).

Accuracy: 0.25% Class (ANSI Std 460-1988).
Vref 0.5% @FREF = FLINE +/- 1Hz
Frequency: +/- 0.01 Hertz
Phase: +/- 0.3°

Signal Frequency: 45Hz to 1860Hz (Including Harmonics).
45.00Hz to 75.00Hz Frequency Measurement

Energy Registers: 0 - 99,999,999 kWattHours Positive and Negative
0 - 99,999,999 kVARHours Leading and Lagging
Energy is calculated continuously, and stored every 90 seconds

Communications protocol: Modbus Plus

Data update rate: New data available every 100msec Global Data only (56 to 75Hz). New data available every 100msec to 150msec with READ or WRITE Holding Registers (45 to 75 Hz)

Power Requirements:

VD10: Universal 55-200 Vac or 20-280 Vdc, 6 Watts

VA5 115 Vac +/- 20%, 6VA

VA3 230 Vac +/- 20%, 6VA

Fuse: 1.5 Ampere, non-time delay (M) fuse, UL listed located in the ungrounded (hot) side of the line, external to meter.

Operating Temperature: -30C to 70C. Humidity: 0-95% non-condensing

Installation Category: IC III (Distribution Level), Pollution Degree: 2

Weight: 3.5 pounds (1.60 kilograms)

Size: 5.25"H x 5.60"W x 5.63"

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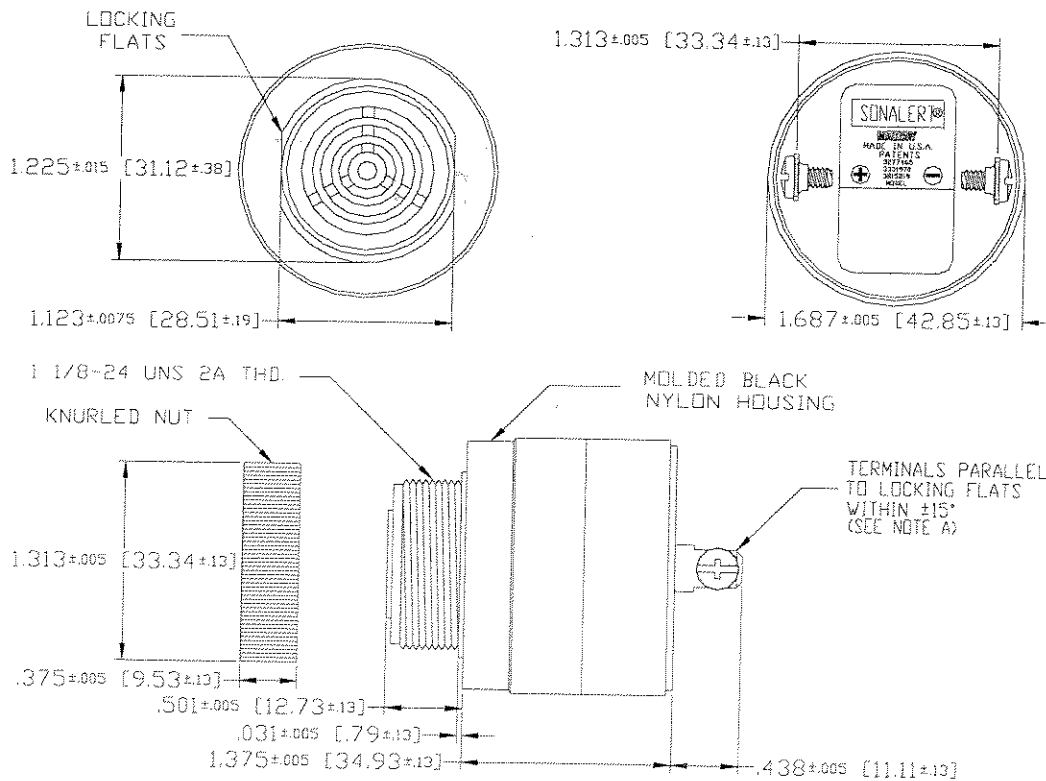
Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

Specifications:

Sound level Category	Medium Sound Level
Mode of Operation	Fast Pulse
Mounting	Panel (see note B)
Voltage Rating	6 to 28 Vdc
Frequency	2900 Hz ±500 Hz
Loudness (Min. Voltage)	68 dB(A) min. @ 2 FT and 6 Vdc
Loudness (Max Voltage)	80 dB(A) min. @ 2FT and 16 Vdc
Current Draw	6 mA Max @ 6 Vdc
Current Draw	26 mA Max @ 28 Vdc
Weight (Typical)	2.1 oz (59 g)
Housing	6/6 Nylon, Style D and Color Black
Options	For other options contact factory

Dimensions: Inches (mm)



NOTE A: TERMINALS-.032 BRASS TIN PLATED, TAPPED FOR #6-32 SCREW. TWO #6-32 NICKEL PLATED BRASS SCREWS INCLUDED. WILL ACCEPT 1/4" QUICK CONNECT.

NOTE B: MOUNTING- REMOVE BLACK PLASTIC NUT AND INSERT THREADED FRONT THROUGH 1.25" HOLE PUNCHED IN PANEL, IF ORIENTATION IS NEEDED, NOTE LOCKING FLATS ON DRAWING. SCREW NUT BACK ON. DO NOT OVERTIGHTEN.

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Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

VOLTAGE TRANSFORMER

Model 468

FREQUENCY:
60 Hz

STANDARD SECONDARY VOLTAGE:
120 Volts

INSULATION LEVEL:
600 Volt, 10 kV BIL full wave.

ACCURACY CLASS:
± 0.6% at all burdens up to 7.5 VA
and ± 1.5% with 20 VA burden.

THERMAL RATING:
75 VA at 30°C amb.,
50 VA at 55°C amb.

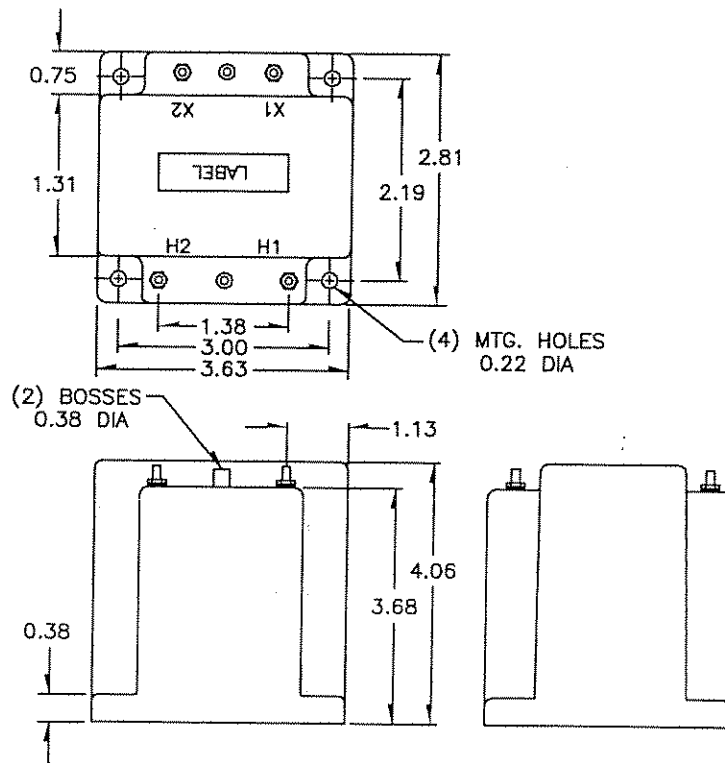
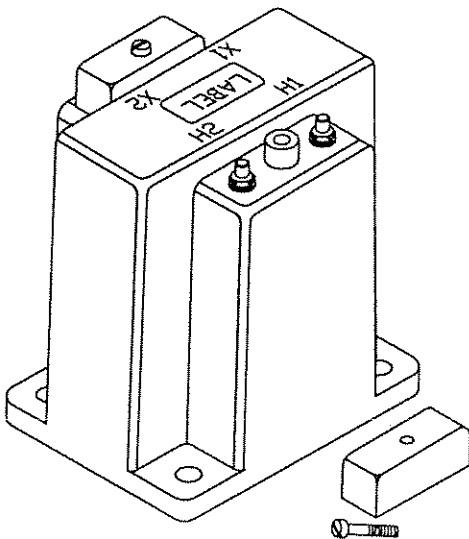
REGULATORY AGENCY APPROVALS



Manufactured to meet the requirements of ANSI C57.13.
Classified by U.L. in accordance with IEC 44-2

See page 16 for 3 phase version.

- Terminals are brass studs No. 10-32 with one lockwasher, flatwasher and regular nut.
- These transformers are designed for operation line-to-line. They may also be operated line-to-ground or line-to-neutral at reduced voltage, (58% of rated volts).
- It is desirable to use a 0.80 amp fuse in the secondary to protect the transformer.
- With two exceptions these transformers are ANSI C57.13 group 1. Those marked * are group 2.
- Models 468-380, 468-400, 468-416 designed specifically for 50Hz operation are available with reduced performance consult factory for details.
- Each transformer has two plastic terminal covers.
- The core and coil assembly is encased in a thermoplastic shell and filled with resin.
- Approximate weight: 4 lbs.



CATALOG NUMBER	VOLTAGE RATING	TURNS RATIO	REC. PRIMARY FUSE RATING
468-069	69.3:120	0.58:1	3.0
468-120	120:120	1:1	2.0
468-208	208:120	1.73:1	1.0
468-240	240:120	2:1	1.0
468-277	277:120	2.31:1	1.0
468-288	288:120	2.4:1	0.75
468-300	300:120	2.5:1	0.75
468-346	346:120	2.88:1	0.75
*468-480	*480:120	4:1	0.50
*468-600	*600:120	5:1	0.40

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Project No. 79538-C31-16

Date: June 21/06 By: [Signature]

1-Phase Power Supply, Primary Switch Mode for Universal Use QUINT-PS-100-240AC/24DC/10

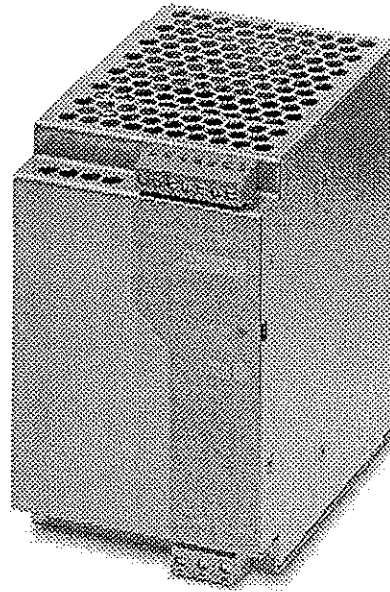
QUINT POWER provides:

- Preventive function monitoring through professional signaling
- Global use due to a wide range input
- A high level of operational safety even in complex global networks
- Reliable startup of heavy loads due to POWER BOOST

The reliability of a power supply determines the availability of individual components in a system and whether complex systems can function safely.

The globalization of markets increases the demands placed on the power supply. A wide range input and a high level of availability are required.

These requirements are met by Generation 2 QUINT POWER.



1. Brief Description

QUINT POWER is the universal 24 V supply of 60 – 960 W. Output currents of 2.5, 5, 10, 20, 30, and 40 A are available at an adjustable and regulated output voltage of 22.5 – 28.5 V DC.

These devices, which are designed as primary switched-mode regulators, operate with a high level of efficiency so that the heat loss is kept to a minimum.

The high level of operational safety is also ensured in complex global networks. QUINT POWER also operates in applications where static voltage dips, transient power supply failures or phase failure are common.

Large capacitors ensure mains buffering of more than 20 ms at full load. All 3-phase QUINT POWER units provide the complete output power even in the event of a continuous phase failure.

Reliable startup of heavy loads is ensured by a power reserve of up to 50% - the POWER BOOST.

Preventive function monitoring diagnoses an impermissible operating state and minimizes downtimes in your system. An active transistor output and an electrically isolated relay contact are provided for remote monitoring of this state.

This signal not only provides information on the device function, but also indicates a system overload at an early stage.

2. Area of Application

QUINT POWER can be used globally due to the consistent provision of a wide range input.

In this way, your entire system can be tested at any production location in the world and can be delivered to any location in the world without faulty switching of the input voltage. This reduces storage costs and logistical effort.

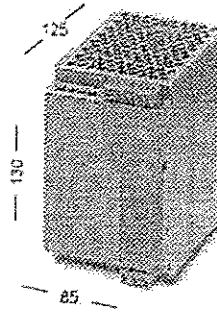
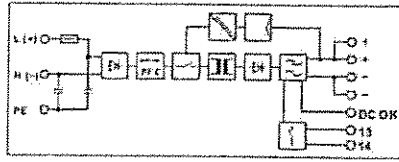
An international approval package including CB Scheme, UL 60950 for IT equipment, and UL 508 for industrial control equipment enables the device to be used globally.

Safe operation in adverse conditions is emphasized by the approval of the entire product range by Germanischer Lloyd.



1-Phase Power Supply, Primary Switch Mode for Universal Use – QUINT 24 V DC/10 A

3. Technical Data



QUINT 24 V DC/10 A

Ø mm (0.31 in.)	solid	flexible	AWG	torque
	[mm ²]			[Nm]
Input	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6
Output	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6
Signal	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6

Description	Type	Order No.	Pcs. Pkt.
Power Supply Primary switch mode for universal use	QUINT-PS-100-240AC/24DC/10	29 38 60 4	1

Technical Data	
Input Data (1)	
Nominal input voltage	160 - 240 V AC (wide range input)
Input voltage range	85 - 264 V AC 90 - 350 V DC
Frequency	45 - 65 Hz 0 Hz
Current consumption (for nominal values)	2.4 A (120 V AC)/1.3 A (230 V AC), approximately
Inrush current limiting ⁽²⁾ (+25°C [+77°F])	15 A, approximately/1.5 A ² s, approximately
Main buffering for a nominal load (typical)	> 40 ms (120 V AC)/> 40 ms (230 V AC)
Switch-on time after applying the AC supply voltage	< 1 s
Transient surge voltage protection	Varistor
Input fuse, internal	6.3 AT (device protection)
Recommended fuse	Circuit breaker 6 A, 10 A or 16 A Characteristic B (EN 60 898)
Discharge current for PE	< 3.5 mA
Output Data (2)	
Nominal output voltage U _N /tolerance	24 V DC ±1%
Setting range for the output voltage	22.5 - 28.5 V DC
Output current (continuous) during convection cooling and nominal values	POWER BOOST I _{BOOST} -25°C to +40°C (-13°F to +104°F) 15 A (U _{out} = 24 V DC)
Nominal output current I _N -25°C to +60°C (-13°F to +140°F)	10 A (U _{out} = 24 V DC)
Derating	From +60°C (+140°F), 2.5% per Kelvin
Short-circuit current limit	I _{BOOST} ≈ 15 A, approximately
Startup of capacitive loads	Unlimited
System deviation on:	Load change static 10 - 90% Load change dynamic 10 - 90% Input voltage change ±10%
Maximum power loss	No load/nominal load < 1%, typical < 2%, typical < 0.1%, typical
Efficiency	4 W/35 W, approximately
Response time U _{OUT} (10% - 90%)	> 88% (for 230 V AC and nominal values)
Residual ripple/switching peaks (20 MHz)	< 2 ms, typical
Can be connected in parallel	< 100 mV _{pp} (for nominal values)
Internal surge voltage protection	To increase redundancy and power
Resistance to return supply	Yes, limited to 35 V DC, approximately 35 V DC
Signal Output Data	
DC OK (active) (3)	+24 V DC signal (with regard to the device weight)
(U _{out} > 0.9 x U _N = high signal)	40 mA, maximum
DC OK (electrically isolated) (4)	30 V AC/DC, maximum, 1 A, maximum
(U _{out} > 0.9 x U _N = contact closed)	
LED 6 (U _{out} < 0.9 x U _N = LED flashing)	Green LED

1-Phase Power Supply, Primary Switch Mode for Universal Use – QUINT 24 V DC/10 A

General Data		
Isolation voltage:	Input/output Input/PE Output/PE	4 kV AC (type test)/2 kV AC (routine test) 3.5 kV AC (type test)/2 kV AC (routine test) 500 V DC (routine test) CE
Approval package Electrical equipment of machines Safety transformers for switched-mode power supplies Electrical safety (of IT equipment) Industrial control equipment Shipbuilding Equipping high voltage installations with electronic equipment Safety extra-low voltage		EN 60 204 (Surge Voltage Category III) EN 61 558-2-17 EN 60950/VDE 0805, UL/C-UL Recognized UL 60 950 ¹⁾ UL/C-UL Listed UL 508 ¹⁾ Germanischer Lloyd F LISTED
Safe isolation Protection against electric shock Protection against dangerous shock currents, basic requirements for safe isolation in electrical equipment Limitation of harmonic line currents		EN 50 178 (VDE 0160) PELV (EN 60 204) SELV (EN 60 950) VDE 0100-410 DIN 57100-410
Mounting position Degree of protection Class of protection MTBF Housing version Dimensions (W x H x D) + DIN rail		DIN VDE 0166-101 According to EN 61000-3-2 On horizontal NS 35 DIN rail according to EN 50022 IP 20 I, with PE connection > 500 000 h according to IEC 1709 (EN 28 500) AluNox (AlMg1), closed Default upon delivery: Rotated 90°: (85 x 130 x 125 mm) (122 x 130 x 160 mm) {3.346 x 5.118 x 4.921 in.} {4.803 x 5.118 x 6.299 in.} 1.3 kg, approximately
Weight		

Climatic Data		
Ambient temperature	Operation Storage	-25°C to +70°C (-13°F to +158°F) (> +60°C [+140°F] derating) -40°C to +85°C (-40°F to +185°F) Up to 95% at +25°C (+77°F), no condensation < 15 Hz, amplitude ±2.5 mm/15 Hz - 150 Hz, 2.3 g, 90 minutes 30 g all space directions 2 (according to EN 50 178) 3K3 (according to EN 50 721)
Humidity	according to IEC 68-2-6	
Vibration	according to IEC 68-2-27	
Shock		
Degree of pollution		
Climatic category		



Conforms to the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC

EMC (Electromagnetic Compatibility) Noise Immunity According to EN 61000-6-2:

Electrostatic discharge (ESD)	EN 61000-4-2 ²⁾	Housing Contact discharge Air discharge
Electromagnetic HF field	EN 61000-4-3 ²⁾	Housing Frequency Field strength
Fast transients (burst)	EN 61000-4-4 ³⁾	Input Output Signal
Surge current loads	EN 61000-4-5 ³⁾	Input Output Signal
Conducted interference	EN 61000-4-6 ²⁾	i/O/S Frequency U _q
Voltage dips	EN 61000-4-11 ²⁾	Input
Simulation of radiophone	EN 50204	Frequency Field strength

Noise Emission According to EN 55081-2:

Radio interference	EN 55011
Radio interference	EN 55011

EN 55011 corresponds to CISPR11/EN 55022 corresponds to CISPR22
EN 61000 corresponds to IEC 1000

²⁾Criterion A: Normal operating characteristics within the specified limits.
³⁾Criterion B: Temporary adverse effects on the operating characteristics that the device corrects independently.

¹⁾UL approval for AC input voltage and ambient operating temperature up to +70°C (+158°F)

Requirements EN 61 000-6-2		QUINT-PS-100-240AC/24DC/10
4 kV 8 kV		Level 4 6 kV 15 kV
60 - 1000 MHz 10 V/m		Level 3 80 - 1000 MHz/1.4 - 2.0 GHz 10 V/m
2 kV 2 kV 1 kV	asymmetrical ⁵⁾ asymmetrical ⁵⁾ asymmetrical ⁵⁾	4 kV (Level 4) 2 kV (Level 3) 1 kV (Level 2)
2 kV 1 kV 0.5 kV 0.5 kV 1 kV	asymmetrical ⁵⁾ symmetrical ⁴⁾ asymmetrical ⁵⁾ symmetrical ⁴⁾ asymmetrical ⁵⁾	4 kV (Inst. Class 4) 2 kV (Inst. Class 4) 0.5 kV (Level 1) 0.5 kV (Level 1) 1 kV (Level 2)
0.15 - 80 MHz 10 V	asymmetrical ⁵⁾	Level 3 0.15 - 80 MHz 10 V
30% reduction of the input voltage for 0.5 periods		See input data. Mains buffering > 20 ms
Not required		900 MHz/1800 MHz 20 V/m
Class A ⁶⁾		EN 55011 (EN 55022) Class B ⁷⁾
Class A ⁶⁾		EN 55011 (EN 55022) Class B ⁷⁾

⁴⁾symmetrical: Cable to cable
⁵⁾asymmetrical: Cable to ground
⁶⁾Class A: Industrial application
⁷⁾Class B: Industrial and domestic applications

4. Device View, Connections and Control Elements

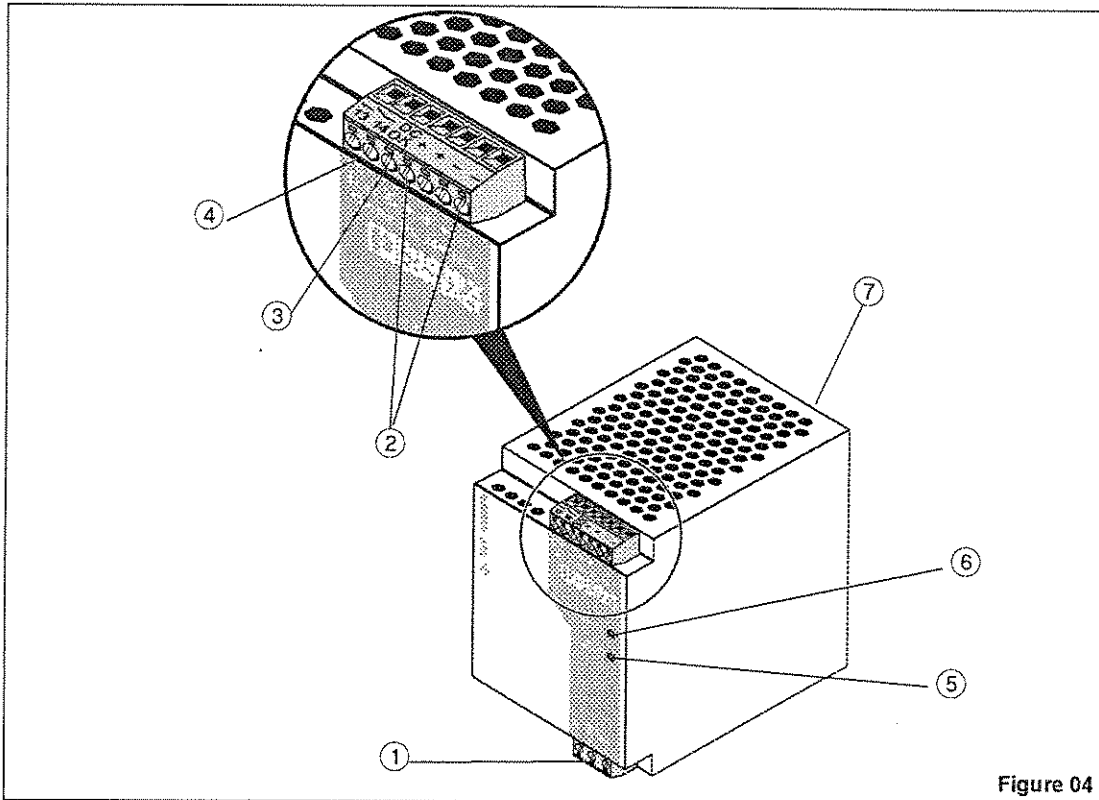


Figure 04

① **AC input:**

Input voltage 85 - 264 V AC
 Frequency 45 - 65 Hz
 (0.2 mm² to 2.5 mm² solid)
 (0.2 mm² to 2.5 mm² flexible)
 (24 - 12 AWG)
 Internal fuse 6.3 AT
 Recommended fuse
 6 A, 10 A or 16 A LS/Characteristic B

② **DC output:**

Output voltage 24 V DC (default),
 can be set from 22.5 - 28.5 V DC using
 a potentiometer ⑤ (0.2 mm² to 2.5 mm² solid)
 (0.2 mm² to 2.5 mm² flexible) (AWG 24 - 12)
 The device is idling-proof and short-circuit-proof.

③ **DC OK output active**

④ **DC OK output electrically isolated**

⑤ **Potentiometer (covered) 22.5 - 28.5 V DC**

⑥ **DC OK LED**

⑦ **Universal DIN rail adapter UTA 107**

QUINT POWER is a built-in device. **Installation and startup** must only be carried out by qualified personnel. The relevant country-specific regulations (e.g., VDE, DIN) must also be observed.

Before startup it is particularly important to ensure that:

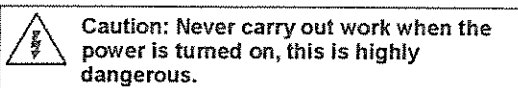
- The line has been connected correctly and protection is provided against electric shock.
- The device can be switched off outside the power supply according to EN 60950 regulations (e.g., by the line protection on the primary side).
- The protective conductor is connected.
- All supply lines have sufficient fuse protection and are the correct size.
- All output cables are the correct size for the maximum device output current or have separate fuse protection.
- Sufficient convection is ensured.

The housing temperature can reach high values depending on the ambient temperature and the load of the device.

The device contains dangerous live components and high levels of stored energy.

5. Safety and Warning Instructions

To ensure that the device can be operated safely and all functions can be used, please read these instructions carefully.



6. Installation

6.1. Mounting

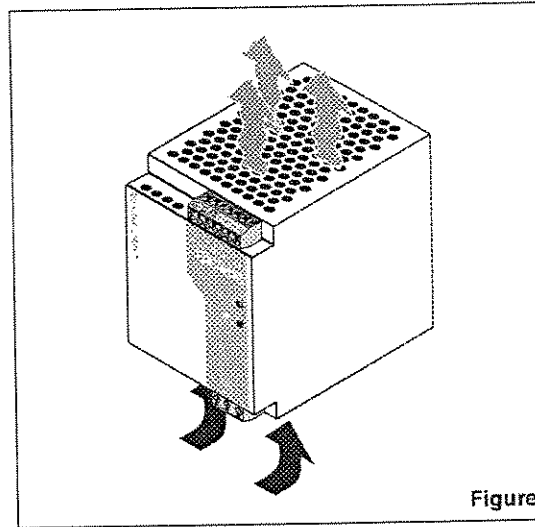
The power supply can be snapped onto all DIN rails according to EN 50022-35 and should be mounted horizontally (input terminals facing downwards).

Installation Dimensions



To ensure sufficient convection, we recommend the following minimum spacing be used between modules:

8.0 cm (3.150 in.) for vertical installation
 1.5 cm (0.591 in.) for horizontal installation



Figure

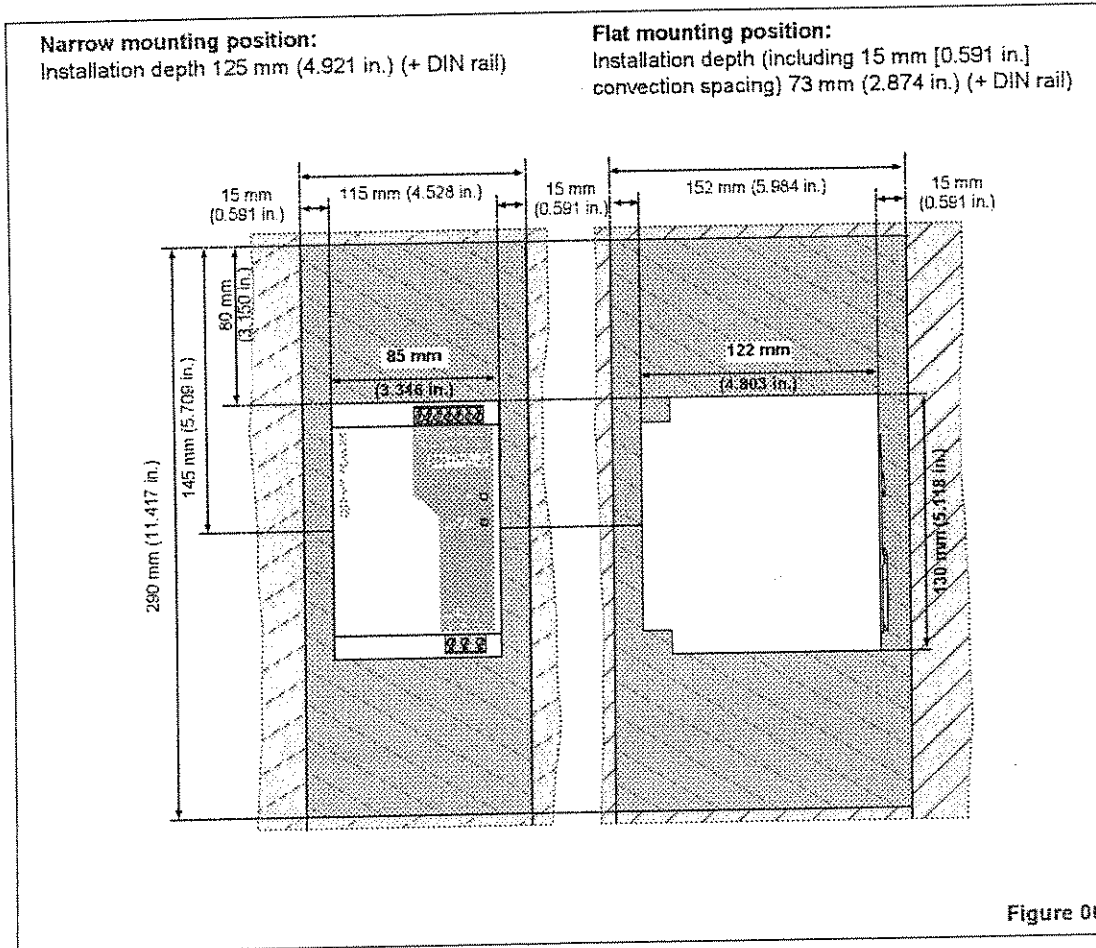


Figure 06

1-Phase Power Supply, Primary Switch Mode for Universal Use – QUINT 24 V DC/10 A

6.2. Narrow Mounting Position

The device is supplied ex works for a narrow mounting position.

Mounting:

Place the module with the DIN rail guideway on the **top edge** of the DIN rail and then snap it **downwards**.

Removal:

Release the snap-on catch using a screwdriver and then detach the module from the **bottom edge** of the DIN rail.

6.3. Flat Mounting Position

A flat mounting position can be achieved by mounting the module onto the DIN rail at a 90° angle. To do this, mount the DIN rail adapter (UTA 107) ⑦ as shown in Figure 08. No additional mounting material is required. Mounting screws: Torx T10 (torque 0.8 - 0.9 Nm).

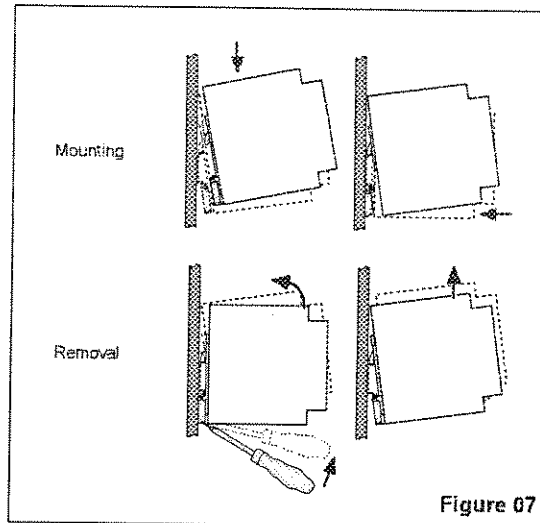


Figure 07

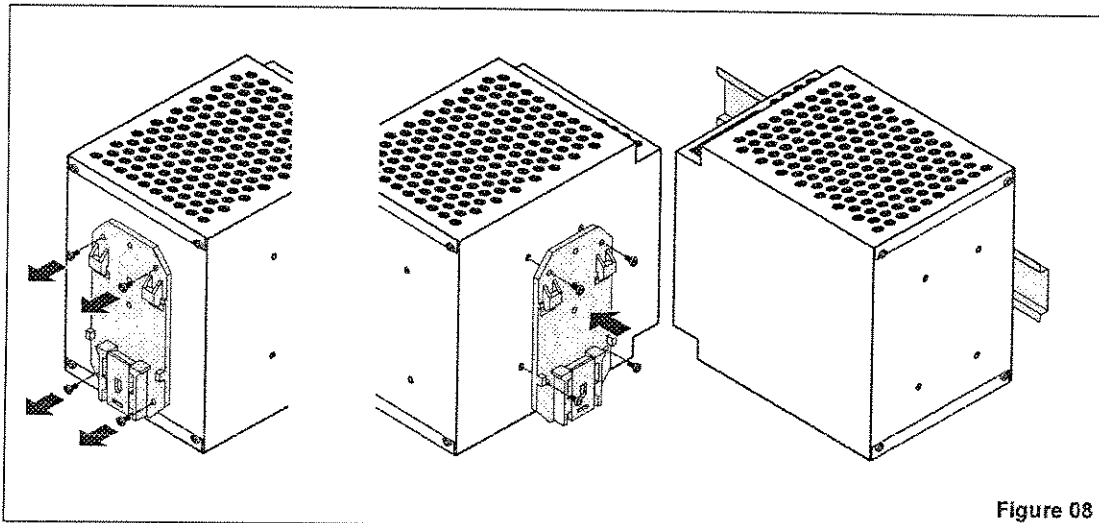


Figure 08

1-Phase Power Supply, Primary Switch Mode for Universal Use – QUINT 24 V DC/10 A

5.6. Output (Figure 11)

The 24 V DC connection is made using the "+" and "-" screw connections on the screw-cage connection (2). The output voltage set upon delivery is 24 V DC. The output voltage can be adjusted from 22.5 to 28.5 V DC on the potentiometer (3).

Protecting the Secondary Side:

The device is electronic short-circuit-proof and idling-proof. In the event of an error, the output voltage is limited to a maximum of 35 V DC.

It should be ensured that all output cables are the correct size for the maximum output current or have separate fuse protection.

The secondary side cables should have large cross sections to keep voltage drops on the cables to a minimum.

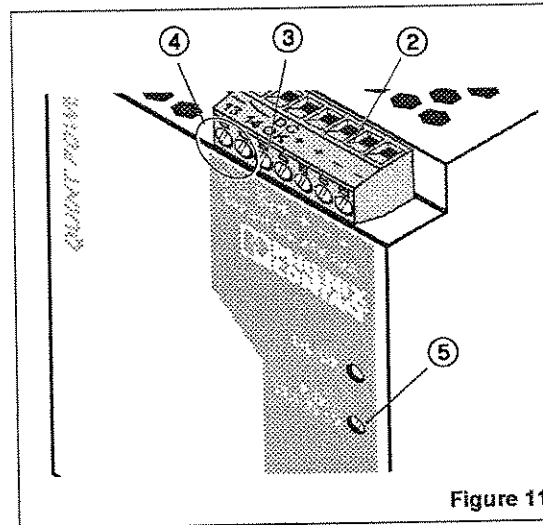


Figure 11

Signaling

Both DC OK outputs are used for preventive function monitoring of the power supply. An electrically isolated signal contact (4) and an active DC OK signal (3) are available. In addition, the DC OK LED (5) can be used to evaluate the function of the power supply directly at the installation location.

Electrically Isolated Contact (Figure 12)

When opened, the electrically isolated signal contact indicates that the output voltage has fallen more than 10% below the set value. Signals and ohmic loads up to a maximum of 30 V and currents up to a maximum of 1 A can be switched.

With heavy inductive loads, e.g., a relay, a suitable protective circuit (e.g., free-wheeling diode) is required.

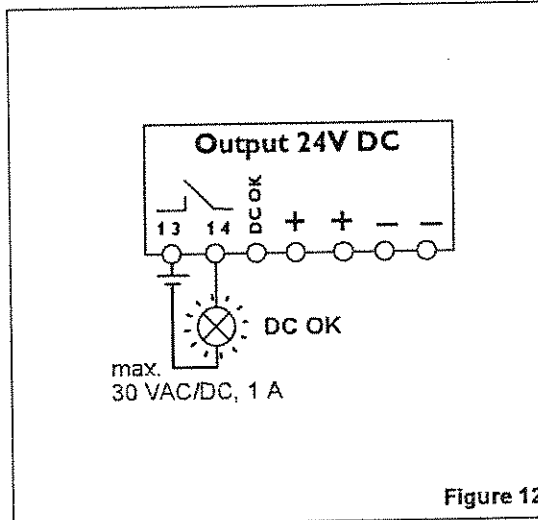


Figure 12

Active Signal Output (Figure 13)

The 24 V DC signal is between the "DC OK" and "-" connection terminal blocks and can be loaded with 40 mA maximum. This signal output indicates that the output voltage has fallen more than 10% below the set value when "active high" changes to "low".

The DC OK signal is isolated from the power output. This ensures that a separate supply does not enter from devices connected in parallel.

The 24 V DC signal can be connected directly to the logic input for evaluation.

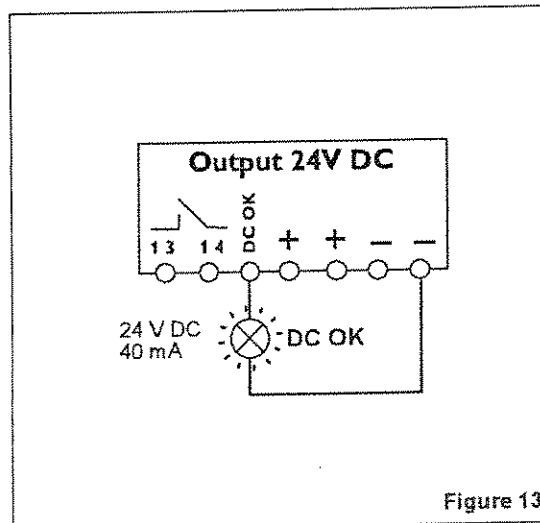
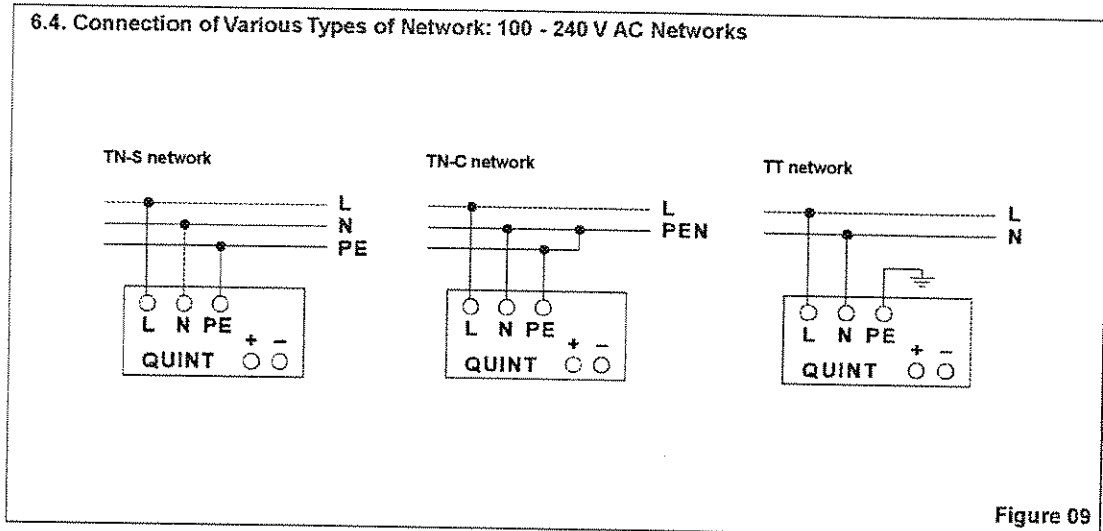


Figure 13



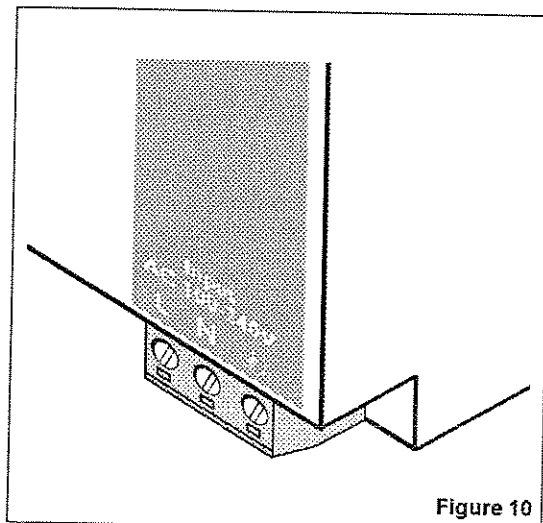
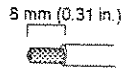
Connection Cable:

The device is equipped with COMBICON connectors. This reliable user-friendly connection method enables quick device connection and safe isolation of the electrical connection, if required. **Only operate connectors when the power is switched off.**

The following cable cross sections can be connected:

	Solid [mm ²]	Flexible [mm ²]	AWG	Torque [Nm]
① Input:	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6
② Output:	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6
③ Signal:	0.2 - 2.5	0.2 - 2.5	24 - 12	0.5 - 0.6

For reliable and safe-to-touch connection: Strip 8 mm (0.31 in.) from the connector ends.



6.5. Input (①, Figure 10)

The 100 - 240 V AC connection is made using screw connections L, N, and Ⓧ.

Protecting the Primary Side

The device must be installed according to the specifications of EN 60 950. It must be possible to switch off the device using a suitable disconnecting device outside the power supply. For example, primary side line protection could be used.

Additional device protection is not required, as an internal fuse is present.

Recommended Fuse:

Circuit breaker 6 A, 10 A or 16 A, Characteristic B (or equivalent). A suitable fuse must be fitted for DC applications.



If the internal fuse is blown, this is most probably due to a device fault. In this case, the device should be checked in the factory.

1-Phase Power Supply, Primary Switch Mode for Universal Use – QUINT 24 V DC/10 A

Signal Loop (Figure 14)

The two signal outputs mentioned above can be combined easily.

Example: Monitoring two devices

Use the active alarm output of device 1 and loop in the electrically isolated alarm output of device 2. In the event of an error, a group error message is generated. It is possible to loop any number of devices.

This signal combination saves on wiring costs and logic inputs.

DC OK LED

The green DC OK LED enables local function evaluation in the control cabinet.

LED ON	Normal operation of the power supply
LED flashing	The output voltage has fallen by more than 10%. There is a secondary load short circuit or overload outside the POWER BOOST area.
LED OFF	No AC supply voltage is present or there is a device fault.

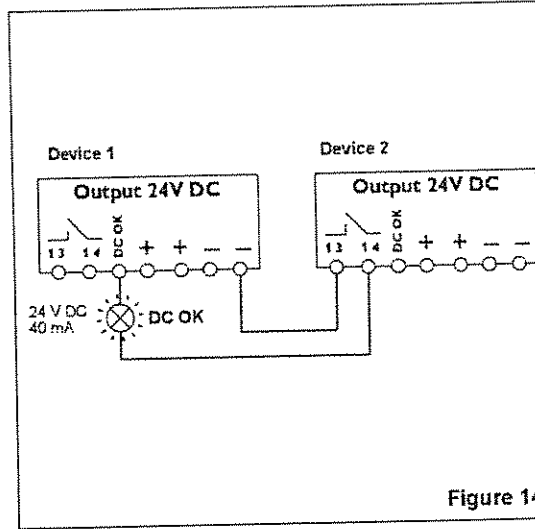


Figure 14

7. Function

7.1. Output Characteristic Curve

At ambient temperatures $T_{amb} < +40^{\circ}\text{C}$ ($+104^{\circ}\text{F}$), the device can continuously supply 15 A with a 24 V DC output voltage ($P_{out} = 360\text{ W}$).

With heavy loads, the working point demonstrates the U/I characteristic curve shown in Figure 13. The output current is limited to I_{BOOST} .

The secondary voltage is reduced until the short circuit on the secondary side is removed.

The U/I characteristic curve ensures that both heavy capacitive loads and devices with DC/DC converters can be supplied by QUINT POWER in the input circuit without any problems.

Connected fuses are reliably tripped. The selectivity in your system configuration is ensured at all times.

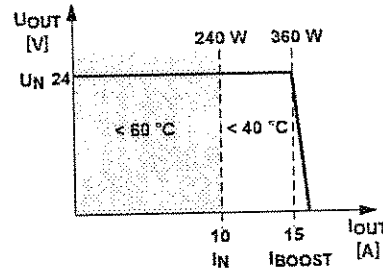


Figure 15

7.2. Temperature Response

At an ambient temperature of up to $+40^{\circ}\text{C}$ ($+104^{\circ}\text{F}$) the device continuously supplies an output current of 15 A.

The device can supply a nominal output current of 10 A up to an ambient temperature of $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$).

The output power must be decreased by 2.5% per Kelvin temperature increase for ambient temperatures over $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$).

At ambient temperatures over $+70^{\circ}\text{C}$ ($+158^{\circ}\text{F}$) or in the event of a thermal overload, the device does not switch off. The output power is decreased so low that device protection is provided. Once the device has cooled, the output power is increased again.

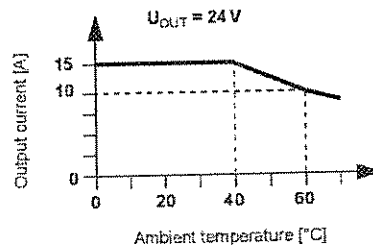


Figure 16

7.3. Parallel Operation

Devices of the same type can be connected in parallel to increase both redundancy and power. The default setting does not have to be adjusted.

If the output voltage is adjusted, an even current distribution can be ensured by precisely setting all power supplies that are operated in parallel to the same output voltage.

To ensure symmetrical current distribution we recommend that all cable connections from the power supply to the DIN rail are the same length and have the same cross section.

Depending on the system, for parallel connection of more than two power supplies a protective circuit should be installed at each individual device output (e.g., decoupling diode or DC fuse). This means that in the event of a secondary device fault high return currents are avoided.

7.4. Redundancy Operation (Figure 17)

Redundant connections are designed for supplying systems, which place particularly high requirements on operational safety. If a fault occurs in the primary circuit of device no. 1, device no. 2 automatically takes over the complete power supply without interruption and vice versa.

For this purpose, the power supplies to be connected in parallel must be large enough that the total current requirements of all loads can be completely covered by one power supply.

External decoupling diodes are required for 100% redundancy.

7.5. Power Increase (Figure 18)

The output current can be increased to $n \times I_N$ where n is the number of devices connected in parallel.

The parallel connection for power increase can be used to extend existing systems. A parallel connection is recommended if the power supply does not cover the current consumption of the most powerful load. Otherwise, the loads should be divided over independent individual devices.

A maximum of five devices can be connected in parallel.

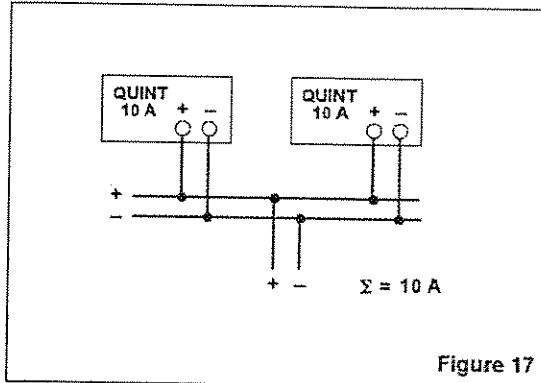


Figure 17

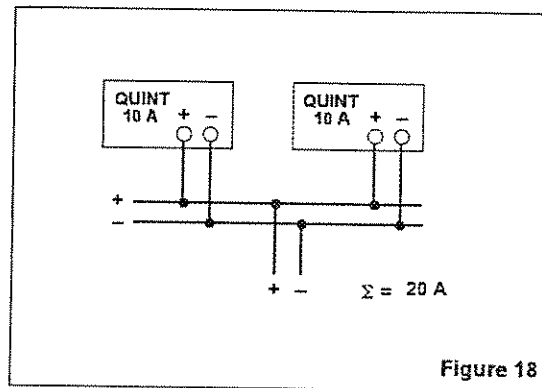
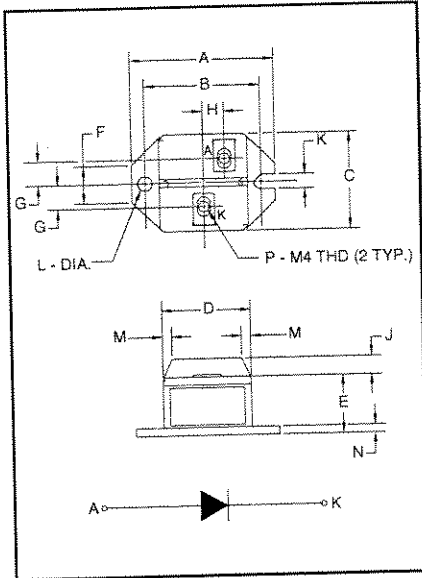


Figure 18

provide DC failure output to PLC
as per 17130 2.1

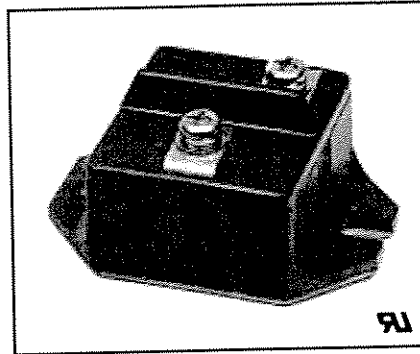
Fast Recovery Single Diode Modules

100 Amperes/600-1200 Volts



Outline Drawing

Dimension	Inches	Millimeters
A	2.087	53
B	1.705±0.008	43.3±0.2
C	1.417	36
D	1.299	33
E	0.866	22
F	0.551	14
G	0.354	9
H	0.315	8
J	0.276	7
K	0.217	5.5
L	0.217 Dia.	Dia. 5.5
M	0.138	3.5
N	0.118	3
P	M4 Metric	M4




CS240610, CS241210
Fast Recovery
Single Diode Modules
100 Amperes/600-1200 Volts

Description:

Powerex Fast Recovery Single Diode Modules are designed for use in applications requiring fast switching. The modules are isolated for easy mounting with other components on common heatsinks. POW-R-BLOK™ has been tested and recognized by Underwriters Laboratories (QQX2 Power Switching Semiconductors).

Features:

- Isolated Mounting
- Planar Chips
- UL Recognized 

Applications:

- Inverters
- Choppers
- Switching Power Supplies
- Free Wheeling

Ordering Information:

Select the complete eight digit module part number you desire from the table below.

Example: CS241210 is a 1200 Volt, 100 Ampere Fast Recovery Single Diode Module.

Type	Voltage Volts (x100)	Current Rating Amperes (x10)
CS24	06	10
	12	



Powerex, Inc., 200 Hillis Street, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

CS240610, CS241210
Fast Recovery Single Diode Modules
100 Amperes/600-1200 Volts

Absolute Maximum Ratings

Characteristics	Symbol	CS240610	CS241210	Units
Peak Reverse Blocking Voltage	V_{RRM}	600	1200	Volts
Transient Peak Reverse Blocking Voltage (Non-Repetitive), $t < 5ms$	V_{RSM}	720	1350	Volts
DC Reverse Blocking Voltage	$V_{R(DC)}$	480	960	Volts
DC Current, $T_C = 75^\circ C$	$I_{F(DC)}$	100	100	Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current (60Hz)	I_{FSM}	2000	2000	Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current (50Hz)	I_{FSM}	1825	1825	Amperes
I^2t (for Fusing), 8.3 milliseconds	I^2t	16700	16700	A ² sec
Storage Temperature	T_{STG}	-40 to 125	-40 to 125	°C
Operating Temperature	T_j	-40 to 150	-40 to 150	°C
Maximum Mounting Torque M5 Mounting Screw	—	17	17	in.-lb.
Maximum Mounting Torque M4 Terminal Screw	—	12	12	in.-lb.
Module Weight (Typical)	—	90	90	Grams
V Isolation	V_{RMS}	2500	2500	Volts



Powerex, Inc., 200 Hillis Street, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

CS240610, CS241210
 Fast Recovery Single Diode Modules
 100 Amperes/600-1200 Volts

Electrical and Thermal Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

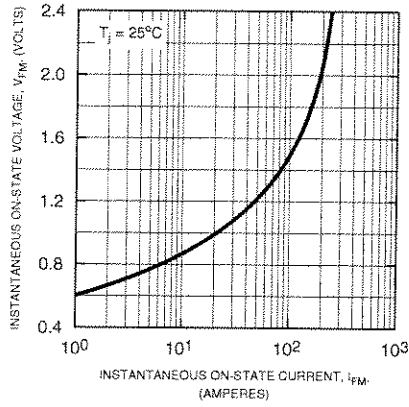
Characteristics	Symbol	Test Conditions	CS240610/CS241210	Units
Blocking State Maximums				
Reverse Leakage Current, Peak	I_{RRM}	$T_j = 150^\circ\text{C}$, $V_{RRM} = \text{Rated}$	20	mA
Conducting State Maximums				
Peak On-State Voltage	V_{FM}	$I_{FM} = 100\text{A}$	1.5	Volts
Switching Minimums				
Reverse Recovery Time	t_{rr}	$I_{FM} = 100\text{A}$, $T_j = 150^\circ\text{C}$ $di/dt = -200\text{A}/\mu\text{s}$, $V_R = 1/2 V_{RRM}$	0.8	μs
Reverse Recovery Charge	Q_{rr}	$I_{FM} = 100\text{A}$, $T_j = 150^\circ\text{C}$ $di/dt = -200\text{A}/\mu\text{s}$, $V_R = 1/2 V_{RRM}$	60	μC
Thermal Maximums				
Thermal Resistance, Junction-to-Case	$R_{\theta(J-C)}$	Per Module	0.5	$^\circ\text{C}/\text{Watt}$
Thermal Resistance, Case-to-Sink (Lubricated)	$R_{\theta(C-S)}$	Per Module	0.15	$^\circ\text{C}/\text{Watt}$



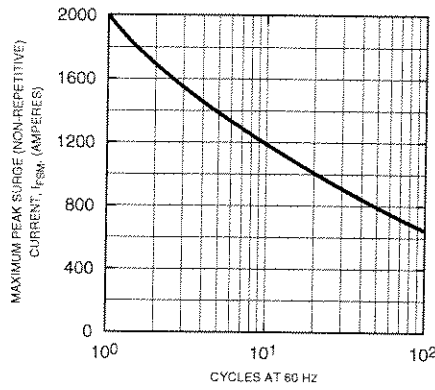
Powerex, Inc., 200 Hillis Street, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

CS240610, CS241210
 Dual SCR POW-R-BLOK™ Modules
 100 Amperes/600-1200 Volts

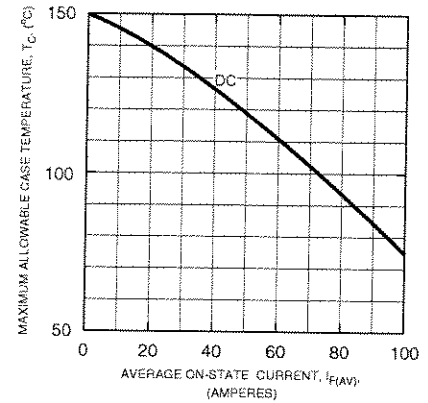
MAXIMUM ON-STATE CHARACTERISTICS



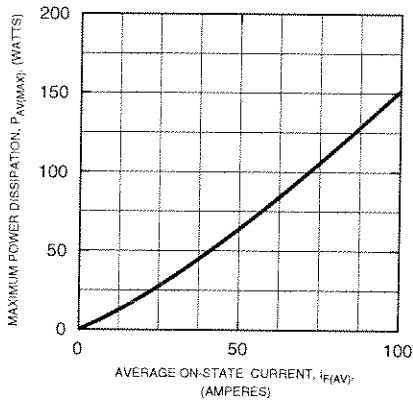
MAXIMUM ALLOWABLE PEAK SURGE (NON-REPETITIVE) CURRENT



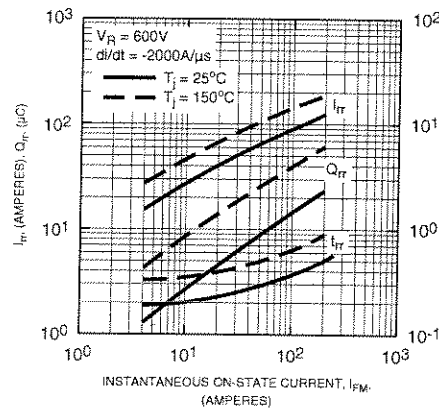
MAXIMUM ALLOWABLE CASE TEMPERATURE



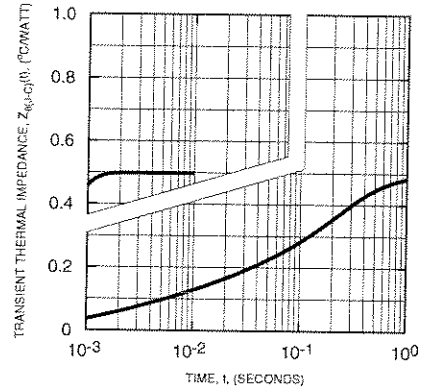
MAXIMUM ON-STATE POWER DISSIPATION

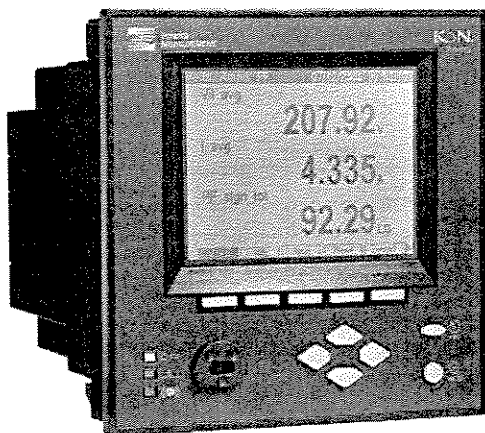


REVERSE RECOVERY CHARACTERISTICS



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (JUNCTION-TO-CASE)





Integrated display model

Intelligent Metering and Control Devices

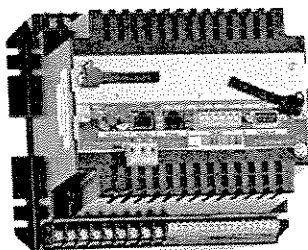
Used at key distribution points and sensitive loads, the ION® 7550 and ION® 7650 meters offer unmatched functionality including advanced power quality analysis coupled with revenue accuracy, multiple communications options, web compatibility, and control capabilities.

The meters come with an extensive selection of pre-configured data screens and measurements that you can use right out of the box or customize to fit your unique requirements.

For an enterprise energy management solution, the meters can be integrated with our ION EEM software, ION Enterprise® software, or other energy management and SCADA systems via multiple communication channels and protocols.

Patented ION technology lets you customize metering or analysis functions at your workstation, without any hard-wiring. Just graphically link a few drag-and-drop icons, or select default setups, and you're ready to go.

Not all features listed are available with every model. Please refer to the detailed descriptions within for a complete list of feature availability.



TRAN option

Applications Summary

Compliance Monitoring

Use the ION 7650 meter to summarize power quality measurements into simple pass/fail indicators. Monitor compliance with international standards such as EN50160, IEC 61000-4-7 (harmonics), and IEC 61000-4-15 (flicker). Or configure the unit for IEEE 519-1992, IEEE 1159 and SEMI F47.

Disturbance Analysis

Maintain revenue accuracy at the regular measurement range while simultaneously capturing large-scale disturbances other meters can miss. Discover the sources of power quality events, harmonics, sags and swells. Analyze problems; avoid repeat interruptions.

Cost Allocation and Billing

Determine cost centers, identify demand control opportunities and check energy consumption patterns.

Demand and Power Factor Control

Avoid penalties with automated load shedding, scheduling, peak shaving or capacitor bank control.

Load Studies/Circuit Optimization

Determine the capacity of your electric network and run at peak efficiency. Perform load trending.

Equipment Monitoring and Control

Improve process yields and extend equipment life. Extensive analog and digital I/O enables system monitoring and control.

Preventative Maintenance

Set up alarms to warn of pending problems. Log events and alarms for all critical conditions.

Integrated Utility Metering

Collect, scale, and log water, air, gas, electricity, and steam readings from connected meters or transducers, and deliver the information to head-end systems.

Instrument Transformer Correction

Use the meter's ITC feature to correct for less accurate transformers, saving money and improving accuracy.

Features Summary

Measurements

- Exceeds Class 0.2 revenue accuracy
- Instantaneous 3-phase voltage, current, frequency, power factor
- Energy: bi-directional, absolute, net, time-of-use, loss compensation
- Demand: rolling block, predicted, thermal
- Harmonics: individual and total harmonic distortion up to the 63rd (511th in software)
- Transient detection: 17us at 60Hz, (20us at 50Hz) and sag/swell recording

Internet-Enabled Communications

- WebMeter, MeterM@t® allow distribution of metered data and alarms over the Internet
- Optional built-in modem with ModemGate allows modem access for 31 other devices
- 10Base-T or 10Base-FL Ethernet port option with EtherGate allows for direct data transfer from Ethernet to RS-485
- Two RS-485 ports, one switchable to RS-232
- One ANSI Type 2 front panel optical port
- Modbus RTU/TCP and DNP 3.0 support
- Modbus Master support

On-Board Data Logging

- Scheduled or event-driven logging
- Sequence-of-events, min/max, waveform, faults, and transient logging

Setpoints for Control and Alarms

- Setpoint on any parameter or condition
- 1 second or 1/2 cycle operation

Inputs and Outputs

- Standard format includes 8 digital inputs, 3 Form C relay outputs (electromechanical) for control functions, and 4 Form A digital outputs (solid state) for pulse functions
- Also available with 8 additional digital inputs, 4 analog outputs, and/or 4 analog inputs

Multi-user, Multi-level Security

- Access to meter information can be controlled and customized for up to 16 designated users with security levels ranging from read access up to administrative rights.

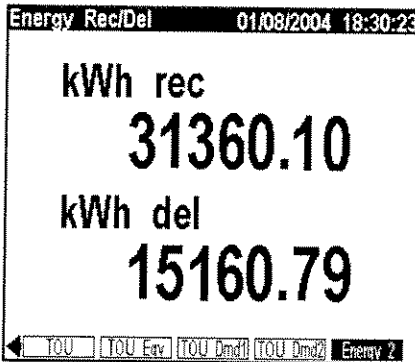


**POWER
MEASUREMENT**

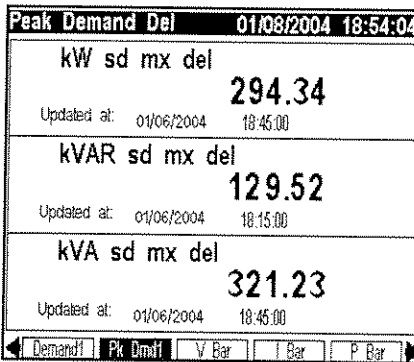
owned by
**Schneider
Electric**

Datasheet: ION® 7550 | 7650

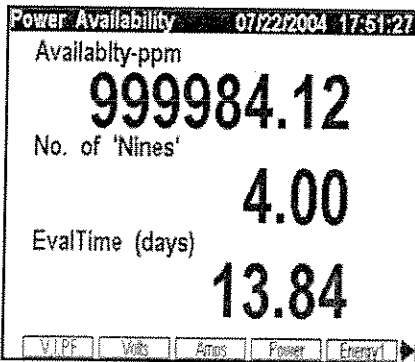
Energy Display



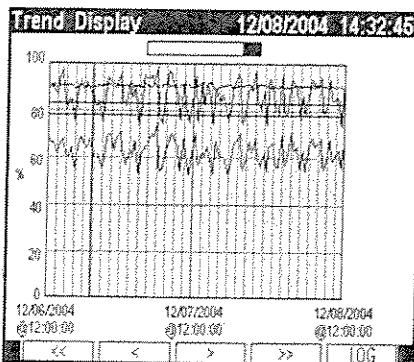
Peak demand with date and time-stamp



The meter's display system reliability in nines, (e.g. 99.99% up-time).



Display kWh usage trends directly on the meter's front panel



Front Panel Display

The meters offer unique, easy-to-read 3½ x 4½ inch (87 x 112mm) LCD display screens with bright back lighting and adjustable contrast. They can show TOU, harmonics, event logs, phasors, and instantaneous power parameters. A selection of character sizes enhance visibility under difficult lighting conditions or at long distances. It provides a user-friendly interface with a screen-based menu system to configure meter settings and an extensive choice of pre-configured display screens for common applications.

Metering Energy

The meters are fully bi-directional and monitor energy in four quadrants. They provide active, reactive and apparent energy parameters and can integrate any instantaneous power parameter to supply measurements like:

- kWh delivered and received
- kWh, kVARh, kVAh net (delivered - received)
- kWh, kVARh, kVAh total (delivered + received)
- kVARh, kVAh delivered and received
- Volt-hours and Amp-hours
- Integration of any instantaneous measurement

Energy registers can be logged automatically on a programmed schedule.

Demand

The meters support all standard demand calculation methods, including block, rolling block, thermal (exponential), and predicted demand. They can measure demand on any instantaneous value and record peak (maximum) and minimum demand with date and time-stamps to the second. Peak demand registers can be reset manually (password protected) or logged and reset automatically on a programmed schedule. Measurements include:

- kW, kVAR, kVA demand, min/max
- Amps, Volts demand, min/max
- Demand on any instantaneous measurement

Trending

Both meters offer access to historical data right at the front panel. The meters display, trend and continuously update historical data with date and timestamps for up to four parameters simultaneously.

Instantaneous

Both meters provide a choice of high accuracy, 1 second or high-speed, ½ cycle measurements, including true RMS, per phase and total for:

- Voltage and current
- Active power (kW) and reactive power (kVAR)
- Apparent power (kVA)
- Power factor and frequency
- Voltage and current unbalance
- Phase reversal

Time-Of-Use

The meters offer comprehensive time-of-use (TOU) metering. A 20 year calendar is configurable in accordance with virtually any utility tariff structure. TOU register values can be automatically recorded at user-specified time intervals, at pre-scheduled dates and times, or when internal or external events occur.

Transformer/Line Loss Compensation

- Flexible compensation methods
- Easy configuration
- Updated every second
- Available through all supported protocols

Instrument Transformer Correction

The meters provide high-accuracy instrument transformer correction, allowing you to use lower-accuracy, lower-cost transformers while retaining high-accuracy transformer function.

Power Quality Metering

Compliance Monitoring*

- EN 50160 compliance monitoring
- IEC 61000-4-7 harmonics and inter-harmonics**
- IEC 61000-4-15 flicker
- CBEMA/ITIC
- IEEE 519 and IEEE 1159

Waveform Recording

The meters can simultaneously capture all voltage and current channels.

- Sub-cycle disturbance capture
- The maximum number of cycles for contiguous waveform capture is 214,000 (based on 16 samples/cycle x 96 cycles and the largest capacity of meter memory)
- Up to 512 samples/cycle standard, 1024 samples/cycle optional with the ION 7650
- Up to 256 samples/cycle with the ION 7550
- Dynamic range: Voltage inputs - 16 bits effective; Current inputs - 19 bits effective

Measure Up-time Using Nines

The current electricity supply infrastructure can typically provide electricity with 99.9% reliability, (3 nines or 8.8 hours downtime a year). However, any disruption is unacceptable for businesses in the digital economy that can require up to 99.9999999% (9 nines or 2 cycles downtime per year) to effectively run their business model. Measure the number of nines of reliability with the ION 7550 and ION 7650.

Out-of-Limit Detection

Detect, record, and report the specifics of voltage or current imbalances and loss, frequency/power factor variations, over and undervoltages, etc.

* Available only on ION 7650

** Compliant with input signals up to 50kHz

Performance Indicators

The meters can be configured to monitor a wide range of utility performance indicators, including:

- Total outage time (in seconds)
- Out-of-tolerance duration for total harmonic distortion, voltage, frequency, power factor and hundreds of other definable indices

Harmonic Distortion Metering

Complete harmonic distortion metering, recording and real-time reporting, up to the 63rd harmonic (511th for ION 7650 via ION Enterprise software) for all voltage and current inputs.

- Individual harmonics (including magnitude, phase and inter-harmonics for the ION 7650)
- Total even harmonics and total odd harmonics
- Total harmonics (even + odd)
- K-factor, Crest factor

Symmetrical Components*

Zero, negative and positive sequences including phase and magnitude for voltage and current inputs. Identify harmful voltage and current unbalances in equipment before they cause damage.

Sag/Swell Detection

The ION 7550 and ION 7650 meters' sag/swell capture capability can help you analyze the severity/potential impact of sags and swells.

- Magnitude and duration data suitable for plotting on voltage tolerance curves
- Per-phase triggers for waveform recording or control operations

Transient Capture*

- The ION 7650 meter can detect and record sub-cycle transients as short as 17us at 60Hz (20us at 50Hz)

Data and Event Recording

The meters provide 5MB (up to 10MB factory option) of configurable, nonvolatile memory for waveform, event and log storage.

Load Profiling

The ION 7550 and ION 7650 meters incorporate 800 channels via 50 data recorders. Channel assignments are configurable for historical trend recording of energy, demand, voltage, current, power quality, or any other measured parameter. Trigger recorders based on time interval, calendar schedule, alarm/event condition, or manually.

High-Speed Data Recording

High-speed "burst" recording (as fast as 1/2-cycle intervals) stores detailed characteristics of disturbances or outages. Trigger recording by a user-defined setpoint, or from external equipment. Gated recording logs data only during the critical event so that memory is conserved.

Coincident Min/Max Recording

Log the values of key parameters or equipment conditions coincident with an extreme condition, complete with date/time stamping. For example, record all feeder voltages and currents at the moment a peak demand condition occurs.

Time Synchronization and GPS

A real-time clock allows internal events and data records to be date-stamped and time-stamped to millisecond resolution. The clock can be synchronized to any one of three sources:

- The meter's internal crystal (+/- 5ppm @ 0° to 40°C, 32° to 104°F)
- The line frequency of the electrical network being metered, which is accurate to 3 seconds per month (+/- 1 ppm)
- An external GPS receiver with an accuracy of +/- 1 millisecond

The serial port used for GPS time synchronization is dedicated exclusively as a GPS input.

Logic, Math and Control

Perform on-board calculations on any measured value, calculate true quantities from pulse inputs (e.g. BTUs) and calculate transformer loss compensation values. You can also implement real-time billing schemes.

Mathematical Functions

Define formulas using the following operators:

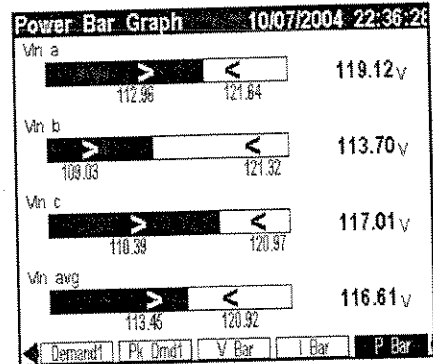
- Arithmetic (+, x, -, ÷)
- Comparison (>, <, =, ≥, ≤, ≠)
- Logical (AND, OR, NOT, TRUE, FALSE, IF)
- Trigonometric (SIN, COS, TAN, ASIN, ACOS, ATAN)
- Math (PI, SQRT, POWER, SUM, SUMSQ, AVG, RMS, LOG10, LN, MAX, MIN)

Programmable Logic and Setpoints

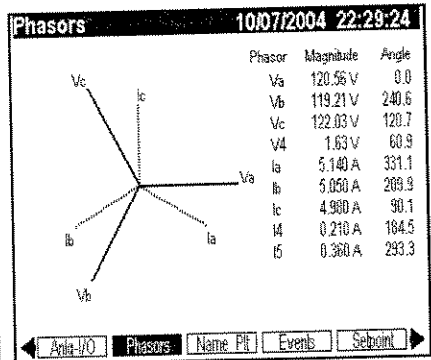
24 setpoints can be set for 1-second or 1/2-cycle operation and can be triggered by any over or under condition. Setpoints can trigger:

- Audible (through software) and visible alarms
- Modem/pager dial-back
- Data logging
- Waveform recording with control over pre-event and post-event capture
- Relay control
- Clearing and reset functions
- Relative setpoints

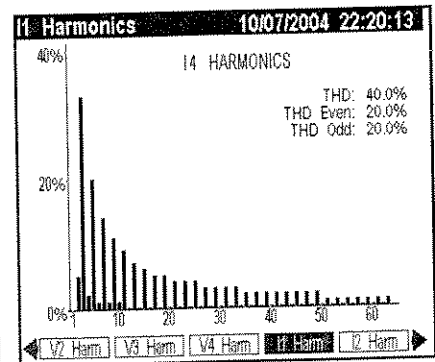
Multiple display formats are available, including bar graphs with min/max indicators



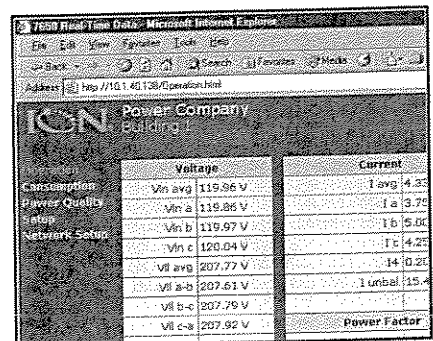
Vector diagram with magnitude and phase angle can help reduce installation time



View THD and individual harmonics through the front panel display screen



Built-in Web server provides browser access to extensive real-time meter data



* Available only on ION 7650

Datasheet: ION® 7550 | 7650

Software Integration

Extensive communication capabilities enable the meters to be easily integrated into Power Measurement's software or with other energy management and distribution control systems.

ION® EEM Software

The meters can be integrated with ION® EEM software, an enterprise level software suite that satisfies a full spectrum of energy management needs, from operational cost reductions to procurement support to cost allocation, benchmarking and budgeting.

ION Enterprise® Software

The meters are compatible with our Windows-based ION Enterprise operations software, which displays real-time and logged data and offers manual control/configuration capabilities. It provides enterprise-wide data sharing in a secure networked environment.

ION Setup Software

Both meters are further enhanced by free ION Setup for Windows, a user-friendly setup assistant and software solution that displays real-time data from your power monitoring devices and provides device configuration capabilities.

Modbus Master

The meters can read and write data to Modbus slave devices through a designated serial port. This powerful feature allows meters to collect data from Modbus devices, process it, then deliver condensed information in a variety of ways.

Modbus Master read ability lets you acquire data from nearby low-cost meters, which can be filed in on-board memory, presented on the graphical display or monitored using built-in setpoints.

Modbus Master write capability lets you perform functions such as controlling remote I/O points, resetting setpoint or configuration parameters on PLCs, and simple data exchange with other information systems.

Internet Connectivity

MeterM@il®

Meters equipped with an Ethernet port can automatically email alarm notifications or scheduled system-status updates. MeterM@il messages can be received like any email message, at a workstation, cell phone, pager or PDA. Data logs can also be sent on an event-driven or scheduled basis via email, while conveniently accommodating firewall restrictions.

WebMeter®

An on-board Web server, combined with an Ethernet port, offers quick and easy access to real-time energy and basic power quality information without special software. Built-in web pages display a range of energy and basic power quality information through any web-enabled device and even support basic meter configuration tasks.

XML Compatibility

The meters can also exchange information using industry-standard XML format. Its simple machine-readable format supports easy integration with custom reporting, spreadsheet, database and other applications.

Communications

Multi-Port, Multi-Protocol Access

Simultaneous communication on up to 4 ports provides secure data sharing with a variety of energy management systems using a choice of communication standards and protocols.

RS-232/RS-485 Port

Selectable between RS-232 and RS-485

- Protocols: ION, DNP 3.0, Modbus RTU, GPS, EtherGate, ModemGate, or Modbus Master
- Baud rate: 300 bps to 115,200 bps

RS-485 Port

- Protocols: ION, DNP 3.0, Modbus RTU, GPS, EtherGate, ModemGate, or Modbus Master
- Baud rate: 300 bps to 57,600 bps

Infrared Data Port

The ANSI Type 2 compliant optical port can download real-time data to a portable PC.

- Protocols: ION, Modbus RTU, DNP 3.0
- Baud rate: 1200 bps to 19,200 bps

Internal Modem

Available internal telephone modem features fast connect time and ModemGate, a gateway letting up to 31 additional devices share a meter's internal modem via the remaining serial ports.

- Protocols: ION, Modbus RTU and DNP 3.0
- Baud rate: Up to 33.6 kbps

Ethernet Port

Optional 10Base-T or 10Base-FL port offers direct access through an Ethernet LAN/WAN and features EtherGate, which permits the direct transfer of data between an Ethernet network and up to 62 devices via the meter's two serial ports.

- Protocols: TCP/IP, ION, Modbus TCP, DNP 3.0, Telnet, NTP, DNS, and SMTP
- Baud rate: Up to 10 Mbps

Interoperability

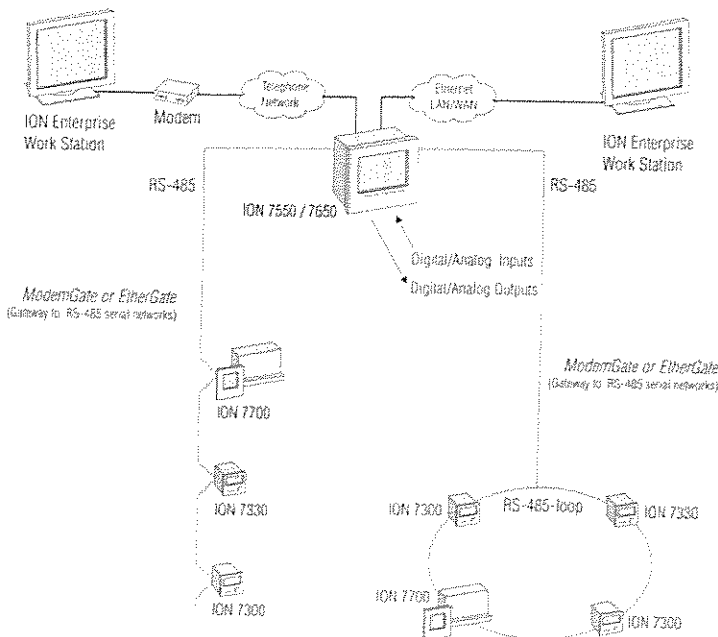
Concurrent communications ability via multiple protocols allows you to use the advanced features of either meter to extend an existing Modbus, DNP or ION software network. Logs and real-time values are also available through Modbus.

UTS Software Support

The meters are fully compatible with UTS software platforms including MV-90, MVP, MVRS, MVLT and MVCOMM, and offer a direct Ethernet connection to MV-90.

Flash-Based Firmware

Perform upgrades via communications without removing the meter from the site.



Inputs/Outputs

Standard digital and optional analog I/O let you monitor a wide range of conditions, such as flow rates, RPM, fluid levels, oil pressures and transformer temperatures. You can output energy pulses to an RTU or perform equipment control operations. The ION 7550 can also be ordered in an optional, dedicated Remote Terminal Unit (RTU) configuration. Please see the ION 7550 RTU Option datasheet for more information.

Digital Inputs/Outputs

- 8 digital inputs can monitor status or count pulses from external "volts free" dry contact
- 4 solid state output ports and 3 on-board relays can be controlled automatically by internal setpoints or manually via a communications port

Analog Inputs/Outputs

Either meter can be equipped with an optional analog I/O card featuring:

- 8 digital inputs
- 4 analog inputs accepting 0 to 1mA or 0 to 20mA (scalable from 4 to 20mA)
- 4 analog outputs accepting -1 to 1mA or 0 to 20mA (scalable from 4 to 20mA)
- 4 analog inputs accepting 0 to 20mA and 4 analog output accepting 0 to 20mA
- 4 analog inputs accepting 0 to 1mA and 4 analog outputs accepting -1 to 1mA

Contact Power Measurement for I/O combinations supported.

The Power of ION

The meters are based on our patented object-oriented ION® technology, which ensures the longevity of your metering solution because it can adapt as your needs change and lets you take advantage of our ongoing advances in technology.

The measurements and other functions of both meters are provided by ION modules. You can quickly add or rearrange functions with drag-and-drop icons and a few clicks of a mouse. Imagine new features and build them with ION.

Mounting

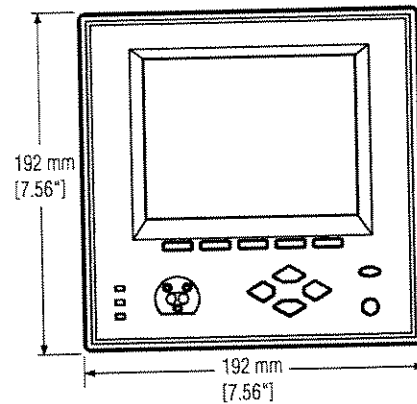
The meters can be panel-mounted in a single DIN standard 186mm x 186mm cutout.

- Bezel size: 192mm x 192mm (DIN)
- A distance of 160mm (6 1/2 inches) clearance is required behind the panel (plus allowance for connectors and cables)
- An adapter plate is available to facilitate the conversion from our 3000 series meters to the ION 7550 and ION 7650 meters. Please contact us for more information.

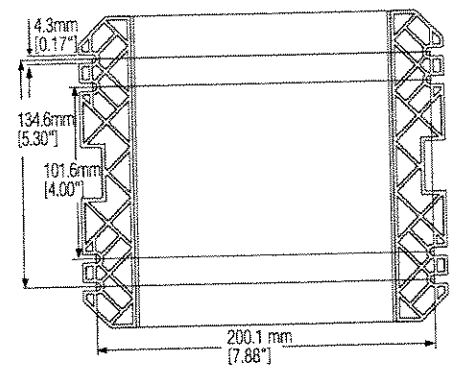
TRAN models have no integrated display and can be flush-mounted against any flat surface.

Dimensions

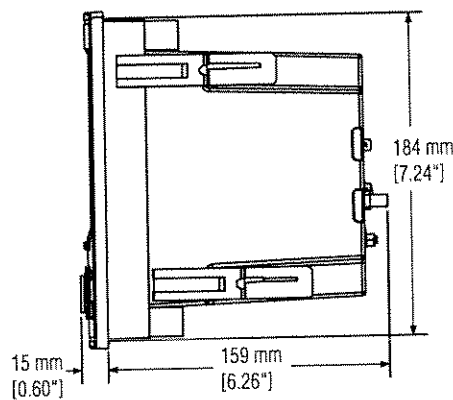
Front view



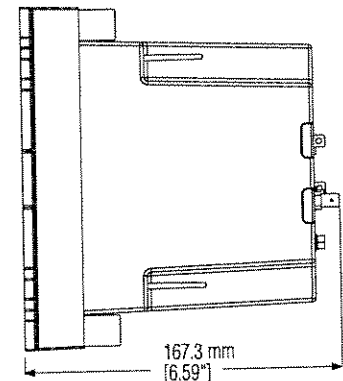
Front view, TRAN model



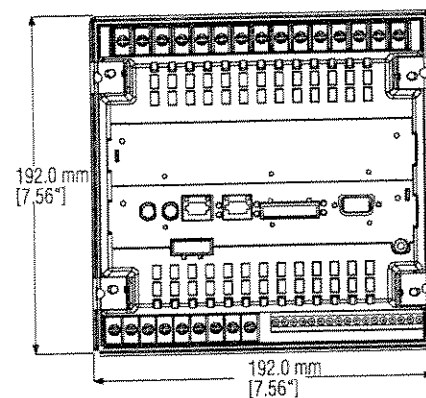
Side view



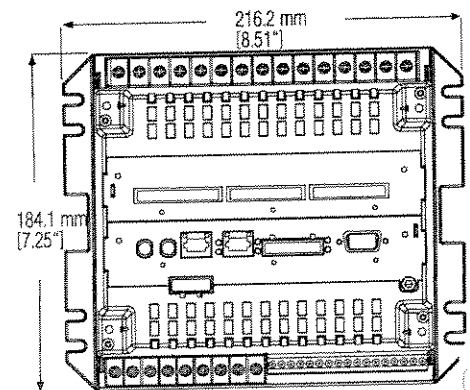
Side view, TRAN model



Rear view



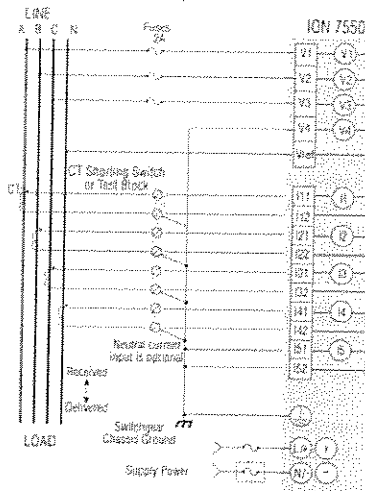
Rear view, TRAN model



Datasheet: ION 7550 | 7650

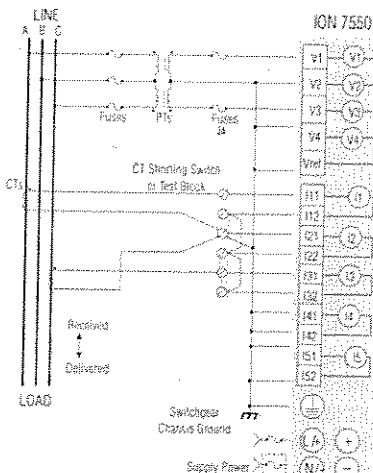
Example Connections

4-Wire Wye (Direct Connection)



NOTE: Fuse is required if power is supplied from an ungrounded

3-Wire Delta (2 PTs and 2 CTs)



NOTE: Fuse is required if power is supplied from an ungrounded

Connections

Installation

- 4-Wire Wye, 3-Wire Wye, 3-Wire Delta, Direct Delta and single phase systems
- 4 voltage and 5 current inputs
- All inputs pass ANSI/IEEE C37.90-1989 surge withstand and fast transient tests

Voltage and Current Inputs

- Autoranging 57V through 347V LN/600V LL inputs
- No PTs needed for Wye systems up to 347/600VAC
- Standard 5 to 20A current inputs
- Optional 1A current inputs
- Low voltage current probe option

Control Power

The meters' standard power supply has a voltage range of 85 to 240VAC and 110 to 330VDC, and can be powered from a dedicated fused feed. An optional low voltage DC power supply with a 20 to 60VDC range is also available.

Measurement Specifications†

Parameter	Accuracy ± (%reading)
	1 second
Voltage (L-L) (L-N)	0.1%
Frequency	±0.005Hz
Current (I1, I2, I3)	0.1%
Current (I4, I5)	0.4%
kW, kVAR, kVA	class 0.2*
kWh, kVARh, kVAh	class 0.2*
KW, KVA Demands	class 0.2*
Power Factor (at Unity PF)	0.2%
Harmonics (to 40th) [#]	IEC 61000-4-7
Harmonics (to 63rd)	1% Full Scale
K Factor	5% Full Scale
Crest Factor	1% Full Scale
Symmetrical Components [#]	Voltage: 0.2% FS**, Current: 0.4% FS**

† Refer to User's Manual for valid measurement ranges

Not applicable for NICT meters, contact factory for measurement specifications

* Refer to Compliance section on page 7

[#]ION 7650 only

** FS = Full Scale

Display resolution meets or exceeds accuracy.

User Programmable Log Capacity - Example Configurations:

	ION 7550		ION 7650	
	500 Events	500 Events	500 Events	500 Events
Data ^A	1.5 years	3.1 years	1.3 years	2.9 years
Waveforms	180 ^B	180 ^B	360 ^C	360 ^C

^A 16 parameters recorded every 15 minutes

^B 30 waveforms on 6 channels at the maximum sampling rate

^C 30 waveforms on 12 channels with any selectable format (for example, 6 channels are 512 samples per cycle for 4 cycles and 6 channels are 32 samples per cycle for 54 cycles)

Specifications

Voltage Inputs

- Inputs: V1, V2, V3, V4, VREF
- Rated input: 347 LN/600 LL VAC RMS
- Overload: 1500VAC RMS continuous
- Dielectric withstand: 2500VAC RMS, 60Hz for 1 minute
- Impedance: 5M Ω /phase (phase-Vref)
- Fault capture: 1200 Vpeak

Current Inputs

- Inputs: I1, I2, I3, I4, I5

Standard Current Transformers:

Standard Current Range:

- Rated nominal: 5A, 10A, and/or 20A (ANSI current class 2 & 10)
- Starting current: 0.005A RMS
- Fault capture: 70A (instantaneous) peak
- Max. voltage: 600V RMS (CAT III IEC61010-1)
- Overload: 500A RMS for 1 second, non-recurring
- Dielectric withstand: 2500VAC, 60Hz for 1 minute
- Burden: 0.05VA per phase (at 5A)
- Impedance: 0.002 Ω /phase (phase-Vref)

Optional Current Range:

- Rated nominal: 1A, 2A, 5A, and/or 10A (ANSI current class 10 & 20)
- Starting current: 0.001A RMS
- Fault capture: 17.5A (instantaneous) peak
- Max. voltage: 600V RMS (CAT III IEC61010-1)
- Overload: 50A RMS for 1 second, non-recurring
- Dielectric withstand: 2500VAC, 60Hz for 1 minute
- Burden: 0.015VA per phase (at 1A)
- Impedance: 0.015 Ω

Current Probes with AC Voltage Output

- Rated inputs: 1V RMS
- Overload: 5.5V (CAT I IEC 61010-1)
- Impedance: 220k Ω max.
- 2 options:
 - Current Probe Inputs for use with 0-1 VAC current probes. Probes sold separately. Accuracy depends on probe specs
 - Current Probe Inputs with 3 calibrated Universal Technic 10A clamp-on CTs, meeting IEC 61036 accuracy

Digital Inputs

- 8 Inputs: S1-S8, SCOM Self-excited, dry contact sensing, no external voltage required
- Minimum pulse width: 1ms
- Maximum pulse rate: 20 pulses/sec.
- Timing resolution: 1ms
- Update rate[‡]: 1/2 cycle (after timing resolution)
- Isolation: 300Vpeak for 10s, 60Hz
- Max rated voltage 120VDC (external excitation)

Electromechanical Relays

- 3 Form C relays: R1 - R3
- Form C contacts: NO, K, NC
NO, K and NC are abbreviations for "Normally Open," "Common," and "Normally Closed" - they correspond to terminals R11, R12, and R13 respectively on relay #1.
- Rated voltage: 250VAC / 30VDC
- Rated load at rated voltage:
 - Resistive: 10A AC/DC
 - Inductive: 7.5A (AC, PF = 0.4) / 5A (DC, L/R = 7ms)
- Max. voltage: 380VAC / 125VDC
- MOV protection: 300V max between NO and NC
- Max. load at max. voltage: 0.2A (DC) / 3A (AC)
- Turn-on time: 15ms max.
- Turn-off time: 5ms max.
- Isolation: 5,000VAC for 1 minute
- Lifetime:
 - 10,000,000 operations (no load)
 - 100,000 operations (rated voltage and load)
- Update rate \ddagger : 1/2 cycle or 1 second

Solid State Outputs

- 4 Form A outputs: D1-D4
- Maximum voltage: 30VDC
- Maximum current: 80mA
- Isolation: Optically isolated. Max. 5000V RMS isolation (UL:E64380)
- Update rate: 1/2 cycle or 1 second

Analog Outputs (optional)

- Outputs: 4: AO1 - AO4
- Signal type: DC current
- Range: 0-20mA (scalable 4-20) or -1-1mA (scalable 0-1)
- Driving capability: 500 Ohms (20mA) or 10k Ohms (1mA)
- Accuracy: +/-0.2% of full scale
- Update rate \ddagger : 1/2 cycle or 1 second
- Isolation: 750V to earth

Analog Inputs (optional)

- Inputs: 4: AI 1 to AI 4
- Signal type: DC Current
- Range: 0 to 20mA (scalable 4 to 20), or 0 to 1mA
- Input impedance: 24 Ohms (20mA), or 475 Ohms (1mA)
- Accuracy: +/-0.2% of full scale
- Update rate: 1 second
- Isolation: 750V to earth
- Common mode: Max. 400k Ohms (channel to channel)

Power Supply

- Standard: AC: 85 to 240VAC (+/-10%), 47 to 63Hz; DC: 110 to 300VDC (+/-10%)
Burden: Typical 15VA, Max 35VA
- Optional: Low Voltage DC Power Supply
Rated inputs: DC: 20 to 60VDC (+/- 10%)
Burden: Typical 12VA, Max 18VA
- Dielectric withstand: 2000VAC RMS, 60Hz for 1 min.
- Ride-through: Min: 100ms (6 cycles at 60Hz at 96VAC), 200ms (12 cycles at 60Hz at 120VAC), 800ms (48 cycles at 60Hz at 240VAC)

Communications

Serial Ports

- 1 RS-232/485 and 1 additional RS-485 port
- Protocols: ION, DNP 3.0, Modbus RTU, GPS, EtherGate, ModemGate, Modbus Master
- Baud rate: RS-232 - 300bps to 115,200bps
- Baud rate: RS-485 - 300bps to 57,600bps

ANSI Type 2 Optical Port

- Interface: ANSI Type 2 Optical Port
- Baud rates: 1200-19,200bps
- Duplex: Half
- Protocols: ION 2.0, Modbus RTU, DNP 3.0
- Location: Front of Meter

Internal Modem

- Data rate: 300bps - 33.6kbps (V.3.4, V.32 bis, V.32, V.22 bis, V.22 A/B, V.23, V.21, Bell 212A, Bell 103)
- Automatic data rate detection is supported
- Error correction: V.42 LAPM, MNP 2-4, MNP 10
- Data compression: V.42 bis/MNP 5
- Interface: RJ11 (tip and ring)
- Governmental approvals: FCC P68 (USA), Industry Canada CS-03, CTR21 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK)

Ethernet Port

- Protocols: TCP/IP, Telnet, ION, Modbus TCP, DNP 3.0
- Interface: IEEE 802.3-1993, ISO/IEC 8802-3:1993 (Ethernet) 10Base-T or 10Base-FL (optional)
- 10Base-T:
 - Cabling: Unshielded twisted pair cable, 0.5mm (24 AWG), max. length 110yds (100m)
 - Connector: RJ45
 - Isolation: Transformer isolated, min. isolation voltage: 1500VAC RMS/2250VDC
- 10Base-FL:
 - Cabling: Fiber optic cable, 62.5/125um nominal, wavelength 850nm, max. length 2190yds (2000m)
 - Connector: ST (male)
 - Isolation: Optical

Environmental Conditions

- Operating temp: -20°C to +70°C (no formation of ice) (-4°F to 158°F)
- Low Voltage DC Power Supply: -20°C to 50°C (-4°F 122°F)
- Storage: -40°C to +85°C (-40°F to 185°F)
- Humidity: 5% to 95% non-condensing

Shipping

- 7.1 lbs / 3.2 kg
- 17 x 10 x 11 inches (0.98 cu. ft.)
- 40.8 x 24 x 27.9 cm (0.0235 cu. m)

Display

- Type: FSTN Liquid Crystal Display (LCD)
- Resolution: 320 x 240 pixels (1/4 VGA)
- Temperature: Operating range -20°C to +70°C (-4°F to 158°F)
- Backlight: LED

Standards Compliance

Accuracy

- Independent Compliance with IEC62053-22 0.2S, 1A and 5A tested by KEMA*
- Complies with ANSI C12.20, Class 10 & Class 20
- Complies with Measurement Canada AE-1021*

Products meet or exceed the accuracy requirements of the standards listed. All products tested internally by Power Measurement. Some products tested by third-party laboratory. Due to form factor of some meters, not all ANSI/IEC compliance tests may apply. Contact Power Measurement for further clarification.

Safety/Construction

- IEC1010-1 (EN61010-1) Safety requirements for electrical equipment for measurement, control and laboratory use
- CSA C22.2 No 1010-1 Safety requirements for electrical equipment for measurement, control and laboratory use Canadian Standards Association
- UL 61010B-1 Measuring, Testing and Signal Generation Equipment

Electromagnetic Immunity

- IEEE C.37-90.1-1989 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI) (All inputs except for the network communication port)
- IEC1000-4-2 (EN61000-4-2/IEC801-2) Electrostatic Discharge
- IEC1000-4-3 (EN61000-4-3/IEC801-3) Radiated EM Field Immunity
- IEC1000-4-4 (EN61000-4-4/IEC801-4) Electric Fast Transient
- IEC1000-4-5 (EN61000-4-5/IEC801-5) Surge Immunity
- IEC1000-4-6 (EN61000-4-6/IEC801-6) Conducted Immunity
- IEC1000-3-2 (EN61000-3-2) Limits for harmonic currents emissions (equipment input current < 16 amps per phase)
- IEC1000-3-3 (EN61000-3-3) Limitation of voltage fluctuations and flicker in low voltage supply systems for equipment with rated current < 16 amps
- EN50082-2 Electromagnetic Compatibility, immunity standards for industrial environment

Electromagnetic Emissions

- FCC Part 15 Subpart B, Class A Digital Device, Radiated Emissions
- EN55011 (CISPR 11) Radiated/Conducted Emissions for industrial, scientific and medical (ISM) equipment
- EN55022 (CISPR 22) Radiated/Conducted Emissions for information technology (IT) equipment
- EN61000-6-4 (EN50081-2) Electromagnetic Compatibility, emissions standards for industrial environment

Datasheet: ION 7550 | 7650

Some features are optional.

To identify standard and optional features, please see the 'Product Order Forms' at www.pwrm.com.

Features and Options List	ION 7550	ION 7650
Power, Energy, and Demand		
Voltage/current per phase, average, unbalance	■	■
Power: real, reactive, apparent, power factor, frequency	■	■
Energy: bi-directional, total, import, export, net	■	■
Demand: block, rolling block, thermal, predicted	■	■
Power Quality		
Sag/Swell monitoring	■	■
Symmetrical components: zero, positive, negative		■
Transient detection, microseconds†		17
Harmonics: individual, even, odd, total up to	63 rd	63 rd
Harmonics: magnitude, phase and inter-harmonics		40 th
Sampling rate, maximum samples per cycle	256	1024
Flicker, (harmonics to EN50160, IEC 6100-4-7/4-15)		■
Configurable for IEEE 519 - 1992, IEEE159, SEMI	■	■
Uptime in number of nines	■	■
Logging and Recording		
Standard memory capacity	5MB	5MB
Maximum optional memory capacity	10MB	10MB
Min/max logging for any parameter	■	■
Historical logs, maximum # of channels	800	800
Waveform logs, maximum # of cycles	96	96
Timestamp resolution in seconds	0.001	0.001
Historical trend information via front panel display	■	■
GPS time synchronization	■	■
Communications and I/O		
RS-232/485 ports	1	1
RS-485 ports	1	1
Ethernet ports	1	1
ANSI Type 2 Infrared optical port	1	1
Internal modem	1	1
3-port DNP 3.0 through serial, modem, Ethernet and I/R ports	■	■
Modbus RTU slave on serial, modem and I/R ports	■	■
Modbus RTU Master on serial ports	■	■
Modbus TCP through Ethernet	■	■
EtherGate, data transfer between Ethernet & RS-485	■	■
ModemGate, data transfer between internal modem & RS-485	■	■
MeterM@il, logged data and alarms via e-mail	■	■
WebMeter, on board web server	■	■
Analog inputs	4	4
Analog outputs	4	4
Digital status inputs	16	16
Digital status outputs (standard)	4	4
Relay outputs (standard)	3	3
Setpoints, Alarming, and Control		
Setpoints, minimum response time	½ cycle	½ cycle
Setpoints, number of	65	65
Math, logic, trig, log, linearization formulas	■	■
Single & multi-condition alarms	■	■
Call-out on alarms	■	■
Revenue Metering & Standards		
ANSI C12.16 accuracy compliant	■	■
ANSI C12.20 0.2 compliant, Class 10 & 20	■	■
IEC 62053-22 0.2S compliant, 1 & 5A*	■	■
IEC 62053-22 0.5S compliant 1 & 5A*	■	■
Measurement Canada approved*	■	■
MV-90 supported	■	■
Transformer/line Loss Compensation	■	■
Instrument Transformer Correction	■	■

† For 60 Hz line frequency, 20us for 50 Hz line frequency

* Certification Pending

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Certificate No. 002188

Push Buttons—Class 9001 Type K—30 mm Selector Switches

Non-Illuminated 2 Position Selector Switch Operators—UL Types 4, 13/NEMA 4, 13

For use in hazardous locations—See page 17-79.
Legend plate and contact block not included unless noted.

17 PUSH BUTTONS AND OPERATOR INTERFACE

Contact Block Required				1—Contact Closed 0—Contact Open			
Contact Block Position	Quantity and Type	Mount on Side	Left		Right		
			Left	Right	Left	Right	
<p>Top View</p>	KA1	KA3	1	0	0	1	
	KA2	KA2 #2	0	1	1	0	
	KA1	KA3	1	0	0	1	
	KA2	KA2 #1	0	1	1	0	
Cam (see page 17-84)				E		D	
Non-Illuminated Operators				Type		Type	

Manual Return

Operator Only a Without Knob With Standard Black Knob With Other Color Knob (See Knob Table) # Key Operated with E10 Key (Code 1, 2, 3) * #	KS11 KS11B KS11# KS11K#	KS12 KS12B KS12# KS12K#
With Contact Block(s) With Standard Knob With 1 KA1 on Side #2 With 1 KA1 on Side #1 With 1 KA1 on Side #1 and 1 KA1 on Side #2	KS11BH13 KS11BH1 KS11BH2	...

Spring Return from Left

Operator Only a Without Knob With Standard Black Knob With Other Color Knob (See Knob Table) b Key Operated with E10 Key (Code 2 only) d	KS25 KS25B KS25# KS25K2	...
--	----------------------------------	-----

Spring Return From Right

Operator Only a Without Knob With Standard Black Knob With Other Color Knob (See Knob Table) b Key Operated with E10 Key (Code 1 Only) d	...	KS34 KS34B KS34# KS34K1
--	-----	----------------------------------

- ▲ These operators can be ordered complete with contact blocks. For maximum block usage, see page 17-85. Add the "H" number chosen from page 17-80 to the end of the operator type number and add the cost of the "H" number to the operator cost.
- Add the color code as chosen from knob color table at right.
Example: KS11# with a green gloved-hand knob = KS11FG
- ◆ Add the key withdrawal code from key withdrawal code table below.
Example: KS11K# with key withdrawal in the right position only = KS11K2
- * All key operated devices come standard with Square D key no. E10 (key only part no. is 2941101100, \$6.50 per key). Other key changes are available at no extra cost. Contact your nearest Square D/Schneider Electric sales office.

◆ Key Withdrawal Code




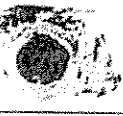




Code	Position
1	Left Only
2	Right Only
3	Left and Right

Selector Switch Knobs






Color	Standard Knob		Gloved-Hand Knob		Coin Operated	
	Knob Code	Type	Knob Code	Type	Knob Code	Type
Black	B	B11	FB	B25	TB	B1B
Red	R	RB	FR	R24	TR	R1B
Green	G	GB	FG	G24	TG	G1B
Yellow	Y	YB	FY	Y24	TY	Y1B
Orange	S	S11	FS	S25
Blue	L	L24	FL	L24	TL	L1B
White	W	WB	FW	W24
Amber	A	AB	FA	A24
Clear	C	CB	FC	C24	TC	C1B

For additional information, reference Catalog #9001CT0001.

Padlock Attachments

	Used On	Description	Type
	Type K non-illuminated push button—Standard or mushroom (KR4, KR5 mushroom buttons only).	Holds button in depressed position and can be padlocked.	K4
	Type K and SK non-illuminated push buttons (with or without) protective boots.	Holds button in depressed position when padlocked.	K5
			K97
	Type K and SK non-illuminated push buttons, cover type attachment (KR, SKR).	Attachment can be padlocked. Does not hold button in depressed position.	K6
	Type K and SK push buttons, cover type attachment.	Spring loaded cover cannot be padlocked. Does not hold button in depressed position.	K60
	Type K and SK push-pull operator and illuminated push buttons (KR8, KR9).	Holds button in depressed position and can be padlocked.	K62
	KR11U and KR12U Interlocked Assembly	Holds maintained button in depressed position and can be padlocked.	K96
	Type KR9 & SKR9 Push-Pull operators—Non-illuminated and illuminated.	Holds button in depressed position. Can be padlocked.	K102

Padlock Attachments

	Used On	Description	Type
	Type K and SK selector switches and potentiometers (will not work with gloved-hand knob).	Cover type attachment that can be padlocked to keep unauthorized personnel from tampering with the operator.	K7
	Type K and SK selector switches and potentiometers (will not work with gloved-hand knob).	Same as 9001K7 but with spring loaded lockout cover.	K107
	Type K and SK illuminated push buttons (with or without guard) and key operated push buttons.	Cover type attachment that can be padlocked to keep unauthorized personnel from tampering with the operator.	K108
	Type K and SK illuminated push buttons (with or without guard) and key operated push buttons.	Same as 9001K108 but with spring loaded lockout cover.	K109
	Type K and SK illuminated push-pull operators using 1 1/8" dia. mushroom buttons (-20 series as shown on page 17-84).	Cover type attachment that holds mushroom button in depressed position and can be padlocked.	K110

Protective Boots







These Type KU protective boots are recommended for very dirty environments or severe hose down, but they are not required for UL Type 4 rating on the Type K operators or UL Type 4 or 4X rating on the Type SK operators. The K1 wrench (see page 17-86) is required for installation of these boots.

For Non-Illuminated Push Buttons *		Clear Color for	Type
Color	Type	Standard knob selector switch	KU17
Black	KU1	Gloved-hand cap for use on standard knob selector switch	KU18
Red	KU2	Standard pilot light and maintained contact push button	KU27
Blue	KU3	Push-to-test and illuminated push button without guard	KU37
Brown	KU4		
Green	KU5		
Yellow	KU6		
Clear	KU7		
Clear	KU8	Illuminated push button with guard	KU17

(*Provides Full Guard)


* Use KU17 for maintained contact push buttons.

Mushroom Button Guards

Type	Used On	Type	Used On
	Aluminum Mushroom Guard for 1 1/8" Mushroom Button Operator (KR4, KR24)		Yellow Plastic Extension Mushroom Guard for 1 1/8" and 1 1/4" Mushroom Button Operators
K48	KR4, SKR4	K50+	KR4, KR9, SKR9, SKR9
		K50+M*	KR9, SKR9
	Aluminum Mushroom Guard for 2 1/4" Mushroom Button Operator		
K88	KR5	K85	KR25

* The mushroom guard has finger holes for push-pull operators.
 B=Black G=Green R=Red Y=Yellow
 + = Red Y=Yellow

Closing Plates

Description	Type
	K51
Chrome Plated	K52

* Meets UL and NEMA 1, 2, 3, 4, 4X, 6, 12 and 13.



















Dimensions Catalog 9001CT0001

For additional information, reference Catalog #9001CT0001.

Push Buttons—Class 9001 Type K and SK Accessories

SQUARE D
www.SquareD.com
For the most up-to-date information

17 PUSH BUTTONS AND OPERATOR INTERFACE

Description	Color	Type	Package Qty.	Description	Color	Type	Package Qty.
 Color inserts for KR1, KR2, KR3, SKR1, SKR2, SKR3, KR11, KR12, SKR11, SKR12, KR4, T, THD	Black Blue Gray Green Orange Red Universal White Yellow	T8BK T8BE T8GY T8GN T8OE T8RD T8U T8WH T8YW	10 10 10 10 10 10 7 10 10	 1 3/4" Mushroom Knob for Illuminated Push Buttons K2L, SK2L *	Amber Blue Clear Green Red White Yellow	A20 L20 C20 G20 R20 W20 Y20	1 1 1 1 1 1 1
 1 7/8" Snap-in Mushroom knob for KR4 and SKR4 *	Black Blue Green Orange Red Red * Yellow	K16B K16L K16G K16S K16R K16R05 K16Y	1 1 1 1 1 1 1	 2 1/4" Mushroom Knob for Illuminated Push Buttons K2L, SK2L *	Amber Blue Clear Green Red White Yellow	A21 L21 C21 G21 R21 W21 Y21	1 1 1 1 1 1 1
 2 1/4" Snap-in Mushroom knob for KR5 and SKR5 *	Black Blue Green Orange Red Red * Yellow	K17B K17L K17G K17S K17R K17R05 K17Y	1 1 1 1 1 1 1	 Plastic Fresnel Pilot Light Lens for KP, KT, SKP, SKT	Amber Blue Clear Green Red White Yellow	A31 L31 C31 G31 R31 W31 Y31	1 1 1 1 1 1 1
 1 3/8" Screw-on Mushroom knob for KR24 and SKR24 *	Black Blue Green Orange Red Yellow	K92B K92L K92G K92S K92R K92Y	1 1 1 1 1 1	 Domed Plastic Pilot Light Lens for KP, KT, SKP, SKT	Amber Blue Clear Green Red White Yellow	A9 L9 C9 G9 R9 W9 Y9	1 1 1 1 1 1 1
 2 1/4" Screw-on Mushroom knob for KR25 and SKR25 *	Black Blue Green Orange Red Yellow	K93B K93L K93G K93S K93R K93Y	1 1 1 1 1 1	 Glass Pilot Light Lens for KP, KT	Amber Blue Clear Green Red White Yellow	A6 L6 C6 G6 R6 W6 Y6	1 1 1 1 1 1 1
 Push-Pull Knobs for KR8, KR9, SKR8, SKR9 Operators	Amber Black Blue Clear Green Orange Orange Red Red White Yellow	A22 B23 L22 C22 G22 S23 R22 R2205 W22 Y22	1 1 1 1 1 1 1 1 1 1 1	 Standard Selector Switch Knob for K and SK Selector Switches	Amber Black Blue Clear Green Orange Orange Red White Yellow	A8 B11 L8 C8 G8 S11 R8 W8 Y8	1 1 1 1 1 1 1 1 1
 Color inserts for Dual Function Operators KR6, KR7, KR67	Black Green Red Universal	B19 G19 R19 U19	10 10 10 10	 Gloved-Hand Selector Switch Knob for K and SK Selector Switches	Amber Black Blue Clear Green Orange Red White Yellow	A24 B25 L24 C24 G24 S25 R24 W24 Y24	1 1 1 1 1 1 1 1 1
 Caps for Illuminated Push Buttons K1L, K2L, K3L, SK1L, SK2L	Amber Blue Clear Green Red White Yellow	A7 L7 C7 G7 R7 W7 Y7	1 1 1 1 1 1 1	 Coin Operated Selector Switch Knob for K and SK Selector Switches	Black Blue Clear Green Red Yellow	B18 L16 C16 G18 R16 Y16	1 1 1 1 1 1
 Color Inserts for KQ and TQ Selector Push Buttons	Black Blue Green Orange Red White Yellow	T5BK T5BE T5GN T5OE T5RD T5WH T5YW	10 10 10 10 10 10 10	 Selector Switch Cams	Cam Type	K13B K13C K13D K13E K13F K13G K13H K13J K13L 3105402402	10 10 10 10 10 10 10

- * Includes one each of the following color inserts: Black, Red, Green, Yellow, Orange, Blue, and White.
- * "EMERGENCY STOP" is in raised letters and hot stamped white across the front of the mushroom button.
- * The mushroom button cap listed here may be assembled to a 9001KR1U or SKR1U to form a 9001KR4 or SKR4.
- * The mushroom button cap listed here may be assembled to a 9001KR1U or SKR1U to form a 9001KR5 or SKR5.
- * The mushroom button cap listed here may be assembled to a 9001KR20 to form a 9001KR24 or SKR24.
- * The mushroom button cap listed here may be assembled to a 9001KR20 to form a 9001KR25 or SKR25.
- These color caps are opaque and are for use on non-illuminated operators only.
- △ Includes two of each of the following color inserts: Black, Red, and Green.
- ▽ May be used on KR8 and KR9 operators. Order mushroom button and K54 adapter (no charge) from page 17-85. Using the K54 adapter voids Type 6 rating.
- ▽ Red knob with "Push Emergency Stop" marked on top of knob.

For additional information, reference Catalog #9001CT0001.

CP1


Discount Schedule

Push Buttons - XB4 22 mm

Complete Devices



Telemecanique
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FOR CURRENT INFORMATION

Pilot Lights with Protected LED (screw clamp terminal connections)

Shape of Head	Supply Voltage	Color	Catalog Number (Components)
 Protected LED	24 Vac/Vdc	White	XB4BV81 (ZB4BV81 + ZB4BV013)
		Green	XB4BV83 (ZB4BV83 + ZB4BV033)
		Red	XB4BV84 (ZB4BV84 + ZB4BV043)
		Yellow	XB4BV85 (ZB4BV85 + ZB4BV053)
		Blue	XB4BV86 (ZB4BV86 + ZB4BV063)
	110-120 Vac	White	XB4BVG1 (ZB4BVG1 + ZB4BV013)
		Green	XB4BVG3 (ZB4BVG3 + ZB4BV033)
		Red	XB4BVG4 (ZB4BVG4 + ZB4BV043)
		Yellow	XB4BVG5 (ZB4BVG5 + ZB4BV053)
		Blue	XB4BVG6 (ZB4BVG6 + ZB4BV063)

XB4BV85


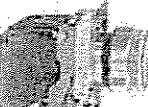
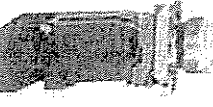
Pilot Lights for BA 9s Bulb (screw clamp terminal connections)

Shape of Head	Supply Voltage	Color	Catalog Number (Components)
Direct supply, for BA 9s (incandescent, LED, neon) V = 250 V, 2.4 W bulb (bulb not included)			
 Protected LED	≤ 250 Vac/Vdc	White	XB4BV61 (ZB4BV6 + ZB4BV01)
		Green	XB4BV63 (ZB4BV6 + ZB4BV03)
		Red	XB4BV64 (ZB4BV6 + ZB4BV04)
		Yellow	XB4BV65 (ZB4BV6 + ZB4BV05)
Transformer type with 1.2 VA, 6V secondary. BA 9s incandescent bulb included			
	110-120 Vac 50/60 Hz	White	XB4BV31 (ZB4BV3 + ZB4BV01)
		Green	XB4BV33 (ZB4BV3 + ZB4BV03)
		Red	XB4BV34 (ZB4BV3 + ZB4BV04)
		Yellow	XB4BV35 (ZB4BV3 + ZB4BV05)

XB4BV64

XB4BV33

Illuminated Push Buttons, Momentary, Flush (screw clamp terminal connections)

Shape of Head	Description	Type of Contact		Supply Voltage	Color of Push	Catalog Number (Components)
		N/O	N/C			
 Protected LED	Protected LED	1	1	24 Vac/Vdc	White	XB4BW31B5 (ZB4BW0B15 + ZB4BW313)
					Green	XB4BW33B5 (ZB4BW0B35 + ZB4BW333)
					Red	XB4BW34B5 (ZB4BW0B45 + ZB4BW343)
					Yellow	XB4BW35B5 (ZB4BW0B55 + ZB4BW353)
					Blue	XB4BW36B5 (ZB4BW0B65 + ZB4BW363)
		110-120 Vac	White	XB4BW31G5 (ZB4BW0G15 + ZB4BW313)		
			Green	XB4BW33G5 (ZB4BW0G35 + ZB4BW333)		
			Red	XB4BW34G5 (ZB4BW0G45 + ZB4BW343)		
			Yellow	XB4BW35G5 (ZB4BW0G55 + ZB4BW353)		
			Blue	XB4BW36G5 (ZB4BW0G65 + ZB4BW363)		
 Direct supply for BA 9s 2.4 W max. bulb Not included	1	1	≤ 250 Vac/Vdc	White	XB4BW3165 (ZB4BW065 + ZB4BW31)	
				Green	XB4BW3365 (ZB4BW065 + ZB4BW33)	
				Red	XB4BW3465 (ZB4BW065 + ZB4BW34)	
				Yellow	XB4BW3565 (ZB4BW065 + ZB4BW35)	
 Transformer type 1.2 VA, 6 V secondary. BA 9s incandescent bulb included	1	1	110-120 Vac 50/60 Hz	White	XB4BW3135 (ZB4BW035 + ZB4BW31)	
				Green	XB4BW3335 (ZB4BW035 + ZB4BW33)	
				Red	XB4BW3435 (ZB4BW035 + ZB4BW34)	
			230-240 Vac 50/60 Hz	Yellow	XB4BW3535 (ZB4BW035 + ZB4BW35)	
				White	XB4BW3145 (ZB4BW045 + ZB4BW31)	
				Green	XB4BW3345 (ZB4BW045 + ZB4BW33)	
Red	XB4BW3445 (ZB4BW045 + ZB4BW34)					
Yellow	XB4BW3545 (ZB4BW045 + ZB4BW35)					

XB4BW33B5

XB4BW34G5

XB4BW3545

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Searchable Features:

Other Properties:

Brand: P&B

Contact Arrangement: 2 Form C, DPDT, 2 C/O

Series: PRD

Contact Current Rating (Amps.): 20

Coil Magnetic System: Monostable

Coil Selection Criteria: Nominal Voltage

Actuating System: DC

Input Voltage (VDC): 24

Coil Suppression Diode: Without

Options: Magnetic Blowout

Approx. Dimensions (L x W x H) (mm [in]): 85.70 x 63.80 x 63.50 [3.376 x 2.513 x 2.501]

Contact Material: Silver

Polarized: No

Approved Standards: UL Recognized, UL Listed, CSA Certification

2

3

4


5

Coil Resistance (Ω):	288
Coil Power, Nominal (W):	2.00
Mounting Options:	Mounting Holes
Termination Type:	Screw Terminals
Enclosure:	Open
LED Indicator:	Without

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Date:	June 21/06 By: 

2

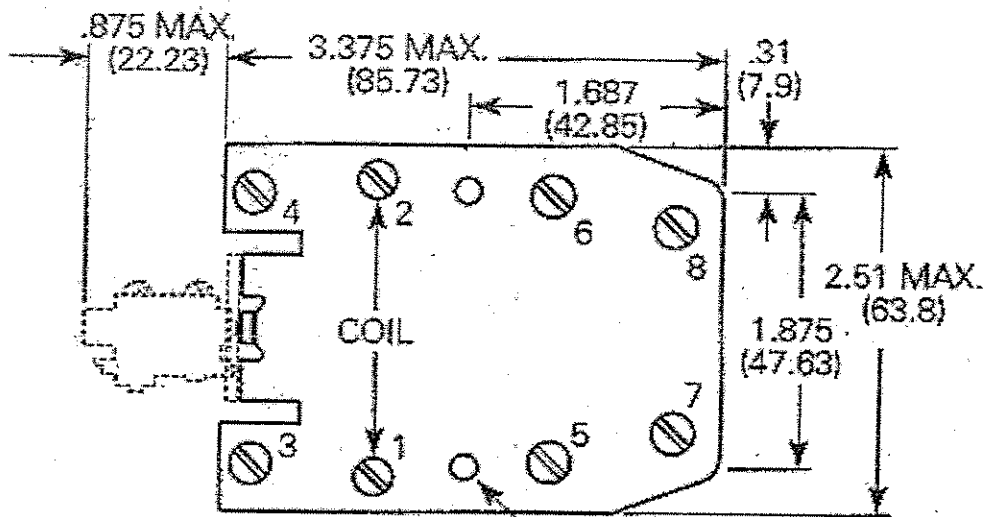
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1911

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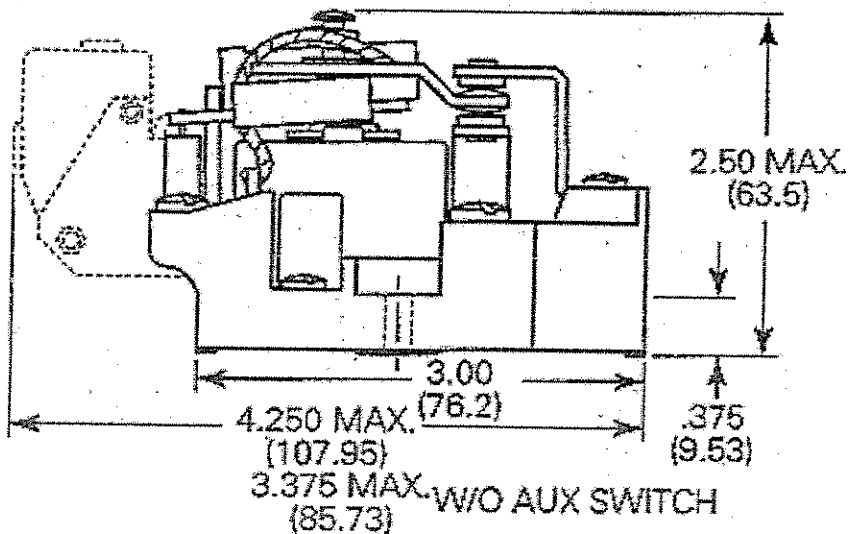
Outline Dimensions

PRD/PRDA Large Base - Top View



DIMENSIONS APPLY TO
PRD 11 AND PRDA 11

2 MTG. HOLES
DIA.
 $.187 + .005$
 $- .003$
 $(4.75 + .13)$
 $- .08$



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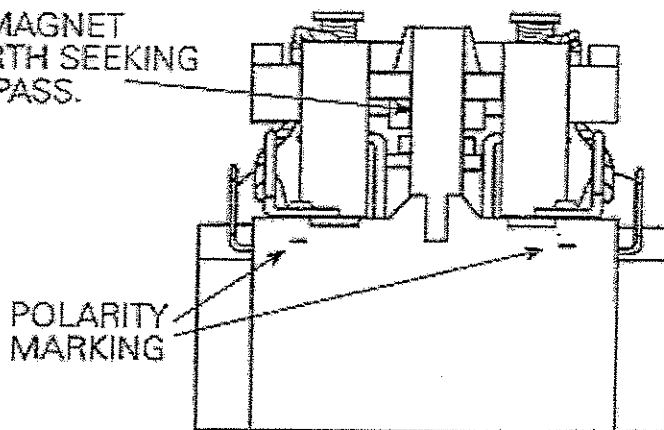
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PRD Magnetic Blow-Out Drawings

PRD11 with Magnetic Blow-Out

THIS SIDE OF MAGNET
ATTRACTS NORTH SEEKING
POLE OF COMPASS.



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1. The first part of the document is a list of names and titles, including the names of the authors and the titles of their works. This list is followed by a section of text that discusses the importance of the work and the role of the authors.

(

USD Base Mounted Terminal Blocks

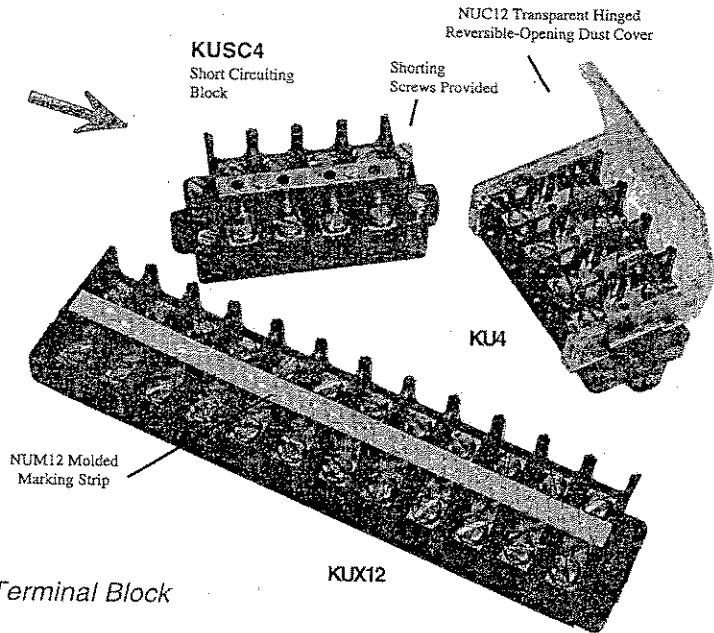
KU Series

SPECIFICATIONS

Rating: 50A, 600V; UL/CSA
Center Spacing: .625" or 5/8" (15.88mm)
Number of Poles: 2 thru 14
Wire Size: AWG#8 and Smaller
Screw Size: #10-32 Brass, Nickel Plated
Mounting Options: Base Mount

MATERIAL SPECIFICATIONS

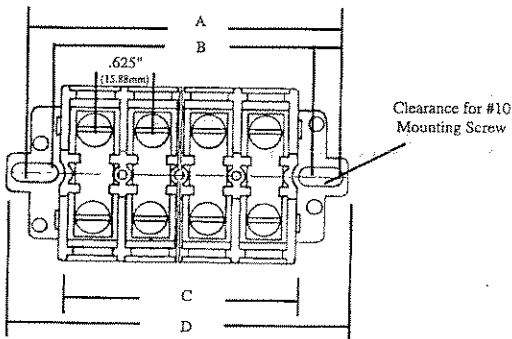
Molded Material: UL Recognized
 94V-1 Thermoplastic - Black
Screws and Terminals: Nickel Plated Brass



KU - Versatile, Cost Effective, Base Mount Terminal Block
 Available in 2-14 Poles.

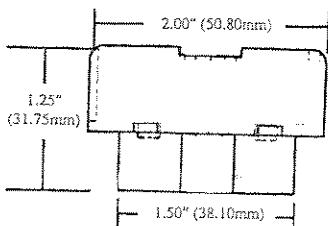
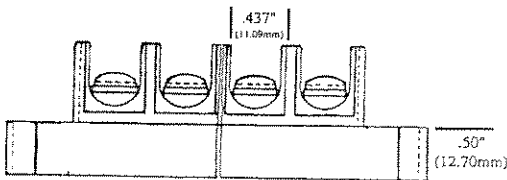
KUSC - Short Circuiting Terminal Block.
 4 Shorting Screws Provided Per Block.

KUX - Same as KU Series but 1/2" Less
 Overall Length.



No. of Poles	Length Dimensions				
	KU, KUSC, KUX			KU, KUSC	KUX
	A	B	C	D	D
02	2.125	1.625	1.345	2.500	2.000
03	2.750	2.250	1.970	3.125	2.625
04	3.375	2.875	2.595	3.750	3.250
05	4.000	3.500	3.220	4.375	3.875
06	4.625	4.125	3.845	5.000	4.500
07	5.250	4.750	4.470	5.625	5.125
08	5.875	5.375	5.095	6.250	5.750
09	6.500	6.000	5.720	6.875	6.375
10	7.125	6.625	6.345	7.500	7.000
11	7.750	7.250	6.970	8.125	7.625
12	8.375	7.875	7.595	8.750	8.250
13	9.000	8.500	8.220	9.375	8.875
14	9.625	9.125	8.845	10.000	9.500

For mm, multiply by 25.4



ACCESSORIES

<p>MTMU## Molded Marking Tape Matte Finish</p>	<p>NUM## Molded Marking Tape</p>	<p>JU12 Jumper (12 Circuits)</p>
<p>NUE End Piece for NUC</p>	<p>NUC## Cover</p>	

Note: ## denotes number of poles.

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rests with the Contractor.

Responsibility for verification and correlation of field
dimensions, fabrication process, techniques of
construction, installation and coordination of all
parts of the work rests with the Contractor.

REVIEWED

✓

REVIEWED AS MODIFIED

REVISE AND RE - SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

Date: June 21/06

By: [Signature]

Model 11

Vishay Spectrol



25.4mm Dia Eleven Turn Dial



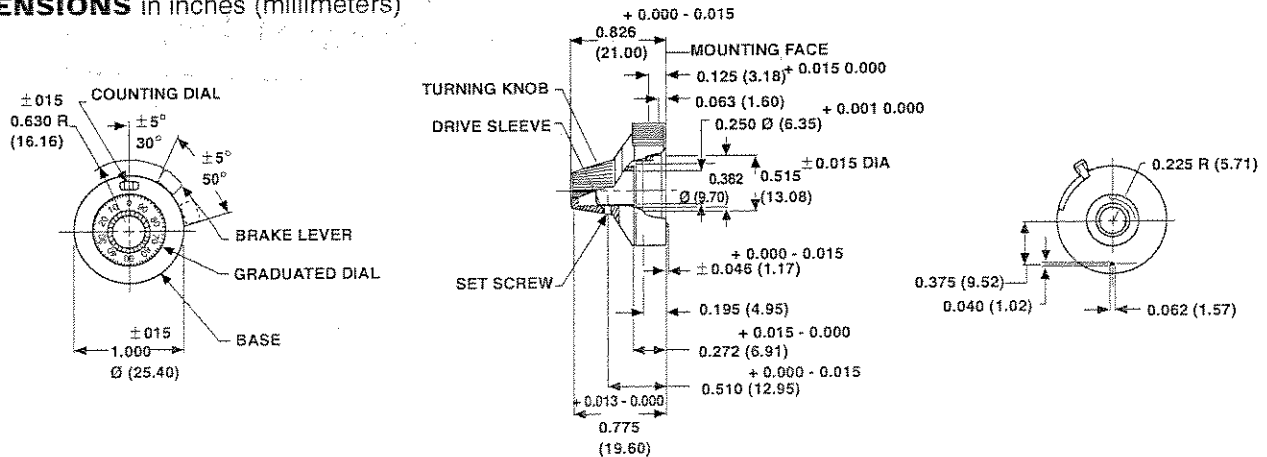
FEATURES

- Round Vernier Scale
- 1" Dia.
- 1/4" or 1/8" Shaft Adapter
- Black Chrome Finish with White Markings
- Brushed Chrome Finish with Black Markings
- Satin Chrome Finish with Black or White Markings

MECHANICAL SPECIFICATIONS	
PARAMETER	
Runout	Dial to be free running and without binds, with axis of drive sleeve perpendicular or in any position within 0.004 per inch (0.10) out of perpendicular with the mounting face
Mounting	Directly to shaft with #2 - 56 spline socket set screw. Drive sleeve set screw on lower side of vertical center line with a graduated circular dial reading of 0
Numeral Size	0.75 H (1.90) x 0.13 Width (0.33) of line
Graduation Size:	
Numeral	0.40 inches L (1.02cm)
Intermediate	0.030 Inches L (0.76cm)
Width	0.010 Inches (0.25cm)
Weight	0.7 oz maximum (19.84gm)

OPERATIONAL SPECIFICATIONS	
Indication	Single counter type wheel and a graduated circular dial registering a total count of 10 turns
Operation	Single numeral in window (0 thru 10) indicates completed number of turns of the drive sleeve. Graduated circular dial indicates the percent of the partial turn of the drive sleeve
Transfer Point	Between 97 and 0
Rotation	
Increasing indication	CW direction
Decreasing indication	CCW direction
Accuracy	Zero backlash between dial and the drive sleeve
Mounting Hardware	Lock washer, internal tooth, steel, nickel plated panel nut: brass, nickel plated

DIMENSIONS in inches (millimeters)



ORDERING INFORMATION		
11	1	11
MODEL	SHAFT DIAMETER AND NUMERICAL DISPLAY	FINISH AND OTHER FEATURES
Example: 11 - 1 - 11	1. 1/4" Shaft (standard) 2. 1/8" Shaft adapter	11. Satin chrome, black markings 21. Black chrome, white markings 31. Brushed chrome, black markings 41. Satin chrome, white markings

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REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

NOT REVIEWED

Project No. 79538-C31-16

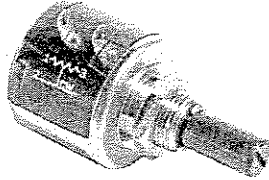
Date: June 21/06 By: Bm

Model 533, 534, 535

Vishay Spectrol



7/8" (22mm) Precision Wirewound Potentiometer



FEATURES

- Special Resistance Tolerances to 1%
- Rear Shaft Extensions and Support Bearing
- Non Turn Lug
- Insulating Plastic Shaft
- Special Independent Linearity to $\pm 0.75\%$
- Dual Gang Configuration and Concentric Shafts
- High Torque and Center Tap
- Special Markings and Front Shaft Extensions
- Servo Unit available and Slipping Clutch

ELECTRICAL SPECIFICATIONS

PARAMETER	MODEL 533	MODEL 534	MODEL 535
Resistance Range			
Standard Values	50 Ω to 20K Ω	100 Ω to 100K Ω	50 Ω to 50K Ω
Capability Range	5 Ω to 60K Ω	10 Ω to 200K Ω	5 Ω to 100K Ω
Standard Tol	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
Linearity (Independent)	$\pm 0.25\%$	$\pm 0.25\%$	$\pm 0.25\%$
Noise	100 Ω ENR	100 Ω ENR	100 Ω ENR
Rotation (Electrical & Mechanical)	0° + 10°	0° + 10°	0° + 10°
Power Rating (@ 70°C)	1.0 watts	2.0 watts	1.5 watts
Additional Sections	75% of section 1		
Insulation Resistance	1000M Ω minimum 500VDC		
Dielectric Strength	1000V _{RMS} minimum 60Hz		
Absolute Minimum Resistance	Not to exceed linearity x total resistance or 1 Ω , whichever is greater		
Tempco	20ppm/°C (standard values, wire only)		
End Voltage	0.25% of total applied voltage, maximum		
Phasing	CCW end points - section 2 phased to section 1 within $\pm 2^\circ$		
Taps	Center tap only		

MARKING

Unit Identification	Manufacturer's name and model number, resistance value and tolerance, linearity specification date code and terminal identification
---------------------	---

RESISTANCE VALUES

Ohms	
533:	50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K
534:	100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 100K
535:	50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K

ORDERING INFORMATION

The Models 533 (3 turn), 534 (10 turn) and 535 (5 turn) can be ordered by stating			
534	1	2	XXX
MODEL	MOUNTING	NUMBER OF SECTIONS	RESISTANCE EIA CODE SECTION #N
	1. Bushing 2. Servo		(consult factory)

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REVIEWED

REVIEWED AS MODIFIED

REVISE AND RE-SUBMIT

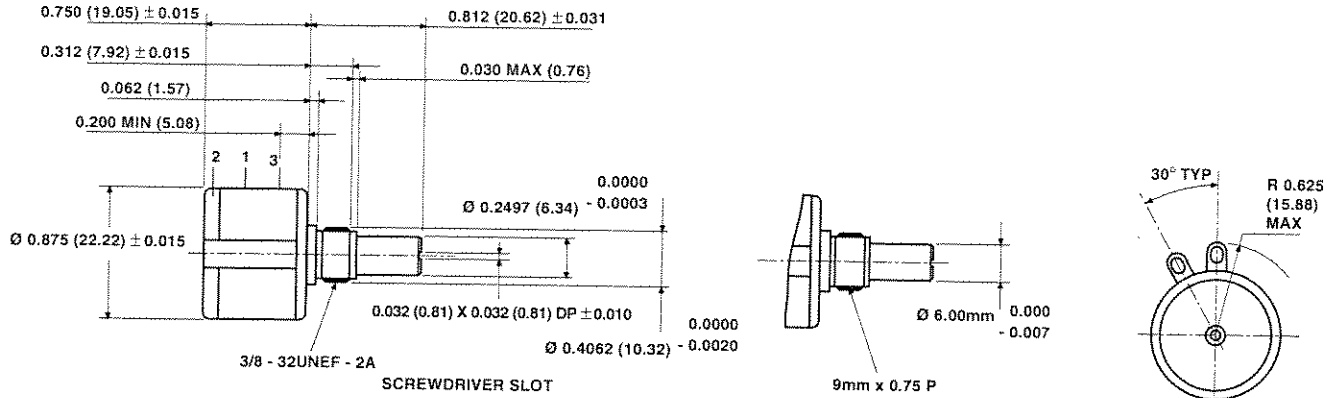
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Project No. 79538-031-16

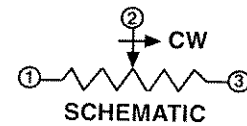
June 21/06 By: 



DIMENSIONS in millimeters

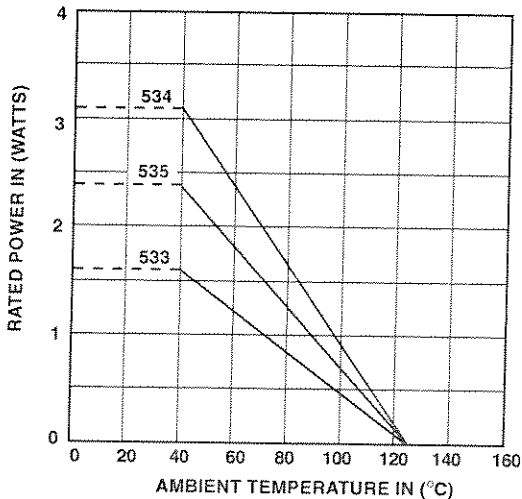


Mounting hardware, washer and panel nut, nickel plated



MECHANICAL SPECIFICATIONS		
PARAMETER		
Bearing Type Bushing	Sleeve bearing	
Torque (maximums): starting		
Section 1	534 0.5 oz - in (36gm - cms)	533/535 0.7 oz - in (50gm - cms)
Section 2	0.9 oz - in (65gm - cms)	1.1 oz - in (79gm - cms)
Weight (maximums)		
Section 1	0.75 oz (21.26gm)	
Section 2	1.25 oz (35.44gm)	
Stop Strength	75 oz - in (static) (5.4Kgm - cm)	
Ganging	2 sections maximum	

POWER RATING CHART



ENVIRONMENTAL SPECIFICATIONS	
Vibration	15g thru 2000Hz
Shock	50g
Rotational Life (Shaft Revolution)	
533	300,000
534	1,000,000
535	500,000
Load Life	900 Hours
Operating Temperature Range	- 55°C to + 125°C
Moisture Resistant Salt Spray	96 Hours

Model 533, 534, 535



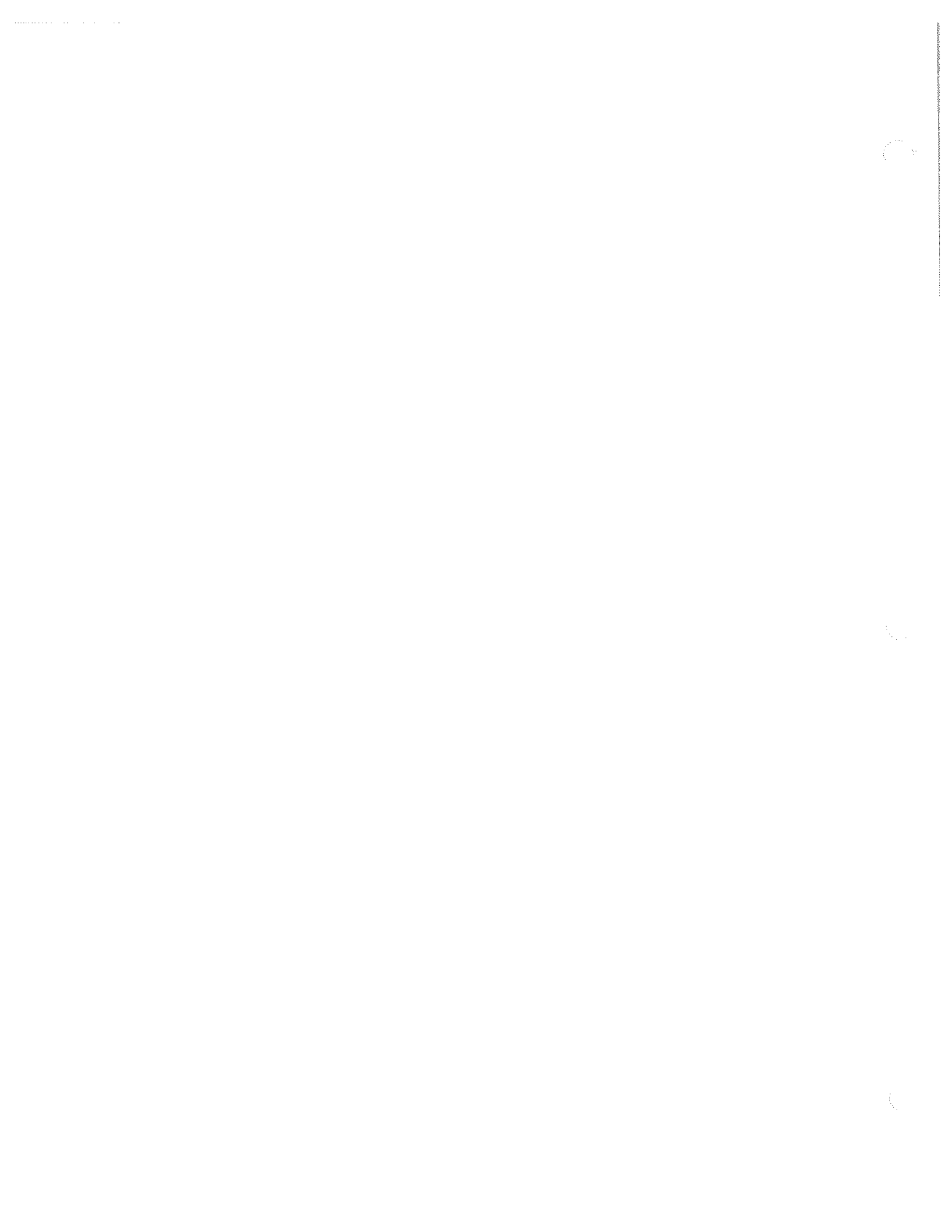
Vishay Spectrol

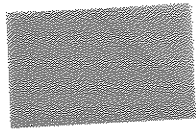
7/8" (22mm) Precision
Wirewound Potentiometer

RESISTANCE ELEMENT DATA														
RESISTANCE VALUE (Ω)			RESOLUTION %			OHMS PER TURN			MAX CURRENT AT 70°C AMBIENT (mA)			MAX VOLTAGE ACROSS COIL (V)		
533	534	535	533	534	535	533	534	535	533	534	535	533	534	535
50	-	50	0.149	-	0.120	0.0746	-	0.0603	141.0	-	173.0	7.07	-	8.66
100	100	100	0.111	0.060	0.075	0.1114	0.0603	0.0746	100.0	141.0	122.0	10.0	14.1	12.2
200	200	200	0.097	0.037	0.061	0.1954	0.0746	0.1220	70.7	100.0	86.6	14.1	20.0	17.3
500	500	500	0.069	0.031	0.049	0.3424	0.1520	0.2459	44.7	63.2	54.7	22.4	31.6	27.4
1K	1K	1K	0.063	0.025	0.041	0.6331	0.2459	0.4113	31.6	44.7	38.7	31.6	44.7	38.7
2K	2K	2K	0.041	0.021	0.031	0.8206	0.4113	0.6331	22.4	31.6	27.4	44.7	63.2	54.8
5K	5K	5K	0.044	0.016	0.034	2.2330	0.8206	1.7230	14.1	20.0	17.3	70.7	100.0	86.6
10K	10K	10K	0.034	0.017	0.030	3.4510	1.7230	3.0160	10.0	14.1	12.2	100.0	141.0	122.0
20K	20K	20K	0.031	0.015	0.020	6.1790	3.0160	3.9910	7.07	10.0	8.66	141.0	200.0	173.0
-	50K	50K	-	0.009	0.015	-	4.6690	7.4560	-	6.32	5.47	-	316.0	274.0
-	100K	-	-	0.007	-	-	7.4560	-	-	4.47	-	-	447.0	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Engineering Drawings





Installation & Maintenance

0

0



Cutler-Hammer

**Instructions for
5/15 kV Type VacClad-W Arc Resistant
Metal-Clad Switchgear Indoor Housings**
Instructional Booklet

New Information

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3. Installing Indoor Switchgear	5
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11. Metal-Clad Switchgear Field Taping Procedure (5-15 kV)	32



Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

Read and understand these instructions before attempting installation, operation, or maintenance of this equipment. This equipment must be installed and serviced only by qualified electrical personnel. Retain this document for future use.

⚠ WARNING

HAZARD OF ELECTRICAL SHOCK OR BURN. OPERATING THE SWITCHGEAR ASSEMBLY OUTSIDE OF ITS RATINGS MAY CAUSE FAILURE RESULTING IN PROPERTY DAMAGE, SEVERE PERSONAL INJURY, OR DEATH. THE SWITCHGEAR ASSEMBLY MUST BE OPERATED WITHIN ITS NAMEPLATE RATINGS.

⚠ DANGER

ALL APPLICABLE SAFETY CODES, SAFETY STANDARDS, AND SAFETY REGULATIONS MUST BE STRICTLY ADHERED TO WHEN INSTALLING, OPERATING, OR MAINTAINING THIS EQUIPMENT.

Section 1: Introduction

1.1 Purpose

This instruction bulletin covers the installation, operation, and maintenance of a 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housing Assembly. It does not cover all possible contingencies, variations, and details that may arise during installation, operation, or maintenance of this equipment.

1.2 Application and Description

The Eaton Electrical 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housing Assembly provides centralized control and protection of medium voltage power equipment and circuits in industrial, commercial, and utility installations involving generators, motors, and feeder circuits. Arc Resistant Switchgear provides additional protection in the event of an internal arcing fault. In addition to meeting the American National Standards Institute / Institute of Electrical and Electronics Engineers / Canadian Standards Association (ANSI/IEEE/CSA) Metal-Clad switchgear standards, this arc resistant switchgear also meets IEEE C37.20.7 or Electrical and Electronic Manufacturers Association of Canada (EEMAC) G14-1. See Table 1 for the switchgear arc ratings.

Table 1. Arc Resistant Switchgear Ratings.

MAXIMUM VOLTAGE RATING	BREAKER / SWITCHGEAR CURRENT RATING	BREAKER / SWITCHGEAR SC (K x SC) RATING	MAXIMUM ARC FAULT RATING	SWITCHGEAR CONSTRUCTION		ARC DUCT OPTION
				1-HI	2-HI	
4.76 kV	1200	250 MVA (36 kA)	37 kA [2]	X	X	[1]
	2000, 3000	250 MVA (36 kA)	37 kA [2]	X		[1]
	1200, 2000, 3000	350 MVA (49 kA)	50 kA [2]	X		[1]
	1200	500 MVA (63 kA)	37kA [2]	X	X	[1]
	1200, 2000, 3000	500 MVA (63 kA)	50 kA [2]	X		[1]
8.25 kV	1200	500 MVA (41 kA)	37 kA [2]	X	X	[1]
	1200, 2000, 3000	500 MVA (41 kA)	50 kA [2]	X		[1]
15 kV	1200	500 MVA (23 kA)	37 kA [2]	X	X	[1]
	1200, 2000, 3000	500 MVA (23 kA)	50 kA [2]	X		[1]
	1200	750 MVA (36 kA)	37 kA [2]	X	X	[1]
	1200, 2000, 3000	750 MVA (36 kA)	50 kA [2]	X		[1]
	1200	1000 MVA (48 kA)	37 kA [2]	X		[1]
	1200, 2000, 3000	1000 MVA (48 kA)	50 kA [2]	X		[1]
	1200	1500 MVA (63 kA)	37kA [2]	X	X	[1]
	1200, 2000, 3000	1500 MVA (63 kA)	50 kA [2]	X		[1]

[1] 40 kA Arc Duct is the maximum arc fault rating available.

[2] All switchgear specified to IEEE C37.20.7 requires an Arc Exhaust Wall. The Arc Duct option may be substituted in place the Arc Exhaust Wall to meet the IEEE standard.

1.3 Revision Level

This is a new document.

1.4 Documentation Reference

For further information on installation and application, refer to the applicable technical data, publications, and/or industry standards. Download Eaton Electrical electronic information from www.eatonelectrical.com.

1.5 Eaton Electrical Contact Information

For the location of your nearest Eaton Electrical sales office or distributor, call toll-free 1-800-525-2000 or log onto www.eatonelectrical.com.

Eaton Electrical Services and Systems (EESS) can be reached at 1-800-498-2678.

1.6 Safety Precautions

Only qualified electrical personnel with training and experience on high-voltage apparatus shall be permitted to work on this equipment. They shall be familiar with the work to be performed, as well as industry and local safety procedures and standards.

1. Read and understand these instructions before attempting installation, operation, or maintenance of the switchgear assembly.
2. Disconnect all low voltage and medium voltage power sources to the switchgear assembly before working on the equipment per Occupational Safety and Health Act (OSHA) and lockout procedures. Verify that the voltage has been removed. Ground load and line side connections. Observe National Electrical Code (NEC), OSHA, and local procedures and standards. This includes visual inspections while the door is open, making any adjustments inside or outside the enclosure, performing maintenance, or installing replacement parts.
3. Never leave a breaker in an intermediate position in its compartment. Always continue to lever the breaker to the fully connected or withdrawn / test position.
4. Never try to disconnect or open the secondary circuit of a current transformer that is carrying load current. In this situation, the transformer develops a dangerous high voltage.

▲ CAUTION

BEFORE ATTEMPTING ANY WORK, EITHER DE-ENERGIZE THE CIRCUIT BY OPENING THE BREAKER OR SHORT-CIRCUIT THE SECONDARY OF THE CURRENT TRANSFORMER.

5. The user is responsible for conforming to all applicable code requirements with respect to grounding the switchgear assembly.

▲ CAUTION

BEFORE ENERGIZING THE SWITCHGEAR ASSEMBLY, ENSURE THAT:

6. The switchgear assembly is secured on a true and level surface.
7. Confirm all hardware is in place and torqued per Section 3.1, Table 4.
8. Confirm no tools or objects are left inside the enclosure
9. Confirm all devices, covers, doors, panels, etc., are in place.

Section 2: Receiving, Handling, and Storing Indoor Switchgear

2.1 Receiving Indoor Switchgear

The switchgear is shipped to the customer as a complete assembly. Depending on the number of switchgear vertical sections, it may be necessary to ship the switchgear in several shipping sections to facilitate handling.

Each indoor switchgear assembly ships from the factory bolted to wooden skids and covered with weatherproof material. VCP-W breakers are shipped in individual containers. See breaker I.B. 32-255-1C for breaker handling instructions.

Each order ships with a box labeled "Installation Parts". This box contains the packing list. The packing list identifies all cartons and crates. Each carton and crate is labeled with the shop order number and a shipping weight.

Accept items from shipping carrier if all items described on the packing list have been received. If the switchgear has been damaged, file a claim as soon as possible with the carrier and notify the nearest Eaton Electrical representative.

A copy of this instruction bulletin is located inside the "Installation Parts" box.

If the switchgear is to be installed upon receipt, unpack and handle according to Section 2.2. If the switchgear is to be stored, see Section 2.3

2.2 Handling Indoor Switchgear

Refer to Tables 2 and 3 for the approximate weights of the various combinations of switchgear and the various rating of breakers.

Table 2. Typical Vertical Section Weights.

TYPE OF VERTICAL SECTION	MAIN BUS RATINGS (AMPERES)	INDOOR VERTICAL SECTION (LESS BREAKER) LBS (KG) 5/15 kV
Breaker	1200	2200 (997.9)
	2000	2300 (1043.3)
	3000	2425 (1100.0)
Auxiliary	1200	2100 (952.5)
	2000	2225 (1009.2)
	3000	2325 (1054.6)
Auxiliary / Auxiliary	1200	2200 (997.9)
	2000	2400 (1088.6)
	3000	2725 (1236.0)

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

Table 3. Typical Breaker Weights

TYPE BREAKER	CURRENT RATING AMPERES	BREAKER ELEMENT (STATIC) LBS (KG)	BREAKER ELEMENT (IMPACT) LBS (KG)
50 VCP-W 250 & 50 VCPW-SE 250	1200	350 (158.8)	525 (238.1)
	2000	410 (186.0)	615 (279.0)
	3000	525 (238.1)	788 (357.4)
50VCP-W 350	1200	460 (208.7)	690 (313.0)
	2000	490 (222.3)	735 (333.4)
	3000	525 (238.1)	788 (357.4)
50VCP-W 500	1200	525 (238.1)	788 (357.4)
	2000	530 (240.4)	795 (360.5)
	3000	550 (249.4)	825 (374.2)
75 VCP-W 500 & 75 VCPW-SE 500	1200	375 (170.1)	563 (255.4)
	2000	410 (186.0)	615 (279.0)
	3000	525 (238.1)	788 (357.4)
150 VCP-W 750 & 150 VCPW-SE 500	1200	350 (158.8)	525 (238.1)
	2000	410 (186.0)	615 (279.0)
	3000	525 (238.1)	788 (357.4)
150 VCP-W 750 & 150 VCPW-SE 750	1200	350 (158.8)	525 (238.1)
	2000	410 (186.0)	615 (279.0)
	3000	525 (238.1)	788 (357.4)
150VCP-W 1000 & 150VCPW-SE 1000	1200	350 (158.8)	525 (238.1)
	2000	410 (186.0)	615 (279.0)
	3000	525 (238.1)	788 (357.4)
150VCP-W 1500	1200	525 (238.1)	788 (357.4)
	2000	530 (240.4)	795 (360.5)
	3000	550 (249.4)	825 (374.2)

If a crane is not available, move the shipping section by use of rollers. Skids run the length of the shipping section. If the shipping section is to be moved sideways, place rollers at the front and back of the skid. If it is to be moved from front to back, place rollers under the skid every 2 ft (0.61 m) and roll into place.

Note: Never maneuver the switchgear directly on the rollers. Skids are used to protect the switchgear from being distorted or damaged.

2.3 Storing Indoor Switchgear

A switchgear assembly contains insulating materials, electrical contacts, and operating mechanisms, which must be protected against dirt, moisture, cement dust, other foreign materials, corrosive atmospheres, and extreme temperature change. Packaging for shipping is not suitable for storage. If it is necessary to store the equipment before installation, place the equipment on a true and level surface in order to reduce strain and distortion in the equipment. Cover the equipment and keep it in a clean and dry location with ample air circulation and heat to prevent condensation.

Note: Storing the switchgear outdoors is not recommended.

Note: For detailed instructions on storing switchgear, refer to Eaton Electrical drawing 700B214. A copy of the drawing is located on the inside door of each switchgear shipping section.

2.4 Recommended Safety Practices

Refer to Section 1.6.

The preferred method of handling switchgear assemblies is by crane. To lift and remove the shipping section, place a crane hook through each of the four holes. Figure 1 shows the lifting members for indoor switchgear.

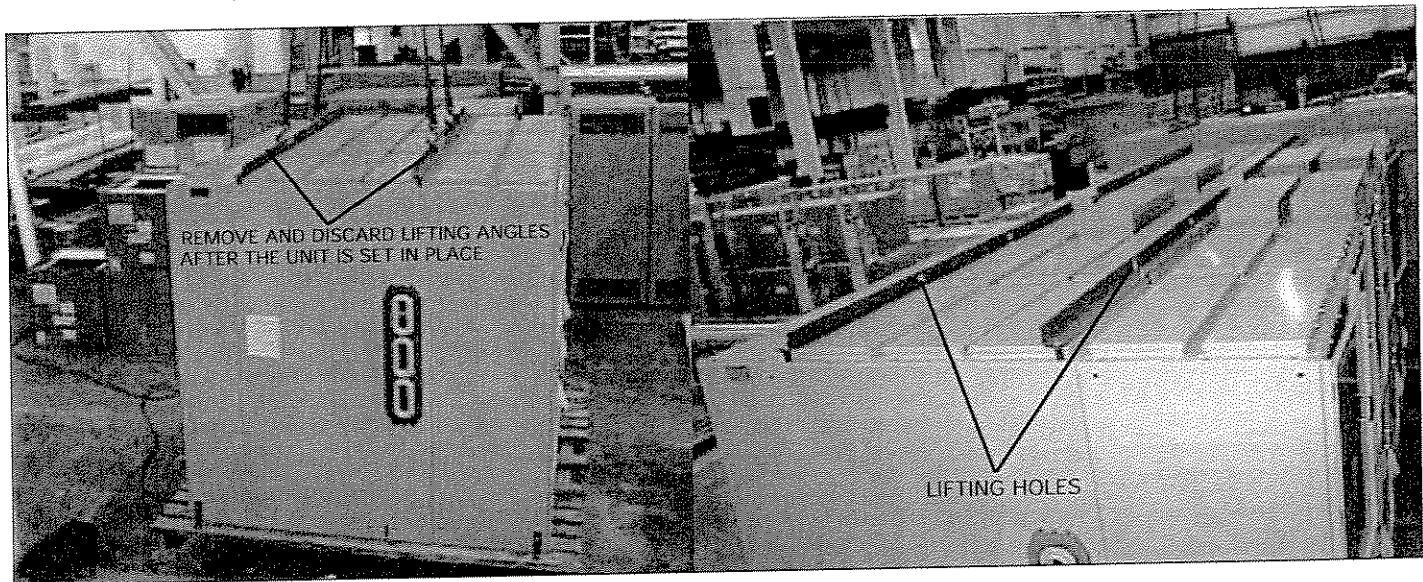
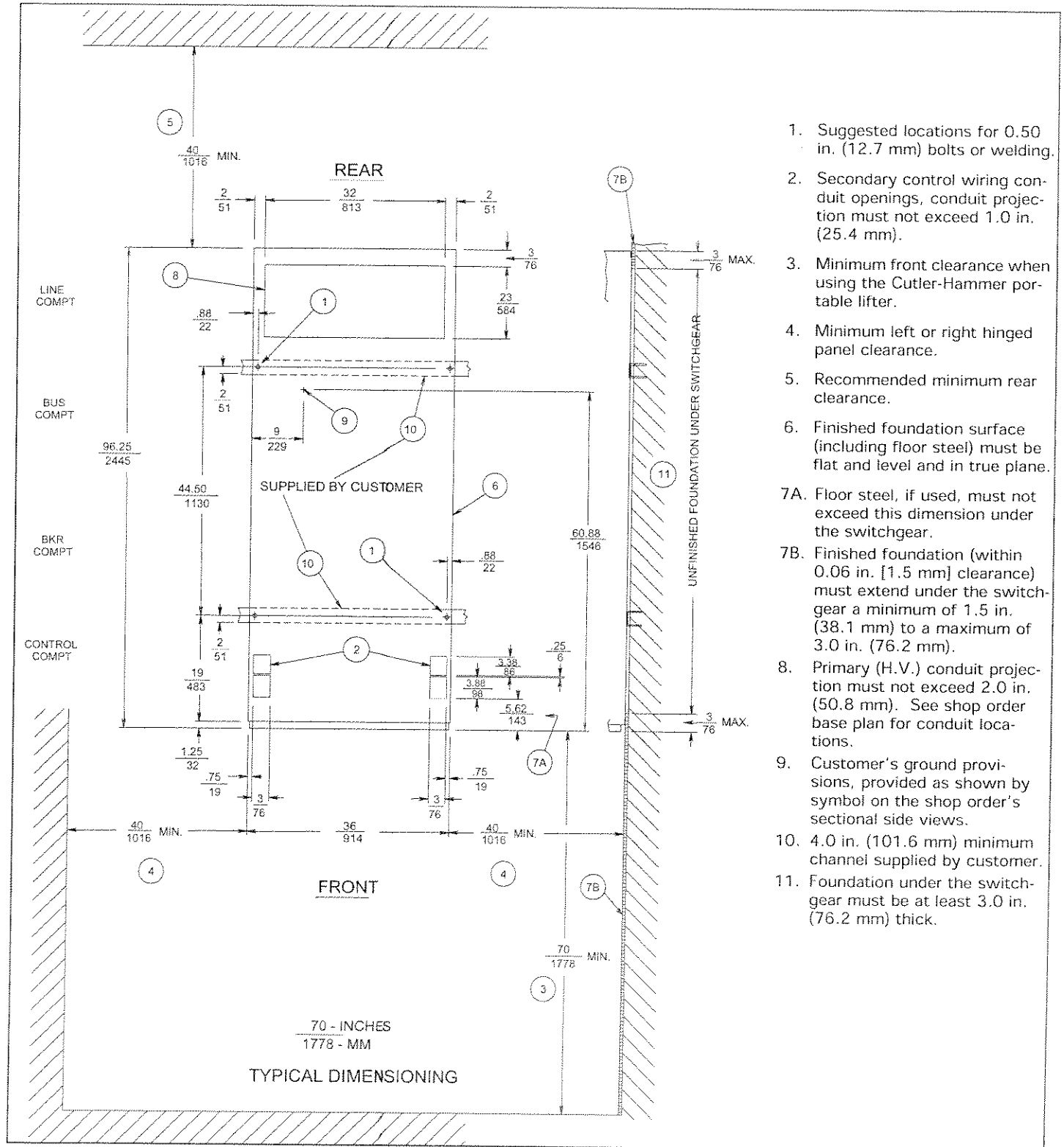


Figure 1. Handling of Indoor Shipping Group

Section 3: Installing Indoor Switchgear

Instruction bulletins and drawings are located inside the upper compartment door of the first vertical section.

The detail box contains kits, bus, splice-plates, boots, tape kits for taping cable to riser joints, and hardware required for installation of the switchgear.



1. Suggested locations for 0.50 in. (12.7 mm) bolts or welding.
2. Secondary control wiring conduit openings, conduit projection must not exceed 1.0 in. (25.4 mm).
3. Minimum front clearance when using the Cutler-Hammer portable lifter.
4. Minimum left or right hinged panel clearance.
5. Recommended minimum rear clearance.
6. Finished foundation surface (including floor steel) must be flat and level and in true plane.
- 7A. Floor steel, if used, must not exceed this dimension under the switchgear.
- 7B. Finished foundation (within 0.06 in. [1.5 mm] clearance) must extend under the switchgear a minimum of 1.5 in. (38.1 mm) to a maximum of 3.0 in. (76.2 mm).
8. Primary (H.V.) conduit projection must not exceed 2.0 in. (50.8 mm). See shop order base plan for conduit locations.
9. Customer's ground provisions, provided as shown by symbol on the shop order's sectional side views.
10. 4.0 in. (101.6 mm) minimum channel supplied by customer.
11. Foundation under the switchgear must be at least 3.0 in. (76.2 mm) thick.

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

3.1 Installation Procedure

Step 1: Prepare the foundation.

Review the floor plan drawings supplied for the order and follow the instructions carefully.

- A. The minimum recommended clearances at the front, rear, and sides of the switchgear are shown in Figure 2. Locate the foundation so there is adequate space at the front, rear, and sides of the switchgear lineup. There must be at least 6.6 ft (2 m) of unobstructed space above the roof of the switchgear for arc expulsion. When applicable, an arc exhaust wall is installed within this space. No electrical equipment should be located above the switchgear without proper protection suitable to withstand arc expulsion.
- B. Design the foundation so it will be strong enough to support the weight of the switchgear without sagging. Tables 2 and 3 give the weights of the various ratings of switchgear and breakers. Be sure to take into account the shock or impact weight that occurs when the breaker trips and when it closes. The impact weight is 1.5 times the weight of the breaker.

The weights in the tables are only an approximation. The actual weight will vary, depending on the type and the amount of equipment in the switchgear. Use adequate safety factors.

- C. Careful preparation of the foundation is important for simplicity of erection, ease of operation, and good performance. The recommended foundation consists of steel channels embedded in a level concrete floor. The channels shall be level within 0.0125 in. in 36 in. (0.318 mm in 914.4 mm) left to right, front to rear, and diagonally, as measured by a laser level. In no case may the non-supporting areas of the concrete floor be higher than the tops of the steel channels.

The anchor bolts, channels, and other materials are to be furnished by the purchaser of the switchgear. A 4-in. (106.6-mm) structural channel is recommended as the minimum size for the average indoor switchgear system.

- D. Install the conduits in the foundation. When the primary and secondary cables enter the switchgear from below, the conduits that carry them are embedded in the foundation. A floor plan drawing is furnished with each order. Use this drawing to determine the conduit locations. Avoid circling of steel around single-phase cables rated 600 A or more to prevent overheating due to induced currents. See Figure 2 for a typical base plan.

Step 2: At the factory, the switchgear lineup may have been divided into several shipping sections to facilitate shipping. At the installation site, the shipping sections must be rejoined to form the switchgear lineup. Align the shipping sections side by side on the foundation using the following procedure.

- A. Remove the crating and packaging material from the switchgear to be installed. Shipping skids are to remain in place until the shipping section has been moved into its final installation position. The skids protect the switchgear and reduce the risk that it will be damaged or distorted during the move.

- B. If an odd number of shipping sections is to be installed, install the middle one first. Then install the other shipping sections, working out from the middle.

If an even number of shipping sections is to be installed, start with a shipping section on either side of the middle.

If a unit substation or a power center is being installed, line up the power transformer and the adjacent switchgear first. Set them in the position called for on the drawing of the base plan. Then install the rest of the switchgear.

- C. Move the first shipping section into approximate position.
- D. Remove the bolts and discard the skid.
- E. Line up the bolt holes in the base of the switchgear with the holes in the foundation steel channels.
- F. Use a level to make sure the shipping section is level both across its depth and along its length. Use a plumb line to make sure the switchgear is plumb. To level or plumb the switchgear, use shims at the points where the vertical sections will be bolted to the floor.
- G. Draw an installation base line the entire length of the complete switchgear.
- H. Install the remaining shipping sections following above steps with reference to the installation base line.

Step 3: Bolt the shipping sections together through the tie bolt holes using the following procedure.

- A. Obtain the tie bolt hardware kit (Kit# 3A39215G01) located in the Shop Order Detail Box. Install a flat washer on bolt end, insert the bolt through a hole, then install a flat washer, split-lock washer, and nut. Torque the hardware per the specifications contained in Table 4.

Table 4. Bolt Torque Values for All Hardware Connections.

BOLT SIZE IN (MM)	0.25 (6.35)	0.31 (7.87)	0.38 (9.65)	0.50 (12.7)	0.62 (15.75)
BOLT MATERIAL	TORQUE IN FOOT-POUNDS (N-M)				
High Strength Steel	5 (6.78)	12 (16.27)	20 (27.12)	50 (67.8)	95 (128.82)
Silicon Bronze	5 (6.78)	10 (13.56)	15 (20.34)	40 (54.24)	55 (74.58)

- B. Open the rear doors on each end of the shipping section. Remove upper main bus barrier for 37 kA 2000A or 3000A breaker configurations and all 50 kA configurations to allow access to the mid-module tie-bolt holes. Install eight tie bolts in the locations shown in Figure 3. Six are located in the rear-module and two are at the back of the mid-module.

Refer to items 14 and 15 in this section for instructions on opening a breaker or auxiliary compartment door. Open the front doors on each end of the shipping section. Install 11 tie bolts in the locations as shown in Figure 3. Three are located at the front of the mid-module and eight are located in the front-module.

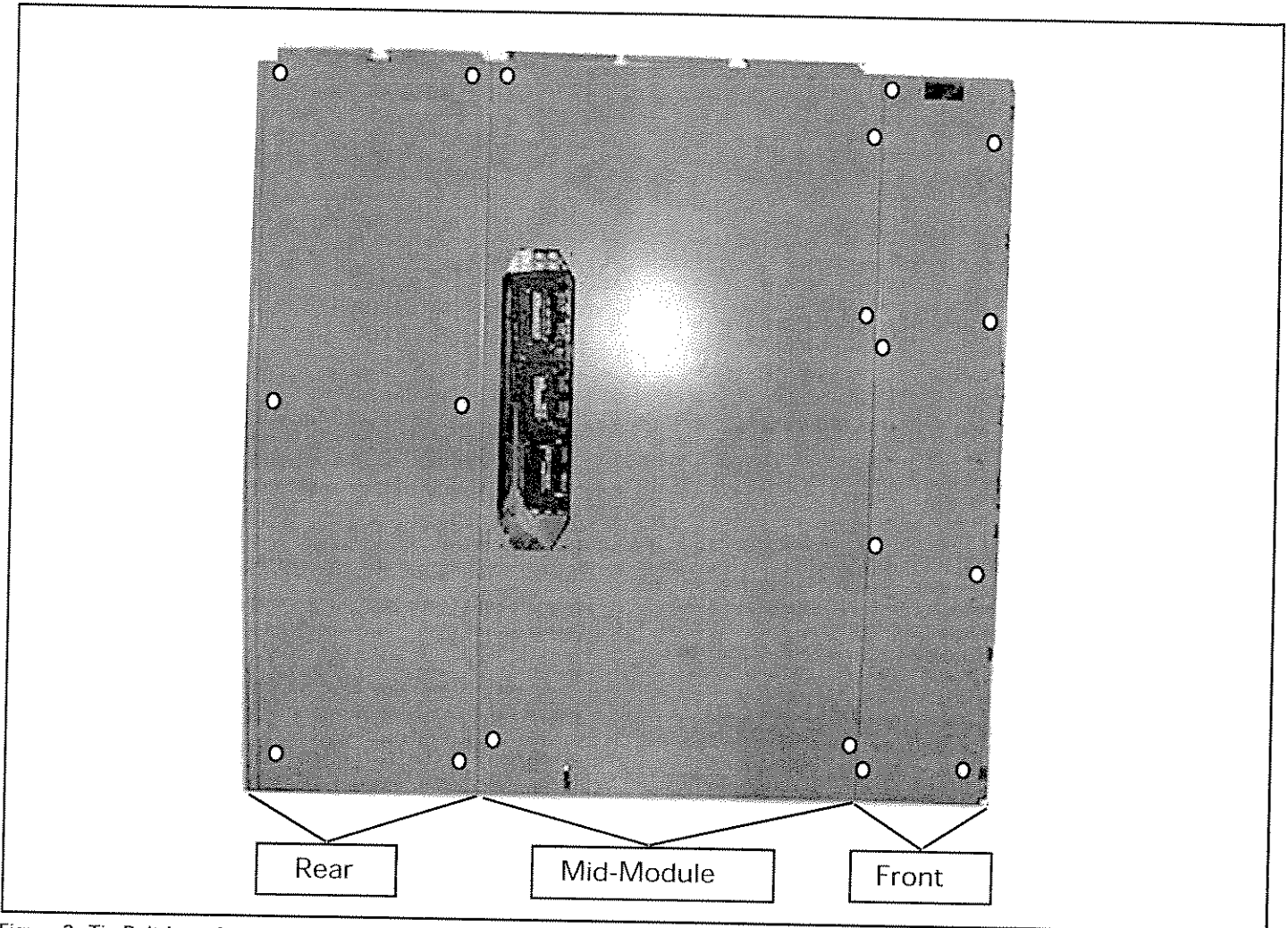


Figure 3. Tie Bolt Locations.

Step 4: Check the entire lineup to make sure it is level and plumb prior to securing the switchgear base to the foundation channels.

Step 5: Remove all shipping blocks or braces located inside the switchgear.

- A. Remove all shipping bracing for dynamic flaps, components, and bus support.
- B. Examine all meters, relays, etc., and remove any shipping blocks or braces.
- C. Remove the lifting angles from top of the units and discard them.

Step 6: Connect the ground bus.

- A. The standard ground bus is a 0.25 in. x 2 in. (6.4 mm x 50.8 mm) copper bus bar boited to the cross members of the frame in the bottom of each switchgear unit. The ground bus runs through the center of each unit, through the length of the entire switchgear assembly. Install a splice plate and hardware (Ground splice kit #8276A77H01, located in detail box) to connect the shipping sections (see Figure 4).



Figure 4. Ground Bus Installation.

- B. Connect the switchgear assembly to the station ground. Solderless terminals are provided on the ground bus at each end of the switchgear for this purpose. The connection shall be made as direct as possible. The connection shall be large enough to carry the ground fault current of the installation. NEVER encase the ground bus in a metal conduit.

⚠ CAUTION

THE SWITCHGEAR INSTALLATION MUST BE PROPERLY GROUNDED.

Note: For the design and installation of a grounding system, refer to Electrical Power distribution For Industrial Plants (IEEE Std 141); Grounding of Industrial and Commercial Power Systems (IEEE Std 142); and the NEC, Articles 100, 200, and 250. For generating stations and larger substations, the ground resistance should be 1 ohm or less. For industrial plants and small substations, the ground should be less than 5 ohms (the NEC states that the ground resistance should never exceed 25 ohms).

Step 7: Connect the high-voltage bus between the shipping sections.

- A. Remove the horizontal metal barriers from the cable compartment in the rear of the switchgear. Remove the bus barriers (same as removed in earlier steps). Also remove any other components such as potheads, surge suppressers, etc., that interfere with access to the bus compartment. Note that the rear assembly of switchgear may vary. Figures 5 and 6 show the removal of necessary barriers (typical for 1-Hi design).

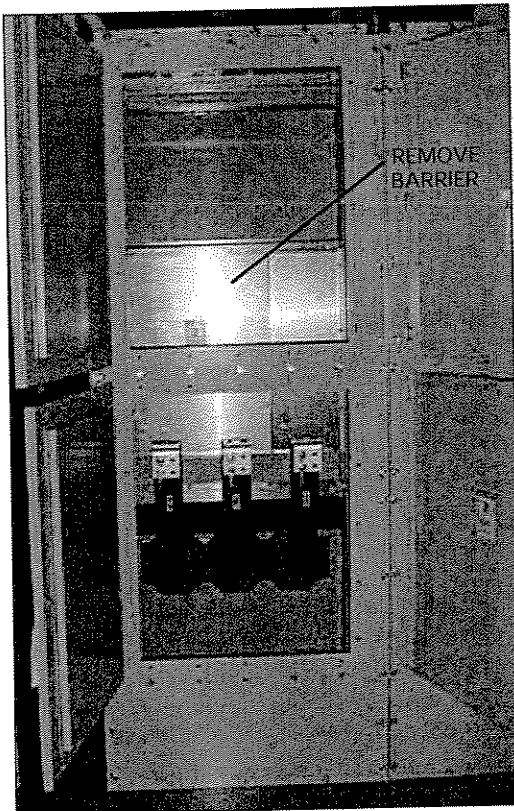


Figure 5. Main Bus Installation with Bus Barriers Installed, Viewed from Rear with Doors Open (Typical 1-High construction shown).

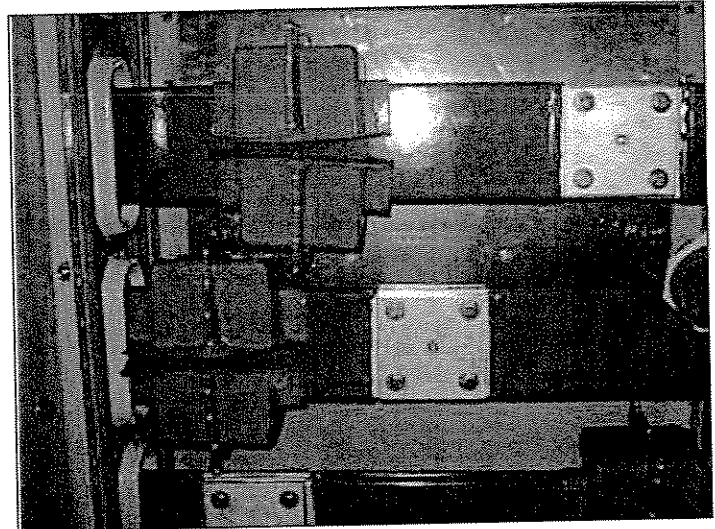


Figure 6. Main Bus Installation with Barriers Removed.

- B. Obtain the section of bus that was removed to separate the shipping sections for shipping. Each shipping section is labeled and shipped in the carton with the details.
- C. The surfaces in the bus joints are silver-plated. Clean the plated surfaces of the bus section if necessary.
- D. Slide the section of main bus through the supports in the side of the vertical section. Slide the rubber snubber along the bus until it fits inside the opening in the bus support.

When the bus section is disconnected for shipping, the splice plates and hardware are left bolted to the end of the bus in each of the adjoining vertical sections. Sandwich the end of the disconnected section between the splice plates and fit the other end of the section between the splice plates on the end of the bus in the adjacent section. Bolt the splice plates together on each end of the bus section (see Figure 6).

⚠ WARNING

USING WRONG HARDWARE MAY RESULT IN REDUCED CLEARANCE AND / OR MAY CAUSE DAMAGES.

- E. Repeat these steps for each section of bus at each shipping break.
- F. Torque the bolts in the splice plate to the values shown in Table 4.
- G. Install the boots over the splice joint at shipping splits.

Step 8: Connect the control wires.

- A. Reconnect the wiring that was disconnected at the factory for shipping. The wiring as well as the connecting points is labeled.
- B. Connect the wiring to the remote apparatus and to the terminal blocks located in the control compartment or within the front of the vertical section.

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Step 9: Replace the metal barriers and any other parts that may have been removed to gain access to the main bus compartments.

Step 10: Connect the main power cables.

- A. Before connecting a cable, determine its phase. The switchgear system is supplied with connections for phasing 1-2-3, left to right (viewed from the front), unless indicated otherwise on the shop order drawings.
- B. If the two systems are to be paralleled, make sure the phase rotation and the phase angles are the same. They must be the same to prevent damaging the equipment. The phase rotation must conform to the phase rotation on the shop order drawing so that the instruments, meters, and relays will operate properly.
- C. When forming cables to fit inside the cable compartment, avoid sharp bending or kinking. Make sure cables do not rest on sharp corners or edges that could damage the insulation.
- D. Follow the instructions of the cable manufacturer to determine what minimum bending radius is permitted. Follow the instructions on insulating the joints so the insulation will taper properly through the correct gradient. The insulation will vary with the type and size of cable and with the service voltage for which it was designed.
- E. Solderless connectors are usually furnished. The connection must be insulated according to the recommendation of the cable manufacturer.
- F. If potheads or other types of terminators are furnished, follow the instructions of the manufacturer when connecting the cable to them. Use the flexible connectors to connect the arial lugs to the conductors. This will keep strain off the insulators of the pothead or the terminator. Tape (or otherwise insulate) the entire joint, including the flexible connectors (see Section 11).
- G. If zero sequence transformers are used, pass the power cables through the transformer (refer to Figure 53).
- H. Replace all metal barriers, vertical section of the bus barrier, and any other components removed during hookup of the high-voltage bus. Replace them in the reverse order in which they were removed.

Close all rear doors (rear covers) and secure all bolts (refer to Figures 7 and 8).

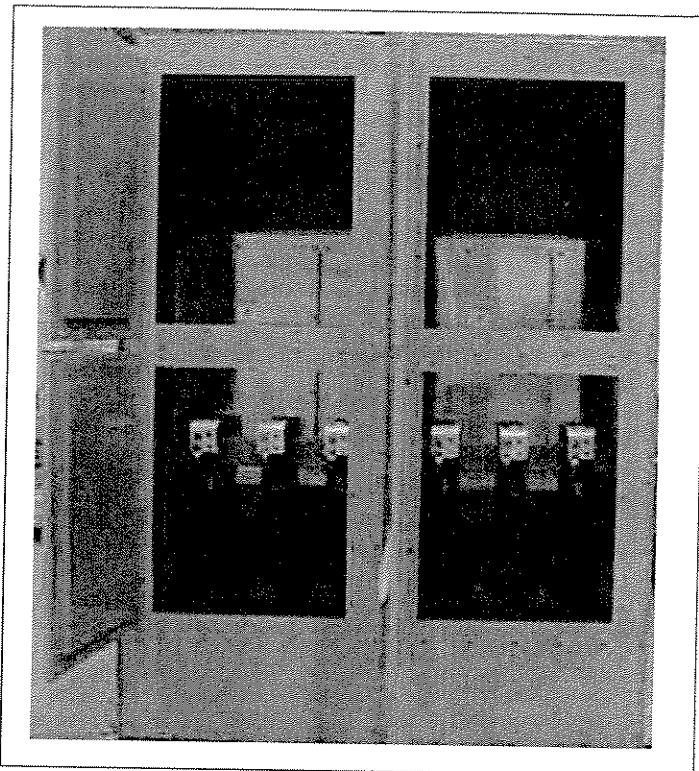


Figure 7. Assembled Switchgear (Shown with Rear Doors Opened).

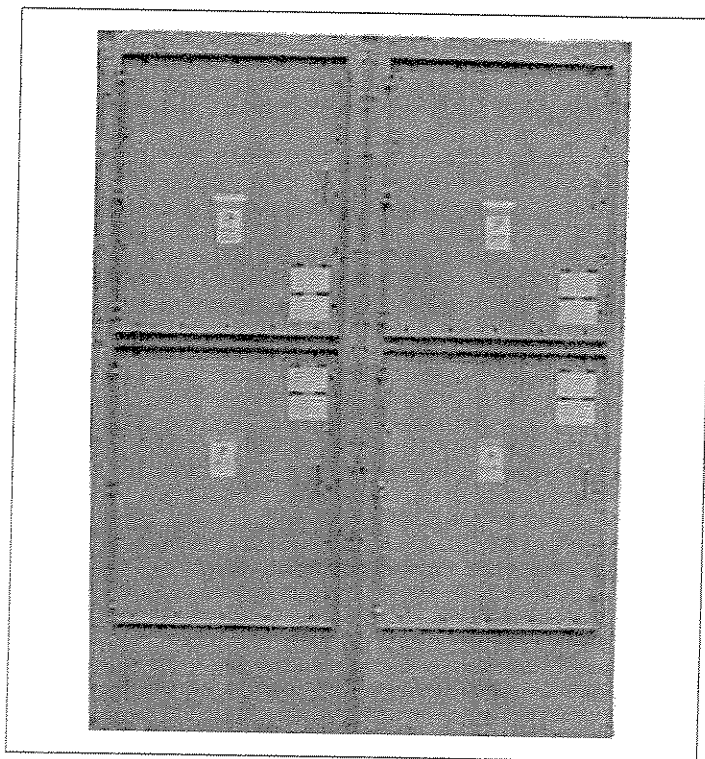


Figure 8. Assembled Switchgear (Shown with Rear Doors Closed).

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Step 11: 5/15 kV Arc Exhaust Wall Assembly Instructions.

An arc exhaust wall provides a degree of protection against the unlikely event of an internal arcing fault within any enclosure in a switchgear lineup. The exhaust wall is designed to direct the arc by-products away from personnel working near the switchgear.

Note: It is important to completely read and understand these instructions before installing an arc exhaust wall.

The following instructions and illustrations show how to assemble an arc exhaust wall to the roof of a 5kV or 15kV arc resistant switchgear lineup. The example construction is on a four-cell lineup as shown in Figure 9. The method of assembly is the same for smaller and larger switchgear lineups.

Note: A two-cell lineup is the minimum number of cells required for installation of an arc exhaust wall.

The item numbers listed in Table 5 are used in figures throughout the "5/15kV Arc Exhaust Wall Assembly Instructions" section and should be referred to when necessary.

Table 5. Arc Exhaust Wall Parts and Mounting Hardware.

ITEM #	EATON ELECTRICAL #	DESCRIPTION
1	69C4073H01	Vertical Panel (Wide)
2	69C4075H01	LH/R & RH/F Vertical Panel (Narrow)
3	69C4076H01	RH/R & LH/F Vertical Panel (Narrow)
4	69C4080H01	Vertical Seam Cover (Short)
5	69C4081H01	Horizontal Seam Cover (Long)
6	69C4093H01	End Roof Panel
7	69C4094H01	Roof Extension Panel (End)
8	69C4095H01	Roof Extension Panel (Middle)
9	70100EG01Q	0.25 - 20 x 0.75" Lg. Hex Cap Screw
10	70500BD31C	0.25" Wide Washer
11	70510CV10M	0.25" Lock Washer
12	70010ANGCM	0.25 - 20 x 0.75" Lg. Self-Tap Screw

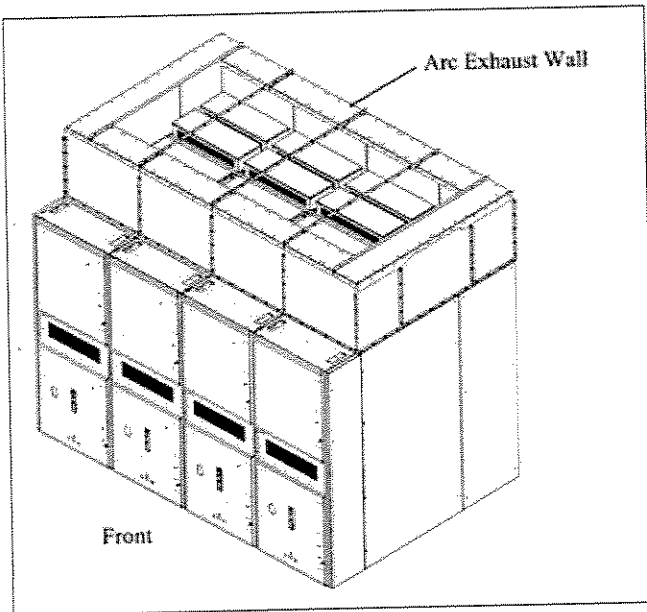


Figure 9. Typical Arc Resistant Switchgear Lineup with Arc Exhaust Wall.

Refer to Figure 10 for arc exhaust wall dimensional information.

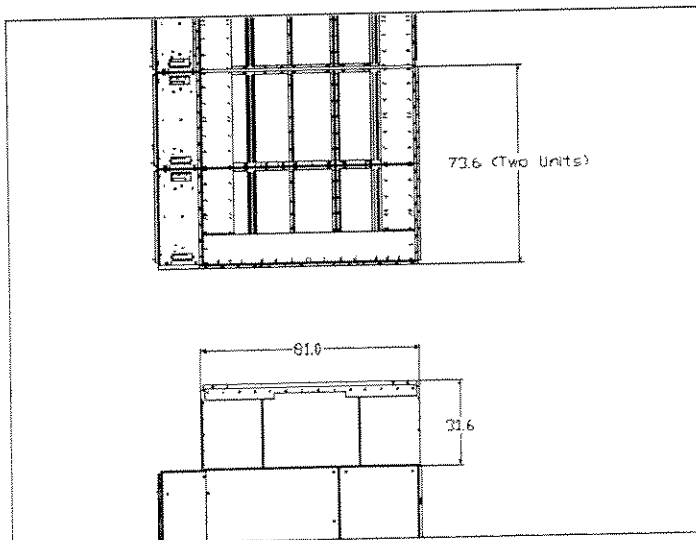


Figure 10. Arc Exhaust Wall Dimensions.

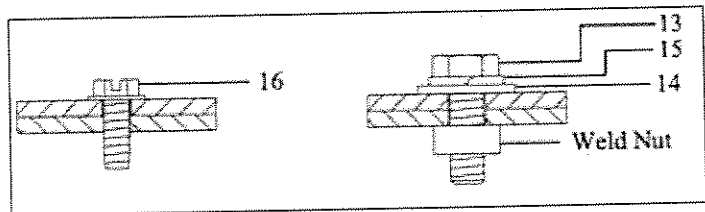


Figure 11. Assembly Hardware.

A. Installing the Arc Exhaust Wall. Construct the left rear corner of the arc exhaust wall (see Figure 12).

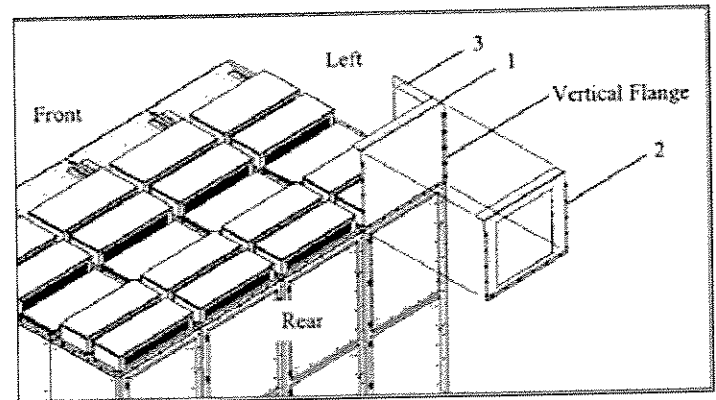


Figure 12. Detail of the Left Rear Corner of the Arc Exhaust Wall.

- Using the 0.25" cap screws and washers (see Figure 11), loosely fasten a wide vertical panel (1) to the rear of the switchgear roof at the left end of the switchgear lineup. Two loose screws in each end of the lower flange are sufficient to hold the part in place temporarily. This is necessary to allow mating parts to adjust while securing one part to another.
- Using the 0.25" cap screws and washers, loosely fasten one narrow vertical panel (2) to the left rear corner of the switchgear roof.
- Using the 0.25" self-tapping screws (see Figure 11) fasten the narrow vertical panel (2) to the wide vertical panel (1) along the vertical flanges.

4. Tighten the 0.25" cap screws left loose in Steps 12-A-1. and 12-A-2, then insert and tighten the remaining cap screws along the bottom flanges of each panel to complete the left rear corner of the arc exhaust wall.
- B. Construct the left front corner of the arc exhaust wall.
1. Repeat Step 12-A but substitute the narrow vertical panel (2) with (3) as shown in Figure 13.

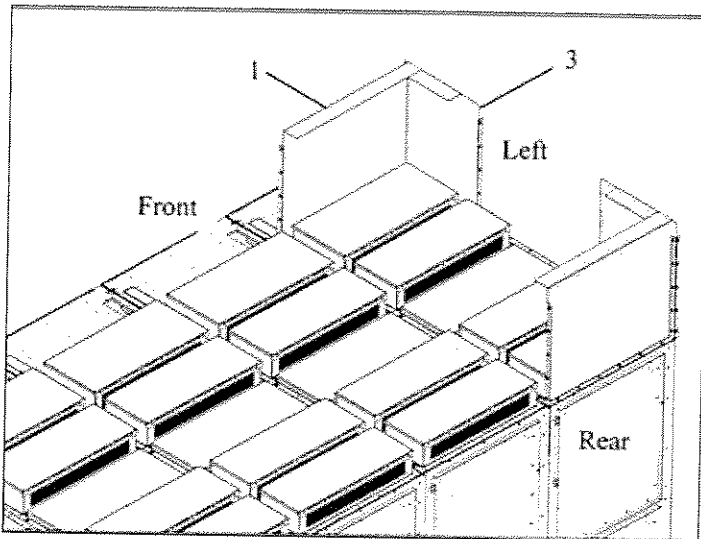


Figure 13. Detail of the Left Front Corner of the Arc Exhaust Wall.

- C. Complete the left arc exhaust wall (see Figure 14).

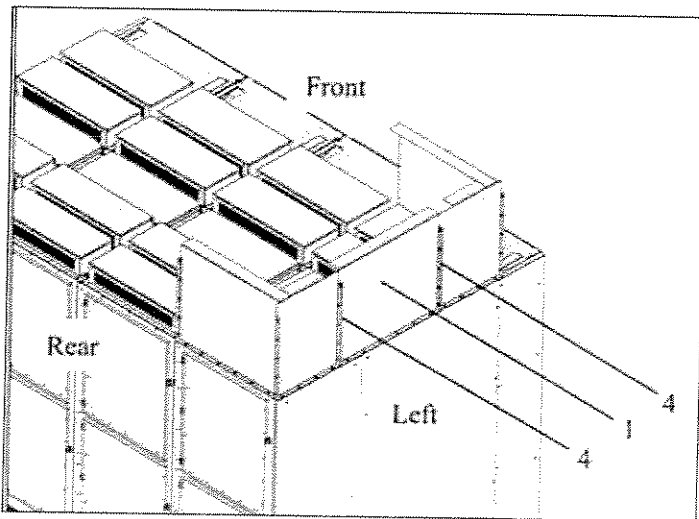


Figure 14. Completing the Left Arc Exhaust Wall.

1. Loosely fasten one wide vertical panel (1) to the left side of the switchgear roof using the 0.25" cap screws and washers at two points of connection as done in previous Steps 1 and 2.
2. Using the 0.25" self-tapping screws, fasten two vertical seam covers (4) to the vertical flanges as shown in Figure 14.

Note: These seam covers can only be installed one way.

3. Tighten down the 0.25" cap screws left loose in Step 12-C-1, then insert and tighten the remaining cap screws along the bottom flange of wide vertical panel (1) to complete the left wall.

- D. Assemble the remaining arc exhaust wall vertical panels (see Figure 15).

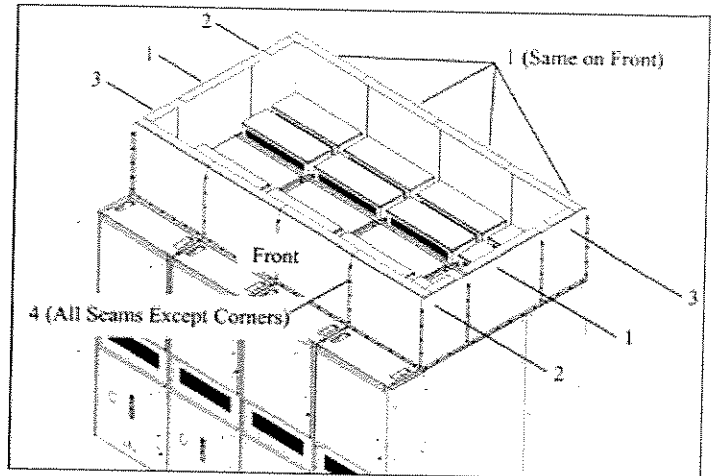


Figure 15. Installing the Remaining Arc Exhaust Wall Vertical Panels.

1. Starting at the front or rear of the switchgear roof, at the completed arc exhaust wall, work along the perimeter of the switchgear roof placing vertical panels and vertical seam covers until the arc exhaust wall is completed. Follow the method of assembly as previous described.

- E. Assemble the arc exhaust wall perimeter roof panels.

1. Start at the left side of the switchgear roof (see Figure 16). Place one end roof panel (6) down on the top flanges of the arc exhaust wall. The end edges of the vertical panels nest inside the roof panel flanges as shown in Figure 16.

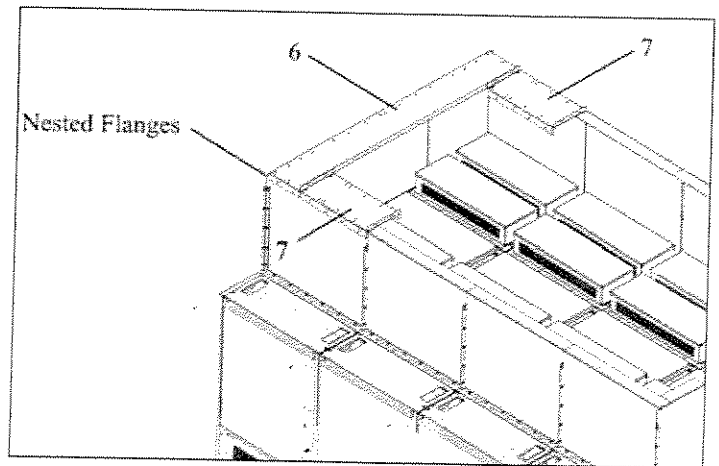


Figure 16. Installing the Arc Exhaust Wall Perimeter Roof Panels.

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2. Insert and tighten the 0.25" self-tapping screws along the vertical flanges of the roof panel to pull the wall panels up against the roof panel.
3. Insert and tighten the 0.25" self-tapping screws along the top edge of the roof panel.
4. At the front of the switchgear, place an end roof extension panel (7) down on top of the arc exhaust wall and up against the roof panel (6) previously assembled (see Figure 16).

Note: Panel (7) can only be assembled one way.

First, insert and tighten the 0.25" self-tapping screws along the vertical flange of (7) and then along the top edge of the panel. Lastly, insert and tighten the 0.25" self-tapping screws in the protruding flanges to secure the end roof panel (6) to the end roof extension panel (7). Repeat this step at the rear of the switchgear as shown in Figure 16.

5. At the front of the switchgear, place a middle roof extension panel (8) down on top of the arc exhaust wall and up against the roof panels (7) previously assembled (see Figure 17).

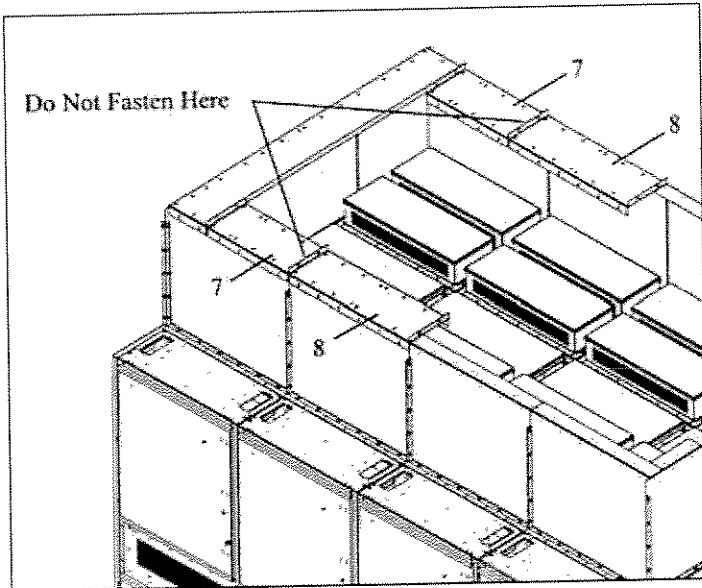


Figure 17. Middle Roof Extension Panel Installation - Beginning.

Note: Panel (8) can only be assembled one way.

First, insert the 0.25" self-tapping screws along the vertical flange of (8) and then along the top edge of the panel. Do not fasten the protruding flanges of (8) to (7) at this time. These flanges are needed in a later step of the assembly. Repeat this step at the rear of the switchgear as shown in Figure 17.

6. Continue placing middle roof extension panels (8) until reaching the other end of the switchgear lineup (see Figure 18). When the other end of the switchgear lineup is reached, install the last two end roof extension panels (7) and end roof panel (6) as done in prior steps.

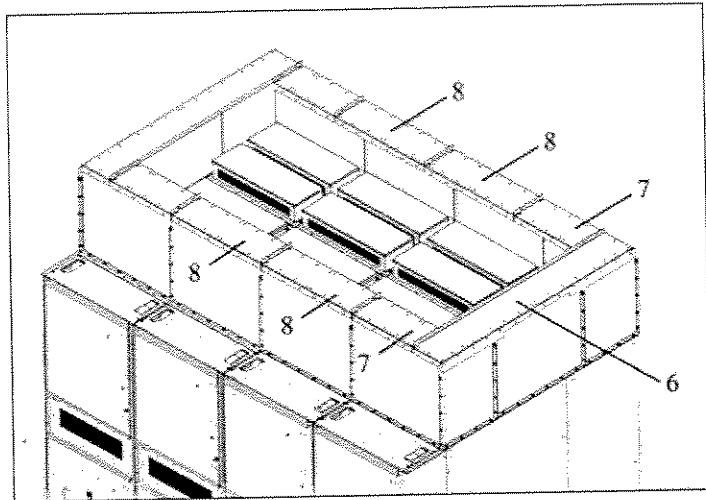


Figure 18. Middle Roof Extension Panel Installation - Completion.

F. Complete the arc exhaust wall assembly.

1. Start at either end of the switchgear lineup. Using the 0.25" self-tapping screws, assemble the horizontal seam covers (5) (see Figure 19) to complete the arc exhaust wall assembly.

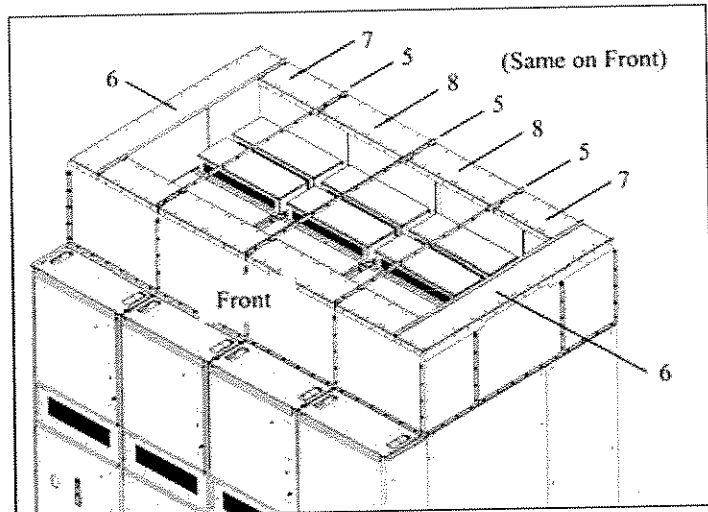


Figure 19. Installing the Horizontal Seam Covers.

Step 12: 5 kV/15 kV Arc Duct Exhaust Assembly Instructions

An arc duct exhaust system provides a degree of protection against the unlikely event of an internal arcing fault within any enclosure in a switchgear lineup. The system is designed to direct the arc by-products away from personnel working near the switchgear and out of the building in which it is housed.

Note: It is important to completely read and understand these instructions before attempting installation of an arc exhaust duct system.

The following instructions and illustrations show how to assemble an arc duct exhaust system to the roof of a 5 kV or 15 kV arc resistant switchgear lineup. The example construction is on a four-cell lineup with the suspended duct exiting the right side of the switchgear arc duct plenum as shown in Figure 20. The method of assembly is the same for smaller and larger switchgear lineups, or when placing the suspended duct in a different location than described in these instructions.

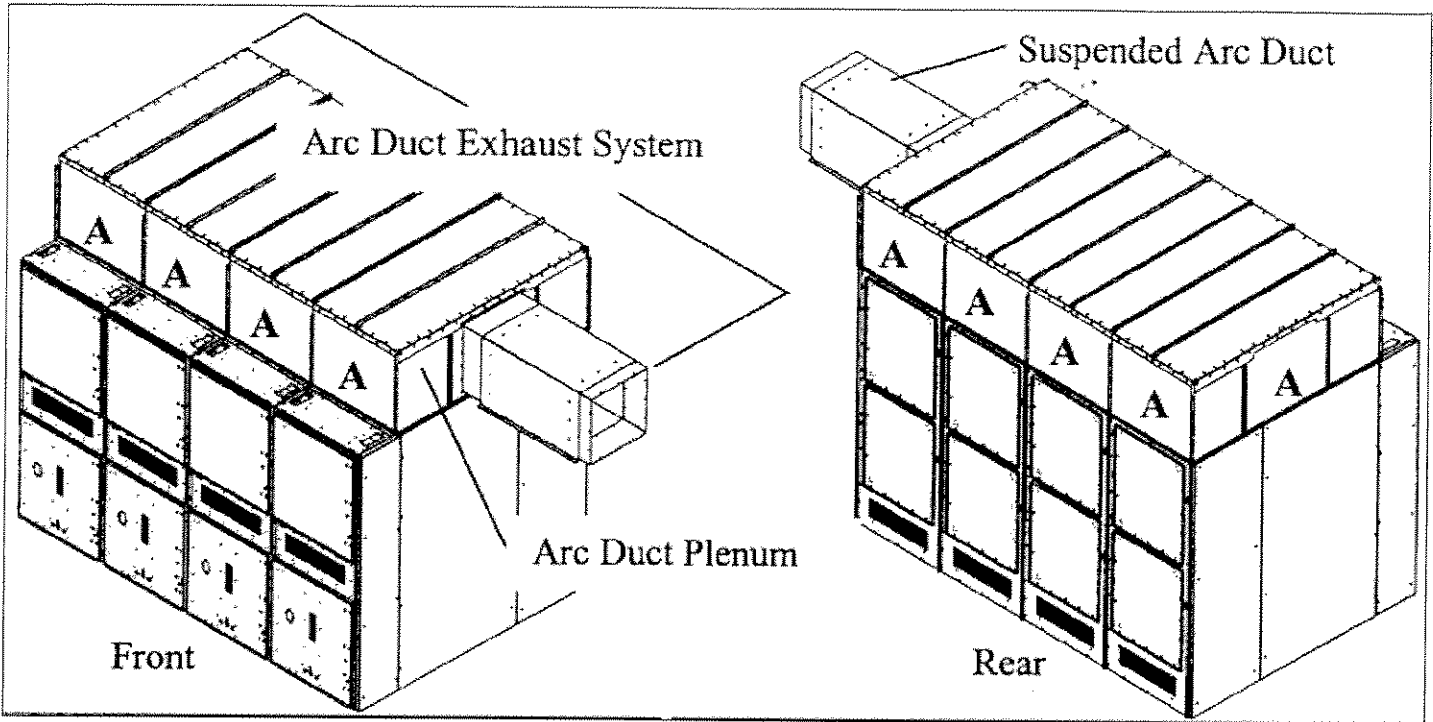


Figure 20. A Typical Arc Resistant Switchgear Lineup with Arc Duct Exhaust System

Notes:

1. A two-cell lineup is the minimum number of cells required for installation of an arc duct exhaust system.
2. One suspended arc duct section is required for a two-cell lineup and greater and can be installed in a number of locations (A) as shown in Figure 20.
3. A minimum 3.3 ft (1 m) long suspended duct section is required on an arc duct exhaust system. For applications that require a switchgear lineup where the suspended arc duct section is in close proximity to a wall, the suspended minimum length can extend through the wall and to the outdoors.

Refer to Figure 21 for arc duct exhaust system dimensional and weight information.

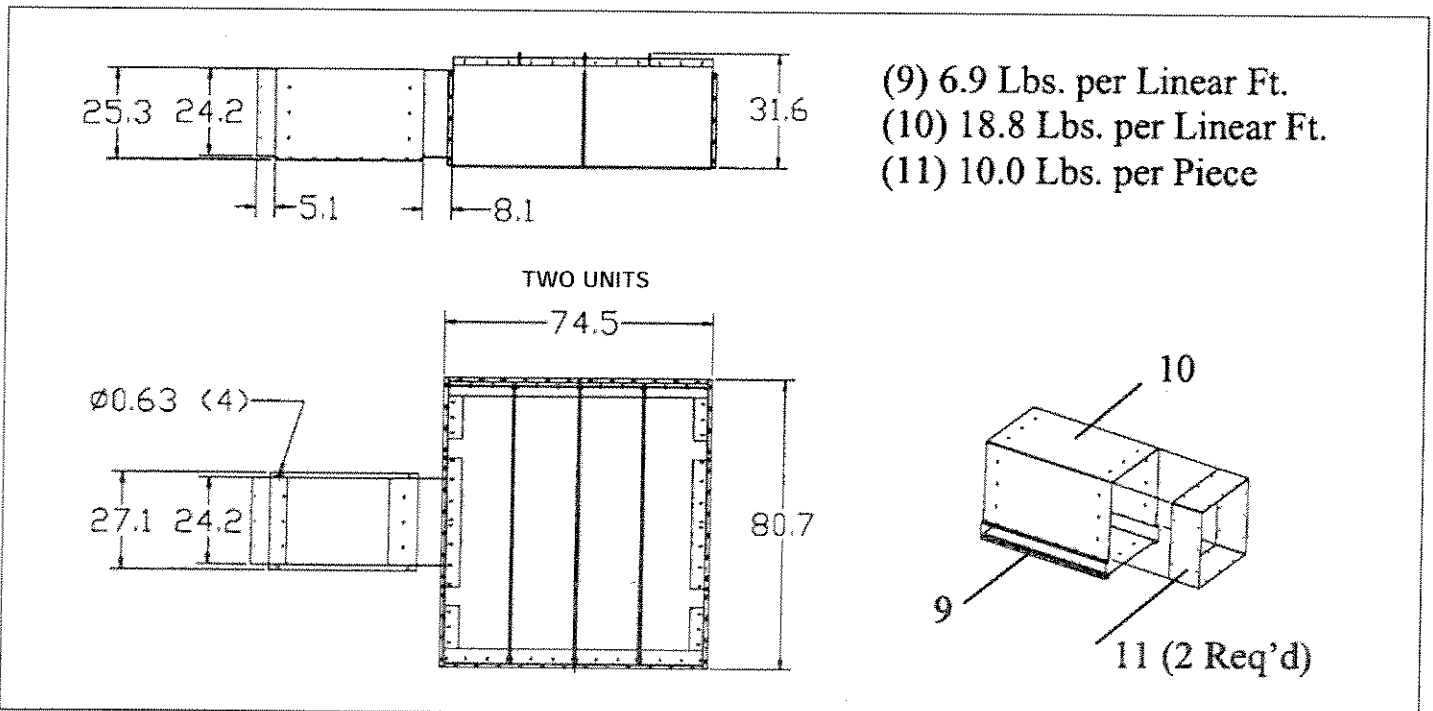


Figure 21. Arc Duct Exhaust System Dimension and Weight Information.

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The item numbers listed in Table 6 are used in figures throughout Section 3.3 - "5/15kV Arc Duct Exhaust Assembly Instructions" and should be referred to when necessary.

Table 6. Arc Duct Exhaust System Parts and Mounting Hardware.

EATON ELECTRICAL #	DESCRIPTION
1	69C4073H01 Vertical Panel (Wide)
2	69C4074H01 Vertical Panel w/Opening
3	69C4075H01 LH/R & RH/F Vertical Panel (Narrow)
4	69C4076H01 RH/R & LH/F Vertical Panel (Narrow)
5	69C4077H01 Duct Roof (End)
6	69C4078H01 Duct Roof (Middle)
7	69C4080H01 Vertical Seam Cover (Short)
8	69C4081H01 Horizontal Seam Cover (Long)
9	69C4084H01 Lower Duct Panel
10	69C4085H01 Upper Duct Channel
11	69C4086H01 Duct Splice
12	69C4087G01 Collar
13	70100EG01Q 0.25 - 20 x 0.75" Lg. Hex Cap Screw
14	70500BD31C 0.25" Wide Washer
15	70510CV10M 0.25" Lock Washer
16	70010ANGCM 0.25 - 20 x 0.75" Lg. Self-Tapping Screw

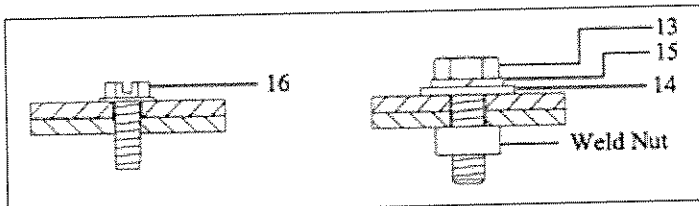


Figure 22. Assembly Hardware.

A. Construct the left rear corner of the arc duct plenum (see Figure 23).

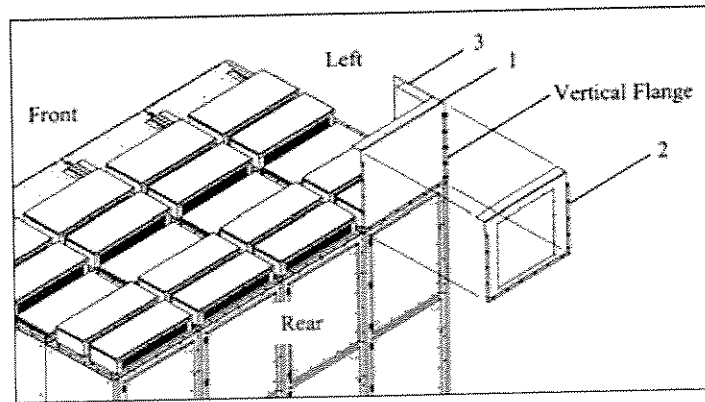


Figure 23. Installing the Left Rear Corner of the Arc Duct Plenum.

- Using the 0.25" cap screws and washers (see Figure 22), loosely fasten a wide vertical panel (1) or a wide vertical panel with opening (2), if placing suspended duct in this location, to the rear of the switchgear roof at the left end of the switchgear lineup. Two loose screws in each end of the lower flange are sufficient to hold the part in place temporarily. This is necessary to allow the mating parts to adjust while securing one part to another.

- Using the 0.25" cap screws and washers, loosely fasten one narrow vertical panel (3) to the left rear corner of the switchgear roof.
- Using the 0.25" self-tapping screws (Figure 22), fasten the narrow vertical panel (3) to the wide vertical panel (1) along the vertical flanges, or the narrow vertical panel (3) to the wide vertical panel with opening (2) if placing the suspended duct in this location.
- Tighten down the 0.25" cap screws left loose in Steps 13-A-1. and 13-A-2. then insert and tighten the remaining cap screws along the bottom flanges of each panel to complete the left rear corner of the arc exhaust wall.

B. Construct the left front corner of the arc duct plenum.

- Repeat Step 13-A but substitute the narrow vertical panel (3) with (4) as shown in Figure 24.

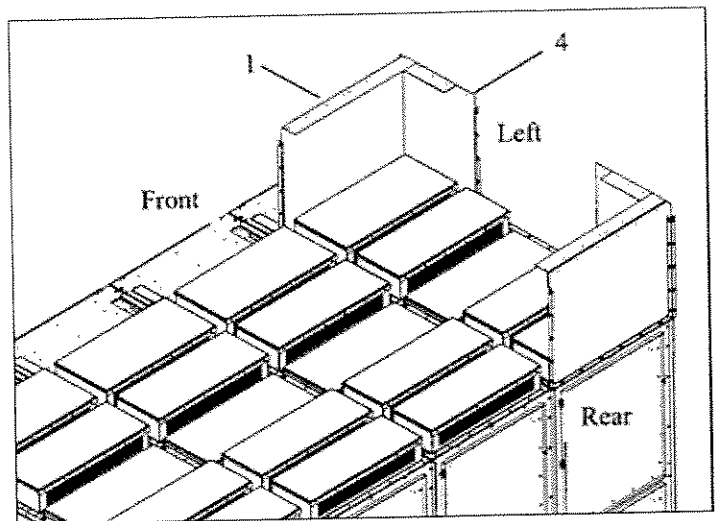


Figure 24. Detail of the Left Front Corner of the Arc Duct Plenum.

C. Complete the left arc duct plenum wall (see Figure 25).

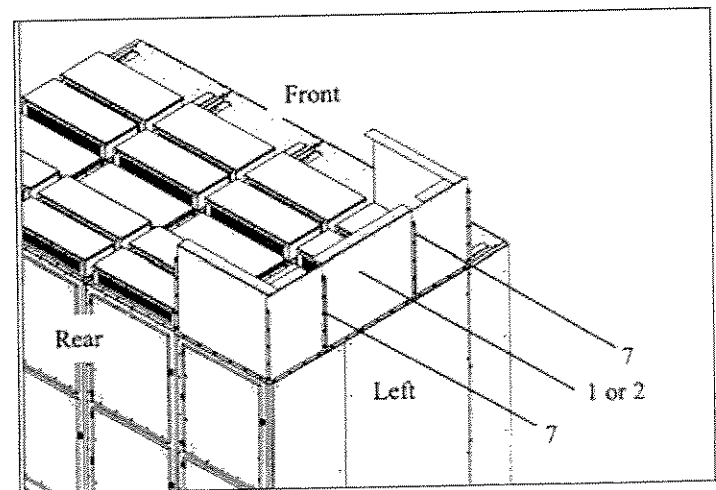


Figure 25. Detail of the Left Arc Duct Plenum Wall.

- Loosely fasten one wide vertical panel (1) or wide vertical panel with opening (2) to the left side of the switchgear roof using the 0.25" cap screws and washers at two points of connection, as done in previous steps.

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- Using the 0.25" self-tapping screws, fasten two vertical seam covers (7) to the vertical flanges, as shown in Figure 25.

Note: These seam covers can only be installed one way.

- Tighten the 0.25" cap screws left loose in Step 13-C-1, then insert and tighten the remaining cap screws along the bottom flange of wide vertical panel (1) or wide vertical panel with opening (2) to complete the left wall.

D. Assemble the remaining arc duct plenum walls and suspended duct collar (see Figures 26 and 27).

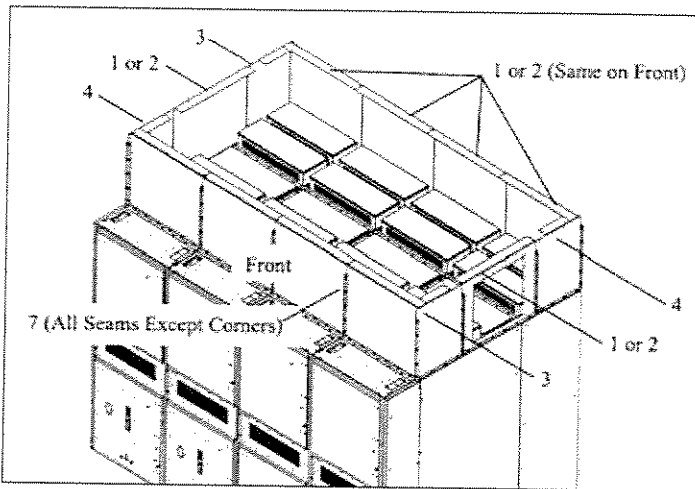


Figure 26. Detail of the Remaining Plenum Walls.

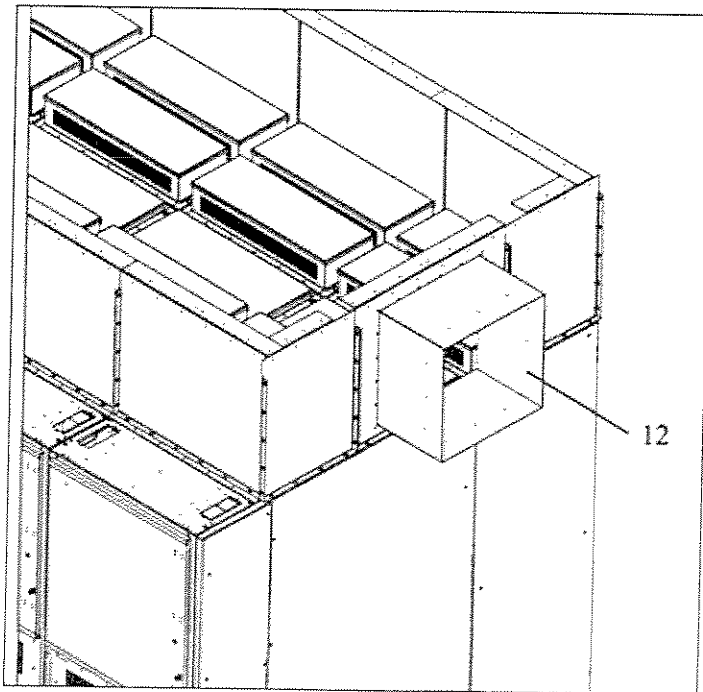


Figure 27. Installation of the Duct Collar.

- Starting at the front or rear of the switchgear roof, at the completed wall, work along the perimeter of the switchgear roof placing vertical panels and vertical seam covers until the plenum wall is completed. Follow the method of assembly described in the previous steps.

- Once all plenum walls are completed, insert a duct collar (12) through the wide vertical panel with opening (2). Secure the collar with the 0.25" self-tapping screws.

E. Assemble the arc duct plenum roof.

- Start at the left side of the switchgear roof. Place one end roof panel (5) down on the top flanges of the arc duct plenum wall. The edges of the vertical panels nest inside the roof panel flanges as shown in the Figure 28. Insert the 0.25" self-tapping screws around the vertical flanges of the roof panel to pull the vertical panels up against the roof piece.

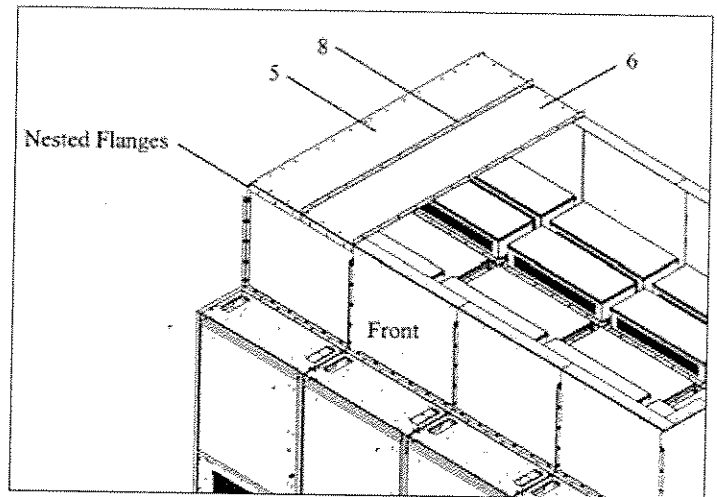


Figure 28. End Roof Panel Nested Inside the Roof Panel Flanges.

- Finish securing the panel by inserting the 0.25" self-tapping screws around the top of the roof panel.
- Place one middle roof panel (6) down on top of the plenum wall flanges and up against the roof panel previously assembled (see Figure 28). Insert the 0.25" self-tapping screws on the vertical flanges.
- Finish securing the panel by inserting and tightening the 0.25" self-tapping screws on the top surface at both ends of the panel.
- Slip a horizontal seam cover (8) on the flanges of both roof panels. Secure the seam cover with the 0.25" self-tapping screws.
- Assemble the remaining middle roof panels (6) and horizontal seam covers (8) until reaching the other end of the switchgear where the end roof panel (5) is installed (see Figure 29).

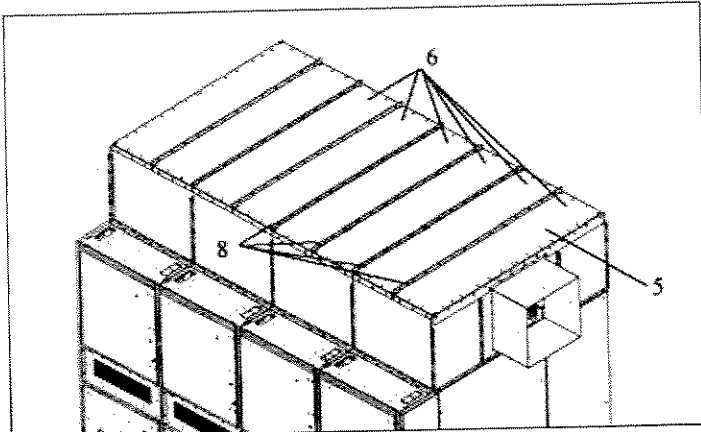


Figure 29. End Roof Panel Installed.

7. At this step of the assembly, the last end roof panel is assembled. To do this will require kneeling on the arc duct plenum roof.

Note: It is important to keep ones weight near the perimeter of the plenum walls while assembling the last roof panel. This will prevent bending panels that are not yet assembled together.

Place the last end roof panel (5) down on the top flanges of the arc duct plenum wall. Follow Steps 13-E-1. and 13-E-2. to secure the end roof panel.

- F. Assemble the suspended arc duct sections.

Note: It is best to construct suspended arc duct sections prior to placement. The sections can then be lifted into position, slid into place, screwed together, and hung with supporting members.

1. Assemble one lower duct panel (9) to one upper duct channel (10) using the 0.25" self-tapping screws as shown in Figure 30.

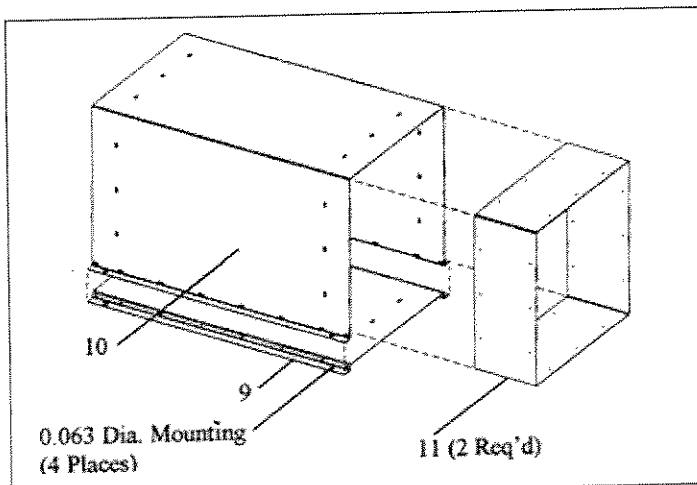


Figure 30. Installation of the Lower Duct Panel on the Upper Duct Channel.

2. If the suspended duct is to be longer than one suspended duct section, screw two duct splices (11) inside the suspended duct section using the 0.25" self-tapping screws.
3. Utilizing the 0.625 in. (15.9 mm) holes at the bottom section of the suspended duct to lift the section to its final location and join it to its mating part. Join each suspended duct section with 0.25" self-tapping screws (see Figure 31).

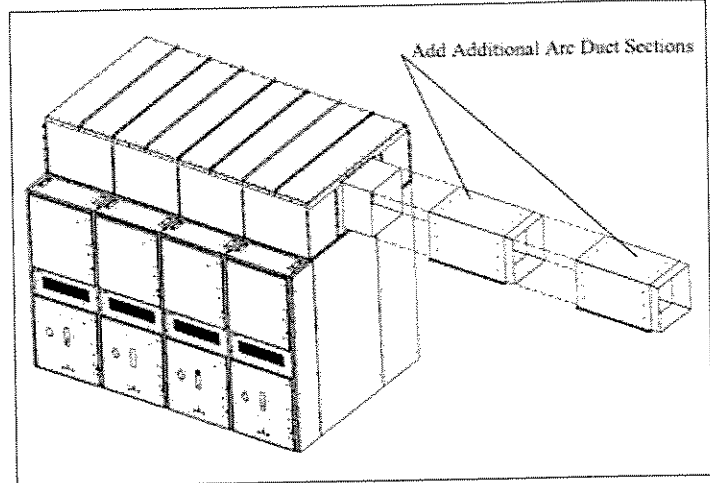


Figure 31. Joining Suspended Duct Sections.

4. Repeat Steps 13-E-1. through 13-E-3. when adding additional suspended duct sections to the arc exhaust system.

Step 13: Operation of the Levering-in System.

Check the operation of the levering-in system in the breaker compartments.

A. Inserting of the Extension Rails.

1. The breaker compartment has a teeter-totter assembly on the compartment levering assembly, located on the inside of both the left and right hand rail assemblies. The purpose of the teeter-totter assembly is to prevent the breaker from being removed from the compartment without the extension rails in place (see Figure 32). In order to insert or remove a breaker from either the upper or lower position, a set of extension rails must be inserted into the left hand and right hand rail assemblies. This is achieved by inserting the appropriate rail, identified with a label, diagonally into the slot such that the extension rail when lowered places the teeter-totter assembly in a horizontal position and the rolling surface of the compartment rail and extension rail are flush. In this position, the breaker can be inserted or removed from the breaker compartment (see Figures 32 and 33).

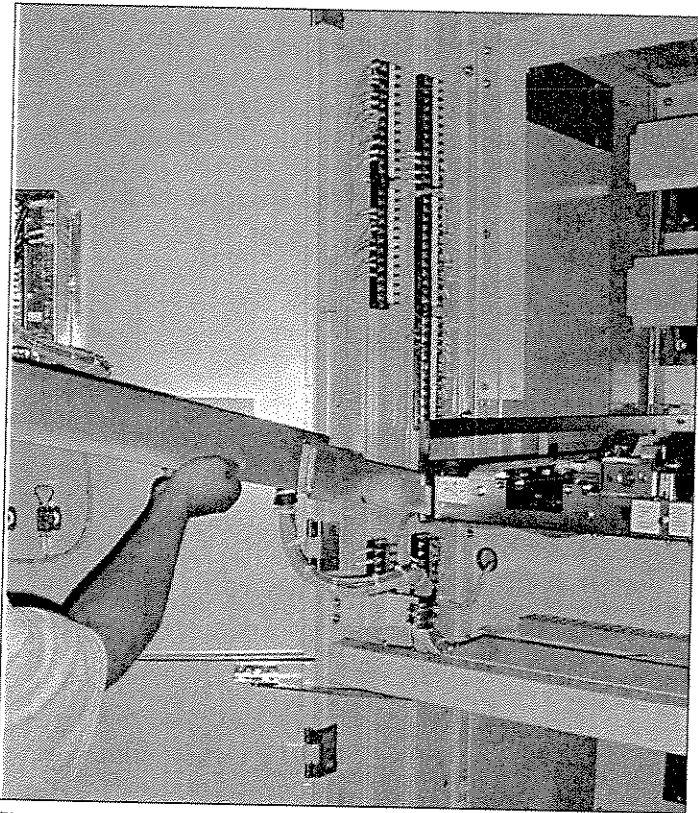


Figure 32. Insertion of the Draw-out Extension Rails.

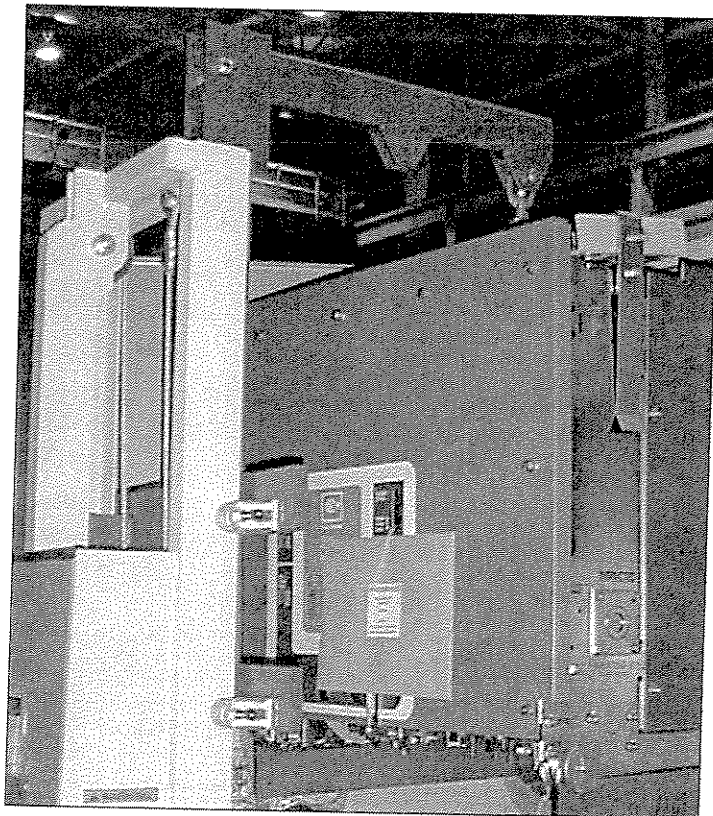


Figure 33. Lifting and Setting the Breaker in the Housing.

- B. Installing the breaker in the breaker compartment.
1. Using a portable lifting device, with the breaker lifting yoke attached (see Figure 33), place the breaker onto the extension rails.
 2. Push the breaker into the compartment until the breaker T-handle latches over the moving block on the levering screw assembly. The breaker in this position is considered in the "Disconnect" position.
 3. In order to place the breaker in the "Test" position mode, you must pull the secondary plug handle forward until the secondary plug located on the compartment levering pan fully mates with the secondary breaker wiring plug. In this position, the breaker compartment control circuit can be tested off line (the breaker is not connected to the primary circuit).

- C. Moving the breaker from the "Disconnected" or "Test" position to the "Connected" position.
1. In order to move the breaker from the "Disconnect" or "Test" position to the "Connected" position, the breaker must be open and the breaker compartment door must be closed and latched.
 2. Lift the sliding window on the door and insert the levering crank through the hole and onto the hex drive nut on the levering assembly. In order to engage the hex drive nut, you must push the levering assembly slider in.

Note: If the breaker is closed, you will not be able to engage the hex drive nut. You must trip the breaker by means of either the "Open" push button on the door or electrically using the control circuit.

3. Rotate the levering crank in a clock-wise direction until the indicator located on the left hand picture frame is visible through the breaker door viewing window.

Note: Once the breaker leaves the "Disconnect" or "Test" position, the breaker compartment door cannot be opened.

- D. Moving the breaker from the "Connect" position to the "Disconnect" position.
1. In order to move the breaker from the "Connect" position to the "Disconnect" position, the breaker must be opened.
 2. Lift the sliding window on the door and insert the levering crank through the hole and onto the hex drive nut on the levering assembly. In order to engage the hex drive nut, you must push the levering assembly slider in.

Note: If the breaker is closed, you will not be able to push the levering assembly slider in to engage the hex drive nut. You must trip the breaker by means of either the "Open" push button on the door or electrically using the control circuit.)

3. Rotate the levering crank in a counter-clock wise direction until the breaker comes to a stop in the "Disconnect" position.

Note: The secondary plug on the compartment levering pan is automatically disengaged from the breaker secondary plug.

4. The breaker compartment door can now be opened.

Step 14: Checking the Voltage and Control Power Transformers and Fuse Truck Assemblies.

Check the draw out voltage transformers, control power transformers, or fuse truck assemblies in the auxiliary compartments.

A. Inserting of the extension rails.

1. The draw out auxiliary assembly compartment has a teeter-totter assembly on the compartment levering assembly located on the in side of both the left and right hand rail assemblies. The purpose of the teeter-totter assembly is to prevent the draw out auxiliary assembly from being removed from the compartment without the extension rails in place (see Figure 32). In order to insert or remove an auxiliary draw out assembly from either the upper or lower position, a set of extension rails must be inserted into the left hand and right hand rail assemblies. This is achieved by inserting the appropriate rail, identified with a label, diagonally into the slot such that the extension rail, when lowered, places the teeter-totter assembly in a horizontal position and the rolling surface of the compartment rail and extension rail are flush. In this position the auxiliary draw out assembly can be inserted or removed from the auxiliary compartment (see Figures 32 and 33).

B. Installing the draw out assembly in the auxiliary compartment.

1. Using a portable lifting device, place the draw out assembly onto the extension rails.
2. Push the draw out assembly into the compartment until the draw out assembly T-handle latches over the moving block on the levering screw assembly.

C. Check the fuses for continuity. Make sure there is proper contact in the fuse clips.

D. Moving the draw out assembly from the "Disconnect" to the "Connect" position.

1. In order to move the draw out assembly from the "Disconnect" to the "Connect" position, the compartment door must be closed and latched.
2. Lift the sliding window on the door and insert the levering crank through the hole and onto the hex drive nut on the levering assembly.
3. Rotate the levering crank in a clock-wise direction until the indicator located on the left hand picture frame is visible through the door viewing window.

Note: Once the draw out assembly leaves the "Disconnect" position, the compartment door cannot be opened.

E. Check the following draw out drawer functions.

1. With the drawer fully inserted into the "Connect" position, check to make sure the primary contacts and secondary contacts are engaged when the drawer is connected. Use the "lighting out" or "ringing" method. They should engage when drawer is within 1.0 in. (25.4 mm) of being closed.

Note: In this position, the compartment door cannot be opened, so in order to check the engagement, remove the door lock defeat nameplate and loosen the setscrew behind nameplate. This will allow you to open the door. This defeat interlock cannot be reset until the draw out assembly is returned to the "Disconnect" position. In order to rack the draw out assembly to the "Disconnect" position, the open door interlock arm attached to the bottom of the door flange must be removed.

2. With compartment door opened, rotate the levering crank in a counter-clock wise direction until the draw out assembly comes to a stop in the "Disconnect" position.
3. Suspended from inside the compartment are three flexible, grounding straps. As the drawer is racked out to the "Disconnect" position, ensure that the grounding straps contact the fuses and ground them.
4. At this point, it is critical that you re-set the door lock defeat block and replace nameplate removed in Step 5-A. This is done by moving the interlock block on the door latch rods so that the setscrew is centered in the hole on door covered by the nameplate. Then tighten the setscrew. Also reconnect open door interlock arm to compartment door, which was removed in Step 5-A.

3.4 Perform a Loading Check

Perform a loading check on both the control and primary circuits to assure the system is ready for operation.

Section 4: Description of Arc Resistant VacClad-W Switchgear

4.1 Arc Resistant Switchgear General Discussion

Arc resistant metal-clad switchgear is metal-clad switchgear tested for resistance to the effects of arcing due to an internal fault. The occurrence of arcing inside switchgear produces a variety of physical phenomena. For example, the arc energy resulting from an arc developed in air at atmospheric pressure will cause a sudden pressure increase inside the enclosure and localized overheating. This results in both severe mechanical and thermal stresses on the equipment. Moreover, the materials involved in or exposed to the arc may produce hot decomposition products, either gaseous or particulate, which may be discharged to the outside of the enclosure.

IEEE Guide C37.20.7, 2001, and EEMAC Standard G14-1, 1987, provide procedures for testing the resistance of metal-clad and metal-enclosed medium voltage switchgear under conditions of arcing due to an internal fault. The arc resistant switchgear is classified by accessibility types in the two documents as follows.

IEEE C37.20.7, 2001 – Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults.

Accessibility Type 1

Switchgear with arc resistant designs or features at the freely accessible front of the equipment only.

Accessibility Type 2

Switchgear with arc resistant designs or features at the freely accessible exterior (front, back, and sides) of the equipment only.

EEMAC G14-1, 1987 – Procedure for Testing the Resistance of Metal-Clad Switchgear Under Conditions of Arcing Due to an Internal Fault.

Accessibility Type A

Switchgear with arc resistant construction at the front only.

Accessibility Type B

Switchgear with arc resistant construction at the front, back, and sides.

The IEEE standard defines internal arcing short-circuit current as the maximum value of the RMS symmetrical prospective current applied to the equipment under conditions of an arcing fault for the arcing duration specified by the manufacturer. The preferred value of the internal arcing short-circuit current is the rated short-time current of the equipment. The preferred arcing duration is indicated as 0.5 sec at the rated power frequency of the equipment.

A single test is done to verify resistance of switchgear against pressure as well as burn through. The actual values (which may be higher or lower than the preferred values) of the internal short-circuit current and arcing duration are specified by the manufacturer on the equipment ratings nameplate.

In the EEMAC standard, internal arc short-circuit current is indicated as the prospective short-circuit current applied during the calibration prior to testing and may be equal to or lower than the rated short time capability of the equipment. This standard requires testing to prove resistance of switchgear against pressure (arcing duration of 10 cycles), and testing to prove the resistance of switchgear to burn through (arcing duration 1 sec).

There are also differences in the two standards in the way testing is conducted and assessed. It is not possible to list differences between the two standards in this instruction book. Refer to the drawings supplied for the equipment for internal arc short-circuit current, duration, accessibility type, and standard to which the equipment is tested. The user should then refer to the applicable standard for details of guidelines under which the equipment is tested and qualified.

Arc resistant features are intended to provide an additional degree of protection to the personnel performing normal operating duties in close proximity to the equipment while the equipment is operating under normal conditions. Several conditions must be met for the equipment to perform as required. These conditions are considered normal operating conditions for proper application of arc resistant switchgear designs and are as follows.

1. All doors and covers providing access to high-voltage components are properly closed and latched.
2. Arc exhaust wall or arc duct assembly is properly installed on top of the switchgear, when applicable.
3. Pressure relief devices are free to operate
4. The fault energy available to the equipment does not exceed the rating of the equipment (short-circuit current and duration).
5. There are no obstructions around the equipment that could direct the arc fault products into an area intended to be protected.
6. The equipment is properly grounded.

The equipment may be used without additional protection where the fault level and the fault duration are within the equipment ratings. When coupled with other protective schemes, selected to operate within the rated duration of the equipment, the damaging effects of the arcing fault associated with fault duration can be minimized. For further review of the nature of internal arcing faults and various mitigating techniques, refer to an application paper, titled "Strategies for Mitigating Internal Arc Faults in Medium-Voltage Metal-Enclosed Switchgear," prepared by Working Group members of IEEE standard C37.20.7, 2001.

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

4.2 Description of Breaker and Auxiliary Compartment Door Features and Interlocks

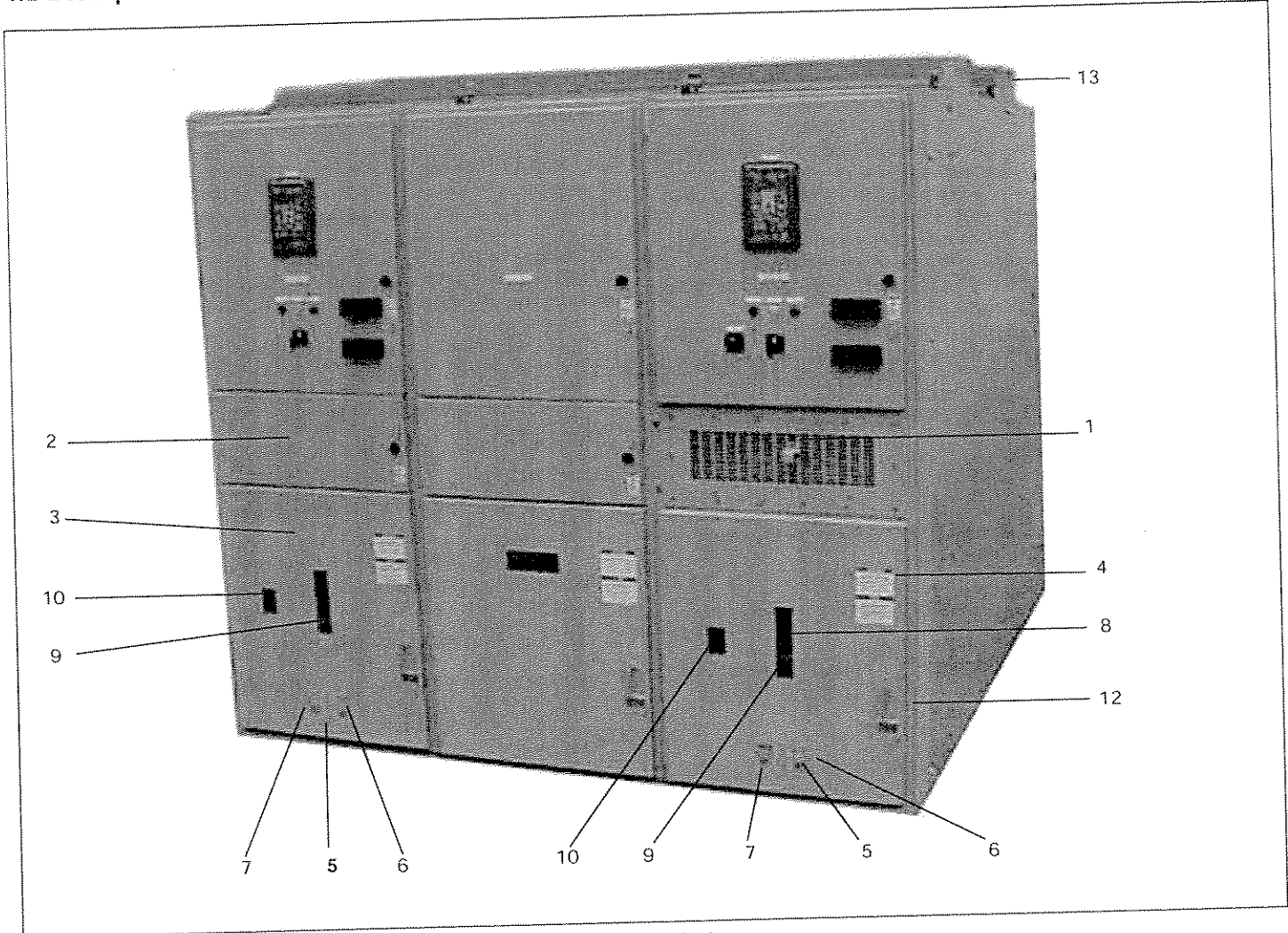


Figure 34. Breaker and Auxiliary Compartment Door Features and Interlocks

IDENTIFICATION #	COMPONENT
1	Shipping Brace
2	Instrument Compartment Door
3	Breaker Compartment Door
4	Safety Note
5	Levering Crank Opening
6	Open Push Button
7	Close Push Button/TOTON
8	Sliding Window
9	Slot in Sliding Window
10	Fixed Window
11	Phosphorescent Connected Position Indicator (see Figure 38, item 8)
12	Door Lock Defeat
13	Roof Pressure Relief Flaps
14	Levering Crank (See Figure 38 item 7)
15	Manual Spring Charging Lever (see Figure 46)

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

Description of Figure 34 Balloons

1. Shipping Brace

Remove the orange shipping brace before breaker is put into service, but only after the enclosure is in its final and permanent position. The safety flap must remain open during normal breaker operation in order to provide adequate ventilation.

CAUTION

DO NOT PUT A BREAKER INTO SERVICE WITH THE SAFETY FLAP CLOSED. THE SAFETY FLAP WILL AUTOMATICALLY CLOSE IN THE EVENT OF AN INTERNAL ARC. FAILURE TO REMOVE THE SHIPPING BRACE WILL PREVENT AUTOMATIC CLOSURE OF THE SAFETY FLAP DURING AN INTERNAL ARC.

2. Instrument Compartment Door

The instrument door **MUST** be closed when breaker is in service.

3. Breaker Compartment

All connection and disconnection of the breaker **MUST** be done with the door closed. The breaker door is interlocked with the breaker to prevent opening of the door while the breaker is connected. The door can only be opened when the breaker has been completely racked out to the disconnect position. A second interlock prevents the racking in of the breaker if the door is not closed.

4. Safety Note

Note: All doors and panels must be properly closed and fastened for the arc resistant feature of the switchgear to be operative.

5. Levering Crank Open

The breaker must be connected and disconnected with the breaker door closed and using the levering crank. With the door closed, lift the cover to expose the hexagon head of the levering-in screw. Insert the levering crank and rotated clockwise to connect the breaker, and counter-clockwise to move the breaker to the test position.

6. Open Push Button (Red)

With the door closed, press the right button to open the breaker main contacts.

7. Close Push Button (Green)

With the door closed, press the left button to close the breaker main contacts.

8. Sliding Window

This window is used for observing:

- The breaker position - connected or disconnected
- The charging spring status - charged or discharged
- The phosphorescent breaker position indicator (see item 11).

9. Slot in Sliding Window

The manual spring charging lever is inserted through the slot to manually charge the breaker springs. A vertical up and down movement of the lever will charge the breaker springs (approximately 38 movements are required).

10. Fixed Window

This window is used to observe:

- The breaker operations counter
- The breaker contact position - open or closed
- The phosphorescent marker (see item 11)

11. Phosphorescent Marker (Not shown)

The phosphorescent marker is only visible through the fixed window when the breaker is in the connected position and serves to indicate such (see Figure 38, Item 8).

12. Door Lock Defeat

The breaker compartment door automatically locks itself closed when the breaker is moved from the "Test" or "Disconnect" position to the "Connect" position. It then becomes impossible to activate the door handle.

In case of emergency it is possible to defeat the locking mechanism by removing the nameplate (Item 12) and loosening the setscrew holding the locking steel block behind the nameplate.

Important: In order to re-close the door after defeating the interlock, the levering-in assembly must be moved to the "Disconnect" position. Failure to do so will prevent the door from closing properly.

13. Roof Pressure Relief Flap

In the event of an internal arc, the explosion gasses and debris are projected through roof pressure relief flap.

14. Levering Crank

This crank is used to rack the breaker in and out. The socket is designed to prevent hot gasses from escaping the front module. Do not use any other tool to replace the levering crank (see Figure 47).

15. Manual Spring Charge Lever

This lever is used to manually charge the breaker. See Item 9 for more details (see Figure 46).

4.3 Safety Features

VacClad-W Switchgear is manufactured with several built-in interlocks. These interlocks are intended to protect persons working on the equipment. Never make these interlocks inoperative. Doing so can damage property and cause severe injury.

The following are four of the interlocks.

1. Code Plates

A coding plate is fastened to the bottom front edge of the breaker compartment. There is also a coding plate fastened to the front of the breaker. If the breaker has a lower interrupting rating than the rating of the compartment, or if the voltage and continuous current characteristics do not match, the coding plate on the compartment will prevent the entrance of the breaker into the compartment.

Note: Even with the coding plates, it is possible to put a breaker, whose control wiring is not coordinated with that compartment, into the compartment. Always check the shop order drawing to make sure the control wiring of the breaker and the compartment are both the same.

2. Automatic Shutter

An automatic shutter, shown in Figure 35 and 36, covers the primary disconnecting contacts when the breaker is withdrawn from the operating position. The shutter prevents persons who are working on the switchgear from accidentally touching the primary contacts. Shutters also cover the stationary disconnects for draw out transformers and primary fuses.

CAUTION

DO NOT MANUALLY RAISE OR REMOVE THE SHUTTER UNLESS MAIN CONTACTS ARE DE-ENERGIZED AND SAFETY PROCEDURES HAVE BEEN INITIATED TO MAKE SURE THE CIRCUITS CANNOT BE ENERGIZED. FAILURE TO EXERCISE CAUTION MAY RESULT IN BODILY INJURY AND PROPERTY DAMAGE.

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings



Figure 35. Automatic Shutters - Ring Type CTs with Shutters Closed and CT Barriers Removed.

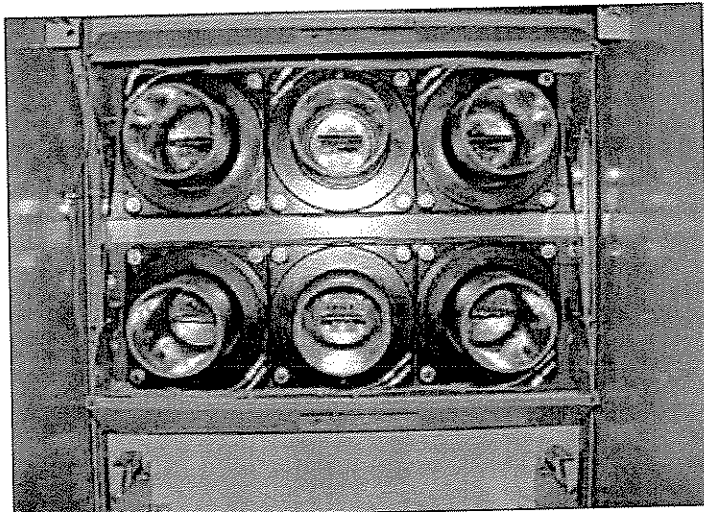


Figure 36. Automatic Shutters - Ring Type CTs with Shutters Blocked Open.

3. **Polyester CT Barrier**
A polyester CT barrier restricts unconscious access to the CT's (see Figure 37).



Figure 37. Ring Type CTs with Shutters Closed and CT Barrier in Place.

4. **Door Interlock**
A bracket is fastened to linkage connected to the levering-in assembly, preventing the breaker door from opening when the breaker/drawer is in "Connect" position. This interlock can be defeated by removing the door lock defeat nameplate (see Section 4.2, Item 12).

4.4 Ring-Type Current Transformers

The ring-type current transformers are mounted so they slip over the primary contact insulating tube on the rear wall of the breaker compartment. There is space for a maximum of four standard accuracy transformers per phase (two on each side of the breaker).

They are mounted so they can be reached from the front of the enclosure (see Figures 35 and 36). This makes it possible to add or to change transformers when the switchgear is de-energized without handling high-voltage connections or breaking the primary insulation. The polarity marks on the transformers show the relative instantaneous polarity in the primary and secondary windings. Factory "As-Built" diagrams show how to connect the transformers to give polarity needed to operate relays and instruments.

4.5 Key Interlocks

Key lock interlocks are often supplied in conjunction with disconnecting switches, dummy elements, and special compartments to which access is to be denied unless the circuit breakers controlling the power to these no-load-switching devices have been withdrawn to the test position. The operation of key interlock schemes is generally described by a note or keying chart on the shop order assembly drawings.

▲ CAUTION

TO FACILITATE MANUFACTURE AND INSTALLATION PROCEDURES, A KEY IS USUALLY SUPPLIED WITH EACH LOCK. BEFORE PLACING SWITCHGEAR WITH KEY INTERLOCKS IN OPERATION, THE KEY SCHEME MUST BE CAREFULLY CHECKED, AND ONLY THE PROPER KEYS LEFT IN THE LOCKS.

ALL EXTRA KEYS MUST BE REMOVED AND DESTROYED OR STORED WHERE NOT AVAILABLE SINCE IMPROPER USE OF SPARE KEYS WILL DEFEAT THE INTERLOCKING SCHEME.

4.6 Breaker Pan Assembly

Refer to Figure 38 to identify components of the breaker pan assembly.

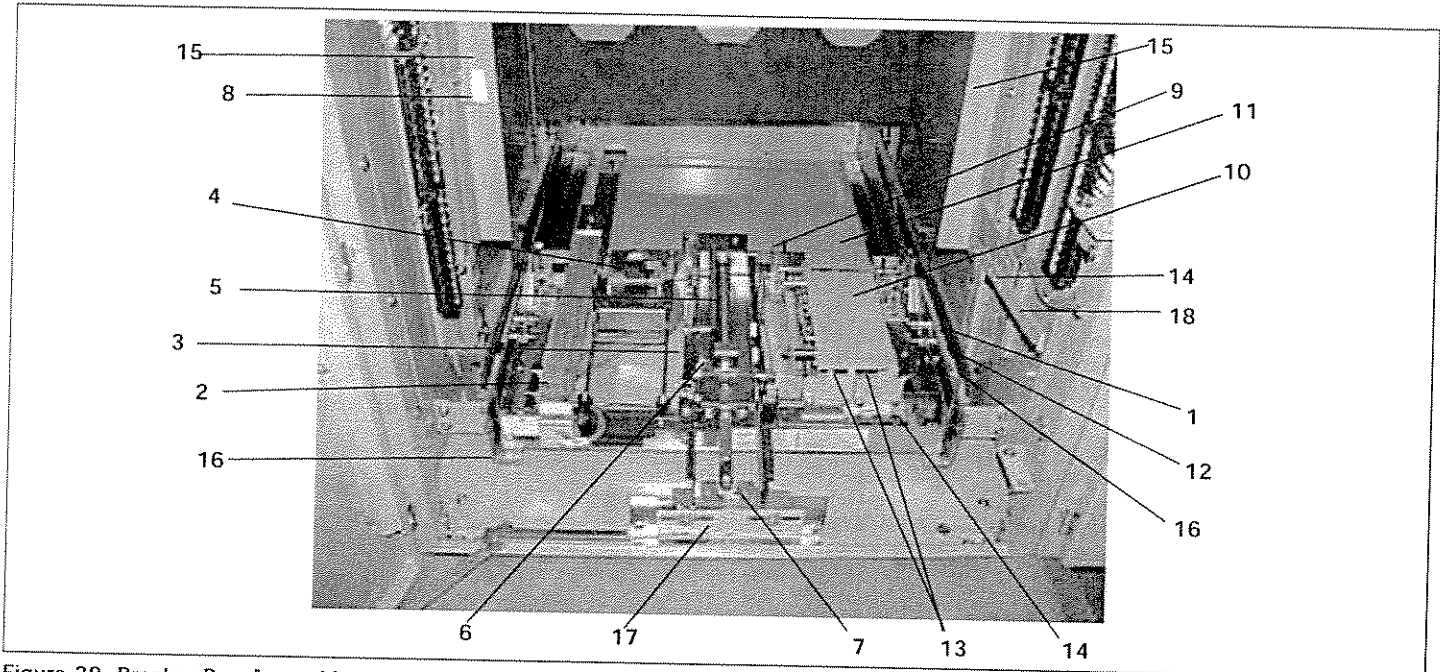


Figure 38. Breaker Pan Assembly.

Description of Figure 38 Balloons

1. Prevents breaker withdrawal without the extension rails in place.
2. Grounds the breaker in all positions.
3. Prevents removal of the breaker in any position other than "Test"/"Disconnect".
4. The control wiring is arranged for pullout disconnecting by means of a 25-point female receptacle arranged to connect to a male plug on the breaker. The secondary disconnect is the connection for the control leads between the removable breaker and the stationary housing. **See the breaker Instruction Book for further description.**
5. & 6. Racking Screw and Moving Block: Permit breaker insertion and withdrawal.
7. Used with 9 to prevent levering a closed breaker. May also be used in conjunction with 14 to padlock a breaker in any position.
8. Indicates when the breaker is in the fully connected position. This indicator is viewed through the viewing window on the door, when the door is closed.
9. Used to prevent removing a closed breaker.
10. The mechanism-operated compartment switch (MOC Switch) is an assembly of switches that is operated by a lever on the breaker mechanism. It can contain as many as 12 normally closed and 15 normally open contacts (beneath the cover) in the standard design. The MOC switch is activated by the breaker closing. It extends a lever out the bottom of the mechanism pushing down on the plunger of the operating mechanism. This, in turn transmits the motion to operate the switch.
11. Truck Operated Cell Switch (TOC Switch): The TOC switch has nine poles in the normal design – four contacts make and five break as the breaker is levered to the "Connect" position. As the breaker is being levered into the "Connect" position, a bracket on the breaker pushes the TOC Switch lever during the last inch of travel. As a result, the TOC switch can be used to electrically indicate whether or not the breaker is in the connected position (beneath the cover).
12. Allows opening of the primary breaker disconnect shutter using the maintenance tool when breaker is removed.
13. Code Plates: See safety features Section 4.3-1.
14. Provision for padlocking (up to four locks) a breaker in any position.
15. Seals the primary compartment when breaker is connected.
16. Rail on which the breaker rolls.
17. Interlock to prevent racking of the breaker with the door open.
18. Interlock to prevent the opening of the breaker door with the breaker not in the "Disconnect" or "Test" positions.

Section 5: Adjusting and Testing

Step 1: After the switchgear has been installed and connected to the apparatus it is to control, give it a final check before it is put into service.

Note: Make sure the apparatus being controlled is not connected to the system while the tests are being carried out.

The testing equipment will depend on the size and type of installation. Use portable voltmeters. Use simple devices for "ringing" or "lighting out" circuits.

Step 2: Examine all wiring circuits to make sure they have not been damaged or loosened during shipment or installation.

Step 3: Make sure all the connections are correct before the equipment is operated. "Light out" connections between the switchgear and the remote apparatus such as instrument transformers, auxiliary switches, and remote control and interlock circuits.

Step 4: Coordinate the settings of the relays with other parts of the system in accordance with the standards or operating practice of the purchaser.

Step 5: If the covers are removed from meters, relays, or other devices for installation or test, handle them carefully. Replace the covers as soon as possible to keep out dust and dirt.

Step 6: Perform a loading check of the control circuits. Before energizing the control circuits, check the control bus with an ohmmeter to make sure there are no short circuits in the control wiring. If an ohmmeter is not available, connect a small fuse in series with the source of the control power. This will protect the control wiring against damage. (The fuse should be one-fourth the normal rating of the circuit).

Section 6: Operation of the System

Step 1: Study and be sure to understand the diagrams furnished with each switchgear system.

Step 2: Install the circuit breaker in the "Test" position. Lift and pull the secondary disconnect forward to engage the control circuit. Check the breaker operations.

Step 3: A green light on the hinged instrument panel on the front of the breaker compartment shows the breaker is open. A red light shows the breaker is closed. In a dc control scheme, the red light supervises the trip coil and indicates the trip coil circuit has continuity. Refer to the diagrams supplied for the switchgear for the control scheme details, indicating light colors, and functions.

Step 4: The details of the breaker control schemes vary from one installation to another. They comply with the requirements set forth by IEEE, National Electrical Manufacturers Association (NEMA), and ANSI. All of the schemes are designed to coordinate electrically with the mechanical design of the breaker.

Section 7: Inspection and Maintenance

7.1 Safety Precautions

Refer to Section 1.6, "Safety Precautions".

Some Common General Precautions for High Voltage Work Are:

1. All connections should be considered energized until the crew expecting to work on them is assured that the circuits are de-energized, and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working.
2. Switches, which have been opened to de-energize a circuit to permit work on equipment, should be locked or blocked open and a suitable visible warning device placed on them.
3. Do not work on parts normally carrying current at high voltage until these parts have been disconnected and grounded to the ground bus. The purchaser should make provision for connecting adequate flexible ground leads to every part of the switching equipment.
4. A good and reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus. Refer to Section 3.1, Step 6, "Connect the Ground Bus".

7.2 Access to Switchgear Parts

7.2.1 High-Voltage Parts

VacClad-W switchgear is a metal-clad design. All major parts of the primary circuit are isolated by grounded metal barriers and enclosed within separate compartments. For example, circuit breaker, main bus, and primary line and load terminations are isolated from each other and enclosed in separate compartments, which are made from grounded metal barriers and covers. Access to high-voltage parts can be gained by removing the covers and barriers. The covers and barriers should not be removed unless the parts to be exposed are de-energized.

7.2.2 Main Contacts

Stationary main disconnecting contacts are located behind the automatic safety shutters. Upper and/or lower stationary contacts can be exposed by manually opening the shutters (see Figures 39 and 40). Do not expose any contacts unless all upper and lower high-voltage parts are de-energized. Failure to do so could cause death, personal injury, or property damage.



Figure 39. Primary Disconnects Behind the Closed Shutter.

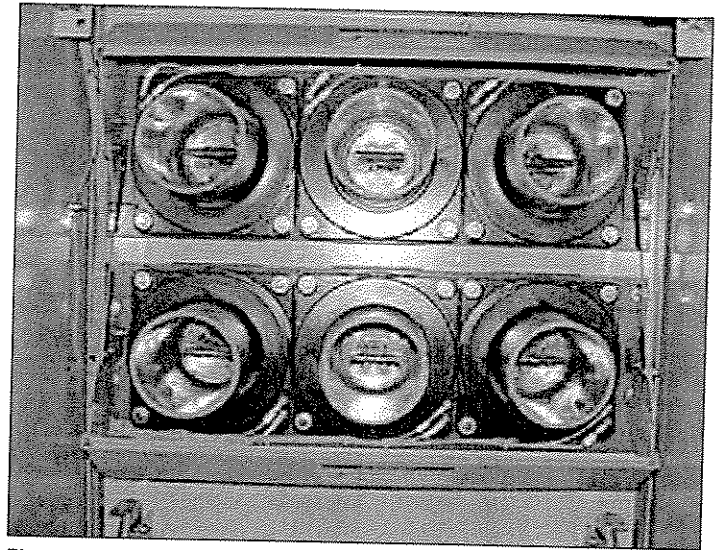


Figure 40. Primary Disconnects with Shutters Latched Open.

7.2.3 Current Transformers

Window type current transformers are installed over the bushings in the front of the unit (see Figure 40). All primary circuits must be de-energized prior to gaining access to any CTs.

7.2.4 VT and Primary Fuses

Disconnecting transformers and fuses: Simply racking out the drawer automatically disconnects and grounds the moving high-voltage parts. Shutters automatically cover the primary disconnects (see Figures 41, 42 and 43).

⚠ CAUTION

DO NOT ATTEMPT TO REMOVE THE BACK DOORS AND/OR COVERS, THE DISCONNECTING ASSEMBLIES, OR SHUTTERS UNLESS THE HIGH-VOLTAGE CIRCUIT TO THE COMPARTMENT IS DE-ENERGIZED AND PRECAUTIONS TO PREVENT RE-ENERGIZING HAVE BEEN TAKEN. FAILURE TO DE-ENERGIZE THE CIRCUIT AND TO TAKE PRECAUTIONS TO PREVENT RE-ENERGIZING COULD RESULT IN BODILY INJURY OR ELECTROCUTION WHEN ENERGIZED, THE CIRCUIT CARRIES LETHAL HIGH VOLTAGE.

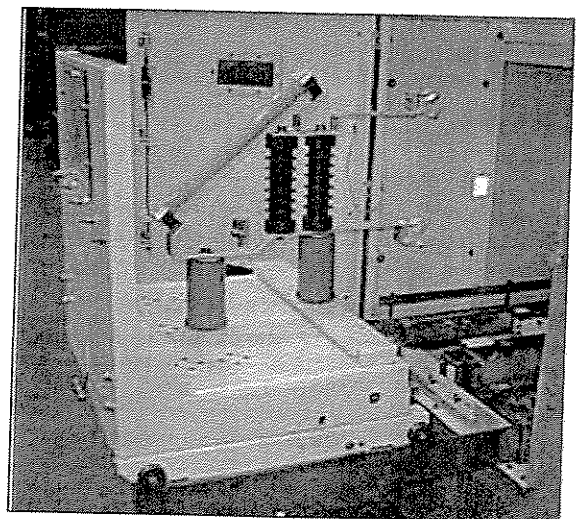


Figure 41. Typical Fuse Drawer in Lower Draw Out Position.

Instructions for 5/15 kV Type VacClad-W Arc Resistant Metal-Clad Switchgear Indoor Housings

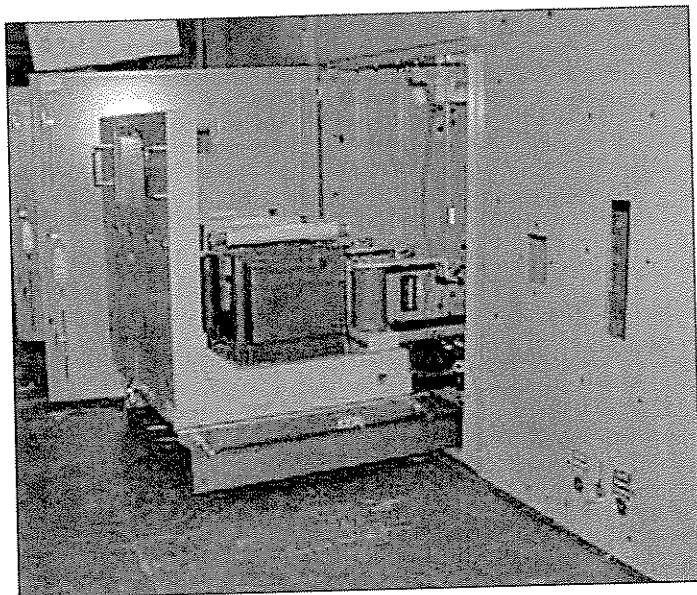


Figure 42. Typical VT Drawer in Lower Draw Out Position.

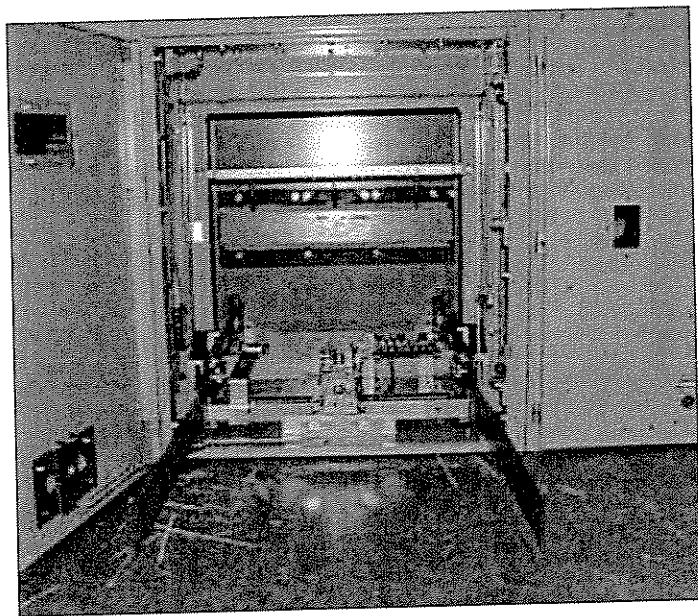


Figure 43. Typical Auxiliary Compartment (VT Compartment Shown with VT Drawer Removed).

7.2.5 Control Equipment

With the exception of apparatus such as current transformers and rear-mounted heaters, control equipment and wiring is generally accessible without exposing high-voltage parts.

7.3 Inspection and Maintenance Schedule

To assure high quality service, a definite maintenance schedule, systematically followed, is essential. Plant, operating, and local conditions vary to such an extent that the schedule must be prepared to suit the conditions. However, the following general requirements should be helpful in setting up the program.

⚠ CAUTION

BEFORE ATTEMPTING ANY INSPECTION OR MAINTENANCE, BE SURE THAT ALL PRIMARY AND CONTROL CIRCUITS HAVE BEEN DE-ENERGIZED AND GROUNDED AS REQUIRED AND THAT THE PROPER STEPS HAVE BEEN TAKEN TO BE SURE THAT THEY WILL REMAIN DE-ENERGIZED UNTIL ALL WORK IS COMPLETED. FAILURE TO DO SO COULD RESULT IN BODILY INJURY OR ELECTROCUTION. WHEN ENERGIZED, CIRCUIT CARRIES LETHAL HIGH VOLTAGES.

7.3.1 Individual Devices

The maintenance schedule for individual devices such as circuit breakers, relays, etc., should be based upon recommendations contained in the individual instruction book for the device. These operations should be coordinated with the overall program to result in the least operating inconvenience and circuit shutdown.

7.3.2 Overall Installations

The switchgear installation should be given a thorough overall maintenance check at the end of the first year in service because it provides an opportunity to evaluate conditions at an early point in the life of the equipment. Where conditions are abnormal, more frequent inspection and maintenance is necessary, where conditions warrant, a longer period of time between maintenance periods may be used. The following require attention:

1. Buses and Connections

De-energize the primary circuits and remove the cover plates from the primary compartments. Before cleaning, take megohmmeter (megger) readings between phases and each phase to ground. Inspect for signs of overheating or weakened insulation. Remove dust from buses, connections, supports, and enclosure surfaces. A vacuum cleaner with a long nozzle will be of assistance. Wipe clean with warm water and wipe dry.

After buses have been dusted and wiped clean, take megger readings again between phases and each phase to ground. Keep a record of these readings for future reference in determining when trends occur that would indicate a lowering of the insulation resistance.

Periodic high-potential tests are not required. They are recommended only after repair of high-voltage buses or installation, or when the trend of megger readings indicates it to be advisable. This field test should be made before the main cables are connected and should not exceed 14.25 kV, 60 HZ, for 1 minute for 4.76 kV switchgear; 27 kV, 60HZ, for 1 minute for 8.25 kV and 15 kV switchgear. Transformer primary fuses should be removed and surge protective devices, such as capacitors and arresters, disconnected during high-potential tests.

2. Primary Disconnecting Contacts and Supports (Spouts)

Remove each breaker from its compartment. De-energize the primary circuits and expose the primary contacts and their supports by manually opening the automatic safety shutters. Wipe clean with a cloth moistened in a non-flammable solvent. Inspect for abnormal wear or overheating. Discoloration of the surfaces is not harmful unless corrosion due to atmospheric conditions is severe, leaving deposits on the surface. If necessary, these can be removed by a light application of crocus cloth. Check each breaker while it is out of the housing for all items recommended in the instruction book applying to that particular type of breaker.

3. Other Disconnecting Contacts

Inspect all secondary disconnecting contacts, such as those on draw out transformers, for abnormal wear, fatigue, or overheating. Replace if necessary. Otherwise treat the same as the main disconnecting contacts above.

4. Control Contactors

Contacts should be inspected and dressed or replaced when the surface becomes pitted. Unless repetitive duty has been experienced, little attention should be required.

5. Instruments, Relays, and Other Panel Mounted Devices

Individual devices should be maintained according to the specific instructions supplied for each device. Remove all relay covers and inspect the interiors for dust or dirt. Relay test personnel can easily perform this operation during periodic relay testing.

6. Secondary Wiring

Check all wiring connections for tightness, including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear. Make sure that all secondary wiring connections are properly connected to the switchgear ground bus where so indicated.

7. Mechanical Parts

Visually check and manually operate mechanical moving parts such as the shutter, TOC and MOC switch assemblies, the position interlock, hinged doors, and the draw out features of the fuse drawers. Examine mechanical mating parts such as the breaker secondary contacts blocks, guide rails, and trippers.

8. Ventilation

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. Check to ensure that all dynamic flaps (see Figures 44 and 45) are open to allow natural airflow. These flaps are designed to close automatically during an internal arcing fault.

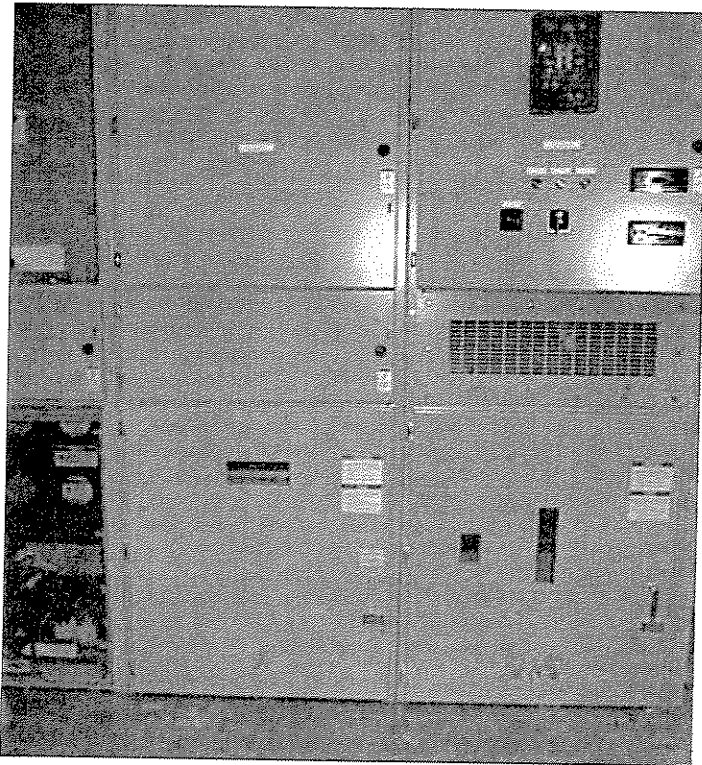


Figure 44. Typical Front Ventilation Dynamic Flaps.

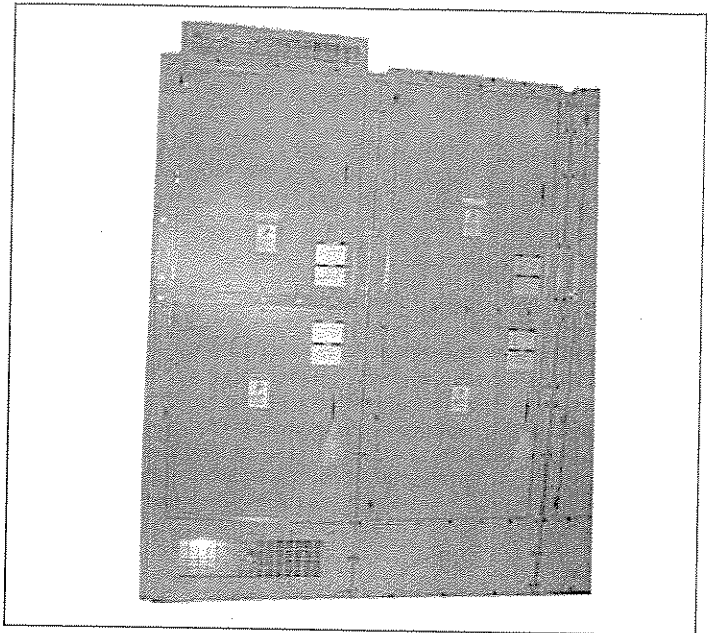


Figure 45. Typical Rear Ventilation Dynamic Flaps.

9. Battery and Charging Equipment

The control battery is such an important item in switchgear operation that it must be given special periodic attention if it is to give reliable service for a long period of time. Periodic inspections and tests are recommended in the battery supplier(s) instructions. At the same time the battery is checked, inspect the battery charger and remove accumulations of dust and dirt. On all chargers having a manual transfer switch for setting the charging rate, check carefully to be sure that the selector switch is returned to the value appropriate for a floating charge at the end of the periodic inspection. Serious damage to the control battery can occur if the charger is left on a high charging rate for an extended period of time.

10. Records

The condition of each switchgear unit at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods. Megger tests are suggested for checking the insulation. A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulation. Megger readings should be taken before and after cleaning the equipment and, where possible, under similar conditions at successive periods. Records should include the megger reading, the temperature, and the humidity.

The readings will vary with the extent and design of the bus structure. In contrast with a small installation, the longer switchgear assemblies will have a more extensive bus structure with a greater number of insulators and thereby, a larger number of parallel insulation resistance paths to ground which will tend to decrease megger readings. This variation in insulation resistance between different switchgear assemblies emphasizes the value of a series of readings, which can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

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Local conditions such as high humidity, salt-laden atmosphere, corrosive gases, heavy dust, or severe circuit operating conditions, are considered to be abnormal. They will require more frequent inspections.

It should be emphasized that a series of inspections should be made at quarterly intervals until the progressive facts of the local conditions can be analyzed to determine a schedule, which will maintain the equipment in satisfactory condition.

In some locations, conditions may be so bad that the frequency of maintenance will interfere with operating and production schedules. In such cases, consideration should be given to the possibility of enclosing the switchgear equipment in a relatively tight room and to supplying a sufficient quantity of clean air to maintain a positive pressure in the room. Under such conditions, maintenance schedules may then be established on a more normal basis. Such an arrangement might also provide for cooling the air where the ambient temperature is relatively high, thus further improving operating conditions.

Section 8: Lubrication

VacClad-W Switchgear is designed so that lubrication is not required under normal conditions. However, abnormal local conditions, such as high humidity, salt-laden atmosphere, corrosive gases, or severe circuit operating conditions, may demand the use of lubricants. All mechanical parts have been lubricated during assembly with molybdenum disulphide grease (Eaton Electrical Material No. 53701QB). The application of the lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

Section 9: Renewal Parts

When ordering renewal or spare parts, include as much information as possible. In many cases, the style number of the new part can be obtained from identification on the old part. Always include a description of the part. Specify the rating, structure number, and shop order number of the switchgear housing in which the part is to be used.

Section 10: Accessories

10.1 Standard Accessories

Each new VacClad installation is provided with a set of accessories. Depending upon customer's specifications and the nature of the installation, the accessories will include one or more of the following.

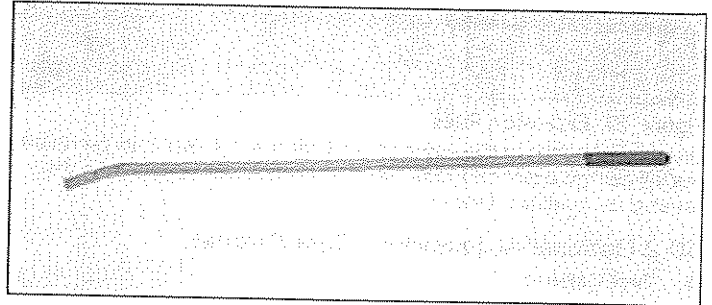


Figure 46. A Maintenance Tool.

Used for manually charging the breaker closing spring and manually opening the shutter.

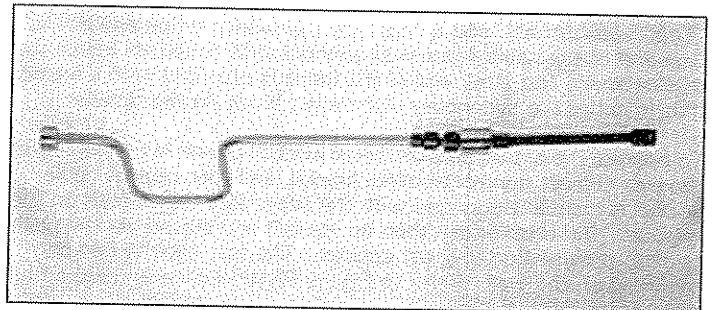


Figure 47. A Levering Crank.

Used for moving the breaker between the "Disconnect" and "Connect" positions.

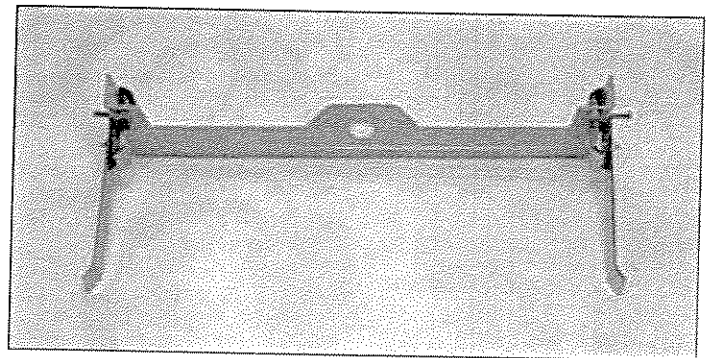


Figure 48. Breaker Lifting Yoke.

Used for attachment to breaker on or off breaker compartment extension rails.

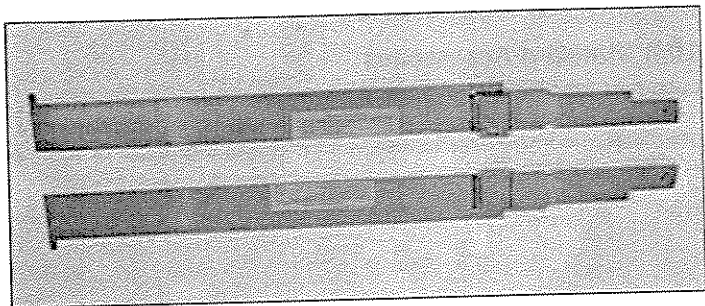


Figure 49. Extension Rails.

Used for extending the cell rails so that the breaker can be rolled out of cell on extended rails for maintenance or removal of the breaker or auxiliary devices

10.2 Optional Accessories - Test Cabinet

1. Test Cabinet

A test cabinet is used for electrically opening and closing of the breaker when it is outside its housing. The cabinet includes terminals for control power connections, a set of pull out fuse blocks for control power disconnect, necessary control equipment, and a cable harness. Control equipment normally includes "Close" and "Trip" pushbuttons, and a capacitor trip device when applicable. One end of the cable harness is connected to terminals inside the test cabinet. The other end of the cable is provided with a socket that matches the secondary disconnect block on the breaker.

To operate the circuit breaker, rated control power is connected to the test cabinet control terminal blocks, and test cabinet cable socket is manually engaged with the secondary disconnect on the breaker. The breaker can then be opened and closed via the pushbuttons provided on the test cabinet. The test cabinet can be mounted on the wall. Refer to Figure 30 for outline and mounting dimensions.

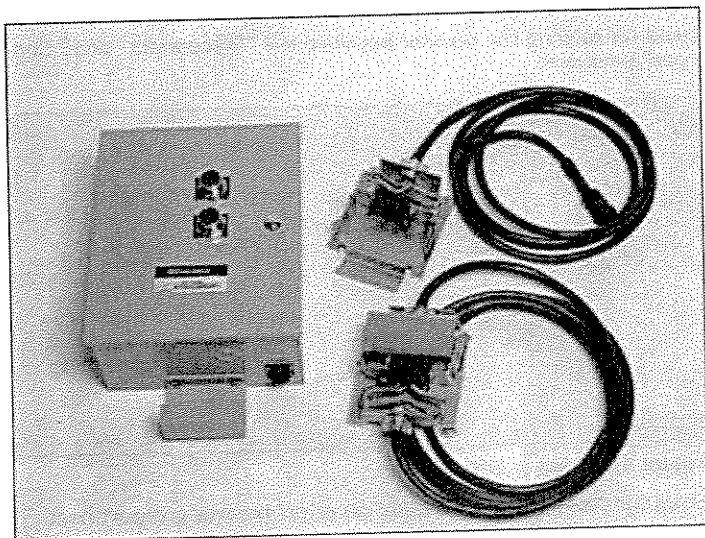


Figure 50. Test Cabinet.

2. Portable Lift Device

For lining the breaker up with the compartment extension rails and either lifting the breaker on to or off the rails (see Figure 21). I.L. 32-275-1A provides complete instructions.

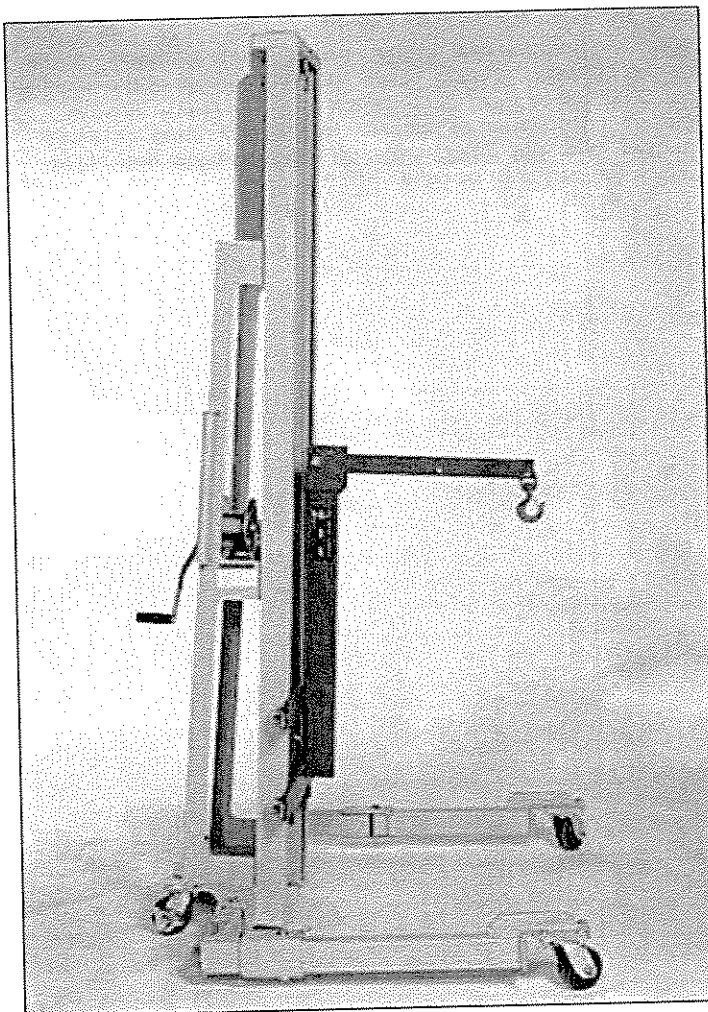


Figure 51. Portable Lift Device.

3. Transportation Dolly

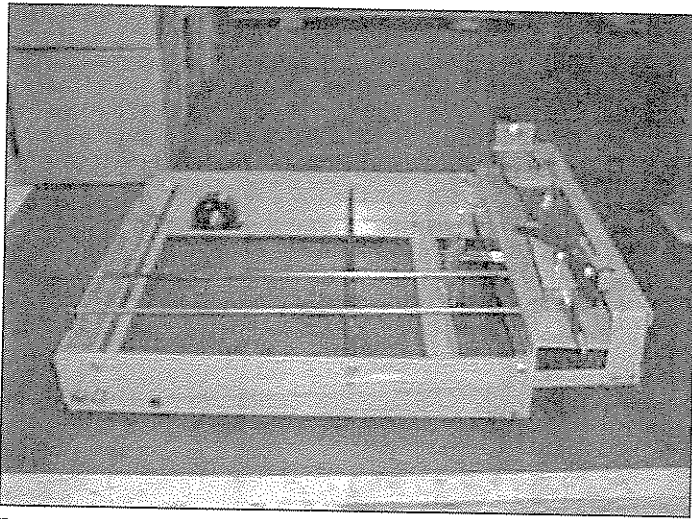


Figure 52. Transport Dolly

For removing the breaker from the lower compartment without lifting (bottom compartment only). This device "docks" with the lower breaker pan assembly in place of the extension rails.

4. Breaker Ramp Assembly

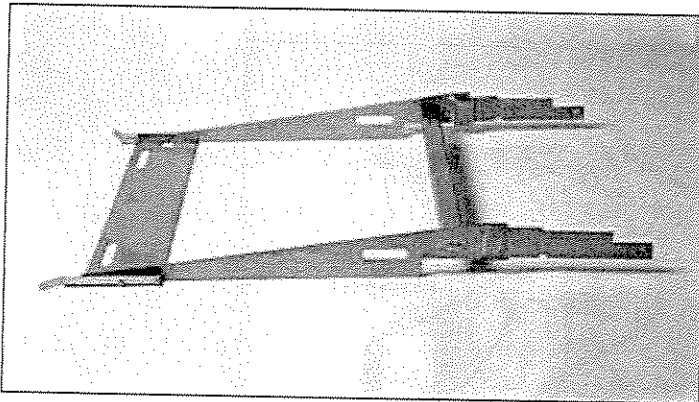


Figure 53. Breaker ramp Assembly

For inserting or removing a breaker from the bottom compartment of a vertical section without the need of any lifting device.

Section 11: Metal-Clad Switchgear Field Taping Procedure (5-15 kV)

Materials for Taping: See Figure 52

- **Filler:** A putty-like material.
- **Trade Name:** Scotchfil or Nashau 102. Pieces of insulating tape may be used.
- **Insulating Tape and Pad:** High-Voltage EPR insulating tape.
- **Trade Name:** Scotch 130C

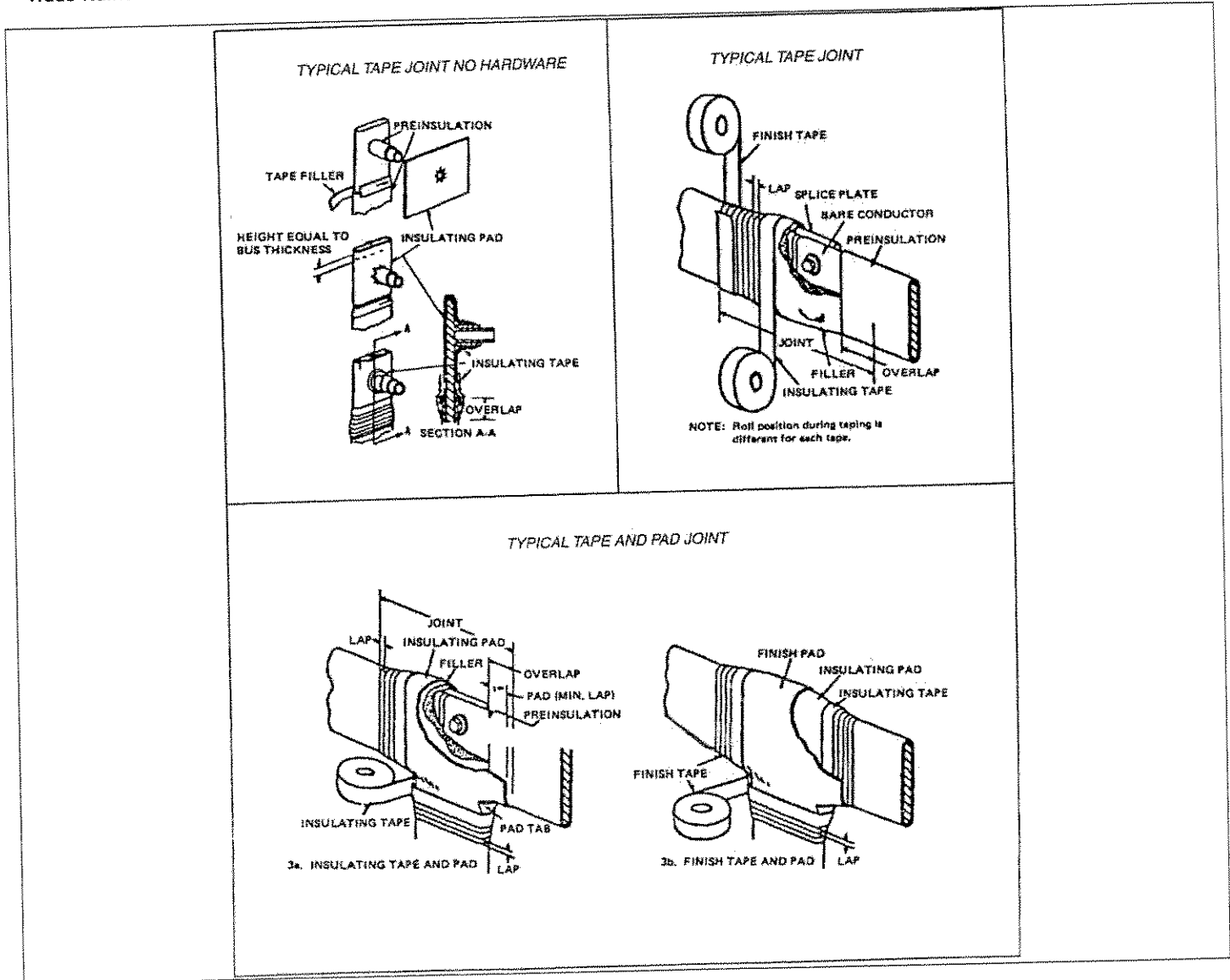


Figure 54. Field Taping Methods.

General

1. Elongate the insulating tape 10 to 25 percent during application to ensure a smooth, tight fit. On pads, elongate corners only.
2. Should a tape roll expire, start the new roll by overlapping the previous end by one-half turn.
3. Apply one layer of insulating tape, lapping as specified in the chart. Overlap any pre-insulation by 1.5 in. (38.1 mm).

Joint-With Hardware

1. Clean the area of dirt and foreign matter.
2. Apply filler over the bare conductor and hardware to cover and smooth out the surface. Blend contour into pre-insulation surfaces. Cover the conductors and hardware with at least 0.125 in. (3.2 mm) of filler.
3. Apply pad(s) of insulating tape of sufficient width to overlap pre-insulation by 1.0 in. (25.4 mm) or more.
4. Apply on layer of insulating tape, lapping as specified in Table 7, overlapping any pre-insulation or pads by 1.5 in. (38.1 mm).

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Table 7. Taping Chart.

KV ON SWGR.	PRE-INSULATION OR PAD OVERLAP MIN. IN. (MM)	INSULATING TAPE		
		LAP OF TAPE	LAYERS	NO. OF PADS
Up to 5	1.5 (38.1)	0.5	1	1
7.5 & 15	1.5 (38.1)	0.66	1	2

Definitions

Joint: Area to be covered with tape. Consists of bare conductor and 1.5 in. (38.1 mm) of any pre-insulation next to the bare conductor.

Pre-insulation: Any insulating tape applied which is wider than 1.0 in. (25.4 mm). Includes a band of tape consisting of one or more turns wrapped directly on top of each other.

Layer: Insulating tape, 1.0 in. (25.4 mm) wide, wrapped from one end of the joint to the other (or to a pad) so each succeeding turn laps the previous turn by the amount specified in the chart.

Overlap: A specified distance measured along the pre-insulation starting from where the pre-insulation ends and the exposed conductor begins.

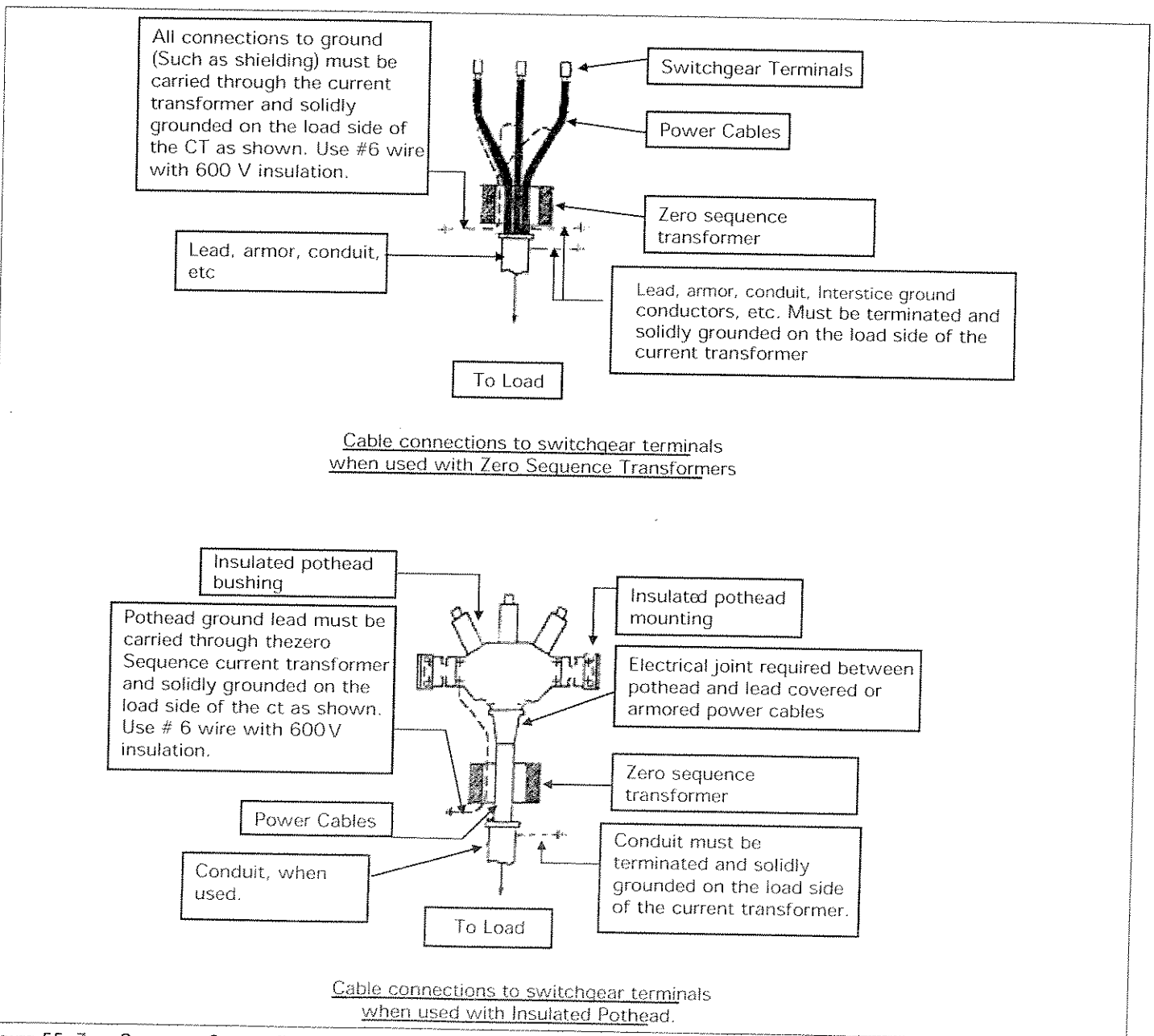
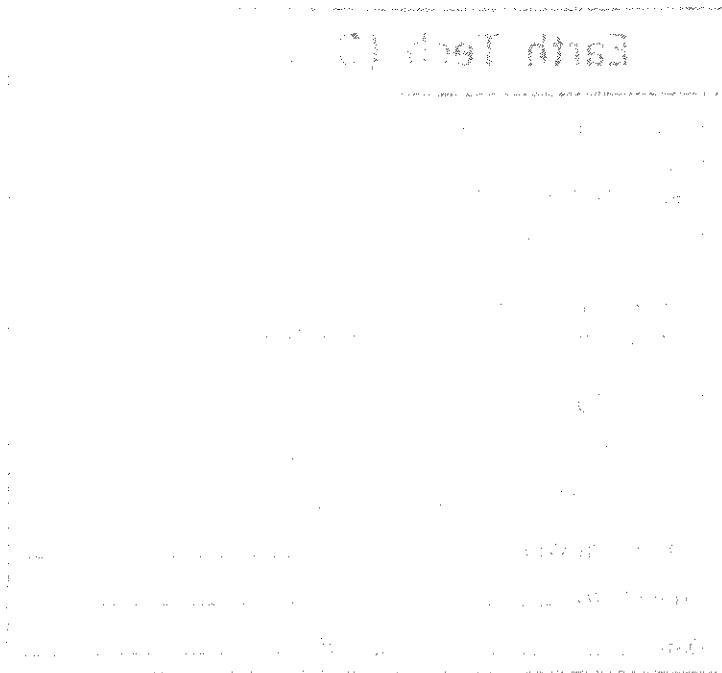


Figure 55. Zero Sequence Current Transformer Connections.

**Instructions for 5/15 kV Type VacClad-W Arc
Resistant Metal-Clad Switchgear Indoor Housings**

Notes:

Notes:



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Caterpillar Switchgear Manufacturer's Warranty

CAT Switchgear Organization warrants its products and materials to be free of defects in material and workmanship for the lesser period of (1) one year from the date of equipment startup, (2) one year from date of beneficial use, or (3) eighteen months from the date of shipment from its factory. This warranty applies to all equipment and materials supplied by the CAT Switchgear Organization. This warranty expressly excludes all materials and equipment supplied by others, whether new or existing, which are incorporated in CAT Switchgear equipment, whether installed by CAT Switchgear Organization or not.

CAT Switchgear Organization reserves the right of final acceptance of any and all claims for warranty. The Customer is responsible for any and all charges related to a warranty claim should the claim be disallowed. Equipment will, at CAT Switchgear Organization option, be replaced, or repaired FOB CAT Switchgear's facility, freight prepaid, and in accordance with the following:

CAT Switchgear Organization requires all non-conforming goods be returned at CAT Switchgear's expense for evaluation, unless specifically stated otherwise in writing by CAT Switchgear Organization. Unless otherwise agreed in writing, CAT Switchgear Organization assumes no responsibility with respect to the suitability of the Customer's equipment or with respect to any latent defects in the same. This warranty does not cover damage to Customer's equipment, components or parts resulting in whole or in part from their deteriorated condition. This warranty does not cover failure or damage due to accident, misuse, abuse or negligence. This warranty does not cover reimbursement for access, removal, installation, temporary power or any other expense, which may be incurred in connection with repair or replacement. The correction of any defects by repair or replacement by CAT Switchgear Organization shall constitute fulfillment of all obligations and liability of CAT Switchgear Organization to the purchaser under this warranty.

Warranty service is provided at no charge during normal business hours. Warranty service provided outside normal business hours is chargeable at published rates less the cost of normal business hours execution. Standby time is billable at published rates regardless of time of day. Warranty includes parts and labor for CAT Switchgear material and equipment for the stated warranty period. A replacement part is warranted for the remainder of the warranty period and expressly does not extend the warranty period.

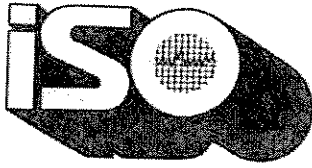
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No other representations, guarantees or warranties, whether expressed or implied, are made by the seller and the foregoing Warranty is in Lieu of all other representations and warranties, whether expressed or implied, which are hereby expressly disclaimed and waived by Buyer, including any warranty of merchantability or of fitness for particular purpose.

WARRANTED EQUIPMENT AND LOCATION:

ISO Manufacturing ID #: 35701
 End User Name: City of Winnipeg
 Equipment Location Street Address:
 Equipment Location City, State & Zip Code:
 WARRANTY EXPIRATION DATE: TBD





Intelligent Switchgear Organization LLC

A Caterpillar Electric Power Business

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Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, maintenance, or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any maintenance or repair on this product until you have read and fully understand the operation maintenance and repair information.

Safety precautions and warning are provided in this manual and on the product. If these hazard warning are not heeded bodily injury, or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING", or "CAUTION" The safety warning alert signal is shown below.



The meaning of this safety alert symbol is as follows:

ATTENTION! Become alert! Your safety is involved!

The message that appears under the warning explains the hazard and can either be written or pictorially presented.

"NOTICE" labels on the product and in this publication identify operations that may cause product damage.

Caterpillar cannot anticipate every possible circumstance that might involve potential hazard. The warnings in this publication and on the product are, therefore not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or be made unsafe by the operation maintenance or repair procedure that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including but not limited to physical dimensions type strength and material.

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