



INSTRUCTION MANUAL

MVT

Millivolt Transmitter

Form 148-701-00 C

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Description

Introduction

The MVT Millivolt Transmitter is used in process control systems to convert a millivolt-range input signal into either a standard process current or a voltage output signal of a higher level. In general, the standard MVT unit consists of a circuit board enclosed in a protective housing. All electronic components are mounted on the circuit board and the entire assembly may be installed in a number of different ways. Specific details about each available unit are presented in the Housing Options portion of this section.

The MVT unit operates by "chopping" the applied DC input signal into an AC signal, using AC coupling to the resulting stages, and then synchronously demodulating the resulting AC signal to produce a DC output that is 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.

Typical applications of the MVT Millivolt Transmitter include gas analyzer output interfacing, the providing of PH meter outputs, or use as a DC current shunt along with either a panel meter recording device or with a computer. In the current shunt application, the input/output isolation (with over 500-volt breakdown capability) permits non-hazardous monitoring of DC motor power.

Housings

The standard (STD) unit and the various housings that are available with the MVT, Millivolt Transmitter, are presented as follows:

Conduit Plate (CP) - This housing consists of an extension to the lower mounting flange on the standard bracket. The additional surface is cut with two mounting holes to accommodate 1/2-inch electrical conduit.

Angle Bracket (AB) - This housing consists of two angle brackets added, one on the top and the other on the bottom of the unit. The angle brackets are used to mount the unit for applications where the standard U-bracket will not apply. Each bracket is provided with two #10 screw clearance holes to allow for ease of mounting.

NEMA Boxes - MVT units equipped with the angle brackets (AB) option may be enclosed in NEMA boxes to provide protection against a harsh environment. Four configurations are available for this purpose and are described as follows:

General Purpose (GP) Enclosure. These enclosures consist of a general purpose steel construction box with knock-outs for various size electrical conduits (1/2, 3/4 or 1 inch). Each cover is hinged and spring-locked. Individual MVT transmitter units are secured to the enclosure with four studs and four 10-32 nuts. Four mounting holes are provided on the back cover of each enclosure for mounting purposes.

Oil Tight (OT) Enclosure. These enclosures consist of a NEMA 12 box construction with two cover-holding screw clamps that are mounted on the side 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 with these enclosure boxes. Recommended fittings are "Myer's Scrutite." Each enclosed unit is provided with a drilled and tapped mounting plate which is located on the back side of each enclosure box.

Water Tight (WT) Enclosure. These enclosures consist of a NEMA 4 box construction with three cover-holding screw clamps that are located on each of the three non-hinged sides of the box. These enclosures are water tight, oil tight, and dust tight. Unit mounting and electrical connections are made in the same manner as for the OT-option enclosures described previously.

Plug-In (PC) Transmitter. This option is electrically similar to the standard STD-type unit. The printed circuit board in this unit is keyed at one end however to identify the unit and to 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 of the unit. A removable plastic safety cover protects the printed circuit board and the other internal components of the unit from normal environmental hazards. When the PC unit is purchased alone, without a mounting option, the user must provide a 15 pin connector, such as Viking part No. ZVK155/1-2 or equivalent, for connection purposes.

Specifications		
Characteristics: MVT	Ordering Specifications	
<p>Front Panel Adjustments Adjustable with multiturn potentiometer Zero: For an input of $\pm 25\%$ of maximum input range, adjusts output to 0% of selected output span. Span: Output fully adjustable over a pre-selected input range to 100% of selected output.</p> <p>Performance Calibration Capability: $\pm 0.1\%$ of span (Linearity and Repeatability) Ambient Temperature: Range: -29°C to $+82^{\circ}\text{C}$ (-20°F to $+180^{\circ}\text{F}$) Range: $\pm 0.005\%$ $^{\circ}\text{F}$ Frequency Response: 5 Hz (3dB point) Isolation: Input, output and power input are transformer isolated with no dc connections between them. Standard on both ac and dc powered units. Common mode rejection exceeds 120dB at 60Hz with a limit of 500 volts rms. Certification: CSA Weight: Approximately 2 lbs. (908 grams)</p>	<p>Input Dc millivolts. Ranges listed are the minimum and maximum inputs to produce full scale output. Ranges: 0-1 mV 0-5 through 10mV 0-10 through 20mV 0-20 through 40mV 0-40 through 80mV 0-80 through 160mV 0-160 through 320mV* *For narrow spans, see optional LSA, LSB Input Impedance: 10 megohm minimum. For current inputs using a shunt input resistor, consult factory.</p> <p>Output Operational amplifier feedback current source; output limited to 150% of maximum output range value Current: 1-5mA into 0-4800 ohm load 4-20mA into 0-1200 ohm load 10-50mA into 0-480 ohm load Voltage: 1-5Vdc standard into 20K ohm minimum (refer to -HI option). For other current or voltage ranges, consult factory. Ripple: 10mV P/P a maximum span and maximum load resistance Load Effect: $\pm 0.01\%$ of span from 0 to maximum load resistance (current output)</p>	<p>Power 24Vdc, 45 Vdc, $\pm 10\%$ standard 117Vac, 240Vac, 50/60Hz $\pm 10\%$ optional 5 watts nominal Line Voltage Effect: ac or dc: $\pm 0.005\%/1\%$ line change</p> <p>Options -DD Downscale open input drive -HI High Current (20mA) 1-5Vdc only -LSA Lower Span-from 2mV to 5mV input (Calibration Capability: 0.25% of span) -LSB Lower Span-from 0.75mV to 2mV input (Calibration Capability: 0.5% of span) -UD Upscale open input drive</p> <p>Housings AB Angle bracket mounting CP Conduit plate for use with standard units EX Explosion-proof enclosure, Single Unit - Div. 1 GP General purpose enclosure, Single Unit - NEMA 1 OT Oiltight enclosure, Single Unit - NEMA 12 PC Plug-in card PM Panel-mount enclosure STD Standard enclosure WT Watertight enclosure, Single Unit - NEMA 4</p>
<p>Model number description: Unit / Input / Output / Power / Options [Housing]</p>		

Important Note: This document is complete as of the printing date; however, subsequent product changes may be reflected in companion documents.

Installation

Introduction

This section provides information for mechanical installation, electrical connections, and power connections for the MVT Millivolt Transmitter. Observe applicable notes and cautions given with the illustrations and text. Input and output values for each unit should be checked on-site before the unit is placed into service (see Calibration section).

Mechanical Installation

Figures 1 and 2 show the outline dimensions and other installation requirements for each available configuration. Although the MVT 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 any material that can serve as a heat sink. For a plug-in unit mounted in a rack, make sure that the rack has adequate ventilation.

Electrical Connections

All electrical connections to standard transmitter units are made to the terminal block on each particular unit as noted. For plug-in units, electrical connections are made to the terminals on the mating connector of the unit. No special wire or cable is required for signal connections. To avoid transients and stray pickups, it is recommended that twisted conductors be used where the signal wires run close to other services (i.e., power wiring).

Three major categories of electrical connections to the MVT transmitter units are described in the remainder of this section as follows:

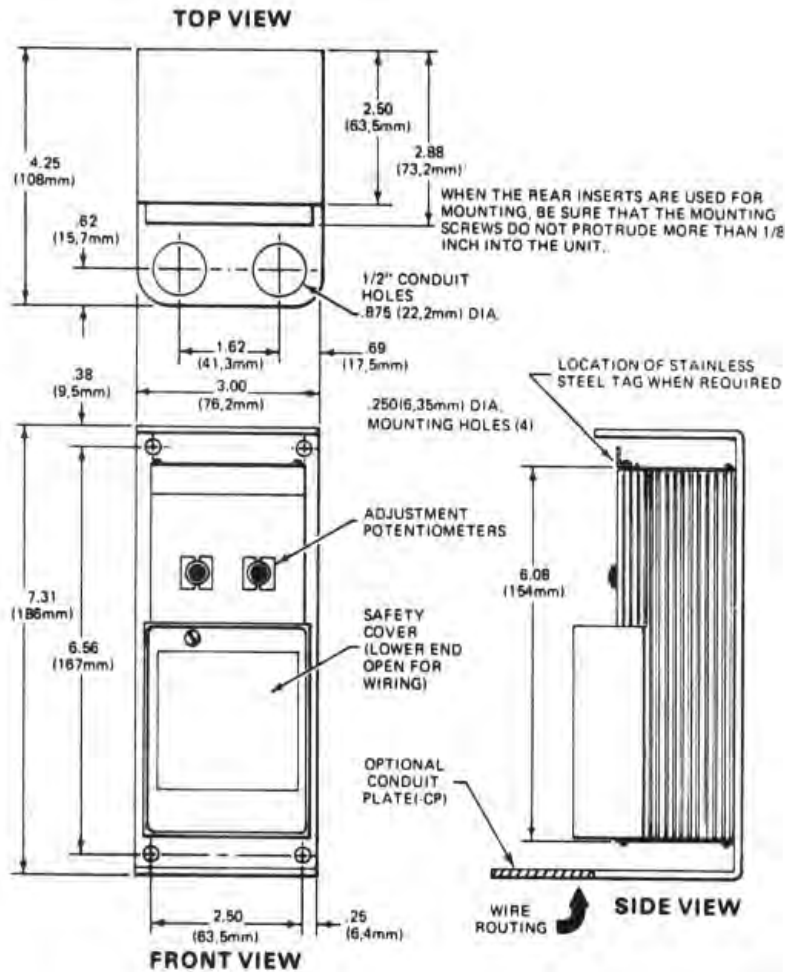
Wiring Information for All Standard Units With Terminal Strips or Blocks. Standard units with terminal strips or terminal blocks have terminals supplied with 6-32 screws that are long enough to easily accommodate three separate spade-lug connectors. Standard units with snap-off plastic covers have an opening in the bottom of the cover.

Dress all wiring to and from the terminals and run it through this opening. Spade-lug connectors are recommended for all wire terminations. Table 1 presents the terminal labeling nomenclature for standard MVT units and for units with any available electrical options. Terminal labeling appears next to the terminal it identifies on standard units. For PT- 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 1. General Purpose (GP) enclosures have conduit knockouts for various sizes of conduits from 1/2-inch to 1-inch. Oil tight (OT) and Water Tight (WT) enclosures do not have conduit holes, fittings, or knockouts. Conduit access for these configurations must be provided by fittings such as Myer Scru-Tite or equivalent fittings. Fiber Glass (FG) enclosures require special attention with regard to the electrical ground connections. Since the FG-type enclosure material is polyester resin, conduit cutouts may be cut with either a hole punch or a hole saw. Ground continuity may be obtained in one of two different ways: (1) if a metal mounting plate is used, the ground connection can be made between the metal conduit locknut and the mounting plate at the point of enclosure entry and exit; or (2) if no metal mounting plate is used, a jumper connected between the conduit entry and exit is necessary to maintain ground continuity. As appropriate, remove the snapoff plastic cover to gain access to the terminal strips during the wiring procedure.

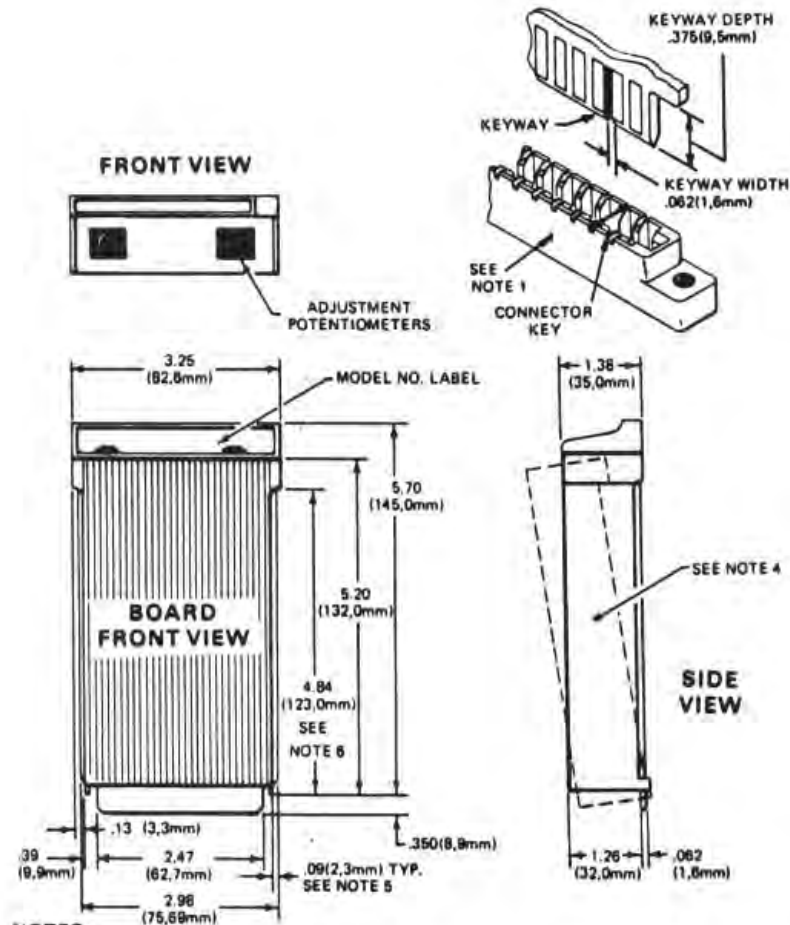
Wiring Information for Plug-In Units and Card Rack Assemblies. Electrical connections for plug-in units and card rack configurations are made either to the terminals on the mating connector for the individual unit or to the card rack terminal strips. Table 2 provides the complete terminal nomenclature for both plug-in and card-rack assemblies.



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 1. STD Outline and Installation Dimensions



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 2. PC Outline and Installation Dimensions

Power Connections

Input Power Connections

MVT transmitter units are designed to operate either from a DC (24 VDC or 45 VDC) or an AC (117 VAC or 220/240 VAC) power input source. The model number of the particular unit, which is usually stamped on either a tag attached to the housing case or on the inside of the housing case itself, specifies the appropriate power input source that is to be used with the respective instrument. When the proper power input source is determined, perform the appropriate connection procedure described as follows:

For DC-Powered Units, connect the DC terminal of the transmitter to the positive (+) side of the power input source and connect the DCC terminal to the negative (-) side. The DC power source should be regulated to within $\pm 10\%$ of the nominal voltage and should be capable of delivering 5 watts.

For AC-Powered Units, connect the AC terminal of the transmitter to the ungrounded or "hot" side of the power input source (if possible) and connect the ACC terminal to the common or neutral side. Connect the GND terminal on the transmitter directly to the housing case. These units require either 117 VAC $\pm 10\%$, 50/60 Hz at 5 VA of nominal power or 220/240 VAC optionally.

For Rack Power Connections, connect the power input source wires to the appropriately labeled terminals of the 3-terminal connector strip located on the card rack assembly. The third terminal on the connector strip is for chassis ground.

Electrical Connections on Units with the Selectable Current (SC) Option. For MVT transmitter units with the selectable current (SC) option, connect the output selectable current resistor either to the terminals on the transmitter marked SC or to those terminals specified in Table 1. The current range is marked on the body of each resistor.

For plug-in type transmitter units, mount the selectable current resistors externally. Either connect the resistors to the terminal block of the card rack or solder them to the appropriate terminals on the PC connector. Refer to Table 2 for appropriate connections.

Calibration

Introduction

This section provides information necessary to adjust and calibrate the unit. Each unit is adjusted and checked at the factory for proper performance before shipping.

General Information

After the MVT transmitter unit is unpacked, general operation-level checks of the individual unit are recommended. Generally these checks, which are specified in the Calibration portion of this section, require little or no adjustments. If the transmitter unit is ordered with the factory calibration (FC) option specified, this means that an exact calibration is performed at the factory and that red caps will be placed on the controls to guard against accidental adjustment. The red caps should never be removed from the controls. Also, field adjustments should not be made on these units unless a new range of input or output signal levels is desired.

Control Description and Location

The MVT transmitter has both ZERO and SPAN controls located on the front panel of the unit. Both controls are multiturn potentiometers that are adjustable with a blade screwdriver.

Caution

The screwdriver blade should not be more than 0.1 inches (2.54 mm) wide. A wider blade may permanently damage the potentiometer mounting.

The type of potentiometer used with these controls usually requires 22 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 each end to prevent damage if the control is turned beyond the wiper stop. Usually a slight change can be felt when the clutch is at the end of a range (i.e., it is slipping). However, if this change is not felt, either end can be reached by turning the shaft 22 turns in the desired direction. Turning the span control clockwise makes the Span larger, and turning the zerocontrol clockwise raises the Zero point.

Table 1. STD Terminal Nomenclature

Options (Note 1)												
	1	2	3	4	5	6	7	8	9	10	11	12
None				DCC	DC	GND			+ IN	- IN	+ OUT	- OUT
AC				ACC	AC	GND			+ IN	- N	+ 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 labelin positions to change, but nomenclature will remain as shown.

Legend:

DC	+ DC Power Input	\pm IN	Signal Input
DCC	-DC Power Input	\pm OUT	Signal Output
GND	Chassis Ground	SC	Selectable Current Resistor
AC	AC Power Input		
ACC	AC Power Return		

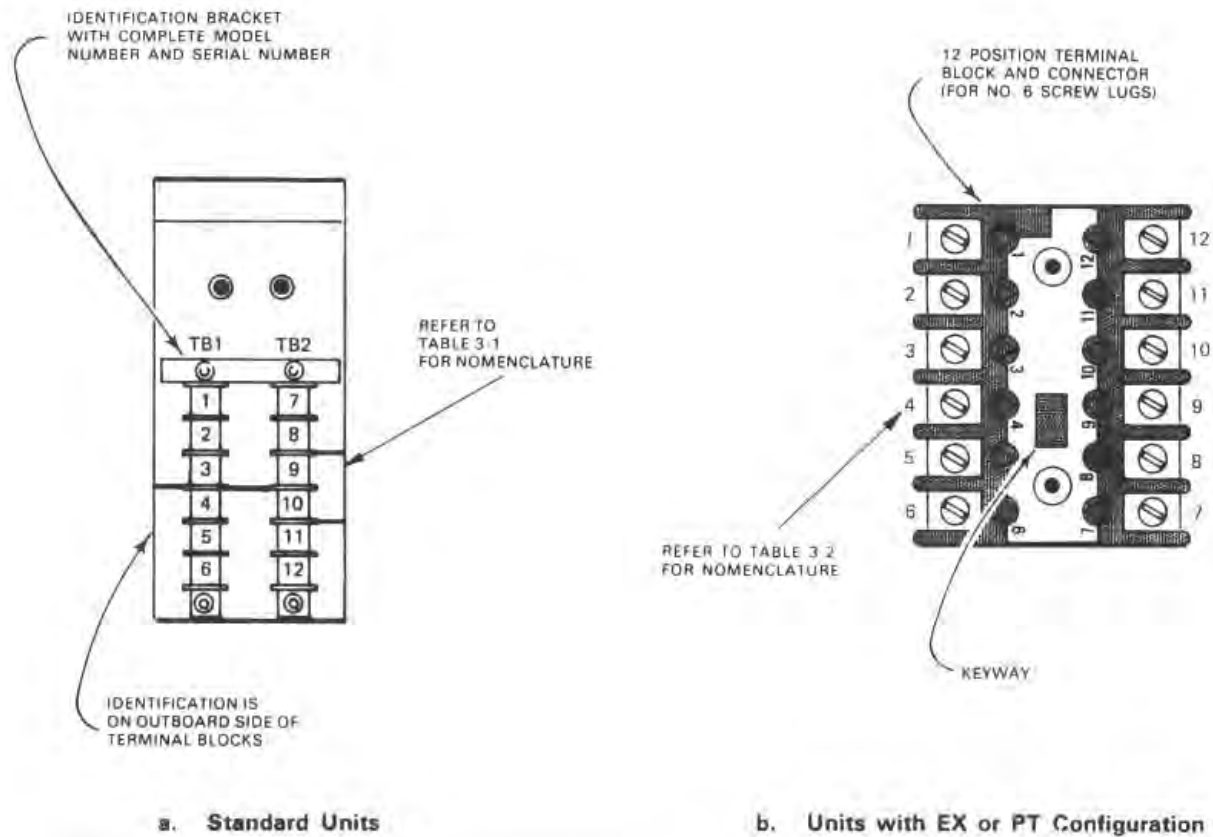


Figure 3. STD Terminal Block Identification

Table 2. Connector Pins and Terminal Assignments for Plug-In Units and Card Rack Assemblies

Options	Terminal Position (See Figure 13)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
None			+ IN	+ OUT			- OUT	DCC	DC	- IN				
SC (Output)		SC			SC									

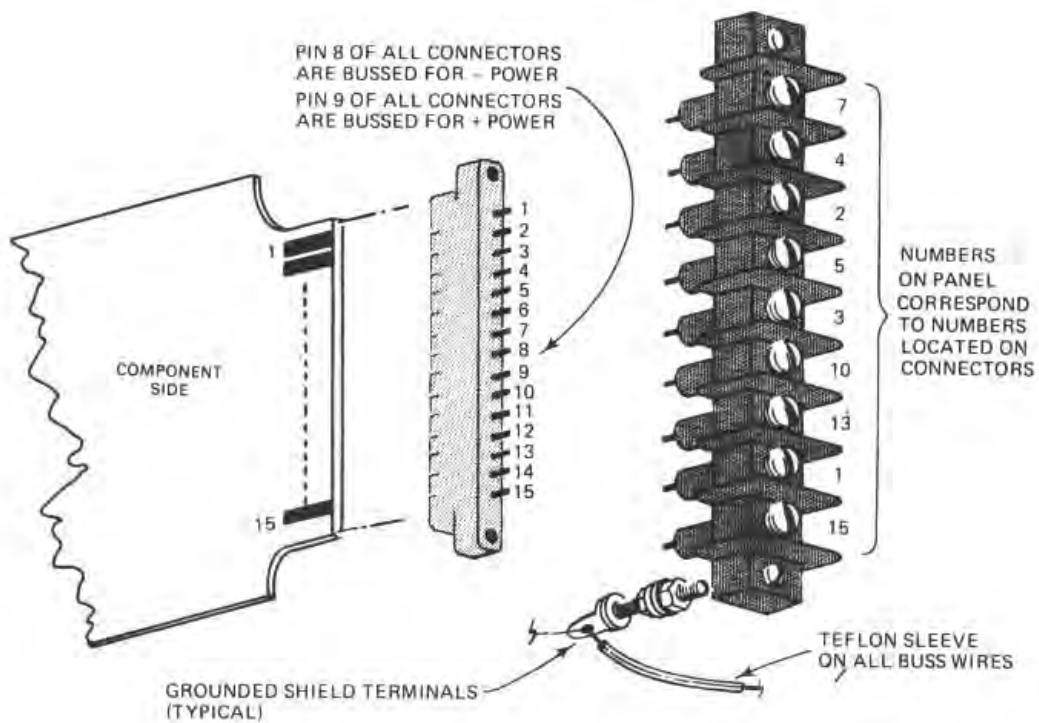


Figure 4. Plug-In Connectors and Terminal Strip Wiring and Identification

Calibration Equipment and Tools Required

Test equipment and tools required to calibrate the MVT transmitter are listed in Table 3. Test equipment and tools are not supplied with the unit and must be provided by the user.

Calibration Setup

Off-line calibration for all MVT units requires the same test equipment setups regardless of the physical configuration or types of options used. Hookup requirements and physical preparations may vary for some specific units however. To setup a particular unit for calibration, refer to the appropriate test equipment setup procedure as presented in this section as follows:

General Setup. Test equipment setup for transmitter calibration is the same for all units with the exception of connection identification. Figure 5 illustrates the general test equipment setup configuration. The connection nomenclature called out in the figure refers to specific terminal markings on the standard units with CP, AB, AA/TA, PM and NEMA box housing options.

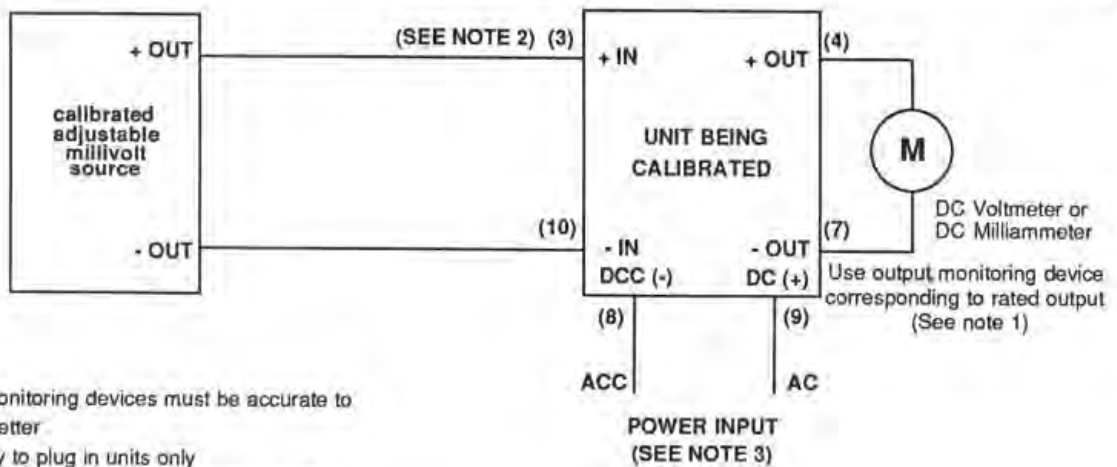
Plug-In Unit Setup. The equipment test setup for a plug-in unit is the same as for that shown in Figure 6 with the stipulation that the printed circuit board connections for the plug-in unit are identified by the numbers in parentheses rather than by the standard nomenclature. Corresponding connection identification numbers are etched into the component side of the PC board of the plug-in unit. Plug-in units that are installed in card rack assemblies (i.e. rack-mounted and surface mounted assemblies) also use the test equipment setup configuration shown in Figure 6 and the card rack terminal connections are also identified by the numbers shown in parentheses in the figure.

Calibration

MVT transmitter 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.

Table 3. Calibration Tools and Equipment

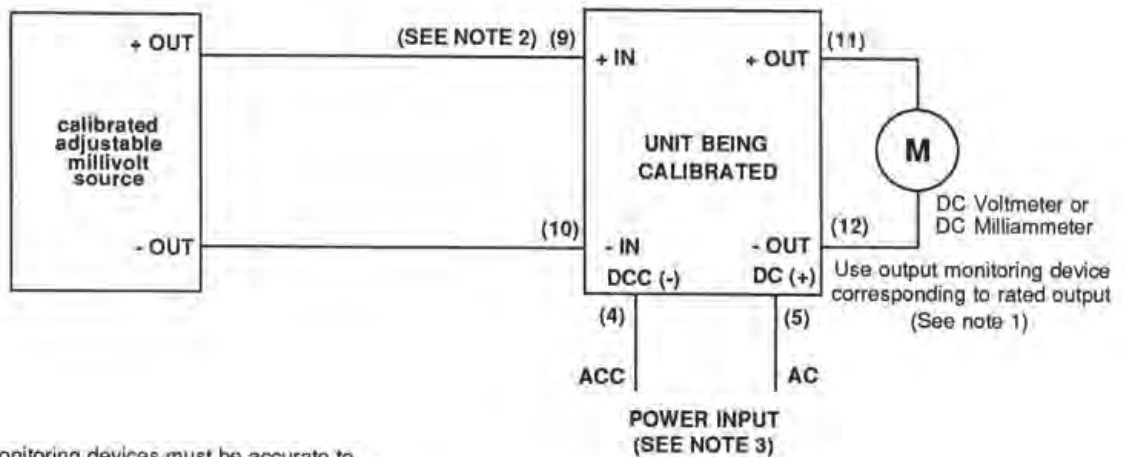
Equipment or Tool	Characteristic	Purpose
Screwdriver (blade)	Blade not wider than 0.1 inch (2.54 mm)	Front panel control adjustment
Millivolt Source	Must be capable of producing signal ranges defined by INPUT level requirements of purchased unit (see Specifications)	Simulate input signal levels
DC Voltmeter	Must be accurate to within $\pm 0.05\%$ or better	Output signal monitoring (voltage outputs only)
DC Milliammeter	Must be accurate to within $\pm 0.05\%$ or better	Output signal monitoring (current outputs only)



NOTES:

1. Input and Output monitoring devices must be accurate to within +/-0.05% or better
2. Numbers in () apply to plug in units only
3. Either AC power or DC power is supplied, but not both

Figure 5. General Test Equipment Setup for Calibration of Unit



NOTES:

1. Input and Output monitoring devices must be accurate to within +/-0.05% or better
2. Numbers in () refer to terminal block connector positions
3. Either AC power or DC power is supplied, but not both

Figure 6. Test Equipment Setup for Calibration of Explosion-Proof and PB-Type Units

NOTE

Adjustments should not be made in the field to units that are calibrated to values specified on 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.

To calibrate an MVT transmitter unit, perform the following procedure:

- 1 Connect the unit and test equipment as shown in Figures 5 or 6, as appropriate.
- 2 Apply power input to the unit.
- 3 Adjust the millivolt source to the value of the minimum input signal that will be applied to the unit (0 V or whatever the minimum signal will be).
- 4 Adjust the ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the 0% output is) with the minimum input signal applied as described in step 3.
- 5 Adjust the millivolt source to the value of the maximum input signal that will be applied to the unit (5 mV, 10 mV, 80 mV, 320 mV, or whatever the maximum input signal will be).
- 6 Adjust the SPAN potentiometer to obtain 100% output with the maximum input signal applied as in step 5.
- 7 Repeat steps 3 through 6 until no further adjustment of either the ZERO or SPAN potentiometer is required.
- 8 Apply 25%, 50%, and 75% of the input span and check that the output is linearly proportional (within $\pm 0.1\%$ of the output span).
- 9 After step 8 has been successfully completed, remove the input signal and then turn off the primary power to the unit.

Theory of Operation

Introduction

This section briefly describes how the MVT transmitter operates. A simplified block diagram is presented in Figure 7 to help in understanding the circuit description. In addition, detailed schematic and assembly drawings are presented in Figures 8 through 11 which are located at the back of this manual.

Operation

The following sub-sections present detailed descriptions of individual circuit operation grouped according to the major circuit blocks of the transmitter system as follows: input stage; output stage; and power supply. Component references in these sub-sections refer to either Figure 8, the schematic diagram for standard units, or to Figure 10, the schematic diagram for plug-in units. When referring to these sub-sections, note that component references for standard units are always listed first, while the component references for plug-in units are listed subsequently and in parentheses. If both component references are the same, the reference is listed only once.

Input Stage

Input Network and Zero Adjust Circuit

General: The floating input signal is provided with the proper termination by the input network and combined with the voltage from the zero adjust circuit. The zero adjust circuit, which operates from \pm DC input supply adds an adjustable voltage of the proper polarity to the basic input signal. With the minimum input signal applied, the zero adjust circuit is adjusted so the voltage added to the applied input signal results in the required minimum output signal. The composite input signal (applied input signal plus the voltage introduced by the zero adjust circuit) is then applied to the series input switch.

Detailed: The zero adjust circuit is connected across plus and minus 6.2 volts, regulated by CR7 and CR8 and derived through R17 and R18 from the input section plus and minus 15-volt outputs of the power inverter. The ZERO potentiometer is arranged so the voltage at its wiper can be of either polarity and is adjusted to the value that will produce the required minimum output from the unit with the minimum input applied. The input signal modified by the voltage from the ZERO potentiometer is applied through R20 (R21) to input series switch Q3. C12 (C16) acts as a filter to

remove any noise or other high-frequency components from the signal applied to Q3. When the Read Out (RO) option is selected, jumpers JS1 and JS2 are removed and jumpers JR1 and JR2 are added. These changes effectively reverse the input lines so as to make the input signals appear inverted to the MVT processing circuits.

Input Switches Circuit

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. Q3, 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 Q3, and out-of-phase square-wave signals from the inverter are applied through R21 and R22 (R22, R23) as drive signals to the gates of Q3 and Q4. When the square wave applied to Q3 is positive, Q3 conducts and passes the applied signal to C11 (C9) while at the same time the negative drive signal to Q4 cuts off this switch.

Operational Amplified Circuit

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 IC1, an operational amplifier, is used in the non-inverting mode with the 3 KHz signal from C11 (C9) applied to the non-inverting input. The network, consisting of R3, C3, the SPAN potentiometer, and R2, 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 higher 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. (R4 protects IC1 from damage if the output terminals of the unit become short circuits). The output from IC1 is applied to the primary of isolation transformer T2. IC1 is operated from the input-section ± 15 -volt supplies produced by the power inverter.

When the drive signal to Q3 becomes negative, Q3 is cut off. Simultaneously, the drive signal to Q4 causes Q4 to conduct, making the left side of C11 (C9) to drop to zero potential. Thus, C11 (C9) is alternately charged to a level that is proportional to the input signal applied, then it is discharged to zero potential at approximately a 3 KHz rate. This chopped signal is then applied to operational amplifier IC1.

Output Stage

Demodulator Circuit

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 inverter 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, Q5. The signal from the

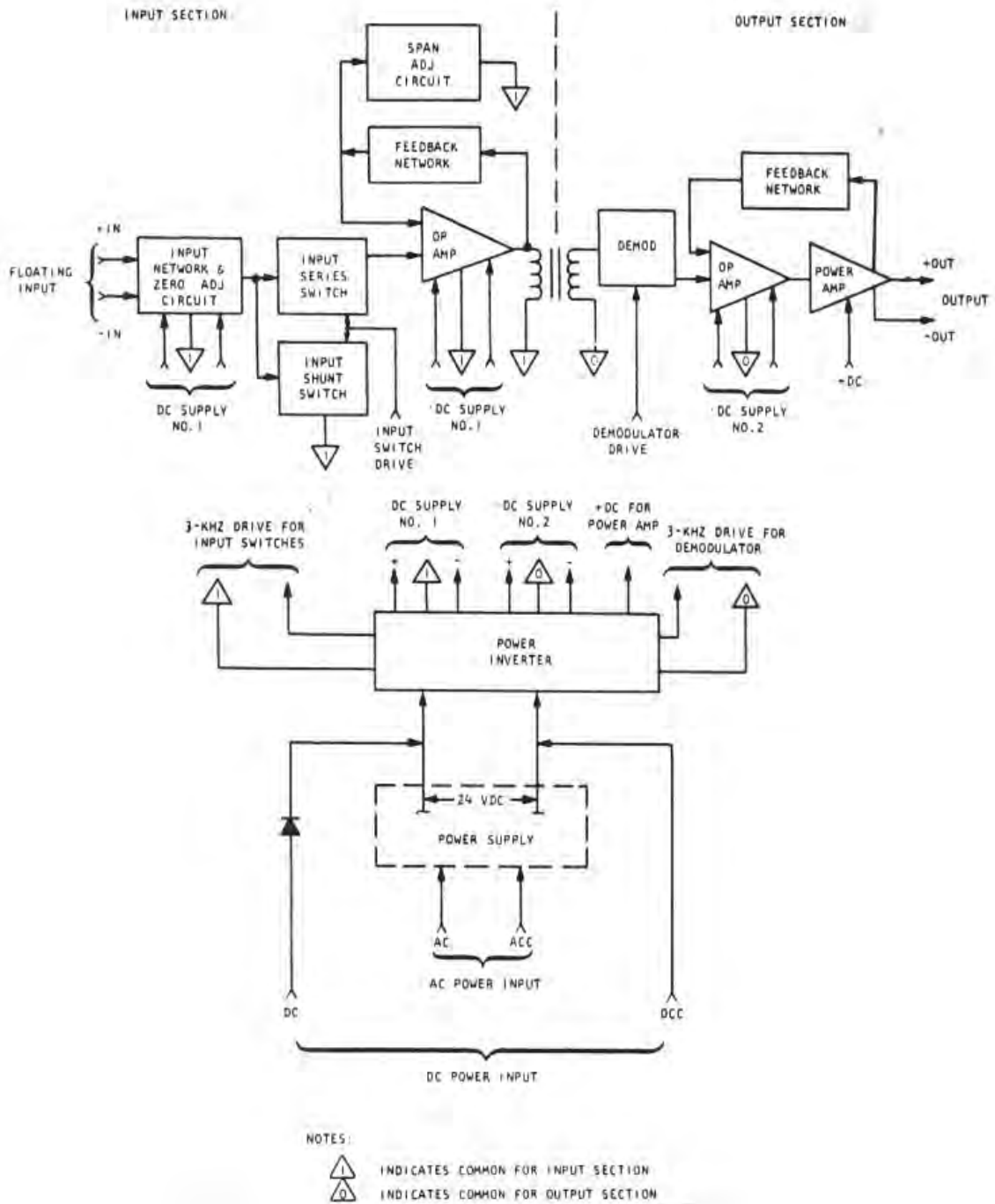


Figure 7. Simplified Block Diagram for MVT Transmitter

secondary of T2 is applied to the drain of Q5, and a 3 KHz square wave from the power inverter (point K) is applied to the gate. Q5 is connected as a series switch with the output charging C13 (C18). During the negative portions of the 3 KHz square wave applied to its gate, Q5 conducts and charges C13 (C18) to a voltage proportional to the input signal. During the positive portions of the square wave, Q5 is cut off. Because the impedance across C13 (C18), represented by the effective input impedance of IC2, is extremely high, C13 (C18) 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 Q5, R23 (R24) is used to provide the proper load for the secondary of T2.

Output Amplifier Circuit

General: The output amplifier circuit consists of two stages: an operational amplifier and a power amplifier stage. The operational amplifier provides both internal circuits isolation from output loads and the drive necessary for the power amplifier stage. The power amplifiers consist of two transistors connected in a Darlington pair configuration. When greater drive is necessary, an additional transistor is connected in parallel with the output transistor of the Darlington pair to provide the additional drive necessary. Feedback from the output is applied to the operational amplifier stage to provide high overall stability and high output impedance.

Detailed: The output amplifier consists of integrated circuit IC2, which is an operational amplifier, and a power amplifier stage, Q7, Q8 (Q6, Q8) and Q6 (Q7) for the 10-50 mA range. The demodulated signal from Q5 is applied to the non-inverting input of IC2. Feedback from the power amplifier is applied to the inverting input and stabilizes the amplifier performance in the same manner as previously described for IC1. The resulting voltage gain of IC2 is very nearly unity and, in addition, the output impedance is brought to a value that is suitable for driving the power output stage. R28 and R29 (R29, R30) are 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 which are produced by the power inverter.

For the two lower current ranges, the output amplifier consists of Q7 and Q8 (Q6, Q8) connected as a direct-coupled amplifier. R28 and R29 (R29, R30) 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 Q7 (Q6). For a current range of 10-50 mA, Q6 (Q7) is connected essentially in parallel with Q7 (Q6) to provide additional current capacity. In units with the SC option on the output, the optional selectable current output resistor replaces R30 (R31). For voltage output, no transistors are used in the output amplifier. Voltage output is taken across R30 and R31 (R31, R32), with the junction of the two resistors forming the feedback point. C22 (C20) 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).

Power Supply

Power Supply Circuit

General: Units are usually supplied with either an AC or DC power input, but may have both in the case of an AC primary power input with a 24-volt battery backup as a DC secondary power input. On units with an AC power input, the power supply develops a 24-volt DC output that is applied to the input of the power inverter. On units with 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 DC output from the power supply.

Detailed (Standard Units Only): In a unit operated from an AC power source, the power supply consists of a power transformer and a rectifier/filter to produce a DC output. Referring to the schematic diagram, VS1 is connected across the primary of power transformer T3 and suppresses transients that may be present on the power line. The output from the series-connected secondaries of T3 is rectified by CR16 and CR15 or CR18 and filtered by C8 to produce the proper DC voltage to be applied to the input of the power inverter.

Power Inverter Circuit

General: The power inverter produces a number of different AC (square-wave) and DC outputs from the DC applied to its input. Two separate square-wave outputs at approximately 3 KHz are developed and are used as drive voltages for the input switches and demodulator. Two isolated sets of regulated plus and minus DC outputs are produced and used as operating voltages for the amplifiers in the input and output sections of the unit. The inverter also produces a higher plus DC output as the operating voltage for the power amplifier.

Detailed: The DC applied to the power inverter input is regulated by VR1 and CR5, then converted to a square wave of approximately 3 KHz by Q1, Q2, and the primaries of T1, functioning as a DC-to-AC inverter. When the unit is operated from a DC supply, filter L1-C19 (C7) prevents the 3 KHz signal from getting back into the external DC source. C23 (C15) minimizes the high-frequency potential difference between the DCC and - OUT terminals. CR16 (CR6) provides protection against damage from inadvertent application of DC of incorrect polarity. In AC-operated standard 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 T1 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 voltages at points C and D, pins 13 and 8 of T1, are used to drive the input switches and the voltage at point K, pin 14, drives the demodulator. The square waves at points C and K are out of phase with each other. The voltage across secondary 8-13 of T1 is rectified by two sets of full-wave rectifiers, CR1 through CR4, to produce positive and negative DC outputs, respectively. These outputs are filtered by C4 and C5 to provide outputs of +15 and -15 volts, respectively, for the input section of the unit.

The voltage across secondary 14-11 of T1 is applied to half-wave rectifier CR14, which produces the minus operating potential for the output section. The voltage across secondary 17-16 of T1 is applied to bridge rectifier CR10 through CR13, which produces the plus DC operating voltage for the output section. C14 (C10), R19 and CR9 filter and regulate the +15-volt output voltage and C15 (C11) filters the -15-volt

output. In addition, a higher DC output (approximately +38 volts) is taken from the junction of CR10 and CR12 (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 sections, thus providing isolation between the two sections of the unit. C20 and C23 (C17, C15) minimize the high-frequency AC potential difference between the -IN terminal, the - OUT terminal, and the DCC terminal of the unit.

Maintenance

Introduction

This section contains maintenance and troubleshooting information together with unit documentation.

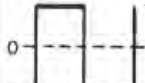
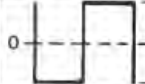

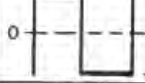
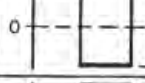
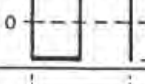
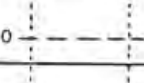
Troubleshooting

In general, to troubleshoot the unit, trace the signal with an oscilloscope and refer to the schematic diagrams presented in Figures 8 and 10 to determine what component or devices are causing the abnormal indication. The schematic diagrams include flagged numbers (or letters) at various points in the circuit and Table 4 indicates the appropriate voltages and waveforms at these points for specified input signal conditions. The circuit board assembly drawings presented in Figures 9 and 10 illustrate the physical locations of each individual component on each respective circuit board.


If the original symptom is a complete failure of the unit to operate, the most logical components to suspect are those associated with the power supply inside the unit (including any voltage regulators). If the unit is producing an incorrect (but not zero) output, check the outputs from the voltage regulator and, if these are normal, apply a standard input signal to trace the resulting signal through the unit until the malfunctioning component is discovered.

When working on or near a circuit board during troubleshooting procedures, keep in mind that each board is protected with a moisture-resistant coating. Because of this coating, it may be necessary to use a needle-point probe while exerting a fair amount of pressure to break through the coating to observe a particular signal or voltage at a specific point. When connecting a probe to a component on the circuit board, always exercise care to make sure that the probe does not short-circuit to an adjacent component.

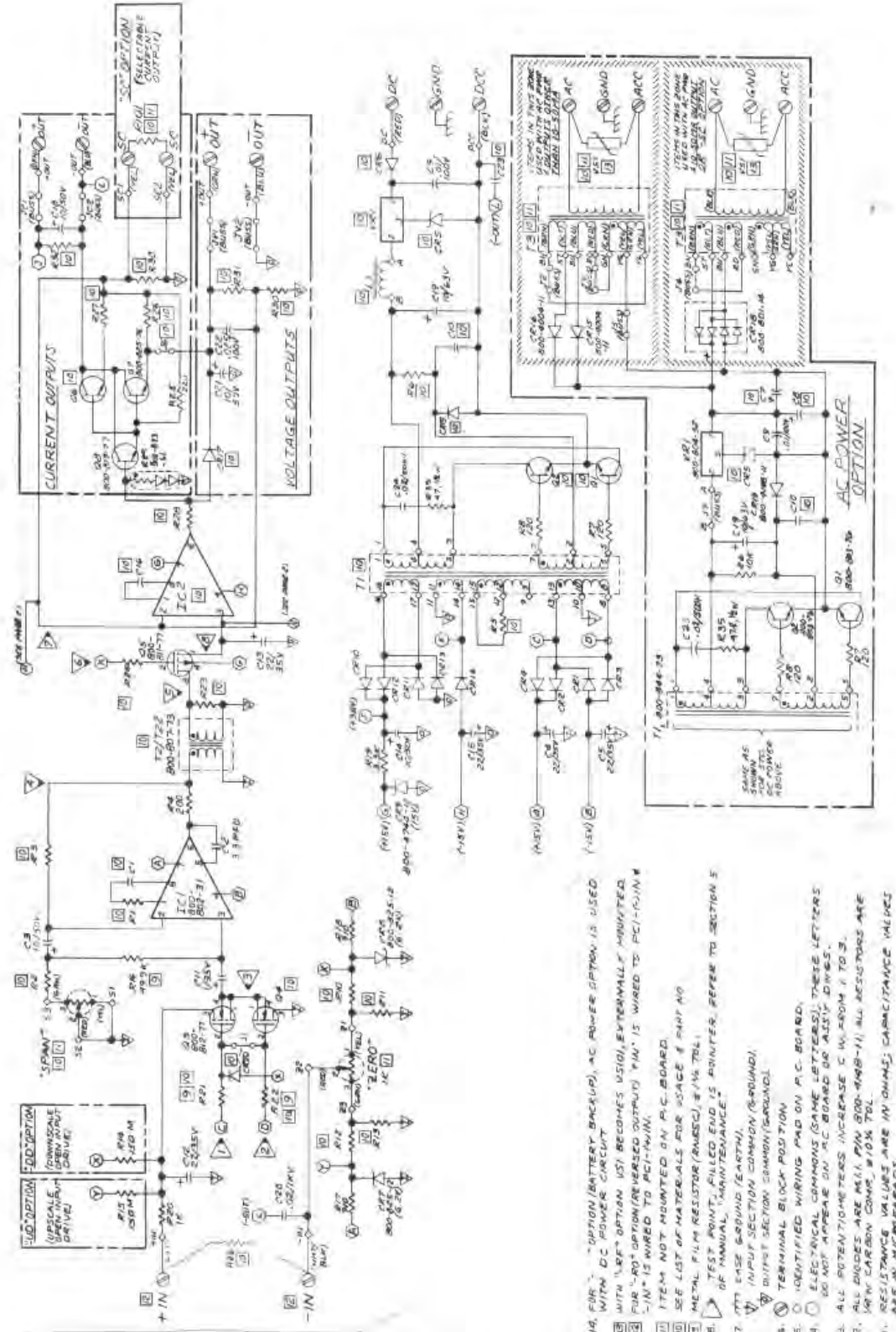
Table 4. Waveforms and Voltages

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

~ 333μs

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

~ 333μs



- 1. FOR "DC OPTION (BATTERY BACKUP)", AC POWER OPTION IS USED WITH DC POWER CIRCUIT.
- 2. FOR "AC POWER OPTION" (REVERSE OUTPUT) "M" IS WIRED TO "P1-MIN".
- 3. ITEM NOT MOUNTED ON P.C. BOARD.
- 4. SEE LIST OF MATERIALS FOR USAGE OF RHP 40.
- 5. METAL FILM RESISTOR (R45C), 2 1/4% TOL.
- 6. TEST POINT, FILLED END IS POINTER, REFER TO SECTION 5 OF MANUAL, "MAINTENANCE".
- 7. 100 OHM GROUND (EARTH).
- 8. INPUT SECTION COMMON (GROUND).
- 9. OUTPUT SECTION COMMON (GROUND).
- 10. TERMINAL BLOCK POSITION.
- 11. IDENTIFIED WIRING PAD ON P.C. BOARD.
- 12. DO NOT APPEAR ON P.C. BOARD OR ALISSY DRIVES.
- 13. ALL POTENTIAL TESTS INCREASE 1 W. FROM 1 TO 3.
- 14. ALL DIMENSIONS ARE MEAS. FROM 800-448B-11. ALL RESISTORS ARE 1/4W. CARBON COMP. 10% TOL.
- 15. RESISTANCE VALUES ARE IN OHMS; CAPACITANCE VALUES ARE IN MICROFARADS.

Figure 8. Schematic Diagram for Standard MVT Transmitter (Sheet 1 of 2)

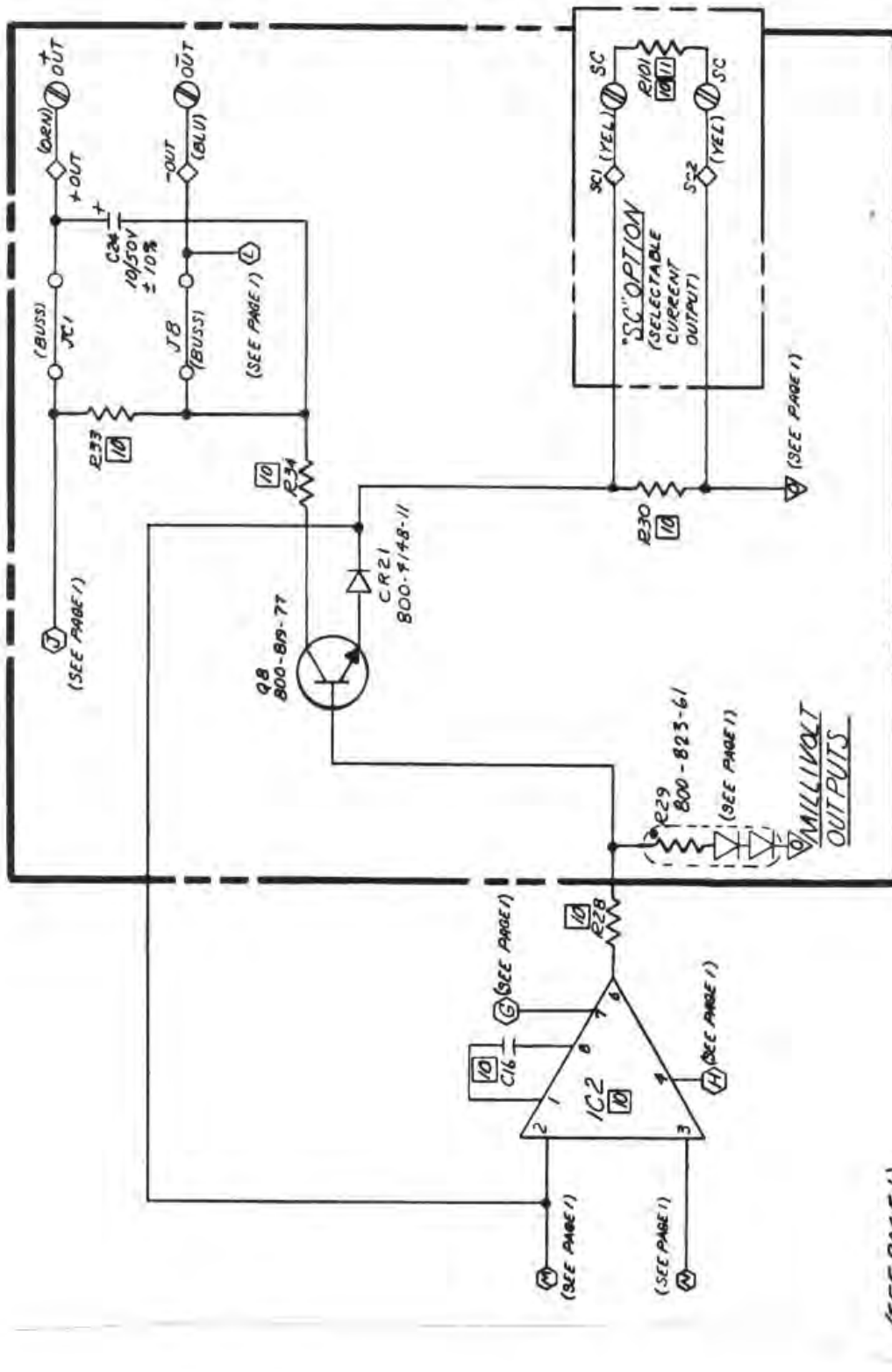


Figure B. Schematic Diagram for Standard MVT Transmitter (Sheet 2 of 2)

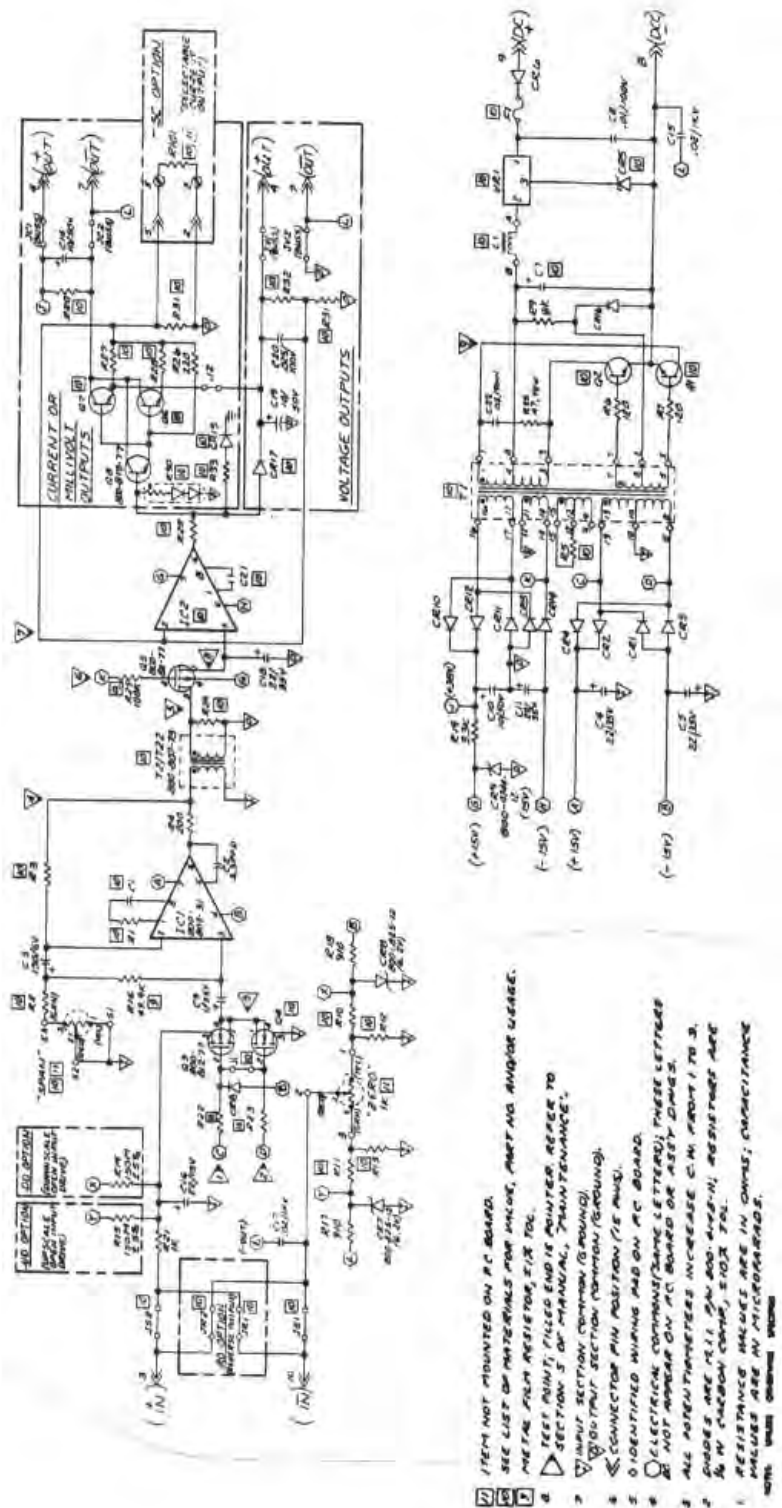


Figure 9. Schematic Diagram for Plug-In MVT Transmitter

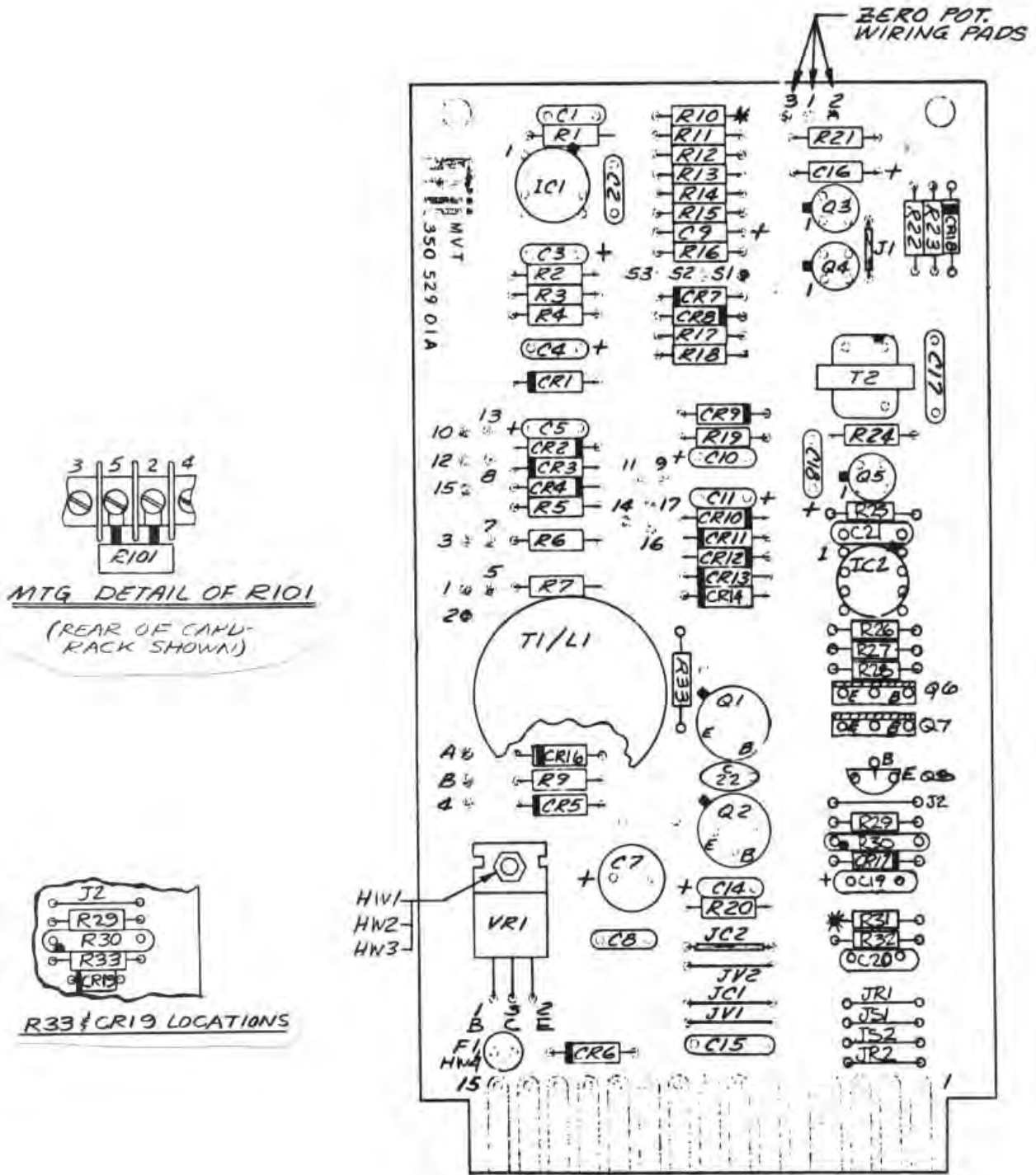


Figure 11. Printed Circuit Board Assembly for Plug-In MVT Transmitter

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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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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