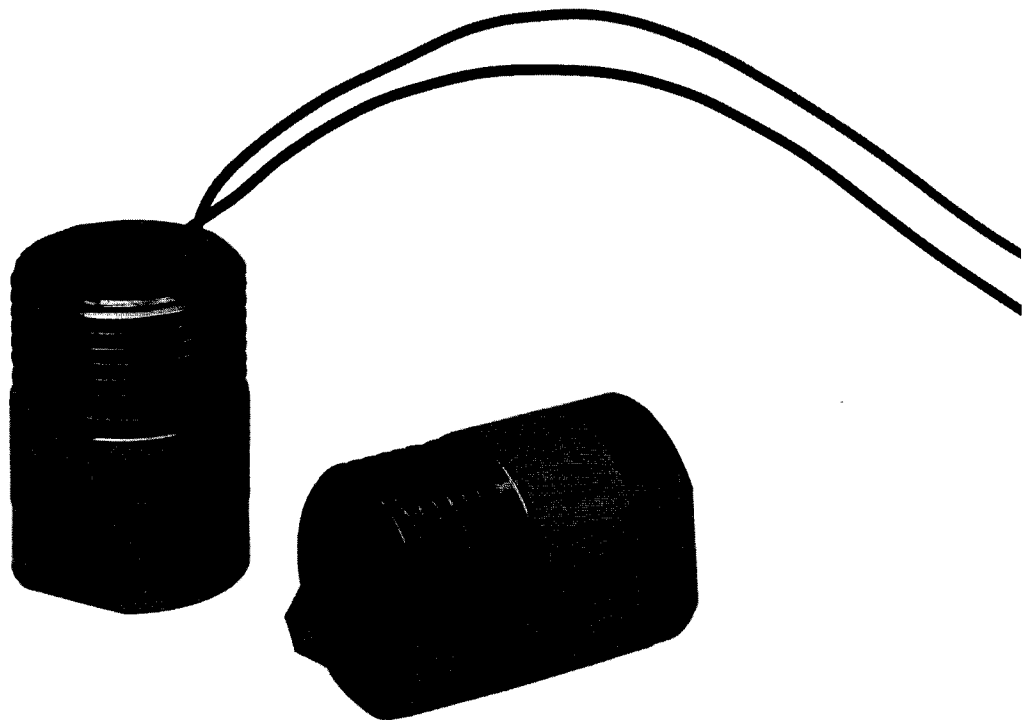
BALMAC

OPERATION MANUAL

MODEL 140 VIBRATION TRANSMITTER



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INTRODUCTION

Vibration Transmitters

The industrial class 140 Vibration Transmitter can continuously monitor the absolute bearing or housing vibration of blowers, pumps, engines, fans, compressors, and motors. Monitoring vibration detects problems like unbalance, bearing failure, and alignment errors.

The 140 connects in series with a DC power source and a measurement device (receiver). The 4-20 mA current draw from the DC source is proportional to the 140 vibration range. This 4-20 mA signal requires only a single pair of twisted wires between the 140 and receiver. The 140 Transmitter can connect in series with a milliampere meter, a 4-20 mA monitor (like the Balmac 1111, or 1112), a datalogger, a DC recorder, a PC (Process Controller), or a PLC (Programmable Logic Controller) to form a complete vibration monitoring system.

Balmac manufactures "custom" 140 Vibration Transmitters upon request. Supplemental information for "custom" 140 Transmitters may be inserted as an appendix in this manual.

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FEATURES

Piezoelectric Sensor

The 140 Transmitter has a rugged, built-in piezoelectric crystal vibration sensor. When deformed the crystal provides an electrical vibration signal. The 140 is sensitive to vibration in a single axis. This is called the axis of sensitivity. The 140 axis of sensitivity is perpendicular to the mounting base.

Encapsulated Circuitry

The sensor and solid-state circuitry are completely encapsulated in a protective epoxy potting compound. Circuitry converts the crystal's signal into an industry standard 4-20 mA output proportional to vibration.

Mounting

Transmitter can be easily attached onto a 1/4"-20 threaded stud.

Plated Steel Housing

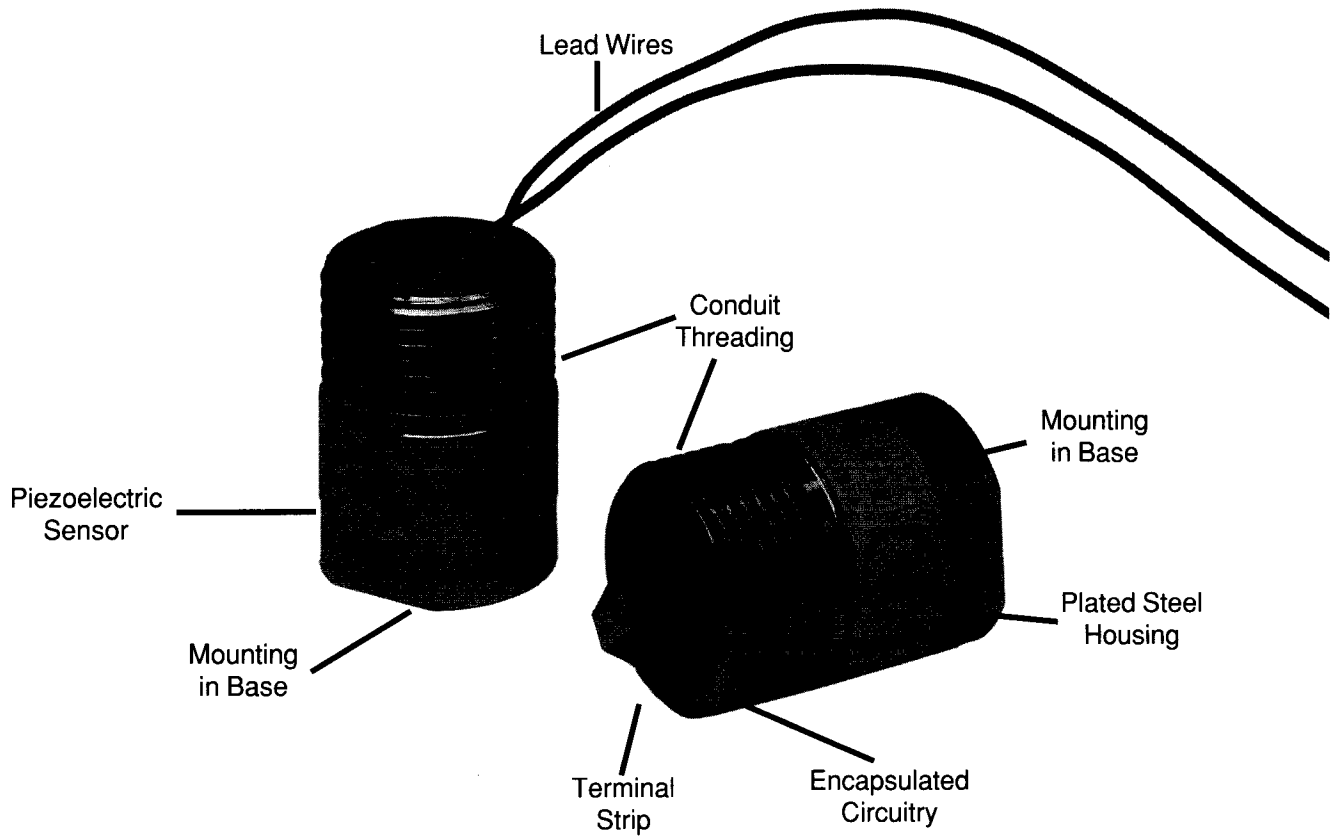
The convenient size transmitter is made for tough, industrial applications. NEMA 4 plated housing resists corrosion.

Conduit Threading

Transmitter is provided with 1" NPT threads for applications requiring conduit protected hook-up.

Lead Wires

Two #18 AWG lead wires, 24" long or a terminal strip come standard with Model 140. The 4-20 mA signal format provides immunity from voltage interference and allows transmission of signals over thousands of feet using low-cost wiring.



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SPECIFICATIONS

Model 140 Technical Specifications

Vibration Range: Output 4-20 mA for the following models:

140-1	0 to 1 in/sec	[0-25.4 mm/s]
140-2	0 to 2 in/sec	[0-50.8 mm/s]
140-5	0 to 5 in/sec	[0-127 mm/s]
140-X	(Special order)	

Frequency Range:
7 Hz to 1300 Hz to -3 dB
(420 RPM to 78,000 RPM)
(LF units to 3Hz)

Supply Voltage:
12.5 to 50 Vdc Unregulated
Black Lead/Terminal - Negative [-]
Red Lead/Terminal - Positive [+]
With reverse voltage protection.

Adjustments: Red - Span
Yellow (White) - Zero

Maximum Load Resistance:
$R_L = 50 (V_s - 12.5)$ ohms

Isolation: 500 V / Circuit to Case

Electrical Connection:
2-wire (Red and Black) AWG-#18,
24"-Length Supplied or Terminal Strip

Temperature Range:
-40°C to +100°C [-40°F to +212°F]

Environment Rating:
Standard Non-controlled NEMA 4
Weatherproof

RFI/EMI Immunity with Wiring installed in Metal Conduit

Circuitry: Solid-State Circuitry encapsulated in epoxy compound.

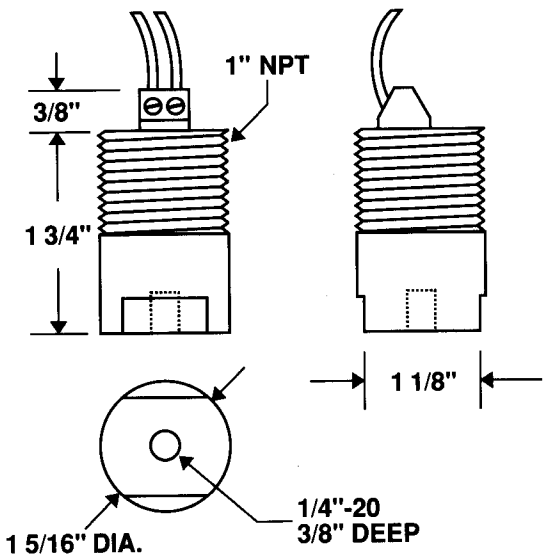
Case: Plated Steel

Mount: ¼"-20 Stud x 3/8" deep

Weight: 6 Oz. [172 grams]

Warranty: 2-Year

MODEL 140 DIMENSIONS



INSTEAD OF TERMINAL STRIP SHOWN, UNIT MAY BE ORDERED WITH 2 #18 AWG LEADS 24" LONG

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INSTALLATION

Mounting Location

The 140 axis of sensitivity is perpendicular to the mounting base. The mounting orientation can be in any position (omni-directional). In most instances, the 140 is mounted in a vertical, axial, or horizontal plane close to the centerline of the machinery shaft. This position should be in an area for the best vibration signal definition or where there is good transfer of the rotor vibrations. The best location will vary from machine to machine depending on the type and construction, or the component of concern. When selecting the mounting location, it is helpful to survey the site with a vibration meter or analyzer.

Mounting Adapters

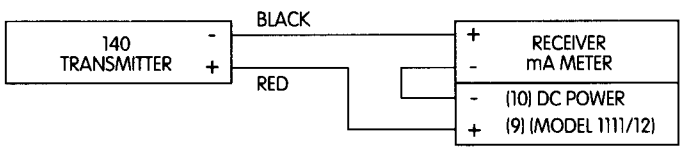
Mounting adapters should be used only if the 140 cannot be mounted on a smooth flat surface or into a threaded fitting in the desired measurement direction. The mounting surface should be clean and flat for good contact with the 140 base when stud mounting. Adapters should be as small as possible and rigid by design. It is recommended that a ½" thick plate that is well reinforced be used for mounting brackets. Ensure that the adapter resonant response is not within the frequency range of the 140 or machinery speed range. Confirm that the 140 is securely attached for proper sensing of vibration.

System Configuration

The Model 140 Transmitter can be installed as part of a simple vibration monitoring system. (See Figure 1) The components, wired in series, consist of a 140, a mA meter, and a dc power supply. The 140 acts as a variable resistor that controls the current passing through the loop. The amount of current (4-20 mA) allowed to flow through the loop is directly proportional to the amplitude of vibration.

The 4-20 mA vibration transmitter output can be displayed with the milliampere meter. Other measurement instruments can be connected in the loop also. For example, a single 140 can support multiple instruments such as digital meters, process controllers, computer systems, data loggers, recorders, and PLC's.

FIGURE 1
VIBRATION MONITORING SYSTEM



Power Supply Requirements

The only limitation on the circuit or the number of instruments in the loop is the power supply voltage. The power supply voltage must be sufficient to drive the entire loop and/or provide the required 12.5-50 Vdc across the 140. (See Figure 2) The minimum power supply voltage is determined by Ohms Law V=IxR, where voltage equals current (in amps) times resistance (in ohms).

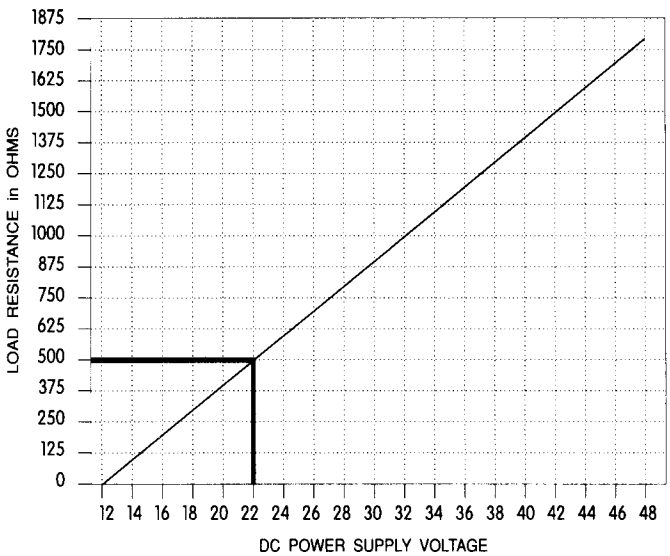
MINIMUM VOLTAGE REQUIRED =
$(0.02\ \text{AMPS} \times R_{LOAD}) + V_{TRANSMITTER}$

WHERE:
R_{LOAD} = Total of Instrumentation Resistances
$V_{TRANSMITTER}$ = Minimum Supply Voltage Requirement for Transmitter

Example:
(1) Model 140 Transmitter (4-20 mA) with a 12.5 Vdc minimum supply voltage requirement
(2) Panel Meter with a 1 ohm input impedance
(3) Recorder with a 250 ohm input impedance
(4) Computer with 250 ohm input impedance
(5) Circuit Wire resistance 4 ohms

MINIMUM VOLTAGE REQUIRED =
(0.02) (1+250+250+4)+12.5 = 22.6 VOLTS
Use a 24 Vdc supply (24 volts is a common power supply).

FIGURE 2
140 MINIMUM SUPPLY VOLTAGE for 4-20 mA OUTPUT



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Complete Balmac Monitoring System

The Balmac Model 1111 or 1112 4-20mA Monitors, using the 140 as a source, completes a cost-effective system for monitoring rotating machinery. The monitor guards against destructive levels of vibration by tripping a solid-state relay (Triac). This relay output is connected to your alarm or control system to provide a warning or shutdown. Limits are N/O or N/C with adjustable time delay. A readout meter in the 140 circuit will display the vibration level. Balmac also supplies a 0 to 100% scale remote panel meter (part number A11347) to connect in series with the 140 to display the 4-20 mA signal.

Wiring

In vibration monitoring applications, the two-wire Model 140 Transmitter is energized from a 12.5-50 Vdc power source. The 140 acts as a variable resistor to control the current-loop so that it represents the variable vibration level in a 4-20 mA format. The 4 mA component (sometimes called a live-zero, or elevated-zero) is a constant drain on the dc power supply. The 16 mA change to 20 mA represents the vibration variable.

The 140 wiring requires a single pair of twisted copper wires for signal transmission. Wiring properly installed is virtually unaffected by temperature, radio frequencies or electromagnetic interference (RFI/EMI), voltage surges, and switching transients.

Wiring subject to physical damage should be adequately protected. When installing electrical conduit it is recommended that a short length (approximately 12") of flexible conduit be used between the 140 and an associated junction box. This will provide some vibration isolation in the conduit line. Conduit and fitting should conform to the environment and safety requirements. In hazardous locations the proper circuitry protection and fittings should be used. Weather resistant or raintight fittings should be used to protect the 140 wiring from a humid and corrosive atmosphere. Model 140 stainless steel housings are available upon request.

Safety Barriers

In processes where flammable gases, liquids, or dusts may be present, the method of intrinsic safety is used to protect against the danger of explosion. This method restricts the electrical energy available in the hazardous location circuits so that any sparks or hot surfaces that may happen as a result of electrical faults are too weak to cause ignition. Typically a safety barrier is connected in series with each non-grounded circuit line between the safe area (control room) and the sensor (140) in the hazardous location. Under normal conditions the barrier passes the signal without attenuation, but in the event of electrical fault it limits the current and voltage. For information on safety barriers contact MTL Inc. of Manassas, VA, Telephone 703/361-0111. Part #'s:
MTL 702+ Shunt-Diode Safety Barrier
MTL 3041 Repeater Power Supply Interface.

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OPERATION

Output

The Model 140, when installed with an adequate power supply (See Installation Section) provides a 4-20 mA current signal that is proportional to the peak velocity of the vibration in inches per second. Velocity readings can be determined using Figure 3.

Example: If the output of a Model 140-5 (transmitter range of 0 to 5 inches/sec.) is 12.0 mA or 50 percent, then the peak vibration velocity is 2.5 inches/sec.

FIGURE 3
140 SYSTEM OUTPUT

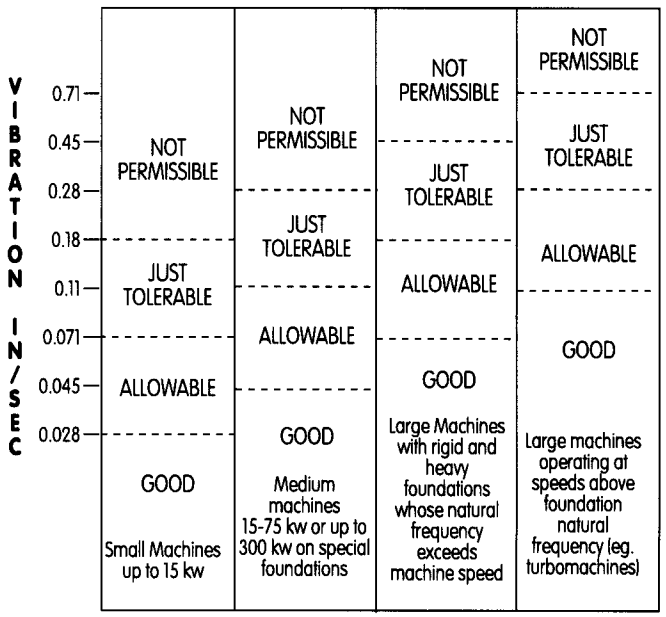
% of OUTPUT	4-20 mA	140-1 0-1 IPS	140-2 0-2 IPS	140-5 0-5 IPS
0%	4.0 mA	0.0 IPS	0.0 IPS	0.0 IPS
10%	5.6 mA	0.1 IPS	0.2 IPS	0.5 IPS
20%	7.2 mA	0.2 IPS	0.4 IPS	1.0 IPS
30%	8.8 mA	0.3 IPS	0.6 IPS	1.5 IPS
40%	10.4 mA	0.4 IPS	0.8 IPS	2.0 IPS
50%	12.0 mA	0.5 IPS	1.0 IPS	2.5 IPS
60%	13.6 mA	0.6 IPS	1.2 IPS	3.0 IPS
70%	15.2 mA	0.7 IPS	1.4 IPS	3.5 IPS
80%	16.8 mA	0.8 IPS	1.6 IPS	4.0 IPS`
90%	18.4 mA	0.9 IPS	1.8 IPS	4.5 IPS
100%	20.0 mA	1.0 IPS	2.0 IPS	5.0 IPS

Vibration Velocity

Measuring vibration velocity (inches per second) provides the best protection for equipment operating in the 600 to 12,000 rpm range. Acceptable vibration levels are based on a number of considerations. (See Figure 4) Some of the equipment's factors to consider are:

a. Type and size
b. Location and mounting
c. Service and operating environment
d. Speed

FIGURE 4
VIBRATION VELOCITY GUIDELINES



There are several standards available to use as a guide for setting the vibration limit(s). For example two are the international standards ISO 2372 and ISO 3945. The American National Standards counterparts are S2.18X and S2.41X, respectively. These standards can be used to evaluate mechanical vibration of machines with service speeds of 600 to 12,000 cpm.

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UNIT CONVERSION

When a structure vibrates at a given frequency, a mathematical relationship exists among the parameters used to measure vibration amplitude: (1) Displacement, (2) Velocity, (3) Acceleration.

$D=V/f\pi$ Where: D=Displacement, peak-to-peak (inches)
$V=\pi fD$ V=Velocity, peak (inches per second)
$A=.016Vf$ A=Acceleration, peak (g's)
f=Frequency (hertz or cycles per second or RPM/60)
π=Pi constant=3.14

These equations can be used to convert vibration readings.

Example: If a fan's vibration level is specified not to exceed a displacement of 2 Mils (.002 inches), and the fan operates at 1800 RPM, what is the vibration limit in velocity (inches per second)?

$V=\pi fD$
$V=(3.14)\ (1800\ RPM/60)\ (.002\ inches)$
$V=0.188$ inches per second

The same answer can be obtained from Figure 5.

FIGURE 5
CONVERTING VIBRATION DISPLACEMENT TO VELOCITY

	120 RPM	450 RPM	900 RPM	1800 RPM	3600 RPM
0.5 MILS	*	*	0.024 IPS	0.047 IPS	0.094 IPS
1.0 MILS	*	0.024 IPS	0.047 IPS	0.094 IPS	0.188 IPS
2.0 MILS	*	0.047 IPS	0.094 IPS	0.188 IPS	0.377 IPS
3.0 MILS	0.019 IPS	0.071 IPS	0.141 IPS	0.283 IPS	0.565 IPS
4.0 MILS	0.025 IPS	0.094 IPS	0.188 IPS	0.377 IPS	0.754 IPS
5.0 MILS	0.031 IPS	0.118 IPS	0.236 IPS	0.471 IPS	0.942 IPS
10.0 MILS	0.063 IPS	0.236 IPS	0.471 IPS	0.942 IPS	1.880 IPS

FIGURE 6
METRIC CONVERSION FOR VELOCITY READINGS

To Convert From	To	Multiply By
inches per second	millimeters per second	25.4
millimeters per second	inches per second	0.03937

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SERVICE

For warranty, service and return shipping information see inside back page of this manual.

Trouble Analysis

The following consists of some general trouble symptoms with a listing of possible causes and suggested corrections.

No Output (less than 4 mA):

The minimum circuit voltage of 12.5 Vdc must be observed to ensure proper 140 operation. The 4 mA "zero" is used to provide operating power to the 140. This live-zero 4 mA signal provides a test for line fault detection if the level falls below this value. The 140 has a zero-set adjustment for field 4 mA zero setting corrections.

High Output (greater than 20 mA):

Signal levels greater than 20 mA is determined by the power source voltage and the circuit resistance. Circuit leakage (conductor to conductor, or conductor to ground) will draw excessive current. Short circuits are usually caused by broken insulation that has rubbed through or by moisture (water) in the wire conduit. High resistance terminal connections will draw excessive current.

The 140 has a span adjustment for setting the amplitude calibration.

Erratic Output:

Control circuits in an industrial environment are susceptible to a high degree of electronic and electrical circuit noise. An example is when relay contacts are used to switch inductive loads, such as motors, solenoids, or auxiliary relays. Large voltage spikes can be generated. These spikes can be coupled from power circuits or cause rapid load changes in the ac power line. Noise (spikes) can enter directly from the power line, via the transmitter input leads, or into the instrument.

It is recommended that instruments be connected to a relatively clean power source. Transmitter input leads (a single pair of twisted copper wires) should be kept away from large inductive loads. If shielded cable is used, it is recommended that the shield be connected only to one point (earth ground). Input and output instrument commons should not be mixed. An inductive load suppressor installed across an inductive circuit or load, such as a contactor, solenoid, or relay, will help suppress transient surges.

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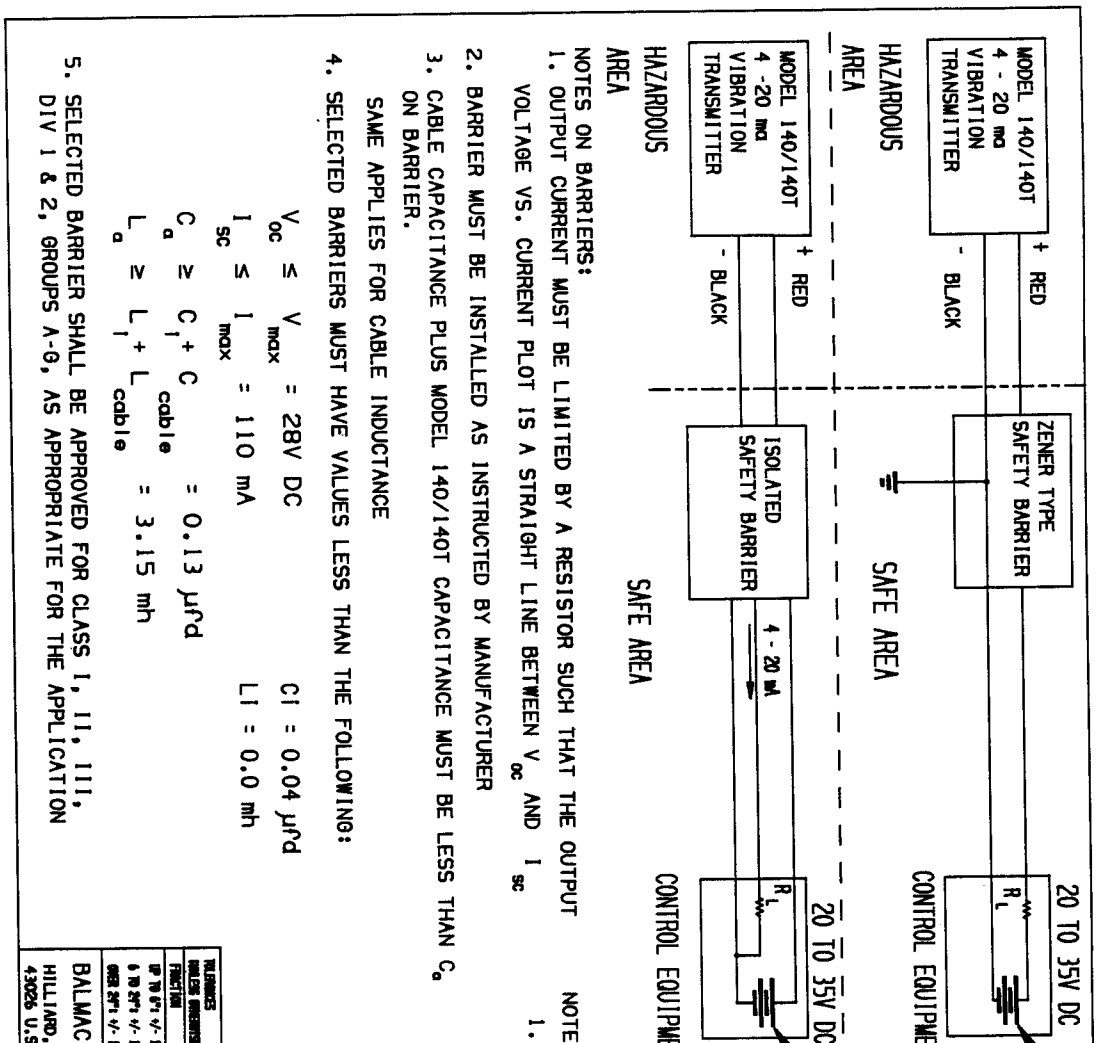
APPENDIX



NOTES ON BARRIERS:

1. OUTPUT CURRENT MUST BE LIMITED BY A RESISTOR SUCH THAT THE OUTPUT VOLTAGE VS. CURRENT PLOT IS A STRAIGHT LINE BETWEEN V_{oc} AND I_{sc}
2. BARRIER MUST BE INSTALLED AS INSTRUCTED BY MANUFACTURER
3. CABLE CAPACITANCE PLUS MODEL 140/140T CAPACITANCE MUST BE LESS THAN C_a ON BARRIER.
   SAME APPLIES FOR CABLE INDUCTANCE
4. SELECTED BARRIERS MUST HAVE VALUES LESS THAN THE FOLLOWING:

$V_{oc} \leq V_{max} = 28V$ DC Ci = 0.04 µfd

$I_{sc} \leq I_{max} = 110$ mA Li = 0.0 mh

$C_a \geq C_i + C_{cable} = 0.13$ µfd

$L_a \geq L_i + L_{cable} = 3.15$ mh

5. SELECTED BARRIER SHALL BE APPROVED FOR CLASS I, II, III, DIV 1 & 2, GROUPS A-G, AS APPROPRIATE FOR THE APPLICATION

NOTES ON CONTROL EQUIPMENT:

1. MAINS POWER MUST NOT EXCEED 250 VOLTS WITH RESPECT TO EARTH

UNLESS OTHERWISE SPECIFIED		TITLE	CONTROL DRAWING
FRACTIONAL	DECIMAL	MODEL	140/140T
UP TO 6" +/- 1/64	.X +/- .1		
6 TO 24" +/- 1/32	.XX +/- .05		
OVER 24" +/- 1/16	.XXX +/- .005	DATE	8SEP93
DRAWN BY	dt	DWG NO.	B-11812-1
SCALE	NONE	REV.	A
SHEET	1 OF 1		

BALMAC, INC.
HILLIARD, OH
43026 U.S.A.

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WARRANTY

Balmac, Inc. warrants each instrument of its manufacture to be free of defects in materials and workmanship for a period of two years from the date of purchase. Instruments covered by this warranty will be serviced provided the instrument is returned freight prepaid to Balmac, Inc. This warranty does not apply to batteries, fuses, lamps, or any other products or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

Instruments and parts other than those manufactured by Balmac, Inc. will carry the original manufacturer's warranty.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Balmac, Inc. and Balmac, Inc. neither assumes nor authorizes any person to assume for them any other liability in the connection with sale and/or use of Balmac, Inc. products.

SERVICE INFORMATION

When returning products for service, either normal or warranty, include details on the nature of the problem and/or service desired. To insure a through checkout of equipment, return all accessories used with the instrument. Equipment returned for service should be packaged in suitable containers for safe shipment.

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