



INSTRUCTION MANUAL
RBA/STD
Resistance Bulb Alarm

No. 193-701-00B

April 2016

1.1 SCOPE OF MANUAL

This manual contains a description, installation and operating instructions, and maintenance instructions for the Resistance Bulb Alarm. To support any maintenance that might be required, a description of the theory of operation is also included, and a list of replaceable parts is given. A list of recommended spares is also included.

1.2 PURPOSE OF EQUIPMENT

The Resistance Bulb Alarm (RBA) provides a signal that will operate an alarm system at a predetermined but adjustable value of DC voltage that is controlled by a temperature-sensitive resistance bulb. The unit can also be supplied to operate the same or separate alarms at two different predetermined and adjustable values of bulb-controlled voltages. As standard equipment, a lamp is supplied on the front panel for each trip point to indicate visually the state (tripped or untripped) of the alarm.

1.3 GENERAL DESCRIPTION

The unit amplifies the applied input signal, adds the adjustable trip-point signal(s), and then uses the composite signal to drive the control amplifier(s). The signal for the external alarm system is produced by the closing or opening of a relay (or relays) controlled by the control amplifier(s). High stability is achieved through the use of feedback in each of the stages other than the control amplifier(s).

1.4 PHYSICAL DESCRIPTION

The unit consists of two printed-circuit boards, with one board mounted on the other. One board contains the output components. The other, which can be considered the main board, contains the rest of the electronics. The boards are enclosed in a protective housing, and the entire assembly may be installed in a number of different ways. A bracket (supplied when specified in order) may be used to mount the assembly. For hazardous environments, an explosion-proof housing with a base containing up to four threaded hubs for wiring can be supplied. Also available are an enclosure that is oil-tight and dust-tight and another that is water-tight. Although the electrical circuit is identical regardless of the mounting method, the external connections may be made to different terminals on the terminal blocks. Specific details for making electrical connections are given in Section 2, Installation Information.

1.5 SPECIFICATIONS

The specifications of the RBA are given in Table 1-1.

TABLE 1-1. RBA SPECIFICATIONS

<u>INPUT SPANS</u>	RANGE A: 10 ohms change RANGE B: 25 ohms change RANGE C: 100 ohms change RANGE D: 400 ohms change 2 & 3 Wire RTD only
<u>INPUT IMPEDANCE</u>	1 megohm minimum
<u>ZERO ADJUSTMENT</u>	Adjustable $\pm 10\%$ of span, minimum
<u>FRONT PANEL ADJUSTMENTS</u>	
<u>TRIP POINTS</u>	Multiturn front panel adjustment over a range of 0% to 110% of span
<u>INPUT ZERO</u>	$\pm 10\%$ of span (minimum)
<u>OUTPUT</u>	SPDT relay contacts 5 A @ 117 VAC non-inductive
<u>PERFORMANCE</u>	
<u>REPEATABILITY</u>	Trip point repeats within $\pm 0.1\%$ full span
<u>DEADBAND</u>	1% of span, standard
<u>AMBIENT TEMPERATURE RANGE</u>	0°F to +150°F (-18°C to +65°C)
<u>AMBIENT TEMPERATURE EFFECT</u>	Less than $\pm 0.01\%/^{\circ}\text{F}$ over above range
<u>RESPONSE</u>	50 milliseconds for a step change of 1% of span beyond set points
<u>ISOLATION</u>	Input, output, and power input are isolated with no DC connections between them. Both AC and DC powered units have this as standard
<u>POWER INPUT</u>	117 VAC, 240 VAC, 50/60 Hz, $\pm 10\%$ standard 24 VDC, 45 VDC, 65 VDC $\pm 10\%$ optional 5 watts maximum
<u>LINE VOLTAGE EFFECT</u>	AC or DC: $\pm 0.005\%/1\%$ line change

1.6 MODEL NUMBERING SYSTEM

Model Numbers describe an instrument's type, functional range, and features. If all accompanying documentation of a unit should be missing, one can still "translate" the Model Number back into a working description of the unit by using the information in this paragraph as a guide.

BASIC EXAMPLE:

RBA/5-25FS/D-XIX3/117AC

RBA, resistance bulb of 5-25 ohms change for maximum input to RBA, dual trip, output in XIX3 configuration, 117 VAC power, ten-turn dial option

BASIC INSTRUMENT TYPE:

RBA indicates Resistance Bulb Alarm

INPUT:

Numbers: Minimum and maximum nominal change of bulb resistance in ohms for maximum (full scale) input to RBA

OUTPUT RELAY MODES:

First Letter: S indicates single trip (either upper or lower trip point)
D indicates dual trip (both upper and lower trip point)

XIX3: XI indicates that upper trip-point relay is energized when input signal is below upper trip point (fail-safe mode); standard unless other option requested
X3 indicates that lower trip-point relay is energized when input signal is above lower trip point (fail-safe mode); standard unless other option requested

POWER INPUT:

DC: DC power, 24 VDC $\pm 10\%$ unless stated otherwise, e.g., 45 VDC
AC: AC power, 117 VAC $\pm 10\%$ unless stated otherwise, e.g., 240 VAC

Table 1-2 lists the option letters in the model number and explains their meanings.

TABLE 1-2. EXPLANATION OF OPTION LETTERS IN MODEL NUMBERS

-AD	Adjustable Deadband
-AR	Factory Set Response Time Delay
-DC	24, 45, 65 VDC $\pm 10\%$ Optional Power
-DPDT	Double-Pole-Double-Throw Relays
-FU	Fuse Option
-HS	Hermetically Sealed Relay Output
-MR	Manual Reset - External Pushbutton
-PR	Solid-State Power Relay Including Socket*
-TT	Precision 10-Turn Dial
*	Must be used in separate enclosure (-GP, etc.)

INSTALLATION INFORMATION

2.1 GENERAL INSTALLATION INFORMATION

Installation, in general, consists of adjustment (when required), mechanical mounting, and making the electrical connections to the unit. The following paragraphs describe the necessary procedures.

2.2 ADJUSTMENT

Units are checked for proper performance at the factory before they are shipped. However, unless adjustment was requested to a specific trip point (or pair of trip points), the unit should be adjusted by the user before the unit is placed in service.

NOTE

Adjustments should not be made in the field on units that are adjusted at the factory to a value (or values) specified in the purchase order. Units that are adjusted at the factory to customer's specifications have protective caps over the ZERO, UPPER, and LOWER TRIP point potentiometers; do NOT remove these caps.

A precision decade resistance box (hereafter called simply resistance box with an accuracy within $\pm 0.05\%$ or better is required for adjustment. In the following procedure, it is assumed that the unit being adjusted is a dual-trip unit (with both upper and lower trip points) and with both upper and lower deadband adjustment options included. If the unit actually being adjusted does not have all these features, simply perform those steps that apply to that particular unit and omit the others.

To adjust a unit, proceed as follows:

- a. Connect unit and test equipment as shown in Figure 2-1. Initially turn the trip point, ZERO, and DEADBAND potentiometers fully counterclockwise. If the trip point potentiometers have 10-turn dials (TT option), carefully turn each dial to the desired setting instead of full counterclockwise. It is assumed here that the LOWER trip point dial is set to a number greater than 0 and that the UPPER dial is set to a number less than 100.

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- b. Adjust the resistance box to a value equal to that of the bulb at the temperature of the desired lower trip point.
- c. Apply power to the unit.

NOTE

Refer to paragraph 1.6 for information on how to use the model number to obtain the output configuration.

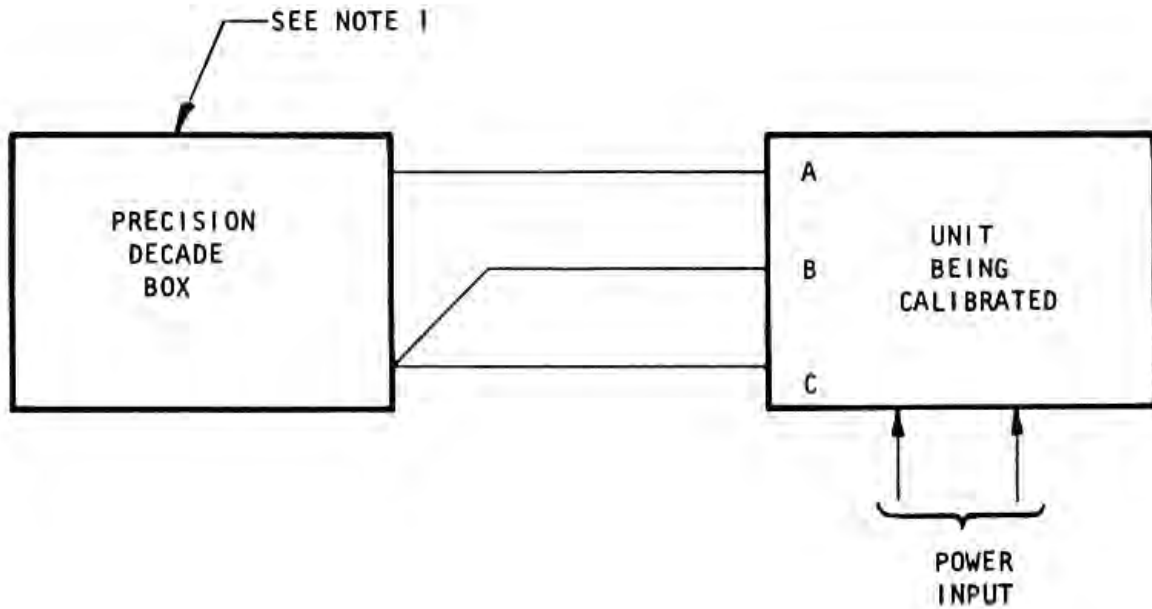
- d. Refer to Table 2-1 to determine which state of a lamp corresponds to a given state of the associated output section for a given configuration of that section. Turn the ZERO potentiometer clockwise until the lower section of the unit trips, and then turn the potentiometer counterclockwise until this section just untrips.

TABLE 2-1. OUTPUT STATES VS. OUTPUT CONFIGURATIONS

OUTPUT		ALARM STATE	OUTPUT LAMP & (RELAY) STATE
CONFIGURATION			
UPPER	X1	TRIPPED	LAMP "OFF" (K1 DEENERGIZED)
		UNTRIPPED	LAMP "ON" (K1 ENERGIZED)
	X2	TRIPPED	LAMP "ON" (ENERGIZED)
		UNTRIPPED	LAMP "OFF" (K1 DEENERGIZED)
LOWER	X3	TRIPPED	LAMP "OFF" (K2 DEENERGIZED)
		UNTRIPPED	LAMP "ON" (K2 ENERGIZED)
	X4	TRIPPED	LAMP "ON" (K2 ENERGIZED)
		UNTRIPPED	LAMP "OFF" (K2 DEENERGIZED)

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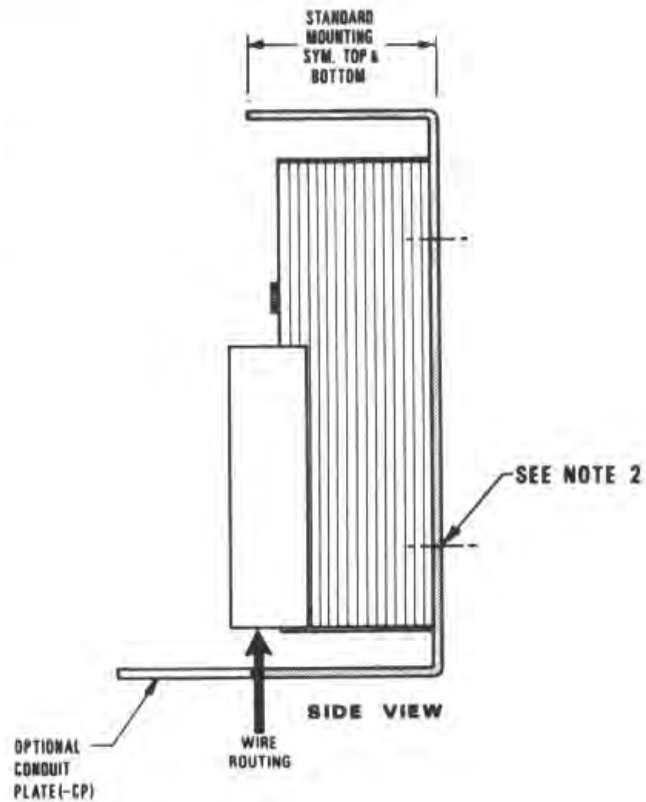
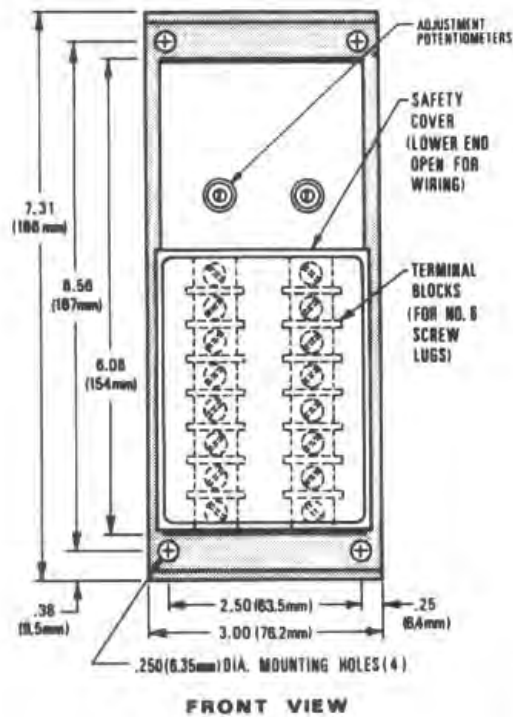
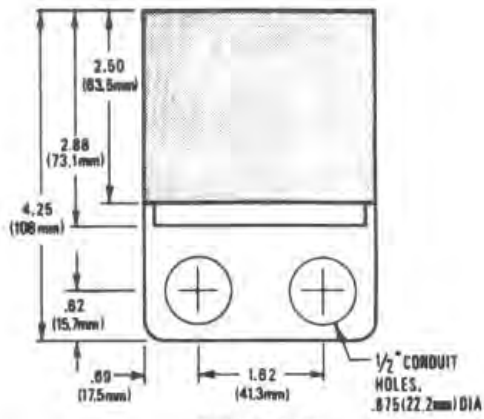
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NOTES:

1. DECADE BOX MUST BE ACCURATE TO WITHIN $\pm 0.05\%$ OR BETTER

Figure 2-1. Test equipment Setup For Adjustment Of Unit



NOTES:

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

CAUTION

WHEN THE REAR INSERTS ARE USED FOR MOUNTING, BE SURE THAT THE MOUNTING SCREWS DO NOT PROTRUDE MORE THAN 1/8 INCH INTO THE UNIT.

Figure 2-2. Outline and Installation

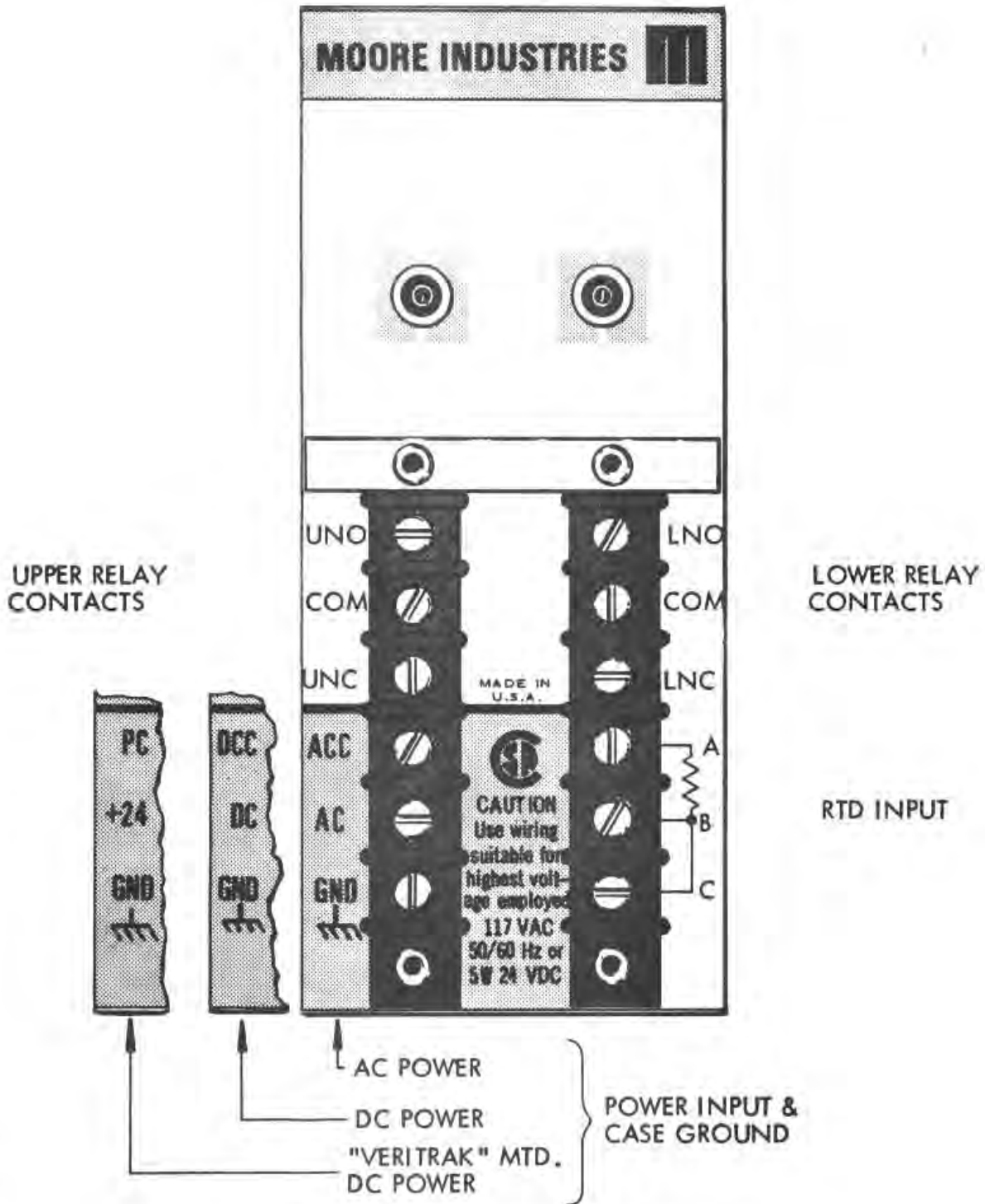


Figure 2-3 Electrical Connections For Standard Unit

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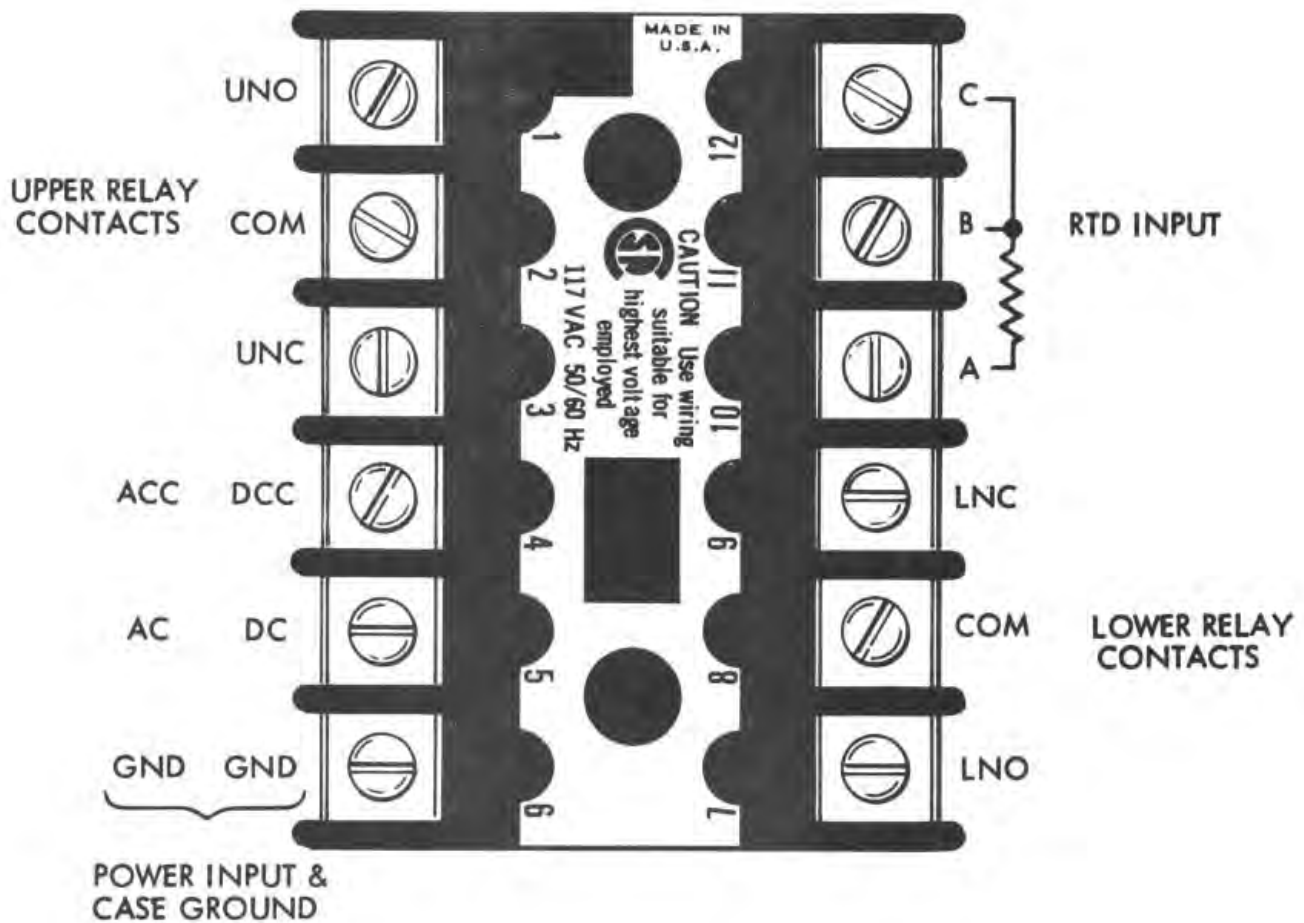


Figure 2-3. Electrical Connections For -EX (Explosion Proof) Housing Mounted Single Unit & -PST Std. Plug-In Units

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- e. Slowly turn the LOWER trip point potentiometer clockwise until the lower section of the unit just trips.
- f. Check, and readjust if necessary, the ZERO potentiometer by verifying that the lower section of the unit can be tripped and untripped with the LOWER trip point potentiometer. Leave this section of the unit in the tripped condition with the potentiometer adjusted almost, but not quite, fully counterclockwise. If the unit has the TT option, return the LOWER trip point dial to the desired setting, and make sure that this section of the unit is in the tripped condition.
- g. Turn the LOWER DEADBAND potentiometer fully clockwise. Increase the resistance of the resistance box to a value equal to that of the bulb at the temperature of the upper end of the lower deadband, and then slowly turn the LOWER DEADBAND potentiometer counterclockwise until the lower section of the unit returns to the untripped condition.
- h. Recheck the trip and return action of the lower section of the unit with the resistance box set at resistance corresponding to the lower trip point temperature and to the upper end of the lower deadband. Verify that the lower section of the unit trips at the desired lower trip point and exhibits the desired deadband.
- i. Adjust the resistance box to a value equal to that of the bulb at the temperature of the desired upper trip point.
- j. Turn the UPPER trip point potentiometer clockwise until this section of the unit is in the untripped condition, and then slowly turn the potentiometer counterclockwise until this section trips again. If the unit has the TT option, return the UPPER trip point dial to the desired setting, and make sure that this section of the unit is in the tripped condition.
- k. Turn the UPPER DEADBAND potentiometer fully clockwise. Decrease the resistance of the resistance box to a value equal to that of the bulb at the temperature of the lower end of the upper deadband, and then slowly turn the UPPER DEADBAND potentiometer counterclockwise until the upper section of the unit returns to the untripped condition.

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- l. Recheck the trip and return action of the upper section of the unit with the resistance box set at resistances corresponding to the upper trip point temperature and to the lower end of the upper deadband. Verify that the upper section of the unit trips at the desired upper trip point and exhibits the desired deadband.
- m. After step (l) has been successfully completed, turn off the power input to the unit and disconnect the resistance box.

2.3 MECHANICAL INSTALLATION

Figure 2-2 shows the outline dimensions and other installation requirements. 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.

2.4 ELECTRICAL CONNECTIONS

All electrical connections are made to the terminal blocks in the unit. The terminals to be used for the electrical connections are indicated in Figure 2-3. The following paragraphs provide additional information on wiring the unit.

2.4.1 General Wiring Techniques

No special wire or cable is required for signal connections to the unit. To avoid transients and stray pickup, it is recommended that twisted conductors be used where they are run close to other services (such as power wiring). On open units supplied with a snap-off cover, dress all wiring up through the opening in the bottom of the cover. Spade-lug connectors are recommended for all wire terminations. All terminals are supplied with 6-32 screws long enough to easily accept three spade-lug connectors.

2.4.2 Power Connections

A given unit is designed to be operated from either a DC power source or an AC power source. Refer to paragraph 1.6 for information on how to use the model number to determine the type of power required.

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On DC-powered 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 3 watts.

On AC-powered unit, 117 volts AC $\pm 10\%$ - 50/60 Hz, 3 VA nominal power is required. 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 side. The GND terminal is the mechanical case connection.

3.1 OPERATING PROCEDURE

Once adjusted and installed, the unit may be operated unattended. The only controls on the outside of the unit are the ZERO and trip point potentiometers which, after initial adjustment, need no further attention. A lamp associated with each output relay is included on the unit as a standard feature. These lamps inform the operator when an alarm condition has occurred. Note carefully, however, that an illuminated lamp does not necessarily indicate an alarm condition, since a relay may be energized either with a normal (non-alarm) input signal (X1 and X3 output configurations, non-fail-safe operation). There are no other indicators on the unit. Because the circuit uses highly reliable solid-state components, except for relays, 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 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 concern unless a malfunction is also observed.

4.1 INTRODUCTION

This section describes the theory of operation of the unit. The description is based on a unit that has dual trips in the X1, X3 configuration (see main schematic diagram) and two deadband adjustments. If the particular unit supplied does not have all these features, simply disregard those elements of the schematic and the accompanying text that do not apply.

4.2 CIRCUIT DESCRIPTION

The main schematic diagram of the unit is near the end of this manual. Except where otherwise indicated, refer to this diagram when reading the following paragraphs.

4.2.1 Description Of AC Power-Supply Circuit

In a unit that is operated from AC power, the power supply consists of a power transformer, rectifiers, filters, and regulators to produce positive and negative voltages with respect to common. Referring to the main schematic diagram, it is seen that AC power is filtered by V51 and applied to the primary of power transformer T1. The filter elements serve to prevent line noise or spikes from getting into the unit. AC voltage from the center-tapped secondary of T1 is rectified by CR6 and CR9 to produce positive DC output, and by CR7 and CR8 to produce negative DC output. These outputs are filtered by C8, C9, C11 and C12 by R25 and CR11 and R26 and CR12 to produce outputs of +12 and -12 volts as operating voltages for the unit. A somewhat higher positive voltage (point C) is utilized for operating the output relay(s) and lamp(s). The other (blue-violet) secondary of T1 provides AC input to the circuit that develops the DC excitation source for the resistance bulb.

4.2.2 Description Of Power-Inverter Circuit

The components of the power inverter are mounted on a printed-circuit board wired to the main board. Descriptions of the power-inverter circuit of the unit are given in the following paragraphs.

4.2.2.1 Power-Inverter Circuit

Drawing 400-404-00 is the schematic diagram of the power inverter (PCA). When the unit is ordered for use with DC power, the power inverter is used instead of the AC source (T1) shown on the main schematic diagram. The DC applied to the power inverter is converted to a square wave of approximately 3 KHz by Q1, Q2, and the primaries of T1 (PCA schematic diagram), functioning as a DC-to-AC inverter. Filter L1-C1 on PCA prevents the 3-KHz signal from getting back into

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the external DC source. CR1 provides protection against damage from inadvertent application of DC of incorrect polarity. The square-wave output from center-tapped secondary 8-13 is applied to CR6 through CR9 (main schematic), and the action from this point is identical to that described in paragraph 4.2.1. Secondary 17-16 of T1 on PCA supplies AC voltage to points D and E of the resistance-bulb excitation source circuit (main schematic diagram).

4.2.3 Description Of Resistance-Bulb Excitation Source Circuit

The circuit that produces the excitation for the resistance bulb consists of CR3 and an associated filter capacitor, resistors, and zener diodes. The AC voltage supplied to points D and E is applied through R13 to half-wave rectifier CR3. C10 filters the pulsating output from CR3 and the resulting DC voltage is applied through R14 to zener diode CR4 for initial regulation and then through R15 to zener diode CR5 for final regulation to 6.4 volts. This voltage is applied as excitation to the bridge circuit that includes the resistance bulb as one of the legs.

4.2.4 Description Of Lead-Length Compensation And Zero-Adjust Circuit

This circuit is arranged as a bridge with the resistance bulb (including the resistance of leads A and B) and the sum of R10 and the resistance between terminals 3 and 2 of the ZERO potentiometer as one pair of legs, and R17 and the sum of R16 and the resistance between terminals 1 and 2 of the ZERO potentiometer as the other pair of legs. The regulated output across CR5 in the resistance-bulb excitation source is applied to the bridge between the junction of lead C of the bulb and R10 (at lead B, which is connected to lead C at the bulb) and the junction of R16 and R17. The effect of leads A and B of the resistance bulb is cancelled because these leads are connected to opposite sides of the bulb. Since lead C is common to both legs of the bridge that are connected to input terminal B, the resistance of lead C has no effect on the operation of the bridge. Thus, complete lead-length compensation of the resistance bulb is accomplished. The ZERO potentiometer modifies the original bulb-determined voltage at the A input terminal so that, with the bulb at minimum resistance, the total voltage at this point will allow the output of the lower section of the unit to just trip when the LOWER trip point potentiometer is turned almost fully counterclockwise. This composite signal (voltage at the A input terminal originally determined by the resistance of the bulb and then modified by the zero-adjust voltage) is applied to input buffer ICI.

4.2.5 Description Of Input Buffer Circuit

The input buffer consists of ICI and associated components. The stage serves to isolate the input-signal source from later stages in the unit, so adjustments in the value of trip point(s) will not affect the input signal. The composite signal at the A input terminal is applied through R6 and R22 to the non-inverting input (pin 3) of ICI, which is used as a buffer amplifier with sufficient gain and a low output impedance to reliably drive the following stages. C4, R22 and C5 together with ICI, form an active low-pass filter with a very sharp cutoff characteristic to remove any noise or other high-

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frequency components from the signal applied to IC1. R2 and R3 provide feedback to the inverting input and thus determine the gain of IC1. R2 is selected to establish the gain of IC1 according to the range of variation in bulb resistance. The ± 12 -volt outputs from the power supply are used to power IC1.

4.2.6 Description Of Upper Comparator Circuit

The upper comparator consists of IC2 and associated components. The output from IC1 is applied through UPPER TRIP PT. ADJ. potentiometer to the inverting input (pin 2) of IC2. The voltage at pin 3 (non-inverting input) is determined by the setting of the UPPER DEADBAND ADJ. potentiometer. With no input signal, a portion of the $-6.2V$ derived by CR16, is applied to the inverting input. This voltage is inverted by IC2 and therefore CR18 and CR19 are reverse-biased. When the input signal is applied and reaches the upper trip point, the output of IC2 becomes negative. This negative voltage forward-biases CR18 and CR19 thus providing feedback for IC2 and input to the relay driver circuit.

When the applied signal again falls below the upper trip point, the output of IC2 does not immediately return to the original positive state. Since the feedback through CR18 keeps pin 3 less positive than before the output from IC2 remains negative until the input signal from IC1 decreases to a value below that of the signal at pin 3. When this occurs, the output of IC2 returns to its original positive state, thus reverse-biasing CR18. The difference between the value of voltage that forward-biases CR18 then reverse-biases it, is determined by the DEADBAND ADJ.

4.2.7 Description Of Lower Comparator Circuit

The lower comparator circuit consists of IC3 and its associated components. The description of this circuit is the same as the upper comparator circuit described in paragraph 4.2.6.

4.2.8 Description Of Upper Relay Driver

The upper relay driver consists of Q203, Q204 and associated components. With jumper JX1 connected, transistor Q203 is conducting and consequently relay K1 is energized below the upper trip-point level. When the upper trip point is reached by the input signal, Q203 is turned off and K1 becomes deenergized. With jumper JX2 connected Q203 is conducting when the input signal is below the upper trip point. Since Q203 is conducting Q204 is off and consequently relay K1 is deenergized. When the input signal goes above the upper trip point, Q203 is turned off, Q204 is turned on causing K1 to become energized and the upper lamp to illuminate.

4.2.9 Description Of Lower Relay Driver

The lower relay driver consists of Q201 and Q202. The circuit description of the lower relay driver is the same as the upper relay driver described in paragraph 4.2.8.

MAINTENANCE INFORMATION

5.1 INTRODUCTION

This section contains information on maintenance of the unit. General troubleshooting procedures are given, using conventional signal-tracing techniques. Precautions and special techniques used to replace components are also described.

5.2 PERIODIC MAINTENANCE

It is suggested that the adjustment of the unit be checked approximately every 6 months as described in Section 2. No other periodic maintenance is required.

5.3 CORRECTIVE MAINTENANCE

The following paragraphs provide information on corrective maintenance of the unit. Corrective maintenance should be carried out only by qualified personnel who have read and thoroughly understand the description of circuit operation given in Section 4.

5.3.1 Disassembly

To troubleshoot the unit, it is first necessary to disassemble it so the circuit board is exposed. These steps are described in the following paragraphs. Disconnect the input signal and turn off the power input before disassembling unit.

5.3.1.1 Disassembly Of Standard And -CP Units

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

- a. Remove the two front 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.

5.3.2 Troubleshooting

The schematic diagram(s) includes flagged numbers 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(s) 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 tracking the signal with an oscilloscope and referring to the schematic diagram(s) 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 the voltage regulators). If the unit tripped (or failed to trip) with an applied input that should have produced the opposite condition, check the outputs from the power supply and, if these are normal, apply a standard input signal and trace the resulting signal through the unit.

5.3.3 Component Replacement Techniques And General Precautions

Replace all defective components with identical parts. Refer to the assembly drawing(s) for a list of replacement parts. The letter S and a number, all enclosed in a circle, appear after the description of certain parts in this list. The number indicates 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.

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

- a. Use a transformer-operated low-voltage soldering iron with a grounded tip and rated at not more than 50 watts. A temperature-controlled tip is desirable.
- b. Use extreme care when unsoldering the leads to any component. Do not keep the soldering iron on a point for more than a few seconds at a time. Use a suction-type solder-removing tool (solder sucker) as an aid in unsoldering transistors and integrated circuits. The protective coating on the unit may be removed with trichloroethane or equivalent. Be sure adequate ventilation is provided when using this or any other chemical.

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NOTE

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

- c. Do not excessively bend or twist the leads of small components; they break easily.
- d. Before removing a component, observe the lead dress. Be sure that the lead dress of the replacement is the same as that of the original.
- e. Remove all flux from soldered joints with trichlorethane or equivalent.

NOTE

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

- f. Test, and if necessary, adjust the unit for proper operation as follows:
 - (1) Connect the unit and test equipment as shown in Figure 2-1, except do not connect the resistance box.
 - (2) Apply power input to the unit. Jumper +IN to common and adjust R1 for 0V at pin 6 of IC1. Disconnect jumper and connect resistance box.
 - (3) For a unit without a 10-turn dial (no TT option), adjust the resistance box to a value equal to that of the bulb at the temperature of the lower trip point. For a unit with one or two 10-turn dials (TT option), adjust the resistance box to

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(3) Cont'd)

a value slightly higher than that of the bulb at its lowest specified operating temperature; note that this temperature will, in general, be lower than that of the desired lower trip point. If the unit does not have the TT option, continue by performing step (d) and the following steps in paragraph 2.2. If the unit does have the TT option, continue with step (4) in the present paragraph.

NOTE

Adjust the sealed potentiometers only if required to obtain the specified results.

(4) Set the LOWER trip point dial to exactly 0. From a higher value, adjust the resistance box to a value equal to that of the bulb at its lowest specified operating temperature. If the lower section of the unit is now in the untripped condition, adjust ZERO potentiometer until lower section just trips.

NOTE

If the field selected resistor (FSR) does not allow for sufficient adjustment of the ZERO potentiometer proceed as follows:

1. Replace FSR with new FSR. Install Bourns switching device on FSR.
2. Set ZERO potentiometer to mid-range. Apply 0% input to the input terminals.
3. Set Bourns switching device for the exact resistance to read 0V at pin 6 of IC3.
4. When the exact value of resistance has been determined note the resistance of the FSR selected by the switching device. Apply solder to the appropriate pads and their adjacent collectors.

MAINTENANCE INFORMATION

- (5) Slowly increase the resistance of the resistance box until the lower section of the unit just untrips, and note the value on the resistance box. Slowly decrease the resistance of the resistance box until the lower section of the unit just trips again. The difference in values of the resistance box at which the lower section of the unit untrips and trips must be not more than 1% of the maximum resistance span for the bulb range over which unit may be used. In addition, the trip and untrip resistances on the resistance box must each repeat within $\pm 0.1\%$ of this same resistance span when the procedure is repeated. Make sure that the lower section of the unit is in the tripped condition with the resistance of the resistance box set to that of the bulb at its lowest specified operating temperature.
- (6) Turn the LOWER DEADBAND potentiometer fully clockwise, and then slowly increase the resistance of the resistance box until the lower section of the unit just untrips. The resistance at which this occurs must be higher than the trip value in step (5) by not less than 20% of the maximum bulb-resistance span.
- (7) If necessary, repeat steps (4), (5), and (6) to make sure that all specified conditions are met.
- (8) Set LOWER trip point dial to 100. From a higher value, decrease the input to exactly the 100% value. If the lower section of the unit is now in the untripped condition, adjust R31 until the lower section just trips.
- (9) Set the UPPER trip point dial to 100. From a lower value, increase the input to exactly the 100% value. If the upper section of the unit is not tripped, adjust R33 until the upper section just trips.
- (10) Slowly decrease the resistance of the resistance box until the upper section of the unit just untrips, and note the value on the resistance box. Slowly increase the resistance of the resistance box until the upper section of the unit just trips again. The difference in values of the resistance

MAINTENANCE INFORMATION

(10) Cont'd


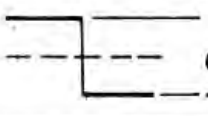
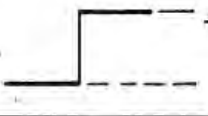
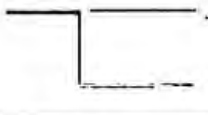
box at which the upper section of the unit untrips and trips must be not more than 1% of the maximum resistance span for the bulb range over which the unit may be used. In addition, the trip and untrip resistances on the resistance box must each repeat within $\pm 0.1\%$ of this same resistance span when the procedure is repeated. Make sure that the upper section of the unit is in the tripped condition with the resistance of the resistance box set to that of the bulb at the highest specified operating temperature.

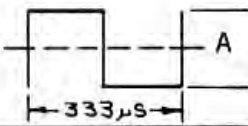
(11) Turn the UPPER DEADBAND potentiometer fully clockwise, and then slowly decrease the resistance of the resistance box until the upper section of the unit just untrips. The resistance at which this occurs must be lower than the trip value in (10) by not less than 20% of the maximum bulb-resistance span.

(12) If necessary, repeat steps (9), (10), and (11) to make sure that all specified conditions are met.

- g. When proper operation of the unit has been verified as in step (f), readjust the unit by the procedure given in Section 2. When the performance of the unit is known to be satisfactory, apply clear acrylic to reseal the unit where required.
- h. Check that all leads are clear of the board edge before reinstalling the board into its case.
- i. When reinstalling the unit onto the mounting bracket, be sure to use the same screws (or screws of the same size) as the ones removed. Longer screws will damage the unit.

TABLE 5-1. WAVE FORMS AND AMPLITUDE

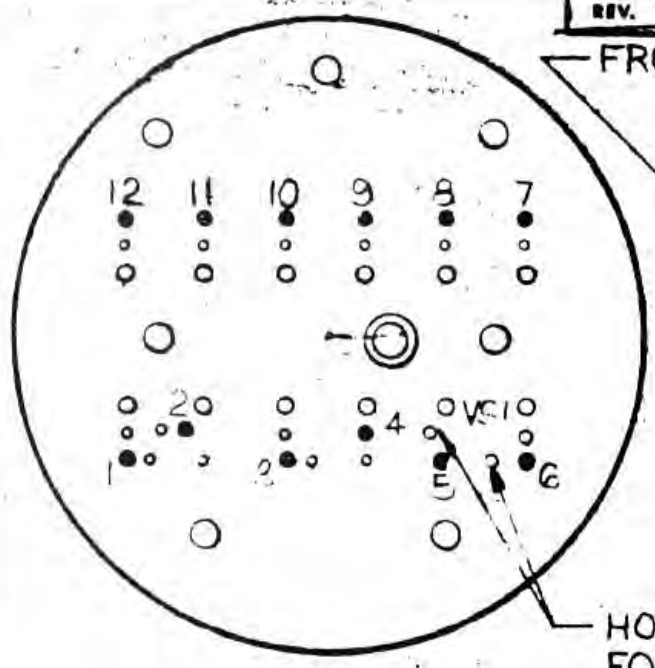
TEST POINT	WAVE FORM AND AMPLITUDE OR VOLTAGE LEVEL
1	 0 TO 1V DEPENDING ON INPUT 0V
2,5*	 +10V INPUT LESS THAN SET POINT 0 -10V INPUT GREATER THAN SET POINT
3,6*	 +6V (X2), +20V (X1) (X4)*, (X3)* 0
4,7*	 +20V (X2), (X4)* 0

DC OPERATED UNITS				
TEST POINT	WAVE FORM	POWER INPUT AND WAVE FORM AMPLITUDE		
		24VDC	45VDC	65VDC
(ON PCA BRD) A	 333 μs	48V	90V	130V

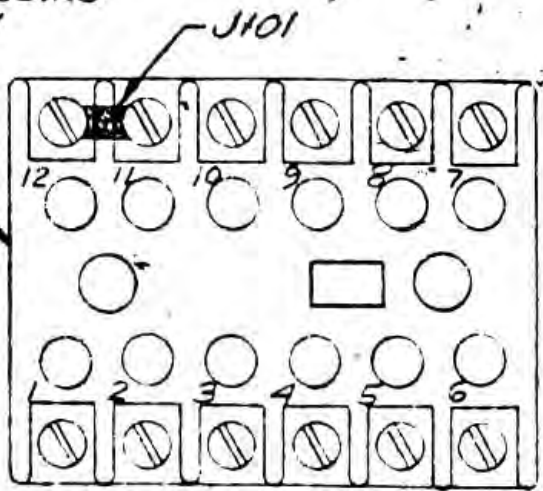
* WAVE FORMS 5, 6, & 7 ARE FOR DUAL TRIP UNITS ONLY

REVISION EFF :
 A P-1

REV.	DESCRIPTION	DATE	BY	APPROV.



FROM HOUSING ASS'Y

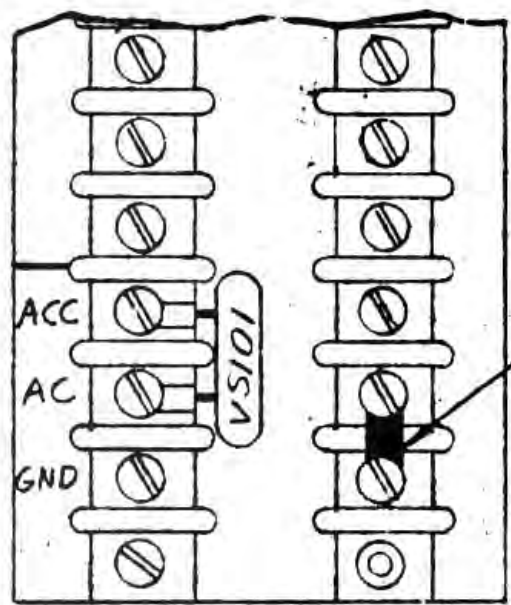


HOLES FOR VSI

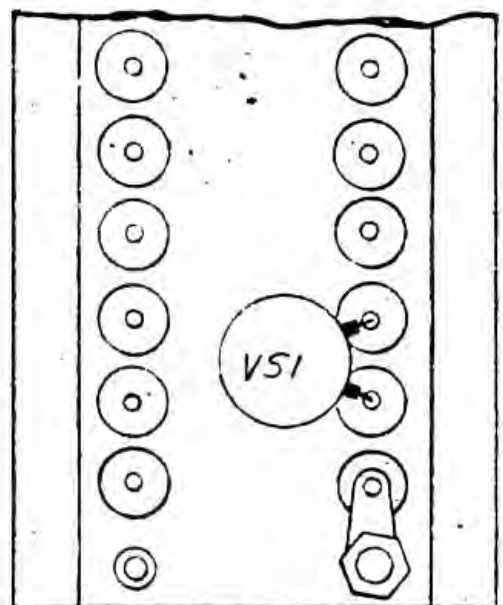
VSI

J101

"SP CASE"



J101



J101, VSI01, VSI02 & VSI03

VSI

"SR CASE" SLEEVE LEADS

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE

TOLS. UNLESS NOTED:

.X = ± .10

.XX = ± .030

.XXX = ± .010

ANGLES = ± 30'

DO NOT SCALE DRAWING

SCALE: 1/1

DRAWN	
CHECKED	
PROJ. ENGR.	<i>R. S. ...</i> 2/14/75
CUSTOMER	

MOORE INDUSTRIES INC.
VAN NUYS CA.

ADDITIONAL PARTS LOC'N,
STANDARD RBA
DUAL

DWG. NO. 193-502-00 REV. H

REV.	DESCRIPTION	DATE	BY	APPROV.
D	ECO 5965 -	1/2/81	lum	JK

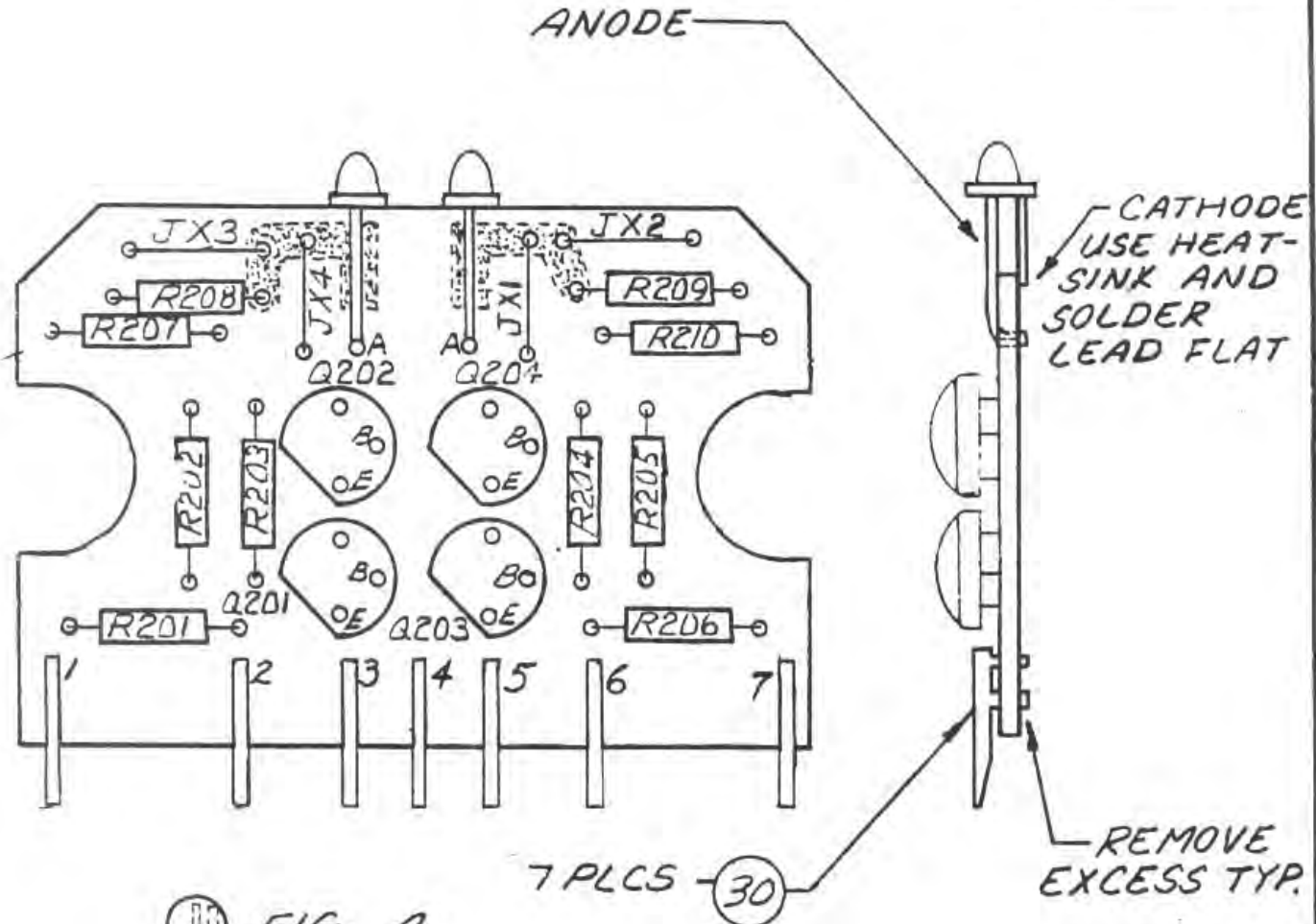


FIG. A
LEAD IDENTIFICATION

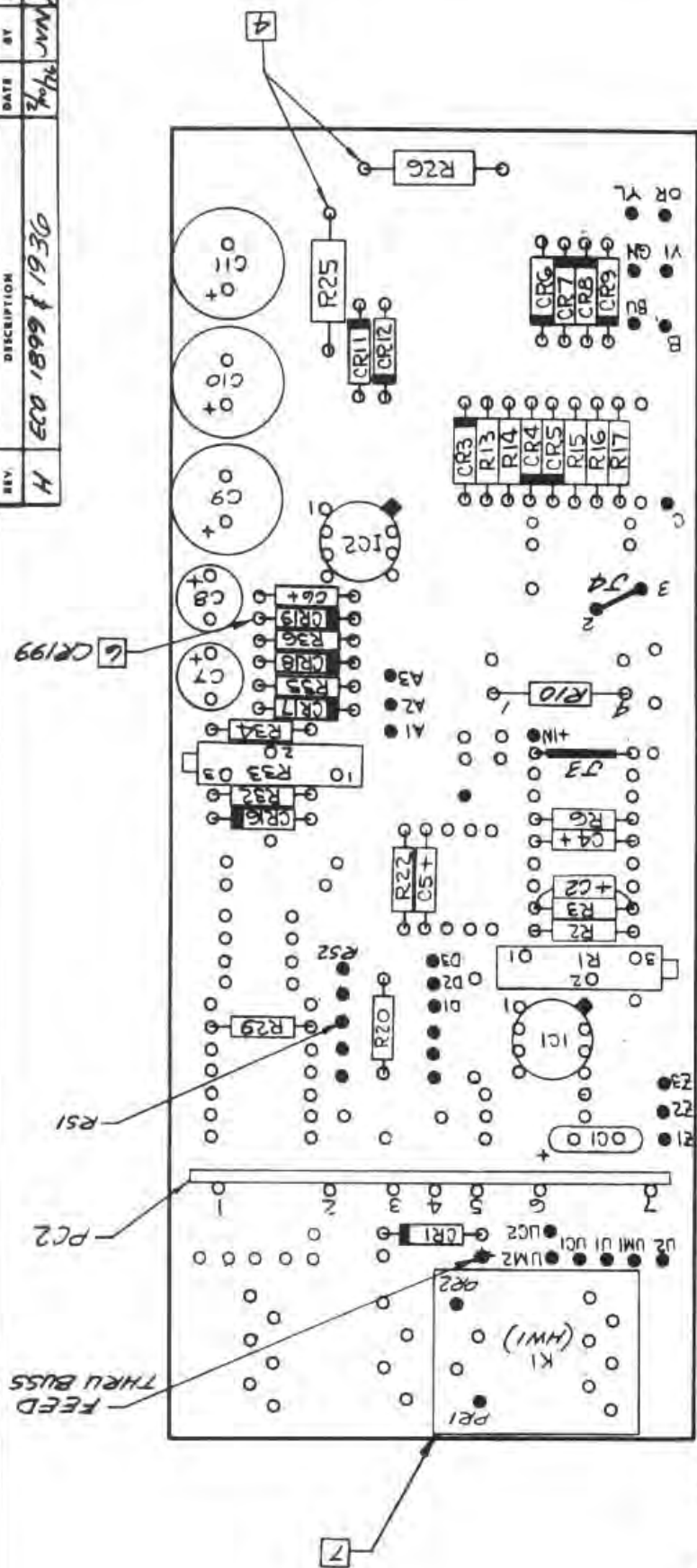
(CATHODE) C A (ANODE)

3. JUMPERS JX1, JX2, JX3 & JX4 CORRESPOND TO X1-X4 RELAY MODE. EXAMPLE:
JX1 = X1 RELAY MODE.
2. SEE FIG. A FOR "LED" LEAD I. D. ANODE TO PAD "A" CATHODE TO PAD "C".
1. ALL JUMPERS 22 AWG BUSS, TEFLON SLEEVED AS REQ'D.

NOTES: UNLESS OTHERWISE SPEC'D.

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE TOLS. UNLESS NOTED: .X = ±.10 .XX = ±.030 .XXX = ±.010 ANGLES = ± 30' DO NOT SCALE DRAWING SCALE: 2/1	DRAWN A. MUNGUIA 10/14/73 CHECKED C. FIEDERER 5/22/79	MOORE INDUSTRIES INC. VAN NUYS CA. P.C. BOARD ASS'Y. STD. RBA DUAL TRIP (PC2)	DWG. NO. 193-504-00 REV. D
	PROJ. ENGR. CUSTMR.		

REV.	DESCRIPTION	DATE	BY	APPROV.
H	ECO 1899 & 1936	7/2/76	MM	MM



7. RELAY OR RELAY SOCKET TO BE MTD FLUSH ON P.C. BD. CHECK FOR PROPER ALIGNMENT.

6. CR199 IS CR19 MOUNTED IN REVERSE.

5. R25 AND R26 MOUNTED IN BACK OF BOARD FOR DC POWER.

4. ALL JUMPERS ARE 22 AWG BUSS, TEFLON SLEEVED AS REQ'D.

3. ALL LEADS MUST BE SOLDERED TO PADS EXCEPT UNUSED I.C. LEADS.

2. NOTES: UNLESS SPECIFIED OTHERWISE

ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DIMENSION
1	10-73	ASSEMBLY STANDARD SINGLE RBA	MOORE INDUSTRIES INC. VAN NUYS, CALIF.	193-501-00H PAGE 1 OF 2
LIST OF MATERIALS				
1	10-73	ASSEMBLY STANDARD SINGLE RBA	MOORE INDUSTRIES INC. VAN NUYS, CALIF.	193-501-00H PAGE 1 OF 2
DO NOT SCALE DRAWING				
SCALE 2" = 1" JOB NO 193				

MOORE INDUSTRIES INC.
VAN NUYS, CALIF.

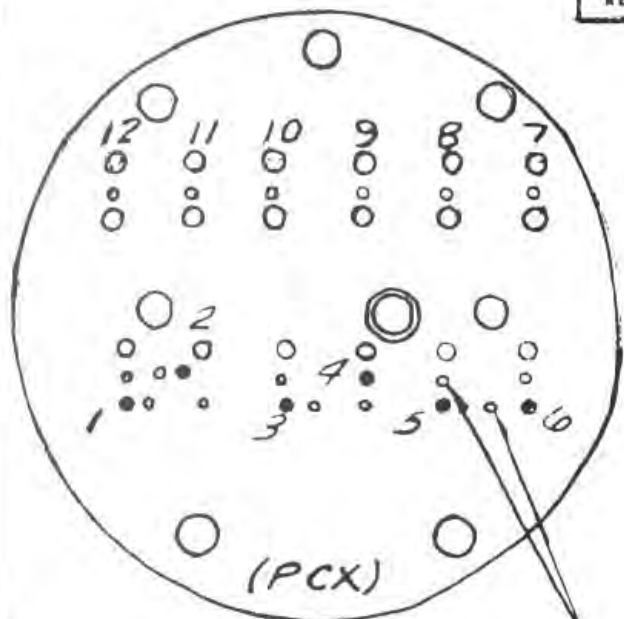
ASSEMBLY STANDARD SINGLE RBA

193-501-00H
PAGE 1 OF 2

ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DIMENSION
1	10-73	ASSEMBLY STANDARD SINGLE RBA	MOORE INDUSTRIES INC. VAN NUYS, CALIF.	193-501-00H PAGE 1 OF 2
LIST OF MATERIALS				
1	10-73	ASSEMBLY STANDARD SINGLE RBA	MOORE INDUSTRIES INC. VAN NUYS, CALIF.	193-501-00H PAGE 1 OF 2
DO NOT SCALE DRAWING				
SCALE 2" = 1" JOB NO 193				

1. ALL LEADS MUST BE SOLDERED TO PADS EXCEPT UNUSED I.C. LEADS.

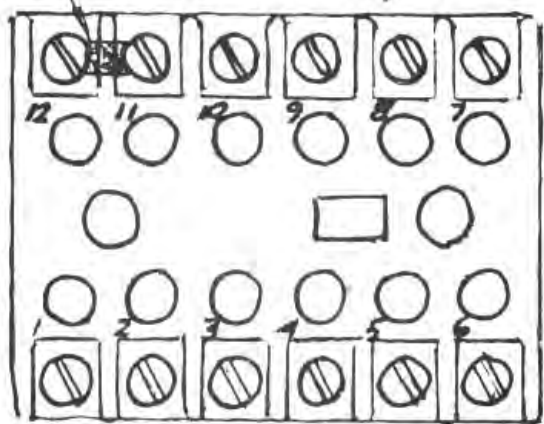
NOTES: UNLESS SPECIFIED OTHERWISE



MTG OF VSI

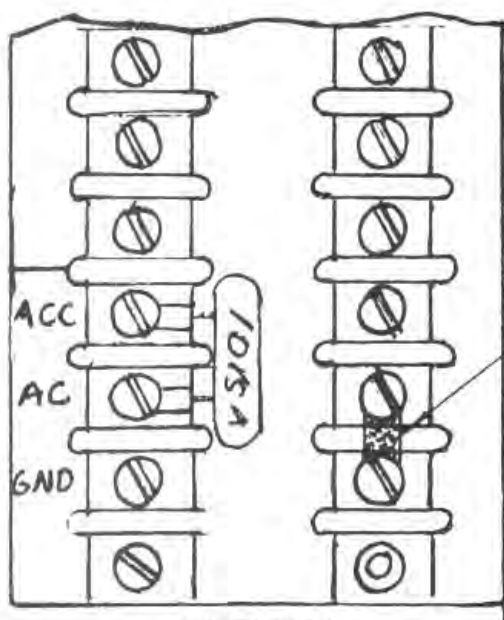
MTG HOLES FOR VSI

J101



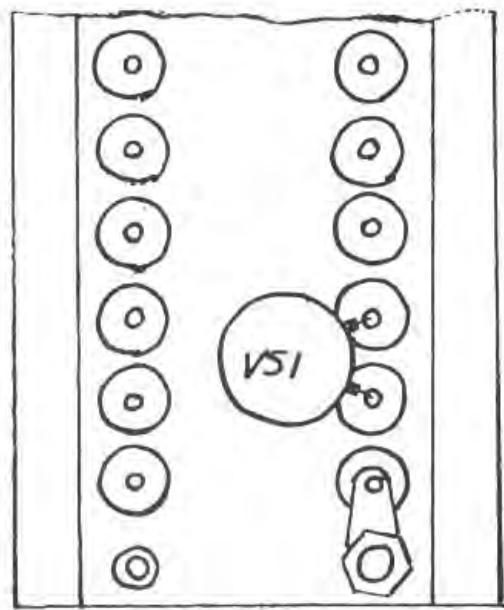
MTG OF J101

"SP CASE"



VSI01

J101



MTG OF VSI

SLEEVE LEADS

"SR CASE"

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE TOLS. UNLESS NOTED: .X = ± .10 .XX = ± .030 .XXX = ± .010 ANGLES = ± 30°	DRAWN: <i>[Signature]</i> 3/26/74
	CHECKED: <i>[Signature]</i> 2/10/76
DO NOT SCALE DRAWING	PROJ. ENGR. <i>[Signature]</i> 2/10/76
SCALE: 1/1	CUSTMR.


MOORE INDUSTRIES INC.
 VAN NUYS ■ CA.

**ADDITIONAL PARTS LOC'N,
 STANDARD RBA
 SINGLE TRIP**

DWG. NO. 193-501-00

REV. **H**

REV.	DESCRIPTION	DATE	BY	APPROV.
E	ECO 5965	2/2/87	Cim	JM

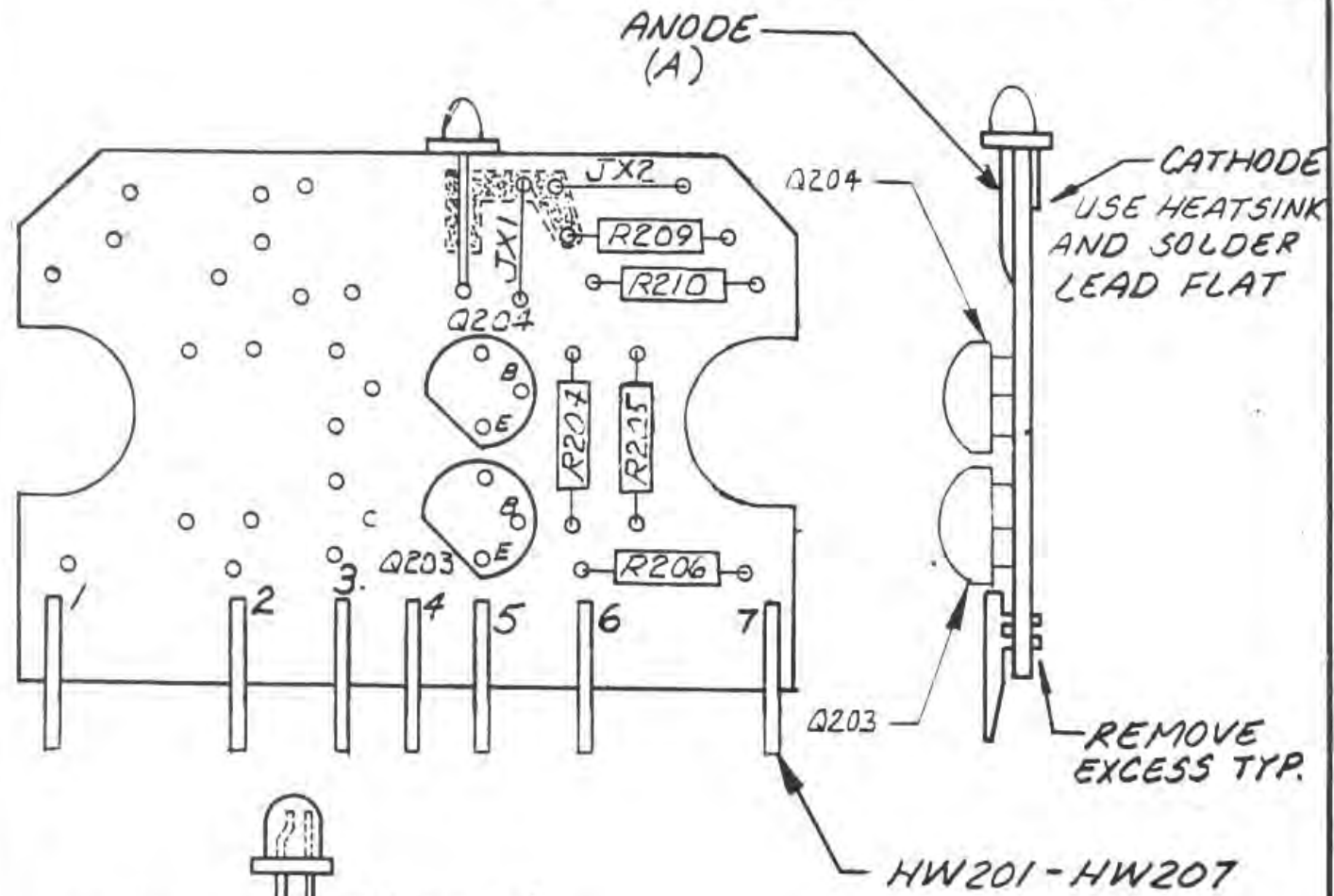


FIG. A
LEAD IDENTIFICATION

3. JUMPERS JX1 & JX2 CORRESPOND TO XI AND X2 RELAY MODE. EXAMPLE:
JX1 = XI RELAY MODE.
2. SEE FIG. A FOR "LED" LEAD I. D. ANODE TO PAD "A," CATHODE TO PAD "C."
1. ALL JUMPERS 22 AWG BUSS TEFLON SLEEVED.

NOTES: UNLESS OTHERWISE SPEC'D.

DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE	DRAWN	A. M.	10/10/73	MOORE INDUSTRIES INC. VAN NUYS ■ CA.
	CHECKED	L. Anderson	5/24/74	
TOLS. UNLESS NOTED: .X = ±.10 .XX = ±.030 .XXX = ±.010 ANGLES = ± 30'	PROJ. ENGR.	A. S. Little	7/2/74	BOARD ASSEMBLY STD. R B A PC2 SINGLE TRIP
	DO NOT SCALE DRAWING			
SCALE: 2/1	CUSTMR.			DWG. NO. 193-503-00
				REV E

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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