



INSTRUCTION MANUAL

PTT

Potentiometer Transmitter

Form 150-701-00C

July 1988

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual contains operating and maintenance information on the Potentiometer Transmitter (PTT), 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 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. The section also lists the various procedures required for calibration of the units in any configuration.

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 as well as defines the electrical connections for each unit regardless of physical modifications. A brief outline of periodic observations required during the equipment operation is also included here.

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 element, 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.

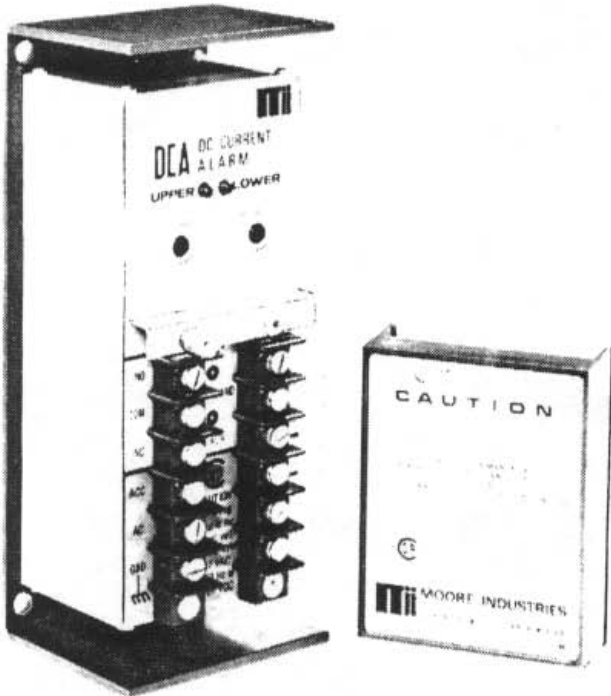
1.2 EQUIPMENT DESCRIPTION

The Potentiometer Transmitter (PTT) is used in process control systems to convert the signal from a potentiometer sensing element into a current or voltage output signal of a higher level. The transmitter also provides isolation between a floating input and a grounded-common output (or vice versa).

1.3 PHYSICAL DESCRIPTION

The standard unit usually consists of a single printed-circuit board (PC1) on which most electronic components are mounted. An additional board (PC2) is mounted on PC1. This board provides the circuits necessary to generate the external potentiometer excitation power.

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. Electrical connections information are given in Section 3, Installation and Operation.



Standard (STD) 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 is cut with two mounting holes to accommodate 1/2-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 each, for ease of mounting.



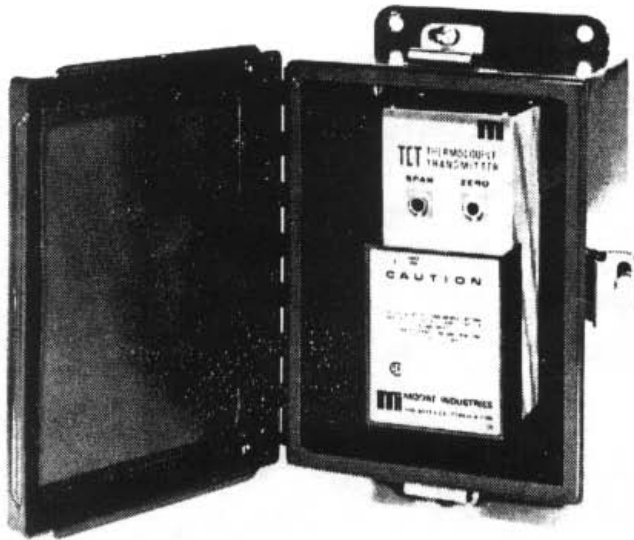
Unit with Angle Bracket (AB) Option

1.3.3 NEMA Boxes Options Description

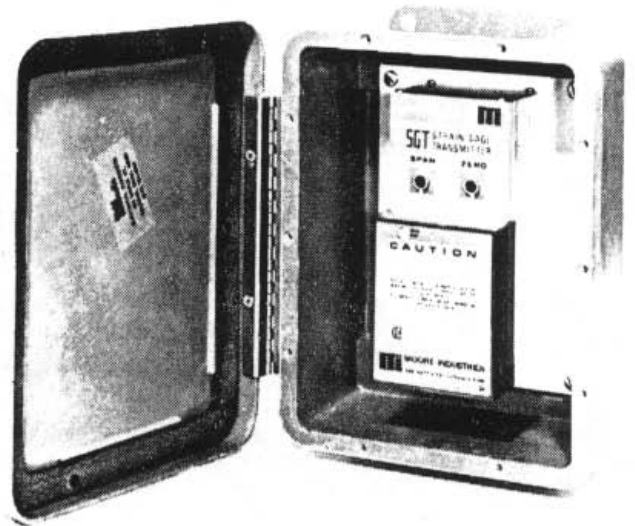
Units equipped with angle brackets (AB) option may be enclosed in NEMA boxes to ensure protection against harsh environments that may be damaging to the unit. Four configurations are available for this purpose.

Oil Tight (OT) NEMA Box Option. This enclosure consists of a NEMA12 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. Suggested fittings are "Myer's Scrutite." 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 construction 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.



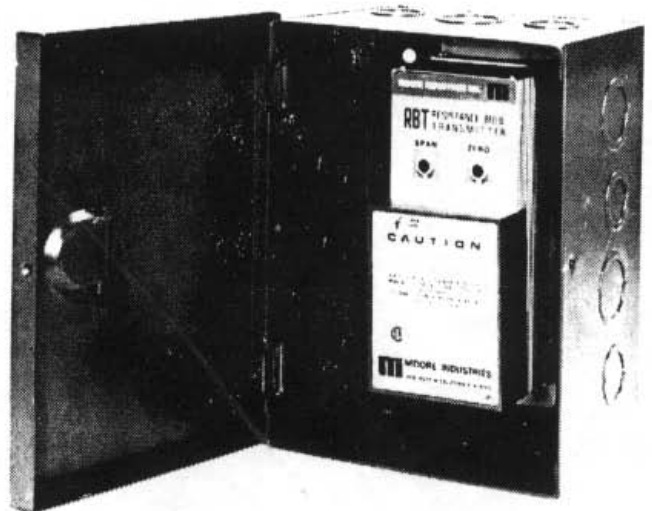
Unit in Water Tight (WT) Enclosure



Corrosion Resistant Fiber Glass (FG) 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.

General Purpose (GP) Options Enclosures. This enclosure consists of a general purpose steel construction box with knock-outs for various size electrical conduits ($\frac{1}{2}$, $\frac{3}{4}$, or 1 inch). The cover is hinged and spring locked. Units are secured into the enclosure on four studs and four 10-32 nuts. The complete enclosure can be secured through four mounting holes provided on the box back cover.



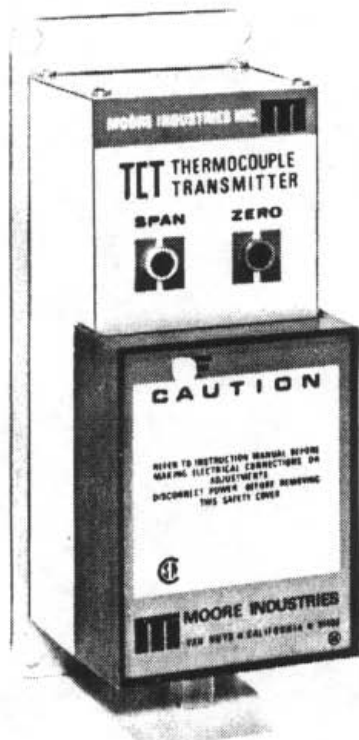
General Purpose (GP) Enclosure

1.3.4 RAA and RAT Options Description

These options consist of special mounting hardware attached to MOORE units to replace obsolete instrumentation of other manufacturers.



Replacement Mounting (RAA) Option

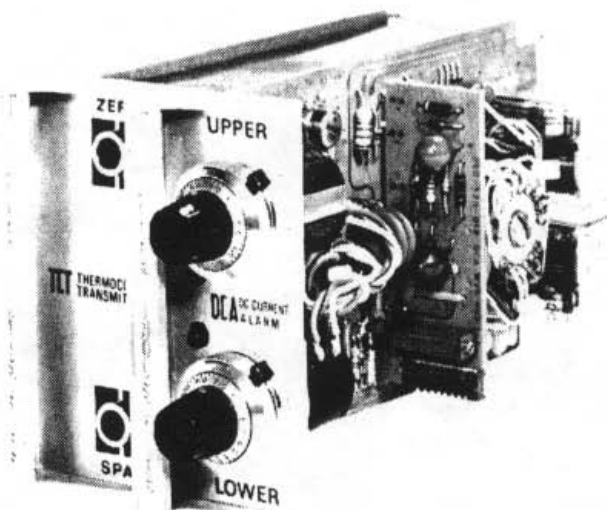


Replacement Mounting (RAT) Option

1.3.5 Plug-In (PC) Units Description

The plug-in unit is electrically similar to the standard unit. As in the standard unit, the additional PC board (PC2) is mounted piggy-back on the main board, PC1, and provides the power necessary to excite the external potentiometer.

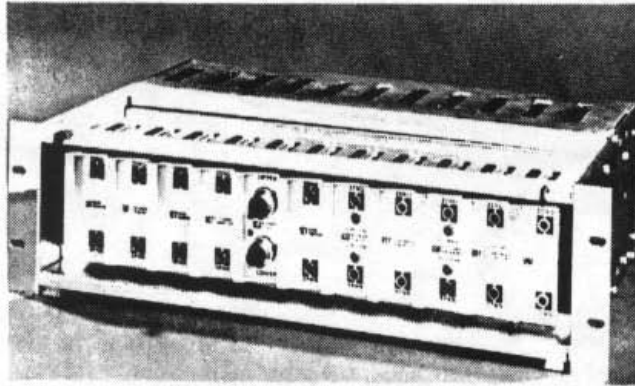
The printed circuit board is keyed to identify the unit and ensure proper connection mating. The other end of the main board is fastened to a display panel that allows external access to the various controls for the unit. A removable plastic safety cover protects the printed circuit board and components 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. Several mounting options are available for the plug-in unit.



Plug-In (PC) Unit

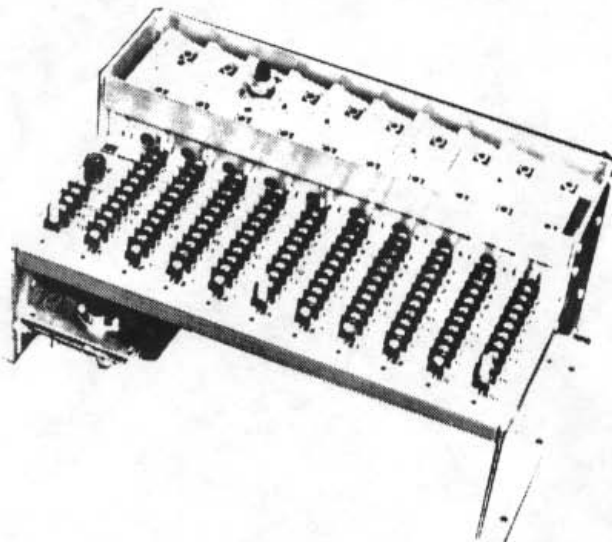
Rack Mounted (RMR) Card Racks. These enclosures are designed to flush-mount in standard 19 and 24-inch relay racks. The enclosures are provided with standard EIA hole patterns. Eleven and fifteen position RMR racks are available. These are pre-wired from the module PC connector to the screw-type barrier 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 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.



Card Rack Enclosure for Relay Racks (RMR)

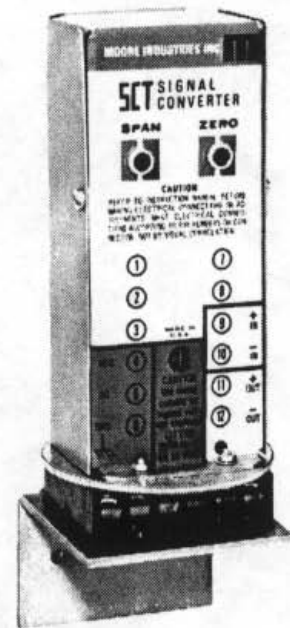
Surface Mounted (SMR) Card Rack. These rack enclosures are designed to accommodate as few as five and up to 15 modules. Mounting flanges are located in the rear of the side panel which allows for surface mounting or for NEMA box mounting. These enclosures are electrically identical in construction to 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)

1.3.6 Standard Plug-In Transmitter (PST) Options

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 pre-drilled 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 (PST)

1.3.7 Explosion Proof (EX) Option

The explosion-proof enclosure option consists of a PST option unit described in paragraph 1.3.6 enclosed into a two-piece cast aluminum alloy enclosure. The two pieces consist of a screw-type

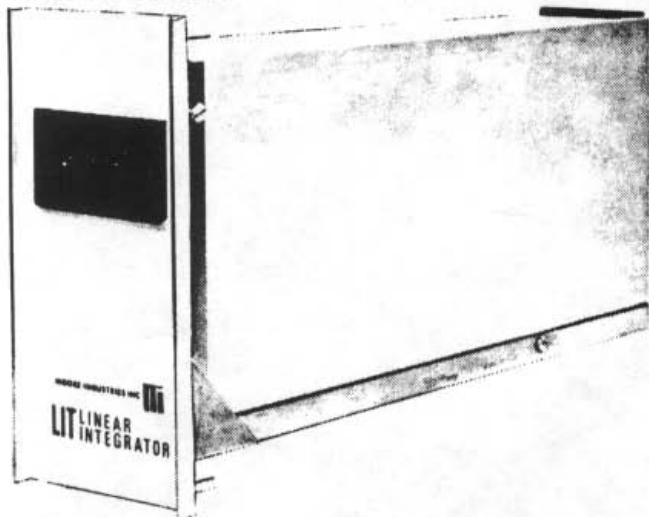
cover and a connector housing. When the cover is removed, the PST type unit is easily accessible. With the PST unit unplugged, the terminal block is clearly visible and connections are made with ease. No mounting bracket is used on the terminal block as with the PST option. Instead, the terminal block is secured flush with the bottom of the housing. Electrical conduit hubs are provided for external electrical wiring through electrical conduits. Several configurations of conduit inputs are available. Refer to Section 3 for detailed description of conduit configurations.



Explosion Proof Housing

1.3.8 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 blank 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 1/2-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. PT units have the model number on top of the transmitter case. 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 box 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 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

INPUT:

Potentiometer, standard 3-wire 0-100 ohm thru 0-10,000 ohm range

Higher ranges on special order

For 2-wire (slide wire) input, see Model RBT

Input Impedance: 10 megohm minimum

FRONT PANEL ADJUSTMENTS: Adjustable with multi-turn potentiometer

Span: Output fully adjustable over a preselected input range to 100% of selected output span

Zero: With minimum input, adjusts output to 0% \pm 10% of selected output span

OUTPUT: Operational amplifier feedback current source; output limited to 150% of maximum output range 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: 1-5V DC standard into 20K ohms minimum

Ripple: 10 mV P/P at maximum span and maximum load resistance

Load Effect: \pm 0.01% of span from 0 to maximum load resistance (current output)

PERFORMANCE:

Calibration Capability: \pm 0.1% of span (linearity and repeatability)

Ambient Temperature:

Range: -20°F to $+180^{\circ}\text{F}$ (-29°C to 82°C)

Effect: \pm 0.005%/ $^{\circ}\text{F}$ over above range

Frequency Response: 5 Hz (3-dB point)

Isolation: Input, output, and power input are transformer isolated with no DC connections between them. Both AC and DC powered units have this as standard. Common mode rejection exceeds 120 dB at 60 Hz with a limit of 500 volts rms.

POWER INPUT:

24V DC, 45V DC, \pm 10% standard

117V AC, 240V AC, 50/60 Hz, \pm 10% optional

5 watts nominal

Line Voltage Effect: AC or DC: \pm 0.005%/1% line change

CERTIFICATION: Canadian Standards Association

WEIGHT: Approximately 2 lbs. (908 grams)

TABLE 1-2. MODEL NUMBER EXAMPLE

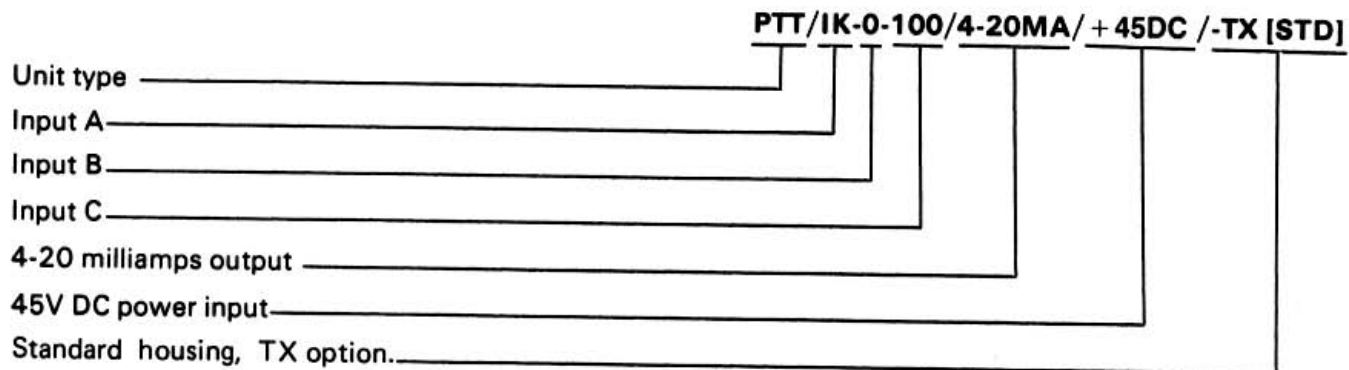


TABLE 1-3. PTT ELECTRICAL OPTIONS

OPTION DESCRIPTION	CODE
Power selection of 117V AC or 24V DC (not available with PC housing)	EO
Power fuse on plug-in transmitter card (PC housing), 400 mA rating	FU
High-current voltage (20 mA) 1-5V DC output	HI
RFI Filter Terminal Assembly — adds Moore Industries patented integral filter terminal assembly which prevents radio frequency energy from entering standard aluminum case	RF
Selectable output current	SC
Upscale open input drive	UD

CALIBRATION

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 of units is 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.

CAUTION

SCREWDRIVER BLADE MUST NOT BE 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

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
Resistance Box	Must be accurate to within $\pm 0.05\%$ or better	Simulates resistance input
DC Voltmeter	Must be accurate to within $\pm 0.05\%$ or better	Output signal monitoring (voltage signals only)
DC Milliammeter	Must be accurate to within $\pm 0.05\%$ or better	Output signal monitoring (current signals only)

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. Figures 2-1 and 2-2 show the general test setup configuration. Connection nomenclature refer to terminal markings on the standard units with CP, AB, RAA/RAT, PM, and NEMA boxes mechanical options.

2.4.2 Plug-In Units Test Equipment Setup

Plug-in units 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

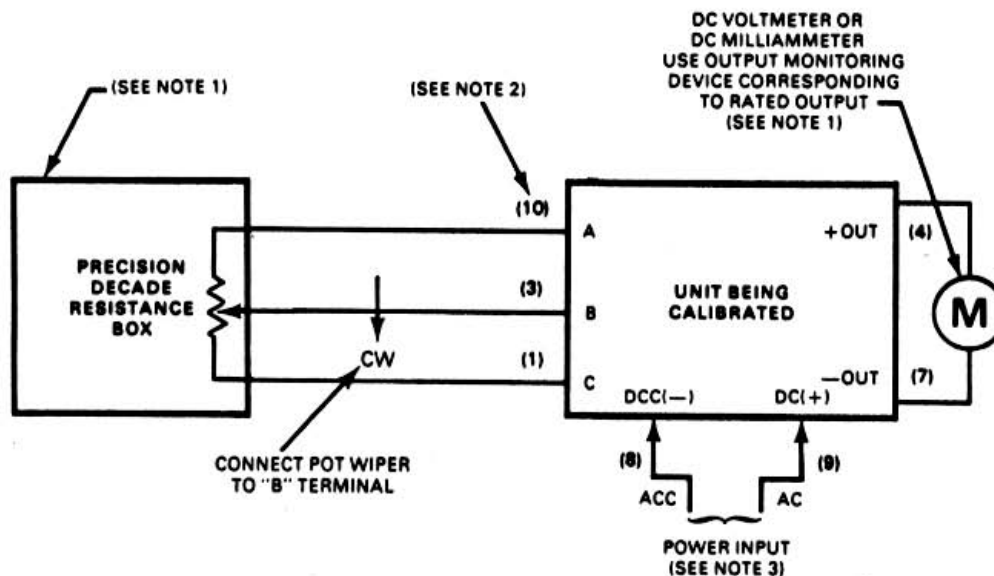
a rack also use the test setup shown in Figure 2-1 with card rack terminal connections identified by numbers in parentheses. These include either the rack mount (RMR) or the surface mounted (SMR).

2.4.3 Explosion-Proof (EX) and PST Option Test Setup

Figure 2-2 shows the general test setup configuration for an explosion-proof enclosure or a PST option. Note that in the explosion proof configuration the protective housing must be opened and the unit removed to expose the connection block. Similarly, units with the PST configuration must be unplugged from the connection block in order to access the connections more effectively. Numbers in parentheses refer to terminal block numbers.

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.



NOTES:

1. INPUT AND OUTPUT MONITORING DEVICES MUST HAVE AN ACCURACY RATING OF $\pm 0.05\%$.
2. NUMBERS IN PARENTHESIS REPRESENT PIN ASSIGNMENTS FOR PLUG-IN UNITS ONLY.
3. EITHER AC OR DC POWER CAN BE SUPPLIED, BUT NOT BOTH.

Figure 2-1. Calibration Setup For Plug-In Units

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.

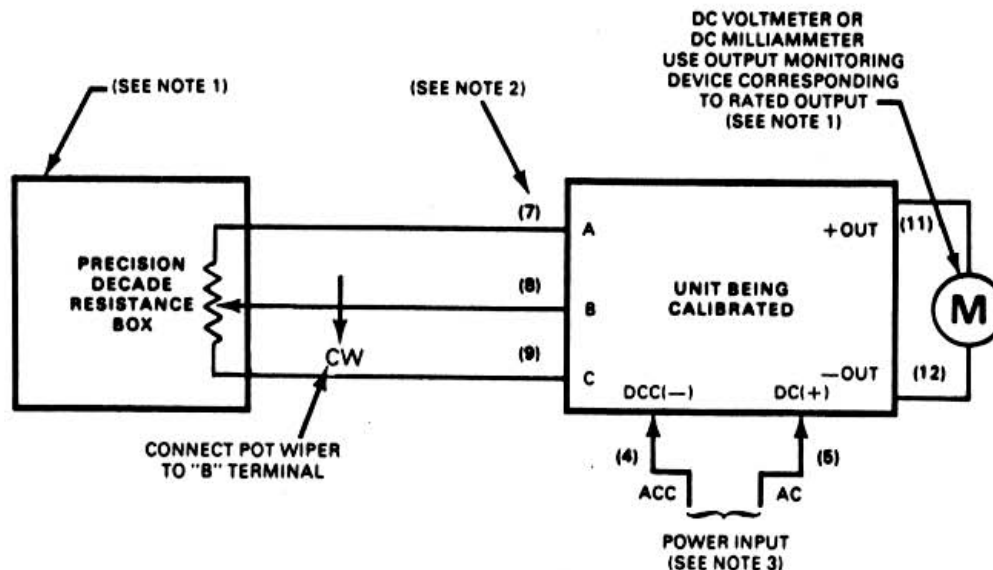
A precision potentiometer and an output monitoring device are required for calibration. The output monitoring device must have an accuracy within 0.05% or better. To calibrate a unit, proceed as follows:

- a. Connect unit and test equipment as shown in Figure 2-1 or 2-2.
- b. Make sure the precision potentiometer is adjusted near zero resistance. Apply power input to the unit.

NOTE

Refer to paragraph 1.6 for information on how to use the model number to obtain the specified values of minimum and maximum inputs and outputs.

- c. Adjust the precision potentiometer to zero resistance.
- d. Adjust the ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1V DC, or whatever the 0% output is) with the precision potentiometer adjusted as in step (c).
- e. Adjust precision potentiometer to the maximum resistance specified for the potentiometer with which the unit is to be used.
- f. Adjust the SPAN potentiometer to obtain 100% output with the precision potentiometer adjusted as in step (e).
- g. Repeat steps (c) through (f) until no further adjustment of either the ZERO or SPAN potentiometer is required.
- h. Adjust the precision potentiometer to 25%, 50%, and 75% of the maximum resistance and check that the output is linearly proportional (within $\pm 0.1\%$ of the output span).
- i. After step (h) has been successfully completed, return the precision potentiometer to zero resistance and then turn off the power input to the unit.



NOTES:

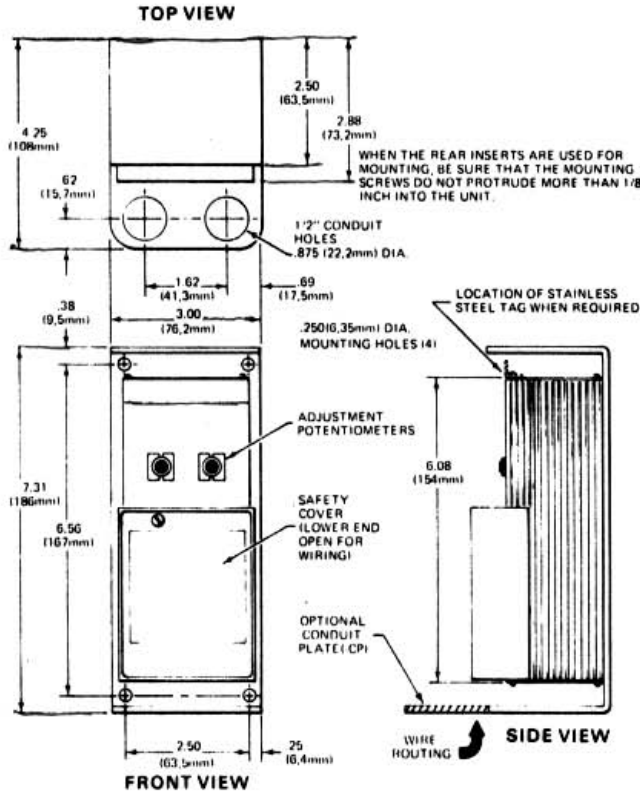
1. INPUT AND OUTPUT MONITORING DEVICES MUST HAVE AN ACCURACY RATING OF $\pm 0.05\%$.
2. NUMBERS IN PARENTHESIS REPRESENT PIN ASSIGNMENTS FOR STANDARD UNITS ONLY.
3. EITHER AC OR DC POWER CAN BE SUPPLIED, BUT NOT BOTH.

Figure 2-2. Calibration Setup For Standard Units

INSTALLATION AND OPERATION

3.1 MECHANICAL INSTALLATION

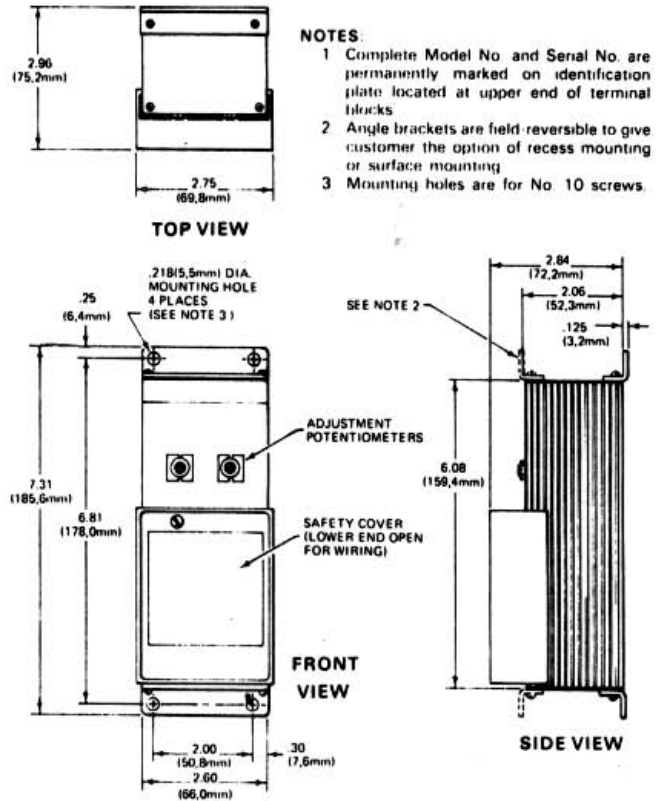
Units may be obtained in various physical configurations. Figures 3-1 through 3-10 show the outline dimensions and other installation requirements for the available configurations. Select the proper outline and dimension figure applicable to the unit purchased. Be sure to observe the applicable special 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

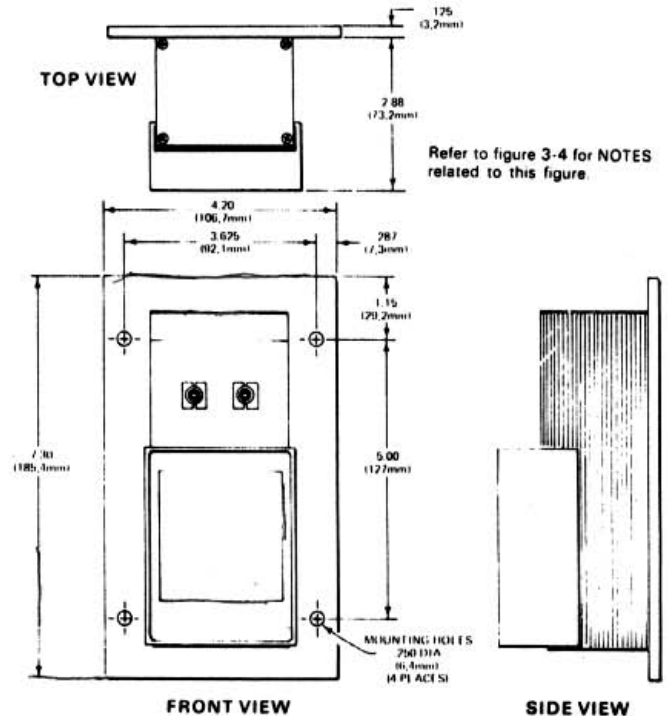
Figure 3-1. Standard Unit and Unit with CP Option, Outline and Dimension



NOTES:

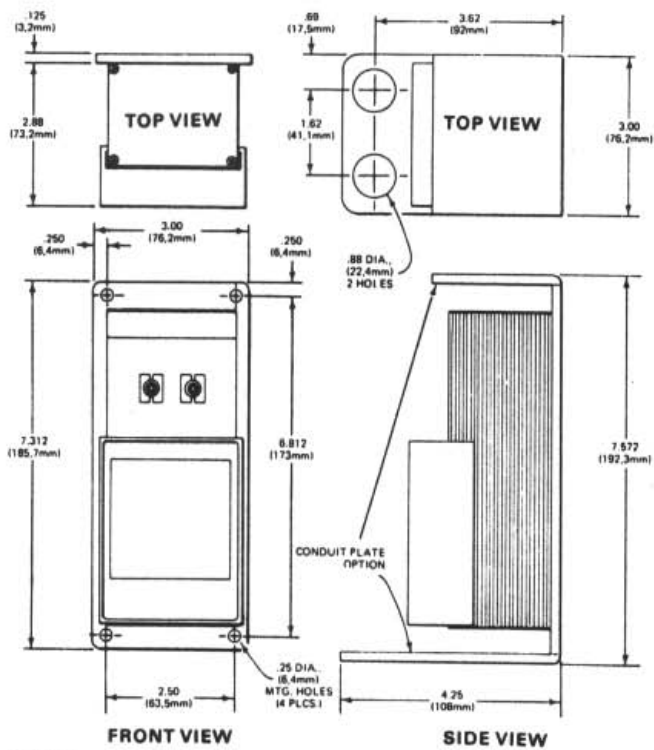
- 1 Complete Model No and Serial No are permanently marked on identification plate located at upper end of terminal blocks
- 2 Angle brackets are field reversible to give customer the option of recess mounting or surface mounting
- 3 Mounting holes are for No. 10 screws.

Figure 3-2. Standard Unit with Angle Brackets (AB) Option, Outline and Dimensions



Refer to figure 3-4 for NOTES related to this figure.

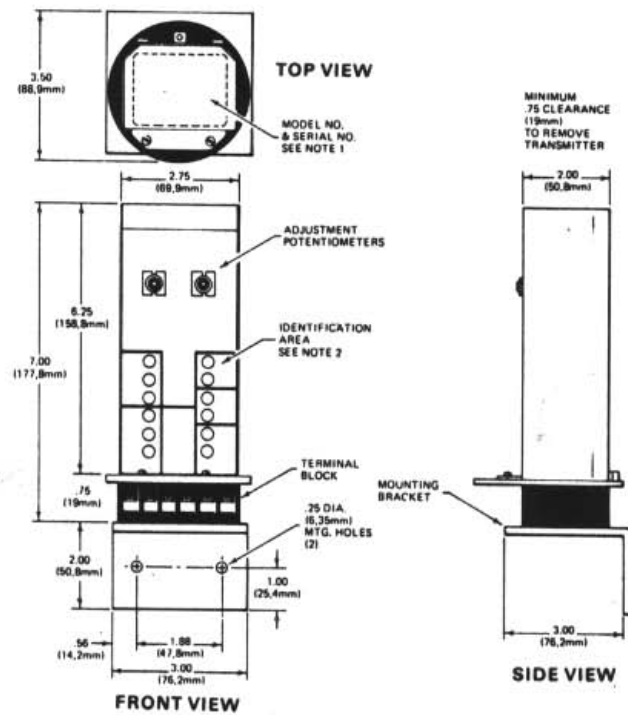
Figure 3-3. Standard Unit, With Adapter Plate (RAA) Option, Outline and Dimensions



NOTES:

1. Use two threaded inserts (located 4.00 inches apart on back of standard transmitter) for mounting adapter plate to transmitter. Use 6-32 NC machine screws.
2. Unit to adapter plate mounting screws should not protrude more than 1/8" into the unit.

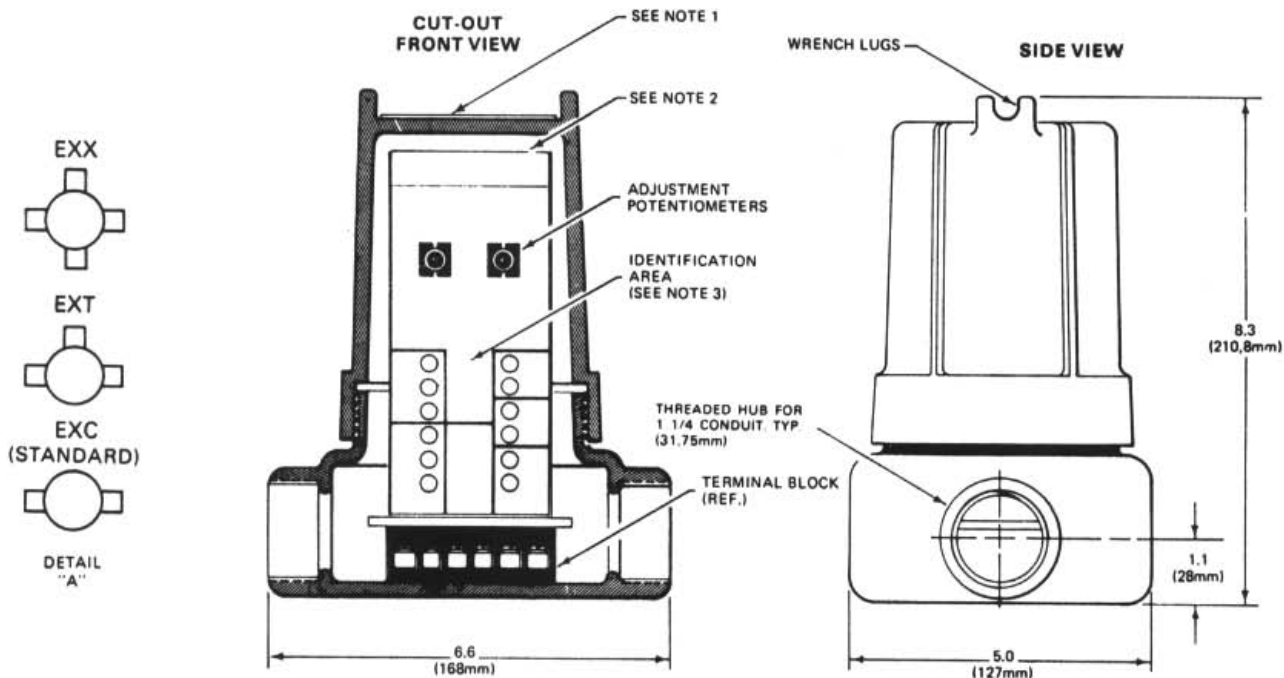
Figure 3-4. Standard Unit, With Adapter Plate (RAT) Option, Outline and Dimensions



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 3-5. Standard Unit With Plug-In STD Transmitter (PST) 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. Standard "EXC" 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 3-6. Standard Unit in Explosion-Proof Enclosure, Outline and Dimensions

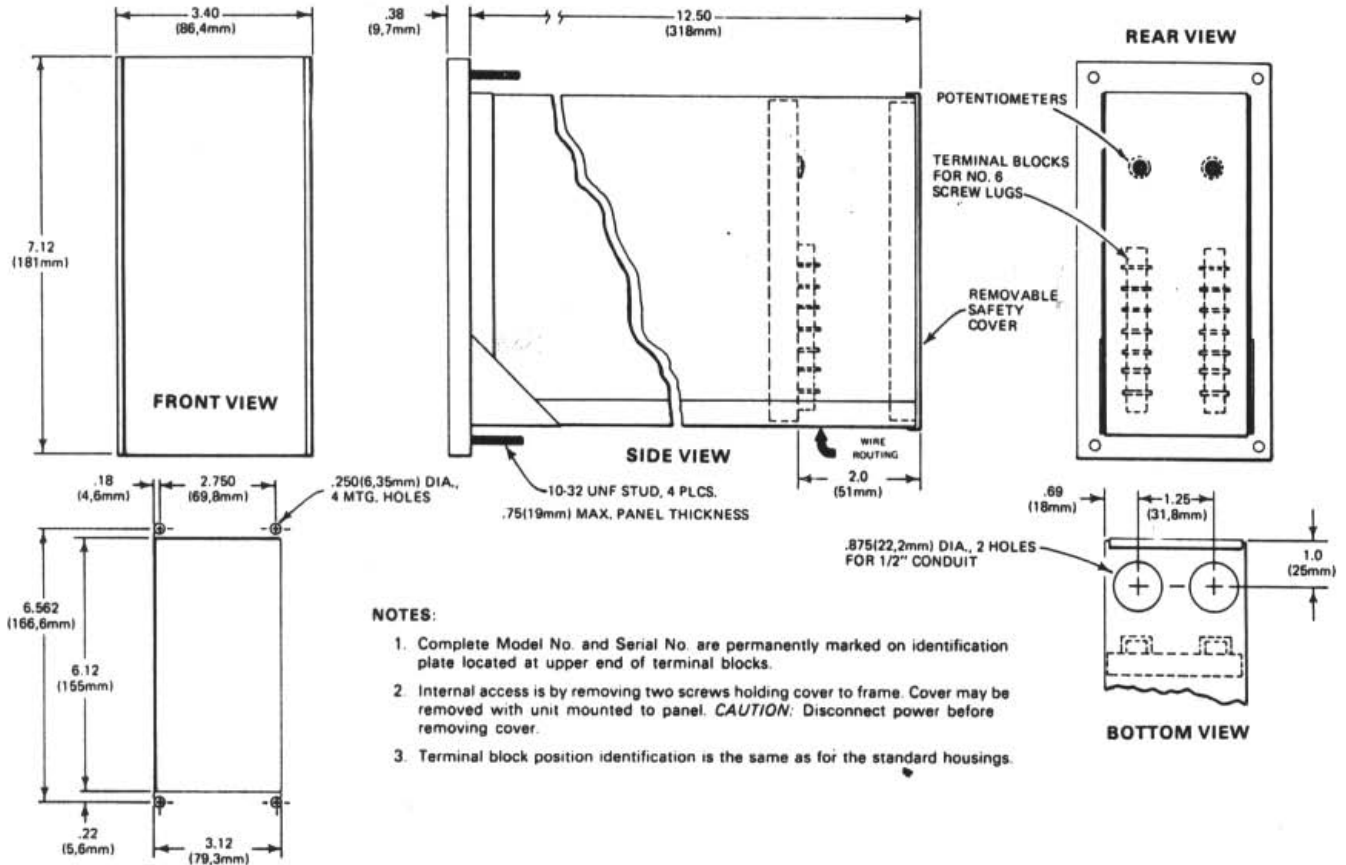


Figure 3-7. Standard Unit with Panel Mount Enclosure (PM) Option, Outline and Dimensions

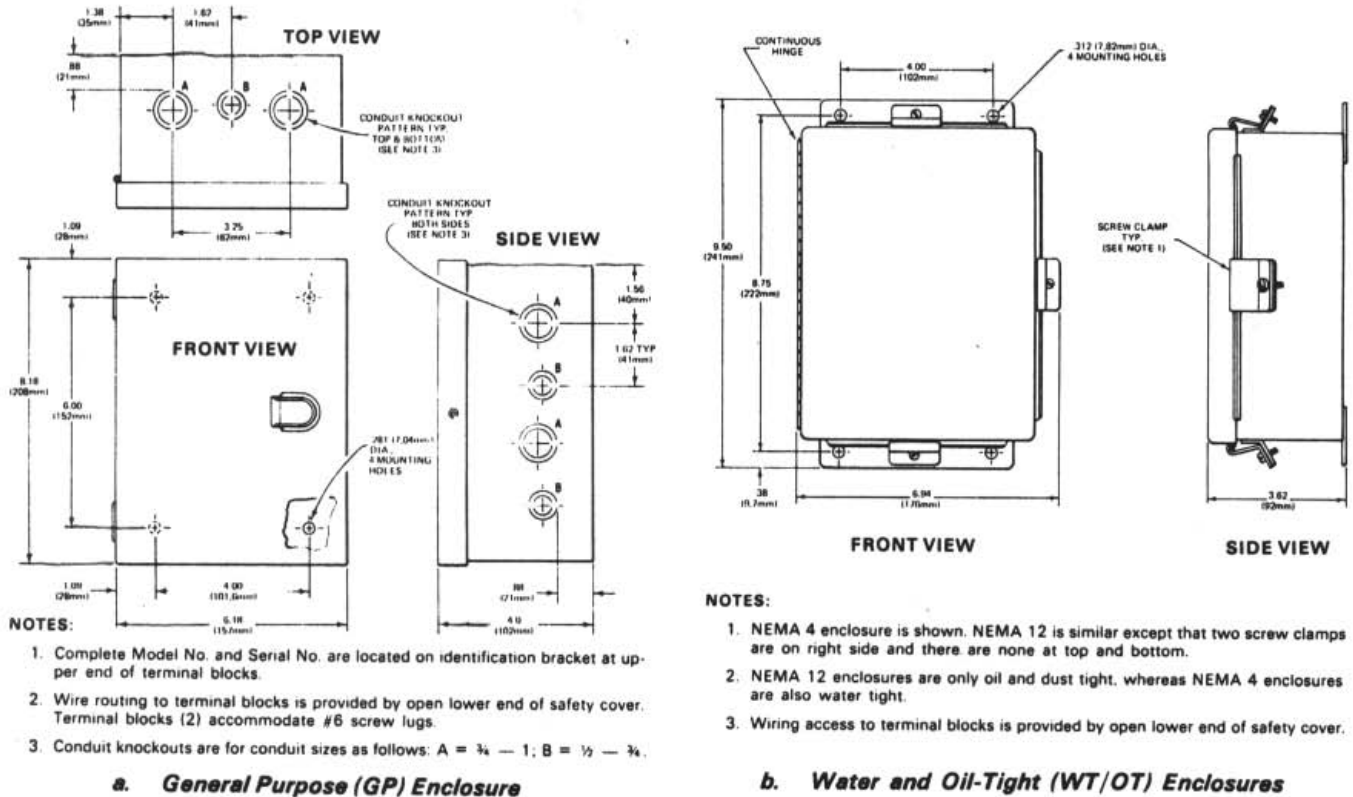
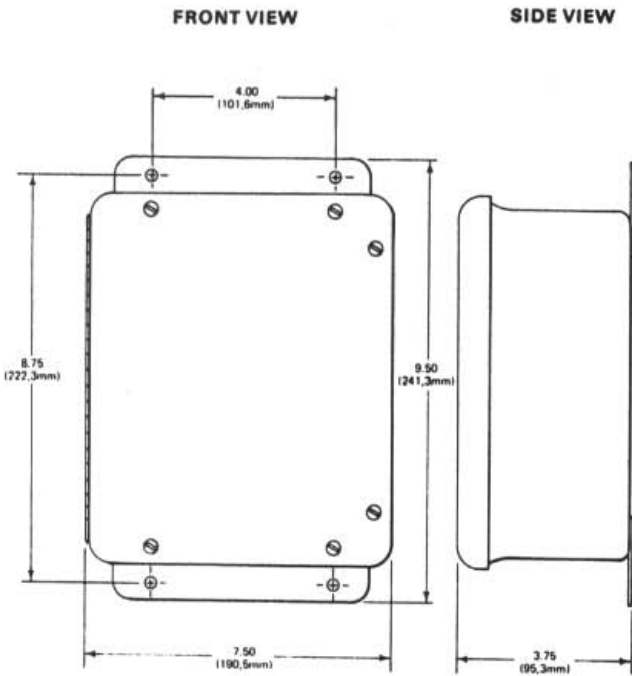


Figure 3-8. Standard Unit in NEMA Boxes, Outline and Dimensions

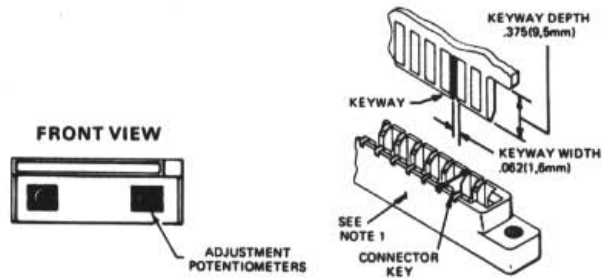


NOTES:

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

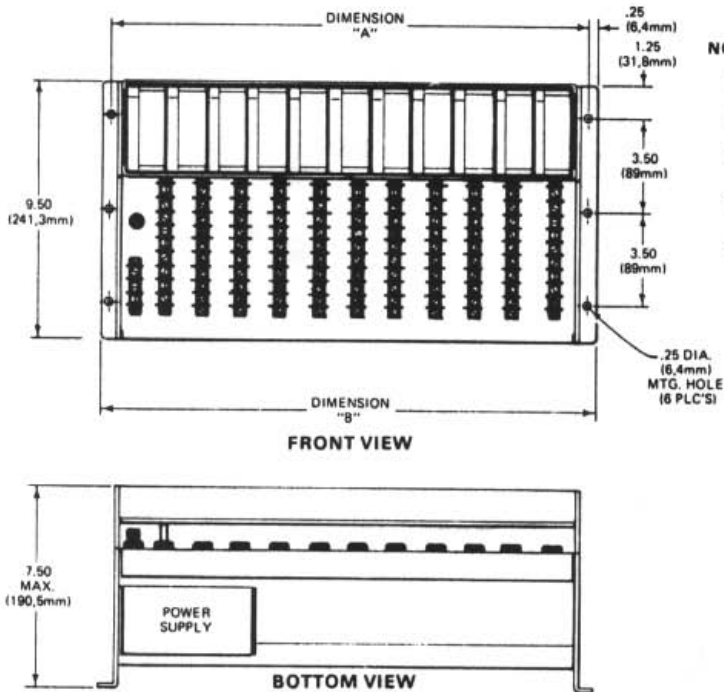
Figure 3-8. Standard Unit in NEMA Boxes, Outline and Dimensions (Cont.)



NOTES:

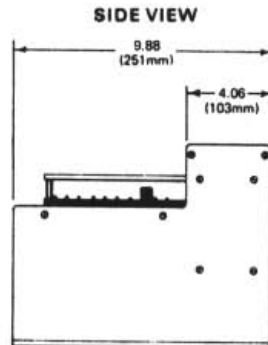
1. Connectors used must have contacts on .156 (3.96mm) centers, with contacts for both surfaces of board (recommended type: Viking part no. 2VK155/1-2).
2. Maximum card insertion depth in connector is .350 (8.89mm).
3. Minimum width of connector insertion slot is 2.470 (62.70mm).
4. Removable plastic 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 3-9. Plug-In Unit, Outline and Dimensions



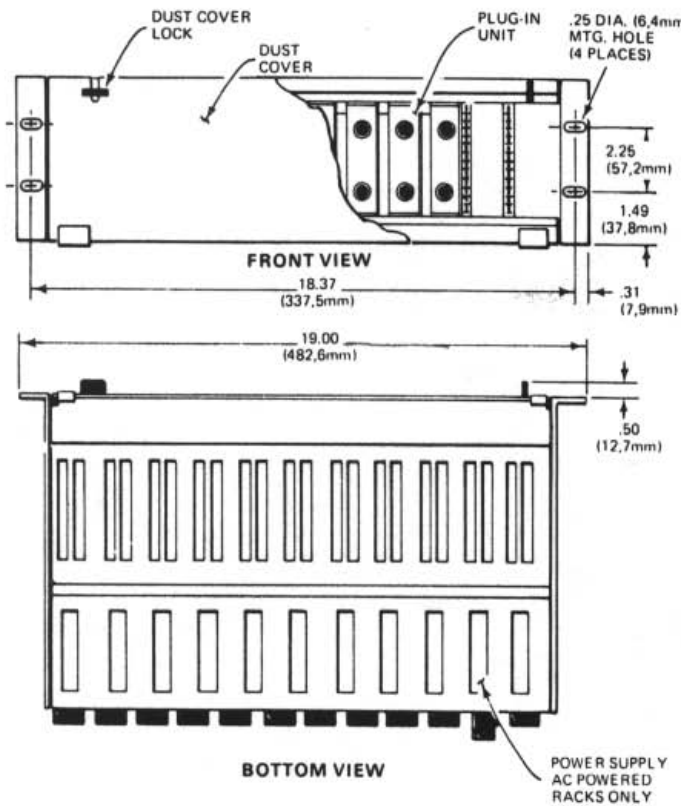
NOTES:

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 \pm 10%, 50/60 Hz, approximately 40 watts.



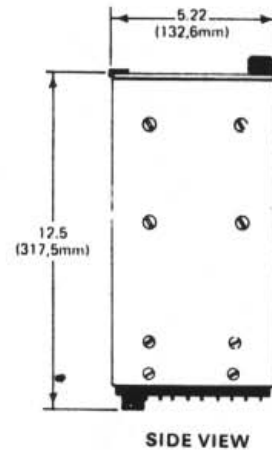
NUMBER OF POSITIONS	DIMENSION			
	A	mm	B	mm
5	9.19	233.4	9.69	246.1
6	10.62	269.7	11.12	282.4
7	12.06	306.3	12.56	319
8	13.50	342.9	14.00	355.6
9	14.94	379.5	15.44	392.2
10	16.38	416	16.88	428.8
11	17.81	452.4	18.31	465
12	19.25	489	19.75	501.7
13	20.69	525.5	21.19	538.2
14	22.12	561.8	22.62	574.5
15	23.56	598.4	24.06	611.1

Figure 3-10. Surface Mounted Card Racks (SMR), Outline and Dimensions

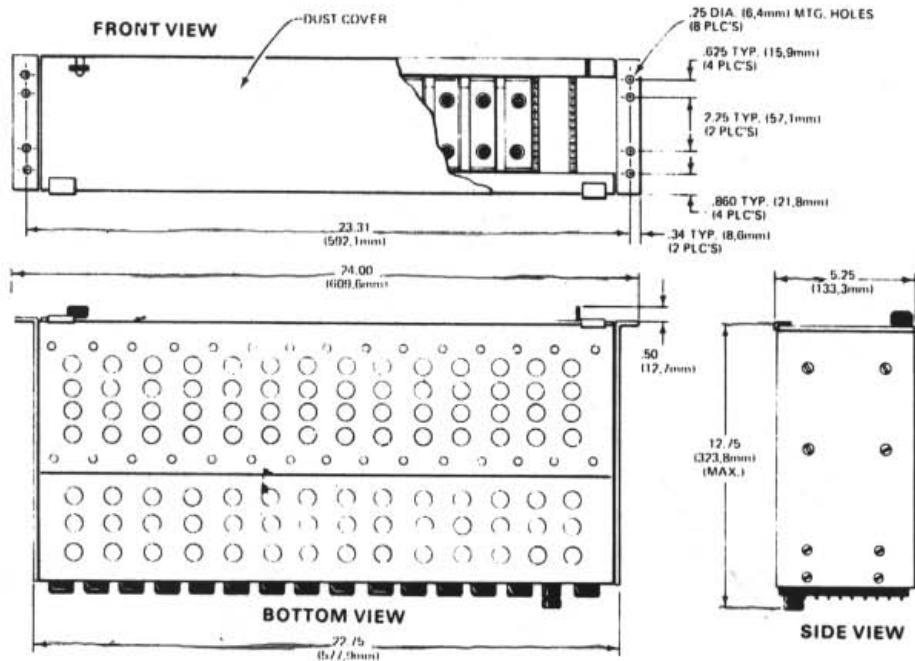


NOTES:

- 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 \pm 10% 50/60 Hz approximately 40 watts



a. Eleven-Position Card Rack



b. Fifteen-Position Card Rack

Figure 3-11. 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 units 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 3-12 illustrates the

terminal strip locations and identification for the standard units and the terminal block identifications for the explosion proof and PST configurations. Table 3-1 provides the complete labeling nomenclature for standard unit and any available electrical options. Terminal labeling appears next to the terminal it identifies on standard units. For PST and explosion proof units, terminal labeling is marked on the front of the unit housing with the referenced terminals identified numerically.

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 1/2-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 con-

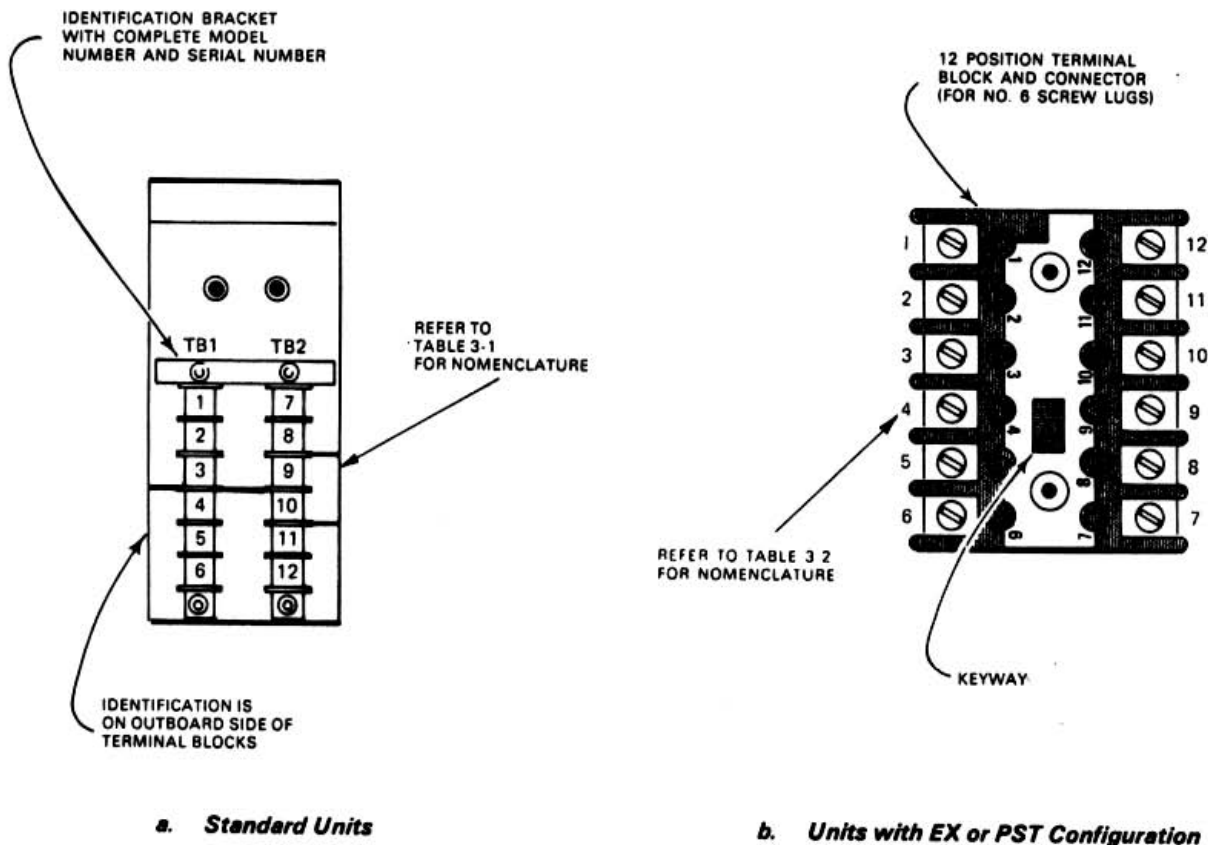


Figure 3-12. Terminal Strips and Terminal Blocks Identification

TABLE 3-1. TERMINAL PIN ASSIGNMENTS FOR STANDARD UNITS

Options*	Terminals (see figure 3-12)											
	1	2	3	4	5	6	7	8	9	10	11	12
DC POWER				DCC	DC	GND	A	B	C		+OUT	-OUT
AC POWER				ACC	AC	GND	A	B	C		+OUT	-OUT
SC (Output)		SC	SC									

* Combinations of options may cause labeling positions to change, but terminal designations will be as shown here.

Legend: DC = +DC Power Input GND = Chassis Ground
DCC = DC Return A,B,C = Signal Input
AC = AC Power Input ±OUT = Signal Output
ACC = AC Return SC = Selectable Current Resistor

duit 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 3-13 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.

3.2.2 Power Connections

Units are designed to operate from either a DC or AC power source. Refer to paragraph 1.6 for information on how to use the model number to determine the type of power required.

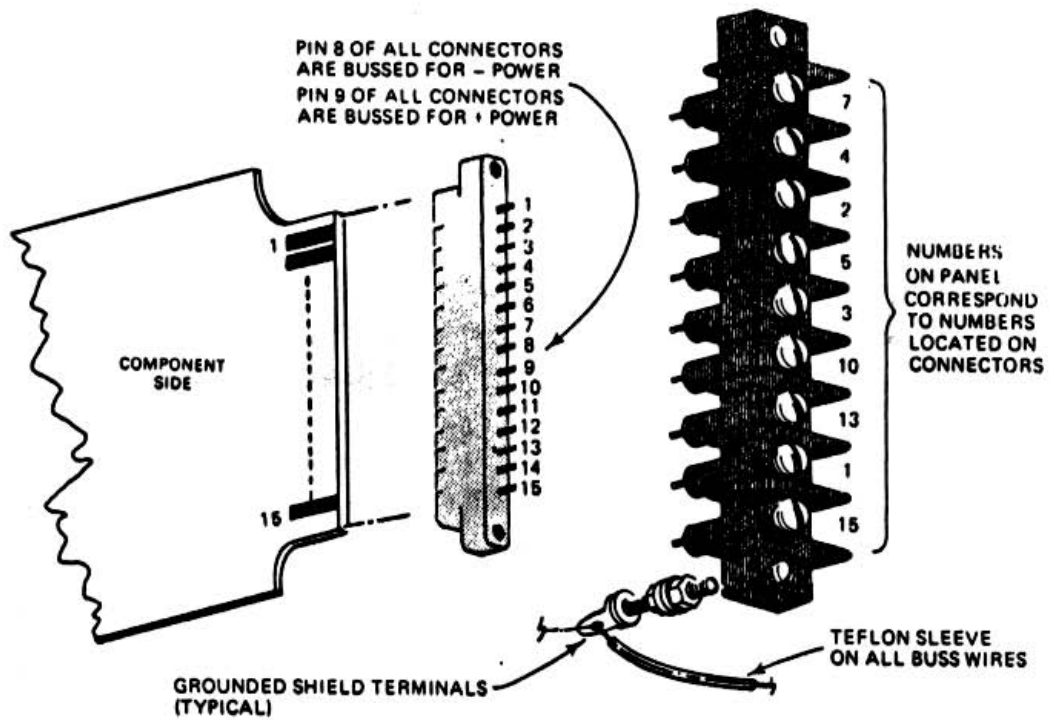


Figure 3-13. Plug-In Connectors and Terminal Strips Wiring and Identification

TABLE 3-2. CONNECTOR PIN ASSIGNMENTS FOR PLUG-IN UNITS

Options	Connector Pins (see figure 3-13)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DC POWER	C		B	+OUT			-OUT	DCC	DC	A					
AC POWER	C		B	+OUT			-OUT	ACC	AC	A					
SC (Output)		SC			SC										

Legend:

DC = +DC Power Input
DCC = DC Return
AC = AC Power Input
ACC = AC Return

GND = Chassis Ground
A,B,C = Signal Input
±OUT = Signal Output
SC = Selectable Current Resistor

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 $\pm 10\%$ of the nominal voltage and should be capable of delivering 5 watts.

AC-Powered Units. These units require 117 volts AC $\pm 10\%$, 50/60 Hz at 5 VA of nominal power or 220 or 240V A C optionally. The AC terminal should be connected to the ungrounded or "hot" side of the supply, if possible, 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 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.

THEORY OF OPERATION

4.1 INTRODUCTION

This section describes the unit operation. An overall view of the unit function based on the block diagram of Figure 4-1 introduces the user to the unit functional elements. This functional analysis is further detailed in the circuit description paragraphs that follow. Each of these paragraphs also contains a detailed description of the circuit operation. These descriptions are based on the schematic diagram included in Section 6, Unit Documentation.

A rapid familiarization of the unit can be obtained by reading the general functional description (paragraph 4.2) and the functional section of the circuit description paragraphs entitled "General." The "Detailed" section of these paragraphs provides sufficient data so that troubleshooting, if required, can be performed intelligently and rapidly.

Circuit description is provided for both the plug-in and the standard units. If differences in reference designations exist between the two models the plug-in unit reference designator is shown in italics and parentheses immediately following the standard unit reference designator.

4.2 EQUIPMENT FUNCTIONAL DESCRIPTION

The unit operates by "chopping" the applied DC input signal into an AC signal, using AC coupling to the following stages, and then synchronously demodulating the resulting AC signal to produce a DC output proportional to the input. In this way, complete isolation is obtained between the input and output terminals. High stability is achieved by using operational amplifiers with large amounts of feedback. A variation in the output circuit allows the unit to produce either current or voltage output.

4.3 POWER SUPPLY CIRCUIT DESCRIPTION (Standard Units Only)

General: Units are usually supplied for use with either an AC or DC power input. On units for use with an AC power input, the power supply typically develops a 24-volt DC output that is applied to

the input of the power inverter. On units intended for a DC power input, the power is applied directly to the input of the power inverter, with diode protection to prevent damage to the power inverter components if the DC power input is accidentally connected with reversed polarity.

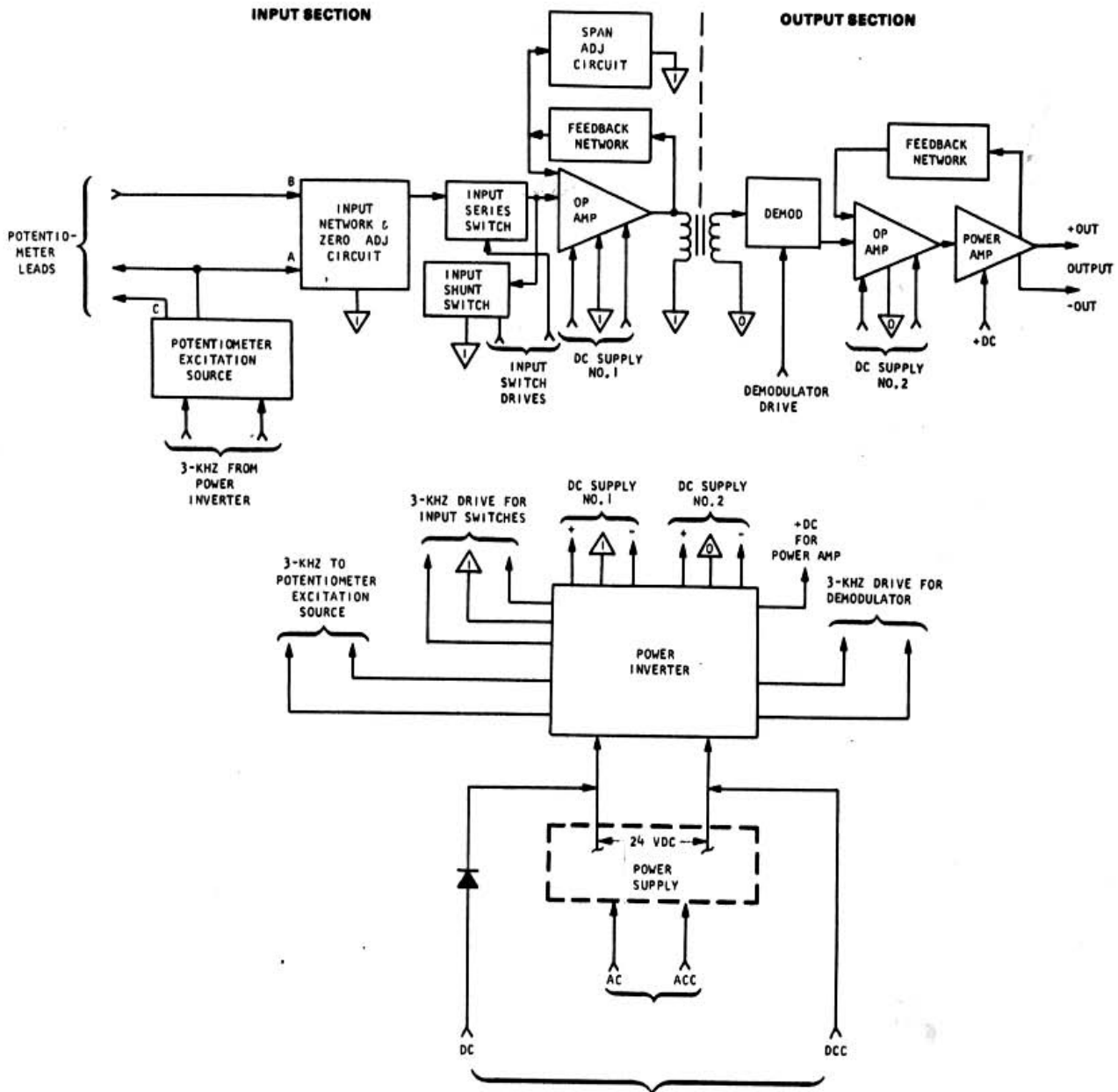
Units with battery backup are normally AC-powered and the DC power source is used only when the AC power source drops below a level that will maintain a 24-volt (or other normal voltage) DC output from the power supply.

Detailed: Units operated from an AC power source use a power supply consisting of a power transformer, rectifier and filter to produce a DC output. Referring to the schematic diagram, VS1 is connected across the primary of power transformer T1 and suppresses transients that may be present on the power line. The output from the series-connected secondaries of T1 are applied to the input of rectifiers and filter circuits. These consist of CR14 and CR19 and are filtered by C15 to produce the proper DC voltage to be applied to the input of the power inverter.

4.4 POWER INVERTER CIRCUIT DESCRIPTION

General: The power inverter produces a number of different AC (square wave) and DC outputs from the DC applied to its input. Four separate square-wave outputs at approximately 3 KHz are developed. These are used as (a) the power source for the potentiometer excitation source, (b) and (c) the drive voltages for the two input switches, and (d) the drive voltage for the demodulator. Two isolated sets of regulated plus and minus DC outputs are also produced and used as operating voltages for the amplifiers in the input section and output section of the unit. The inverter also produces a higher plus DC output as the operating voltage for the power amplifier. A 400 milliamp fuse may be placed in series with the +DC input as illustrated in schematic diagram 146-451-00. This configuration, used in the fuse option (FU), protects the unit from damage where DC voltage may fluctuate enough to cause excessive current drain on the unit.

Detailed: The DC applied to the power inverter input is converted to a square wave of approximate-



NOTE:



1.  INDICATES COMMON FOR INPUT SECTION
2.  INDICATES COMMON FOR OUTPUT SECTION

Figure 4-1. PTT Block Diagram

ly 3 KHz by Q6, Q7, and the primaries of T2, functioning as a DC-to-AC inverter. When the unit is operated from a DC supply, filter L3-C15 prevents the 3-KHz signal from getting back into the external DC source. C102 (C16) minimizes the high-frequency potential difference between the DCC and —OUT terminals. CR51 provides protection against damage from inadvertent application of DC of incorrect polarity. In AC-operated units with battery backup power, the diode serves to switch to the battery backup power if the power supply output falls below its normal value.

The output from the secondaries of T2 are used both as square-wave voltages for driving the input switch and the demodulator and as AC sources that are rectified and filtered to produce isolated DC operating voltages for the unit. The square-wave voltage at points C and D (pins 13 and 8 of T2) are used to drive the input switches and that at point K (pin 14) drives the demodulator. The square waves at points C and K are out of phase with each other. The square wave from points E and F (pins 15 and 12 of T2) is applied to the excitation source for the potentiometer. The voltage across secondary 8-13 of T2 is rectified by two sets of full-wave rectifiers, CR3 and CR5, and CR4 and CR6, to produce positive and negative DC outputs, respectively. These outputs are filtered and regulated by C2-R7 and C3-R9 to provide outputs of +15 and —15 volts, respectively, for the input section of the unit. The voltage across secondary 14-11 of T2 is applied to half-wave rectifier CR9, which produces the minus operating potential for the output section. The voltage across secondary 17-16 of T2 is applied to bridge rectifier CR16, CR17, CR7, and CR18, which produce the plus DC operating voltage for the output section. C9, R3, and CR2 filter and regulate the +15-volt output, and C11, R20, filter and regulate the —15-volt output. In addition, a higher DC output (approximately +38 volts) is taken from the junction of CR7 and CR16 (point J) as operating voltage for the power output stage.

Separate commons, isolated from each other, are used for the DC and square-wave voltages applied to the input and output section, thus providing isolation between the two sections of the unit. C101 (not used in plug-in) and C102 (C16) minimize the high-frequency AC potential

difference between the A terminal, the —OUT terminal, and the DCC terminal of the unit.

4.5 POTENTIOMETER EXCITATION SOURCE CIRCUIT DESCRIPTION

General: The excitation source accepts the 3-KHz voltage from the power inverter and converts it to an adjustable regulated DC voltage. This DC voltage is applied as excitation to the potentiometer.

Detailed: Square-wave voltage from points E and F in the power converter enters PC2 (the second printed-circuit board) at points A and B of that board. Bridge rectifier CR201 through CR204 produces a DC voltage, which is filtered by C201. Integrated circuit IC201, which contains its own reference source, and external pass transistor Q201 regulate the voltage from C201 and apply it through R213 as excitation to the potentiometer. The output at Q201 is also applied to the inverting input, pin 2 of IC201, and a portion of the internal reference voltage at pin 4 is applied to the non-inverting input, pin 3, of IC201 through a voltage divider consisting of R203, potentiometer R201, and R204. Adjustment of R201 determines the voltage fed to pin 3 of IC201, thereby controlling the output of IC201 and the voltage drop across Q201. In this manner, the output from the potentiometer excitation source is regulated. After R201 is adjusted at the factory for a specific regulated output voltage from the potentiometer excitation source, the shaft of R201 is sealed and normally requires no further attention.

4.6 INPUT NETWORK AND ZERO ADJUST CIRCUIT DESCRIPTION

General: When an external floating potentiometer is connected to the A and C terminals, the component completes a bridge network in the PTT that includes the ZERO potentiometer. The bridge is powered by a regulated power supply. The output of the bridge is monitored by the input switches through the wiper of the external potentiometer and referenced input to ground. Thus when the external floating potentiometer is at its lowest setting, the ZERO potentiometer can be adjusted to produce a PTT output equivalent to 0% of output range. Figure 4-2 illustrates these relationships.

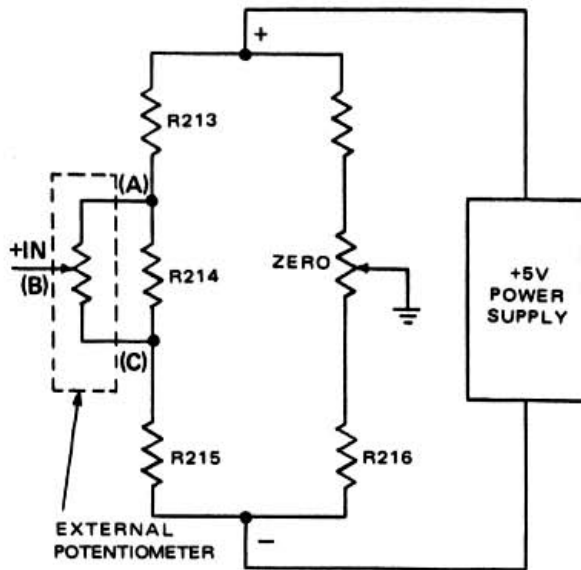


Figure 4-2 Input Network and Zero Adjust Circuits

Detailed: The leg of the input bridge that includes the external potentiometer also includes R213, R214, in parallel with the external potentiometer, and R215. The other leg of the bridge, consists of R28, the ZERO potentiometer, and R216. The bridge output is measured between the wipers of the external and the ZERO potentiometers. The bridge is powered by a 5V DC regulated supply, derived from a 15V AC secondary winding of T2. This signal is received at points A and B of PC2, full-wave rectified by CR201 thru CR204 and regulated by regulator IC201 and pass transistor Q201.

4.7 FUNCTIONAL DESCRIPTION OF INPUT SWITCHES

General: The input switches produce a 3-KHz square-wave output with an amplitude proportional to the input signal applied to the unit. Each switch is operated by a separate 3-KHz square-wave drive signal from the power inverter. During one half of the drive signals, the series switch passes the composite input signal to the input of the next stage (operational amplifier). At the same time, the drive signal applied to the shunt switch causes this switch to act effectively as an open circuit. During the next half-cycle of the drive signals, the series switch opens and the shunt switch acts as a short-circuit to ground. In this manner, the DC input signal is chopped into a proportional 3-KHz signal so AC coupling can be used from this point to the demodulator.

The use of both a series and shunt switch for chopping virtually eliminates any loading of the composite input signal by the circuit following the switches.

Detailed: Two enhancement-mode metal-oxide-semiconductor field-effect transistors (MOSFET's) are used as the input switches. Q5, an n-channel type, is used as the series switch. Q4, also an n-channel type, is used as the shunt switch. The composite signal from the input circuit is applied to the drain of Q5, and out-of-phase square wave signals from the inverter are applied through R27 and R8 as drive signals to the gates of Q5 and Q4. When the square wave applied to Q5 is positive, Q5 conducts and passes the applied signal to C8, while at the same time the negative drive signal to Q4 cuts off this switch. When the drive signal to Q5 becomes negative, Q5 is cut off. Simultaneously, the drive signal to Q4 causes Q4 to conduct, making the left side of C8 drop to zero potential. Thus, C8 is alternately charged to a level proportional to the input signal applied and discharged to zero potential, at approximately a 3-KHz rate. This chopped signal is then applied to operational amplifier IC2.

4.8 CIRCUIT DESCRIPTION OPERATIONAL AMPLIFIER

General: The operational amplifier following the input switches is used to provide gain and a low-impedance source for driving the primary of the isolation transformer between the input and output sections. High stability is achieved through the use of feedback. In addition, the gain of the amplifier is varied by the span adjust circuit to establish the maximum output signal when the maximum specified signal is applied to the input of the unit. The transformer couples the signal from the output of the operational amplifier to the output switch and also completely isolates the input section from the output section of the unit.

Detailed: Integrated circuit IC2, an operational amplifier, is used in the non-inverting mode with the 3-KHz signal from C8 applied to the non-inverting input. The network consisting of R5, C5, the SPAN potentiometer, and R13 causes a portion of the output to be applied to the inverting input. The amount of feedback applied is determined by the adjustment of the SPAN potentiometer, which effectively determines the gain of the amplifier and thus the output from the unit when the maximum specified input signal is applied. Feedback also provides a high degree of stabilization of the amplifier with respect to changes in operating voltages, temperature, and any changes in the characteristics of either the internal elements of the integrated circuit or the associated discrete circuit components. R22 protects IC2 from damage if the output terminals of the unit become short-circuited. The output

from IC2 is applied to the primary of isolation transformer T3. IC2 is operated from the input-section ± 15 -volt supply produced by the power inverter.

4.9 DEMODULATOR CIRCUITS DESCRIPTION

General: The demodulator accepts the 3-KHz signal from the secondary of the transformer and converts it back into a proportional DC level. The power converter provides a 3-KHz demodulator drive signal that is out of phase with the drive signal applied to the series input switch. This phase relationship between the two drive signals satisfies the drive requirements for simultaneous (i.e., synchronous) identical switching action of solid-state devices with opposite-type channels, thereby assuring proper operation of the unit.

Detailed: The demodulator uses a p-channel enhancement-mode MOSFET, Q3. The signal from the secondary of T3 is applied to the drain of Q3, and a 3-KHz square wave from the power inverter (point K) is applied to the gate. Q3 is connected as a series switch with the output charging C12. During the negative portions of the 3-KHz square wave applied to its gate, Q3 conducts and charges C12 to a voltage proportional to the input signal. During the positive portions of the square wave, Q3 is cut off. Because the impedance across C12, represented by the effective input impedance of IC1, is extremely high, C12 discharges a negligible amount between positive excursions of the square wave, and therefore remains charged to a voltage that is essentially proportional to the value of the applied input signal. Because of the high input impedance of Q3, R31 is used to provide the proper load for the secondary of T3.

4.10 OUTPUT AMPLIFIER CIRCUIT DESCRIPTION

General: The output amplifier circuit consists of an operational amplifier and a power amplifier. Feed-

back is used to achieve high stability and a nearly ideal output impedance for the type of output used (i.e., either current or voltage). The operational amplifier operates from \pm DC Supply No. 2, and the power amplifier operates from the higher positive voltage from the power inverter.

Detailed: The output amplifiers consist of integrated circuit IC1, which is used as an operational amplifier, and a power amplifier stage, Q1, Q2. For the 10-50 mA range, an additional driver, Q8 is used. The demodulated signal from Q3 is applied to the non-inverting input. Feedback from the power amplifier is applied to the inverting input and stabilizes the amplifier performance in the same manner as described for IC2 (para. 4.3.6). The resulting voltage gain of IC1 is very nearly unity and, in addition, the output impedance is brought to a value that is suitable for driving the power output stage. R2 is used to protect the IC against damage that might otherwise be caused by excessive output current. IC2 is operated from the output section ± 15 -volt supplies produced by the power inverter.

For the two lower current ranges, the output amplifier consists of Q1 and Q2 connected as a direct-coupled amplifier. R32 and R2 form a voltage divider to limit to a safe value the maximum overload current the output will supply. Current output is taken from the collector of Q2. For a current range of 10-50 mA, Q8 is connected essentially in parallel with Q2 to provide additional current capacity. In units with the SC option on the output, the optional selectable current output resistor replaces R18. For voltage output, only Q2 is used in the output amplifier. Voltage output is taken across R17 and R18, with the junction of the two resistors forming the feedback point. C13 eliminates any high-frequency AC from the output when the voltage-output configuration is used. The power amplifier is operated from the higher positive output (approximately 38 volts) obtained from the same source from which the output-section +15 volts is derived (point J).

MAINTENANCE

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 and Units With AB or CP Options

To disassemble a standard, AB, or CP 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 HEX-head screws at the top of the unit.
- b. Remove the four HEX-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 following 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 PST 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.

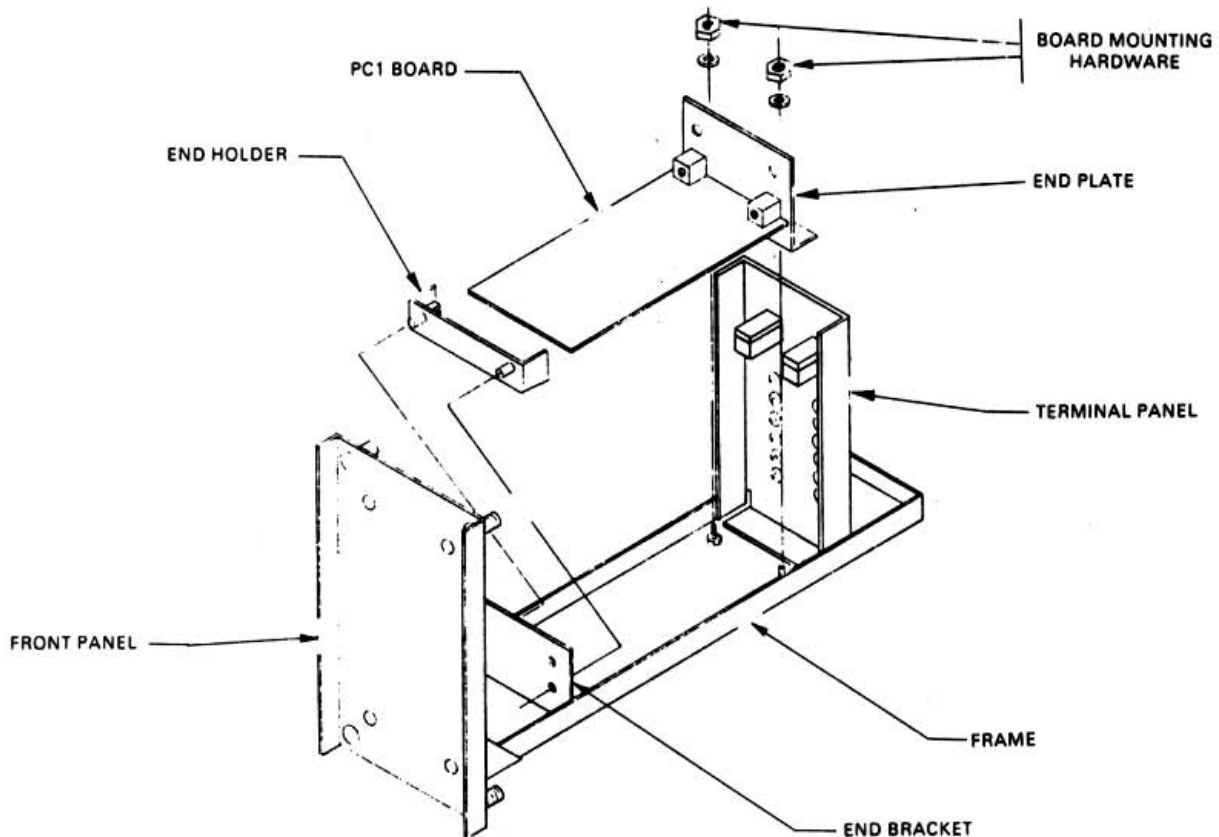


Figure 5-1. Disassembly of PM Units

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.
- 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 com-

ponent 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.

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 ethand 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:

CAUTION

CMOS INTEGRATED CIRCUITS ARE VERY SUSCEPTIBLE TO STATIC ELECTRICITY. WHEN REPLACING THESE COMPONENTS, DO NOT HANDLE LEADS BEFORE SOLDERING INTO BOARD. ENSURE THAT SOLDERING IRON IS GROUNDED. SOLDER INTEGRATED CIRCUITS LEAD V (POWER INPUT) BEFORE SOLDERING G (GROUND CONNECTION).

FAILURE TO TAKE THESE PRECAUTIONS WILL DAMAGE COMPONENTS.

- 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 trichlorethane or equivalent. Be sure adequate ventilation is provided when using this or any other chemical.

NOTE

Unused connections on integrated circuits are left unsoldered to aid in removal. Refer to the assembly drawing for more complete information.

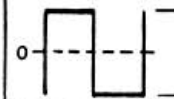






- c. Do not excessively bend or twist the leads of small components; they break easily.
- d. Before removing a component, observe the lead dress. Be sure that the lead dress of the replacement is the same as that of the original.
- e. Handle MOSFETs only by the case; if the fingers are allowed to contact the leads, the MOSFET may be ruined. Be sure to leave the metal sleeve around the leads until just before the device is installed on the printed circuit board.
- f. Remove all flux from soldered joints with trichlorethane or equivalent.

NOTE

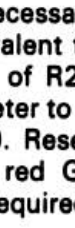
Units that were calibrated at the factory to customer's specifications have protective caps over the SPAN and ZERO potentiometers. These caps must be removed so the unit can be recalibrated. LIFT, DO NOT TWIST, the caps off, using a screwdriver tip as a prying tool. Snap the caps back in place, WITHOUT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

- g. Test the unit for proper operation as follows. Adjust the sealed potentiometer on circuit board PC2 *only* if necessary to obtain the specified voltage.

TABLE 5-1. WAVE FORMS AND VOLTAGES

TEST POINT(S)	WAVEFORM AND AMPLITUDE OR VOLTAGE LEVEL
1	 37V
2	 37V
3	 (Note 1)
4	 1 to 5V (Note 2)
5	 0.4 to 2V (Note 2)
6	 40V
7,8	 0.2 to 1V (Note 2)

→ ≈ 333μs ←

TEST POINT	WAVEFORM	POWER INPUT AND WAVEFORM AMPLITUDE	
		24VDC/117VAC/220VAC	45VDC
9	 A	48V	90V

→ ≈ 333μs ←

NOTES:

- Amplitude varies with pot value and setting. Amplitudes are as follows for *full scale* input (i.e., a 2K ohm pot, set for 2K ohm): 100 ohm pot = 123MV; 500 ohm pot = 201MV; 1K ohm pot = 218MV; 2K ohm pot = 230MV; 5K ohm pot = 236MV.
- Low value of amplitude corresponds to calibrated zero of potentiometer and high value to calibrated full scale setting. *Example:* A 2K pot is used and calibrated to 5 ohms to 1990 ohms. Therefore A = 1V for a 5 ohm input and 5V for a 1990 ohm input.

- The voltage between M(—) and the emitter of Q201(+) on PC2 (see schematic diagram and assembly drawing) should be within ±0.1 volt of 5 volts.

- If necessary, use trichlorethane or equivalent to remove the sealer on the shaft of R201, and adjust this potentiometer to obtain the voltage specified in (1). Reseal the potentiometer shaft with red Glyptal or equivalent when the required voltage is indicated.

- Test, and, if necessary, recalibrate the unit 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.

- h. Check that all leads are clear of the board edge before reinstalling the board into its case.

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

PARTS LISTS

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.

REF: Lists the reference designation for the component, referred to in Section 4, and illustrated on the schematic and assembly drawings.

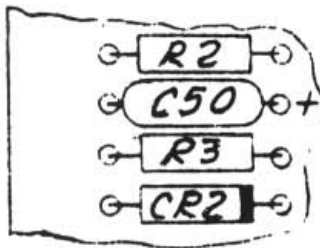
PART NUMBER: This column specifies the Moore Industries assigned part number. This is the part identification required when ordering parts from Moore Industries.

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.

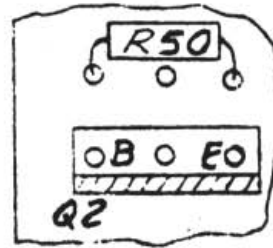
6.2 GLOSSARY OF ABBREVIATIONS

C	Capacitor
CR	Diode — Zener included
HW	Special hardware
J	Connecting buss wire
L	Inductor
LBL	Label
PC	Printed circuit board

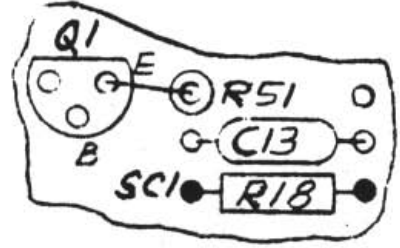
R	Resistor
T	Transformer
IC	Integrated circuit
Q	Transistor
LED	Light emitting diode
TB	Terminal block
VS	Voltage regulating varistor



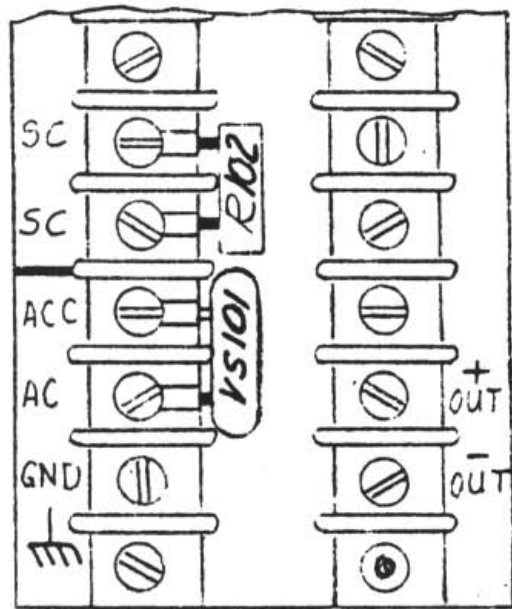
C50



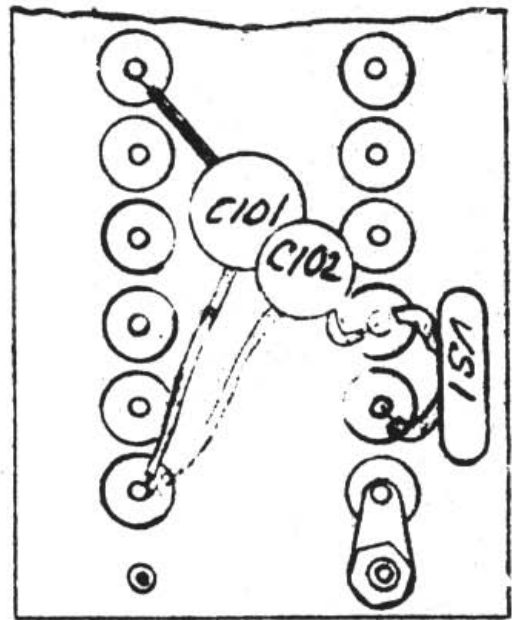
R50



R51



R102 VS101



C101, C102, VS1

SLAVE LEADS
(REAR OF PANEL SHOWN)

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE

TOLS. UNLESS NOTED:
 .X = ± .10
 .XX = ± .020
 .XXX = ± .010
 ANGLES = ± 30'

DO NOT SCALE DRAWING

SCALE: *x*

DRAWN	
CHECKED	
PROJ. ENGR.	<i>T. S. ... 3/1/74</i>
CUSTOMER	

MOORE INDUSTRIES INC.
VAN NUYS ■ CA.

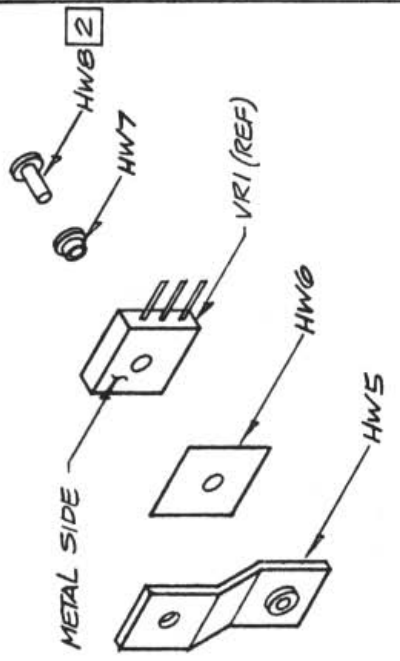
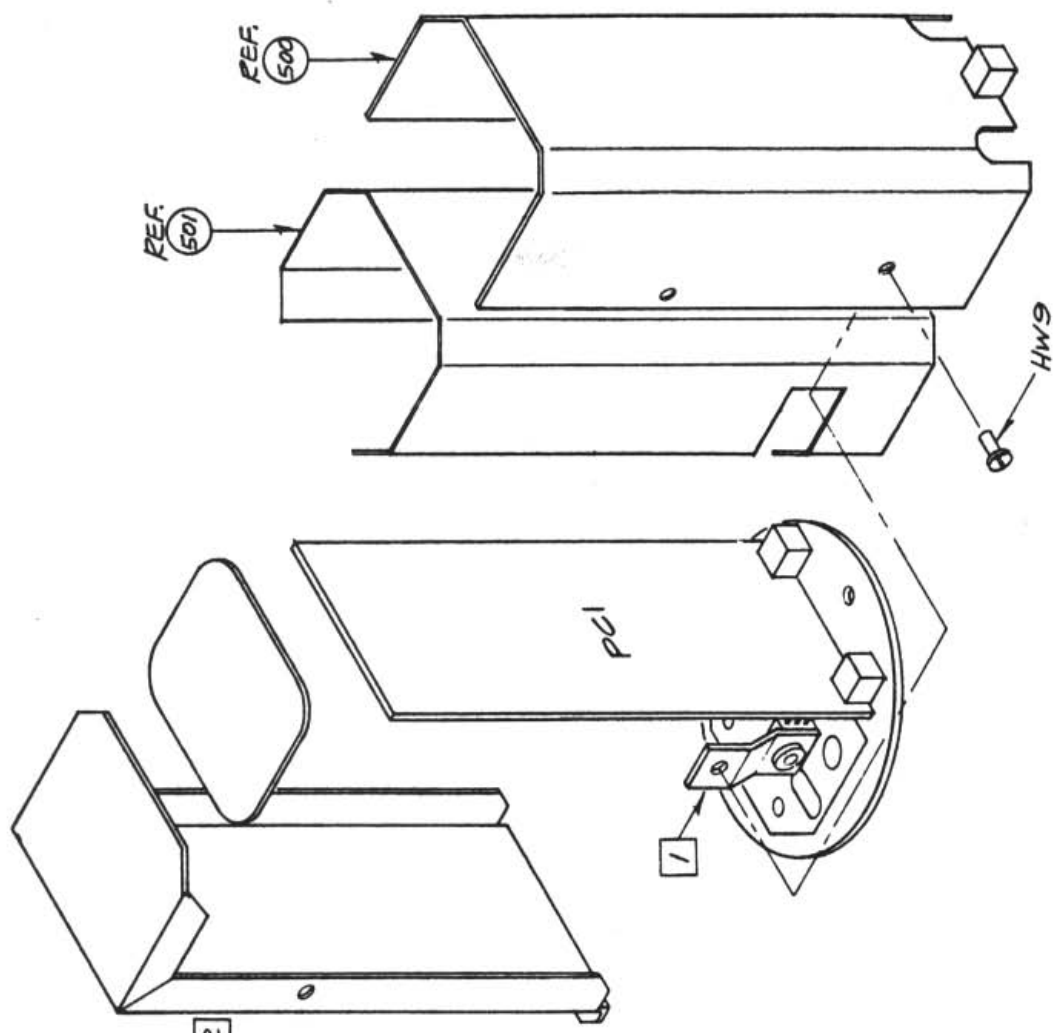
ASSEMBLY - STANDARD PTT
ADDITIONAL PARTS
LOCATION ("SR & CH")

DWG. NO. 150-501-00 PG. 20 OF 5 REV. Q

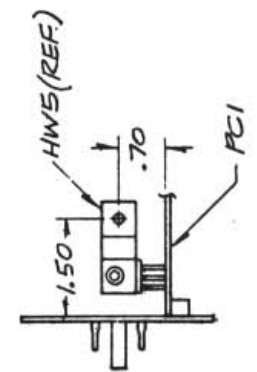
DO NOT SCALE DRAWING	
TOLERANCES UNLESS NOTED	DESIGNED BY J.A. DURR 3/28/78
.X ±.1	CHECKED
.XX ±.03	DATE 1/11/78
.XXX ±.010	SCALE 1/1
ANGLES ±30°	

VRI
 SUB ASS'Y.
 "PTT"
 (EXPLOSION-PROOF)

MOORE NUMBER	150-501-00	Q
CATEGORY	ASSEMBLY	
REVISED BY		
DATE		
APPROVED		
SHT. 4 OF 5		



VRI SUB ASS'Y. DET. 1



HEAT SINK POSN. DET. 3

PCI/HOUSING/HEAT SINK SUB ASS'Y. DET. 2

- Notes:
- 2 FIRMLY TIGHTEN THIS SCREW.
 - USE HEAT SINK POSITIONING FIXTURE WHEN SOLDERING VRI SUB ASS'Y. TO PCI.

Notes:



MOORE INDUSTRIES
 16650 Schoenborn Street
 Sepulveda, California 91343

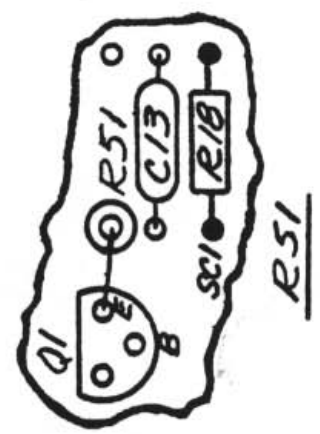
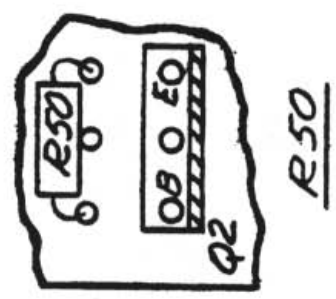
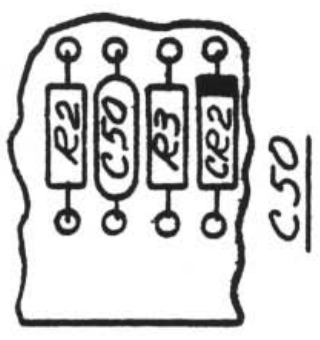
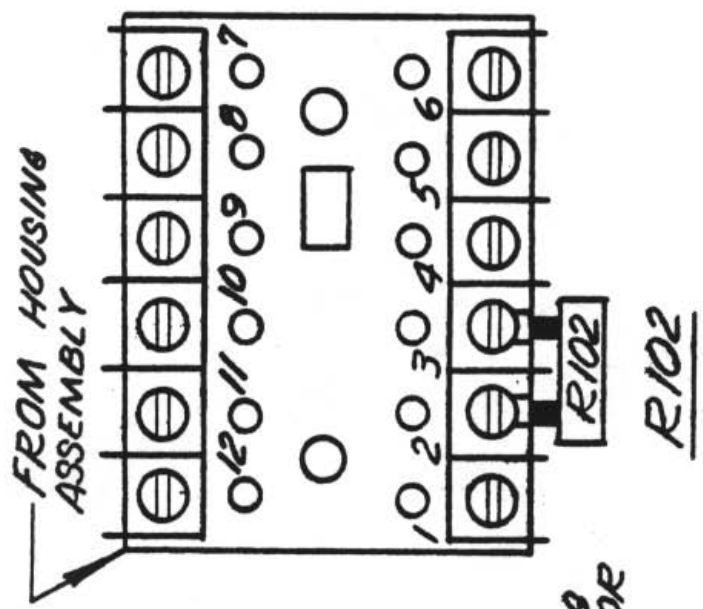
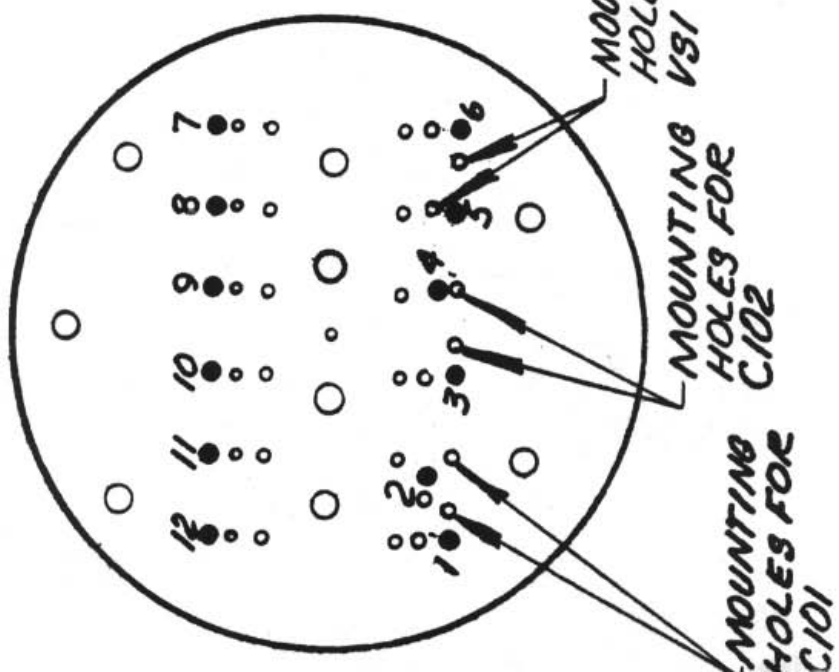
DO NOT SCALE DRAWING

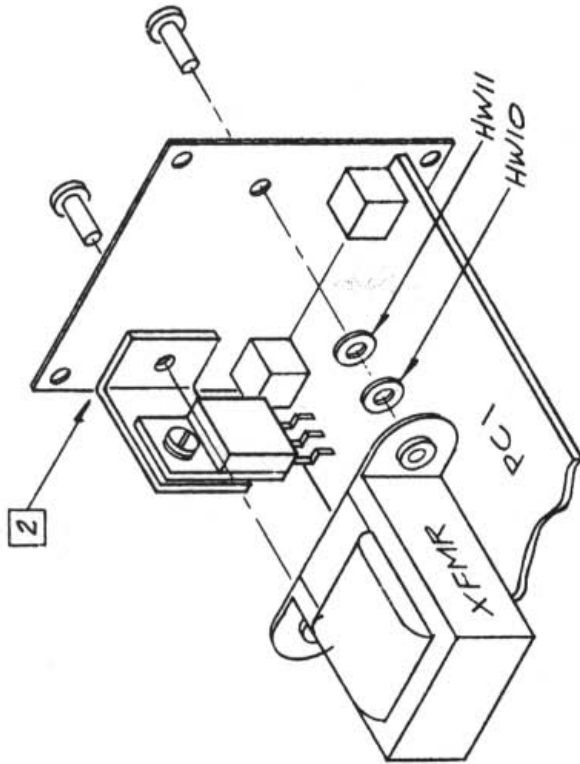
TOLERANCES UNLESS NOTED	DATE
.X ±.1	2/7/74
.XX ±.03	
.XXX ±.010	3/1/74
ANGLES ±30°	SCALE
	1/4"

ASSEMBLY, STD.
PTT
 (ADDITIONAL PARTS LOCATION) - ("SP")

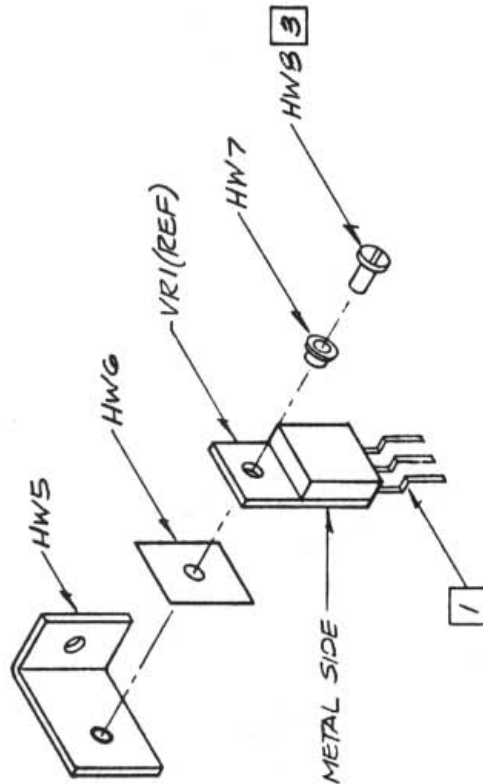
DRAWING NUMBER	REVISION
150-501-00 (PAGE 3 OF 5)	Q
CATEGORY	DATE BY
ASSEMBLY	

MOUNTING OF C101, C102 & VSI





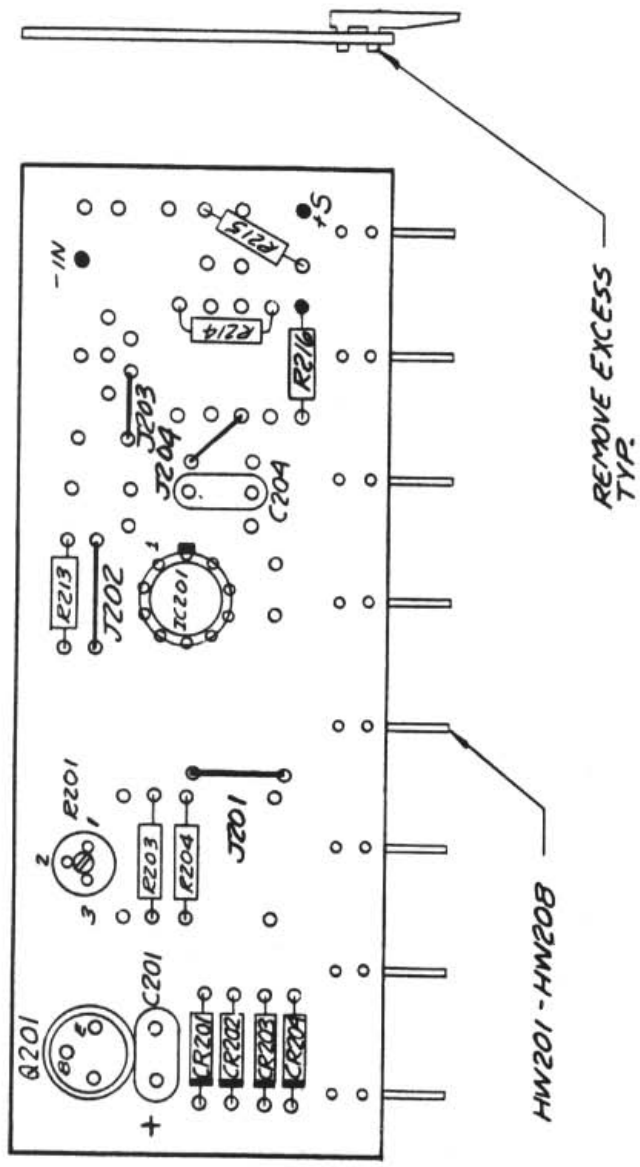
PCI/XFMR/HEAT SINK SUB ASS'Y. DET. 2



VR1 SUB ASS'Y. DET. 1

- NOTES:**
- 3 FIRMLY TIGHTEN THIS SCREW.
 - 2 USE END PLATE 200-236-13 FOR HEAT SINK POSITIONING WHEN SOLDERING VR1 SUB ASS'Y. TO PCI.
 - 1 USE SPECIAL FIXTURE TO BEND TRANSISTOR LEADS FOR CORRECT BOARD MOUNTING HEIGHT.

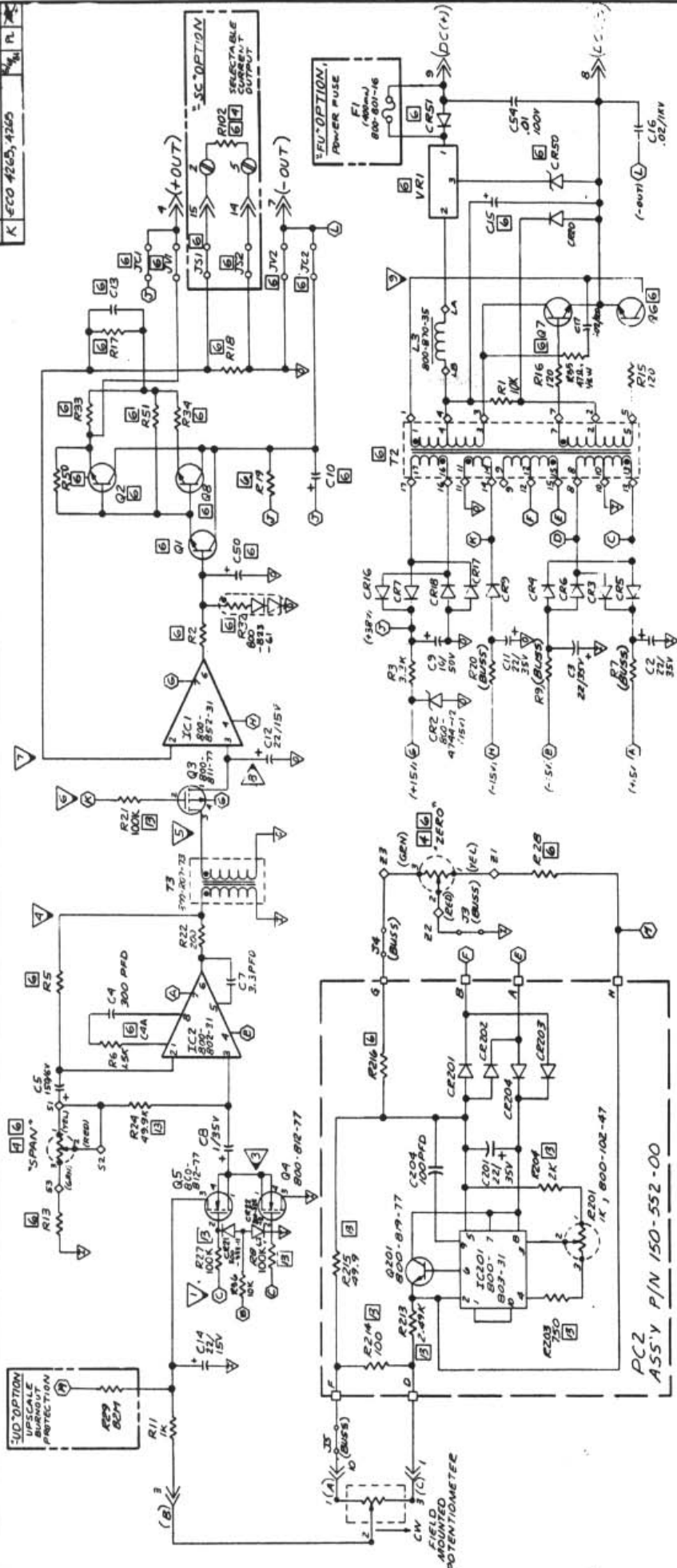
REV.	DESCRIPTION	DATE	BY	APPROV
E	ECO# 1765, 1769, 1860	10/18	JVN	T/S



ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DESIGNATION
-1	NO. 150-501-00	P.C. BD. ASSY		
LIST OF MATERIALS				
NO. 150-501-00	NO. 150	SCALE 2/1	JOB NO. 150	
POTENTIOMETER EXCIT. SUPPLY (P.T.T. SIDE CAED, PC2, STANDARD VERSION)				
DO NOT SCALE DRAWING				
MOORE INDUSTRIES INC. VAN NUYS • CALIF. 150-502-00E				

- 2. R201 TO BE SEALED AFTER ADJ.
- 1. ALL JUMPERS ARE 22 AWG, TEFLON SLEEVED

NOTES: UNLESS OTHERWISE SPECIFIED

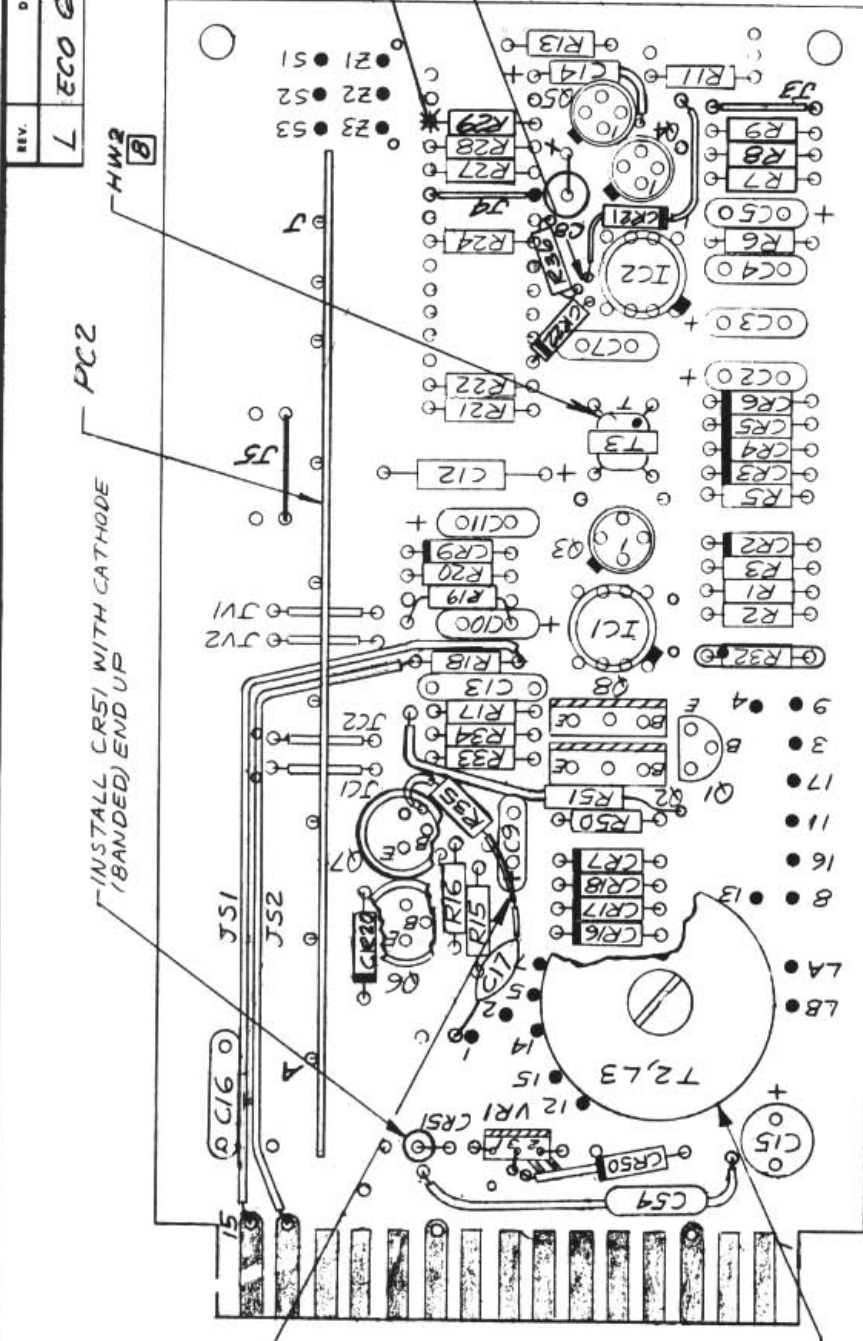


- PC2
 ASSY P/N 150-552-00
1. METAL FILM RESISTOR, R155C, ±1% TOL.
 2. TEST POINTS; FILLED END IS POINTER. REFER TO SECTION 5 OF MANUAL, "MAINTENANCE."
 3. INDICATES TERM. BLOCK POSITION ON CARD RACK.
 4. INDICATES INPUT SECTION COMMON (GROUND).
 5. INDICATES OUTPUT SECTION COMMON (GROUND).
 6. INDICATES PLUG-IN CONNECTOR POSITION.
 7. 0 INDICATES IDENTIFIED WIRING PAD ON P.C. BD.
 8. SEE LIST OF MATLS FOR USAGE VALUE & PIN.
 9. INDICATES ELECTRICAL COMMONS (SAME LETTERS); LETTERS DO NOT APPEAR ON P.C. BD. OR ASSY DWS.
 10. ITEM NOT MOUNTED ON P.C. BD.
 11. ALL POTENTIOMETERS INCREASE C.W. FROM 1 TO 3.
 12. ALL DIODES ARE MIL. PIN 900-4148-11; ALL RESISTORS ARE 1/4W CARBON COMP, ±10% TOL.
 13. RESISTANCE VALUES ARE IN OHMS; CAPACITANCE VALUES ARE IN MICROFARADS.
- NOTE: UNLESS OTHERWISE SPECIFIED

REV. 1	REV. 2	REV. 3	REV. 4	REV. 5	REV. 6	REV. 7	REV. 8	REV. 9	REV. 10
SCHEMATIC, PLUG-IN PTT BOBBE INDUSTRIES INC. VAN DYKE • CALIF. 150-451-00 K 00-155-037									

REV.	DESCRIPTION	DATE	BY	APPRV
L	ECO 6625	11/17/74	PFA	WDR

SOLDER TWO LEADS TOGETHER - SLEEVE AND INS. TALL AS SHOWN.



DRILL THREE HOLES (AVOID ETH ON BACK) BEND LEADS TO OVER-LAP AND SOLDER TO MAKE ELECTRICAL CONNECTIONS TO EACH OTHER (SLEEVE LEADS ON CR21)

FEED THREE BUSES WHEN R29 NOT USED

PC2

INSTALL CR51 WITH CATHODE (BANDED) END UP

- HW2 IS USED FOR MOUNTING UNDER T3. SEE PAGE 2 FOR ADDITIONAL COMP. LOCATIONS.
- INDICATES METAL SIDE OF Q2, Q8 & VR1.
- ALL JUMPERS ARE 22AWG BUIS, TEFLON SLEEVED A/R.
- SLEEVE LEADS OF CR50, C14, C51, C52, C54 & R51.
- SEE DWG. 200-237-00 FOR MTG. OF T2 & L3.
- SLEEVE BODY OF Q6.
- DELETED

NOTES - UNLESS OTHERWISE SPEC'D:

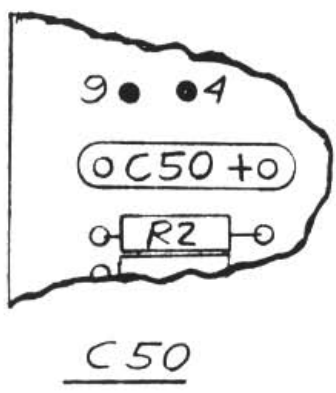
REFERENCE DESIGNATION		MANUFACTURER		PART NAME	
P.C. BD. ASS'Y		P.C. BD. ASS'Y		PLUG-IN	
PTT		PTT		PTT	
MOORE INDUSTRIES INC. VAN NUYS • CALIF.		MOORE INDUSTRIES INC. VAN NUYS • CALIF.		MOORE INDUSTRIES INC. VAN NUYS • CALIF.	
150-551-00 L		150-551-00 L		150-551-00 L	
1 OF 2		1 OF 2		1 OF 2	
DO NOT SCALE DRAWING		DO NOT SCALE DRAWING		DO NOT SCALE DRAWING	
SCALE 2/1		SCALE 2/1		SCALE 2/1	
JOB NO. 150		JOB NO. 150		JOB NO. 150	

ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DESIGNATION
1	HW2	HW2	MOORE INDUSTRIES INC.	HW2

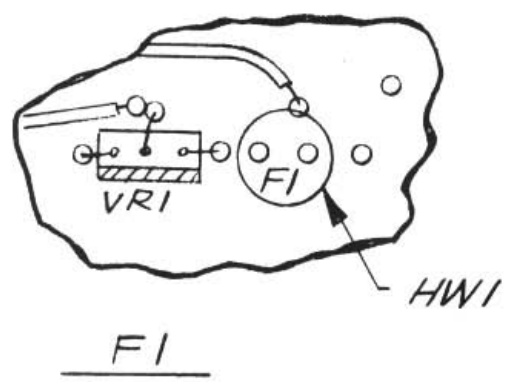
NO.	REV.	DESCRIPTION
350-221 00		NEXT ASSEMBLY

REV.	DESCRIPTION	DATE	BY	APPROV.
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(SEE PG. 1)



C50



FI



INSTALL ON CARD-RACK
TERMINAL BLOCK
R102

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE

TOLS. UNLESS NOTED:
.X = ± .10
.XX = ± .030
.XXX = ± .010
ANGLES = ± 30'

DO NOT SCALE DRAWING

SCALE: 2/1

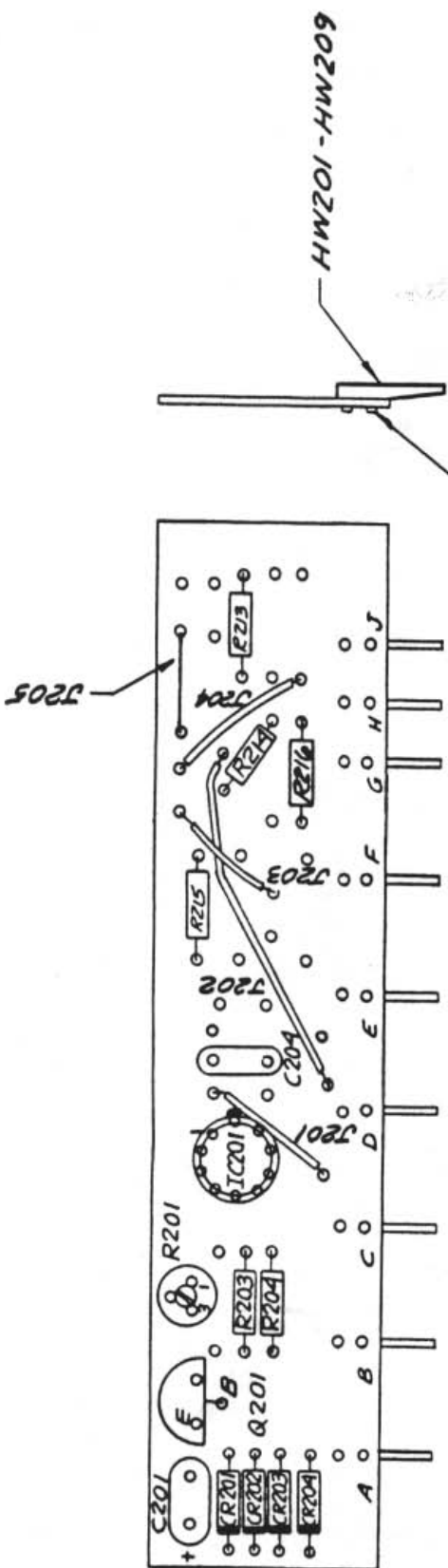
DRAWN	<i>[Signature]</i>	2-11-74
CHECKED	<i>[Signature]</i>	
PROJ. ENGR.	<i>[Signature]</i>	3/1/74
CUSTMR.		

MOORE INDUSTRIES INC.
VAN NUYS ■ CA.

P.C. BD. ASS'Y, PLUG-IN PTT
(ADDITIONAL PARTS LOCATION)

DWG. NO.	150-551-00	Pg. 2 of 2	REV.	L
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REV.	DESCRIPTION	DATE	BY	APPV
D	ECO # 1765, 1860	7/19/75	JVN	[Signature]



ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DESIGNATION
-1	150-551-00	P.C. BOARD ASSY	MOORE INDUSTRIES INC.	
150-551-00		POTENTIOMETER EXCITATION SUPPLY PC2 SIDE CARD PLUG-IN PTT		
DO NOT SCALE DRAWING		SCALE 2/1 FOR NO. 150		
150-551-00		150-552-000		

2. R201 TO BE SEALED AFTER ADJ.
 1. ALL JUMPERS ARE 22 AWG, TEFLON SLEEVED.

NOTES: UNLESS OTHERWISE SPECIFIED

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.

WARRANTY DISCLAIMER

THE COMPANY MAKES NO EXPRESS, IMPLIED OR STATUTORY WARRANTIES (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY GOODS OR SERVICES SOLD BY THE COMPANY. THE COMPANY DISCLAIMS ALL WARRANTIES ARISING FROM ANY COURSE OF DEALING OR TRADE USAGE, AND ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY ACKNOWLEDGES THAT THERE ARE NO WARRANTIES IMPLIED BY CUSTOM OR USAGE IN THE TRADE OF THE BUYER AND OF THE COMPANY, AND THAT ANY PRIOR DEALINGS OF THE BUYER WITH THE COMPANY DO NOT IMPLY THAT THE COMPANY WARRANTS THE GOODS OR SERVICES IN ANY WAY.

ANY BUYER OF GOODS OR SERVICES FROM THE COMPANY AGREES WITH THE COMPANY THAT THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONCERNING THE GOODS OR SERVICES SHALL BE FOR THE COMPANY, AT ITS OPTION, TO REPAIR OR REPLACE THE GOODS OR SERVICES OR REFUND THE PURCHASE PRICE. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES EVEN IF THE COMPANY FAILS IN ANY ATTEMPT TO REMEDY DEFECTS IN THE GOODS OR SERVICES, BUT IN SUCH CASE THE BUYER SHALL BE ENTITLED TO NO MORE THAN A REFUND OF ALL MONIES PAID TO THE COMPANY BY THE BUYER FOR PURCHASE OF THE GOODS OR SERVICES.

ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.



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