MOORE INDUSTRIES

INSTRUCTION MANUAL

PAM

Pulse Accumulating Module

Form 120-701-00A

January 1982

SECTION 1
GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual contains operating and maintenance information on the Pulse Accumulating Module (PAM), manufactured by MOORE INDUSTRIES INC., Sepulveda, California. The manual consists of six sections, as follows:

Section 1, General Information, introduces the equipment function and describes the equipment physical appearance, the equipment specifications, and options available for the unit. The introduction also provides information on the use and description of the MOORE INDUSTRIES model numbering system.

Section 2, Calibration, provides all the information necessary to calibrate the unit before installation. This section contains a list of the tools necessary for calibrating the equipment; and illustrates the test setups essential to perform that task.

Section 3, Installation and Operation, supplies all the information needed to install and operate the equipment. The section contains figures that specify the installation requirements for the units, and text that informs the user on recommended wiring practices for the equipment and defines the electrical connections for each unit regardless of physical modifications.

Section 4, Theory of Operation, gives the maintenance personnel a detailed explanation of the internal function of the unit. The circuit theory is based on a block diagram that shows the functional elements of the unit. Each element operation is then described, first in relation to the other elements, then independently where its major components' use and purpose are described.

Section 5, Maintenance, offers complete disassembly procedures for all unit configurations available. Troubleshooting information is also provided in this section as well as component replacement techniques to aid the technician in the repair of the equipment.

Section 6, Unit Documentation, acquaints the user with the MOORE IND. computerized parts listing and identification system. The section also provides a recommended spare parts list. All schematics and parts assembly drawings referred to by the text are located in the back of Section 6.

1.2 EQUIPMENT DESCRIPTION

The pulse accumulation module (PAM) accepts pulse inputs, or contact closures, having a peak amplitude within the range of 5 to 25 volts at frequencies up to 20 kilohertz, and produces a DC output that is proportional to the accumulated number of input pulses during the frame time, or window, controlled by the update command.

The circuitry consists of anti-concidence, input wave shaping components, control logic, digital counter and latch components, and the necessary buffer amplifiers required to produce an analog output that is proportional to the digital input.

1.3 PHYSICAL DESCRIPTION

The unit is available in several physical configurations. In general, the standard unit consists of a main circuit board and a small board mounted on the main board. The small board contains the clock circuit, and the input circuit. The main board contains the D/A converter buffer and analog output circuits.

The boards are enclosed in a protective housing, and the entire assembly may be installed in a number of ways. Specific details about each unit is outlined in this section, while the following paragraphs outline the physical differences of each option available for the units.

STANDARD UNIT

1.3.1 Conduit Plate Option (CP) Description

This option consists of an extension of the standard bracket lower mounting flange. The additional surface has two mounting holes to accommodate ½-inch electrical conduit. This option is illustrated in the next section outline and dimension drawings.

1.3.2 Angle Bracket (AB) Option Description

This option consists of two angle brackets, one on the top and the other on the bottom of the unit. These brackets are used to mount the unit in applications where the standard U-bracket will not apply. The brackets are provided with two #10 screw clearance holes, for ease of mounting.

UNIT WITH ANGLE BRACKET (AB) OPTION

1.3.3 NEMA Boxes Options Description

Units equipped with angle brackets (AB) option may be enclosed in NEMA boxes to ensure protection against harsh environments that may be damaging to the unit. Four configurations are available for this purpose.

Oil Tight (OT) NEMA Box Option. This enclosure consists of a NEMA 12 box construction, with two cover-holding screw clamps, mounted opposite to the hinged side of the cover (right side). These enclosures are oil and dust tight only. Conduit holes, fittings, or knockouts are not provided on these boxes. The units are mounted on a drilled and tapped mounting plate at the back of the box.

Water Tight (WT) NEMA Box Option. This enclosure consists of a NEMA4 box, equipped with three cover-holding screw clamps, one on each of the three non-hinged sides of the box. These enclosures are watertight, in addition to oil and dust tight. Unit mounting and electrical connections are made in the same manner as the OT option enclosures.

UNIT IN WATER TIGHT (WT) ENCLOSURE

Fiber Glass (FG) Option Enclosures. This enclosure is molded from pigmented polyester resins, using 302 stainless steel for all exposed hardware. A one-piece neoprene jacket provides additional sealing protection against corrosive environments. Boxes are normally hinged on the long side. The cover is secured by four slot-head screws accessible at the top of the cover and located on each side of the top and bottom cover corners opposite the hinge side. Conduit holes may be cut with a hole punch, and special precautions must be taken with ground connections, since the box material is non-conductive. Refer to Section 3 for wiring information. Units are mounted into the enclosure in the same way as in the OT enclosures.

CORROSION RESISTANT FIBER GLASS (FG) ENCLOSURE

General Purpose (GP) Options Enclosures. This enclosure consists of a general purpose steel construction box with knock-outs for various size electrical conduits (½, ¾, or 1 inch). The cover is hinged and spring locked. Units are secured into the enclosure on four studs and four 10–32 nuts.

GENERAL PURPOSE (GP) ENCLOSURE

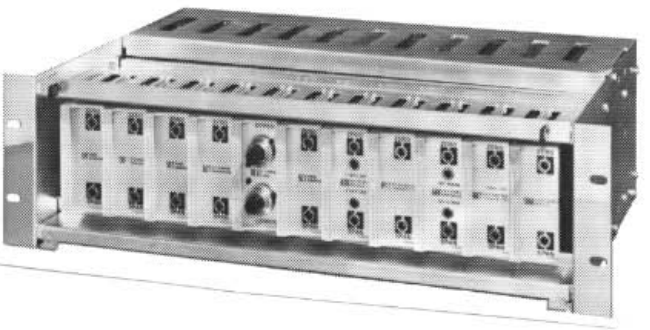
PLUG-IN (PC) UNIT

loaded and a dust cover is provided to minimize the effects of environmental hazards. Module connectors are keyed to assure that units are plugged into their proper position; keying, however, may be altered in the field if the system configuration changes. Filler cards are available for positions not used by a module.

1.3.4 Plug-In (PC) Units Description

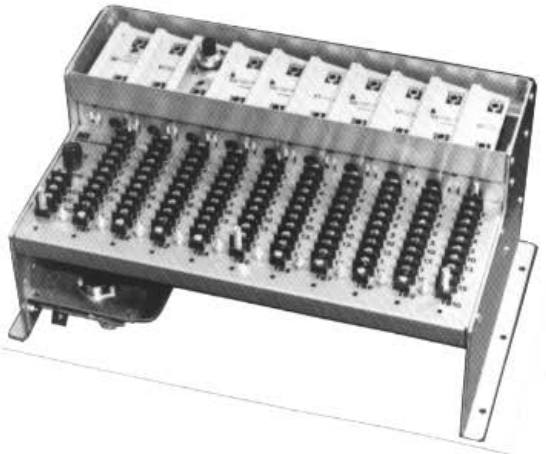
The plug-in unit is electrically similar to the standard unit. The printed circuit board is keyed to identify the unit and ensure proper connection mating. The other end of the main board is fastened to a display panel that allows external access to the various controls for the unit. A removable plastic safety cover protects the printed circuit board and components from normal environmental hazards. When the PC unit is purchased alone, the user must provide a 15 pin connector, such as Viking part No. ZVK155/1-2 or equivalent.

Rack Mounted (RMR) Card Racks. These enclosures are designed to flush-mount in standard 19 and 24-inch relay racks, respectively. The enclosures are provided with standard EIA hole patterns. Eleven and fifteen position RMR racks are available. These are pre-wired from the module PC connector to the screw-type barrier strip, which are rear-accessed for rack-wiring convenience. All power connections from the PC connectors are bussed together to a separate 3 terminal barrier-strip for external power input. DC power supplies are available. Electrical connections to the card rack are detailed in Section 3, Installation and Operation. Modules are front



CARD RACK ENCLOSURE FOR RELAY RACKS (RMR)

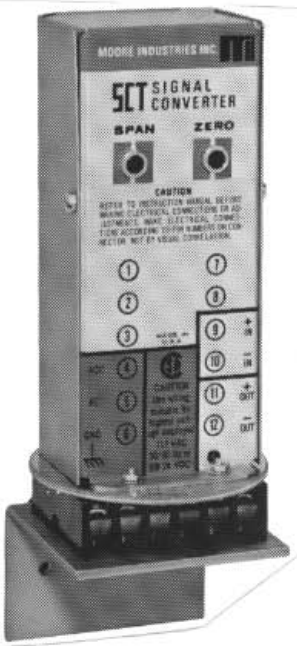
Surface Mounted (SMR) Card Rack. These rack enclosures are designed to accommodate as few as five and up to 15 modules. Mounting flanges are located in the rear of the side panel which allows for surface mounting or for NEMA box mounting. These enclosures are electrically identical in construction to the RMR racks. Terminal strips for external connections, however, are front-accessed for wiring convenience whenever the rack is mounted into a NEMA box or against a wall.



SURFACE MOUNTED CARD RACKS (SMR)

1.3.5 Standard Plug-In Transmitter

The standard plug-in transmitter consists of a standard enclosure as described in paragraph 1.3 except that connections are not provided on the face of the unit. Instead, the transmitter is attached physically and electrically to a circular interconnect card with plug-in pins, keyed to eliminate errors in connections. The mating connector consists of a bracket-mounted square terminal block. External electrical connections are made to screw terminals located on the periphery of the connector block. A plug-in receptacle arrangement is located in the center of the block to accommodate the keyed interconnect card plug-in pins from the transmitter. The mounting bracket secured to the terminal block is predrilled with clearance holes for 10–32 screws. When the transmitter assembly is removed, the terminal block screw connections are easily accessible.



PLUG-IN STANDARD UNIT

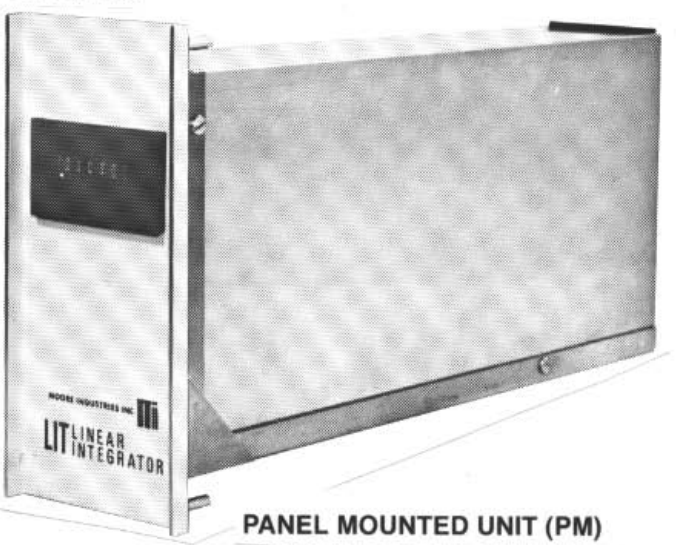
1.3.6 Explosion Proof Option

The explosion-proof enclosure option consists of a unit described in paragraph 1.3.5 enclosed into a two-piece cast aluminum alloy enclosure. The two pieces consist of a screw-type cover and a connector housing. When the cover is removed, the unit is easily accessible. With the unit unplugged, the terminal block is clearly visible and connections are made with ease. No mounting bracket is used on the terminal block. Instead, the terminal block is secured flush with the bottom of the housing. Electrical conduit hubs are provided for external electrical wiring. Several configurations of conduit inputs are available. Refer to Section 3 for detailed description of conduit configurations.

EXPLOSION PROOF HOUSING

1.3.7 Panel Mounted Transmitter (PM) Option

This option is electrically similar to the standard unit of paragraph 1.3, except that the enclosure and terminals locations are different. Instead of the standard enclosure, the printed circuit boards are enclosed in a metal frame equipped with a front panel. Controls and electrical connections are accessible to the rear of the enclosure by removing a cover. The bottom of the frame is provided with two holes to accommodate ½-inch electrical conduit.



PANEL MOUNTED UNIT (PM)

1.4 SPECIFICATIONS

The specifications for the unit are listed in Table 1-1.

1.5 MODEL NUMBER EXPLANATION AND USE

MOORE INDUSTRIES' model numbers describe an instrument's type, functional characteristics, operating parameter, and include option identification. If all accompanying documentation of a unit is missing, the model number may be used to obtain technical information on the unit by following the example of Table 1-2. The model number for standard units, and units with CP and AB options, is located at the upper end of the terminal block stamped on a stainless steel tag. Plug-in units have their model number labeled on the inside of the grip extension to the front panel. For explosion-proof units, the model number is stamped on a stainless steel tag on top of the enclosure and on the identification label on the unit within the enclosure. PM units model numbers are stamped on a stainless steel tag, visible when the rear safety cover is removed. To expose the model number on all NEMA enclosures, open box and remove safety cover of the unit.

1.6 SERIAL NUMBER USE AND LOCATION

A complete history is kept on every MOORE INDUSTRIES unit. This information is keyed to the serial number. Whenever service data is required on a unit, it is necessary to provide the factory with a serial number as well as a model number. This identification is usually located with the model number (see paragraph 1.5 for location on equipment) except for plug-in units and explosion proof where the serial number is engraved into the PC board or stamped on a stainless steel tag respectively, and is usually preceded by the letter E.

TABLE 1-1. UNIT SPECIFICATIONS

SIGNAL INPUT: 5–25 volt pulse
when input signal requires contact closure, specify the -CC option
FREQUENCY: Counted pulses or updated command not to exceed 20 KHZ
Ranges: Switch selectable
A 32–64 Pulses for F. S. output
B 64–128 Pulses for F. S. output
C 128–256 Pulses for F. S. output
D 256–512 Pulses for F. S. output
E 512–1024 Pulses for F. S. output
F 1024–2048 Pulses for F. S. output
UPDATE COMMAND INPUT: 5–25 volt pulse
when update command requires contact closure, specify the -CCU option
Linearity: Below 128 counts F. S.: ±1%
Above 128 counts F. S.: ±1 count ±.05%
ADJUSTMENTS: Multiturn potentiometer
Span: Adjusts over selected full-scale count range
Zero: With zero pulse input, adjusts output to 0% ± 10% of output span

OUTPUT: Operational amplifier, limited to 150% at maximum output value
Current: 1–5 mA into 0–4800 ohm load
4–20 mA into 0–1200 ohm load
10–50 mA into 0–480 ohm load
Voltage: 1–5 VDC into 20K ohm minimum
Ripple: 10 mV, P/P at maximum span and load
Load Effect: ±0.01% of span from 0 to maximum load specified (current output)
Repeatability: ±1 count
Ambient Temperature:
Range: −29°C to +82°C (−20°F to +180°F)
Effect: ±0.01%/°F
Isolation: Units have input negatives common to output negative. Power input isolation is maintained on both AC and DC powered units.
POWER INPUT: 24 VDC, 45 VDC ±10%
117 VAC, 220 VAC, 240 VAC, 50/60 HZ ±10%
WEIGHT: Approximately 2 lbs. (908 grams)

TABLE 1-2
MODEL NUMBER EXAMPLE

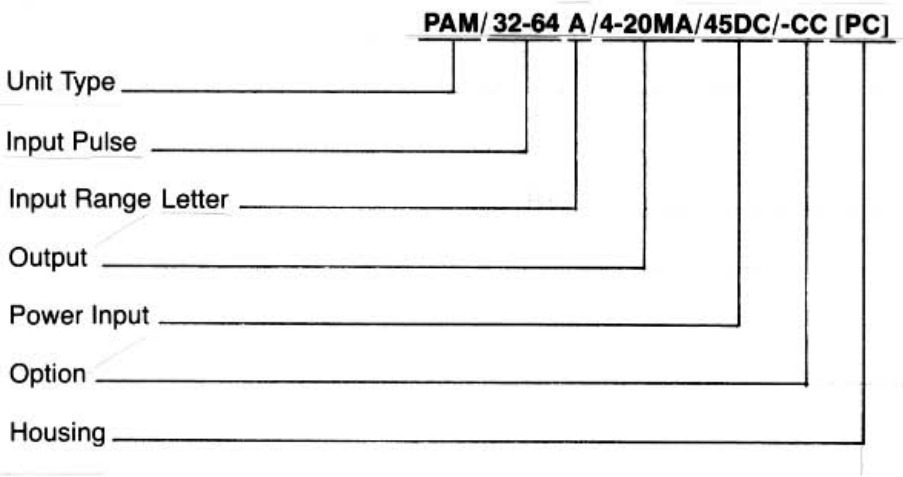


TABLE 1-3
ELECTRICAL OPTIONS

OPTION DESCRIPTION	CODE
Window control, pulses are counted while update input is held low	-WC
Input attenuation for signal input voltage exceeding specification—specify voltage (200V maximum)	-AT
Contact Closure Input—provides capability to process relay contact closure signals	-CC
Contact Closure Update Command provides capability to process update command inputs	-CCU
Factory calibration of unit	-FC
Power fuse on Plug-In Transmitter Card (PC Option), 400 mA rating	-FU
High-Current/Voltage Output—(Analog units only) 1-5V output, capable of delivering 20 mA	-HI
RFI Filter Terminal assembly—(Standard Units Only) adds Moore Industries patented integral Filter Terminal Assembly which prevents radio frequency energy from entering standard aluminum case	-RF
Selected Current Output—provides external selection of different current outputs (1-5 mA, 4-20 mA, or 10-5 mA)	-SC

SECTION 2
CALIBRATION PROCEDURES

2.1 GENERAL INFORMATION

This section provides information about unit calibration. Units with standard input and output levels are normally calibrated at the factory. After the unit is unpacked, general operating level checks are recommended. Usually these checks, specified in this section under calibration procedures, require little or no adjustments. If units are ordered with factory calibration option (FC), an exact calibration is performed at the factory, and red caps are placed on the controls. Adjustments should not be made in the field on these units unless a new range of input or output signal level is desired. Red caps should not be removed as a precaution against accidental adjustments.

2.2 CONTROLS DESCRIPTION AND LOCATION

The controls consist of ZERO and SPAN adjustments, located on the unit front panel.

External controls are multiturn potentiometers that are adjusted with a blade screwdriver NOT MORE THAN 0.1 INCH (2.54 mm) WIDE. USE OF A WIDER BLADE MAY PERMANENTLY DAMAGE THE POTENTIOMETER MOUNTING. This type of potentiometer usually requires 20 turns of the shaft to move the wiper from one end of its range to the other. It is equipped with a slip clutch at either end of its travel to prevent damage if it is turned beyond the wiper stop. Usually a slight change in feel will be noticed when the clutch is slipping. However, if this change is not observed, either end can be reached by turning the shaft 20 turns in the desired direction. Controls are connected, so turning the shaft clockwise increases the quantity or makes it more positive, and turning the shaft counterclockwise has the opposite effect.

2.3 TEST EQUIPMENT AND TOOLS REQUIRED

Test equipment and tools required for calibration of the unit are described in Table 2-1; they are not supplied and must be provided by the customer at the installation or test site.

2.4 TEST EQUIPMENT SETUPS

Off-line calibration for all units require the same test equipment setups regardless of option or physical configuration. The hookup requirements and physical preparations may vary on some units. The following paragraphs define the general test setup and identify the units that require special attention for test preparation and connections.

2.4.1 General Test Equipment Setups

The test equipment setup required for calibration of all units is identical except for connection identification. Figure 2-1 shows the general test setup configuration.

TABLE 2-1
TEST EQUIPMENT AND TOOLS REQUIRED

Equipment or Tool	Characteristic	Purpose
Screwdriver (blade)	Blade not wider than 0.1 inch (2.54 mm)	Front Panel Control Adjustment
Pulse or Contact Closure Input Device	Must be capable of producing signal ranges defined by INPUT level requirements of purchased unit (see Table 1-1)	Simulate input signal levels
DC Voltmeter	Must be accurate to within ±0.05% or better	Output signal monitoring (voltage outputs only)
DC Milliammeter	Must be accurate to within ±0.05% or better	Output signal monitoring (current outputs only)

2.4.2 Plug-In Units Test Equipment Setup

Plug-in unit equipment test setup is the same as the one shown in Figure 2-1, except that printed circuit board connections are identified in that figure by numbers in parentheses. Connection identification numbers are etched in the component side of the PC board. Plug-in units inserted in a rack also use the test setup shown in Figure 2-1 with card rack terminal connections identified by numbers in parentheses. These include either the rack mount (RMR) or the surface mounted (SMR).

2.5 CALIBRATION

Units are calibrated and checked for proper performance at the factory before they are shipped. However, unless calibration was requested to a specific set of input-output values, the unit performance should be checked by the user before the unit is placed in service. Calibration consists of simulating the operative signal input and adjusting the unit to obtain the specified output.

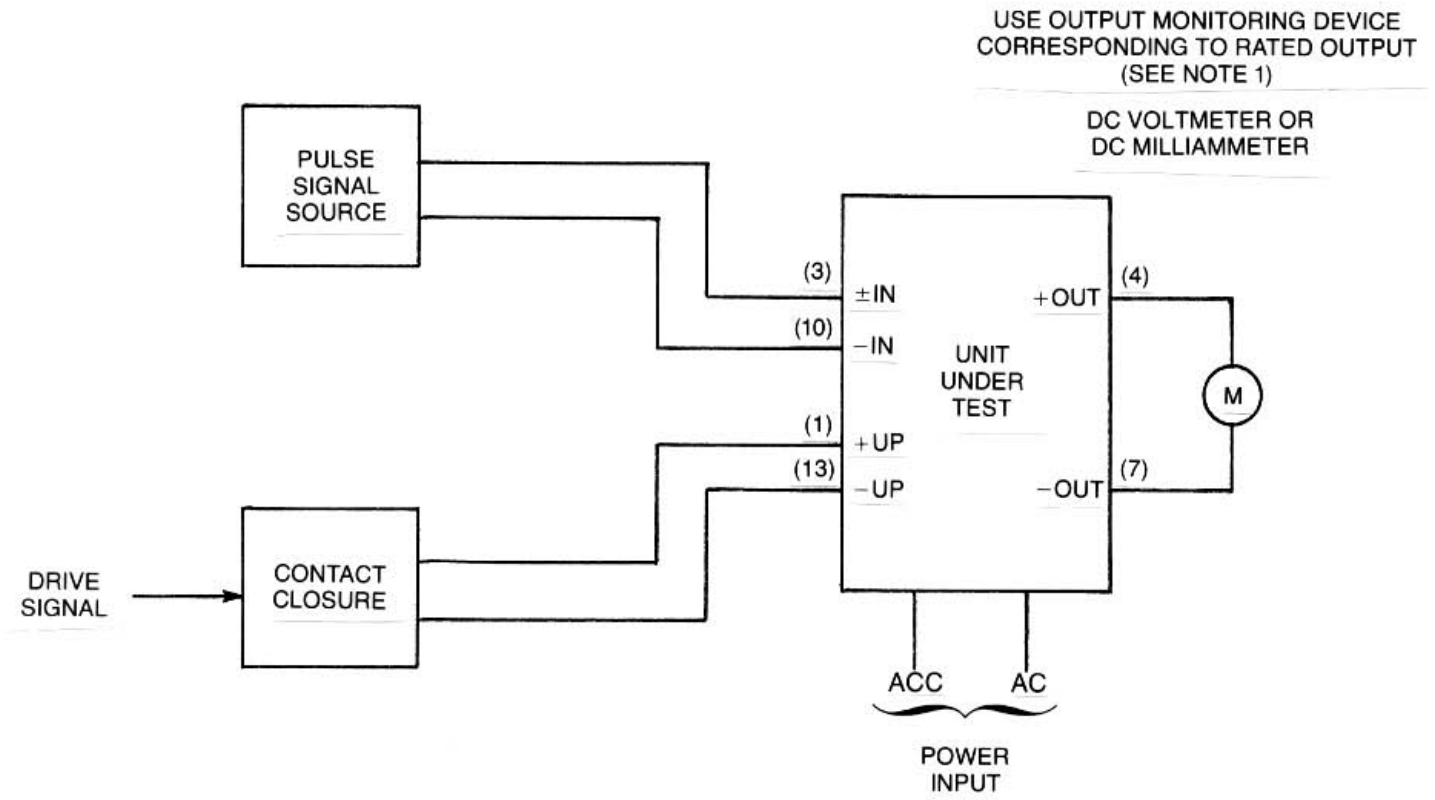


FIGURE 2-1 TEST EQUIPMENT SETUP

TABLE 2-2
INPUT RANGE SELECTION

Switch	Input Range
1	1024 - 2048
2	512 - 1024
3	256 - 512
4	128 - 256
5	64 - 128
6	32 - 64
7	NOT USED
8	NOT USED

2.6 INPUT RANGE SELECTION

Input ranges for the unit are switch selectable, and may be set to the inputs specified in Table 2-2, by activating the proper switch. Only one switch should be activated at any time, since more than a single switch being active will compromise the integrity of the unit linearity.

When input range changes are made to the unit, it is recommended that the calibration procedure specified in paragraph 2.5 be performed to ensure proper ZERO and SPAN adjustment.

NOTE

Adjustments should *not* be made in the field on units that are calibrated to values specified in the purchase order. Units that are calibrated at the factory to customer's specifications have protective caps over the SPAN and ZERO potentiometers; do NOT remove these caps.

A pulse signal source, with an appropriate pulse repetition rate is required to calibrate the unit. The signal may be supplied by a pulse generator with the required range and with an adjustable pulse width. The accuracy of the pulse duration of the input signal (in terms of percent of pulse repetition period) must be ±0.01% or better. If the unit has the CC (contact closure) option, the external contacts are used instead of the signal generator. Appropriate adjustable drive must be supplied to the contact closure device (e.g., relay). An output monitoring device (current or voltage) with an accuracy within ±0.05% or better.

NOTE

Refer to paragraph 1.5 for information on how to use the model number to obtain the specified values of minimum and maximum output.

To calibrate a unit, proceed as follows:

a. Connect unit and test equipment as shown in Figure 2-1.

b. Apply power input to the unit.

c. Adjust the pulse signal source to produce the minimum pulse count of the input range selected, or 0% input.

d. Apply an update command and ensure that no counts have been ignored during the update sequence.

e. If the unit under test has the -WC option, apply an update command and ensure the output is updated on the rise of the update input.

NOTE

Figure 2-2 illustrates the update command position in relation to the pulse count output for both the -WC option (window control) and the unit standard configuration

f. Adjust the ZERO potentiometer to obtain 0% output.

g. Apply an update command and ensure that no counts have been ignored during the update sequence.

h. If the unit under test has the -WC option, apply an update command and ensure the output is updated on the rise of the update input.

i. Adjust the pulse signal source to produce the maximum pulse count of the input range selected.

j. Adjust the SPAN potentiometer to obtain a 100% output.

k. Repeat steps (c) through (j) until no further adjustment of the ZERO or SPAN potentiometers is required.

l. After completion of step (k), remove power from the unit under test and disconnect the test equipment.

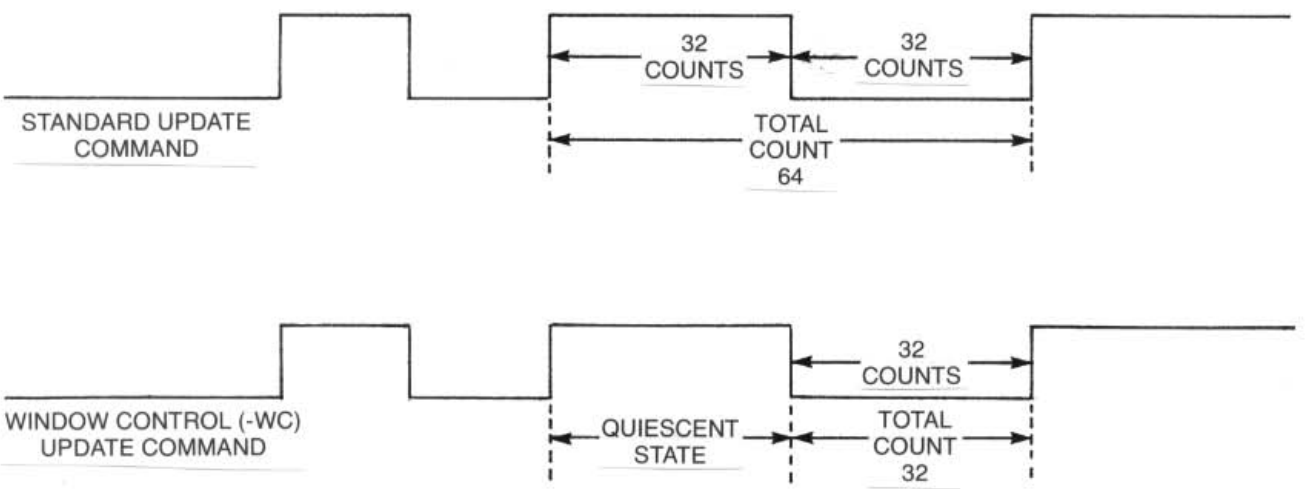
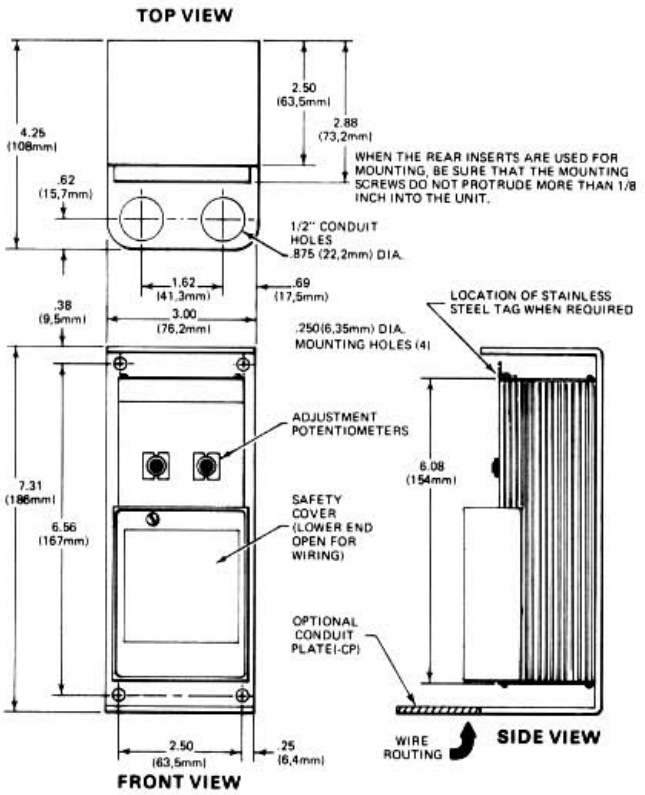


FIGURE 2-2
UPDATE COMMAND

3.1 MECHANICAL INSTALLATION

Units may be obtained in various physical configurations. Figures 3-1 through 3-9 show the outline dimensions and other installation requirements for the available configurations. Select the proper outline and dimension figure applicable to the unit purchased. Be sure to observe the applicable special procedures and precautions given with the illustration. Although the units are designed to operate in free air at quite a high ambient temperature, it is advisable, if possible, to mount the unit on a surface made of material that can serve as a heat sink. For a plug-in unit mounted in a rack, be sure that the rack has adequate ventilation.



NOTES:

1. Complete Model No. and Serial No. are permanently marked on identification plate located at upper end of terminal blocks.
2. When extra-compact mounting is required for rack or portable installation, C-shaped mounting bracket may be removed and two threaded inserts (located 4.00 inches apart) may be used for mounting, using 6-32NC machine screws.

FIGURE 3-1. STANDARD UNIT AND UNIT WITH CP OPTION, OUTLINE AND DIMENSION

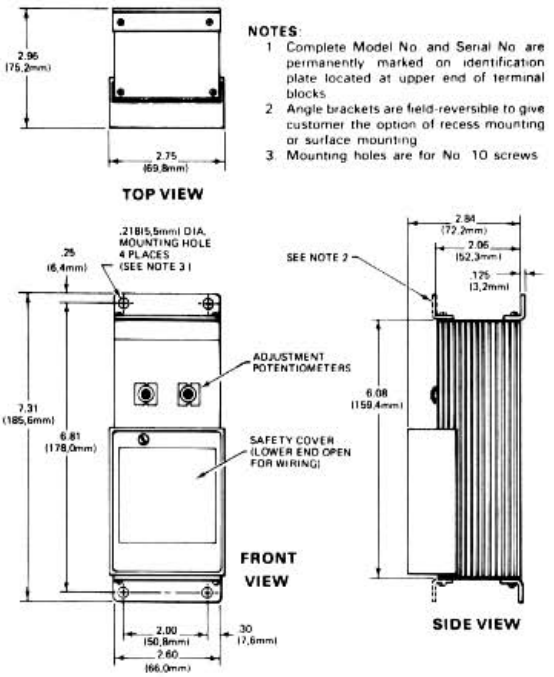
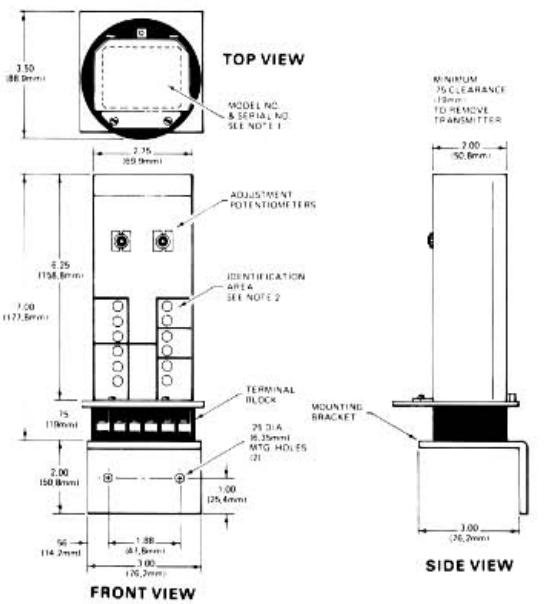


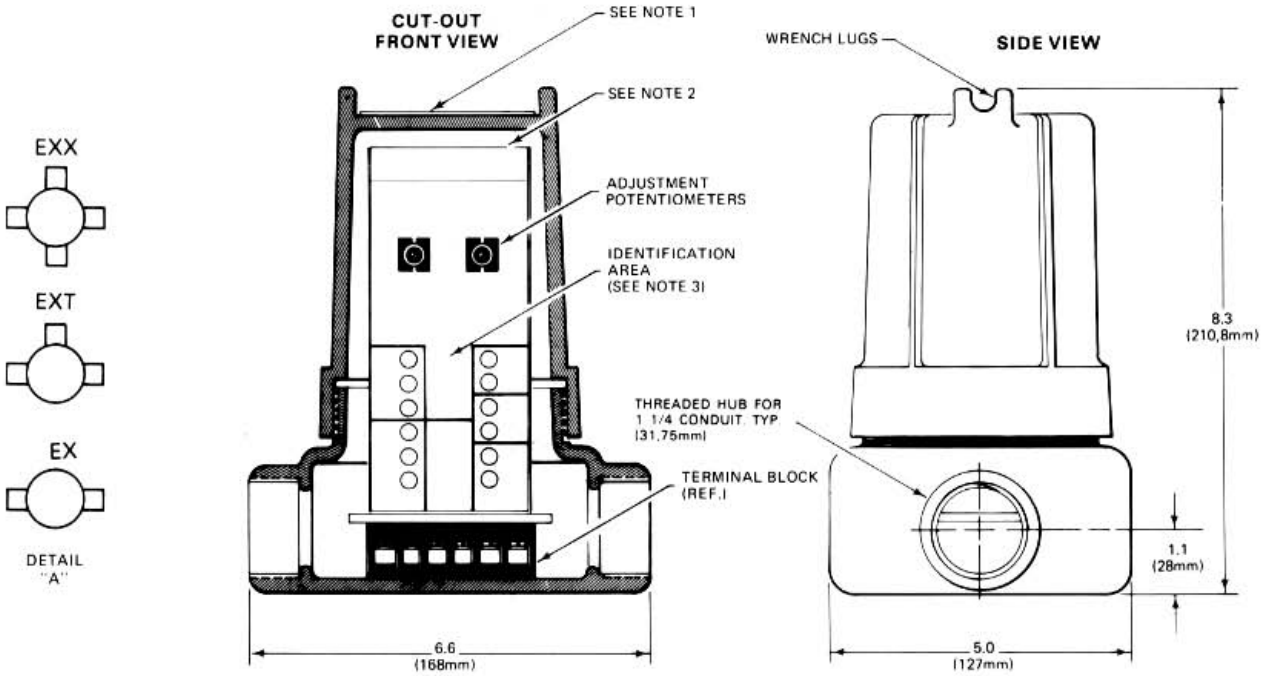
FIGURE 3-2. STANDARD UNIT WITH ANGLE BRACKETS (AB) OPTION, OUTLINE AND DIMENSIONS



NOTES:

1. Identification area on top of unit case carries complete model number and serial number.
2. Identification area on front of transmitter case gives electrical connection information.

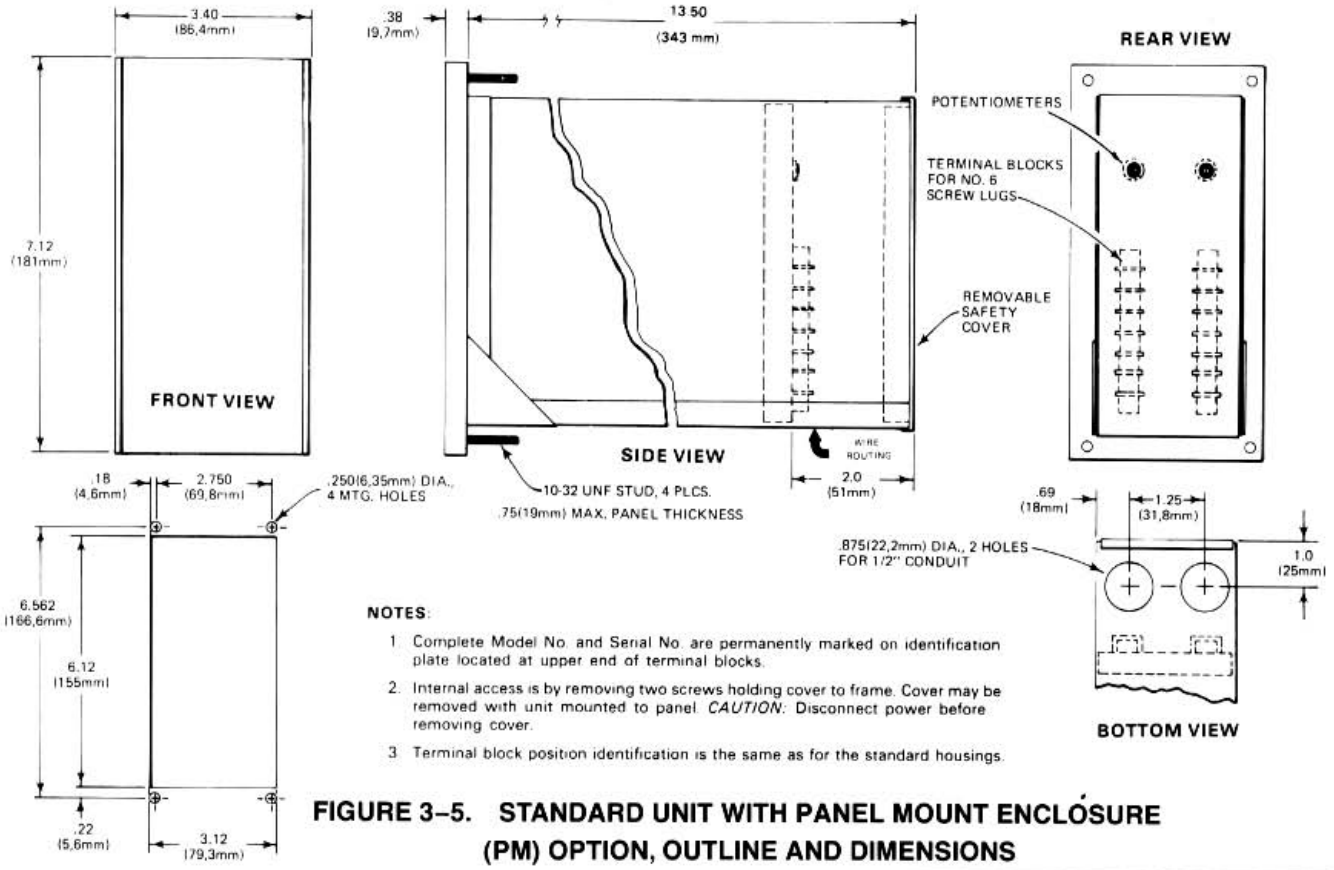
FIGURE 3-3. STANDARD UNIT WITH PLUG-IN STD TRANSMITTER (PB) OPTION, OUTLINE AND DIMENSIONS



NOTES:

1. Top of cover has metal label carrying unit type (e.g., TCT, MVT) and equipment number (if any).
2. Identification area on top of unit case carries complete model number and serial number.
3. Identification area on front of unit case gives electrical connection information.
4. "EX" housing (two conduit hubs) is shown above. Similar housings with three or four hubs is illustrated in detail A. Housings are cast aluminum alloy and meet NEMA specifications for Class I, Groups C and D and Class II, Groups E, F, and G.

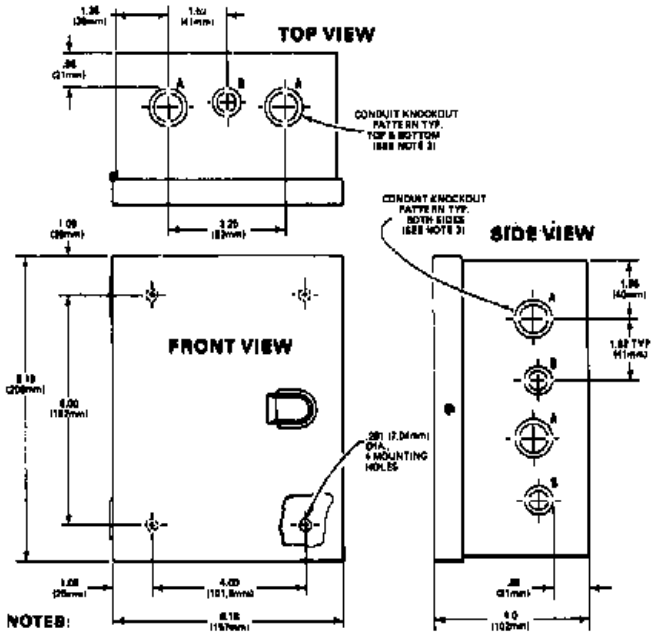
FIGURE 3-4. STANDARD UNIT IN EXPLOSION-PROOF ENCLOSURE, OUTLINE AND DIMENSIONS



NOTES:

1. Complete Model No. and Serial No. are permanently marked on identification plate located at upper end of terminal blocks.
2. Internal access is by removing two screws holding cover to frame. Cover may be removed with unit mounted to panel. *CAUTION:* Disconnect power before removing cover.
3. Terminal block position identification is the same as for the standard housings.

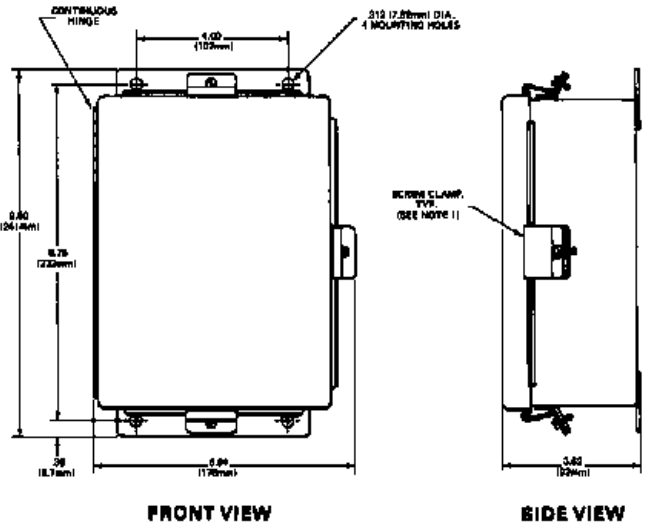
FIGURE 3–5. STANDARD UNIT WITH PANEL MOUNT ENCLOSURE (PM) OPTION, OUTLINE AND DIMENSIONS



NOTES:

1. Complete Model No. and Serial No. are located on identification bracket at upper end of terminal blocks.
2. Wire routing to terminal blocks is provided by open lower end of safety cover. Terminal blocks (2) accommodate #6 screw lugs.
3. Conduit knockouts are for conduit sizes as follows: A = ¾ — 1; B = ½ — ¾.

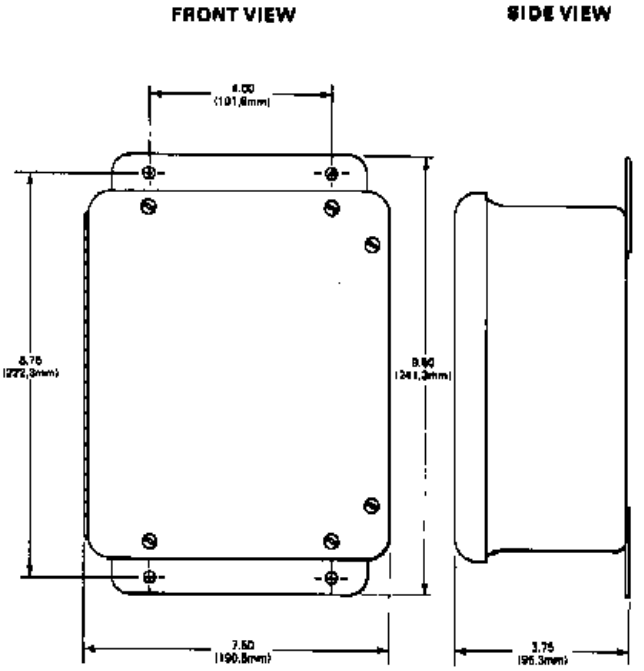
a. General Purpose (GP) Enclosure



NOTES:

1. NEMA 4 enclosure is shown. NEMA 12 is similar except that two screw clamps are on right side and there are none at top and bottom.
2. NEMA 12 enclosures are only oil and dust tight, whereas NEMA 4 enclosures are also water tight.
3. Wiring access to terminal blocks is provided by open lower end of safety cover.

b. Water and Oil-Tight (WT/OT) Enclosures

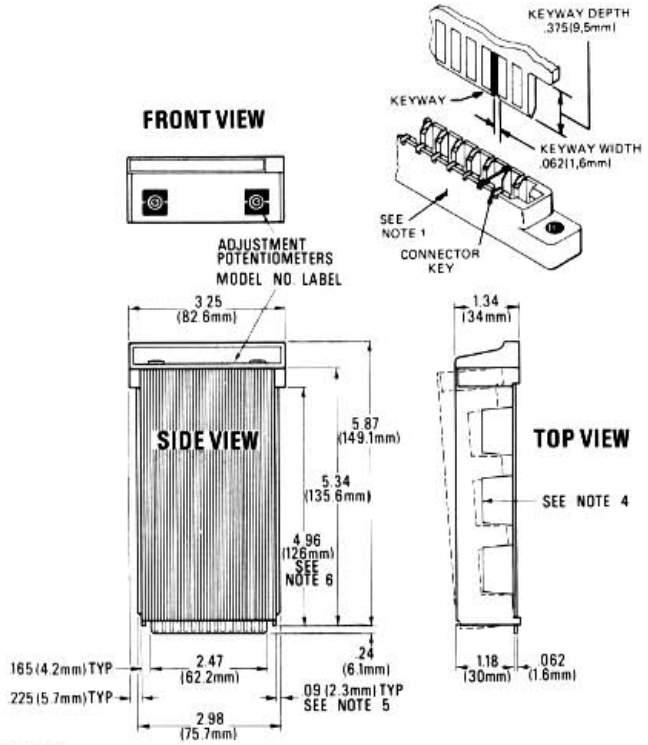


NOTES:

1. All exposed metal hardware is type 302 stainless steel. Boxes are hinged on the long side unless otherwise specified.
2. All boxes include a one piece closed cell neoprene gasket.
3. Standard color is machine tool grey. Boxes are molded from pigmented polyester resins with the color throughout the box wall for a maintenance-free installation.

c. Corrosion-Proof (FG) Enclosure

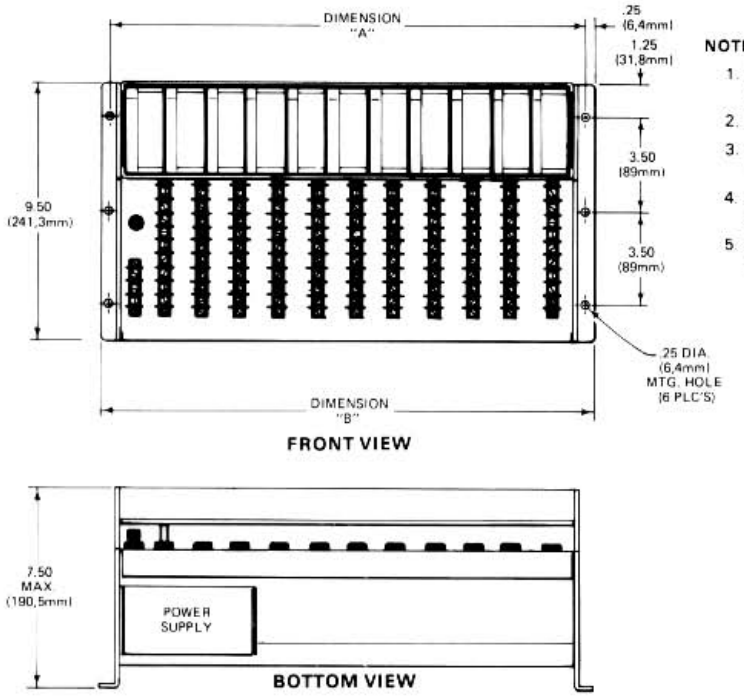
FIGURE 3-6. STANDARD UNIT IN NEMA BOXES, OUTLINE AND DIMENSIONS



NOTES:

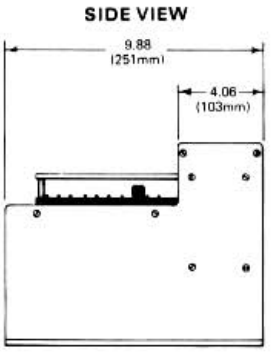
1. Connectors used must have contacts on .156 (3,96mm) centers, with contacts for both surfaces of board (recommended type: Viking part no. 2VK155/1-2).
2. Maximum card insertion depth in connector is .350 (8,89mm).
3. Minimum width of connector insertion slot is 2.470 (62,70mm).
4. Removable plastic safety cover, 2.800 (71,12mm) wide.
5. Maximum card edge-guide insertion depth is .09 (2.29mm). Guides must be non-conductive.
6. Card edge-guides cannot extend beyond here.
7. Card extender part no. 350-513-00 is available for testing unit while in operating position.

FIGURE 3-7. PLUG-IN UNIT, OUTLINE AND DIMENSIONS



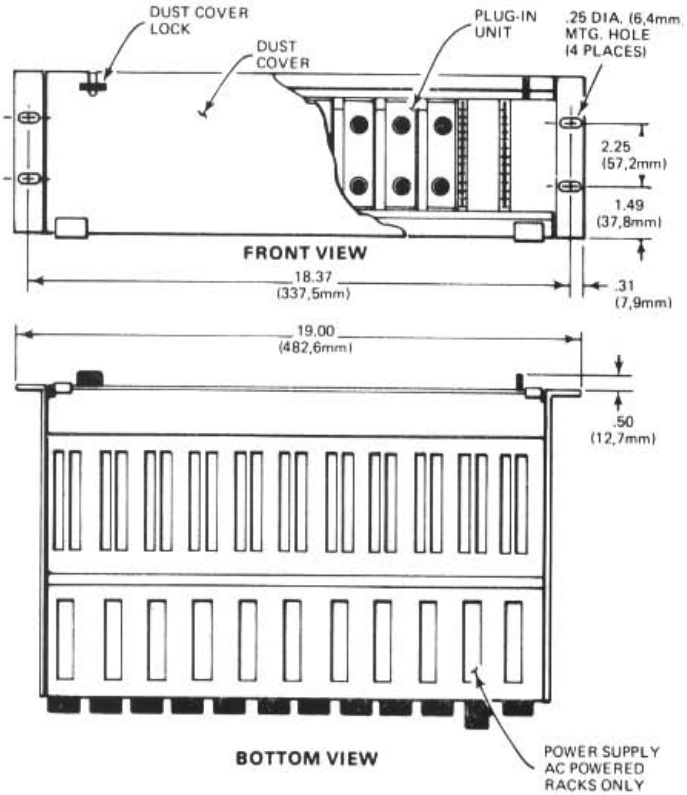
NOTES:

1. M.I.I. surface mounted card rack accommodates as few as 5, and as many as 15 plug-in units.
2. Empty positions may be closed by means of filler cards, P/N 350-213-00.
3. Connections are keyed to assure units will be plugged into proper position. Keying may be changed in the field if the system configuration changes.
4. Eleven position card rack is illustrated. Dimensions for mounting larger or smaller racks may be found in the table.
5. 24V power supply, shown, is capable of powering all models in card rack. Input specification: 117 VAC ±10%, 50/60 Hz, approximately 40 watts.



NUMBER OF POSITIONS	DIMENSION A	mm	B	mm
5	9.19	233,4	9.69	246,1
6	10.62	269,7	11.12	282,4
7	12.06	306,3	12.56	319
8	13.50	342,9	14.00	355,6
9	14.94	379,5	15.44	392,2
10	16.38	416	16.88	428,8
11	17.81	452,4	18.31	465
12	19.25	489	19.75	501,7
13	20.69	525,5	21.19	538,2
14	22.12	561,8	22.62	574,5
15	23.56	598,4	24.06	611,1

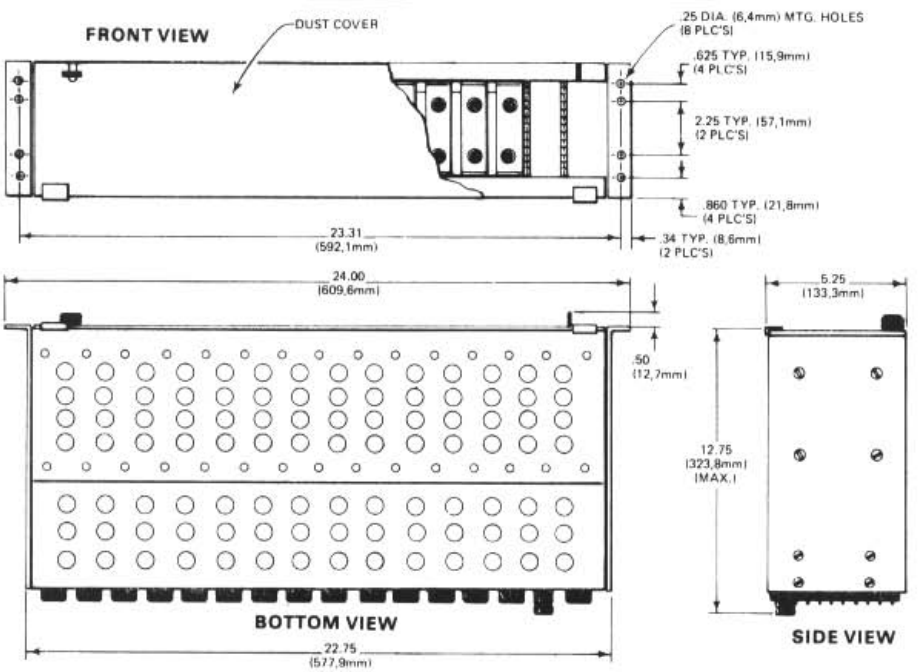
FIGURE 3-8. SURFACE MOUNTED CARD RACKS (SMR), OUTLINE AND DIMENSIONS



NOTES:

1. Connectors are keyed to assure units will be plugged into proper position. Keying may be changed in the field should the system configuration change.
2. This enclosure is designed to mount in a standard 19-inch rack with E.I.A. hole pattern.
3. Surface mounting card racks for use in NEMA type enclosures are also available. Contact factory for further details of card racks and card rack assemblies.
4. Barrier strip connectors are CSA approved.
5. Empty positions may be closed by means of filler cards, Part No. 350-213-00, which must be ordered individually in quantity required.
6. 24 volt power supply furnished capable of powering a typical complement of up to fifteen modules. Input specification 117 volts ± 10% 50/60 Hz approximately 40 watts.

a. Eleven-Position Card Rack



b. Fifteen-Position Card Rack

FIGURE 3-9. RACK-MOUNTED CARD RACKS (RMR) ENCLOSURE, OUTLINE AND DIMENSIONS

3.2 ELECTRICAL CONNECTIONS

All electrical connections to standard units are made to the terminal blocks on the unit. On plug-in units, the electrical connections are made to terminals on the mating connector for the unit. Terminals used for standard units and their options are defined in the following paragraph.

3.2.1 General Wiring Information

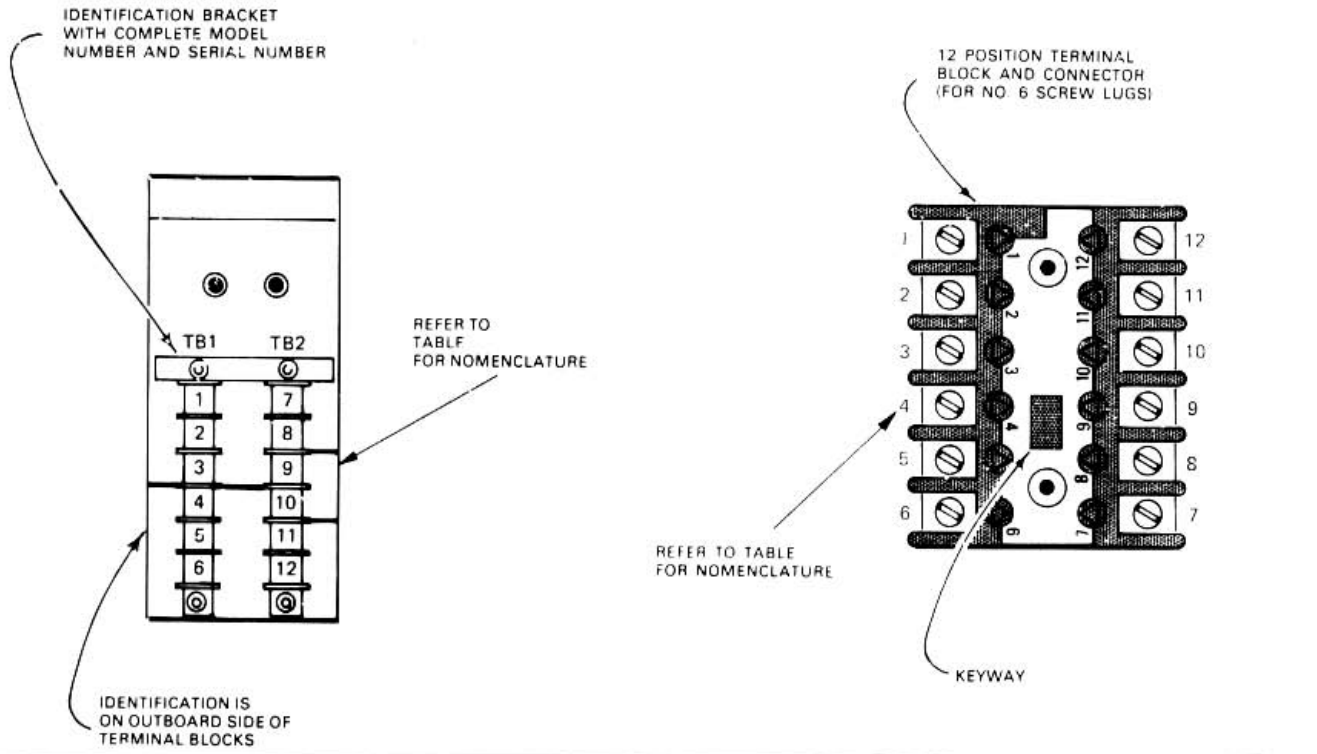
No special wire or cable is required for signal connections to the unit. To avoid transients and stray pickups, it is recommended that twisted conductors be used where they are run close to other services (such as power wiring). Electrical connections to the unit fall into two major categories: connections to all standard units with terminal blocks, and connections to plug-in units and their associated enclosures.

Wiring Information for All Standard Units With Terminal Strips and Blocks. Standard units with terminal strips or terminal blocks have terminals supplied with 6-32 screws long enough to easily accommodate three spade-lug connectors. Standard units with snap-off plastic covers have an opening in the bottom of the cover. Dress all wiring to and from the terminals through this opening. Spade lug connectors are recommended for all wire terminations. Figure 3-10 illustrates the terminal strip locations and identification for the standard units and the terminal block identifications for the explosion proof and PB configurations. Table 3-1 provides the complete labeling nomenclature for standard units and any available electrical options. Terminal labeling appears next to the terminal it identifies on standard units.

Wiring Information for All Units in NEMA Boxes. Units mounted in NEMA boxes are standard units with or without the options listed in Table 3-1. NEMA boxes for OT or WT options do not have conduit holes fittings or knockouts. Conduit access must be provided by fittings such as Myer Scru-Tite or equivalent.

General Purpose (GP) enclosures have conduit knockouts for various sizes of conduits from 1-inch down to ½-inch. Corrosion-Proof (FG) enclosures require special attention with ground connections. Since enclosure material is polyester resin, conduit cutouts may be cut with a punch or hole saw. Ground continuity may be obtained in two different ways. If a metal panel is used, ground can be made between the metal conduit locknut and the panel at enclosure entry and exit. If the enclosure is used without the back panel, a jumper between the conduit entry and exit is necessary to maintain ground continuity. Remove snap-off plastic cover to access terminal strips.

Wiring Information for Plug-In Units. Plug-in units and card rack electrical connections are made to terminals on the mating connector for the unit or the card rack terminal strips. Figure 3-12 illustrates the terminal strip connections and their numerical reference designator. Table 3-2 provides a complete terminal nomenclature for both Plug-In and Rack assemblies.



a. Standard Units **b. Units with EX or PT Configuration**

FIGURE 3-10. TERMINAL STRIP AND TERMINAL BLOCK IDENTIFICATION

TABLE 3-1. TERMINAL NOMENCLATURE

Options (Note 1)	Terminal Positions											
	1	2	3	4	5	6	7	8	9	10	11	12
None				DCC	DC	GND	+UP	−UP	+IN	IN	+OUT	−OUT
AC				ACC	AC	GND			+IN	−IN	+OUT	−OUT
SC (Output)		SC	SC									

NOTES:

1. Labeling shown here may be combined. The combination may include standard labeling and one or more options. Combinations of options may cause labeling positions to change, but nomenclature will remain as shown.

Legend:

DC	+DC Power Input	ACC	AC Power Return
DCC	−DC Power Input	±IN	Signal Input
GND	Chassis Ground	±OUT	Signal Output
AC	AC Power Input	SC	SC Resistor
±UP	Update Input		

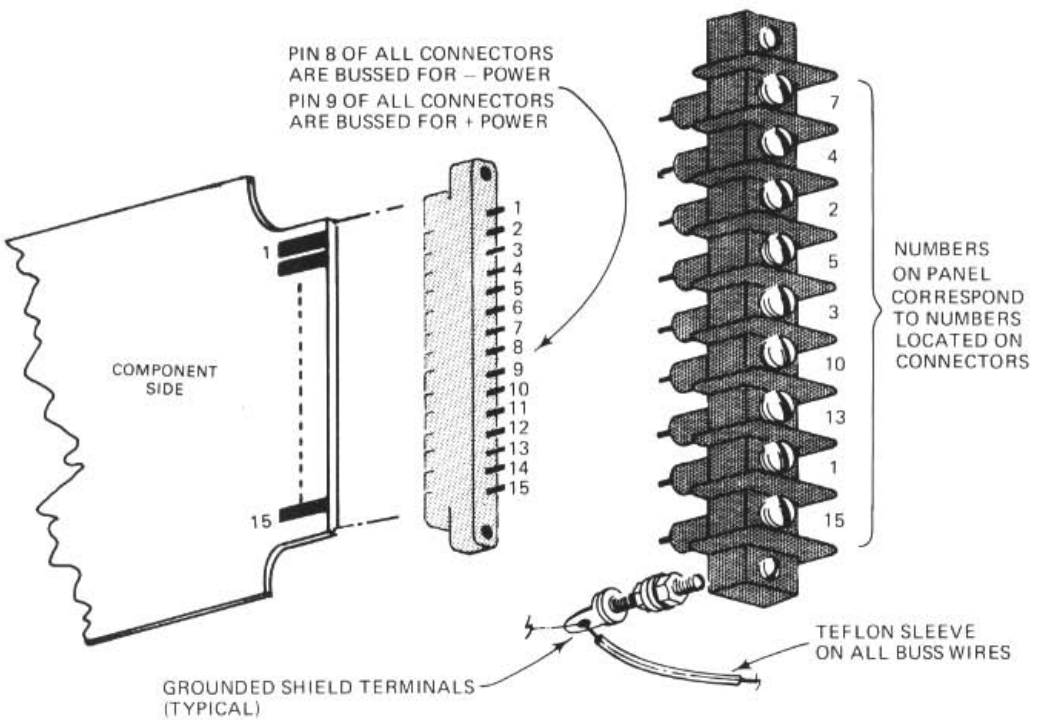


FIGURE 3-11.
PLUG-IN CONNECTORS AND TERMINAL STRIPS WIRING AND IDENTIFICATION

TABLE 3-2.
CONNECTOR PINS AND TERMINAL ASSIGNMENTS FOR PLUG-IN UNIT AND CARD RACKS

Options	Terminal Position														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NONE, CC, or AT Options	+UP		+IN	+OUT			−OUT	DCC	DC	−IN			−UP		
SC (Output)		SC			SC										

Keyways

Legend:

DC	+DC Power Input	±IN	Signal Input
DCC	−DC Power Input	±OUT	Signal Output
GND	Chassis Ground	SC	SC Resistor
±UP	Update Input		

3.2.2 Power Connections

Units are designed to operate from either a DC or AC power source. Refer to paragraph 1.5 for information on how to use the model number to determine the type of power required.

DC-powered units. On these units the DC terminal is connected to the + (positive) side of the source, and the DCC terminal is connected to the − (negative) side. The DC source should be regulated to within ±10% of the nominal voltage and should be capable of delivering 5 watts.

AC-Powered Units. These units require 117 volts AC ±10%, 50/60 Hz at 5 VA of nominal power or 220/240 VAC optionally. The AC terminal should be connected to the ungrounded or "hot" side of the supply, and the ACC terminal is connected to the common or neutral. The GND terminal is the mechanical case connection.

Rack Power Connections. Connect power input wires to the appropriately labeled terminals of the 3-terminal connector strip. The third terminal on the strip is chassis ground.

3.2.3. Connections On Units With SC Option

On units with the SC (selectable current) option, connect the output selectable current resistor to the terminals marked SC, or those specified in Table 3-1. The current range is marked on the body of each resistor. If provided, the selectable current resistors for a plug-in unit should be mounted externally either at the terminal block of the card rack, or soldered to the appropriate terminals on the PC connector. See Table 3-2 for correct connections.

3.3 OPERATION AND PERIODIC OBSERVATION

Once calibrated and installed, the unit may be operated unattended. The only controls on the outside of the unit are the SPAN and ZERO potentiometers, which, after initial adjustments, need no further attention. There are no indicators on the unit. Because the circuit uses highly reliable solid-state components with no moving parts, the unit should operate virtually maintenance-free for a long period of time. However, if a malfunction should occur, refer to Section 5 for maintenance information.

A periodic check of input and output connections is recommended every six months to ensure continued dependability of operation.

A unit may become warm during operation, especially where the ambient temperature is rather high. This is perfectly normal and should not be a cause for alarm unless a malfunction is also observed.

SECTION 4
THEORY OF OPERATION

4.1 INTRODUCTION

This section describes the theory of operation of the unit. The description of each circuit is presented in sufficient detail so troubleshooting, if required, can be carried out intelligently and rapidly.

A schematic diagram and a block diagram (Figure 4-1) are included in this manual. Unless otherwise directed, refer to the schematic diagram when reading the following paragraphs.

Components reference designators are listed here for both the standard and the plug-in models. The standard unit reference designator is listed first followed by the reference designator for the plug-in unit in parentheses and italics. If both reference designators are the same, only one is listed.

4.2 GENERAL FUNCTIONAL DESCRIPTION

The PAM Electronics consist of input wave shaping circuits, timing and control logic, binary counter and latch components, and digital to analog conversion circuits which drive a buffer amplifier whose output is processed to provide either current or voltage outputs.

4.3 AC POWER SUPPLY

The AC power supply will accept either the 117VAC or the optional 220/240VAC, across the primary winding of transformer T1. In parallel with the primary winding of the transformer is varistor VS1, which provides transient suppression in the event of input power fluctuation. The secondary winding of T1 is connected to a bridge rectifier circuit.

4.4 DC POWER SUPPLY

When the PAM is to be powered by direct current, a power inverter circuit is used that replaces the AC input transformer. When the selected DC voltage is applied to the power inverter, it is converted to a square wave of approximately 3 KHZ, using transistors and the primary windings of a transformer to form an oscillator circuit. Polarity reversal protection is provided by a diode, in series with the positive DC input line, & additional isolation is provided by an inductor, and filter capacitors.

4.5 VOLTAGE REGULATION

The regulation circuit derives voltage from the full-wave bridge rectifier, CR9 through CR12 (CR7 through CR10),

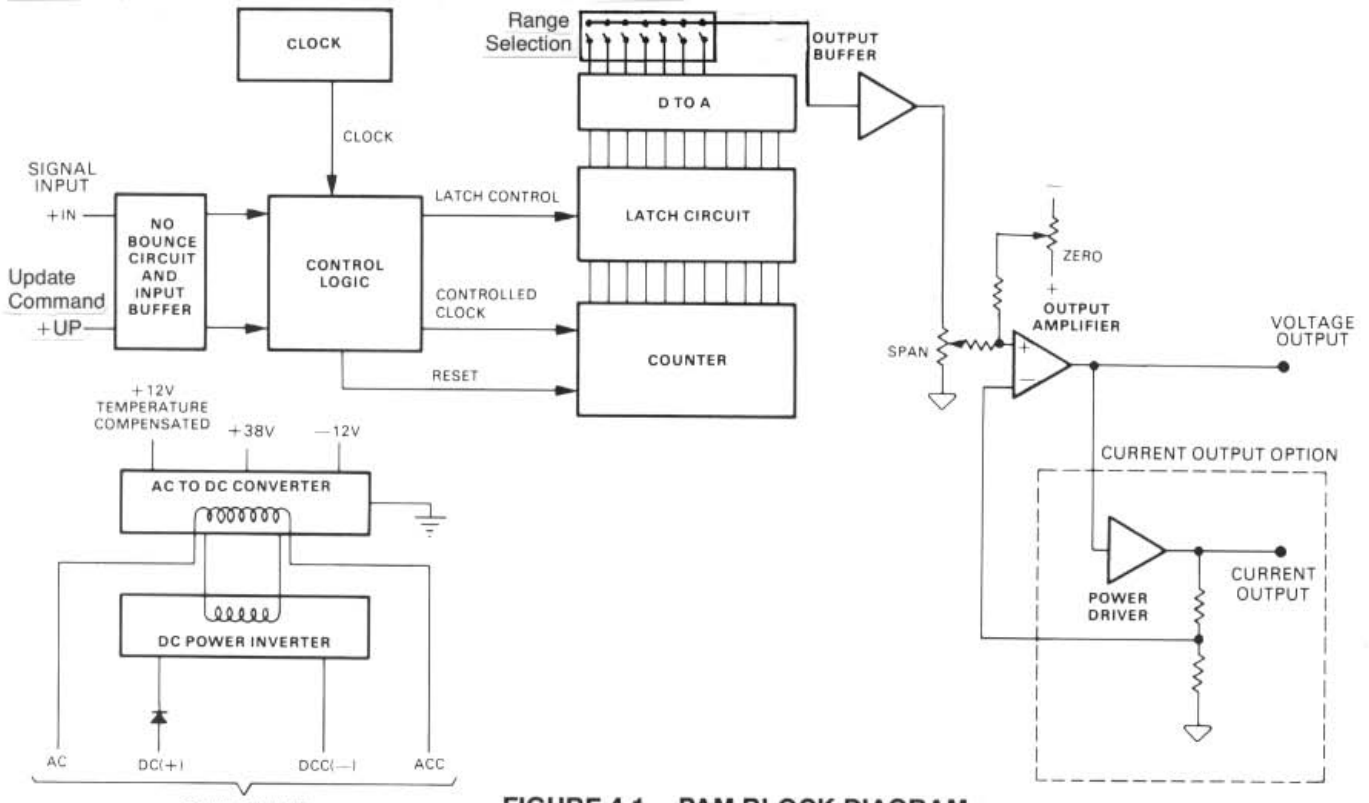


FIGURE 4-1. PAM BLOCK DIAGRAM

to produce positive and negative DC output voltages. The positive DC voltage is filtered, then regulated and temperature compensated using IC9 (IC3) and transistor Q4 (Q3) to produce the regulated +12 vdc.

The negative DC output is filtered, and regulated by a zener diode to produce the −12 volts at power supply connection B. An additional voltage is taken from the transformer secondary, then applied to a half-wave rectifier and filter capacitor, to produce the +38 vdc required by the power output stage.

4.6 INITIALIZATION CIRCUIT

When power is applied to the unit, the RC network of R208 (R209) and C203 (C204) causes a portion of IC203 to momentarily go low, thus producing outputs that are used as power on clear (POC) logic. This reset function is applied to the wave shaping flip-flops and the binary counter as a positive pulse, and inverted at the output of IC203 Pin 12, to provide a negative going reset pulse to the 6 bit latches, IC2 and IC4, (IC4 and IC6).

4.7 INPUT CIRCUIT

Two identical input circuits are used to accept pulse information. The incoming pulse signal to be counted, is applied to the ± in (input) terminals, and pulse information to update the count sequence is applied to the ± up (update) terminals.

When an input pulse is received, it is applied to the base of the transistor, biasing the transistor on, and pulling the inverter input low thus providing a high to the clock input of the wave shaping flip-flop. When the contact closure option (-CC) has been selected, contact bounce is eliminated since the duration of the input signal, determined by the RC time constant circuit, holds the transistor on for a minimum of 10 Msec.

4.8 CONTROL LOGIC

This circuit consists of priority arbitration logic and a dual sequencing circuit that is driven by a clock. Two inverter sections of IC203 along with capacitor C201 and resistors R201 and R202 form the clock circuit which provides a time base for the sequencers. When an input, or an update command is applied, a function request is sent to the arbitration logic of IC201 whose output drives the sequencers. The sequencing circuit is connected so that the data input to one half of the device is also the reset input to the remaining portion. In this configuration only one sequencer is active depending on the input signal selected by the arbitration logic.

4.9 COUNTER CIRCUIT

The counter consists of IC3 (IC5), which is a binary up counter that begins the count sequence on the negative going edge of the inverted clock pulses received from the control logic. The count sequence will continue until a reset pulse is received at Pin 11 of IC3 (IC5) at which time the counter returns to zero. As the count function is being performed, the binary output of IC3 (IC5) provides input data to the two 6-bit latches, IC2 and IC4 (IC4 and IC6).

4.10 LATCH AND D TO A CIRCUITS

The latches and the digital to analog circuit consist of Two Hex D Flip-Flops, IC2 and IC4 (IC4 and IC6). Each 6-bit output device looks into a resistive ladder network, that develops a voltage across its respective divider, with Pin 14 of IC2 (IC4) being the most significant bit, (MSB) and Pin 6 of IC4 (IC6) being the least significant bit, (LSB). When power is applied, the POC signal, generated by the initialization circuit, resets the latch outputs, then input pulses are passed through the latches continuously. Until the input returns to the quiescent state, and the control logic generates a latch command. As the contents are converted, by the D to A, the resistive ladder network produces a signal level that is equal to the combined outputs of the latch circuits.

4.11 OUTPUT BUFFER

The buffer amplifier, IC5 (IC1), accepts its input from the resistive ladder network through one of the switches contained in IC8 (IC9), a count range selection device. IC5 (IC1) provides inpedance matching from the divider resistance network to the low impedance of the span adjustment circuit, and prevents loading by the output circuits.

4.12 POWER OUTPUT STAGE

The DC output from IC5 (IC1), is applied across the span divider circuits, and provides a signal to the non-inverting input of IC1 (IC2) where it is summed with the voltage from the Zero adjust circuit which appears at the inverting input, Pin 2. The resulting output voltage is applied through R15 (R13) to transistor Q3 and Q5 (Q1 and Q2) to derive current output. When the −HI option has been selected, the DC output voltage is derived from the emitter follower circuit of Q3 (Q2) and its related components, which develop the 1-5 VDC rated at 20 milliamps.

5.1 INTRODUCTION AND GENERAL INFORMATION

This section contains information to aid in the maintenance of the unit. This includes disassembly instructions for all mechanical options, as well as general troubleshooting. Precautions and special techniques required to replace components are also described.

5.2 DISASSEMBLY

When unit troubleshooting is required, it is first necessary to disassemble the unit. The physical configuration of the unit determines the steps to be followed in disassembly. These are described in the following paragraphs.

NOTE

Always identify wires — usually by tagging — before disconnecting existing connections.

CAUTION

DISCONNECT INPUT SIGNAL AND REMOVE POWER INPUT BEFORE DISASSEMBLING UNIT.

5.2.1 Disassembly of Standard Unit

To disassemble a standard unit, remove the unit from its installed position. If the mounting bracket is used, separate it from the unit by removing the two countersunk screws at the rear of the unit. After the unit has been removed from its installed position, disassemble the unit as follows to gain access to the circuit board.

a. Remove the two front Phillips-head screws at the top of the unit.

b. Remove the four Phillips-head screws at the bottom of the unit.

c. Slide the front panel (with the circuit board still attached) down and free of the sides of the case. Points on the circuit board may now be reached for troubleshooting. It is suggested that the case be used as a container for storing the removed hardware.

5.2.2 Disassembly of Unit in NEMA Boxes

Normally electrical connections are made to NEMA boxes through conduits. Units are secured on a mounting plate in the NEMA boxes. The following disassembly instructions apply to the various configurations.

Disassembly of Units in OT, WT and GP Enclosures. Use the followinwing procedures to disassemble unit:

a. Loosen clamps that hold hinged cover on OT and WT enclosures only, and open enclosure.

b.. Remove plastic safety cover from unit.

c. Tag and disconnect wires from unit.

d. Loosen four mounting screws that hold unit into box.

e. Disassemble unit as described in paragraph 5.2.1.

Disassembly of Units in FG Enclosure. Use the following procedures to disassemble unit:

a. Loosen four screws that secure cover on box.

b. Open box and inspect gasket for damage. Replace if necessary.

c. Remove plastic safety cover from unit.

d. Tag and disconnect wires from unit.

e. Tag and disconnect ground wire from conduit to mounting post.

f. Remove four nuts that secure unit to mounting plate in rear of box.

g. Disassemble unit as described in paragraph 5.2.1.

5.2.3 Disassembly of Units in PB Enclosures

Use the following procedure to disassemble unit:

a. Remove unit from terminal block by rocking it slightly while pulling upward.

b. Remove two nuts, screws, washers, holding front panel to bottom of PC board (two front bottom).

c. Remove two side screws from front panel.

d. Remove one countersunk screw from back-bottom of unit in bottom of PC board.

Terminal block and card connector are keyed to eliminate error when the unit is reinstalled.

5.2.4 Disassembly of Units in EX Enclosures

Use the following procedure to disassemble unit:

a. Using a bar wrench, attach to wrench lugs and loosen the housing cover from the base.

b. Unscrew protective cover to expose unit.

c. Use procedure of paragraph 5.2.3.

5.2.5 Disassembly of PM Units

Use the following procedure to disassemble unit. Refer to Figure 5-1 for parts nomenclature.

a. Pull out safety cover to expose wiring.

b. Tag and disconnect wires from terminal strip. If troubleshooting requires access to reverse side of PC board, perform the procedure described in next step.

c. Remove screws holding cover to frame and lift cover off the case assembly.

CAUTION

WIRE SERVICE LOOP IS SUFFICIENT TO ALLOW PC BOARD AND END PLATE ASSEMBLIES TO BE TURNED OVER. ANY EXCESSIVE MOVEMENT OF THIS ASSEMBLY MAY CAUSE WIRING DAMAGE.

d. Remove two nuts and washers that secure PC board and end plate into frame and carefully lift and slide board and plate towards terminal panel, out of end holder.

5.2.6 Disassembly of a Plug-In Unit

To remove the cover of a plug-in unit, proceed as follows:

CAUTION

DO NOT LIFT FRONT OF COVER MORE THAN ¼ INCH. EXCESSIVE FORCE APPLIED TO COVER MAY BREAK REAR RETAINING CLIPS.

a. Gently spread forward locking feet and lift front of cover.

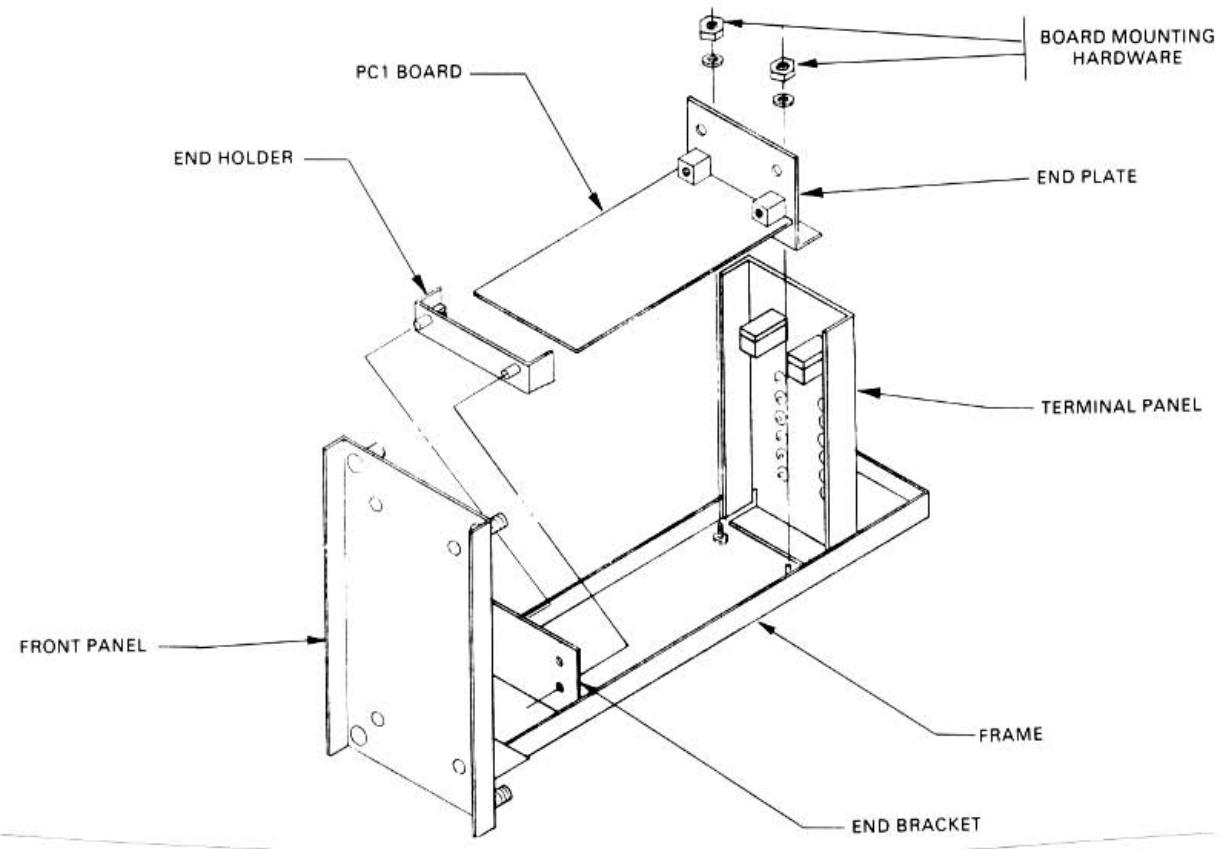


FIGURE 5-1. DISASSEMBLY OF PM UNITS

b. With the front of the cover raised, slide the cover to the rear to disengage it from the plug-in card.

To test a plug-in unit in the operating position, a circuit board extender card (M.I.I. Part No. 350-513-00 or equivalent) is required. The extender card brings the unit forward so components on circuit board are accessible for troubleshooting.

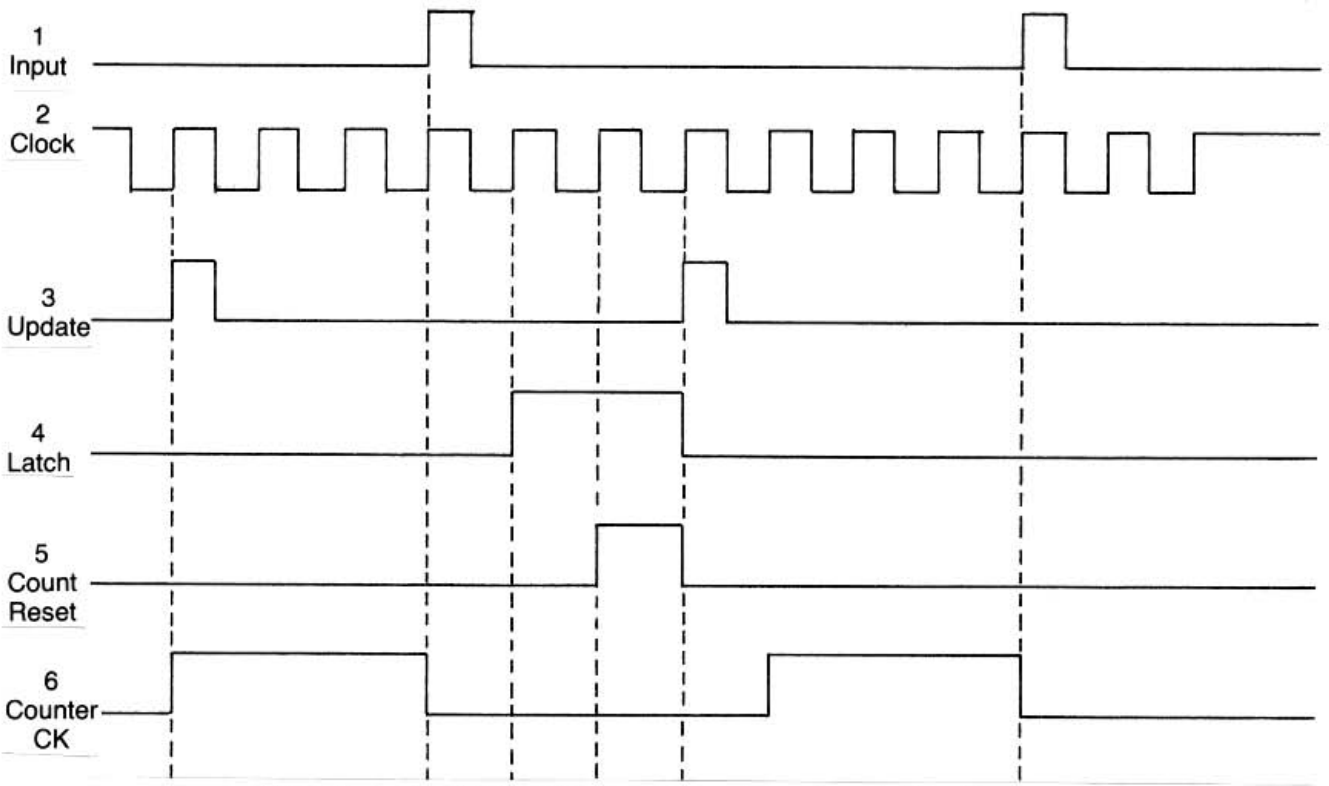
5.2.7 Disassembly of Plug-In Units in Card Racks

Except for SMR, access to units in racks is effected by removing dust cover over plug-in units. Surface Mounted Racks (SMR) do not have a cover over plug-in units since the whole rack may be enclosed into a NEMA box.

5.3 TROUBLESHOOTING

The schematic diagrams include flagged numbers (or letters) at various points in the circuit. Table 5-1 gives the voltages and waveforms at these points for specified input-signal conditions. The assembly drawing shows the physical locations of the parts on the circuit board. Bear in mind that the circuit board is protected with a moisture-resistant coating. Therefore, it may be necessary to use a needle-point probe and exert a fair amount of pressure to break through the coating when it is desired to observe the signal or voltage at a specific point. When connecting a probe to a component on the circuit board, exercise care to make sure the probe does not short-circuit to an adjacent component.

In general, troubleshooting is carried out by tracing the signal with an oscilloscope and referring to the schematic diagrams to determine what component might be causing an observed abnormal indication. If the original symptom was a complete failure of the unit to operate, the most logical components to suspect are those associated with the power supply in the unit (including any voltage regulators). If the unit was producing an incorrect (but not zero) output, check the outputs from the voltage regulator and, if these are normal, apply a standard input signal and trace the resulting signal through the unit.



NOTES 1. Nominal input is 5 volts, maximum input is 25 volts
2. Clock frequency will be within the range of 140Khz to 500Khz

TABLE 5-1 WAVE FORMS

5.3.1 Plug-In Board Connector Cleaning

Occasionally, modules which have been in service for a long period of time may develop resistive coatings on the gold-plated contacts of the plug-in boards. This coating, if allowed to build up, can cause malfunctions by decreasing the noise margin of a circuit.

There are two types of foreign material coatings which can develop on the gold-plated contacts of a plug-in module. The first type is INORGANIC. This type of contamination results when copper "bleeds" through the gold plating and oxidizes. The second form of contamination involves ORGANIC substances, which usually are a result of careless handling, and are mainly made up of fingerprints, salts, and oils deposited when the plug-in boards are handled by the gold-plated contacts. Contamination by organic substances can be greatly reduced by careful handling of the modules.

Although rack connectors are usually of the self-cleaning type, it may become necessary to clean the module fingers to ensure reliable connection. When module contacts are in need of cleaning, the following procedures are recommended:

Removal of Inorganic Contaminants

a. Immerse contacts of plug-in board in an ultrasonic bath of deionized water and a detergent, such as Liguinyx, for at least 30 seconds.

b. Repeat step (a) with pure deionized water only.

CAUTION

REMOVE WATER IMMEDIATELY FROM CONTACTS. IF THIS IS NOT DONE QUICKLY, DAMAGE TO CONTACTS MAY RESULT.

c. Remove water by immersing contacts in an ethane or methanol bath to same depth used during the ultrasonic cleaning of step (a). Never wipe or use an abrasive cleaner on the contacts. If wiping is necessary, use K-Dry towels or equivalent.

Removal of Organic Contaminants

a. After inorganic contaminants and water have been removed, organic materials may be removed by immersion of contacts in trichloroethane for at least 30 seconds.

CAUTION

NEVER USE AN ERASER ON THE CONTACTS. THE USE OF ABRASIVE CLEANERS OR ERASERS ON PLUG-IN BOARD CONTACTS IS CONSIDERED A PHYSICAL ABUSE TO THE PLUG-IN UNIT AND MAY VOID THE UNIT WARRANTY.

b. Let contacts air dry or wipe with a very fine, nonabrasive material such as K-Dry towels or equivalent.

5.3.2 Component Replacement General Information

Replace all defective components with identical parts. Refer to Section 6 for a list of recommended replacement parts. The last row of numbers in the parts list is the number of spares recommended to be kept on hand for that part, per unit, for up to ten units of the same type. For more than ten units, a spares complement of 10% on the indicated parts should be used.

5.3.3 Component Replacement Techniques

Most parts used in the unit are quite small and are located in a confined area. Therefore, small hand tools are a necessity when servicing the unit. The following is a summary of the general techniques and precautions that should be observed to prevent damage to components in the unit:

a. Use a transformer-operated low-voltage soldering iron with a grounded tip and rated at not more than 50 watts. A temperature-controlled tip is desirable.

b. Use extreme care when unsoldering the leads to any component. Do not keep the soldering iron on a point for more than a few seconds at a time. Use a suction-type solder-removing tool (solder sucker) as an aid in unsoldering transistors and integrated circuits. The protective coating on the unit may be removed with trichloroethane or equivalent. Be sure adequate ventilation is provided when using this or any other chemical.

c. Do not excessively bend or twist the leads of small components; they break easily.

d. Before removing a component, observe the lead dress. Be sure that the lead dress of the replacement is the same as that of the original.

e. Remove all flux from soldered joints with trichloroethane or equivalent.

NOTE

Units that were calibrated at the factory to customer's specifications have protective caps over the SPAN and ZERO potentiometers. These caps must be removed so the unit can be recalibrated. LIFT, DO NOT TWIST, the caps off, using a screwdriver tip as a prying tool. Snap the caps back in place, WITHOUT TWISTING, when recalibration has been completed.

f. Test the unit for proper operation and, if necessary, recalibrate by the procedure given in Section 2. When the performance of the unit is known to be satisfactory, apply clear *acrylic* to reseal the unit where required. Check that all leads are clear of the board edge before reinstalling the board into its case.

g. When reinstalling the unit onto the mounting bracket, be sure to use the same screws (or screws of the same size) as the ones removed. Longer screws will damage the unit.

SECTION 6
UNIT DOCUMENTATION

6.1 GENERAL

This section consists of a computer print-out table that provides parts identification information for the unit. Wiring lists have been provided in this section as an aid to the maintenance personnel.

Parts information is grouped according to the number of assemblies. If the unit contains two PC boards, the table will be divided into two major sections: one section will contain information related to PC1 and the other section will list PC2 components information. Each major section in the table contains a complete parts list headed LIST OF MATERIALS specifying which PC board it is describing. This list is usually found at the end of the section. The list of materials consists of the following headings:

ITEM: A reference numeral used for data processing and not used by maintenance personnel.

NAME: Gives the nomenclature of the part.

DESCRIPTION: Identifies the component by manufacturer's part number, usually followed by component's parameters or value.

REF: Lists the reference designation for the components described in Section 4 and illustrated in the schematics and assembly drawings.

PART NUMBER: This column specifies the Moore Industries assigned part number. This is the part identification required when ordering parts from Moore Industries.

SPARE: The numeral in this column specifies the recommended number of component spares per unit type that should be kept on hand by maintenance personnel.

6.2 GLOSSARY OF ABBREVIATIONS

C	Capacitor
CR	Diode—Zener included
HW	Special hardware
J	Connecting buss wire
L	Inductor
LB	Label
PC	Printed circuit board
R	Resistor
T	Transformer
IC	Integrated circuit
Q	Transistor
LED	Light emitting diode
TB	Terminal block
VS	Voltage regulating varistor
VR	Voltage Regulator

RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –
   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –
   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

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