

1.1 SCOPE OF MANUAL

This manual contains operating and maintenance information on the two wire BTX transmitter, manufactured by MOORE INDUSTRIES INC., Sepulveda, California. The manual consists of six sections as follows:

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

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

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

Section 4, Theory of Operation, gives the maintenance personnel a detailed explanation of the internal function of the unit. The circuit theory is based on a block diagram that shows the functional elements of the unit. Each element operation is then described, first in relation to the other element, then independently where its major components, use, and purpose are described.

Section 5, Maintenance, offers complete disassembly procedures for all unit configurations available. Troubleshooting information is also provided in this section as well as component replacement techniques to aid the technician in the repair of the equipment.

Section 6, Unit Documentation, acquaints the user with the MOORE IND. computerized parts listing and identification system. The section also provides a recommended spare parts list. All schematics and parts assembly drawings referred to by the text are located in the back of Section 6.

1.2 EQUIPMENT DESCRIPTION

The BTX is a 2-wire transmitter that provides an accurate measurement of BTU rates. This BTU computer produces a 4-20 milliampere output signal that is directly proportional to engineering measurement rated in British Thermal Units. The device accepts flow rate

pulses from a flow measurement device along with differential temperature that is derived from two solid state temperature probes and produces an analog output that is equivalent to the instantaneous BTU rate.

1.3 STANDARD UNIT PHYSICAL DESCRIPTION

The BTX consists of a printed circuit board that holds all the electronic components. A small additional board is mounted vertically across the center of the main board. This small board provides the circuit strip connections for the plug-in connector. The boards are enclosed in an oval protective housing of extruded aluminum. Electrical connection information is given in Section 3, Installation and Operation.

1.4 EXPLOSION-PROOF UNIT, PHYSICAL DESCRIPTION

The explosion-proof housing option consists of the standard enclosure described in paragraph 1.3, inserted into a two-piece cast aluminum alloy housing. The standard enclosure is inserted into this housing and a spring clip, mounted on the unit, wedges the unit into place.

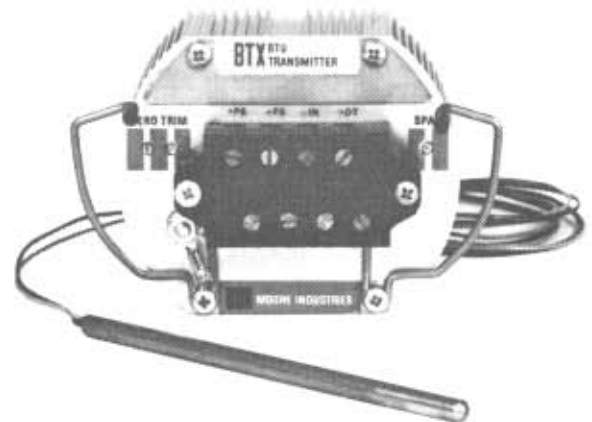


FIGURE 1-1
STANDARD UNIT (HP) HOUSING

**TABLE 1-1
UNIT SPECIFICATIONS**

FREQUENCY INPUT:

Direct Coupled Frequency
Input—Impedance: 10 K Ohms
Input—Amplitude: 10 MV P/P minimum to 30V RMS
maximum—zero based.

Transformer Coupled (II Option)

Input—Impedance: 5 K Ohms
Input—Amplitude: 60 MV Min; 25V Maximum P/P

TEMPERATURE INPUT:

-55°C to +150°C for F.S. Range of sensor.
For higher ranges, consult factory.
Minimum T, 20°C for F.S. Range of sensor.

Ranges (jumper selectable)

- A 0-50 Thru 100Hz
- B 0-100 Thru 200Hz
- C 0-200 Thru 400Hz
- D 0-400 Thru 800Hz
- E 0-800 Thru 1600Hz
- F 0-1600 Thru 3200Hz
- G 0-3200 Thru 6400Hz

ADJUSTMENTS: Multi-turn potentiometers

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

Zero: With an input from 0-10%, of input range, output will adjust to 0% output span.

Temperature Trim: ±15°C null adjustment between T₁ and T₂

TEMPERATURE SENSOR:

2-wire, solid state sensors. Operating range -55°C to +150°C. Sensor packaging: 3/16" OD (4.76mm). Stainless steel sheath length 4", or 6".

Sensor Connection:

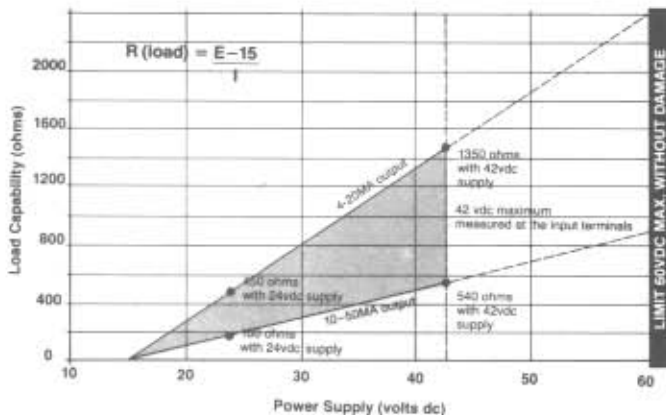
1/4 NPT bushing—316 stainless steel.

OUTPUT: 4-20mA (Limited at 30mA maximum)

10-50mA (Limited at 65mA maximum)

Output Ripple: Will not exceed 25mV P/P on "B" range or higher.

LOAD CAPABILITY:



PERFORMANCE:

Calibration Capability: ±0.1% of span based on simulated probe input. See sensor spec. for probe accuracy.

Ambient Temperature:

Range: -29°C to 82°C (-20°F to +180°F)

Effect: ±0.01% of span/°F over above range

Isolation: Frequency Input may be transformer isolated. See II Option.

Response Time: Compatible with typical temp. sensors and flow meters.

POWER INPUT:

15 Vdc minimum to 42 Vdc maximum (limited by CSA) measured at the input terminals.

Over Voltage: 60 V maximum without damage

Line Voltage Effect: ±0.002% of span/volt change

SENSOR SPECIFICATIONS:

Temperature Range: -55°C to +150°C

Calibration Error: +25°C

K = ±2.5°C L = ±1.0°C M = ±0.5°C

Nonlinearity: K = ±.8°C L = ±0.4°C M = ±.3°C

Positive Lead Color: K = orange L = blue M = green

Storage Temperature: -60°C to +170°C

Time Constant: 2 sec., for all cases, in stirred water

OPTIONS:

- II Input / Output transformer isolation. Input sensitivity 60mV P/P.
- SS Selectable sensitivity. Reduced sensitivity for noise immunity on frequency input. Customer supplied external resistor.
- RF Radio frequency interference protection
- TI Differential Temperature Transmitter Input (0-5V).
- KP Temp. Probe, Type K, specify 4" or 6"
- LP Temp. Probe, Type L, specify 4" or 6"
- MP Temp. Probe, Type M, specify 4" or 6"

HOUSINGS:

- HP Aluminum case illustrated.
- FL Aluminum case with mounting flanges.
- EX Explosion proof enclosure—suitable for Class 1, Div 1 Group C & D; Class II, Groups E, F, & G; Class III.
- DN Aluminum case with bottom mounted clip for DIN rail mounting

1.5 RF UNIT PHYSICAL DESCRIPTION

The RF unit option consists of standard BTX electronics with the addition of an RF filter input. An RF filter assembly replaces the standard input connector, and input and output connections are made through a flex cable wired between the PC board and the filter assembly. This configuration mechanically fastens the housing cover to the PC board; thus both assemblies must be removed together for maintenance.

1.6 SPECIFICATION

The specifications for the unit are listed in Table 1-1.

1.7 MODEL NUMBER EXPLANATION AND USE

MOORE INDUSTRIES' model numbers describe an instrument's type, functional characteristics, operating parameter, and include option identification. If all the accompanying documentation for a unit is missing, the model number may be used to obtain technical information on the unit by following the example of Table 1-2. The model number is located on the identification label on the cover. For explosion-proof units, the model number is stamped on a stainless steel tag on top of the enclosure.

1.8 SERIAL NUMBER USE AND LOCATION

A complete history is kept on every MOORE INDUSTRIES unit. This information is keyed to the serial number. Whenever service data is required on a unit, it is necessary to provide the factory with a serial number as well as a model number. This identification is usually etched on the circuit board and on the bottom of the explosion proof housing.

TABLE 1-2. MODEL NUMBER EXAMPLE

ORDERING INFORMATION: Specify the following:

1. Unit Type
- 2A. Differential Temperature Range
- 2B. Frequency Range Letter
3. Output
4. Power Input
5. Options*
6. Housing

SAMPLE MODEL NUMBER:

BTX/0-100C-E/4-20MA/15-42DC/-TI [HP]

*The -TI option and the temperature probes (-KP, -LP, or -MP) may not be ordered on the same unit.

2.1 GENERAL INFORMATION

This section provides information about unit calibration. Units with standard input and output levels are normally calibrated at the factory. After the unit is unpacked, general operating level checks are recommended. Usually these checks require no adjustment, and if units are ordered with factory calibration, an exact calibration is performed at the factory. Adjustments should not be made in the field on factory calibrated units unless a new range of input or output signal level is desired.

2.2 CONTROLS DESCRIPTION AND LOCATION

The controls consist of ZERO, SPAN, and TEMPTRIM adjustments, located on the unit front panel. The controls are multiturn potentiometers that are adjusted with a blade screwdriver.

<p style="text-align: center;">CAUTION</p> <p>USE BLADE SCREWDRIVER NOT MORE THAN 0.1 INCH (2.54 mm) WIDE. USE OF A WIDER BLADE MAY PERMANENTLY DAMAGE THE POTENTIOMETER MOUNTING.</p>

This type of potentiometer usually requires 20 turns of the shaft to move the wiper from one end of its range to the other. It is equipped with a slip clutch at either end of its travel to prevent damage if it is turned beyond the wiper stop. Usually a slight change in feel will be noticed when the clutch is slipping. However, if this change is not observed, either end can be reached by turning the shaft 20 turns in the desired direction. Controls are connected, so that turning the shaft clockwise increases the quantity or makes it more positive, and turning the shaft counterclockwise has the opposite effect.

2.3 TEST EQUIPMENT AND TOOLS REQUIRED

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

2.4 TEST EQUIPMENT SETUPS

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

2.4.1 General Test Equipment Setups

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

2.4.2 Explosion-Proof (EX) Test Setup

Figure 2-1 also shows the general test setup configuration for an explosion-proof enclosure. Note that in the explosion-proof configuration the protective housing must be opened to expose the connection block.

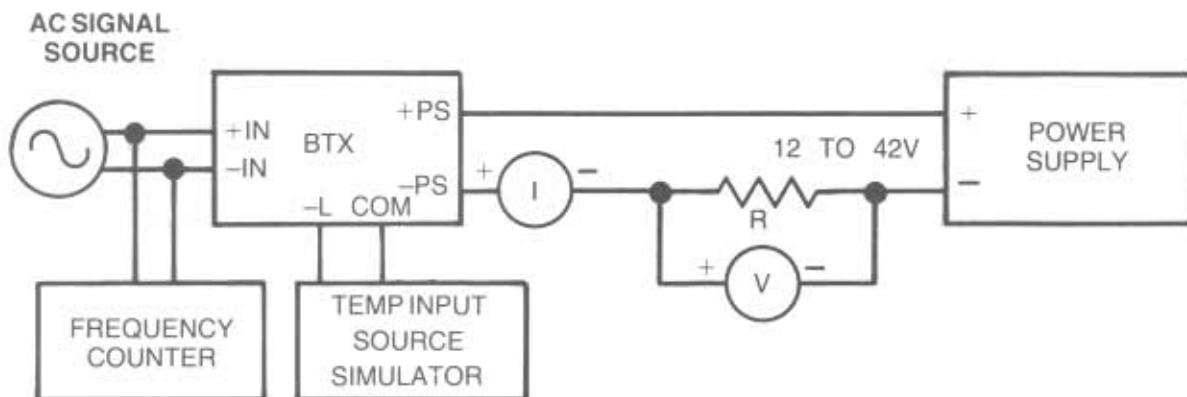
2.5 CALIBRATION

Units are calibrated and checked for proper performance at the factory before they are shipped. However, unless calibration was requested to a specific set of input-output values, the unit performance should be checked by the user before the unit is placed in service. Calibration consists of simulating the operative signal input and adjusting the unit to obtain the specified output.

TABLE 2-1 TEST EQUIPMENT AND TOOLS REQUIRED

Equipment or Tool	Characteristic	Purpose
Screwdriver (blade)	Blade not wider than 0.1 inch (2.54 mm)	Front panel control adjustment
AC Signal Source	Must be frequency stable to within $\pm 0.05\%$ or better	Simulates flow rate input
DC Voltmeter	Must be accurate to within $\pm 0.05\%$ or better	Output signal monitoring (across series output resistor)
DC Milliammeter	Must be accurate to within $\pm 0.05\%$	Output signal monitoring
Frequency Counter	Must be capable of measuring output of AC signal source to within 0.05% or better	Measure frequency of AC signal source
DC Current or Voltage Source	Must to stable to within $\pm 0.05\%$ or better	Temp input source simulation

Figure 2-1. Test Equipment Setup For Calibration of Unit



SECTION 2

CALIBRATION PROCEDURES

2.5 CALIBRATION (Continued)

An audio-frequency signal generator, to simulate flow rate, with a range covering the frequencies of the unit, and an output monitoring device are required for calibration. A frequency counter to determine the frequency of the applied input signal to the required accuracy is also needed. The frequency monitoring device must have an accuracy of within 0.05% or better. To calibrate a unit, proceed as follows:

- A. Connect unit and test equipment as shown in Figure 2-1 except temporarily leave the signal generator disconnected from the unit and short circuit the input terminals of the unit.

NOTE: The temperature probes are solid state devices. The current allowed to pass through them is equal to 1 microamp per degree centigrade. Using a current source or precision voltage source, inject the appropriate current for the temperature desired. If 100% of the temperature is 200°C, then inject 200 microamperes of current or 1 volt in series with 5000 ohms.

- B. Apply input power to the unit, and apply a current equal to 100% of the temperature input.
- C. With the frequency input terminals of the unit shorted, adjust the ZERO potentiometer to obtain 0% output from the unit (4 mA or 10 mA).
- D. Remove the short circuit from the input terminals of the unit and connect the signal generator to these terminals. Adjust the signal generator to the maximum frequency that will be applied to the unit when it is installed, and adjust the output of the signal generator to a value greater than 100 millivolts RMS but not more than 10 volts RMS.
- E. Adjust the SPAN potentiometer to obtain 100% output with the input applied as in step (B) and (D).
- F. Repeat steps (B) through (E) until no further adjustment of either the ZERO or SPAN potentiometer is required.
- G. With temp input as in (B), successively apply frequencies of 25%, 50% and 75% of the frequency used in step (D) and check that the output is linearly proportional (within .1% of the output span).
- H. Set the signal generator to the 100% value, and set the DC current source to the 0% value.
- I. Adjust the temp-trim potentiometer for a zero % output value. With the "temp-trim" pot set correctly, there should be no difference in the zero % output when either of the inputs is at zero %, and the remaining input is at 100%.
- J. Set the temperature current source to the 100% value. Set the frequency to 100%.

- K. Adjust the SPAN potentiometer for an output value equal to 100%.
- L. Repeat steps H. through K. until no further adjustment is necessary.
- M. In sequence, apply signals from the DC current source that are equal to 25%, 50% and 75% of the temperatures to be measured and determine that the output is linear. The unit performs a multiplying function where the % input of temperature is multiplied by % input of frequency. Apply 50% frequency input and a current equal to 50% temperature. The output should equal 25%. Apply 25% frequency and 25% temperature. The output should equal 62.5%. Apply 75% frequency and 75% temperature, the output should equal 56.25%. The results, should be within .1% of span.
- N. After completion of the tests, remove power from the unit and disconnect all test equipment.

2.6 CHANGING INPUT RANGE (FREQUENCY)

The BTX is capable of accepting frequency inputs from 0-100 up to 0-6400 Hz in seven different ranges.

Changing from one input range to another requires selecting one current limiting diode and one internal jumper combination. See Table 2-2 and refer to the schematic in Section 6.

CAUTION

BEFORE MAKING A RANGE CHANGE, READ AND THOROUGHLY FAMILIARIZE YOURSELF WITH PROPER DISASSEMBLY AND SOLDERING PROCEDURES.

TABLE 2-2 RANGE SELECTION

INPUT	RANGE	JUMPER	DIODE
A	50-100 Hz	J5	CR9
B	100-200 Hz	J4	CR12
C	200-400 Hz	J7	CR13
D	400-800 Hz	J8	CR11
E	800-1600 Hz	J3	CR10
F	1600-3200 Hz	J9	CR14
G	3200-6400 Hz	J6	CR8

SECTION 3

INSTALLATION & OPERATION

3.1 MECHANICAL INSTALLATION

Units may be obtained in various physical configurations. Figure 3-1 shows the outline dimensions and other installation requirements for the available configurations. Select the proper outline and dimension figure applicable to the unit purchased. Be sure to observe the applicable special procedures and precautions given with the illustration. Although the units are designed to operate in free air at quite a high ambient temperature, it is advisable, if possible, to mount the unit on a surface made of material that can serve as a heat sink.

3.2 ELECTRICAL CONNECTIONS

All electrical connections to standard units are made to the PC terminal connector on the unit. Terminals used for standard units and their options are defined in the following paragraph.

3.2.1 General Wiring Information

No special wire or cable is required for signal connections to the unit. To avoid transients and stray pickups, it is recommended that twisted conductors be used where they are run close to other services, such as power wiring. Openings are provided under the terminal screws. Insert bare wire into the opening and tighten the terminal screws.

3.2.2 Power Connections

Units are designed to operate directly from a DC power source, within the range of from 15 Vdc minimum up to 42 Vdc maximum as measured at the unit.

3.3 OPERATION AND PERIODIC OBSERVATION

Once calibrated and installed, the unit may be operated unattended. The only controls on the outside of the unit are the 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, the unit should operate virtually maintenance-free for a long period of time. However, if a malfunction should occur, refer to Section 5 for maintenance information.

A periodic check of input and output connections is recommended every six months to ensure continued dependability of operation.

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

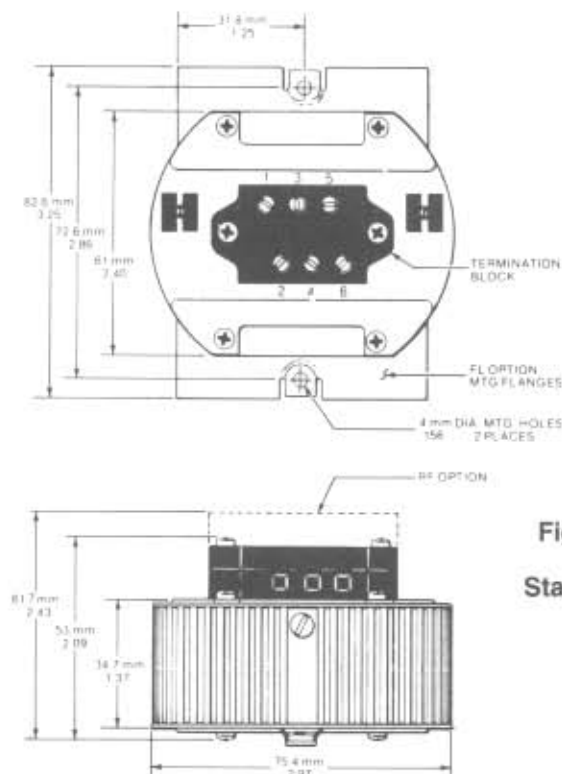


Figure 3-1.
Standard Unit, Outline and Dimensions

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

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

A rapid familiarization of the unit can be obtained by reading the general functional description (paragraph 4-2) and the functional section of the circuit description paragraphs. The "Detailed" section of these paragraphs provides sufficient data so that troubleshooting, if required, can be performed intelligently and rapidly.

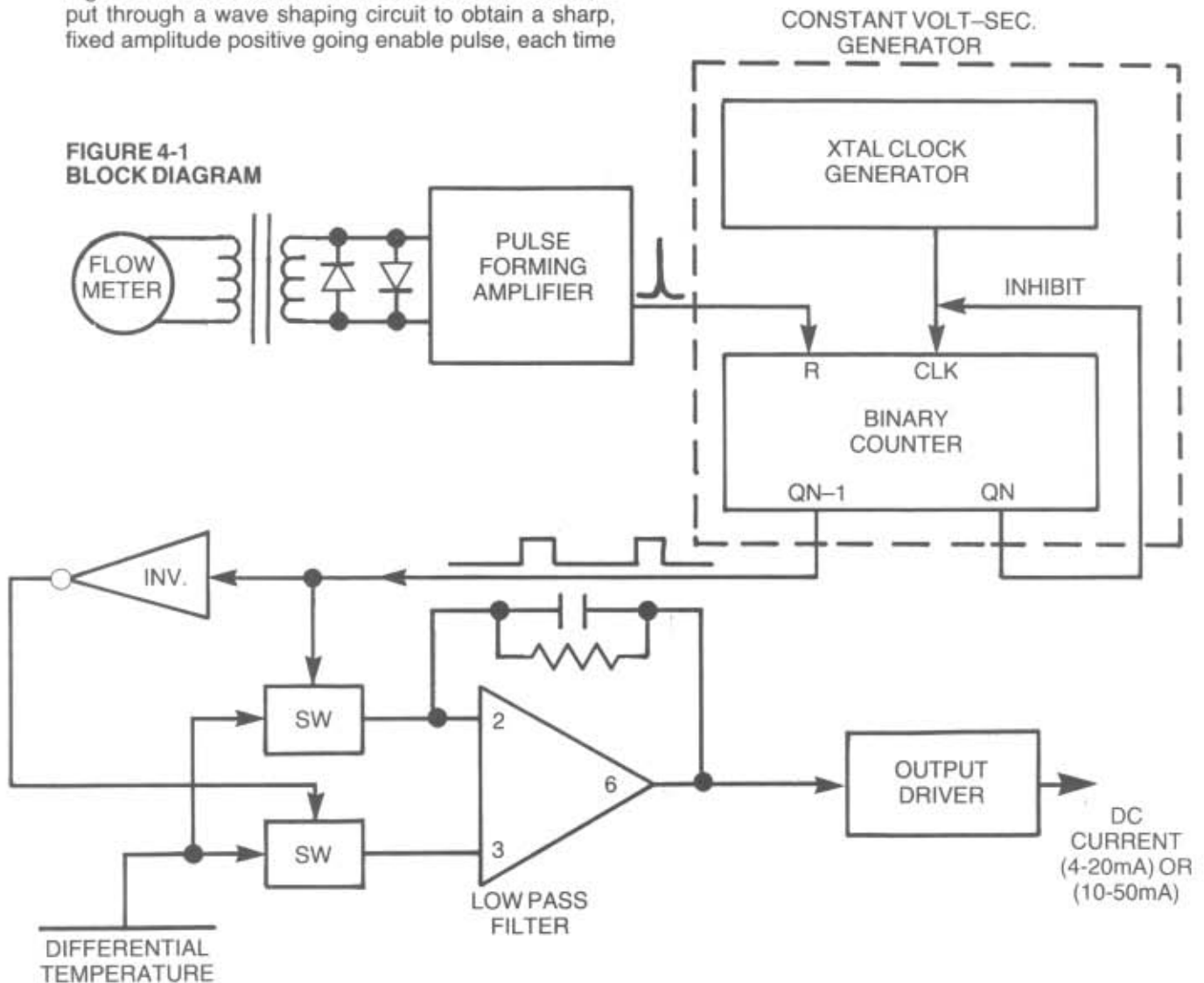
4.2 GENERAL FUNCTIONAL DESCRIPTION

The BTX consists of the functional elements shown in Figure 4-1. The external turbine flowmeter waveform, is put through a wave shaping circuit to obtain a sharp, fixed amplitude positive going enable pulse, each time

a turbine blade passes the magnetic pick-off in the flowmeter. These pulses are used to trigger fixed volt/second square waves, formed by a digital counter and a crystal controlled clock generator. When a train of these fixed volt/second pulses are put through a low pass filter, the average D.C. amplitude becomes an analog of the flow rate. The higher the R.P.M. of the turbine flowmeter, the greater the number of fixed pulses per second that are averaged by the filter and the higher the D.C. analog voltage.

Through the use of two solid state temperature sensors, a voltage is generated which is proportional to the temperature difference between the two sensors. This voltage is used to amplitude modulate the pulse train from the counter-clock circuits, and therefore becomes a multiplier of flow rate. This provides a solution to the basic equation: $\text{BTU TRANSFER RATE} = \text{flow rate} \cdot (T_2 - T_1) \cdot K$, where K is a constant over the range being used.

FIGURE 4-1
BLOCK DIAGRAM



The averaged D.C. value is fed to an output amplifier where the "zero" and "span" adjustments are accommodated and finally to a two stage voltage to current converter where the required output signal format is generated.

4.3 POWER SUPPLY

The BTX is a 2-wire transmitter, and therefore receives d.c. power and sends out data on the same lines. The internal power supply features reverse polarity protection and two regulators to supply 8.4 VDC and 4.2 VDC.

Detailed: Input power is received on pins 1 (+) and 3 (-) as shown on the schematic drawing. CR4 prevents damage if the DC input power is accidentally reversed. CR5 is a constant current diode that controls the current drawn by the signal processing circuitry at 3mA. Q301, Q302, Q303, and CR301 form a shunt regulator to maintain circuit voltage at 8.4V. The reference voltage for the regulator is provided by CR301, a sharp-knee 6.4V zener. Q302 and Q303 form a differential input amplifier with a single ended output, and load R305 and Q301. The regulator operates in a closed loop to maintain the base of Q303 at the same voltage level as the base of Q302 by controlling the current through Q301

The 4.2 volt requirement is supplied by IC2 and the resistance voltage divider that biases the non-inverting input (pin 3), approximately halfway between 8.4 volts and ground. The output (pin 6), is held at 4.2 volts by using 100% negative feedback to the inverting input (pin 2).

4.4 FLOW-METER INPUT CIRCUIT

General: The flow-meter signal is transformer coupled to the input amplifier for D.C. isolation and is amplitude limited by a bipolar diode clamp. The signal is amplified and shaped as a trigger signal for the digital counter.

Detailed: Accommodations for R101 are provided to handle the variations among flow-meters. R101 is customer furnished and can be either connected across the sensor in parallel, for waveform damping or connected in series to meet the 25V maximum P-P input limit.

Transformer T1 has a 1:1 ratio and provides D.C. isolation of the sensor from the BTX input amplifier. Capacitor C2 is a spike eliminator and R1 in series with CR1 and CR2 clamp the flow-meter signal at approximately $\pm 0.6V$, producing a square wave signal train as the input to IC301A. The reference side of this signal is biased from the 4.2 volt power supply to prevent the negative going flow-meter signal from driving IC301A into negative saturation. The output of IC301A is differentiated by C305 and negative pulses removed by CR211. R312 provides D.C. restoration for C305. The remaining positive spikes are fed to digital counter IC302 as a reset pulse.

4.5 CONSTANT VOLT/SECOND PULSE GENERATOR

General: The pulse generator consists of a 12 bit binary counter, an accurate clock generator, and a range selector with a diode and jumper matrix. This range selection is for flow rate only and corresponds to the frequency upper limit generated by the users flow meter. The jumper and diode pair corresponding with each frequency range, controls the pulse duration or duty cycle, while the flow meter signal controls the pulse repetition rate. The pulse amplitude carries no information at this stage since it is used only to operate a solid state switch.

Detailed: A positive wave form from the flow-meter causes a reset pulse at the binary counter reset IC302 pin 11, and forces all counter outputs low, enabling the clock generator input IC302 pin 10. The counter tallies the clock negative going edges, until the selected Qn goes true. That forward biases the chosen range selection diode which in turn, back biases CR10, inhibiting the clock input. This condition remains static until the next flow-meter positive pulse arrives through IC301 to the counter reset IC303 pin 11, again forcing all counter outputs low and enabling the clock input to start a new cycle. It will be seen from the input range selection table that when a diode selection is called out as connecting to counter output Qn, the corresponding jumper call out, is always connected to counter output Qn-1. This counter stage is initially low following reset and goes high at time T/2 for Qn, remaining high until Qn times out at "T" and inhibits further clocking until the next flow-meter pulse. This gives a precise pulse-on interval of $2^{n/2}$ clock pulses for each positive cycle of the flowmeter. The average value of these pulses, as read by a D.C. volt-meter, is directly proportional to flow rate.

4.6 MULTIPLIER AND FILTER

General: The multiplier circuit employs two F.E.T. switches to inject the differential temperature signal into the flow rate signal so that an analog of the product is generated (flow rate $\times (T_2 - T_1)$). Temperature information is provided by two solid state temperature probes connected to provide a signal that is proportional to the difference between the two temperatures sensed. The flow rate pulse train gates the temperature signal through the F.E.T. switches to produce a new pulse train with the timing transitions from the flow rate data and with amplitudes determined by differential temperature. The average d.c. value of the composite pulse train is directly proportional to the flow rate, times $(T_2 - T_1)$.

Detailed: F.E.T. switches IC1A and IC1B have both inputs tied together (pins 1 and 4) and are connected through R2 to the TEMPERATURE TRIM POT. This allows the input to be set to ZERO when both temperature sensors are at the same value. The counter output pulse train described in paragraph 4.5, is used to gate the temperature difference current through F.E.T. switches, to the inverting input of active filter IC5. Since the noninverting input is biased at +4.2V, the output of IC5 will swing from +4.2V toward signal ground as the +H temperature sensor rises above the -L sensor. The temperature sensors are integrated circuit constant current sources and inject a current into IC1 and 1 microamp per degree centigrade of differential temperature. This current provides the signal amplitude going into filter IC5 through switch IC1 pins 4 and 3 when the counter output wave form is in a high state (TRUE). When it is in the low state, it goes through the discrete F.E.T. inverter Q305, and turns on IC1 at pin 13, causing the temperature sensor differential current to flow through pins 1 and 2 to the 4.2V supply bus as a current sink. IC5 has a frequency roll off negative feedback loop consisting of C5 and R8. This is the first step in the smoothing process of the pulsed wave form toward recovering the average value.

4.7 OUTPUT DRIVER

General: Four basic functions are provided in the output driver section of the BTX schematic drawing:

- (1) Final wave form filtering is provided.
- (2) A ZERO pot is provided to adjust the output current to 4mA (or 10mA) when the flow rate and or temperature difference is zero.
- (3) A SPAN pot is provided to adjust the output current to 20mA (or 50mA) when the maximum flow rate and temperature difference is simulated.
- (4) A voltage to current converter is provided to generate the specified output format.

Detailed: Final filtering of the data waveform from IC5, is accomplished in two stages. First, the signal is connected to the inverting input terminal of final voltage amplifier IC3 with increasing frequency degeneration provided by C3. Additional increasing of frequency degeneration is provided by C4, but includes the output current stages within its feed back loop. This can be traced by noting that part of the output current flows through the SPAN pot and is a.c. coupled to IC3, non-inverting input, through C4.

The ZERO pot is biased from the 8.4V supply bus and is connected to the IC3 non-inverting input through resistor IC4.

The SPAN pot adjusts the gain of IC3 and the current output stages using part of the output current as feedback to the non-inverting input of IC3.

Q1 and Q2 provide the voltage to current output converter.

5.1 INTRODUCTION AND GENERAL INFORMATION

This section contains information to aid in the maintenance of the unit. This includes disassembly instructions for all mechanical options, as well as general troubleshooting. Precautions and special techniques required to replace components are also described.

5.2 DISASSEMBLY

When unit troubleshooting is required, it is first necessary to disassemble the unit. The physical configuration of the unit determines the steps to be followed in disassembly. These are described in the following paragraphs.

NOTE

ALWAYS IDENTIFY WIRES – USUALLY BY TAGGING – BEFORE DISCONNECTING EXISTING CONNECTIONS.

CAUTION

DISCONNECT INPUT SIGNAL AND REMOVE POWER INPUT BEFORE DISASSEMBLING UNIT.

5.2.1 Disassembly of Standard Unit

To disassemble a standard unit, remove the unit from its installed position. After the unit has been removed, disassemble the unit as follows to gain access to the circuit board.

- A. Disconnect plug-in connector from unit.
- B. Remove two cover-mounting Phillips-head screws at top of unit.
- C. Loosen heatsink mounting screw, if applicable, and remove screw and mica insulator.

NOTE

WHEN REPLACING PC BOARD INTO HOUSING, ADD THERMAL COMPOUND TO MICA INSULATOR BEFORE SECURING HEATSINK.

- D. Remove cover and lift out PC board.

NOTE

CONTINUE WITH THIS PROCEDURE ONLY IF ADJUSTMENT POTENTIOMETERS REQUIRE REPLACEMENT. SINCE CONNECTOR PINS MAY BE BENT WHEN REMOVING THE POTENTIOMETER, USE CAUTION.

- E. Using solder-suckers or solder wick, remove solder from the potentiometer pin connectors.
- F. Roll the potentiometer to the side to loosen the pins from the mounting holes and lift away from the board while clearing small board edge.

5.2.2 Disassembly Of Units In EX Enclosures

Use the following procedure to disassemble unit:

- A. Using a bar wrench, attach to wrench lugs and loosen the housing cover from the base.
- B. Disconnect plug from unit connector.
- C. Using a 1/4" wrench, reach in and carefully loosen nut that locks wedging bolt in place.
- D. Back wedging bolt away from casing.
- E. Gain access to unit internal wiring by using the procedure of paragraph 5.2.1. When replacing the unit into the case, ensure that one of the flat sides of the HP housing is facing the hubs that carry the external wiring.

5.3 TROUBLESHOOTING

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

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

CAUTION

DEGRADATION OF PERFORMANCE CAN BE CAUSED BY SOLDER FLUX ON CIRCUITS. WHENEVER COMPONENTS ARE REPLACED, ENSURE THAT CIRCUITS ARE THOROUGHLY CLEANED SO THAT NO FLUX IS LEFT ON THE CIRCUIT BOARD.

5.3.1 Plug-In Board Connector Cleaning

Occasionally, modules which have been in service for a long period of time may develop resistive coatings on the gold-plated contacts of the plug-in boards. This coating, if allowed to build up, may cause malfunctions by decreasing the noise margin of a circuit.

There are two types of foreign material coatings which can develop on the gold-plated contacts of a plug-in module. The first type is INORGANIC. This type of contamination results when copper "bleeds" through the gold plating and oxidizes. The second form of contamination involves ORGANIC substances, which usually are a result of careless handling, and are mainly made up of fingerprints, salts, and oils deposited when the plug-in boards are handled by the gold-plated contacts. Contamination by organic substances can be greatly reduced by careful handling of the modules.

Although rack connectors are usually of the self-cleaning type, it may become necessary to clean the module fingers to ensure reliable connection. When module contacts are in need of cleaning, the following procedures are recommended:

REMOVAL OF INORGANIC CONTAMINANTS

- A. Immerse contact of plug-in board in an ultrasonic bath of deionized water and a detergent, such as Liquinix, for at least 30 seconds.
- B. Repeat step (A) with pure deionized water only.

CAUTION

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

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

REMOVAL OF ORGANIC CONTAMINANTS

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

CAUTION

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

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












5.3.2 Component Replacement General Information

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

SECTION 5

MAINTENANCE & TROUBLESHOOTING

TABLE 5-1. WAVEFORMS OR VOLTAGES

TEST POINT	WAVE FORM OR VOLTAGES
INPUT	
1	(REFERENCE POINT FOR OTHER TEST POINTS) COMMON 0V DC 
2 	6.5V DC  0V 
3 (See Note)	6.5V  0V 
4 (See Note)	6.5V  0V 
5	6.5V  0V  FOR PULSE WIDTH SEE TABLE 5-2
6 (-PS)	- 1 VOLT DC AT 100% OUTPUT - 0.2 VOLT DC AT 0% OUTPUT

NOTE: These test points require a high impedance probe. If a high impedance probe is not used, the signal waveform will be affected and/or the unit will not operate as long as the probe is attached.

TABLE 5-2. PULSE WIDTH AT TP5

USE DIODE JUMPER		RANGE CODE	FULL SCALE RANGE (Hz)	PULSE WIDTH (microseconds)
CR9	J5	A	50 — 100	1280
CR12	J4	B	100 — 200	640
CR13	J7	C	200 — 400	320
CR11	J8	D	400 — 800	160
CR10	J3	E	800 — 1600	80
CR14	J9	F	1600 — 3200	40
CR8	J6	G	3200 — 6400	20

REFER TO PARAGRAPH 4.5
USE COMPONENTS IN COLUMN 1.

6.1 GENERAL

This section consists of a computer print-out table that provides parts identification information for the unit. Wiring lists have been provided in this section as an aid to the maintenance personnel.

Parts information is grouped according to the number of assemblies. If the unit contains two PC boards, the table will be divided into two major sections: one section will contain information related to PC1 and the other section will list PC2 components information. Each major section in the table contains a complete parts list headed LIST OF MATERIALS specifying which PC board it is describing. This list of materials consists of the following headings:

ITEM: A reference numeral used for data processing and not used by maintenance personnel.

NAME: Gives the nomenclature of the part.

DESCRIPTION: Identifies the component by manufacturer's part number, usually followed by component's parameters or value.

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

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

SPARE: The numeral in this column specifies the recommended number of component spares per unit type that should be kept on hand by maintenance personnel.

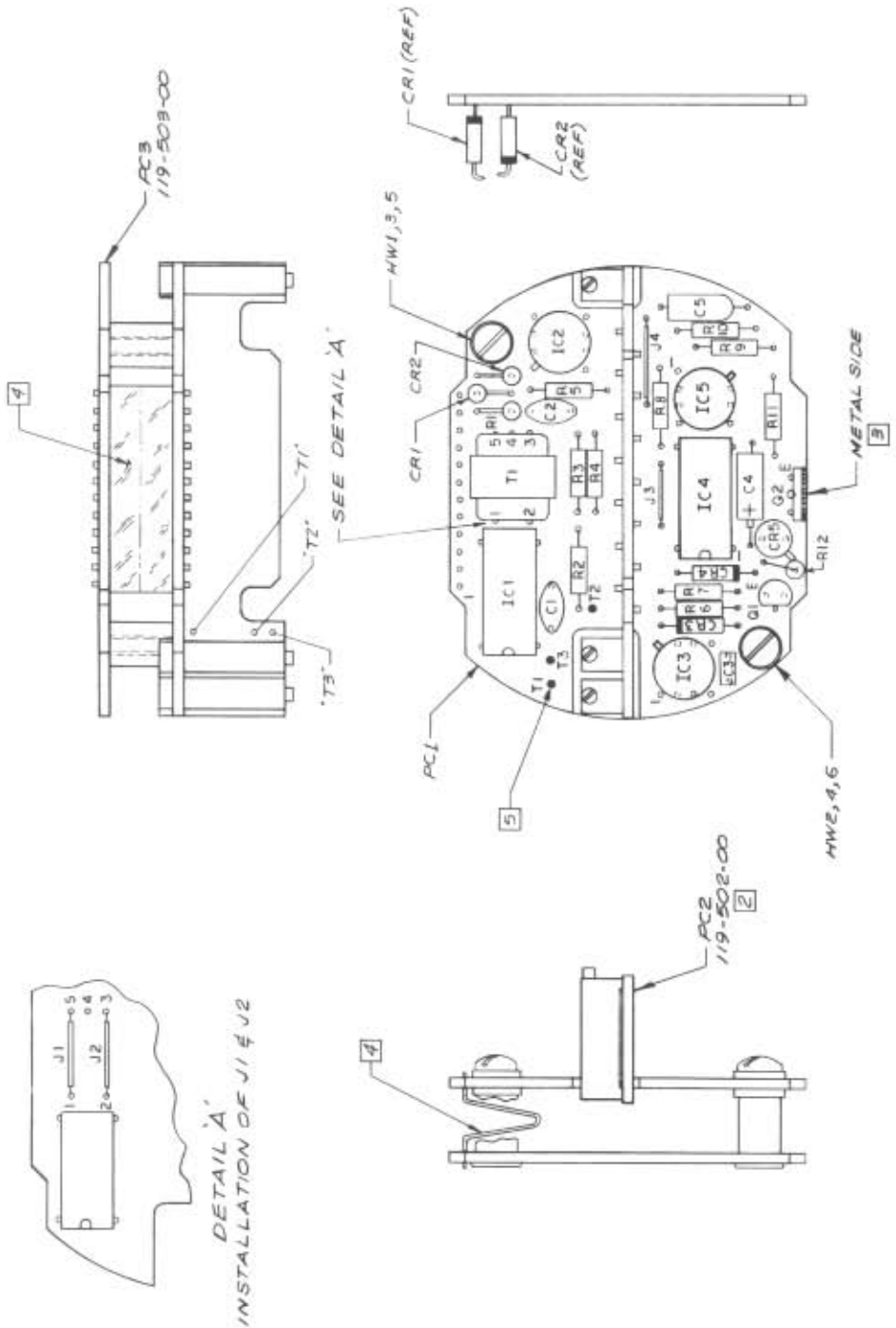
6.2 GLOSSARY OF ABBREVIATIONS

C	Capacitor
CR	Diode - zener included
HW	Special hardware
J	Connecting buss wire
L	Inductor
LB	Label
PC	Printed circuit board
R	Resistor
T	Transformer
IC	Integrated circuit
Q	Transistor
LED	Light emitting diode
TB	Terminal block
VS	Voltage regulating varistor
VR	Voltage regulator

DO NOT SCALE DRAWING	
TOLERANCES UNLESS NOTED	SCALE 2/1
X ±.1	
XX ±.03	
.XXX ±.010	
ANGLES ±30°	
DRAWN	24 APR 79
CHECKED	3/2/82
ENGINEER	

**BTX
PCI
2-WIRE TRANSMITTER**

DRAWING NUMBER	119-501-00	REVISION	B
CATEGORY	ASSEMBLY		
REVISED BY	ECO4948	DATE	2 SEP 82
		BY	D
		APPROVAL	



- 5 ADD WIRES FROM PCI, WIRE PADS T1, T2, T3 TO PC2, WIRE PADS T1, T2, T3 RESPECTIVELY. (22AWG, TEFLON SLEEVED)
- 4 FLEX JUMPER STRIP COMES WITH PC3, BEND INTO PLACE (APPROX AS SHOWN) AFTER SOLDERING TO PCI.
- 3 USE FIXTURE 200-213-11 FOR BENDING Q2 LEADS.
- 2 INSTALL FLAT AGAINST AND PERPENDICULAR TO PCI.

1. ALL LEADS MUST BE SOLDERED TO PADS.
NOTES:



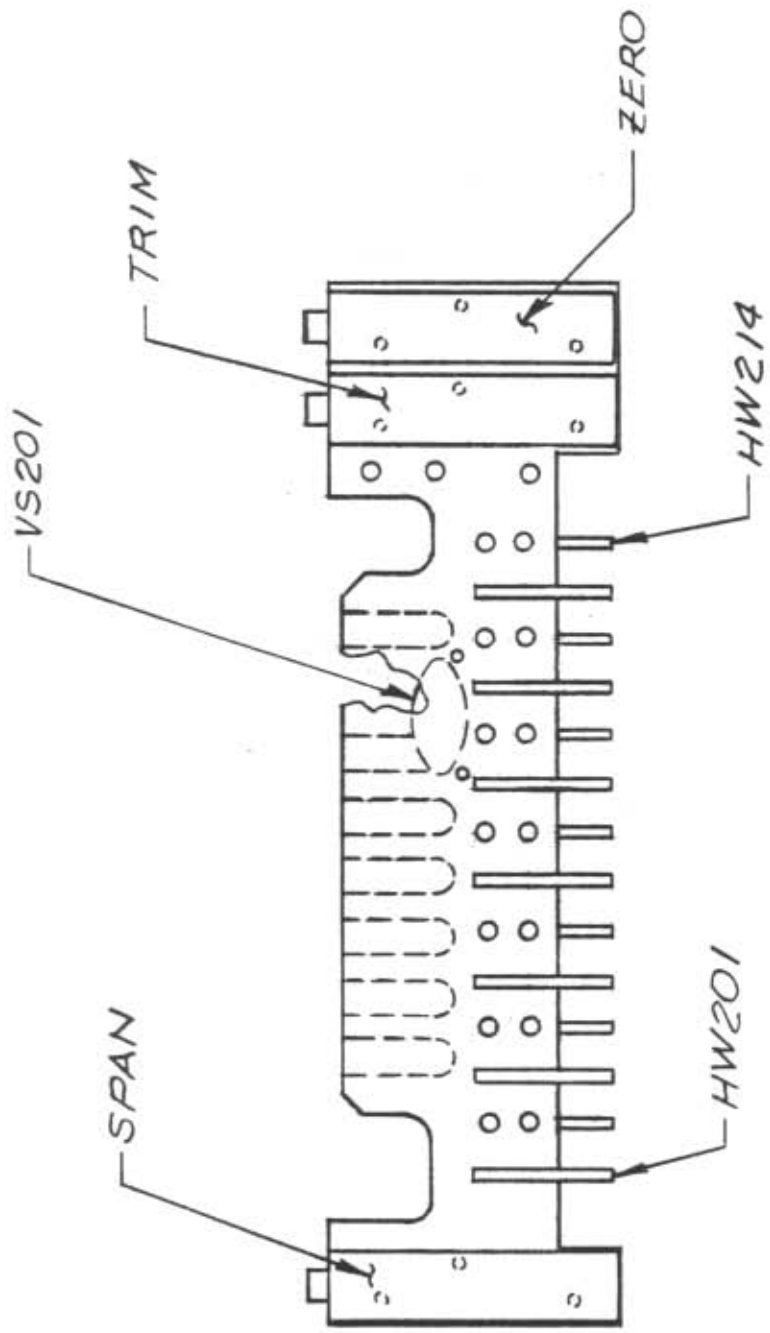
MOORE INDUSTRIES
 16650 Schoenborn Street
 Sepulveda, California 91343

DO NOT SCALE DRAWING

TOLERANCES UNLESS NOTED	DRAWN	23
	CHECKED	APR 79
.X	ENGINEER	
.XX		
.XXX		
ANGLES	SCALE	2/1

BTX
PC2
2-WIRE TRANSMITTER

DRAWING NUMBER	119-502-00	REVISION	A
CATEGORY	ASSEMBLY	DATE	MAR 82
REVISED BY	INITIAL RELEASE	BY	D
APPROVAL			UB

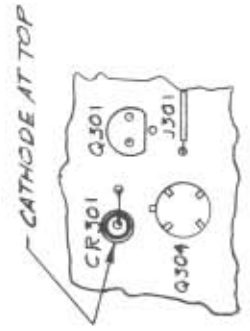
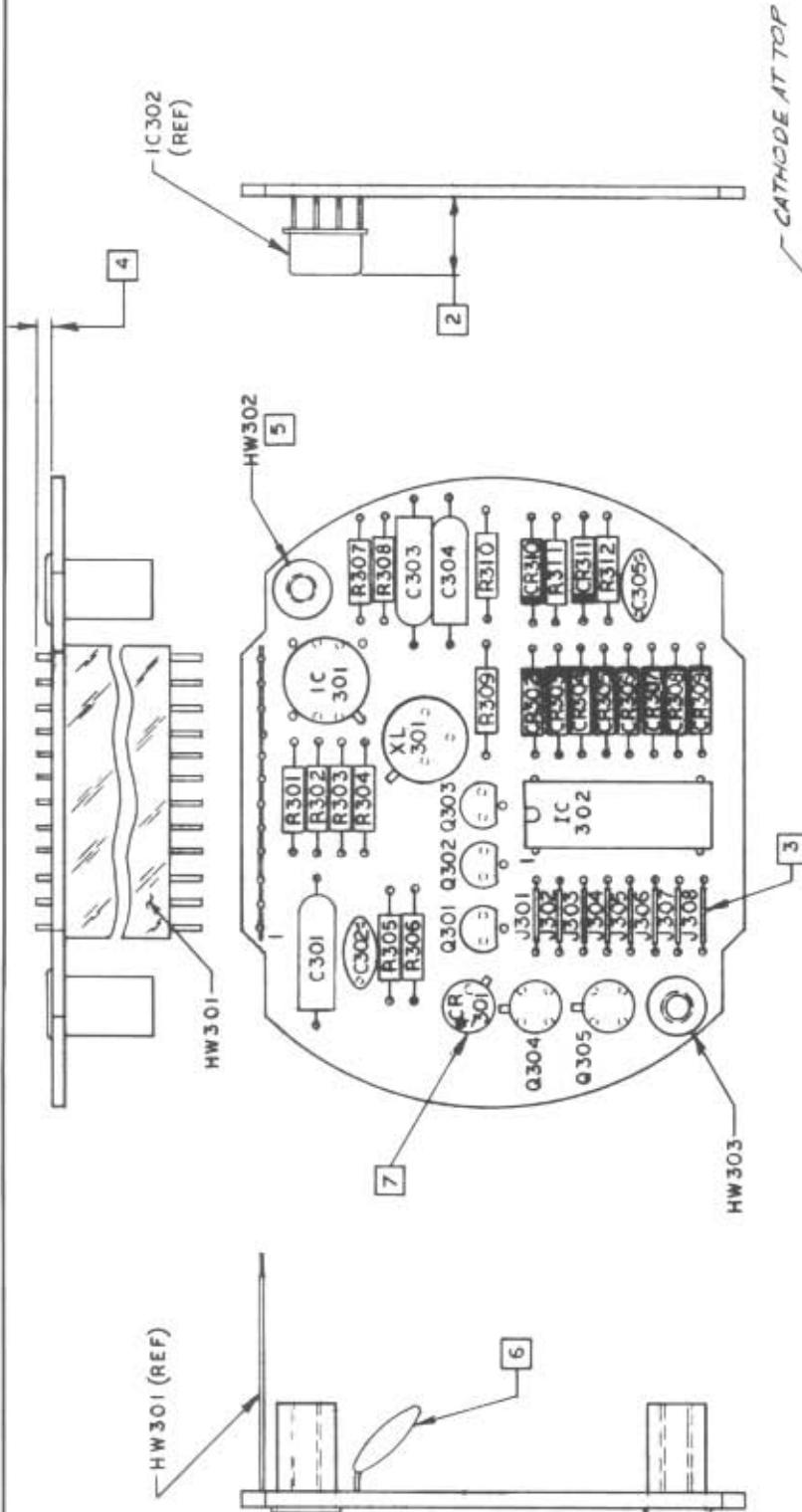


1. ALL LEADS TO BE SOLDERED TO PADS.
 NOTES:

TOLERANCES UNLESS NOTED	DATE	BY
X ±.1	3/2/82	APL 79
XX ±.03		
XXX ±.010		
ANGLES ±30°	SCALE	2/1

**BTX
PC3
2-WIRE
TRANSMITTER**

DRAWING NUMBER	REVISED
119-503-00	8
CATEGORY	
ASSEMBLY	
DESIGNED BY	DATE
ECO G201 F4957	7/1/87
BY	APPROVAL
JAD	[Signature]



DETAIL A
ALTERNATE CR.301

119-503-00
BTX-PC3-ASSY

- 7 NOTE POLARITY DOT, OR SEE DETAIL A.
 - 6 BEND C302 APPROX 45° AFTER INSTALLATION.
 - 5 SWAGE FAR SIDE. (HW302 AND HW303)
 - 4 .06 MAX AFTER INSTALLATION.
 - 3 22 AWG SOLID BUSS WIRE; INSTALL TEFLON SLEEVING. (8 PLACES).
 - 2 MAX. COMPONENT HEIGHT NOT TO EXCEED .990.
1. ALL LEADS MUST BE SOLDERED TO PADS.
- NOTES:

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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