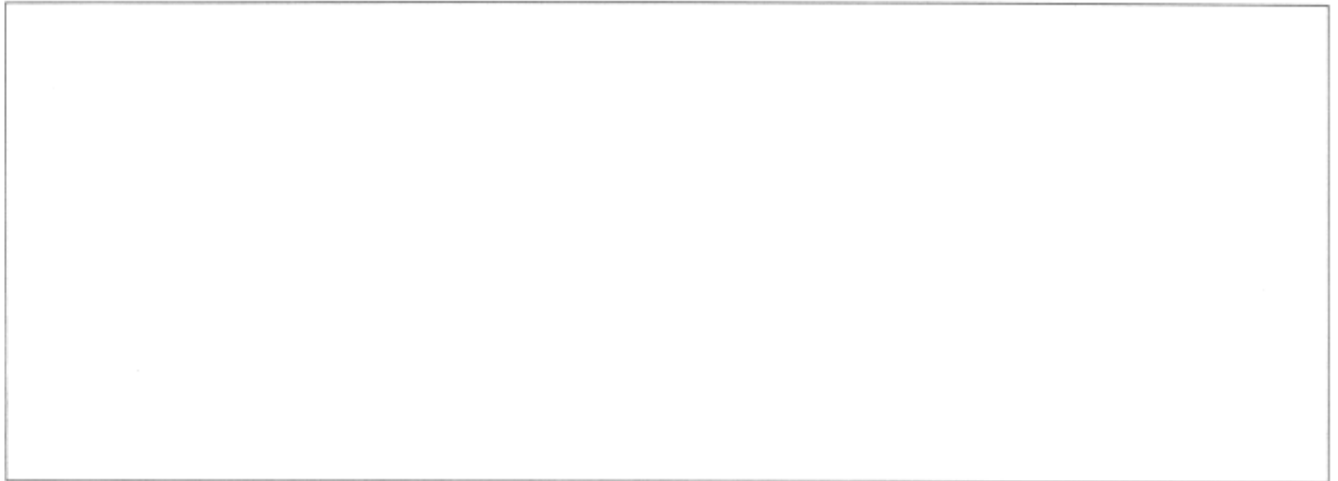




INSTRUCTION MANUAL
ARB
Adjustable Ramp Buffer

Form 213-703-00D

January 1982



1.1 SCOPE OF MANUAL

This manual contains operating and maintenance information on the Digital Adjustable Ramp Buffer (ARB), manufactured by MOORE INDUSTRIES INC., Sepulveda, California. The manual consists of six sections, as follows:

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

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

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

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 Analog Ramp Buffer module (ARB) accepts an analog input signal, and generates an analog output signal with a controlled linear ramp. A step change at the input will cause the output to ramp up or down at an individually adjustable rate, up to or down to a value that corresponds to the new input. The ARB is useful in any application that requires a rate and level adjustable control signal.

The input signal is applied to an input buffer and active filter stage that feeds one side of a comparator circuit. The other side of the comparator is fed from a digital-to-analog (D/A) converter circuit, that produces a signal proportional to the number represented by the output of a bidirectional counter. A clock generator, with its rate controlled by either of two potentiometers, enables the counter. When a new input signal is applied to the unit and is larger than the previous input, the polarity of the comparator output causes the counter to increase its count, and the analog ramps up. Similarly, if a new signal is applied to the unit and is less than the previous input, the polarity of the comparator output causes the counter to decrease its count and the analog ramps down. The analog output is amplified to produce the desired output level.

1.3 PHYSICAL DESCRIPTION

The ARB is available in several physical configurations. In general, the unit consists of a main circuit board and two small boards mounted on the main board. One small board contains the clock circuit, and the other small board contains the D/A converter. The main board contains the input circuit, comparator and analog output circuits. The boards are enclosed in a protective housing, and the entire assembly may be installed in a number of ways. Specific details about each unit is outlined in this section, while the following paragraphs outline the physical differences of each option available for the units. Electrical connections information are given in Section 3, Installation and Operation.

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.



STANDARD (STD) UNIT

1.3.3 NEMA Boxes Options Description

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

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

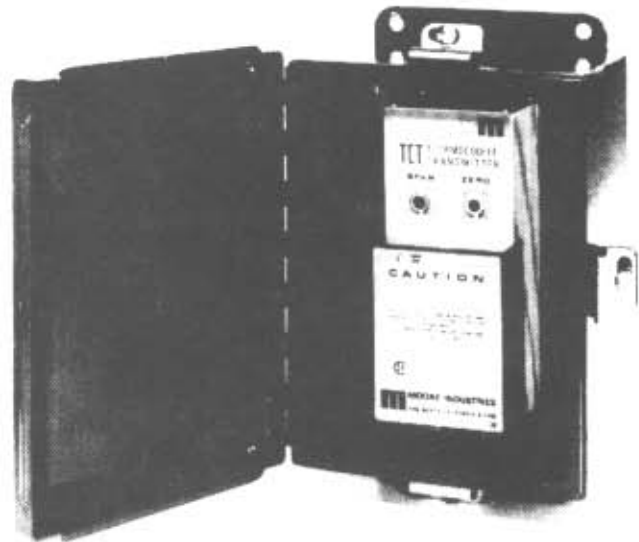
Water Tight (WT) NEMA Box Option. This enclosure consists of a NEMA 4 box construction equipped with three cover holding screw clamps, one on each of the three non-hinged sides of the box. These enclosures are watertight, in addition to oil and dust tight. Unit mounting and electrical connections are made in the same manner as the OT option enclosures.

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.

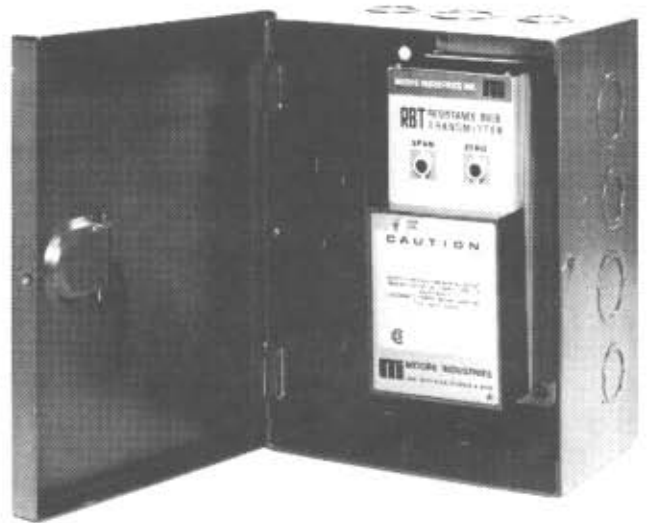


UNIT WITH ANGLE BRACKET (AB) OPTION

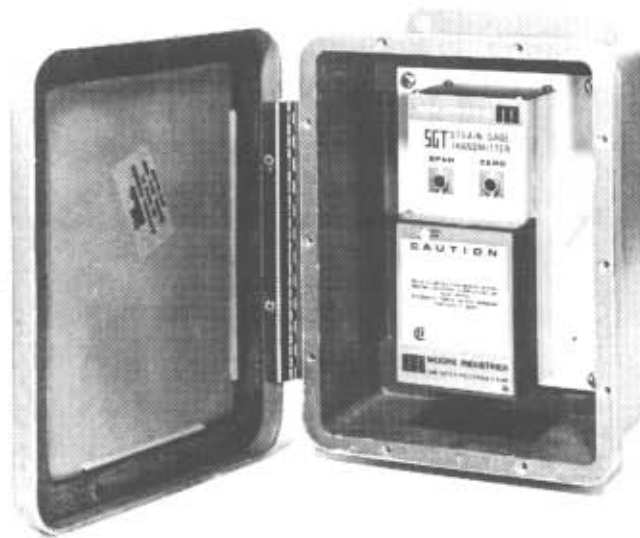


UNIT IN WATER TIGHT (WT) ENCLOSURE

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

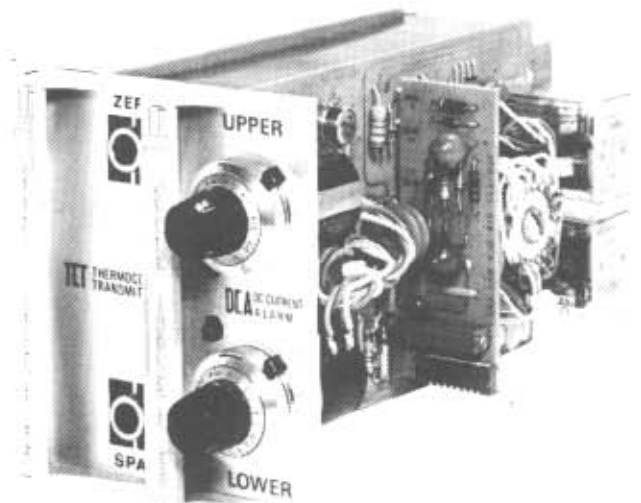


GENERAL PURPOSE (GP) ENCLOSURE



**CORROSION RESISTANT
FIBER GLASS (FG) ENCLOSURE**

General Purpose (GP) Option 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.

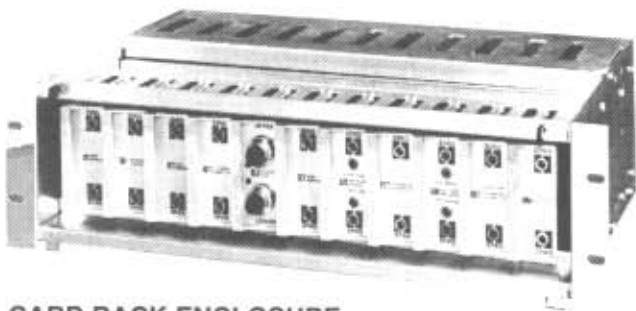


PLUG-IN (PC) UNIT

1.3.4 Plug-In (PC) Units Description

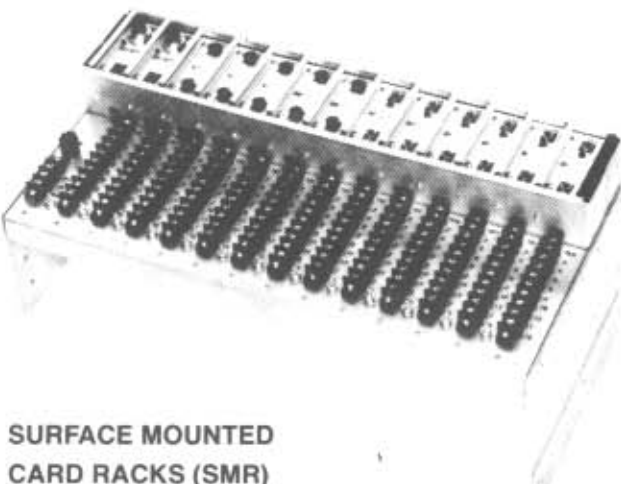
The plug-in unit is electrically similar to the standard unit. The printed circuit board is keyed to identify the unit and ensure proper connection mating. The other end of the main board is fastened to a display panel that allows external access to the various controls for the unit. A removable plastic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

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

1.3.5 Standard Plug-In Transmitter (PST) Option

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)

1.3.6 Explosion Proof (EX, EXT, EXX) Option

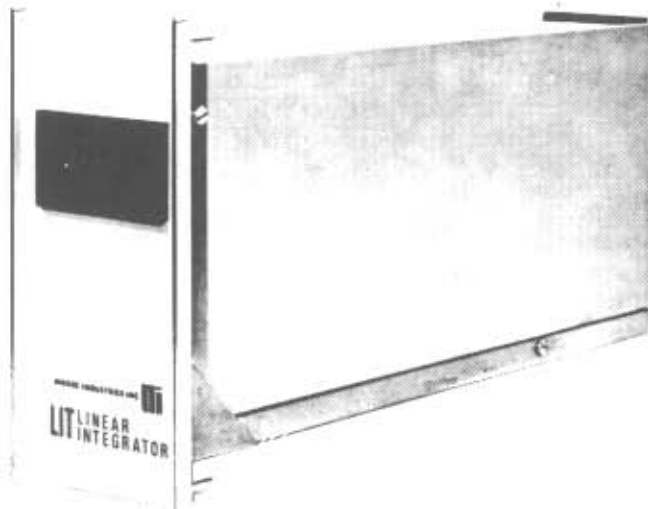
The explosion-proof enclosure option consists of a PST option unit described in paragraph 1.3.6 enclosed into a two-piece cast aluminum alloy enclosure. The two pieces consist of a screw-type cover and a connector housing. When the cover is removed, the PST type unit is easily accessible. With the PST 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 (EXC SHOWN ONLY)

1.3.7 Panel Mounted Transmitter (PM) Option

This option is electrically similar to the standard unit of paragraph 1.3, except that the enclosure and terminals locations are different. Instead of the standard enclosure, the printed circuit boards are enclosed in a metal frame equipped with a 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 parameters, and include option identification. If all accompanying documentation is missing, the model number may be used to obtain technical information on the unit by following the example of Table 1-2.

1.6 SERIAL NUMBER USE AND LOCATION

A complete history is kept on every MOORE INDUSTRIES unit. This information is keyed to the serial number. Whenever service data is required on a unit, it is necessary to provide the factory with a serial number as well as a model number. This identification is usually located with the model number.

TABLE 1-1. UNIT SPECIFICATIONS

INPUT:

Current:

- 1-5 mA into 200 ohms nominal
- 4-20 mA into 50 ohms nominal
- 10-50 mA into 20 ohms nominal

Voltage:

- 0-5V, 1-5V standard
- 10 megohms minimum input impedance
- Other voltages optional

FRONT PANEL ADJUSTMENTS: Adjustable with multiturn potentiometer

Span: With full scale input, adjusts output to 100% ±20% of selected output span.

Zero: With minimum input, adjusts output to 0% ±10% of selected output span.

Increase Rate/Decrease Rate: Increasing output time and decreasing output time are independently adjustable over a single selected range by multiturn potentiometers.

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: 1-5 VDC standard into 20K ohms minimum

Ripple: Less than 0.25% of maximum signal (10mv maximum p/p for a 5V signal).

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

Ramp Time:

- 100ms (fixed)
- 2 to 10 seconds for 0 to 100% output
- 10 to 50 seconds for 0 to 100% output
- 50 to 120 seconds for 0 to 100% output
- 2 to 10 minutes for 0 to 100% output
- 10 to 60 minutes for 0 to 100% output

PERFORMANCE:

Calibration Capability: ±1 part in 1000

Ambient Temperature:

- Range: +32°F to +158°F (0°C to +70°C)
- Effect: ±0.01%/°F over above range

Isolation: Voltage output models have input negative side common to output negative side. Current output models have output negative side elevated above input negative side. Power input isolation is maintained on both AC and DC powered units.

POWER INPUT:

- 24 Vdc, 45 Vdc, ±10%
- 117 Vac, 220/240 Vac, 50/60 Hz ±10%
- 5 watts nominal

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

CERTIFICATION: Canadian Standards Association

ISA COMPLIANCE: ISA S50.1, Section 5.

WEIGHT: Approximately 2 lbs. (908 grams)

TABLE 1-2. MODEL NUMBER EXAMPLE

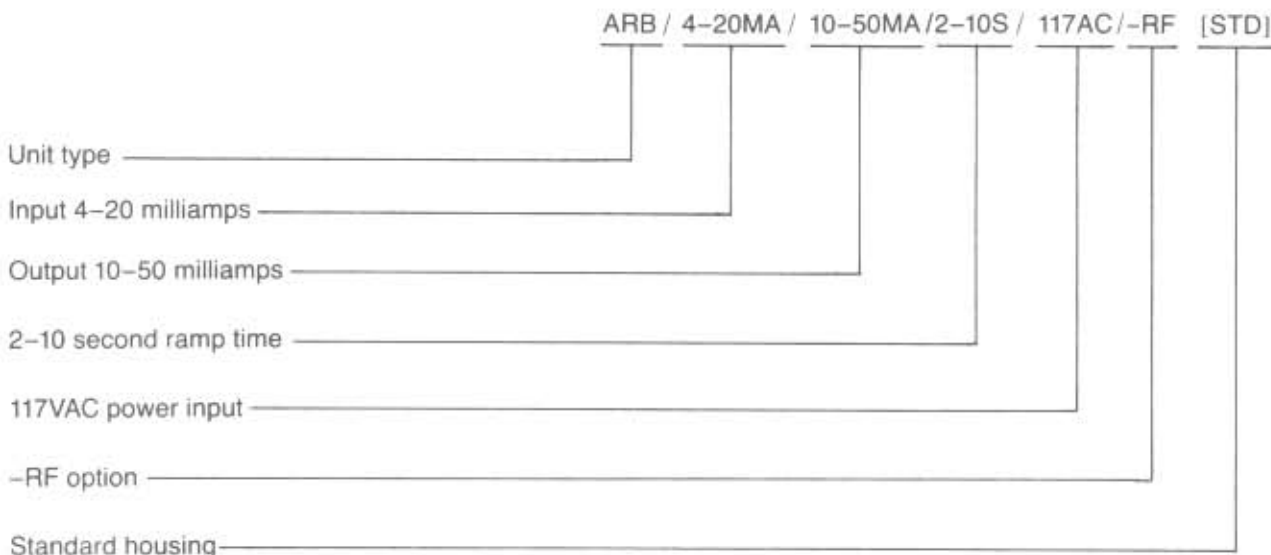


TABLE 1-3. ARB ELECTRICAL OPTIONS

Option Description	Code
Input attenuation for signal input voltage exceeding specification—specify voltage (200V maximum)	-AT
Bailey Input (-10V to +10V)	-BI
Bailey Output (-10V to +10V into 10,000 ohm load minimum)	-BO
Zero elevation—required on all transmitters for inputs exceeding standard zero adjustment capability	-EZ
Excitation for external transmitter (35V DC, 4–20mA input only)	-TX
Factory calibration of unit	-FC
Power fuse	-FU
High-Current/Voltage output	-HI
Independent Ramp Selection	-IR
RFI Filter Terminal Assembly—(Standard Units Only) adds Moore Industries patented integral Filter Terminal Assembly which prevents radio frequency energy from entering standard aluminum case	-RF
Reversed input/output current or voltage relationship (Analog output units only)	-RO

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

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

2.2 CONTROLS DESCRIPTION AND LOCATION

Except for units with the 100ms ramp selection, the ARB controls consist of a ZERO, SPAN, RATE INCREASE, RATE DECREASE adjustments, all located on the unit front panel. Units with 100ms ramp times feature only the ZERO and SPAN adjustments on their front panel.

2.3 TEST EQUIPMENT AND TOOLS REQUIRED

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

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
Voltage or Current Source	Must be capable of producing signal ranges defined by INPUT level requirements of purchased unit (see Table 1-1)	Simulate input signal levels
DC Voltmeter	Must be accurate to within $\pm 0.05\%$ or better	Input signal monitoring (voltage inputs only). Output signal monitoring (voltage outputs only)
DC Milliammeter	Must be accurate to within $\pm 0.05\%$ or better	Input signal monitoring (current inputs only). Output signal monitoring (current outputs only)
Stop Watch (or equivalent)	Must be equipped with sweep second hand and stop/start controls	Measure the ramp timing

2.4 TEST EQUIPMENT SETUPS

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

2.4.1 General Test Equipment Setups

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

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).

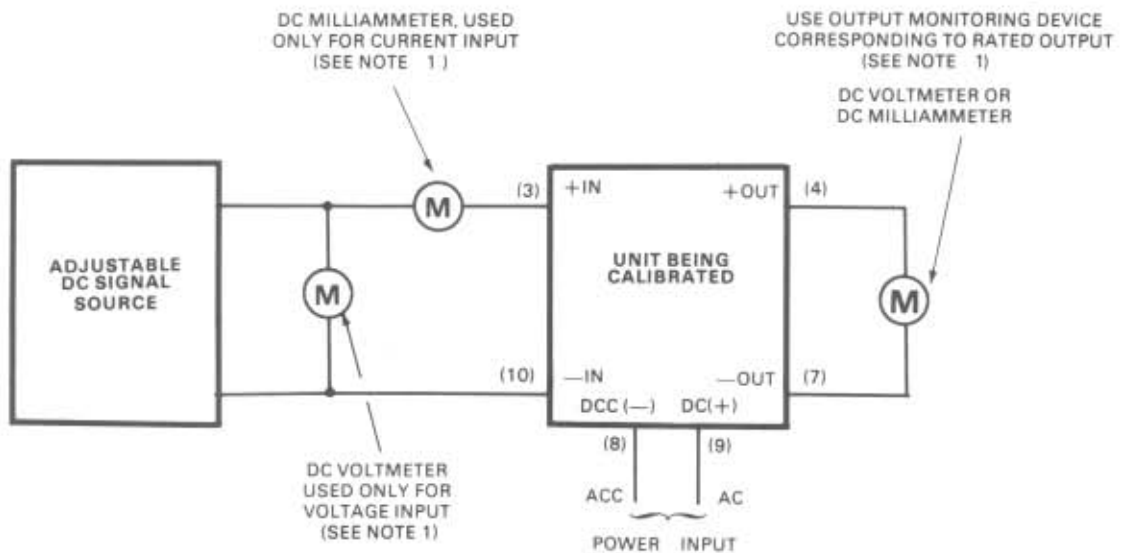
2.5 CALIBRATION

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. Since the ARB may be purchased with an option that affects the calibration procedures, the following paragraphs cover both configurations.

2.5.1 Off-Line Calibration of ARBs Without 100ms Ramp Time Selection

NOTE

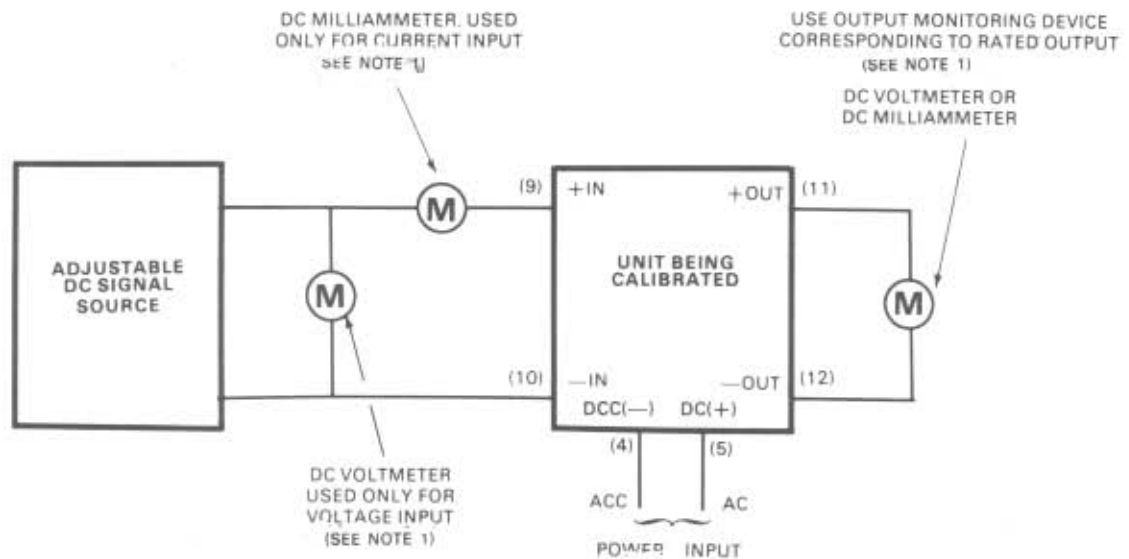
Adjustments should *not* be made in the field on units that are calibrated to values specified in the purchase order. Units that are calibrated at the factory to customer's specifications have protective caps over all potentiometers; do NOT remove these caps.



NOTES:

- 1 INPUT AND OUTPUT MONITORING DEVICES MUST BE ACCURATE TO WITHIN $\pm 0.05\%$ OR BETTER
- 2 NUMBERS IN () APPLY TO PLUG-IN UNITS ONLY
- 3 EITHER AC PWR OR DC POWER IS SUPPLIED, NOT BOTH

FIGURE 2-1. TEST EQUIPMENT SETUP FOR CALIBRATION OF UNIT



NOTES:

1 INPUT AND OUTPUT MONITORING DEVICES MUST BE ACCURATE TO WITHIN $\pm 0.05\%$ OR BETTER.

FIGURE 2-2. TEST EQUIPMENT SETUP FOR CALIBRATION OF EXPLOSION PROOF AND PST UNITS

An adjustable DC signal source and input and output monitoring devices are required for calibration. A method should be included to apply step changes in input (both increasing and decreasing). Refer to Table 2-1 for test equipment information.

NOTE

Refer to Table 1-2 for information on how to use the model number to obtain the specified values of minimum and maximum input and output.

To calibrate a unit, proceed as follows:

- a. Connect unit and test equipment as shown in Figure 2-1 or 2-2. (Refer to paragraph 2-4 to determine which figure is applicable.)
- b. Turn the RATE INCREASE AND RATE DECREASE potentiometers fully clockwise to minimize the time required for the output to respond to changes in input.
- c. Apply power to the unit.
- d. Adjust the signal source to the minimum input specified for the unit (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified minimum input is for the unit).
- e. Adjust the ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified 0% output is for the unit). Be sure to allow sufficient time for the output to reach its final value (especially if the ramp time of the unit is long).
- f. Adjust the signal source to the maximum input specified for the unit (5 mA, 20 mA, 50 mA, 5 VDC, or whatever the specified maximum input is for the unit).
- g. Adjust the SPAN potentiometer to obtain 100% output. Be sure to allow sufficient time for the output to rise.

- h. Repeat steps (d) through (g) as required to obtain the specified 0%–100% outputs with 0% and 100% inputs applied. When the necessary adjustments of the ZERO and SPAN potentiometers have been made, adjust the signal source to 0% input and allow the output to reach 0% before continuing with step (i).
- i. Apply a step input (positive) of the desired value, and then turn the RATE INCREASE potentiometer counterclockwise to obtain the desired up-ramp rate. Use the stop watch (or other timer) to determine the rate. Repeat this step as necessary to obtain the desired up-ramp rate when an increasing step input is applied. Conclude this step with the desired input (greater than 0%) applied and allow the output to reach its corresponding value before continuing with step (j).
- j. Apply a decreasing *step* input from the value used in step (i) down to 0%, and then turn the RATE DECREASE potentiometer counterclockwise to obtain the desired down-ramp rate. Use the stop watch to determine the rate. Repeat this step as necessary to obtain the desired down-ramp rate when a decreasing input is applied.
- k. Remove the signal source and turn off the power input to the unit.

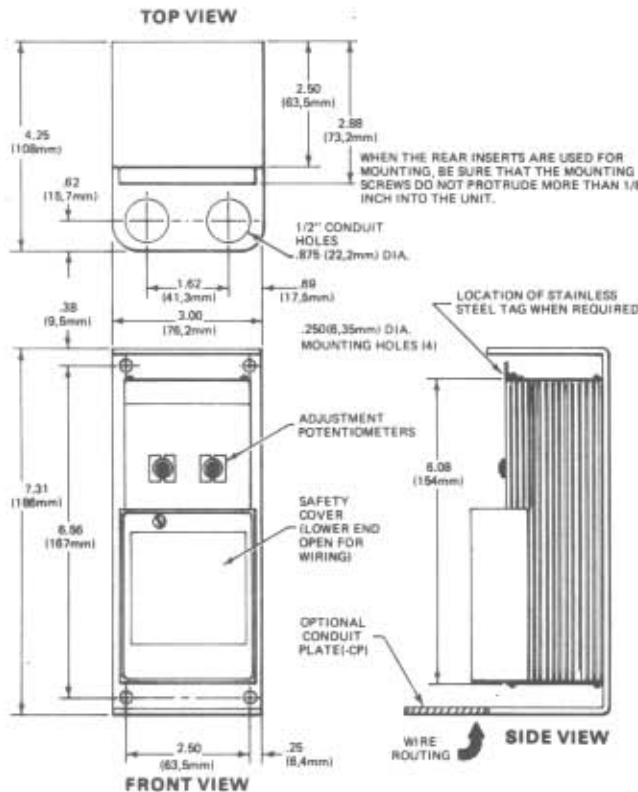
2.5.2 Off-Line Calibration of ARBs with 100 ms Ramp Time Selection

To calibrate a unit with IR option, proceed as follows:

- a. Connect unit and test equipment as shown in Figure 2-1 or 2-2.
- b. Apply power to the unit.
- c. Adjust the signal source to the minimum input specified for the unit (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified minimum input is for the unit).
- d. Adjust the ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified 0% output is for the unit). Be sure to allow sufficient time for the output to reach its final value (especially if the ramp time of the unit is long).
- e. Adjust the SPAN potentiometer to obtain 100% output. Be sure to allow sufficient time for the output to rise.
- f. Repeat steps (c) through (e) as required to obtain the specified 0%–100% outputs with 0% and 100% inputs applied. When the necessary adjustments of the ZERO and SPAN potentiometers have been made, adjust the signal source to 0% input and allow the output to reach 0% before continuing with step (g).
- g. Remove the signal source and turn off the power input to the unit.

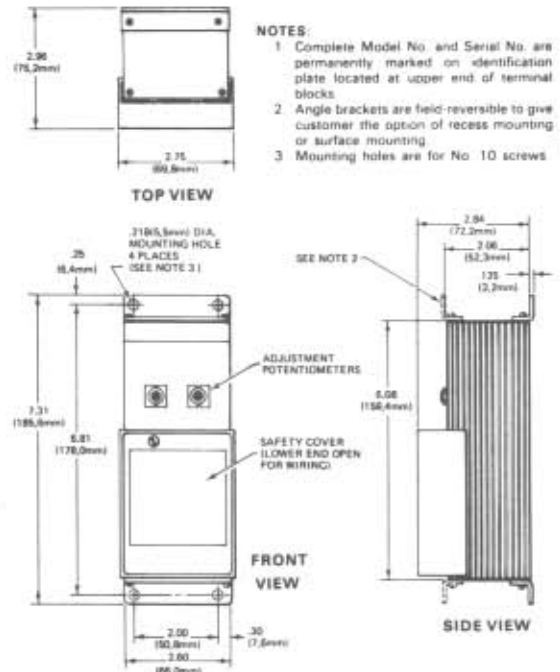
3.1 MECHANICAL INSTALLATION

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 plug-in unit mounted in a rack, be sure that the rack has adequate ventilation.



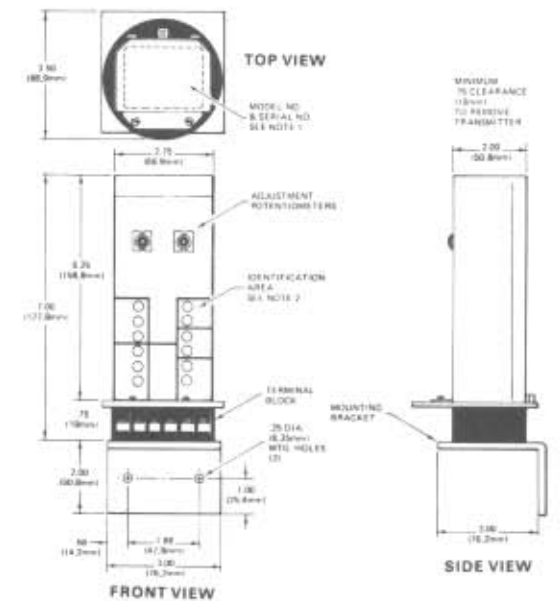
- NOTES:**
- 1 Complete Model No. and Serial No. are permanently marked on identification plate located at upper end of terminal blocks.
 - 2 When extra-compact mounting is required for rack or portable installation, C-shaped mounting bracket may be removed and two threaded inserts (located 4.00 inches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

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



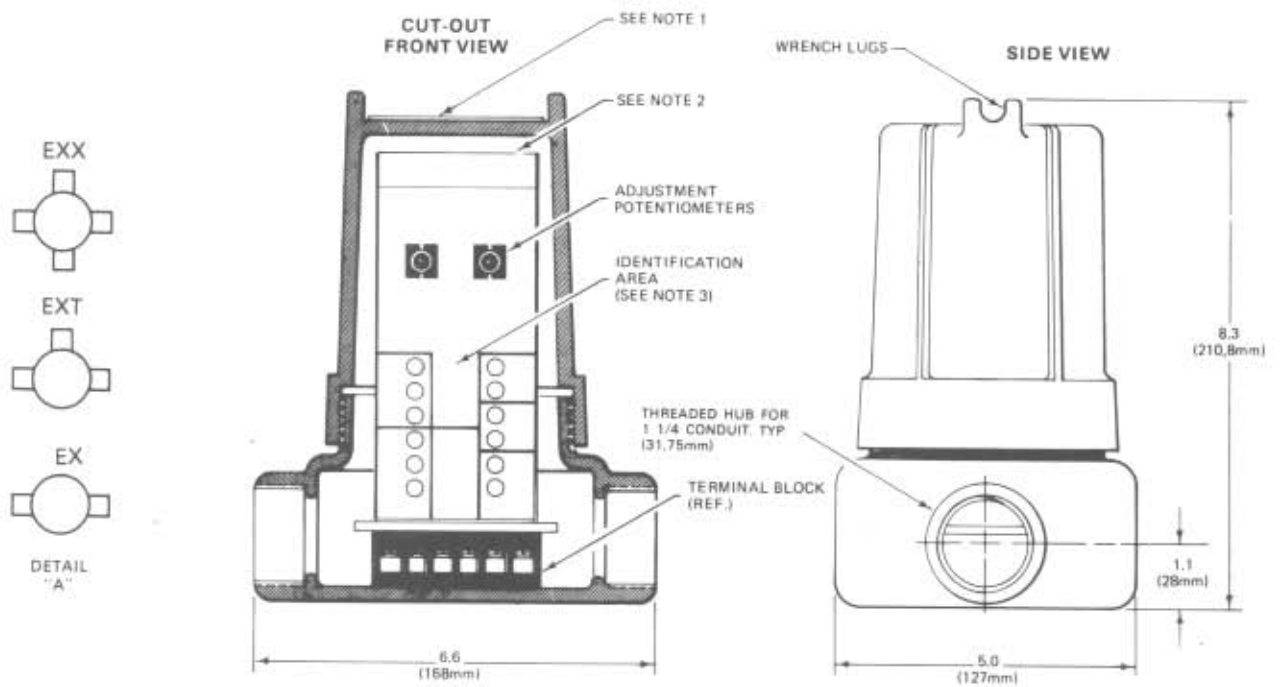
- NOTES:**
- 1 Complete Model No. and Serial No. are permanently marked on identification plate located at upper end of terminal blocks.
 - 2 Angle brackets are field-reversible to give customer the option of recess mounting or surface mounting.
 - 3 Mounting holes are for No. 10 screws.

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



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

FIGURE 3-3. STANDARD UNIT WITH PLUG-IN STD TRANSMITTER (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 "EX" housing (two conduit hubs) is shown above. Similar housings with three or four hubs is illustrated in detail A. Housings are cast aluminum alloy and meet NEMA specifications for Class I, Groups C and D and Class II, Groups E, F, and G.

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

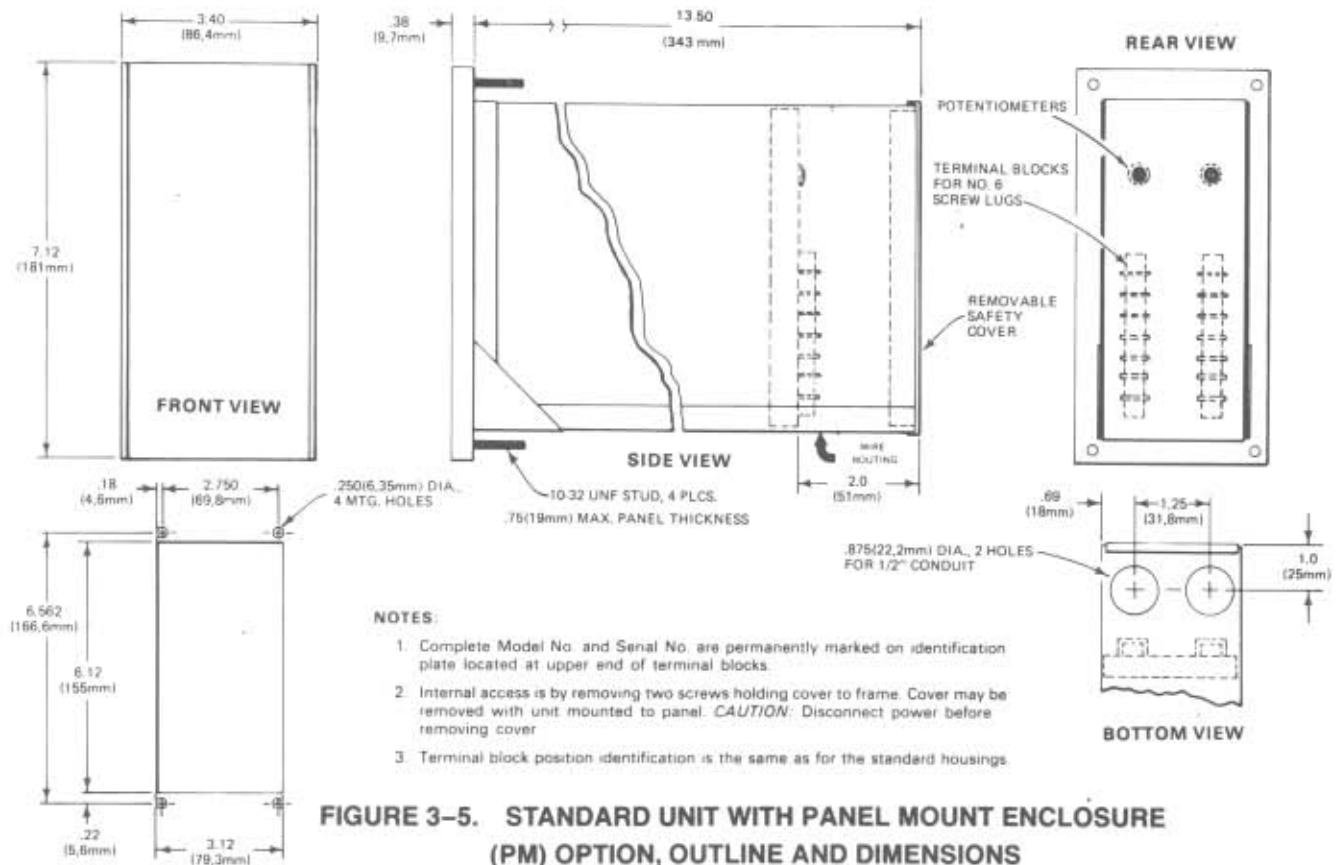
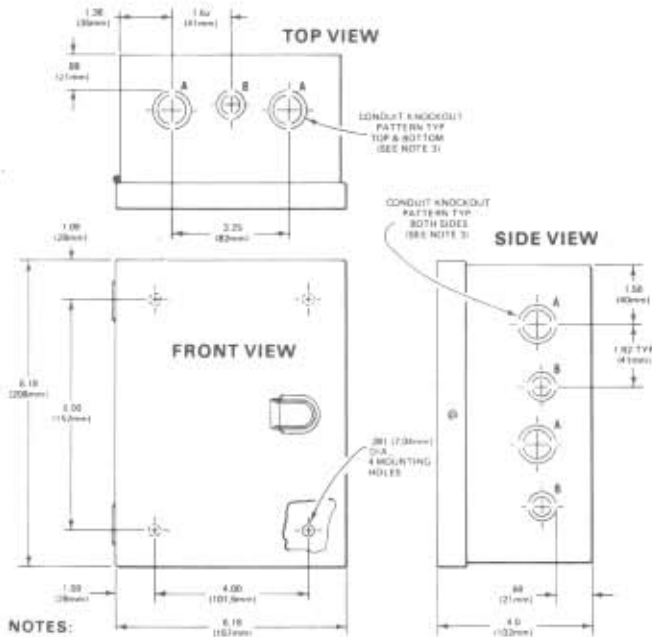


FIGURE 3-5. STANDARD UNIT WITH PANEL MOUNT ENCLOSURE (PM) OPTION, OUTLINE AND DIMENSIONS

SECTION 3

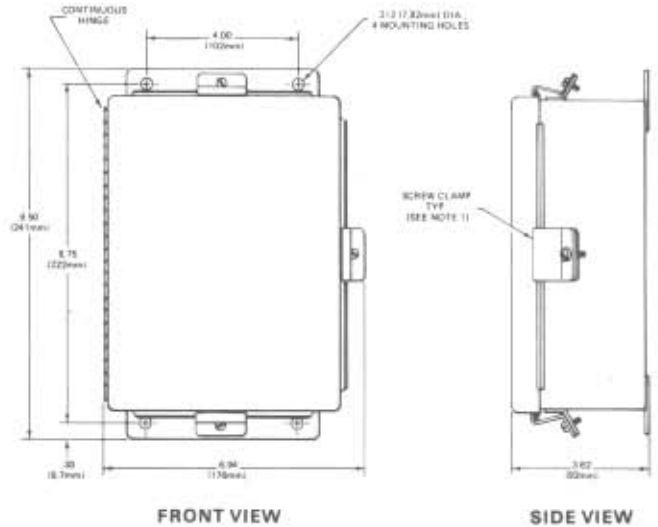
INSTALLATION & OPERATION



NOTES:

1. Complete Model No. and Serial No. are located on identification bracket at upper end of terminal blocks.
2. Wire routing to terminal blocks is provided by open lower end of safety cover. Terminal blocks (2) accommodate #6 screw lugs.
3. Conduit knockouts are for conduits sizes as follows: A = $\frac{1}{4}$ - 1; B = $\frac{1}{2}$ - $\frac{3}{4}$.

a. General Purpose (GP) Enclosure

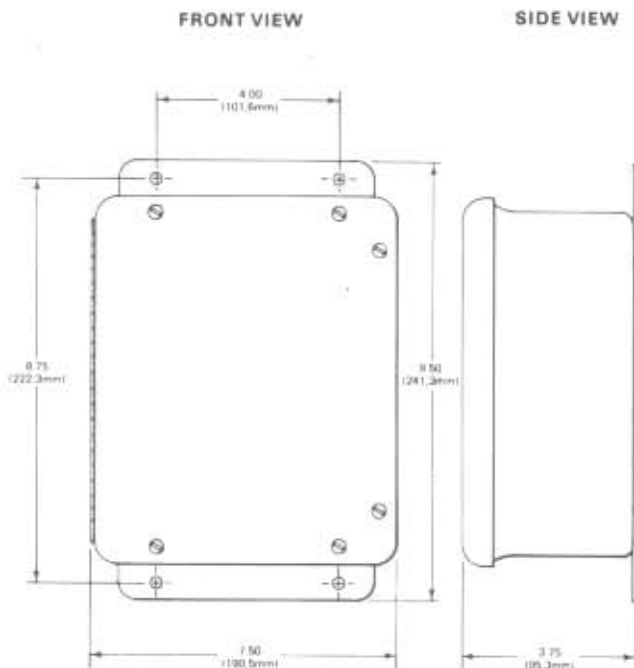


NOTES:

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

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

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

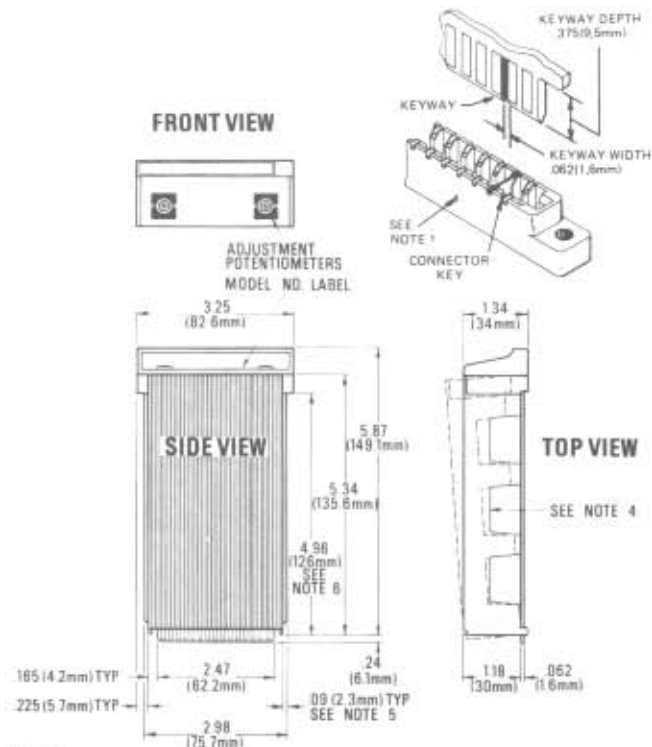


NOTES:

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 3-7. 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 3-8. PLUG-IN UNIT, OUTLINE AND DIMENSIONS

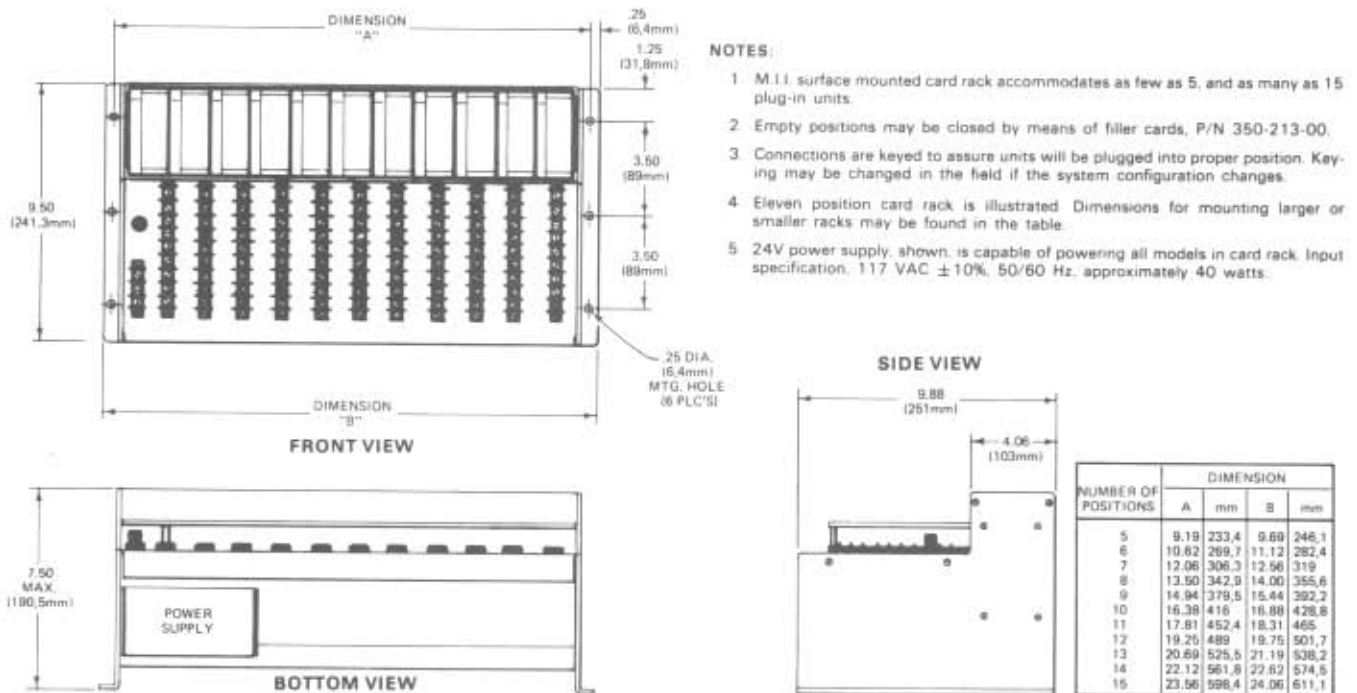
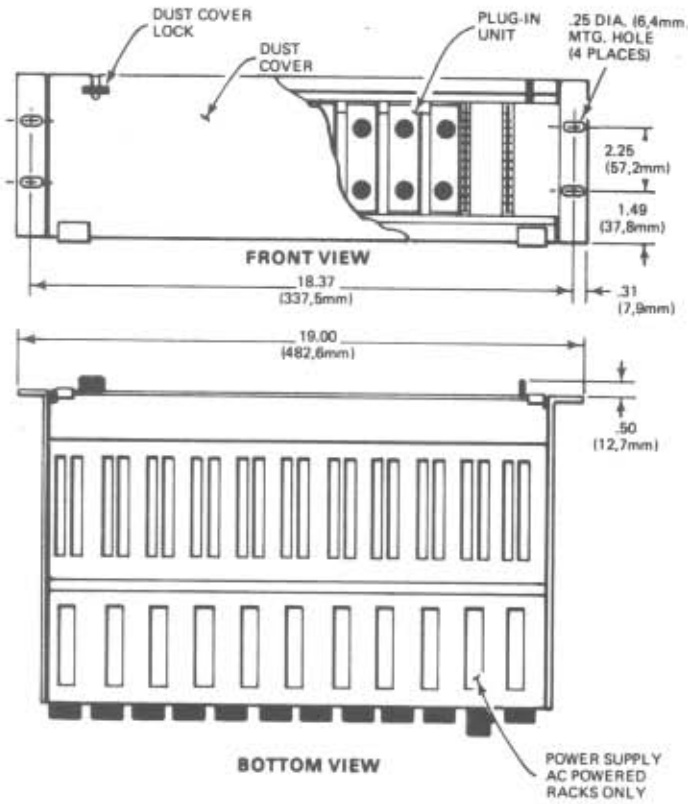


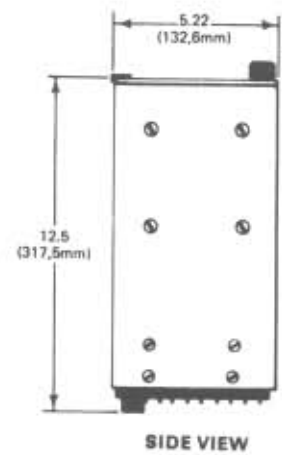
FIGURE 3-9. SURFACE MOUNTED CARD RACKS (SMR), OUTLINE AND DIMENSIONS

SECTION 3

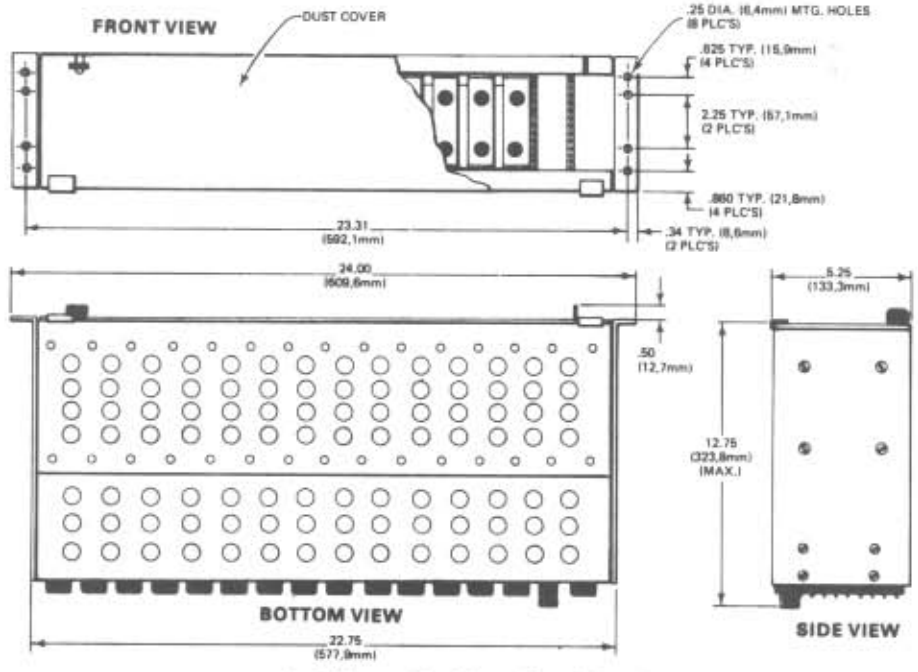
INSTALLATION & OPERATION



- 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 3-10. 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.

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 knock-outs 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 conduit locknut and the panel at enclosure entry and exit. If the enclosure is used without the back panel, a jumper between the conduit entry and exit is necessary to maintain ground continuity.

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 3–11 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.

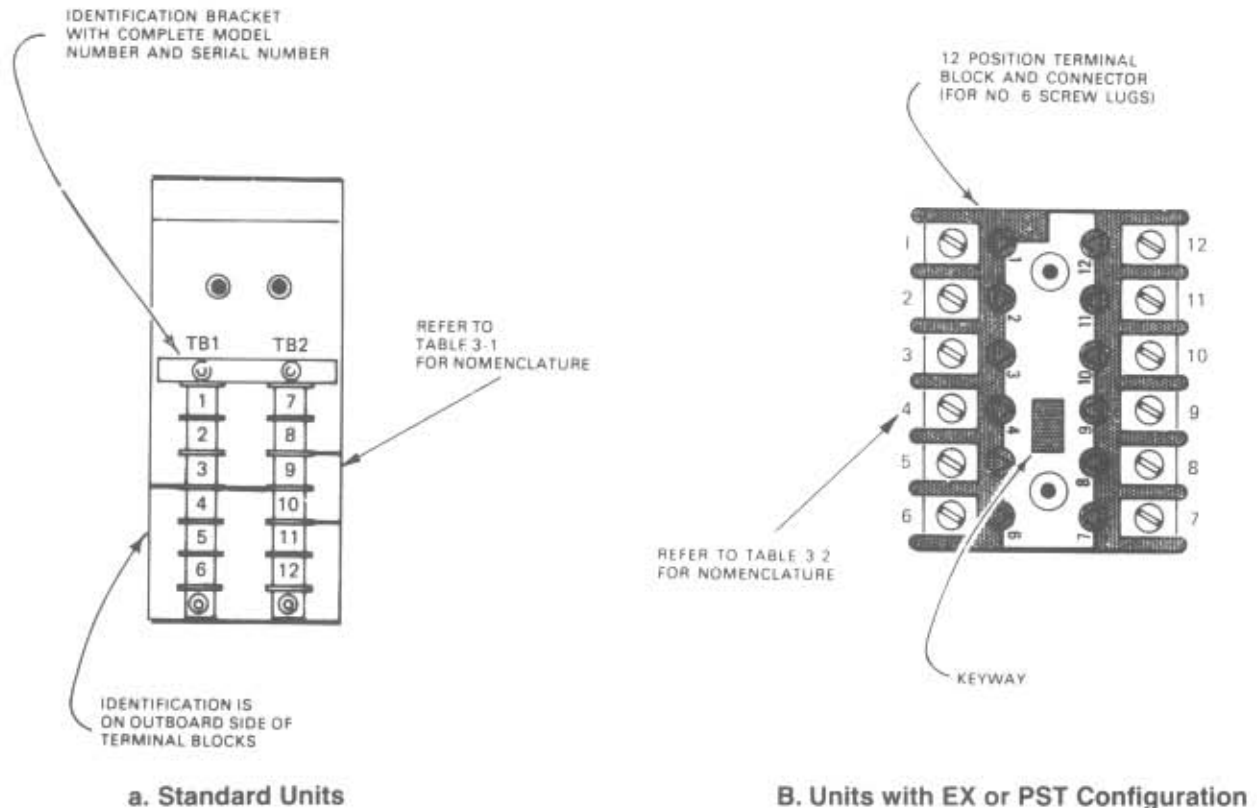


FIGURE 3–11. TERMINAL STRIPS AND TERMINAL BLOCKS IDENTIFICATION

TABLE 3-1. TERMINAL NOMENCLATURE

Options (Note 1)	Terminal Positions (See Figure 3-11)											
	1	2	3	4	5	6	7	8	9	10	11	12
No Options				DCC	DC	GN			+IN	-IN	+OUT	-OUT
AC -SC (Output)			SC	SC	ACC	AC	GND		+IN	-IN	+OUT	-OUT
-SC (Input) (Note 2)												
-TX				+TX					+IN			
-IR (Note 3)												
-HI (Note 3)												

NOTES:

1. Labeling shown here may be combined. The combination may include standard labeling and one or more options. Combinations of options may cause labeling positions to change, but nomenclature will remain as shown.
2. Terminal nomenclature not affected by this option. SC resistor is mounted across +IN and -IN terminals.
3. Terminal nomenclature not affected by this option.

Legend:

DC	+DC Power Input	+IN	Signal Input
DCC	-DC Power Input	+OUT	Signal Output
GND	Chassis Ground	SC	Resistor
AC	AC Power Input	+TX	Power Output
ACC	AC Power Return	+TX	Power Output

3.2.2 Power Connections

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

DC-powered units. On these units the DC terminal is connected to the + (positive) side of the source, and the DCC terminal is connected to the - (negative) side. The DC source should be regulated to within $\pm 10\%$ 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 220/240 VAC 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 is chassis ground.

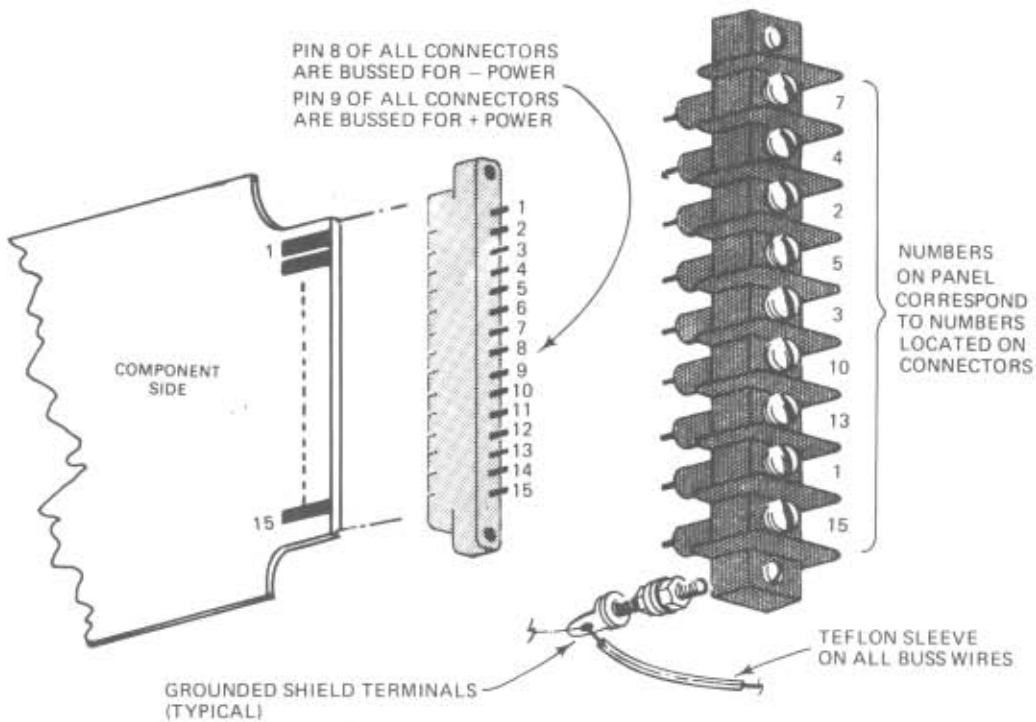


FIGURE 3-12. TERMINAL STRIPS AND TERMINAL BLOCKS IDENTIFICATION

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

Options	Terminal Position (See Figure 3-11)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NONE or -IR Option			+IN	+OUT			-OUT	DCC	DC	-IN					
-SC (Output)		SC			SC										
-SC (Input) (Note)			SC							SC					
-TX															-TX

Keyways

NOTE: SC Input resistor is mounted across -IN and +IN terminals.

Legend:

DC	+DC Power Input	±OUT	Signal Output
DCC	-DC Power Input	SC	SC Resistor
GND	Chassis Ground	+TX	Power Output
±IN	Signal Input		

3.2.3 Connections On Units With -SC Option

On units with the -SC (selectable current) option, connect the input selectable current resistor to the +IN and -IN terminals. 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.

3.2.4 Connections on Units With -TX Option

On units with -TX option, connect the positive output lead from the field mounted transmitter to the +TX terminal on the ARB. Connect the minus output lead from the transmitter to the +IN input on the ARB.

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, ZERO, RATE INCREASE and RATE DECREASE 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.

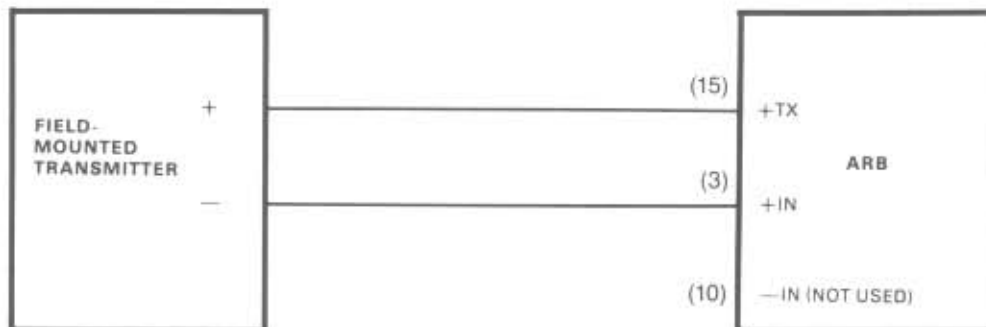


FIGURE 3-13. -TX OPTION CONNECTIONS

4.1 INTRODUCTION

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

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

4.2 AC POWER SUPPLY CIRCUIT (STANDARD UNITS ONLY)

The AC power supply circuit consists basically of a power transformer that produces two different AC outputs. Referring to the ARB module schematic diagram, VS1 is connected across the primary of power transformer T2 and suppresses transients that may be pres-

ent on the power line. Each half of the center-tapped secondary of T2 puts out 18 volts, and the other secondary produces 38 volts. The voltage from the center-tapped secondary is applied to a full wave bridge rectifier. The other secondary voltage is applied to a half-wave rectifier.

4.3 POWER-INVERTER CIRCUIT

When the unit is ordered for use with DC power, the power inverter is used instead of the AC source shown on the ARB module schematic diagram. The DC applied to the power inverter is converted to a square wave of approximately 3 KHz by Q3, Q4 (Q1, Q2) and the primaries of T1, functioning as a DC-to-AC inverter. Filter L1-C6 (L1-C12) prevents the 3-KHz signal from getting back into the external DC source. CR8 (CR9) provides protection against damage from inadvertent application of DC of incorrect polarity.

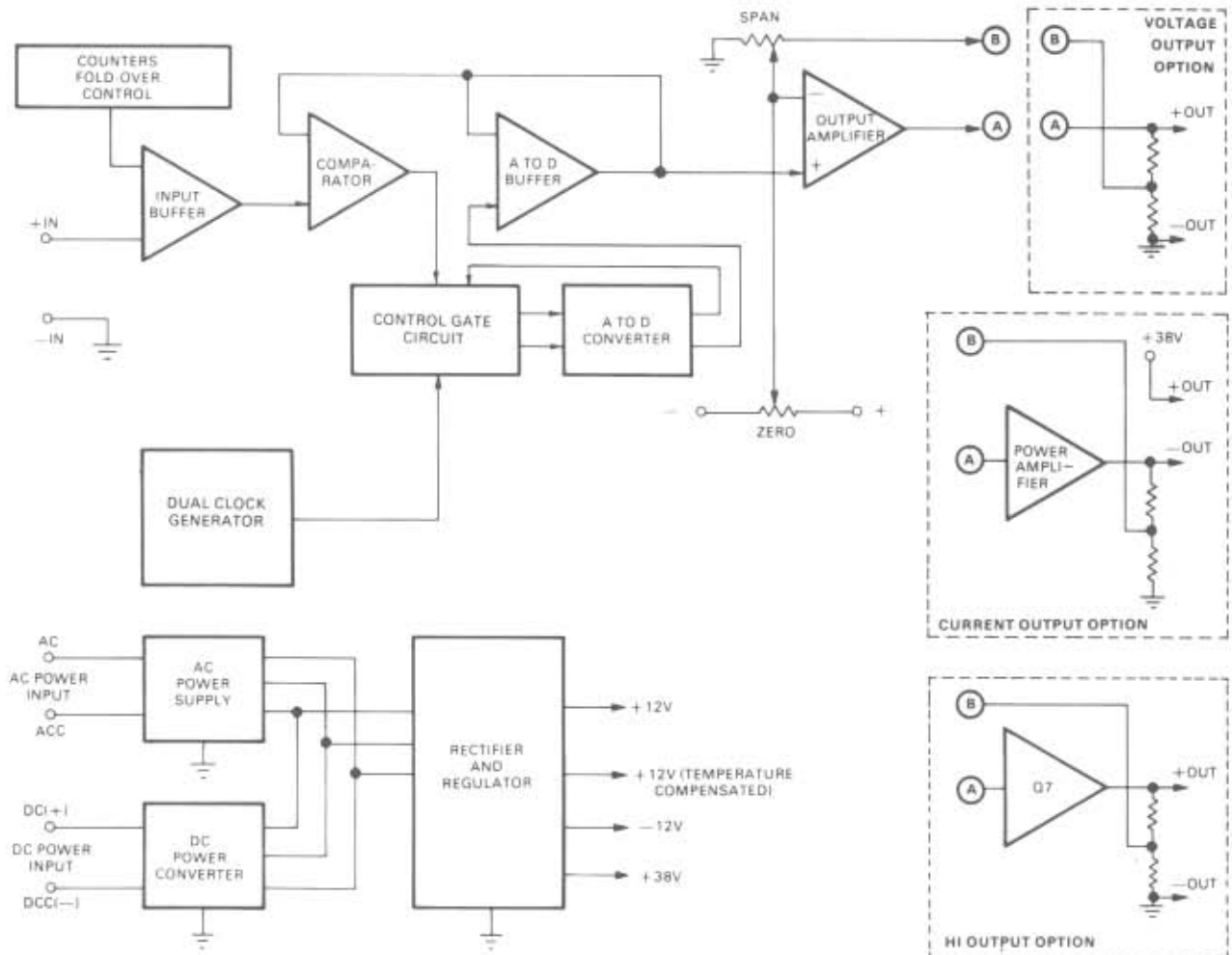


FIGURE 4-1. ARB BLOCK DIAGRAM

The square-wave output from center-tapped secondary 8–13 is applied to a full wave rectifier, and that from secondary 17–16 is applied to a half wave rectifier.

4.4 RECTIFIER AND REGULATOR CIRCUIT FOR STANDARD UNIT

Diode bridge rectifiers CR5, CR6, CR14, CR15 (CR6, CR7, CR13, CR14) form a full-wave bridge rectifier that produces both positive and negative DC outputs (with respect to the grounded center tap of the transformer winding). The positive and negative DC outputs from the bridge are filtered by C4 (C10) and C5 (C11), and regulated to +12 volts and –12 volts by pass transistors Q1 (Q4) and Q2 (Q3). Zener diodes CR9 (CR11), CR 10 (CR12) and CR4 (CR10) are used to clamp the base of the transistors. The power supply also provides an additional +12 volt supply for circuits requiring a temperature compensated voltage. This circuit consists of constant current source CR11, CR13, R21 and Q9 (CR15, CR16, R24 and Q5) that feeds two temperature compensated 6.2 volt zener diodes in series CR9, CR10 (CR11, CR12). A temperature compensated +12 volts is then available at the cathode of CR10 (CR12). Voltage from the transformer winding that is not center-tapped is applied to a half-wave rectifier CR16 (CR3) and filter C11 (C3) to produce operating voltage of approximately 38 volts for the power amplifier and the TX option.

4.5 INPUT CIRCUIT

The input circuit of the ARB module consisting of IC1, IC2, IC3, and associated components, processes the input signals for various operational conditions, provides a digital control signal to the control gate circuit and supplies an analog signal to the output section comparator circuit.

4.5.1 Input Buffer Circuit

The input buffer circuit consists of a differential amplifier input buffer that provides proper termination and buffering for the signal input. Component IC1 (IC2) is a differential amplifier connected as an input buffer stage. Resistor R1 (R16) provides a termination for a specific current analog signal source connected to the +IN and –IN terminals. The signal from the +IN terminal is applied through R2 (R17) and R3 (R7) to IC1 (IC2) pin 3 (non-inverting input). A voltage foldover prevention circuit consisting of CR1, R7 (R3), R8 and R9 (R2) prevents the output of IC1 (IC2) pin 6 from going to zero volts when a zero voltage is applied to the input of the ARB module. Voltage fold-over could cause the up/down counters, on PC2 (PC3) to bottom out, then fold over to all ones. Diode CR1 provides 0.7 volt through R7 (R3), and R8 gives IC1 (IC2) a gain of 0.1 thereby producing a minimum output of 0.07 volt for a zero input voltage. Differential amplifier IC1 (IC2) provides a +5.0 volt output (pin 6) for an input signal level of 100%. The output of IC1 (IC2) goes through R5 (R9) to IC3 (IC1) pin 2. When an input voltage to the ARB module is greater than +5.0 volts, R6 (R4) must be connected to R5 (R9) as a voltage divider. This divider ensures that the voltage to IC3 (IC1) pin 2 is +5.0 volts at 100% of input signal.

4.5.2 Inverting Comparator Circuit

Component IC3 (IC1) is an inverting comparator that produces a low (–12 volts) when the signal on IC3 (IC1) pin 2, representative of the input to the ARB module, is higher than the signal on IC3 (IC1) pin 3, which represents the output of the ARB module. If IC3 (IC1) pin 2 is lower than IC3 (IC1) pin 3, the output will be high. Components C1, C14 (C8), and R24 (R18) filter the input signals to the comparator. Capacitor C15 (C2) provides positive feedback to enable clean switching of IC3 (IC1). The output of IC3 (IC1) pin 6 goes through CR12 (CR2) to R306 (R401) on PC3 (PC4). Diode CR12 (CR2) prevents IC301 (IC402) on PC3 (PC4) from receiving a negative voltage.

Component IC2 (IC3) provides impedance isolation for the output of the D to A converter PC2 pin 2 (PC3 pin 36). The buffered output is sent to IC3 (IC1) pin 3 through R24 (R18) and to the output section through R26 (R19).

4.6 DUAL CLOCK GENERATOR

The dual clock generator consists of IC302 (IC402) and associated components mounted on printed circuit card PC3 (PC4). Figure 4–2 functionally illustrates this circuit. This circuit provides two variable rate clocks, each operating over a predetermined range. When an IR option is selected, each clock operates over a range limited by a specific requirement. A variation within the IR option consists of one variable rate clock operating over a range selected by the specific requirements and a fixed rate clock set to 100 milliseconds. The dual clock generator sends the rate decrease and the rate increase clocks to IC304 (IC401) continuously. IC304 (IC401) selects these clocks as required by the input circuit.

The rate decrease clock circuit consists of one-half IC302, C302, R303, R304 (IC402, C404, R401, R402), and the RATE DECREASE potentiometer. The output of IC302 (IC402) pin 5 is fed to IC304 pin 2 (IC401 pin 2) for control gating.

The rate increase clock circuit consists of one-half IC302, C301, R305, R306 (IC402, C403, R403, R404) and the RATE INCREASE potentiometer. The output of IC302 pin 9 is sent to IC304 pin 5 (IC401 pin 8) for control gating.

4.7 CONTROL GATE CIRCUIT

The control gate circuit consists of IC303, IC304, R302, and IC403, (IC404, IC401, R406, and IC403) with all of the components mounted on printed circuit card PC3 (PC4). This circuit controls the flow of the clock pulses, to the up/down counters in the digital-to-analog circuit located on PC2 (PC3).

When the input to the ARB is higher than the output, IC3 (IC1) pin 2 is higher than the signal at pin 3 forcing the op-amp output, pin 6 low, and back biasing diode CR12 (CR2). This signal is inverted by IC301 (IC403) and applied to IC303 (IC404) to set the latch. The \bar{Q} output from the latch becomes one of the inputs to the NOR

IC3 (*IC1*) pin 2. Comparator IC3 (*IC1*) will switch and cause IC3 (*IC1*) pin 6 to go high. This forward biases CR12 (*CR2*).

The rate decreased clock from IC302 (*IC402*) is now gated through IC304 (*IC401*) and IC301 pin 11 (*IC402* pin 8), enabling the down count function in the digital-to-analog converter. The rate decrease clock passes through into the clock input of the digital-to-analog converter PC2 pin 5 (*PC3* pin 35). The digital-to-analog converter counts down, generating a linear ramped function, until the output at PC2 pin 2 (*PC3* pin 36) reaches a level corresponding to the input voltage of the ARB module.

As long as the input to the ARB module is constant, the operation of the input circuit, the control gate circuit, and the digital-to-analog converter cause the output at PC2 pin 2 (*PC3* pin 36) to rock back and forth on the last digit holding within a few millivolts. If the input to the ARB module goes to 200% of a predetermined value, the digital-to-analog converter will count up until the most significant bit PC2 pin 3 (*PC3* pin 33) goes high. This high on IC301 pin 5 (*IC403* pin 9) sends IC301 pin 6 (*IC403* pin 8) low, enabling the digital-to-analog converter to count down. Thus, protection is provided for over-range input signals to the ARB module.

4.8 DIGITAL-TO-ANALOG CONVERTER

The Digital-To-Analog (D to A) Converter, mounted on printed circuit board PC2 (*PC3*), converts the up or down count clock signals from the dual clock circuit to an equivalent analog signal. The D to A converter consists of 3 four-bit cascading up-down counters IC201, IC202, IC203 (*IC301, IC302, IC303*) and a resistance ladder network. The counters are controlled by signals from the control gate circuit. Each set bit develops a voltage across its respective voltage dividing resistor network. Since the network's outputs are connected in series, the resistances are additive. When the counters are full, PC2 pin 3 (*PC3* pin 33) goes high, providing a control signal to the control gate circuit. The output of the D to A converter issues from the top of the resistance ladder, at the most significant bit side of the counters, providing a sum of all bits to IC2 (*IC3*) pin 3 (non-inverting input) of IC2 (*IC3*). Buffer IC2 (*IC3*) is a unity gain amplifier that isolates the output of the D to A circuits from the output amplifier stage and the input of IC3 (*IC1*) pin 3.

A counter reset circuit is also included on this board. The circuit consists of Q201 (*Q301*) and associated components. When power is applied to the ARB module, capacitor C201 (*C301*) charges through R201 (*R327*). During the charge, Q201 (*Q301*) is off and a high signal appears at the reset input to the counters, initializing these components. When the capacitor charges to 0.7V, Q201 (*Q301*) fires and the reset indicator is removed. The counters are now set to zero and are ready to begin counting. The D to A circuits are powered by a temperature compensated supply to improve signal stability.

4.9 OUTPUT AMPLIFIER CIRCUITS DESCRIPTION

The output amplifier provides the drive necessary for the unit voltage output (see paragraph 4-12) or for the drivers when current output or HI option is selected (see paragraph 4-10 or 4-13 respectively). This circuit provides the zero level and signal span adjustments. The output amplifier is a differential amplifier that consists of IC4 and associated components. IC4 receives the output of IC2 (*IC3*) through signal attenuator R26, R27 (*R19, R10*) that provide about a half-volt signal level at the non-inverting input to IC4. The inverting input also receives the bias zero signal. This bias is generated by the zero circuit consisting of voltage divider R10 through R13 (*R11, R12, R20, R21*), ZERO potentiometer and zener diodes CR2, CR3 (*CR4, CR5*). The voltage divider, zener diode network provide a constant signal across the ZERO potentiometer. A shift in the ZERO potentiometer wiper contact can produce either a positive or a negative signal at the inverting input pin 2. This signal is summed with the positive signal at the non-inverting input pin 3. The resultant output of IC4 at pin 6 is a voltage whose zero shift is directly affected by the position of the ZERO potentiometer.

The inverting input also receives the feedback circuit which includes the SPAN potentiometer. This component selects portions of the feedback loop effectively controlling the gain of the amplifier. Variations in the gain of IC4 result in a variation of the signal output span.

4.10 CURRENT OUTPUT CIRCUIT DESCRIPTION

Output amplifier IC4 provides drive current to power amplifiers Q6, Q7 and Q8 (*Q201, Q202, and Q203*). Transistor Q6, Q7 (*Q203, Q201*) are connected in a Darlington configuration. Transistor Q8 (*Q202*) is connected in parallel with Q7 (*Q201*) to generate greater drive to -OUT output terminal. A power source of approximately 38 volts is provided at +OUT. This configuration allows the ARB load between the OUT terminals to be driven directly by the power amplifiers, thereby offering a very low output impedance. Capacitor C7 (*C201*) filters transients from the load circuit.

4.11 SELECTABLE CURRENT (-SC) OUTPUT OPTION

The -SC option consists of the additional selectable current resistor R102. All other current output circuits are identical to those described in paragraph 4.10. Normally current from the power source flows through the external load through Q8 (*Q202*) and R17 (*R203*) to ground. When the -SC option is selected, however, R17 (*R203*) is removed and replaced by R102. Load current now flows through R102 and is thereby limited to the value specified by the resistor.

4.12 VOLTAGE OUTPUT CIRCUIT DESCRIPTION

When a voltage output is selected, transistors Q6, Q7 and Q8 (*Q201, Q202, Q203*) are removed and the output of IC4, now a higher gain circuit (gain of 5), provides a high impedance output to the OUT terminals. The load now is between the amplifier output and ground and is in parallel with R17 and R34 (*R203 and R210*).

4.13 HIGH CURRENT, VOLTAGE OUTPUT (-HI) OPTION

This option provides higher current for voltage output by adding a driver stage Q7 (*Q201*) between output amplifier IC4 and the output terminals. Driver Q7 (*Q201*) is powered by a 38V source providing the drive necessary for higher current capability for voltage output. Resistor R17 (*R203*) provides the low resistance necessary to generate more current in the output stage. Capacitor C8 (*C9*) is used in amplifier IC4 to minimize the offset generated by the high gain of the amplifier.

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

- a. Remove the two front Phillips-head screws at the top of the unit.
- b. Remove the four Phillips-head screws at the bottom of the unit.
- c. Slide the front panel (with the circuit board still attached) down and free of the sides of the case. Points on the circuit board may now be reached for troubleshooting. It is suggested that the case be used as a container for storing the removed hardware.

5.2.2 Disassembly of Unit in NEMA Boxes

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

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

- a. Loosen clamps that hold hinged cover on OT and WT enclosures only, and open enclosure; otherwise loosen screws securing FG cover. Inspect FG gasket for damage and replace if necessary.
- b. Loosen four screws that secure cover on box.
- c. Remove plastic safety cover from unit.
- d. Tag and disconnect wires from unit. On FG units, tag and disconnect ground wire from conduit to mounting post.
- e. Remove four nuts that secure mounting plate assembly into box.
- f. Remove mounting plate assembly from NEMA box.
- g. Loosen and remove mounting nuts that hold units on mounting plate and remove units.
- h. Disassemble unit as described in paragraph 5.2.1.

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

- a. Open cover on box.
- b. Remove plastic safety cover from unit.
- c. Tag and disconnect wires from unit.
- d. Remove four nuts that secure unit mounting bracket assembly to rear of box.
- e. Remove units with attached brackets.
- f. Disassemble units from mounting brackets.
- 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 PC board (two front bottom).
- c. Remove two side screws from front panel.
- d. Remove one countersunk screw from back-bottom of unit in bottom of PC board.

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

5.2.4 Disassembly of Units in EX Enclosures

Use the following procedure to disassemble unit:

- a. Using a bar wrench, attach to wrench lugs and loosen the housing cover from the base.
- b. Unscrew protective cover to expose unit.
- c. Use procedure of paragraph 5.2.3.

5.2.5 Disassembly of PM Units

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

- a. Pull out safety cover to expose wiring.
- b. Tag and disconnect wires from terminal strip. If troubleshooting requires access to reverse side of PC board, perform the procedure described in next step.
- c. Remove screws holding cover to frame and lift cover off the case assembly.

CAUTION

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

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

5.2.6 Disassembly of a Plug-In Unit

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

CAUTION

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

- a. Gently spread forward locking feet and lift front of cover.
- b. With the front of the cover raised, slide the cover to the rear to disengage it from the plug-in card.

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

5.2.7 Disassembly of Plug-In Units in Card Racks

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

5.3 TROUBLESHOOTING

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

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

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 coat-

ing, 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 Liquinix, for at least 30 seconds.
- b. Repeat step (a) with pure deionized water only.

CAUTION

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

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

Removal of Organic Contaminants

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

CAUTION

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

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

5.3.2 Component Replacement General Information

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

5.3.3 Component Replacement Techniques

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

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 trichloroethane or equivalent. Be sure adequate ventilation is provided when using this or any other chemical.
- c. Do not excessively bend or twist the leads of small components; they break easily.

- d. Before removing a component, observe the lead dress. Be sure that the lead dress of the replacement is the same as that of the original.
- e. 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 trichloroethane or equivalent.
- g. Test the unit for proper operation and, if necessary, recalibrate by the procedure given in Section 2.
- 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 ones removed. Longer screws will damage the unit.

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.

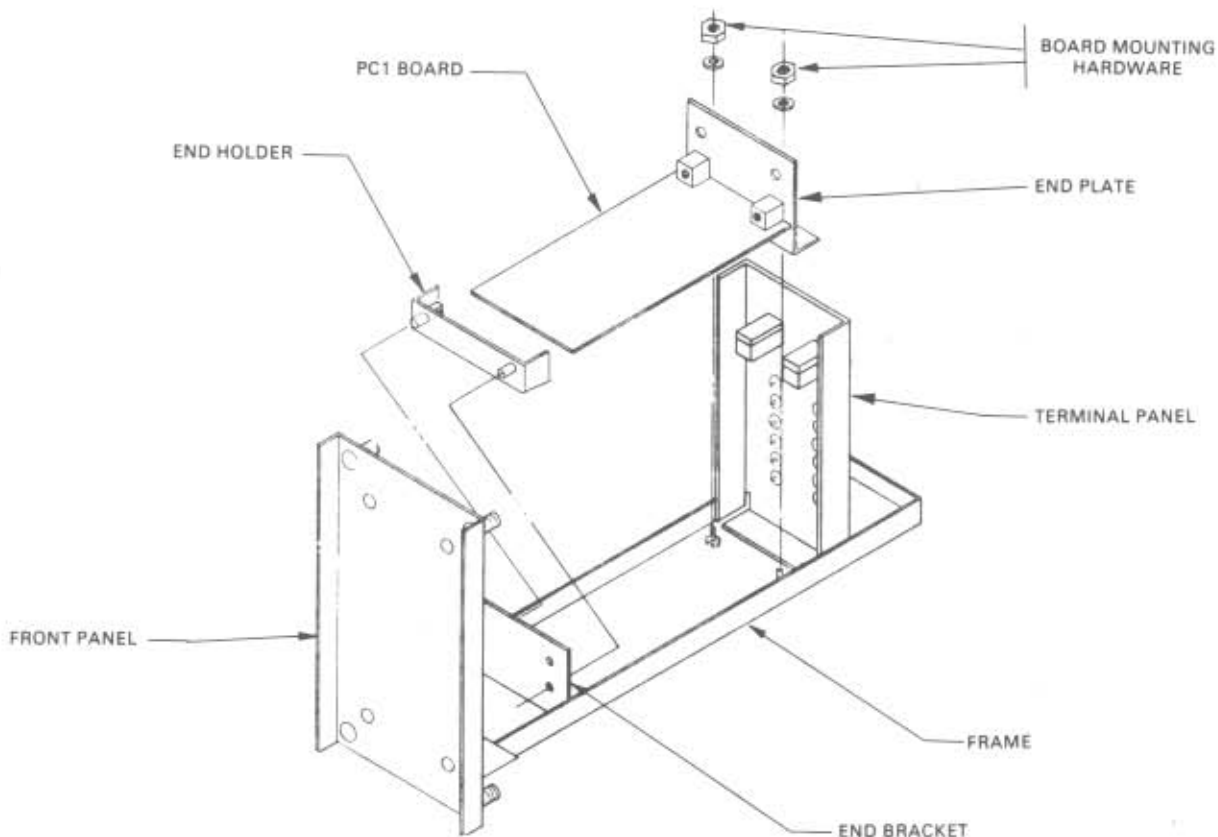


FIGURE 5-1. DISASSEMBLY OF PM UNITS

TABLE 5-1. WAVEFORMS OR VOLTAGES

TEST POINTS	DECREASE	INCREASE
1	<div style="float: right; margin-top: 10px;"> 7.5 V (Approximately) 5.07 V 1.07 V </div>	
2	<div style="float: right; margin-top: 10px;"> +12 V 0 UP-CLOCK (NOTE 2) </div>	
3	<div style="float: right; margin-top: 10px;"> +12 V 0 DOWN-CLOCK (NOTE 2) </div>	
4	<div style="float: right; margin-top: 10px;"> +12V 0 </div>	
5	<div style="float: right; margin-top: 10px;"> 7.5 V 5.07 V 1.07 V </div>	
6	<div style="float: right; margin-top: 10px;"> 0.7 V 0.5 V 0.1 V </div>	
7	<div style="float: right; margin-top: 10px;"> 1.4 V 1.0 V 0.2 V </div>	
8	<div style="float: right; margin-top: 10px;"> +12V 0 </div>	
9	+12V (TEMPERATURE CONTROLLED)	
10	+12 V	
11	+38 V	
12	-12 V	
NOTES: 1. MAXIMUM INPUT SIGNAL STEP CHANGES SHOWN 2. THESE CLOCKS ARE INDEPENDENT OF EACH OTHER AND ARE NOT NECESSARILY SYNCHRONIZED (SHOWN HERE SHIFTED BY 180° TO ILLUSTRATE MAXIMUM VARIATION.) 3. COUNTER IS FULL AND MOST SIGNIFICANT BIT IS RAISED (2048).		



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TOLERANCES
UNLESS NOTED
X ±.1
XX ±.03
XXX ±.010
ANGLES ±30°

DRAWN	E. Kelley	Wagner
CHECKED		
DESIGNED		
SCALE		

STANDARD
DIGITAL
ARB

DRAWING NUMBER
213-403-00

SHT 1 OF 2

REVISION
H

CATEGORY

SCHEMATIC

REVISED BY

ECO 5992

DATE

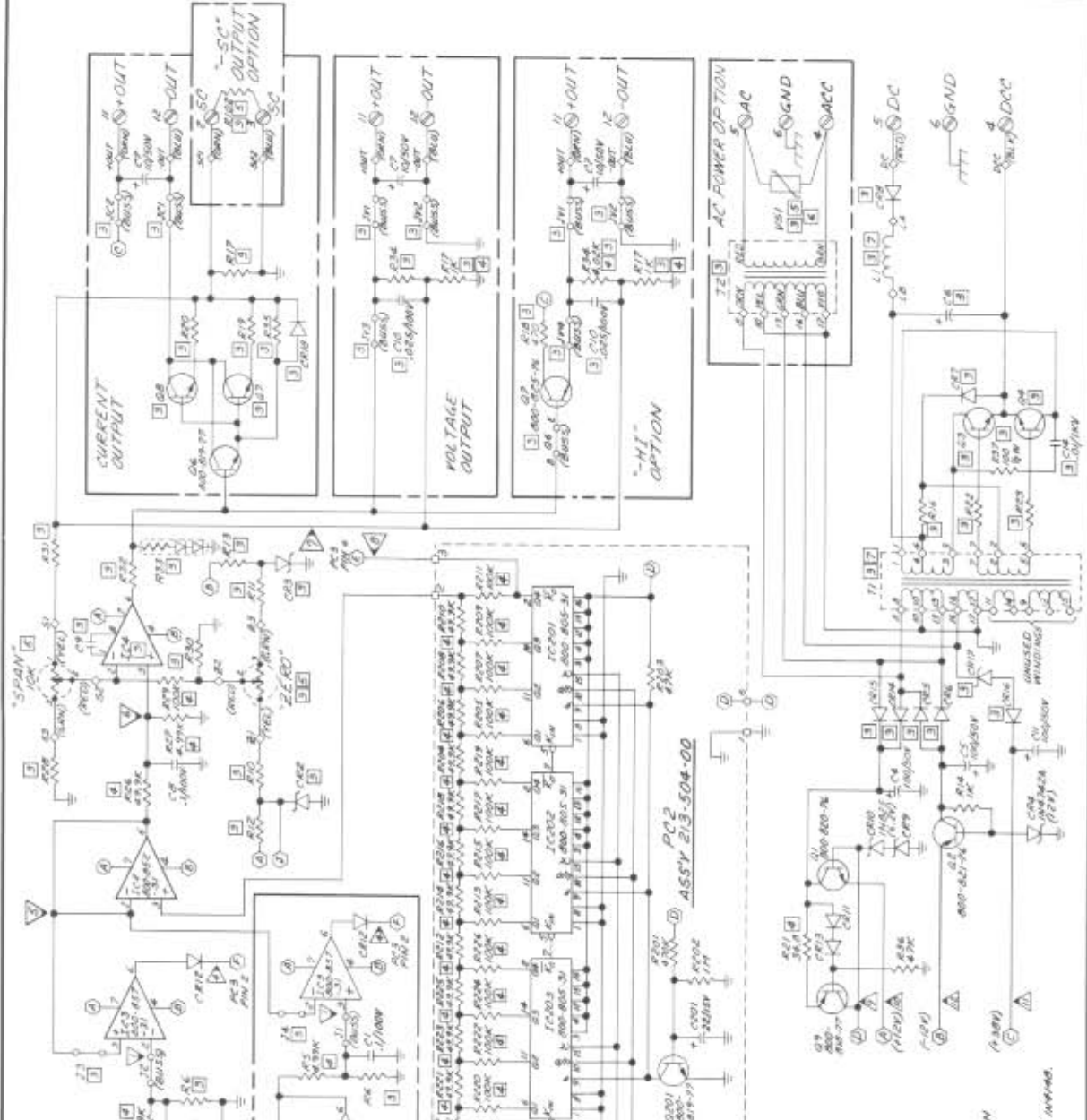
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BY

11/71

APPROVAL

[Signature]



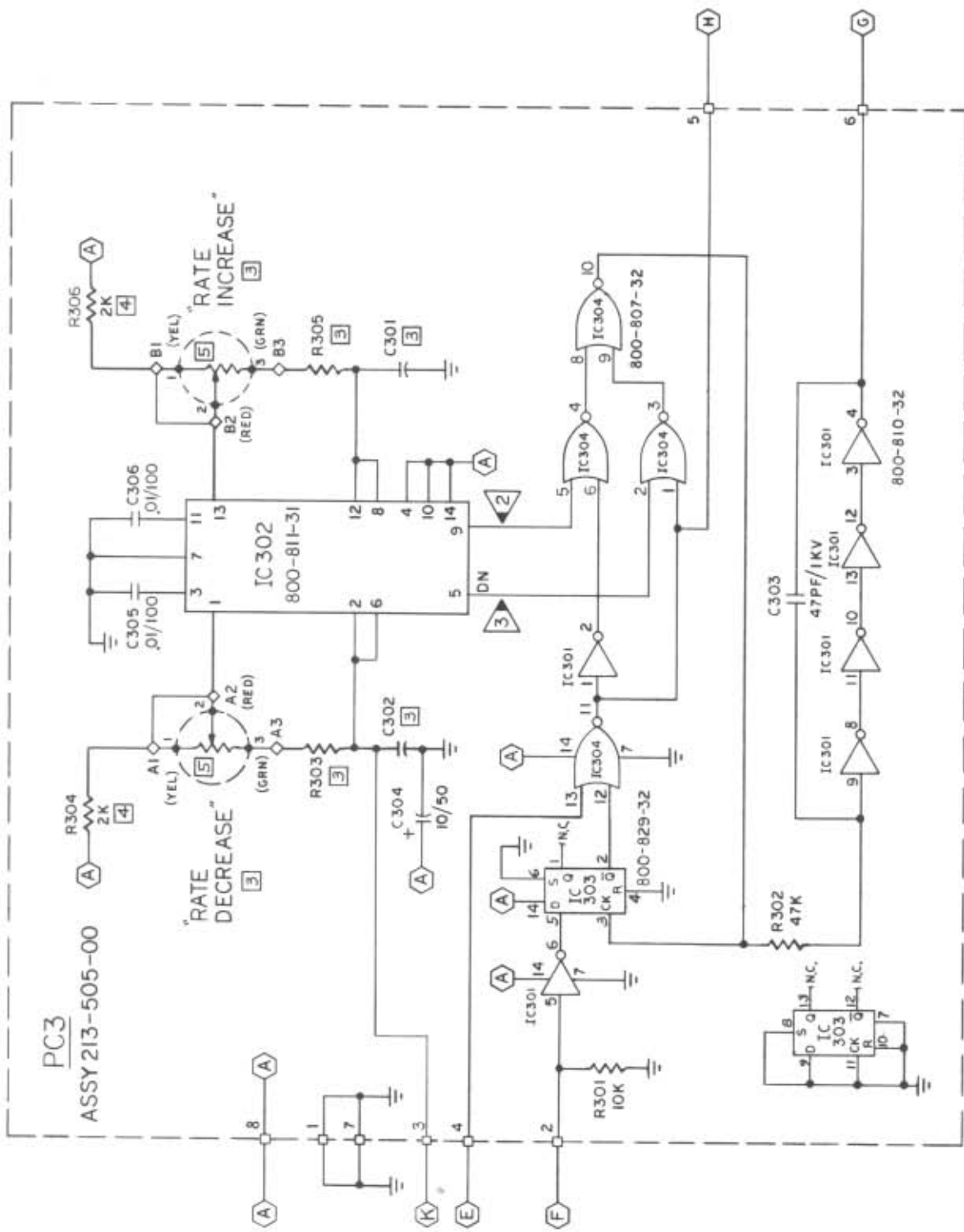
14. TEST POINT, FILLED END IS POINTER. SEE SECTION 5 OF MANUAL, "SERIAL/VOLTAJE".
15. ELECTRICAL COMMONS (SAME LETTERS, LETTERS AND NUMBERS) ARE ON P.C. BOARD OR ASSY. SHG.
16. +V AND GND (COMMON) ARE COMMON (GROUND).
17. TERMINAL BLOCK POSITION (2 POSITION).
18. 1 OR 2 PINS INTERCONNECT PIN.
19. DISCONNECT WIRING PAD ON P.C. BOARD.
20. POTENTIOMETER INCREASE CLOCKWISE FROM 1 TO 3.
21. PINS ARE ENCAPSULATED TOGETHER.
22. PINS BEHIND BOARD, EXTERNALLY MOUNTED FOR -RF OPTION.
23. ITEM NOT MOUNTED ON P.C. BOARD.
24. METAL FILM RESISTOR (MFCO) 1/4W, 1%.
25. RESISTORS ARE CARBON COMPOUND (COP) 1/4W, 1%. RESISTOR ARE 1/4W.
26. RESISTANCE IN OHMS, CHARACTERISTIC IN MICROHM.
- NOTES: UNLESS OTHERWISE SPECIFIED.

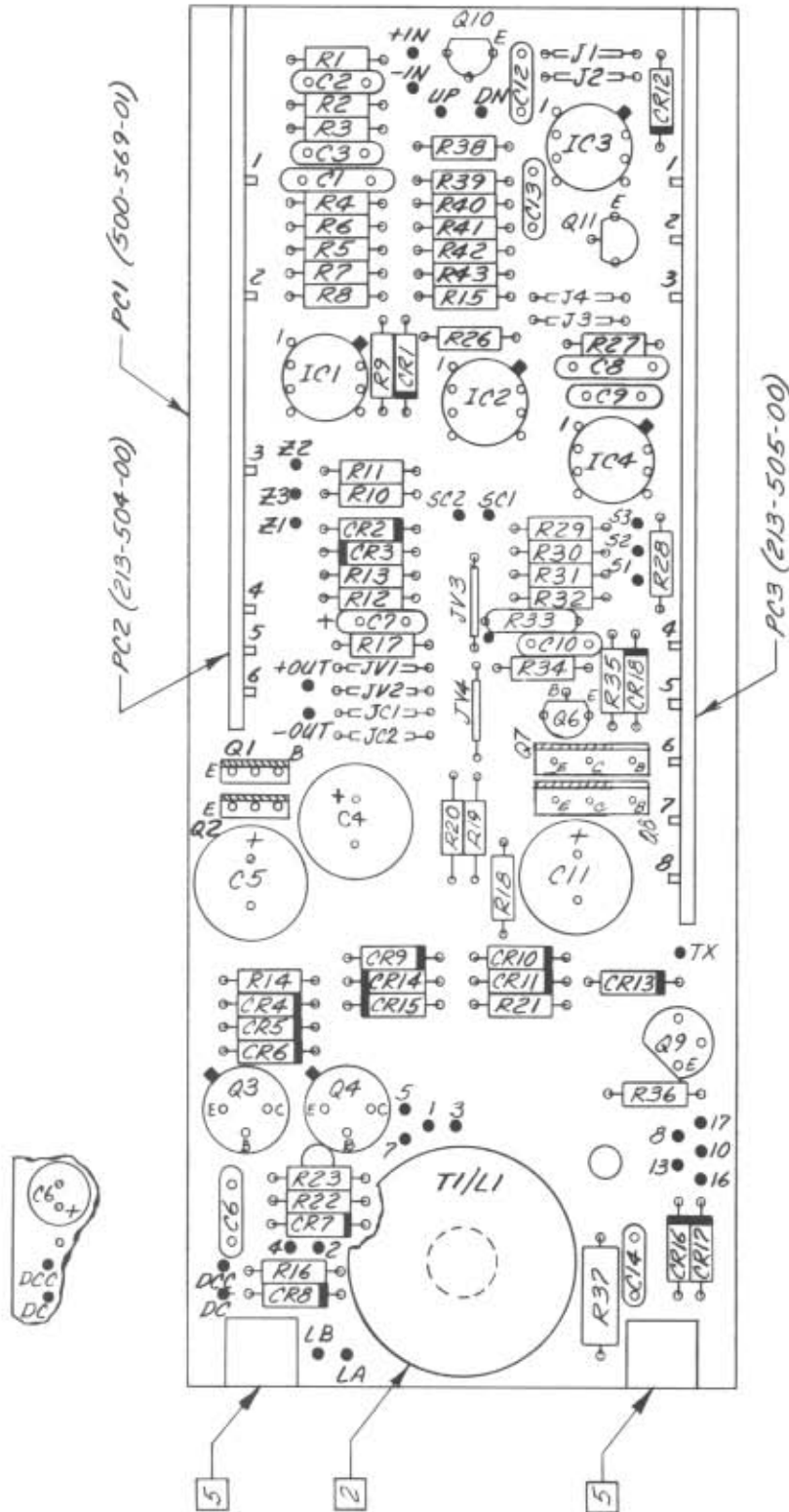


DO NOT SCALE DRAWING	
TOLERANCES UNLESS NOTED	DRAWN <i>De Santis</i> 22 SEP 78
.X ±.1	CHECKED
.XX ±.03	ENGINEER <i>W. G. ...</i>
.XXX ±.010	SCALE NONE
ANGLES ±30°	

ARB
STD, DIGITAL,
(PC1, PC2, PC3)

DRAWING NUMBER	213-403-00	REVISION	H
CATEGORY	SCHEMATIC		
REVISION BY	DATE	BY	APPROVAL





6. SEE PAGE 2 FOR ADDITIONAL COMPONENTS.
5. INSTALL MTG. BLKS. BEFORE ADDING COMPONENTS. SEE CASE ASSY FOR LOCATION.
4. METAL SIDE OF Q1, Q2, Q7 & Q8.
3. ALL JUMPERS ARE 22 AWG BUSS, TEFLON SLEEVED.
2. TO INSTALL T1/L1, USE DWG. 200-237-00.
1. ALL LEADS TO BE SOLDERED TO PADS, FAR SIDE.

NOTES:



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Sepulveda, California 91343

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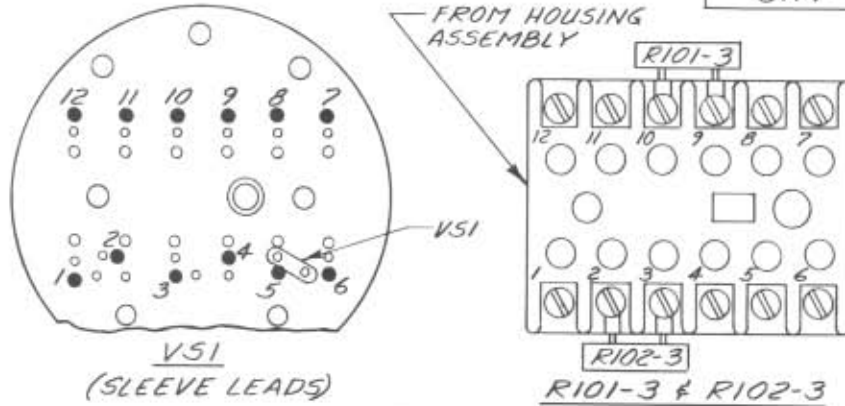
TOLERANCES
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XX ± 0.3
XXX ± 0.10
ANGLES ± 30°

DRAWN *R. Kelley* 10/83
CHECKED
INQUIRY
SCALE 1/1

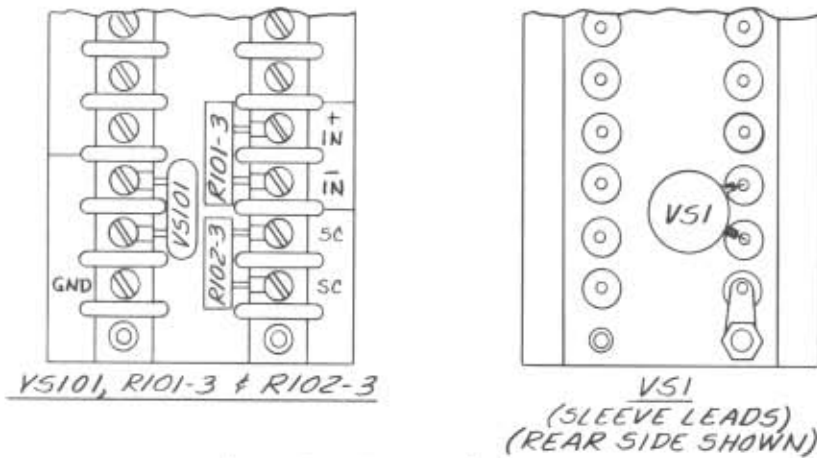
STANDARD
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DESIGN NUMBER 213-503-00	REVISION H
CATEGORY PC ASSEMBLY	
REVISED BY	DATE

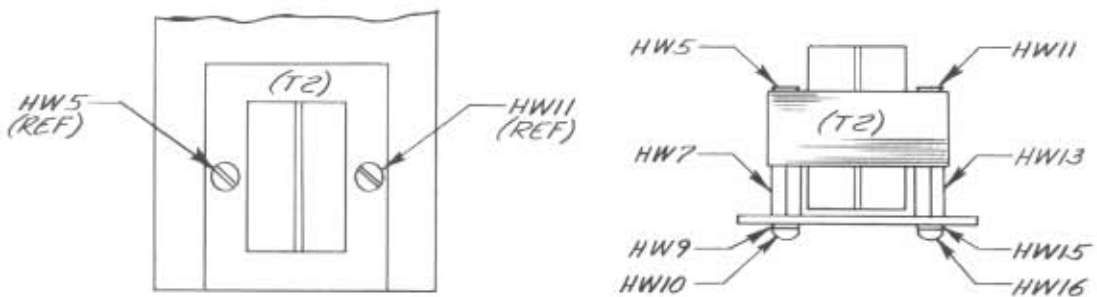
SHT 2 OF 2



"SP" CASE



"SR" & "PM" CASE

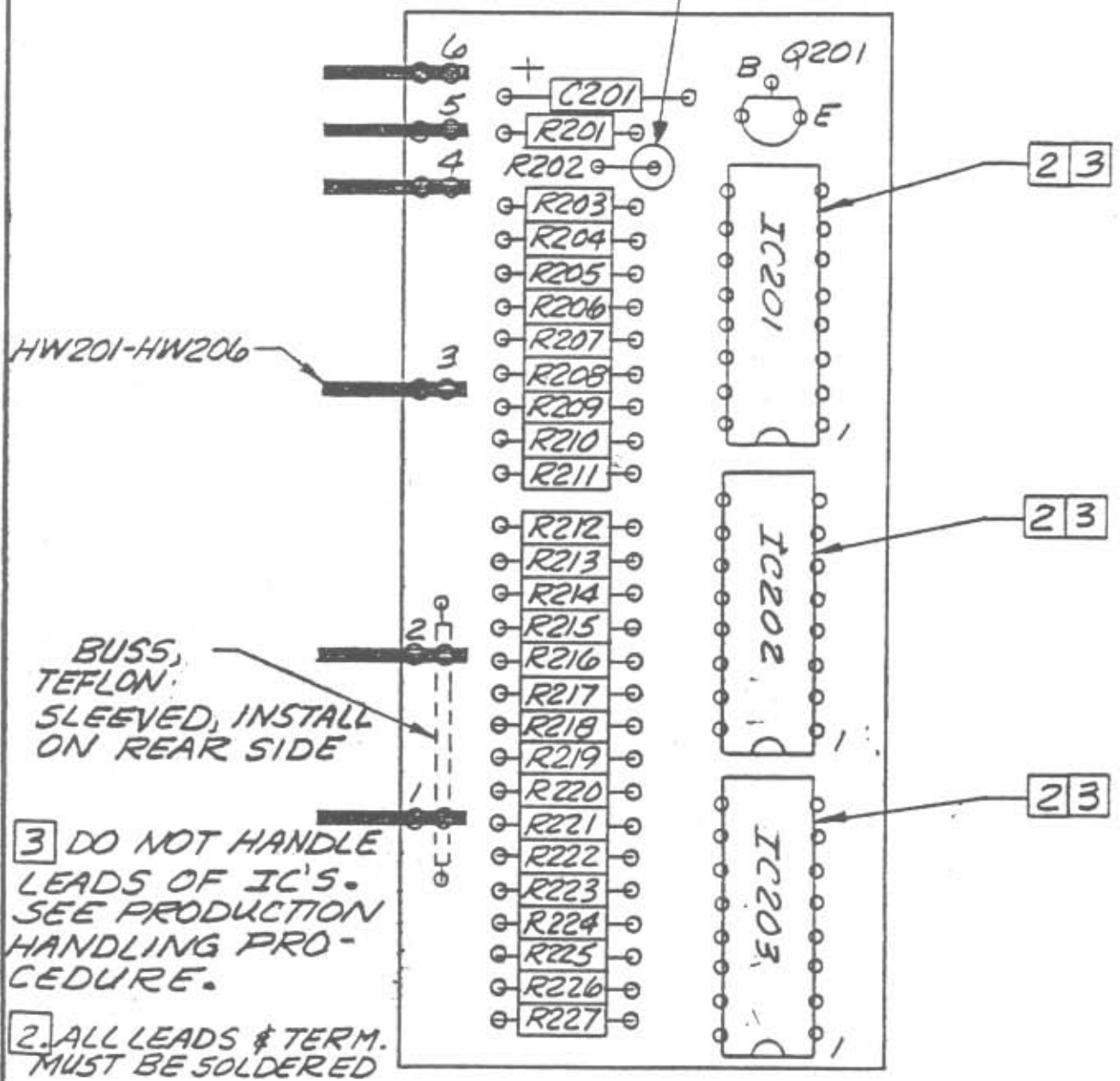


T2 MOUNTING

NOTE: USE LOCKTITE ON SCREWS HW5 & HW11 WHEN INSTALLING.

REV.	DESCRIPTION	DATE	BY	APPROV.
A	INITIAL RELEASE	8/12/75	JVN	JR

MOUNT R202 VERTICAL



3 DO NOT HANDLE LEADS OF IC'S. SEE PRODUCTION HANDLING PROCEDURE.

2 ALL LEADS & TERM. MUST BE SOLDERED

1. ALL JUMPERS ARE 22 AWG BUSS. TRIM EXCESS, TYP.

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE		DRAWN <i>[Signature]</i> 2/20/75	MOORE INDUSTRIES INC. VAN NUYS CA.
TOLS. UNLESS NOTED: .X = ±.10 .XX = ±.030 .XXX = ±.010 ANGLES = ± 30'		CHECKED <i>[Signature]</i>	
DO NOT SCALE DRAWING		PROJ. ENGR. <i>M Reynolds</i> 8/12/75	P.C. BD. ASS'Y STD DIGITAL ARB PC2
SCALE:	CUSTOMR.	DWG. NO. 213-504-00	REV. A



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.XXX ±.010
ANGLES ±30°

DRAWN R. Kelly 10/83
CHECKED
ENGINEER
SCALE 2-1

STANDARD DIGITAL
ARB PC3

DRAWING NUMBER

213-505-00

CATEGORY

P.C. ASSEMBLY

REVISED BY

4658, 4527, 5715

DATE

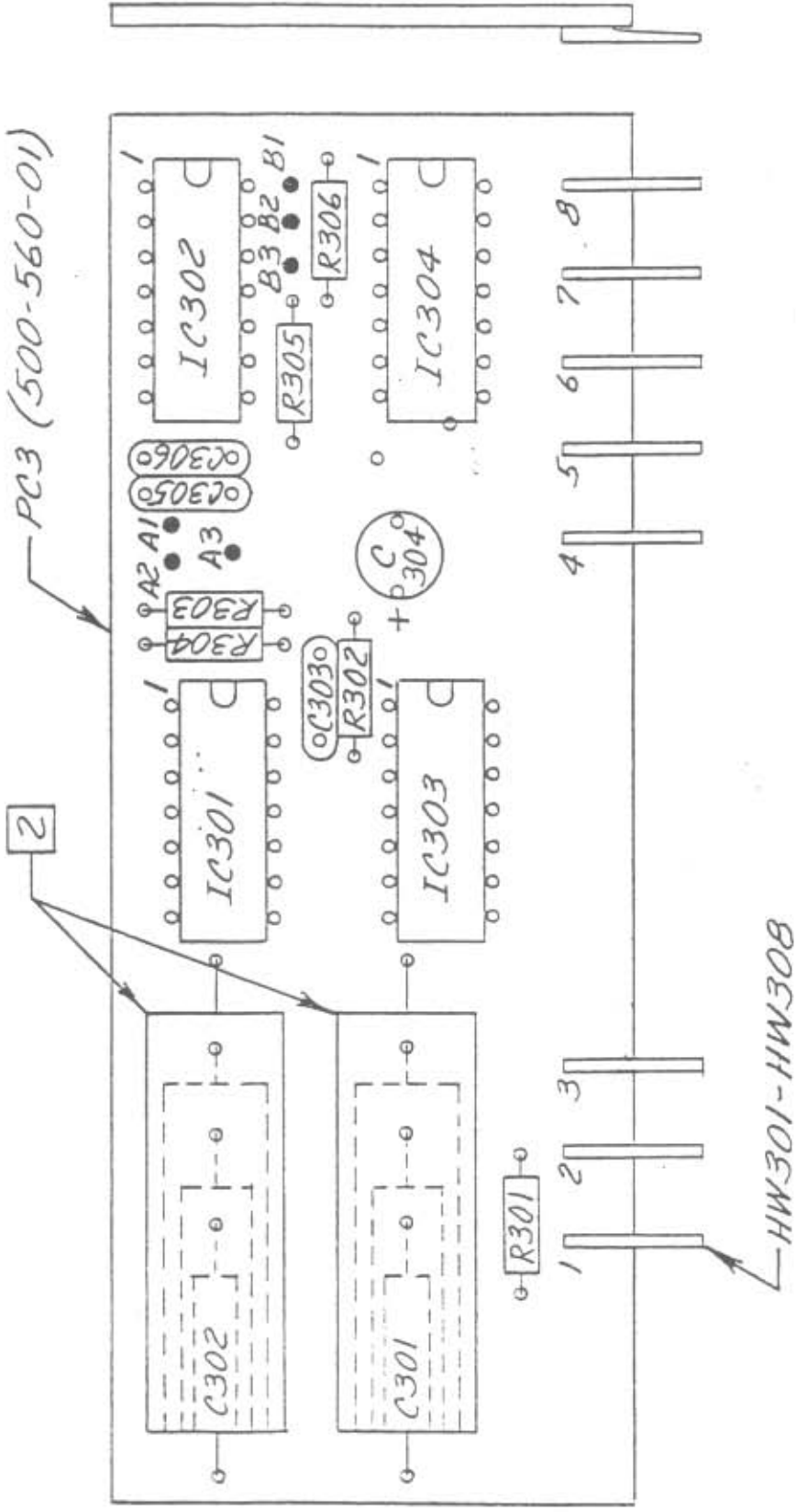
5/1/76

BY

RK

APPV

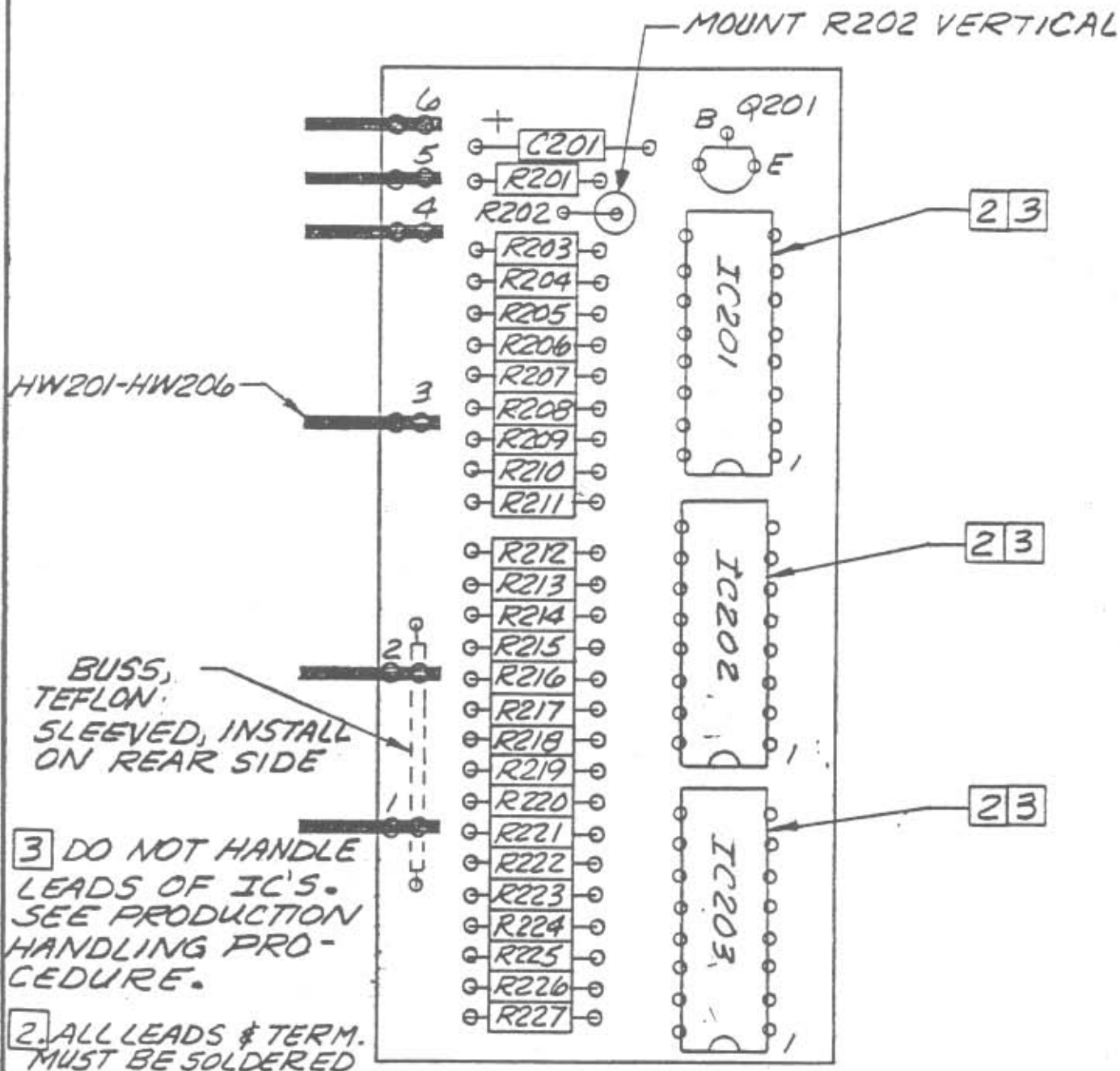
JK



2. C301 & C302 TO BE INSTALLED AS SHOWN DEPENDING ON SIZE OF CAPACITOR.
1. ALL LEADS TO BE SOLDERED TO PADS, FAR SIDE.

NOTES:

REV.	DESCRIPTION	DATE	BY	APPROV.
A	INITIAL RELEASE	8/12/75	JVN	JR



BUSS, TEFLON SLEEVED, INSTALL ON REAR SIDE

3 DO NOT HANDLE LEADS OF IC'S. SEE PRODUCTION HANDLING PROCEDURE.

2 ALL LEADS & TERM. MUST BE SOLDERED

1. ALL JUMPERS ARE 22 AWG BUSS. NOTES:



DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE		DRAWN <i>[Signature]</i> 4/20/75	MOORE INDUSTRIES INC. VAN NUYS CA.
TOLS. UNLESS NOTED: .X " ± .10 .XX " ± .030 .XXX " ± .010 ANGLES ± 30'		CHECKED <i>[Signature]</i>	
DO NOT SCALE DRAWING		PROJ. ENGR. <i>[Signature]</i> 8/12/75	P.C. BD. ASS'Y STD DIGITAL ARB PC2
SCALE:	CUSTOMR.	DWG. NO. 213-504-00	REV. A



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TOLERANCES
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X	±.1
.XX	±.03
.XXX	±.010
ANGLES	±30°

DRAWN	R. Kelly	10/83
CHECKED		
ENGINEER		
SCALE	2-1	

STANDARD
DIGITAL

ARB PC3

DRAWING NUMBER

213-505-00

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D

CATEGORY

P.C. ASSEMBLY

REVISED BY

KGS, 4527, 5715

DATE

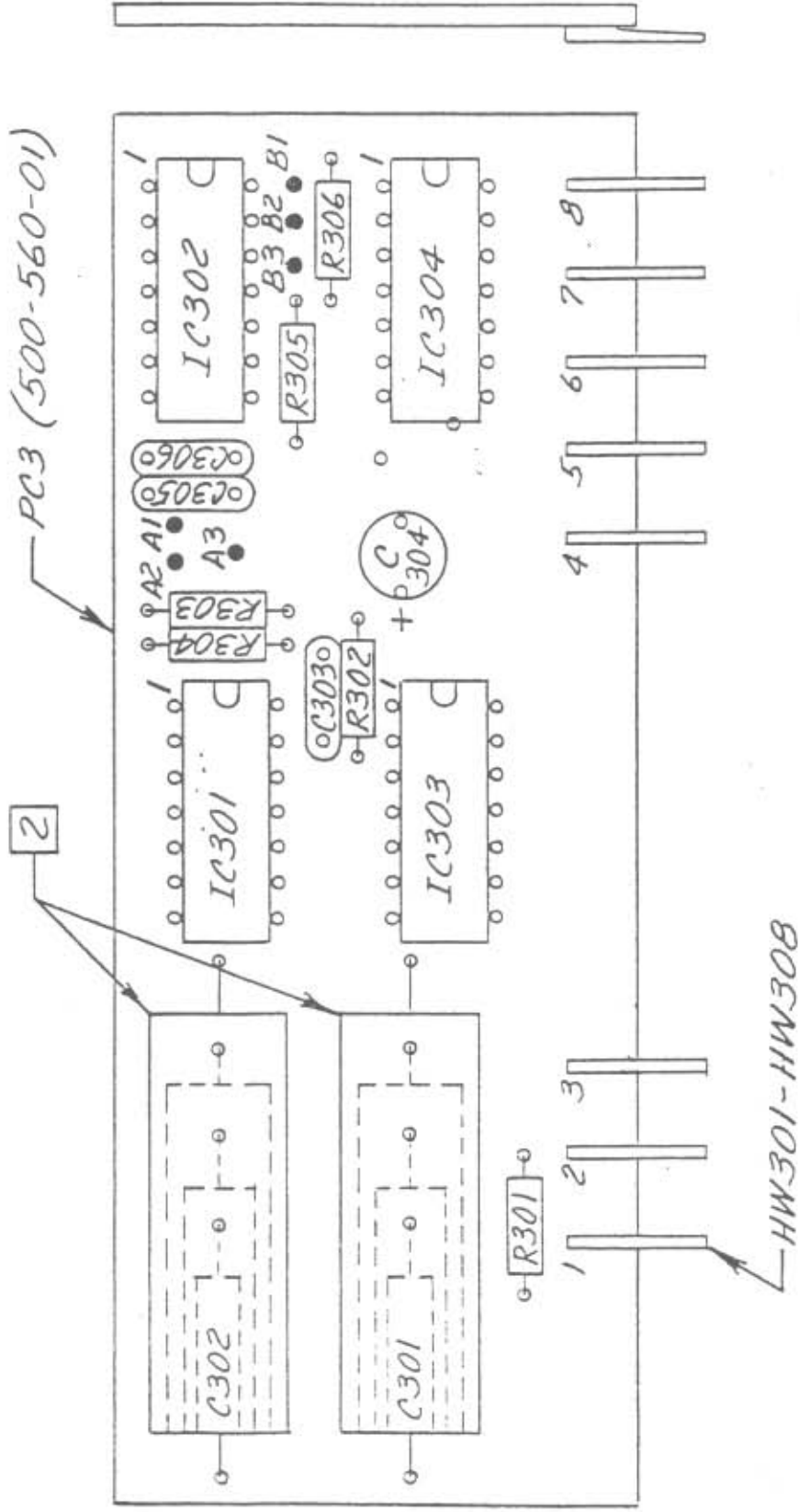
3/1/76

BY

RK

APP

AK



2. C301 & C302 TO BE INSTALLED AS SHOWN DEPENDING ON SIZE OF CAPACITOR.

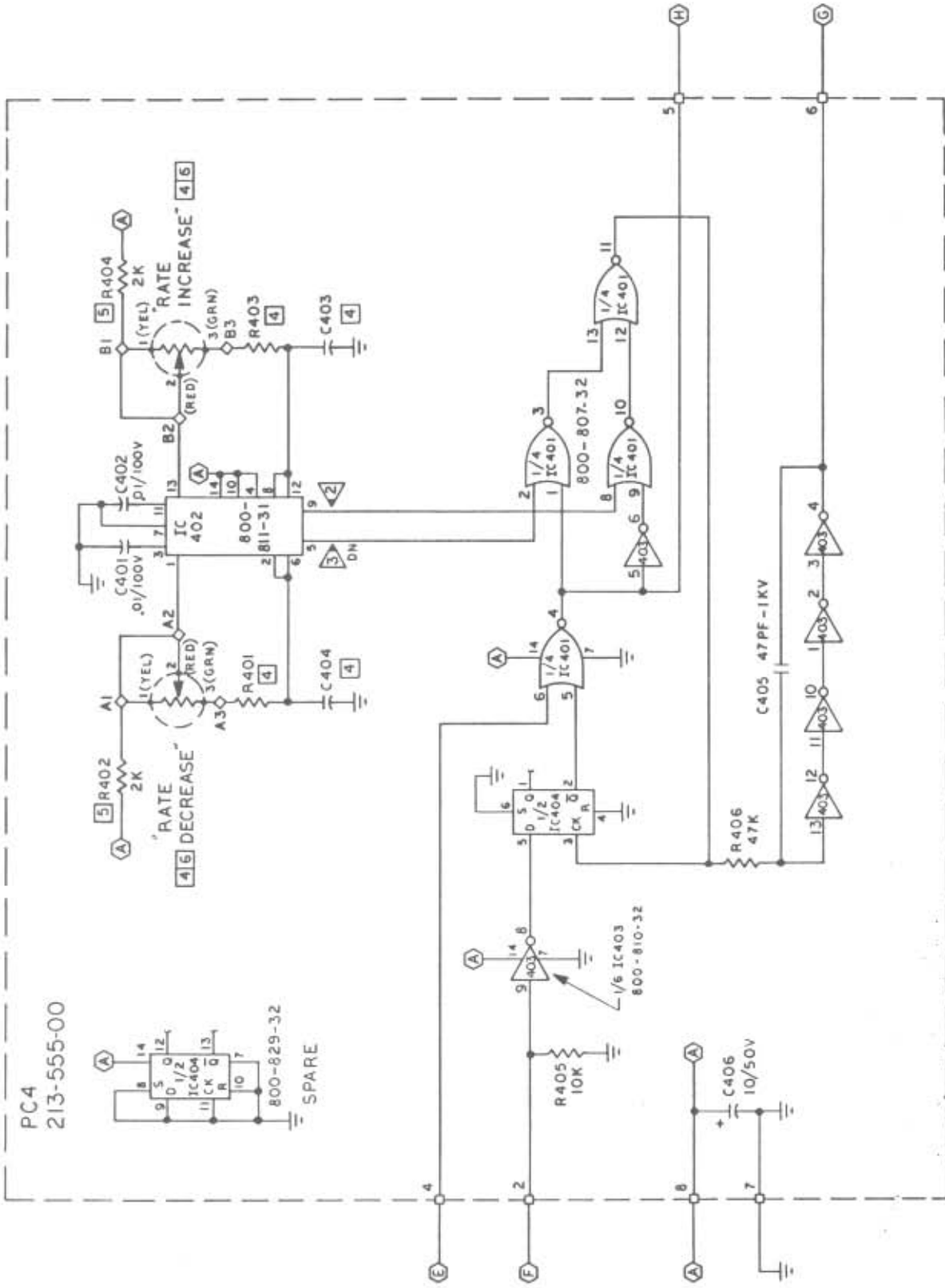
1. ALL LEADS TO BE SOLDERED TO PADS, FAR SIDE.

NOTES:

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.X ±.1	CHECKED 20-MAR-80 <i>[Signature]</i>
.XX ±.03	ENGINEER
.XXX ±.010	SCALE NONE
ANGLES ±30°	

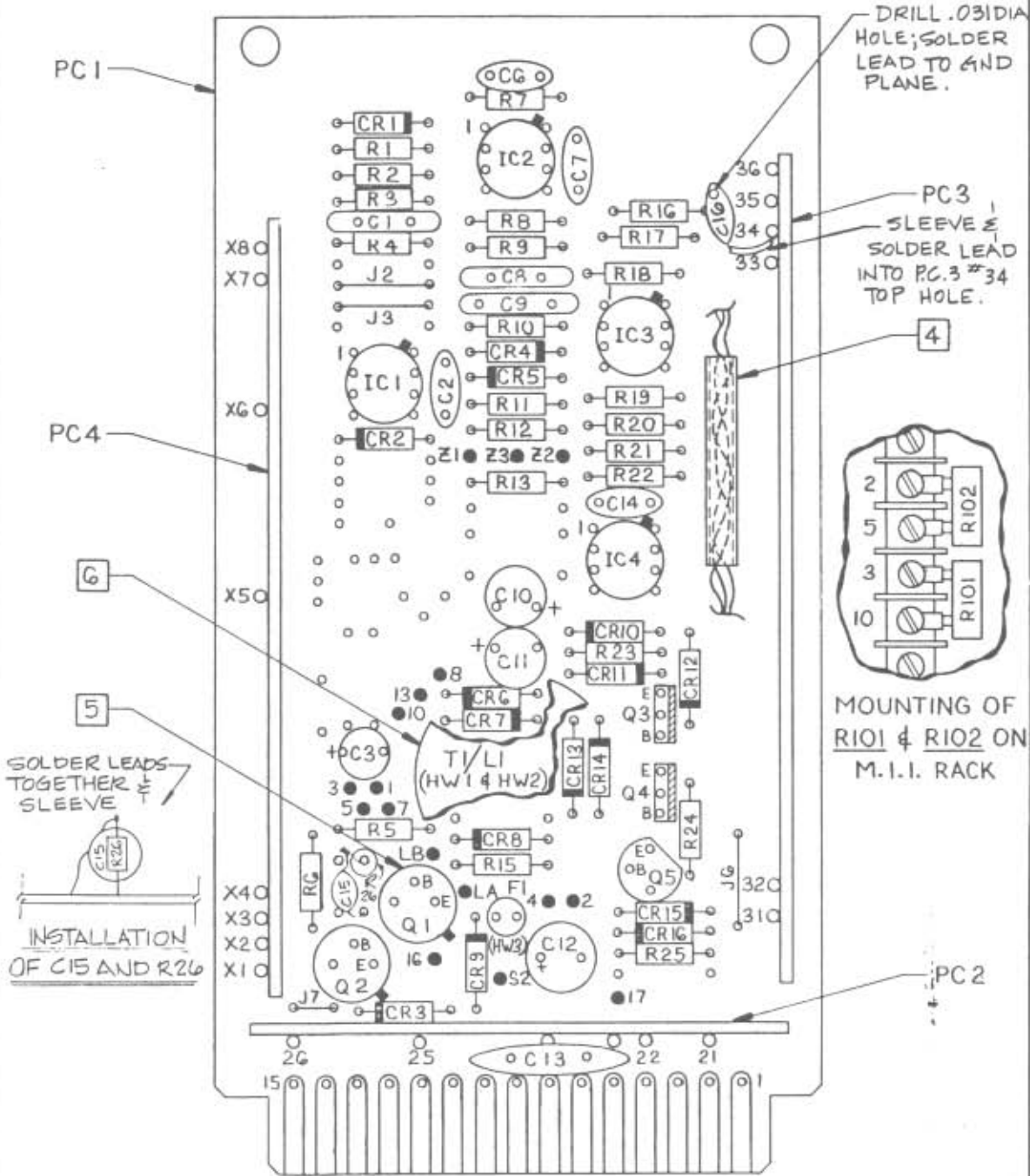
ARB
 PLUG-IN, DIGITAL
 PC4
 (PAGE 2 OF 2)

DRAWING NUMBER 213-452-00	REVISION E
CATEGORY SCHEMATIC	
REVISED BY ECO 4/30	DATE 3/26/81
	BY FL
	APPROVAL <i>[Signature]</i>



PC4
 213-555-00

213-552-00
 PC BOARD ASSEMBLY
 PLUG-IN, DIGITAL ARB PC1



6. MOUNT TI/LI PER DWG 200-237-00.
5. SLEEVE Q1 WITH CLEAR SHRINK TUBING.
4. 1-INCH LENGTH OF #9 "TURBOLEX 76" OR EQUIV., CONTACT CEMENT TO PC1, AND DRESS SPAN POT WIRES THRU.
3. [Symbol] = METAL SIDE OF Q3 & Q4.
2. ALL JUMPERS ARE 22 AWG BUSS.
1. ALL LEADS & TERMINALS MUST BE SOLDERED TO PADS.
- NOTES:



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TOLERANCES
UNLESS NOTED

X ± .1
XX ± .03
XXX ± .010
ANGLES ± 30°

DESIGNED BY T. HART 9-28-76
CHECKED BY [Signature] 11/8/77
DATE 2/1

PC. BOARD ASS'Y
PLUG-IN, DIGITAL

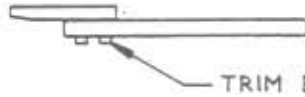
ARB (PC2)

213-553-0012

PC. ASSEMBLY

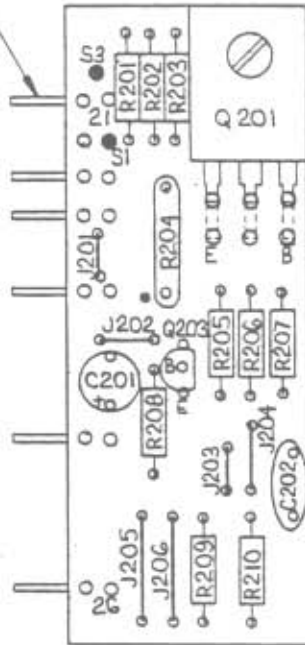
REVISED BY E.C.O. 3423

APPROVED BY [Signature]



TRIM EXCESS, TYP.

HW 201-HW 206

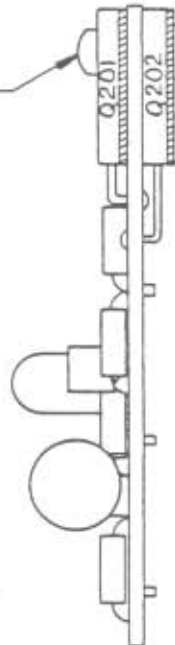


PC 2

HW 209

HW 208

HW 207



3. INDICATES METALIZED SIDE OF Q201 & Q202.
2. ALL LEADS & TERMINALS TO BE SOLDERED TO PADS.
1. ALL JUMPERS ARE 22 AWG BUSS WIRE, TEFLON SLEEVED AS REQUIRED.

NOTES:



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TOLERANCES

X ± .1
XX ± .05
XXX ± .010
ANGLES ± 30'

DESIGNED BY T. HART 9-29-76
DATE 7/9/77
SCALE 2/1

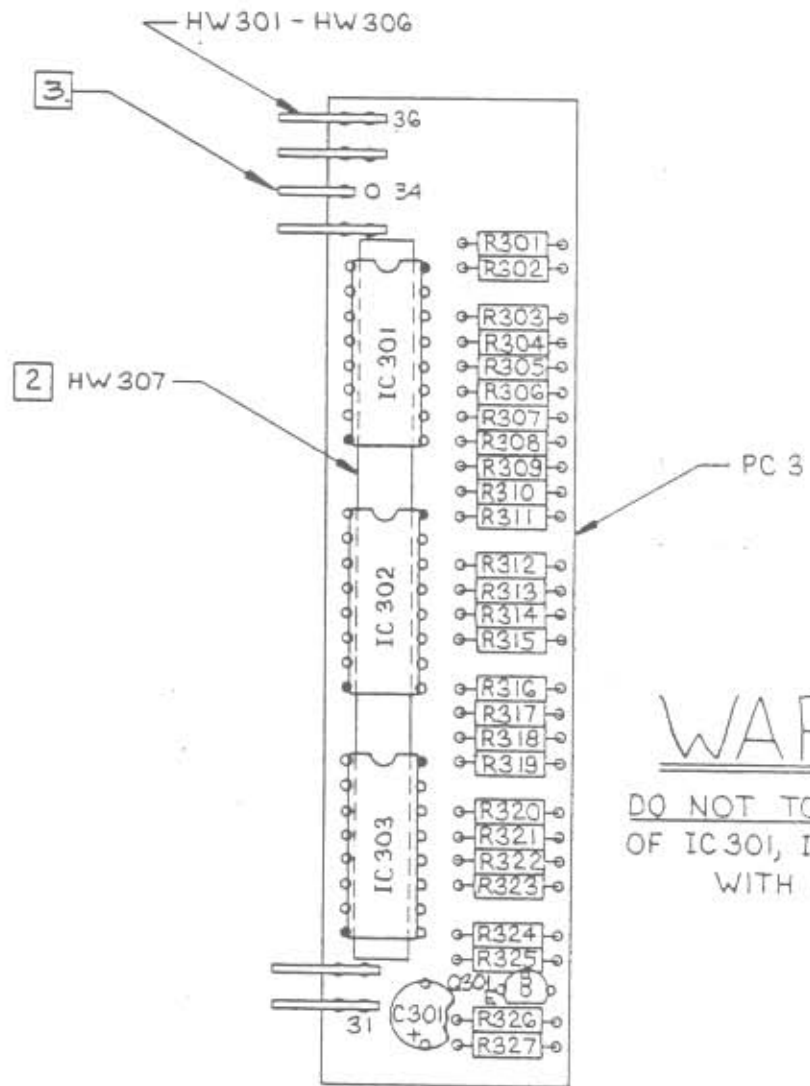
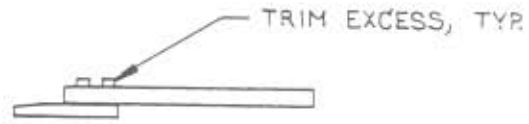
PC. BOARD ASS'Y
PLUG-IN, DIGITAL

ARB (PC3)

213-554-0013

P.C. ASSEMBLY

E.C.O. 3228



WARNING

DO NOT TOUCH LEADS
OF IC 301, IC 302, & IC 303
WITH FINGERS.

3. INSTALL "F" PIN # 34 ; SOLDER BOTTOM PIN ONLY. THEN CUT OFF TOP OF "F" PIN AS SHOWN. (TOP HOLE TO BE LEFT OPEN FOR CAPACITOR LEAD COMING FROM P.C.1).
2. INSERT LEADS OF HW307 INTO DARKENED HOLES (●) BEFORE INSERTING LEADS OF IC301, IC302, & IC303.

1. ALL LEADS AND TERMINALS MUST BE SOLDERED TO PADS.

NOTES:



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Sepulveda, California 91343

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TOLERANCES
UNLESS NOTED

X ± .1
XX ± .03
XXX ± .010
ANGLES ± .30°

DRAWN: *K. L. ...*
DATE: 27 SEP 78
CHECKED: *(Signature)*
TAGS: *(Signature)*
SCALE: 2/1

ARB
PLUG-IN,
DIGITAL, (PC4)

DRAWING NUMBER

213-555-00

REVISION
B

DATE

ASSEMBLY

REVISION

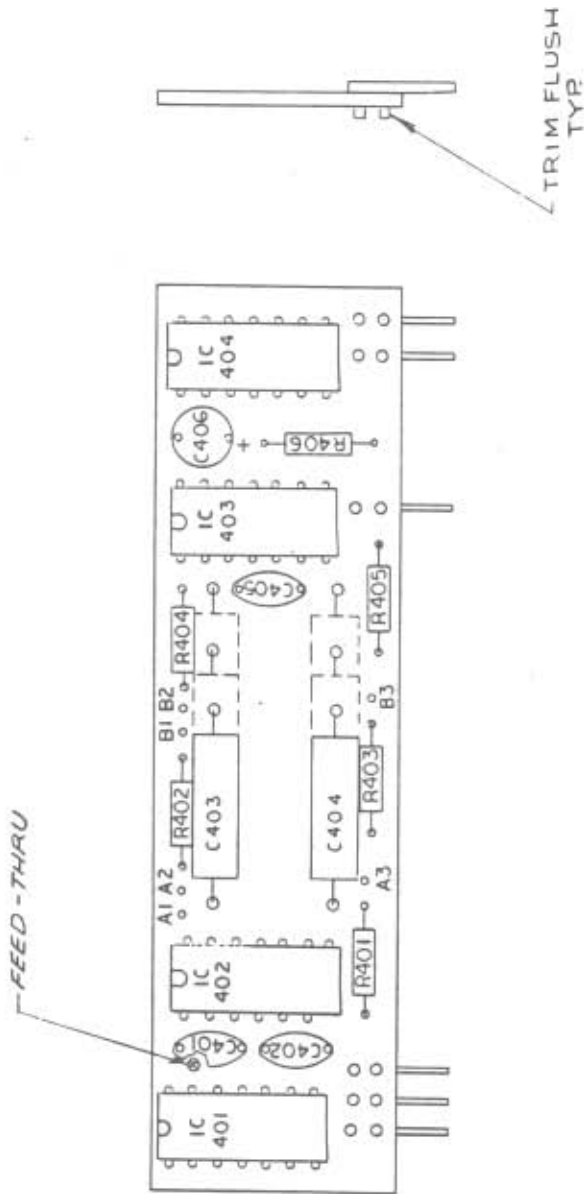
ECO 4008

DATE

BY

APPROVED

(Signature)



2. C403 & C404 TO BE INSTALLED AS SHOWN DEPENDING ON SIZE OF CAPACITOR.
1. ALL LEADS AND TERMINALS TO BE SOLDERED TO PADS.

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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