MOORE INDUSTRIES

INSTRUCTION MANUAL

SHM

Sample Holding Module

189-701-00E

December 1974

SECTION 1

INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains a description of the analog Sample and Hold Module, instructions for its calibration, adjustment, installation, theory of operation, maintenance instructions, schematic diagrams and assembly drawings.

1.2 PURPOSE OF EQUIPMENT

Upon receipt of a sample command pulse, the Sample and Hold Module (SHM) samples an incoming signal and the output reaches a corresponding level within 1 second. When the sample command pulse is removed, the output remains at the sampled level until a new command pulse is received. The SHM is applicable to telemetering systems where data is being transmitted in time-multiplexed pulse-duration or amplitude form. It may also be used in chromatograph systems to store the output representing the quantity of a selected substance. In this application, the sample command may be a momentary contact closure (customer-furnished) across the command-signal input terminals.

Several options modify the sampling cycle of the SHM. Refer to Section 4 for detailed descriptions of these options.

1.3 GENERAL DESCRIPTION

An external processing input signal between+IN and —IN is applied to a buffer amplifier. The output of this element is sampled by a controlled sampling circuit. If the control signal at the HC terminals is not present, no sampling occurs. When a control signal occurs at HC, the sampling circuit samples the input signal for 100 milliseconds. At the end of that period, the sampling circuit resumes its hold condition, no sampling occurs, and the output of the sampling circuit remains at the level it reached just before the sampling mode was interrupted. The output of the sampling circuit is divided down by a voltage divider. Portions of that signal are picked-off by the SPAN control and amplified to produce the desired output level.

Three major alternative sampling options are available: a track and hold (TR) mode, a peak picker (PP) mode, and an analog output (AO) mode. The TR option allows the state of the control signal to directly control the mode of the sampling circuit. In the peakpicker option, sampling occurs when a peak signal is present on the external input lines. In this option the control input is used as a reset command to force sampling during times other than peak periods. The analog output option allows the external input signal to be buffered out of the SHM at different times during the control cycle. Using dual controls, several variations of controls are possible and are fully described in paragraph 4.2.6.4. Refer to Table 1-1 for a complete list of available SHM electrical options.

Table 1-1. SHM ELECTRICAL OPTIONS

Option	Description	Reference Paragraph
AC	117 VAC or 240 VAC 50 to 60 Hz	4.2.1
CC	External contact closure	4.2.6
SC	Selectable current	4.2.9
TR	Tracking	4.2.6.2
RF	RFI filter terminal assembly	4.2.1
HI	High current or voltage output	4.2.11
PP	Peak power input selection	4.2.6.3
AO	Analog output	4.2.6.4

1.4 PHYSICAL DESCRIPTION

The SHM is available in several different physical configurations. In general, the unit consists of a main circuit board and one small board mounted on the main board. The small board, present in a DC-operated standard unit only, contains the power inverter. The main board contains the remaining circuits. The boards are enclosed in a protective housing, and the entire assembly may be installed in a number of 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. Custom enclosures that are oil-tight and water-tight can also be furnished. Although the printed-circuit board assembly is electrically identical regardless of the physical configuration and mounting method, the external electrical connections may be made to different terminals on the terminal block in the various versions of the unit. Refer to Table 1-2 for a list of mechanical options available. Specific details for making electrical connections are given in Section 2, Installation Information.

Table 1-2. SHM MECHANICAL OPTIONS

Option	Explanation
CP	Conduit plate for use with standard units
EX	Explosion-proof enclosure. Single Unit — Div. 1
GP	General purpose enclosure, Single Unit — NEMA 1
OT	Oil-tight enclosure, Single Unit — NEMA 12
WT	Water-tight enclosure, Single Unit — NEMA 4

1.5 SPECIFICATIONS

The specifications of the SHM are given in Table 1-3.

TABLE 1-3. SHM SPECIFICATIONS

INPUT (PROCESS):	
Current:	1-5 mA, 4-20 mA, 10-50 mA
Voltage:	0-5 VDC, 1-5 VDC Other ranges for current and voltage available
INPUT (COMMAND):	
Sample:	Customer-furnished momentary external contact closure, not less than 30 milliseconds in duration, to initiate internally gated sample pulse; sample command may also be a h a pulse width not less than 30 milliseconds.
Track:	Customer-furnished external contact closure to maintain unit in track mode; track command may also be a 5 VDC signal (at 1 mA)
Hold (Track Mode):	Open external contacts or reduce command signal to 0 VDC
INPUT IMPEDANCE:	
Current:	1-5 mA into 200 ohms 4-20 mA into 50 ohms 10-50 mA into 20 ohms
Voltage:	10 megohms minimum
SPAN AND ZERO:	Adjustable with multiturn potentiometer
Span:	At full scale input, adjusts output to 100%±20% of selected output span
Zero:	At minimum input, adjusts output to 0%±10% of selected output span
ISOLATION:	Voltage output units have input negative side common to output negative side. Current output models have output negative side elevated above input negative side (true current source). Mixed outputs are optionally available. Power input isolation is maintained on both AC and DC powered units

Table 1-3. SHM SPECIFICATIONS (Cont.)

OUTPUT:	Operational amplifier feedback current source. Output limited to 150% of maximum output range value
Current:	1-5 mA into 0- to 6000-ohm load 4-20 mA into 0- to 1500-ohm load 10-50 mA into 0- to 600-ohm load
Voltage:	1-5 VDC standard into 20K Ohms minimum
OUTPUT MODES:	
Sample and Hold:	Output level is made to match the input only after initiation of the command input by a pulse at least 30 milliseconds in duration. One second later, output of unit will automatically become equal to the input present at the time command pulse was received and will remain at this value until the next command pulse is received.
TR Option:	Output level follows (tracks) the input signal continuously while command input is maintained. When command input returns to 0 VDC, output will hold at the level present when the command input (5 VDC) was removed.
HOLDING DECAY:	2% of full scale per hour
FREQUENCY RESPONSE:	0.5 Hz (3-dB point) while tracking the input
CALIBRATED ACCURACY:	±0.1% of full scale
LOAD RESISTANCE EFFECT:	±0.01% of span from zero to maximum load resistance (for current output)
OUTPUT RIPPLE:	10 mV P/P at maximum load resistance and maximum span
AMBIENT TEMPERATURE RANGE:	0°F to +150°F (—18°C to +66°C)
AMBIENT TEMPERATURE EFFECT:	±0.005%/°F over above range; compensation curves for extended ambient ranges available
POWER INPUT:	24 VDC standard, maximum optional 65 VDC ±10% 117 VAC 50/60 Hz or 220 VAC 50/60 Hz optional 5 watts maximum Other supply voltages available Line voltage effect ±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 reference.

Table 1-4. EXAMPLE OF MODEL NUMBERING

BASIC EXAMPLE: **SHM/4-20MA/4-20MA/117AC/TR**

SHM, 4-20 mA input, 4-20 mA output, 117 VAC power, tracking mode output

BASIC INSTRUMENT TYPE:

SHM indicates Sample and Hold Module

INPUT RANGE:

Numbers:	Minimum and maximum nominal input range, generally an industry standard

OUTPUT RANGE:

Numbers:	Minimum and maximum nominal output range, generally an industry standard

POWER INPUT:

AC:	AC power, 117 VAC ±10% unless stated otherwise, e.g., 240 VAC
DC:	DC power, 24 VDC ±10% (45 VDC ±10% may be specified as an option)

OPTIONS:

TR:	Indicates Track and Hold option

INPUT AND OUTPUT ABBREVIATIONS

MA = milliamperes V = volts

INSTALLATION INFORMATION

2.1 GENERAL INSTALLATION INFORMATION

Installation, in general, consists of calibration (when required), mechanical mounting, and making the electrical connections to the unit. The necessary procedures are described in paragraph 2.3 and those following that paragraph. Before actually calibrating the unit, however, the reader should first become familiar with the type of controls on the unit and the tools (if any) required for adjustment; these are described in paragraph 2.2.

2.2 CONTROLS

Several types of controls are provided on standard Moore Industries products. They have been carefully selected to fulfill the necessary electrical requirements and also provide optimum ease of adjustment by the user. Standard units have multiturn potentiometers that are adjusted with a blade screwdriver.

CAUTION

SCREWDRIVER BLADE MUST NOT BE MORE THAN 0.1 INCH (2.54 mm) WIDE. USE OF A WIDER BLADE MAY PERMANENTLY DAMAGE THE POTENTIOMETER MOUNTING.

This type of potentiometer usually requires 20 turns of the shaft to move the wiper from one end of its range to the other. It is equipped with a slip clutch at either end of its travel to prevent damage if it is turned beyond the wiper stop. Usually a slight change in feel will be noticed when the clutch is slipping; however, if this change is not observed, one can be certain of reaching either end 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.

When present, internal adjustable controls are single-turn potentiometers that require a screwdriver with a blade not more than 0.1 inch (2.54 mm) wide. Since these devices do not have slip clutches, care must be used t avoid overtorquing them.

2.3 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 should be calibrated by the user before the unit is placed in service.

NOTE

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

One adjustable signal source, a contact closure (switch or relay) or a 5-volt signal source capable of delivering at least 1 mA, and input and output monitoring devices are required for calibration. The monitoring devices (current or voltage) must have an accuracy within ±0.05% or better.

The calibration procedure for units without the TR option ((*Sample*-and-hold units) is slightly different from that for units with the TR (tracking) option (track-and-hold units)). Therefore, two different sets of procedures are provided; use the one that corresponds to the configuration of the unit being calibrated, and ignore the other one.

2.3.1 Calibration Procedure For Units Without TR Option

To calibrate a unit without the TR option, proceed as follows:

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

b. Apply power input to the unit.

NOTE

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

c. Lower +HC signal to 0V (*open* the switch —CC option) and adjust the process signal source to the minimum value specified for the unit (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified minimum input is for the unit).

d. Momentarily raise +HC signal to +5 VDC, then lower to 0V (close and then open the switch —CC option).

e. Allow 1 second delay for the output to reach a steady value. 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).

f. Adjust the process 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. Momentarily raise the signal to +5 VDC, lower to 0V (close and then open the switch, CC option).

h. Allow 1 second delay for the output to reach a steady value. Adjust the SPAN potentiometer to obtain 100% output.

i. Momentarily raise +HC signal input to +5 VDC (switch is momentarily closed —CC option) with the specified 0% and 100% process input signals applied.

j. Adjust the process signal source to 25% of input specified for the unit.

k. Repeat step g.

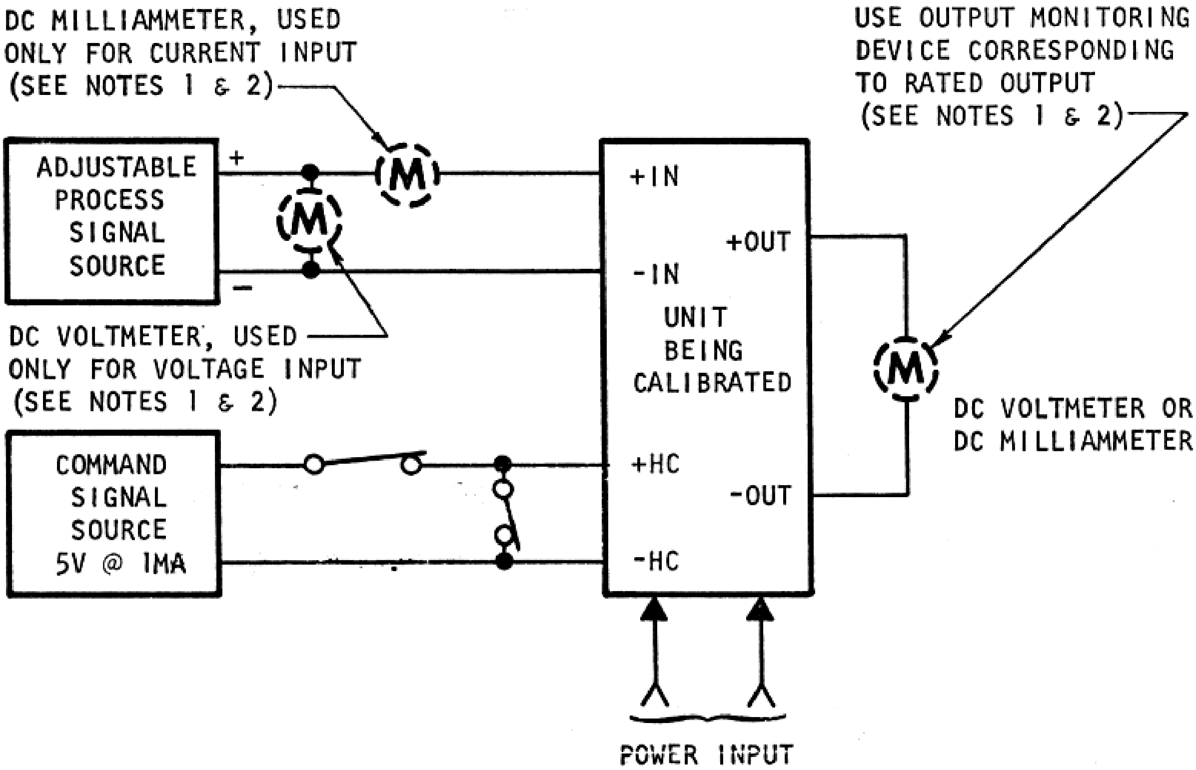
m. Check that unit output reaches 25% of output specified.

n. Adjust the process signal source to 50% of input specified for the unit.

o. Repeat step g.

p. Check that unit output reaches 50% of output specified.

q. Adjust the process signal source to 75% of input specified for the unit.



NOTES:

1. INPUT AND OUTPUT MONITORING DEVICES MUST BE ACCURATE WITHIN 0.05% OR BETTER.

Figure 2-1 Test Equipment Setup For Calibration

r. Repeat step g.

s. Check that unit output reaches 75% of output specified.

t. Remove the input signal sources and turn off the power input to the unit.

2.3.2 Calibration Procedure For Unit With TR Option

To calibrate a unit with the TR option, proceed as follows:

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

b. Apply power input to the unit.

NOTE

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

c. Raise +HC signal to +5 VDC (*close* switch —CC option) and adjust the process signal source to the minimum value specified for the unit (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified minimum input is for the unit).

d. Adjust ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified 0% output is for the unit).

e. Lower +HC signal to 0V (open switch —CC option) and observe that the output remains at the value adjusted for in step (d).

f. Raise +HC signal to +5 VDC (*close* switch —CC option) and adjust the process 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 SPAN potentiometer to obtain 100% output (5 mA, 20 mA, 50 mA, 5 VDC, or whatever the specified maximum output is for the unit).

h. Lower +HC signal to 0V (open switch —CC option) and observe that the output remains at the value adjusted for in step (g).

2.3.3 Calibration Procedure For PP Option

To calibrate a unit with the PP Option, proceed as follows:

a. Repeat steps a, b of paragraph 2.3.2.

b. Adjust process signal source to the minimum value specified for the unit (1 mA, 4 mA, 10 mA, 1 VDC, or whatever the specified minimum input is for the unit).

c. Using a millivolt meter, place positive lead on IC1 pin 11 and negative lead on IC1 pin 5.

d. Raise +HC signal to +5 VDC (or close switch for CC option).

e. Adjust potentiometer R17 on PC1 for a meter reading of 7.0 ± 0.3 mV.

f. Adjust ZERO potentiometer to obtain 0% output (1 mA, 4 mA, 10 mA, 1 VDC or whatever specified 0% output).

g. Lower the +HC input to 0V (or open switch for —CC option).

h. Adjust process signal source to maximum value specified for unit. Unit output automatically goes to 100% of specified output value.

i. Adjust SPAN potentiometer to obtain 100% output (5 mA, 20 mA, 50 mA, 5 VDC or whatever the specified maximum output is for the unit.

j. Raise +HC and repeat steps f through i until correct outputs are obtained.

k. Adjust process signal source to minimum value specified for unit.

m. Momentarily raise +HC signal to +5V (or close switch —CC option).

n. Check that unit output is at 0% of specified output.

o. Adjust process signal source to 25% of value specified for unit.

p. Repeat step m.

q. Check that unit output is at 25% of specified output.

r. Adjust process signal source to 50% of value specified for unit.

s. Repeat step m.

t. Check that unit output is at 50% of value specified for unit.

u. Adjust process signal source to 75% of value specified for unit.

v. Repeat step m.

w. Check that unit output is at 75% of value specified for unit.

x. Remove input signal sources and power to unit.

2.4 MECHANICAL INSTALLATION

As mentioned in Section 1, the unit may be obtained in various physical configurations and/or case sizes. Figure 2-2 shows the outline dimensions and other installation requirements for the particular configuration supplied. 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.

2.5 ELECTRICAL CONNECTIONS

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

2.5.1 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 terminals. All terminals are supplied with 6-32 screws long enough to easily accept three spade-lug connectors.

2.5.2 Power Connections

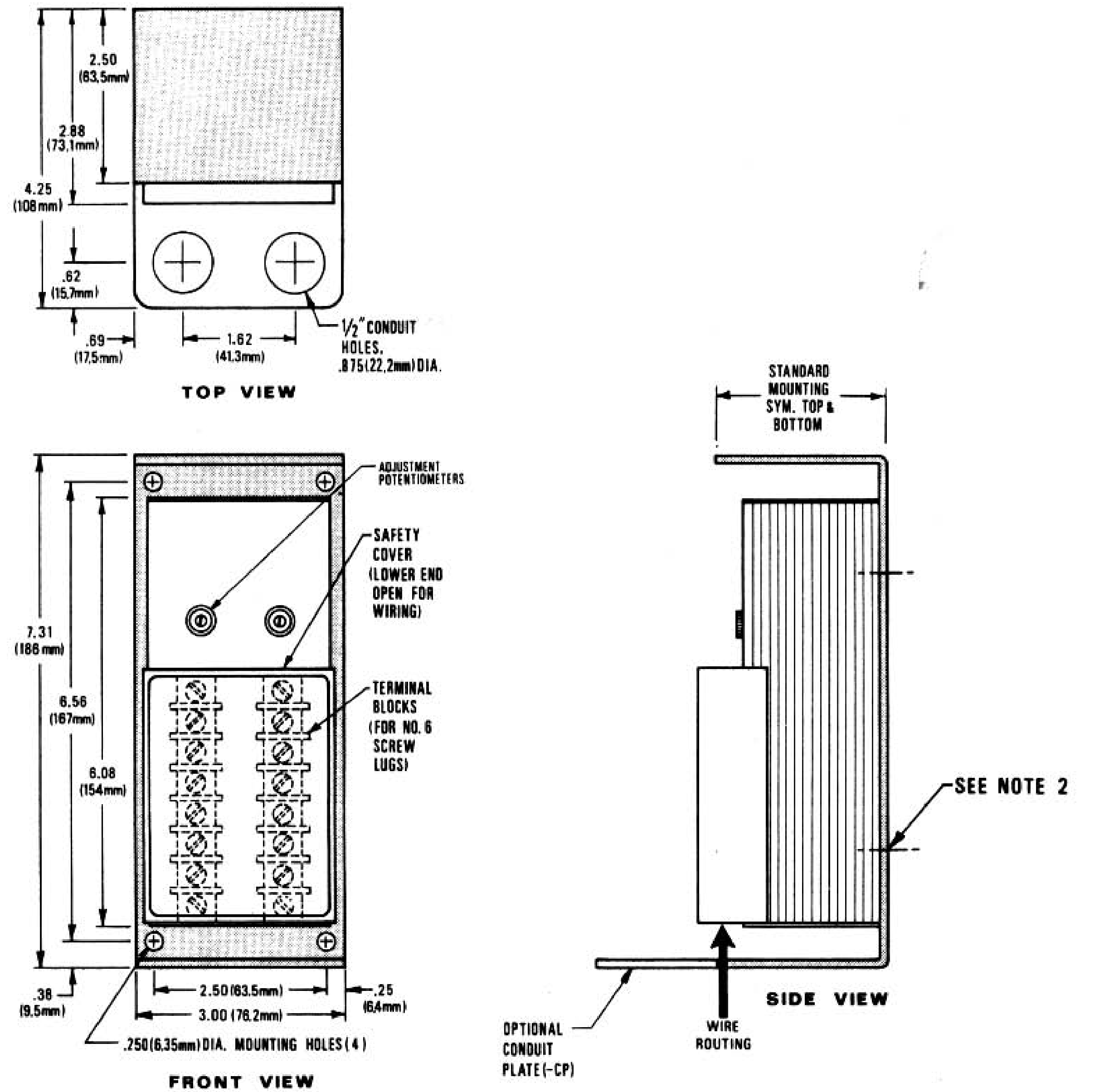
Units are designed to be operated from either a DC power source or an AC power source. Refer to paragraph 1.6 for information on how to use the model number to determine the type of power required.

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 ±10% of the nominal voltage and should be capable of delivering 5 watts.

On AC-powered units, 117 volts AC ±10%, 50/60 Hz, 5 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. The GND terminal is the mechanical case connection.

2.5.3 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. The current range is marked on the body of each resistor.



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.

<u>CAUTION</u>

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

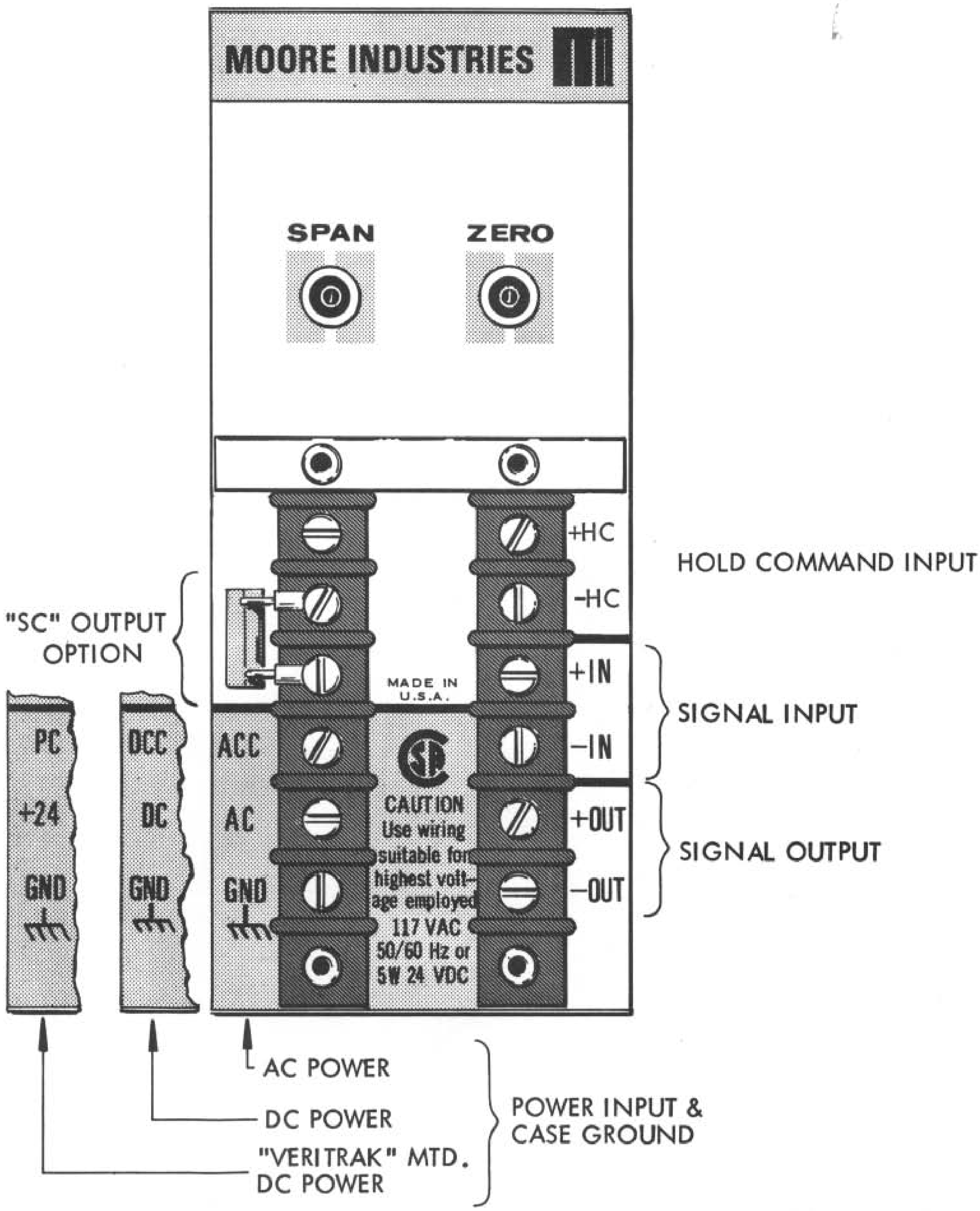


Figure 2-3 Electrical Connections For Standard Unit

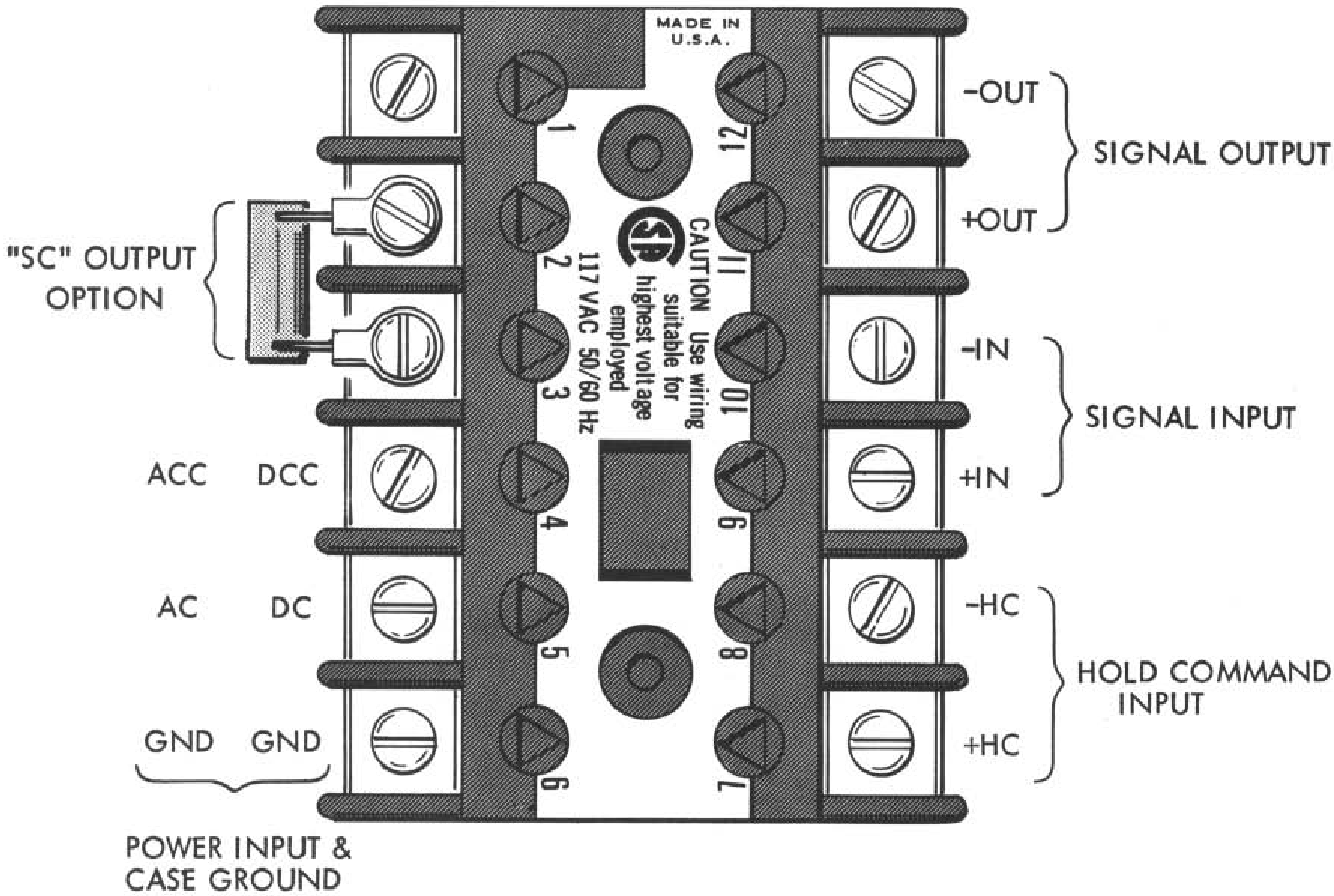


Figure 2-3. Electrical Connections For -EX (Explosion Proof) Housing Mounted Single Unit & -PST Std. Plug-In Units

SECTION 3

OPERATING INFORMATION

3.1 OPERATING PROCEDURE

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

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

THEORY OF OPERATION

4.1 INTRODUCTION

This section describes the 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.

4.2 CIRCUIT DESCRIPTION

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

4.2.1 Description Of AC Power Supply Circuit (AC and RFI Option)

The AC power supply circuit consists basically of a power transformer that produces two different AC outputs. Referring to the SHM schematic diagram, VS1 is connected across the primary of power transformer T1 and suppressing transients that may be present on the power line. Each half of the center-tapped secondary of T1 puts out 18 volts, and the other secondary produces 36 volts. The voltage from the center-tapped secondary is applied to CR5 thru CR8, and that from the other secondary is applied to a half-wave rectifier.

4.2.2 Description Of Power-Inverter Circuit

In a standard unit, the components of the power inverter are mounted on a printed-circuit board attached to the main board. Descriptions of the power-inverter circuit for the unit are given in the following paragraphs.

4.2.2.1 *Power-Inverter Circuit For Standard Unit*

Drawing 400-404-00 is the schematic diagram of the power inverter (PCA) used on the standard units. When the unit is ordered for use with DC power, the power inverter is used instead of the AC source (T1) shown on the SHM 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 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 CR7, CR5, a half wave rectifier, and that from secondary 17-16 is applied to CR202.

4.2.3 Rectifier And Regulator Circuit For Standard Unit

Diode bridge rectifiers CR5 through CR8 form a full-wave rectifier that produces both positive and negative DC outputs (with respect to the grounded center tap of the transformer winding that feeds the rectifier). The positive and negative DC outputs from the bridge are filtered by C202 and C203, and regulated to +12 volts and —12 volts by pass transistors Q201 and Q202. Zener diodes CR203 and CR204 are used to clamp the base of the transistors. Voltage from the transformer winding that is not center-tapped is applied to a half-wave rectifier and filter to produce operating voltage of approximately 38 volts for the power amplifier.

4.2.4 Description Of Input Buffer Circuit

IC4 and associated components form an input buffer stage. R21 provides the proper termination for a current analog-signal source connected to the +IN and —IN terminals. The signal at the +IN terminal is applied through R31 to pin 3 (the non-inverting input) of IC4. A portion of the output at pin 6 is taken from the junction of IC1 and R14 and fed back through R14 to pin 2 (the inverting input) to establish the gain of this stage.

THEORY OF OPERATION

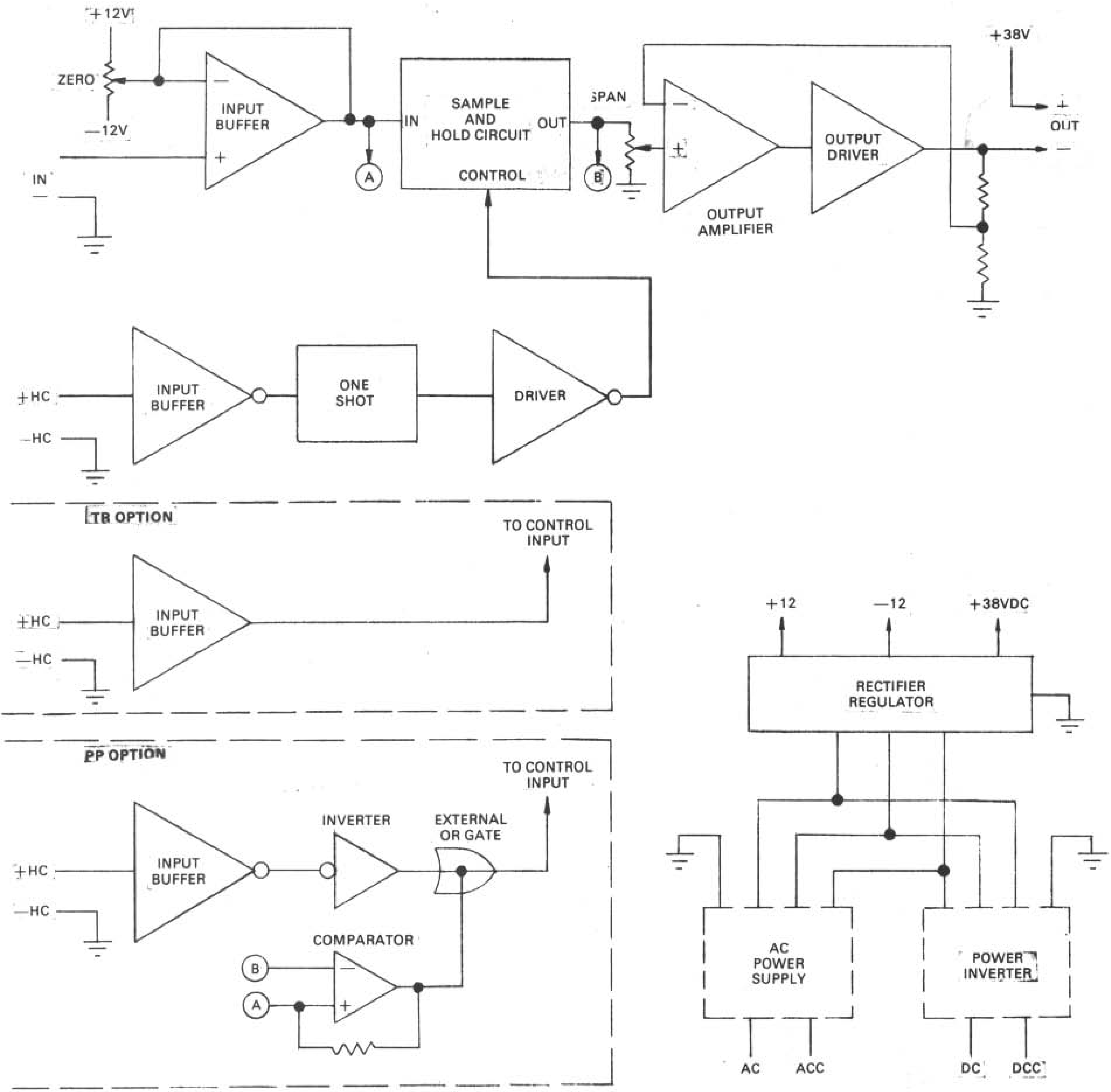


Figure 4-1. SHM With Options Block Diagram

The inverting input also receives the bias Zero signal. This bias is generated by the Zero circuit consisting of voltage divider R9 through R12 ZERO potentiometer and Zener diodes CR1, CR2. 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 an overall gain that is directly affected by the position of the ZERO potentiometer.

4.2.5 Sampling Circuit Description

The sampling circuit consists of sample and hold IC1, offset resistor R17 and the command control circuits. The sample and hold module IC1 samples the signal present at pin 5 and buffers it out on pin 11, in accordance with the state of the control input on pin 6. The control input is normally held at some high state due to the pull-up action of R15. This resistor is referenced internally to a positive signal source derived from the +12V at pin 12. When the control input goes low (near ground), the module ceases to sample the signal at pin 5. During that period, a storage capacitor, C7, holds the input level of the output buffer stage to the state attained just prior to the hold condition. Offset resistor compensates for the offset generated by the peak picker option. Refer to paragraph 4.2.6.3 for a description of R17 action on the sample and hold circuit. During all other modes, R17 is set for an offset between IC1 pin 5 and 11 of 0 volts.

4.2.6 Control Circuit Description

The command gate operates in four major configurations: the standard mode (sample and hold), the tracking mode (the TR option), the peak picker mode (PP option), and the analog output mode (AO option). Figure 4-1 illustrates these modes in block diagram form (except for the AO option). All four inputs may use a positive signal as control or they may use a contact closure. The contact closure (CC option) is effected by an external relay. A +12V source is provided by the SHM (point A in 189-481-00) to provide the necessary excitation power to the +HC command input. The following paragraphs assume the command signal as some positive signal level.

4.2.6.1 *Standard, Sample and Hold Mode*

The standard SHM command circuit illustrated in schematic 189-401-00 consists of a buffer input Q1, a one-shot multivibrator C5, IC2 and a driver Q3. When +HC goes high, Q1 conducts, grounding the input pin 1,2 of IC2. This condition forces IC2-3 high and consequently IC2-11 low, and C5 starts charging, while holding Q3 in cut-off. Since Q3 is off, pin 6 of IC1 is high and sampling of the +IN processing input occurs. When C5 approaches full charge approximately 100 milliseconds, the voltage level on pins 1, 2 of IC2 reaches trigger point of IC2 and IC2-3 goes low forcing IC2-11 high. This event causes Q3 to conduct, effectively grounding pin 6 of IC1 and sampling stops and the hold condition exists. The sample and hold chip IC1 now remains in that state until another command is received at +HC.

4.2.6.2 *TR Option (Tracking Mode)*

The TR option command circuit illustrated in schematic 189-401-00 consists of a buffering circuit Q1 and Q3 that buffers the input command to the control input of IC1 (pin 6). When +HC goes high Q1 conducts, cutting off Q3. This condition provides a high signal on IC1 pin 6 and sampling occurs. When +HC is low Q1 is cut off and Q3 is saturated, grounding pin 6 of IC1 and sampling stops. This circuit then effectively causes the function of the SHM to track the state of the command input.

4.2.6.3 *PP Option (Peakpicker Mode)*

The peakpicker command circuit consists of a buffer Q1, inverter IC2 and a comparator IC3 and associated components. When no command signal is present at +HC, Q1 is cut off due to the —12 volt reference through R1. With Q1 cut off IC2, pins 1,2 are high, forcing pin 3 low back biasing CR4. This condition disables this section of the control signal and allows the circuit of IC3 to operate.

As IC1 processes the signal input from +IN, the input and output of IC1 are sampled by IC3. The output of IC1 is fed to the inverting input of comparator IC3 while the input of IC1 is provided to the non-inverting input to the comparator. When the processed input signal at IC1 is rising, causing IC1 pin 11 to be lower than pin 5, the output of IC3 at pin 6 goes high. This condition allows IC1 to continue sampling. As long as the input from +IN continues to rise, IC3 pin 6 will be high and sampling will continue.

As soon as the processed input signal at IC1 decreases, IC1 pin 11 is higher than pin 5. Now the inverting input to IC3 sees a larger signal than pin 3, the non-inverting input, and consequently IC3 pin 6 goes low, back biasing CR9. Since R19 is referenced to —12V, pin 6 of IC1 will see a low signal and IC1 stops sampling.

If a command input occurs, +HC is high and Q1 conducts. This forces IC2 pin 3 high, raising IC1 pin 6, and IC1 is forced to sample regardless of the state of IC3. These conditions effectively provide a reset provision for the peak sampling circuit of IC3.

Due to the operating characteristics of IC3, an offset of 7 to 10 millivolts is necessary to obtain the operating specifications described above. Resistor R17 is used to obtain this offset condition and is adjusted at the factory to set IC1-11 at 7 to 10 millivolts higher than IC1-5.

4.2.6.4 *AO Option (Analog Output Mode)*

This option provides mechanization for the control of sampling by two command signals, HC1 and HC2. This option is illustrated on drawing 189-403-00. Buss connections J1 through J10 select various output conditions. If only buss J1, J2, J5, J6, J7, J9 are used, command signals +HC1 and +HC2 operate independently (see Figure 4-2). When +HC1 goes high, Q1 conducts, forcing IC2-3 high, and IC2 11 low, cutting off Q3. This condition provides a high state on IC1 pin 6 (on drawing 189-401-00) and sampling of the +IN signal occurs. As soon as the command is removed, IC1 pin 6 returns low and sampling stops.

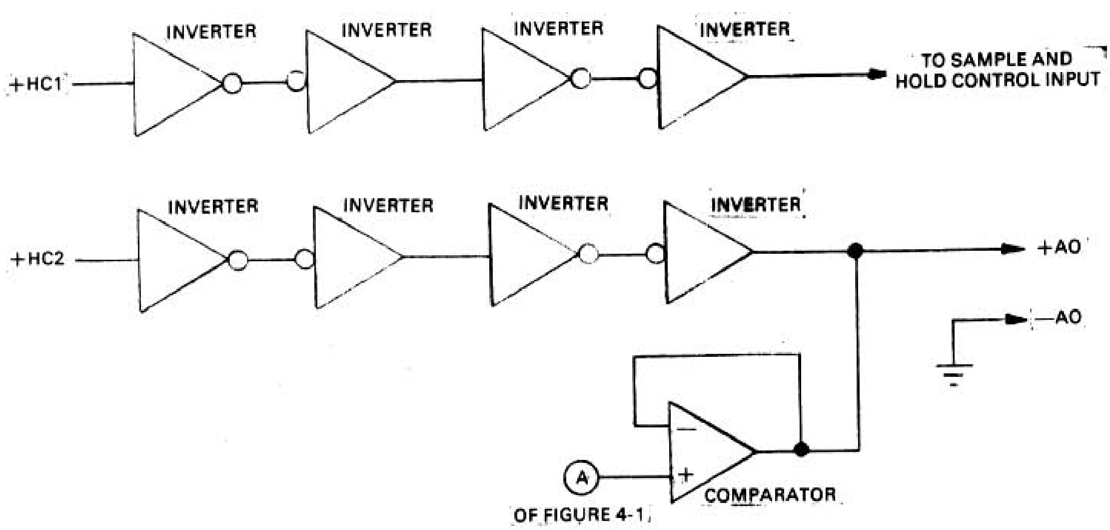


Figure 4-2. Direct Independent Control AO Option

When +HC2 goes high, Q2 conducts, forcing IC2-6 high and IC2-8 low, cutting off Q4. This condition allows unity gain amplifier IC3 to buffer the input processing signal from +IN to terminals +AO. When the command signal is removed, Q2 goes into cutoff due to the —12 volt reference through R8. With Q2 in cutoff, IC2-6 goes low, IC2-8 goes high and Q4 conducts, effectively grounding the output of IC3, and OV signal is present at the +AO outputs. The +HC2 control just described can be effected by +HC1 and vice-versa if busses J1, J2, J5, J6, J8 and J10 only are used.

If buss connections J1, J3, J4 and J6, J7, J9 only are used, the two command inputs operate in conjunction with each other (see Figure 4-3). If +HC1 is low whenever +HC2 is high, Q1 is cut off while Q2 is conducting. With Q2 conducting, IC2-6 is high. Simultaneously as Q1 is cut off, IC2-3 is low, forcing IC2-11 high. With both high inputs, IC2-8 goes low, feeding back through J3 to IC2-12 thereby holding IC2-11 high. With IC2-11 high, Q3 conducts providing a holding mode condition to IC1 pin 6 of drawing 189-401-00. At the same time with IC2-8 in the low state, Q4 is cut off allowing the +IN signal input to be buffered out to +AO terminals by IC3. These conditions will hold until +HC commands invert polarity.

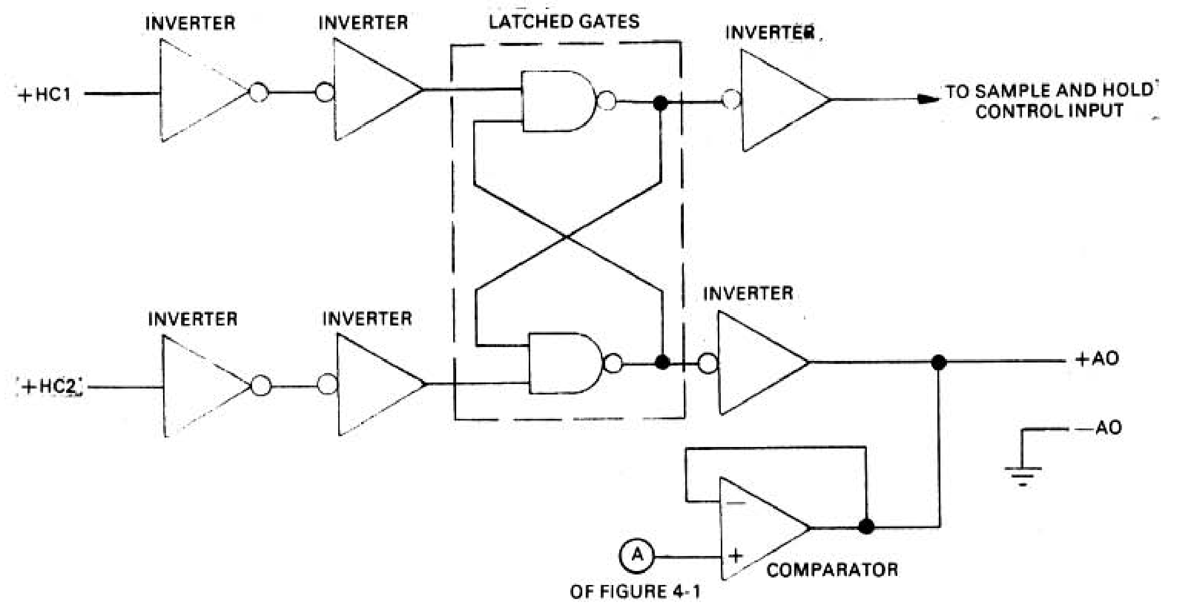


Figure 4-3. Latched Gates AO Option

As +HC1 goes high and +HC2 goes low, Q1 conducts and Q2 is cut off. When Q1 conducts, IC2 pins 1, 2 are low forcing IC2-3 high. Simultaneously as Q2 is cut off, IC2-6 is low, forcing IC2-8 high. This high state propagates to IC2-12 holding IC2-11 low. With IC2-11 low, Q3 is cut off and IC1 of drawing 189-401-00 samples the +IN signal. At the same time, with IC2-8 high, Q4 conducts and grounds the +AO output from IC3.

4.2.7 Output Amplifier Input Circuit Description

Output amplifier IC5 and associated circuits generates the output signal for the SHM. The input of IC5 consists of the output of IC1 divided down by R33, SPAN potentiometer and R34. The SPAN potentiometer wiper selects from 0.2 volts to 1 volt from this voltage divider to produce the output signal.

4.2.8 Current Output Circuit Description

Output amplifier IC5 provides drive current to power amplifiers Q5, Q6 and Q7. Transistor Q5, Q7 are connected in a Darlington configuration. Transistor Q6 is connected in parallel with Q7 to generate greater drive to —OUT output terminal. A power source of approximately 38 volts is provided at +OUT. This configuration allows the SHM load between the OUT terminals to be driven directly by the power amplifiers, thereby offering a very low output impedance. Capacitor C3 filters transients from the load circuit.

4.2.9 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 4.2.8. Normally current from the power source flows through the external load through Q6 and R38 to ground. When the SC option is selected, however, R38 is removed and replaced by R102. Load current now flows through R102 and is thereby limited to the value specified by the resistor.

4.2.9 Voltage Output Circuit Description

When a voltage output is selected, transistors Q5, Q6 and Q7 are removed and the output of IC5, now a higher gain circuit (gain of 5), provides a high inpedance output to the OUT terminals. The load now is between the amplifier output and ground and is in parallel with R38 and R24.

4.2.10 Millivolts Output Circuit Description

When millivolt output is selected, the circuit operates as described in paragraph 4.2.8 except that transistor Q6 is removed. The current gain is reduced to millivolt output by the addition of shunt resistor R18. The low value of R18 develops millivolt values across that resistor. Since the resistor is in shunt with the output, the millivolt signal is available across the OUT terminals.

4.2.11 High Current or Voltage (HI) Output Option

This option provides higher current or voltage output by adding a driver stage Q7 between output amplifier IC5 and the output terminals. Driver Q7 is powered by a 38 volt source providing the drive necessary for higher current or voltage. R38, now a 1K resistor, provides the low resistance necessary to generate more current in the output stage. Capacitor C8 is used in amplifier IC5 to minimize the offset generated by the high gain of the amplifier.

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 calibration 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. The physical configuration of the unit determines the steps to be followed in disassembly, and these steps are described in the following paragraphs. In all cases, disconnect the input signal and turn off the power input before disassembling the unit.

5.3.1.1 *Disassembly Of Standard Units*

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.

5.3.1.2 *Disassembly Of A Plug-In Unit In A Housing*

To disassemble a plug-in unit in an explosion-proof or other type of housing or enclosure (in addition to the case), proceed as follows:

a. Use a bar wrench to loosen the housing cover from the base, and then unscrew and remove the housing cover to expose the unit.

b. If required, remove the unit from the socket by rocking the unit slightly while pulling upward until it is free of the socket. The socket and terminal card are keyed to eliminate error when the unit is reinstalled.

5.3.2 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 drawings show 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.

5.3.3 Component Replacement Techniques And General Precautions

Replace all defective components with identical parts. Refer to the list of materials for a list of replacement parts. A number appears after the description of some 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 trichlorethane or equivalent. Be sure adequate ventilation is provided when using this or any other chemical.

NOTE

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

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

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

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

NOTE

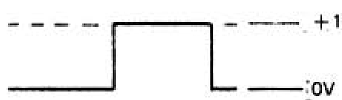
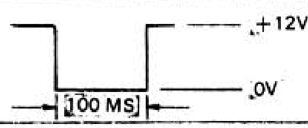
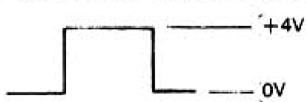
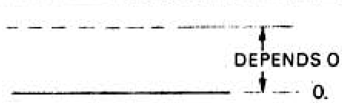
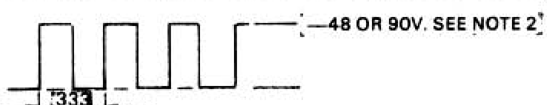
Units that were calibrated at the factory to customer's specifications have protective caps over the SPAN and ZERO potentiometers. These caps must be removed so the unit can be recalibrated. LIFT, DO NOT TWIST, the caps off, using a screwdriver tip as a prying tool. Snap the caps back in place, WITHOUT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

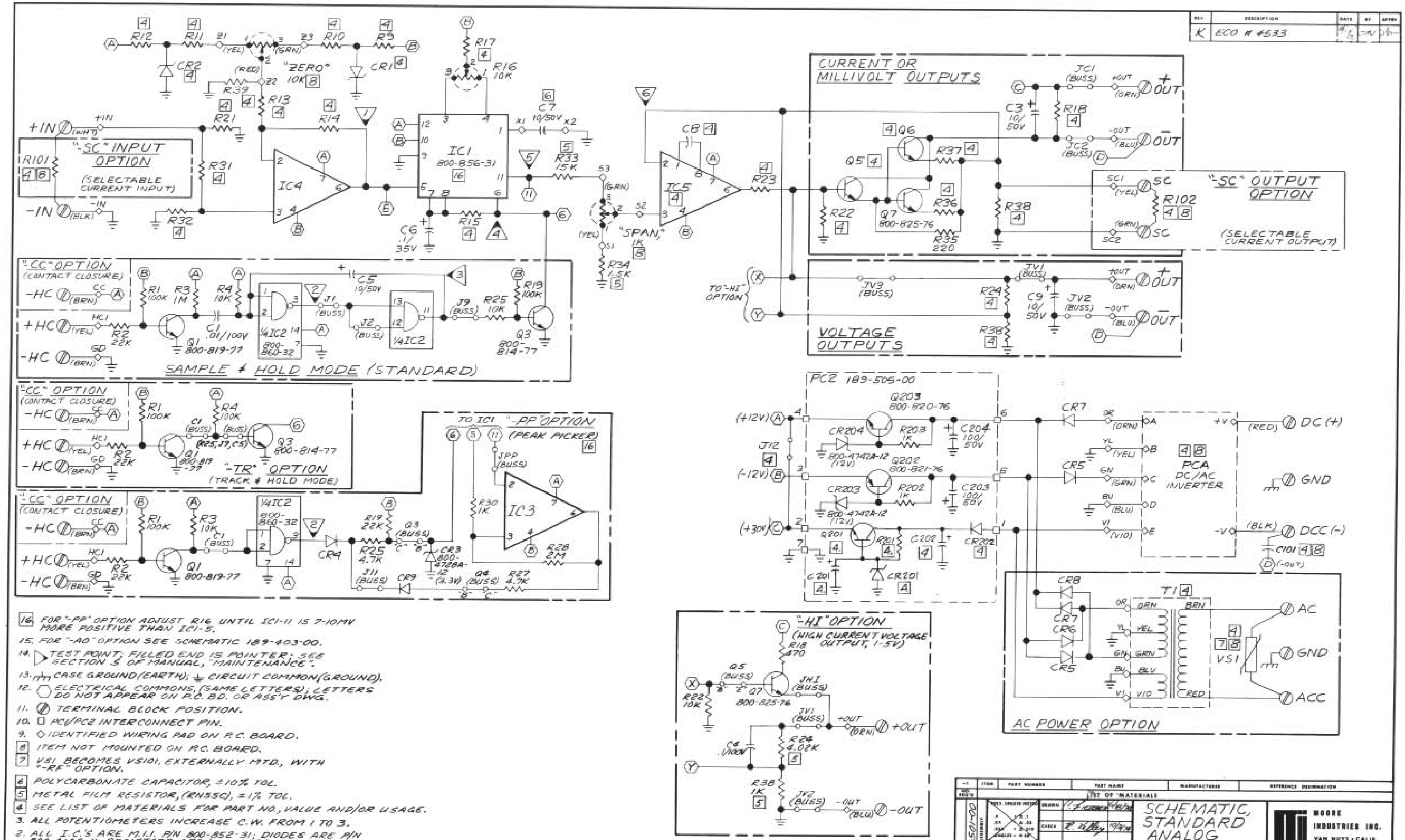
f. Test the unit for proper operation and, if necessary, recalibrate by the procedure given in Section 2. If the unit has the peakpicker option, adjust R17 so that IC5 pin 5 is 7 to 10 millivolts lower than IC5 pin 11. Otherwise adjust R17 so that the difference between IC5-5 and IC5-7 is 0V. When the performance of the unit is known to be satisfactory, apply clear *acrylic* to reseal the unit where required. Refer to Table 5-1 for signal specifications.

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

h. 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 VOLTAGES

TEST POINT	WAVEFORM AND SIGNAL LEVELS	
1		1.8 TO 9.0V FOR ELEVATED OUTPUT 0 TO 9.0V FOR ZERO OUTPUT
2		+HC INPUT HIGH +HC INPUT LOW
3		
4		
5		1.8 TO 9.0V FOR ELEVATED OUTPUT 0 TO 9.0V FOR ZERO OUTPUT
6		0.2 TO 1.0V FOR ELEVATED OUTPUT 0 TO 1.0V FOR ZERO BASED OUTPUT
7		NOTES: 1. Refer to Drawing 400-404-00 2. 48V when 24 VDC is used 90V when 45 VDC is used



16. FOR "-PP" OPTION ADJUST R16 UNTIL IC1-11 IS 7-10MV MORE POSITIVE THAN IC1-5.
15. FOR "-AO" OPTION SEE SCHEMATIC 189-403-00.
14. TEST POINT; FILLED END IS POINTER; SEE SECTION 5 OF MANUAL, "MAINTENANCE".
13. CASE GROUND (EARTH); CIRCUIT COMMON (GROUND).
12. ELECTRICAL COMMONS, (SAME LETTERS); LETTERS DO NOT APPEAR ON P.C. BD. OR ASS'Y DWG.
11. TERMINAL BLOCK POSITION.
10. PC1/PC2 INTERCONNECT PIN.
9. IDENTIFIED WIRING PAD ON P.C. BOARD.
8. ITEM NOT MOUNTED ON P.C. BOARD.
7. VS1 BECOMES VS101, EXTERNALLY MTD., WITH "-RF" OPTION.
6. POLYCARBONATE CAPACITOR, ±10% TOL.
5. METAL FILM RESISTOR, (RN55C), ±1% TOL.
4. SEE LIST OF MATERIALS FOR PART NO., VALUE AND/OR USAGE.
3. ALL POTENTIOMETERS INCREASE C.W. FROM 1 TO 3.
2. ALL I.C.'S ARE M.I.I. P/N 800-852-31; DIODES ARE P/N 800-4148-11; RESISTORS ARE 1/4W, CARB. COMP. ±10%.
1. RESISTANCE VALUES ARE IN OHMS; CAPACITANCE IN MICROFARADS.

NOTES: UNLESS OTHERWISE SPECIFIED

REV.	DESCRIPTION	DATE	BY	APPR
K	ECO # 4533			

SCHEMATIC, STANDARD ANALOG SHM

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JOB NO. 189

189-401-00K

00-105-681

REV.	DESCRIPTION	DATE	BY	APPRV
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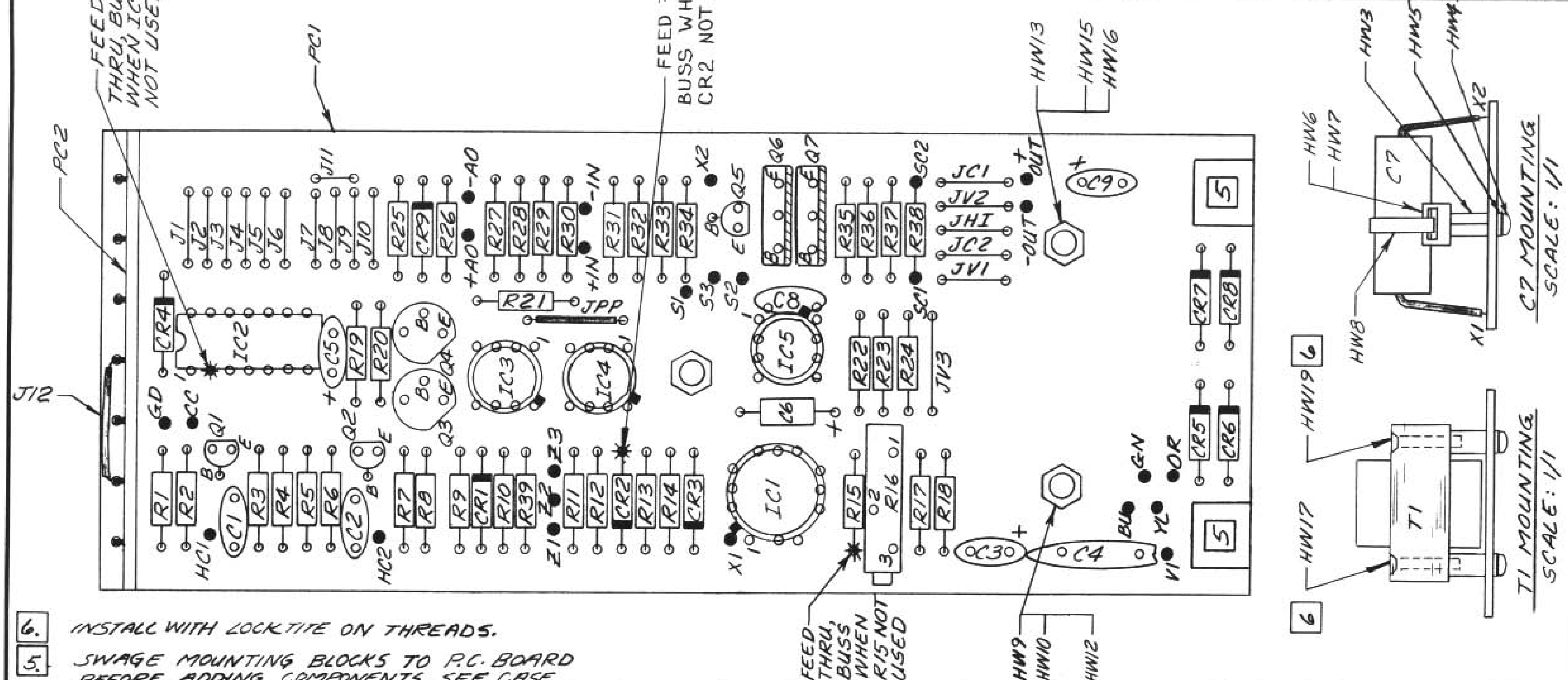

6. INSTALL WITH LOCKTITE ON THREADS.

5. SWAGE MOUNTING BLOCKS TO P.C. BOARD BEFORE ADDING COMPONENTS. SEE CASE ASSEMBLY FOR CORRECT PLACEMENT.

4. LEADS FROM C7 GO TO PADS "X1" & "X2"; SLEEVE LEADS WITH TEFLON.

3. ALL LEADS AND TERMINALS MUST BE SOLDERED TO P.C. BOARD.

2. ▨ IND. METAL SIDE OF Q6 & Q7.

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

NOTES: UNLESS OTHERWISE SPECIFIED

-1	ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DESIGNATION
NO. REQ'D			LIST OF MATERIALS		

NEXT ASSEMBLY	
DASH NO.	
TOLS. UNLESS NOTED	.X ± .1; .XX ± .03; .XXX ± .010; ANGLES: ± 30'
FINISH	
DRAWN	R. Kelley 10/16/74
CHECK	10/23/74
PROJ. ENGR.	10/23/74
CUSTR.	

ASSEMBLY, PC1
STANDARD
ANALOG
SHM

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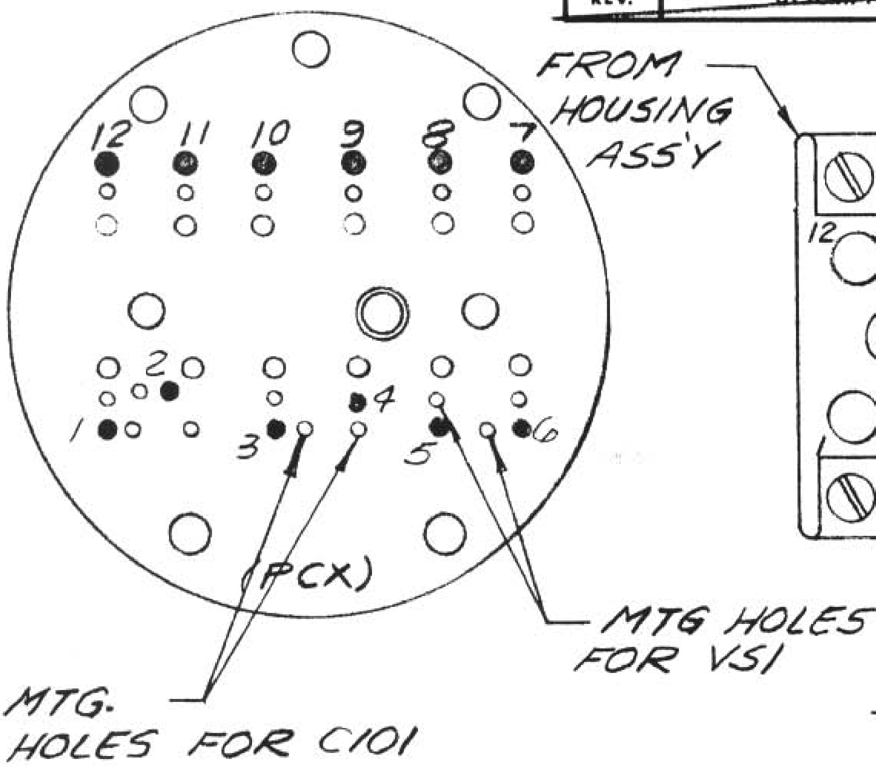
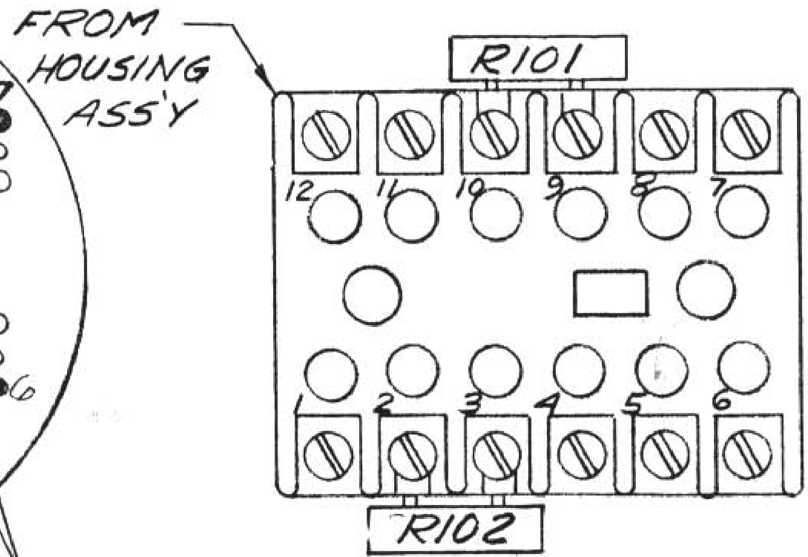
SCALE 2/1 & NOTED | JOB NO. 189

189-501-00 K

PAGE 1 OF 2

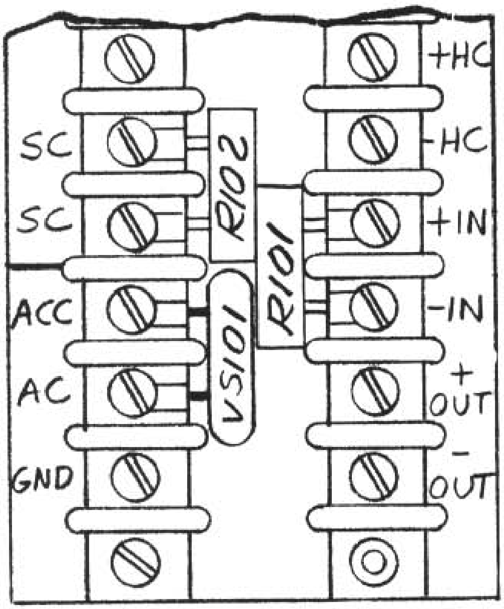
REV.	~~DESCRIPTION~~	DATE	BY	APPROV.



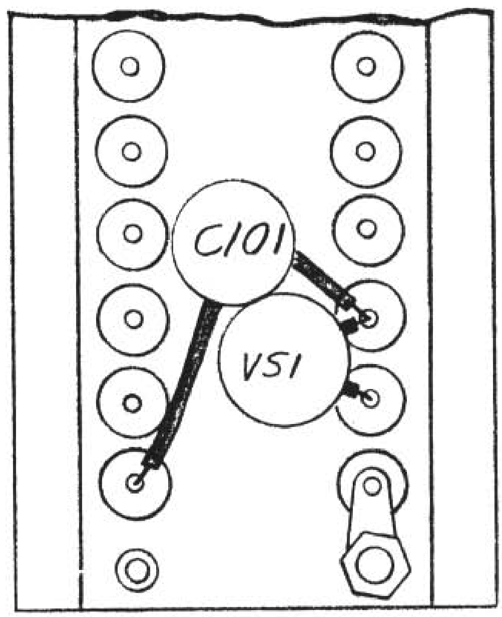


R101, R102

"SP"



VS101, R101, R102

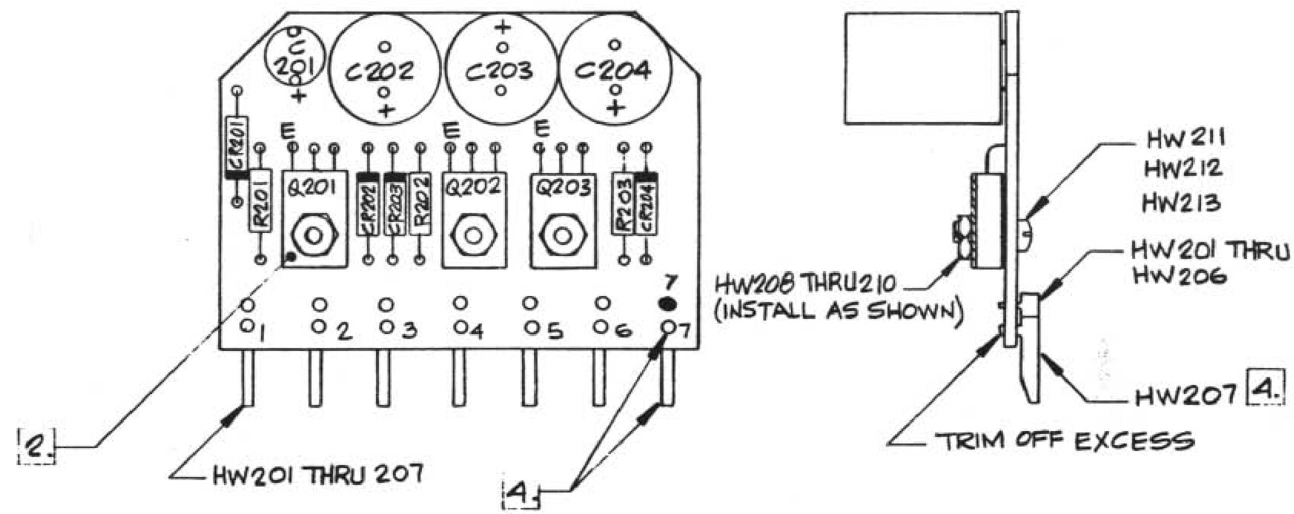


VS1, C101

"SR & CH"

SLEEVE LEADS

~~DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE~~	DRAWN C. Fiederer	7/17/74	MOORE INDUSTRIES INC. VAN NUYS ■ CA.
~~TOLS. UNLESS NOTED: .X = ±.10 .XX = ±.030 .XXX = ±.010 ANGLES = ± 30'~~	CHECKED R. Kelling	10/18/74	ADDITIONAL PARTS LOC'N, STANDARD ANALOG SHM
	PROJ. ENGR. [illegible signature]	10/2?/74	
DO NOT SCALE DRAWING			DWG. NO. 189-501-00 Pg. 2 of 2 REV. K
SCALE: 1/1	CUSTMR.		



4. CUT HW207 BETWEEN TWO UPPER SOLDER PINS & REMOVE UPPER PORTION PRIOR TO INSERTING & SOLDERING IN BOTTOM HOLE. KEEP TOP HOLE FREE OF SOLDER.

3. FOR SCHEMATIC SEE DRAWING 189-401-00.

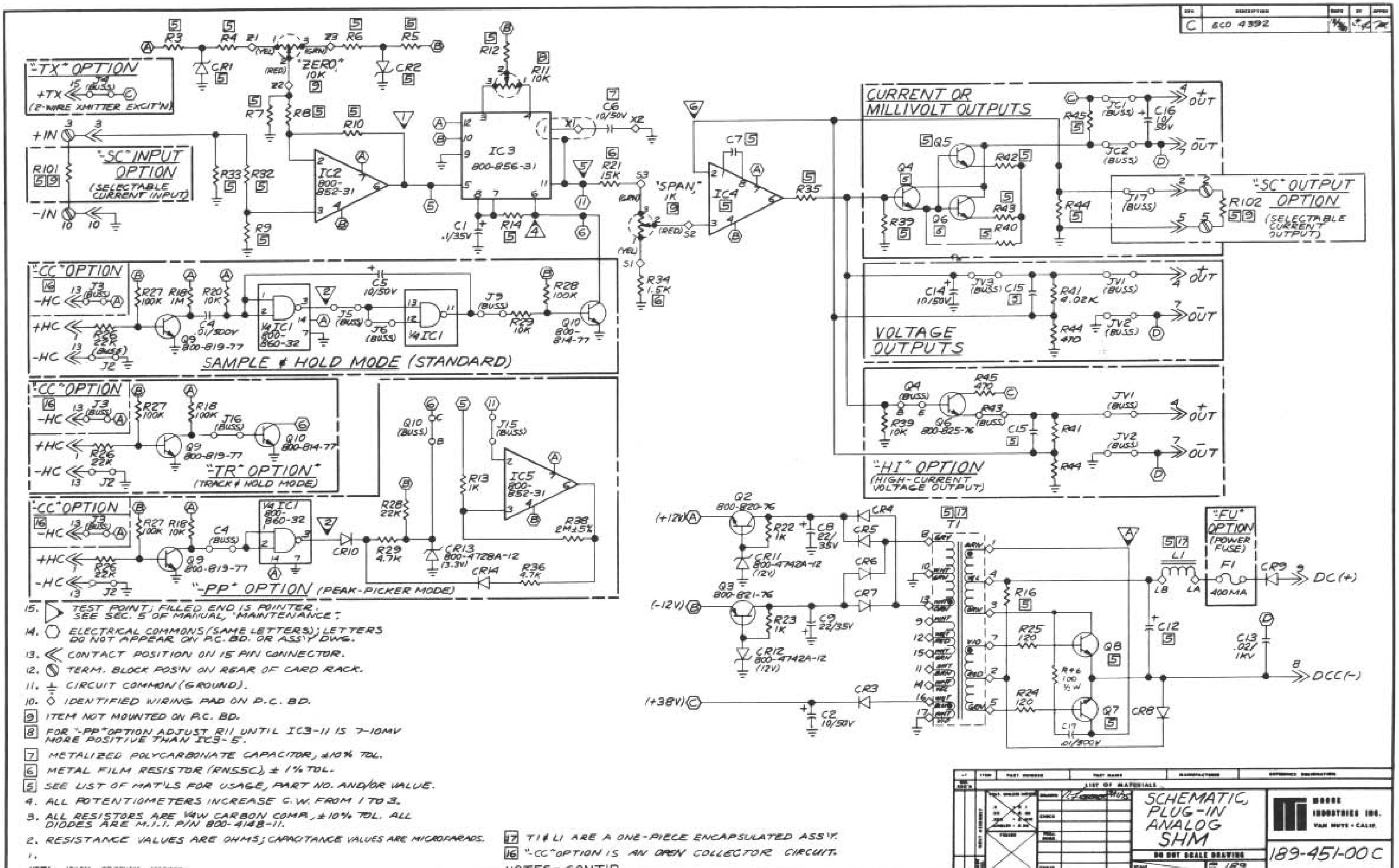
2. METAL SIDE OF Q201, Q202 & Q203 TO FACE UP; (AWAY FROM BOARD).

1. ALL LEADS MUST BE SOLDERED TO PADS.

NOTES: UNLESS OTHERWISE SPECIFIED

MOORE INDUSTRIES 16650 Schoenborn Street Sepulveda, California 91343	DO NOT SCALE DRAWING TOLERANCES UNLESS NOTED .X ±.1 .XX ±.03 .XXX ±.010 ANGLES ±30' DRAWN G. TESSERS CHECKED SCALE 2/1	POWER SUPPLY REGULATOR (P.C.2)	DRAWING NUMBER 189-505-00 REVISION C CATEGORY ASSEMBLY REVISED BY ECO 3268

36



15. TEST POINT; FILLED END IS POINTER. SEE SEC. 5 OF MANUAL, "MAINTENANCE".
14. ELECTRICAL COMMONS (SAME LETTERS); LETTERS DO NOT APPEAR ON P.C. BD. OR ASS'Y DWG.
13. CONTACT POSITION ON 15 PIN CONNECTOR.
12. TERM. BLOCK POS'N ON REAR OF CARD RACK.
11. CIRCUIT COMMON (GROUND).
10. IDENTIFIED WIRING PAD ON P.C. BD.
9 ITEM NOT MOUNTED ON P.C. BD.
8 FOR "PP" OPTION ADJUST R11 UNTIL IC3-11 IS 7-10MV MORE POSITIVE THAN IC3-5.
7 METALIZED POLYCARBONATE CAPACITOR, ±10% TOL.
6 METAL FILM RESISTOR (RN55C), ± 1% TOL.
5 SEE LIST OF MAT'LS FOR USAGE, PART NO. AND/OR VALUE.
4. ALL POTENTIOMETERS INCREASE C.W. FROM 1 TO 3.
3. ALL RESISTORS ARE 1/4W CARBON COMP., ±10% TOL. ALL DIODES ARE M.I.I. P/N 800-4148-11.
2. RESISTANCE VALUES ARE OHMS; CAPACITANCE VALUES ARE MICROFARADS.
1.
NOTES: UNLESS OTHERWISE SPECIFIED

17 T1 & L1 ARE A ONE-PIECE ENCAPSULATED ASS'Y.
16 "CC" OPTION IS AN OPEN COLLECTOR CIRCUIT.
NOTES - CONT'D.

SCHEMATIC, PLUG-IN ANALOG SHM

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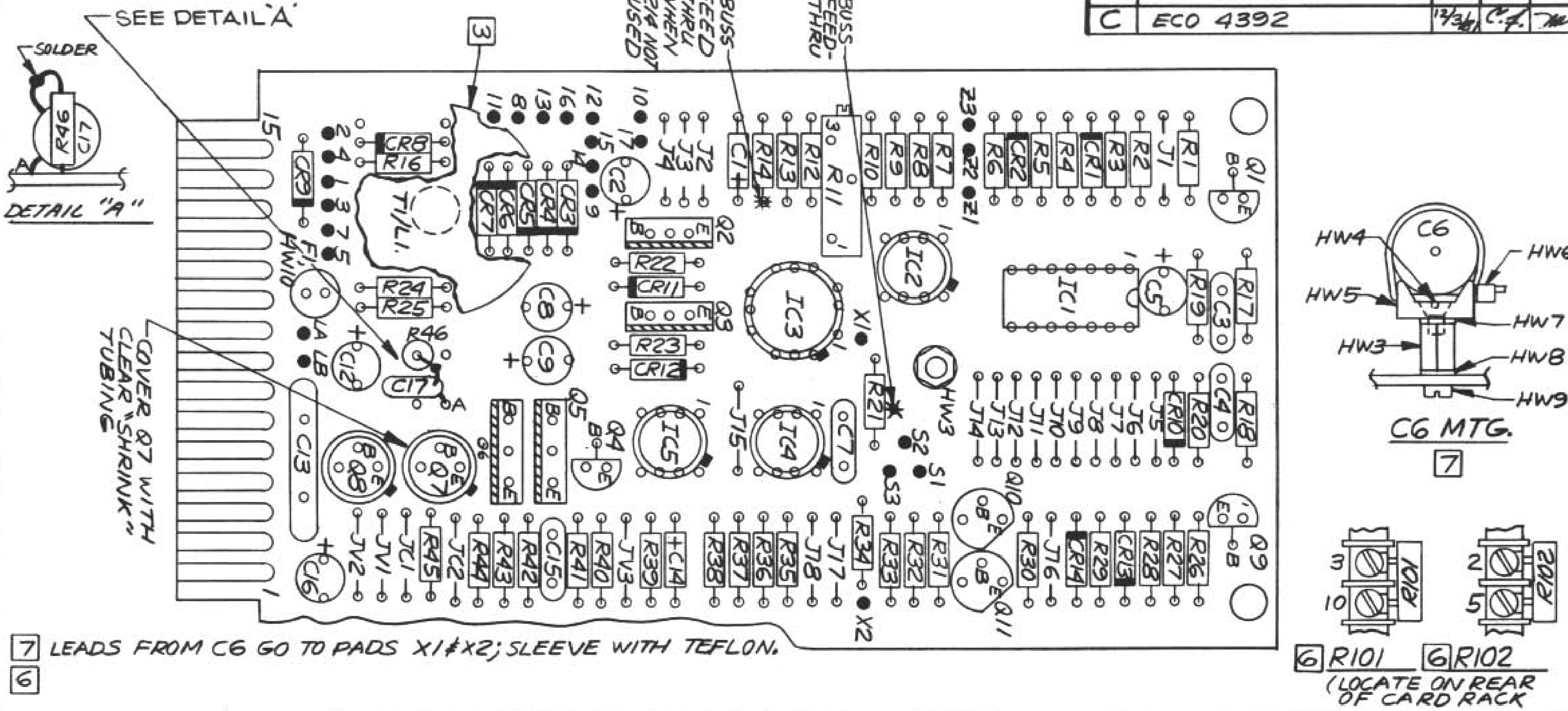
189-451-00 C

C ECO 4392

REV.	DESCRIPTION	DATE	BY	APPRV
C	ECO 4392	12/3/81	C.F.	[illegible]



7 LEADS FROM C6 GO TO PADS X1 & X2; SLEEVE WITH TEFLON.

6

5. ▬▬▬ IND. METAL SIDE, Q2, Q3, Q5 & Q6.

4 SOLDER LEADS OF R46 & C17 TOGETHER.

3 FOR T1/L1 MTG SEE 200-237-00.

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

1. ALL LEADS MUST BE SOLDERED TO BD.

NOTES: UNLESS OTHERWISE SPECIFIED

-1	ITEM	PART NUMBER	PART NAME	MANUFACTURER	REFERENCE DESIGNATION
NO. REQ'D			LIST OF MATERIALS		

TOLS. UNLESS NOTED: .X ± .1, .XX ± .03, .XXX ± .010, ANGLES ± 30'	DRAWN [illegible] 3/11/75	SHM ASSY, PLUG-IN, ANALOG
FINISH	CHECK	
NEXT ASSEMBLY	PROJ. ENGR.	DO NOT SCALE DRAWING
DASH NO.	CUSTR.	SCALE 2/1 — JOB NO. 189

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189-551-00C

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.

MOORE INDUSTRIES

WORLDWIDE • www.miinet.com

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97

The Netherlands • sales@mooreind.nl
Tel: (0)344-617971 • FAX: (0)344-615920

China • sales@mooreind.sh.cn
Tel: 86-21-62491499 • FAX: 86-21-62490635

United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852