OPERATION MANUAL

# MODEL 140 VIBRATION TRANSMITTER

**Includes 140-1, -2, -5, -X**
**and 140-T-1, -2, -5, -X**

BALMAC INC.
8205 Estates Pkwy, Ste N
Plain City, OH 43064-8080 USA

614-873-8222 Fax 614-873-2519
sales@balmacinc.com

balmacinc.com

## TABLE OF CONTENTS





Specifications are subject to change without prior notice. Specially modified units are supplied with individual documentation.

WARNING: Exercise extreme caution when performing any task on rotating machinery. Failure to do so may result in equipment damage or personal injury. Familiarize yourself with the equipment before attempting to perform any operation.

WARNING: ROTATING MACHINERY HAS POTENTIALLY DANGEROUS MOVING PARTS AND SHOULD BE GUARDED IN ACCORDANCE SAFETY TO SAFETY REGULATIONS.

This manual is for the Balmac Vibration Transmitters Models 140-1, -2, -5, -X and 140-T-1, -2, -5, -X.

## SECTION 1 - INTRODUCTION

### Description

The industrial class series Model 140 Vibration Transmitters can continuously monitor the absolute bearing or housing vibration of blowers, pumps, engines, fans, compressors and motors. Monitoring vibration helps detect problems like rotor unbalance, bearing defects and mechanical looseness.

Model 140s connect in series with a DC power source and a measurement device (monitor). The 4 to 20 mA current draw from the DC source is proportional to the 140's vibration range. This 4-20 mA signal requires only a single pair of twisted wires between the 140 and power source/monitor. The Model 140 can connect in series with a milliampere meter, a 4-20 mA monitor (like the Balmac 1112), a data-logger, a DC recorder, or a PLC to form a complete vibration monitoring system.

Balmac also manufactures the Model 140 Vibration Transmitters for special vibration applications such as heavy duty bulk conveyors or crushers. These special range 140's, are designated 140-X. Example: 140-25 “X” equals 25 in/sec for the 4-20 mA range.

## SECTION 2 - FEATURES

### Piezoelectric Sensor

The Model 140 has a rugged, built-in piezoelectric crystal vibration sensor. When deformed the crystal provides an electrical signal. Circuitry converts this signal into an industry standard 4-20 mA output proportional to vibration velocity. The 140 sensor 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 with a sealed top at the wire or terminal-strip exit.

### Mounting

The standard Model 140 mounting attachment is made by using a 1/4"-20 threaded stud or bolt.

### Coated Steel Housing

The Model 140 is designed with a coated housing for tough, industrial applications and to resist corrosion.

### Conduit Threading

The Model 140 is provided with 1" NPT threads for applications requiring conduit-protected hook-up.

### Lead Wires

Model 140-1, -2, -5, -X are provided with two #20 AWG lead wires, 24" long. Model 140-T-1, -2, -5, -X are provided with a Screw Captive Terminal Strip. The 4-20 mA signal format helps provide immunity from electrical interference and allows for the transmission of signals over thousands of feet using standard low cost instrumentation wiring.

## SECTION 3 - INSTALLATION

### Mounting Location

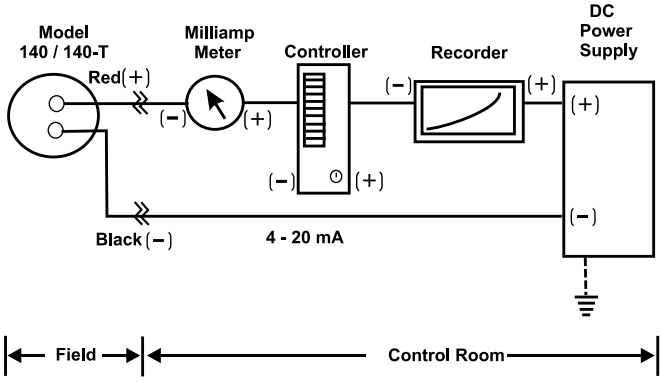
The 140 axis of sensitivity is perpendicular to the mounting base. The mounting orientation can be in any position (omni-directional). In most instances, the 140 is mounted in a vertical, axial, or horizontal plane close to the centerline of the machinery shaft. This position should be in an area for the best vibration signal definition or where there is good transfer of the rotor’s 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 in the desired measurement location. 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 by 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. Torque of 24 in-lbs.

### System Configuration

The Model 140 can be installed as part of a simple vibration monitoring system. 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, DCS, data loggers, recorders and PLCs.

### 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 14 to 50 VDC to the 140. The minimum power supply voltage is determined by Ohm's Law V=IxR where voltage equals current (in amps) times resistance (in ohms).

POWER SUPPLY VOLTAGE REQUIRED =

$$(0.02 \text{ AMPS X } R_{LOAD}) + V_{TRANSMITTER}$$

WHERE

$R_{LOAD}$ = Total of Instrumentation Resistances
$V_{TRANSMITTER}$ = Minimum Supply Voltage Requirement for Transmitter [14 vdc]

Example:

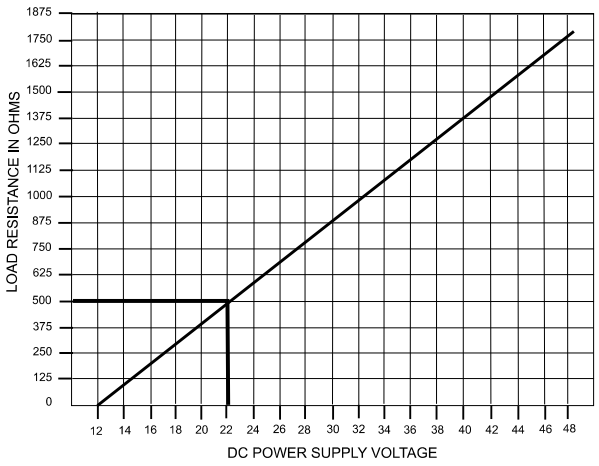
(1) Model 140 Transmitter (4-20 mA) with a 14 VDC minimum supply voltage requirement
(2) Panel Meter with a 1 ohm input impedance
(3) Recorder with a 250 ohm input impedance
(4) Controller with a 250 ohm input impedance
(5) Circuit wire resistance 4 ohms

POWER SUPPLY VOLTAGE REQUIRED =

(0.02) (1+250+250+4) + 14 = 24.1 VOLTS

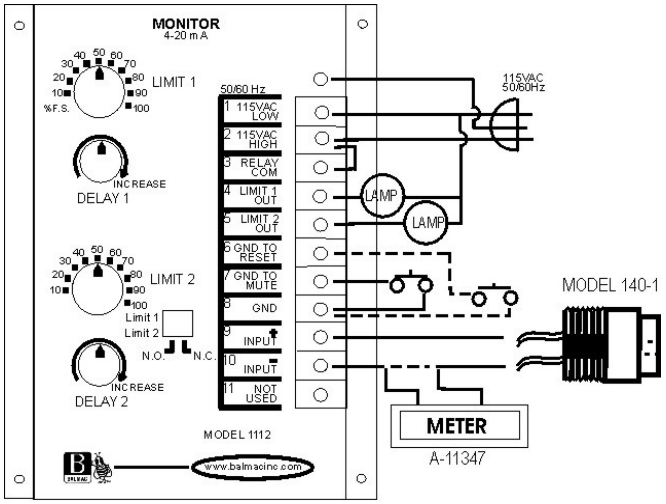
Use a 24 VDC supply (24 VDC is a common supply).

**140 MINIMUM SUPPLY VOLTAGE FOR 4-20 mA OUTPUT**



## Complete Balmac Monitoring System

The Balmac Model 140 and Balmac Model 1112 4-20 mA Monitor completes a cost-effective system for monitoring rotating machinery. The monitor guards against destructive levels of vibration by tripping a contact relay that is connected to your alarm or control system to provide warning and shutdown capability. Limits are N/O or N/C with adjustable time delay. A readout meter in the 140 circuit will display the vibration level. Balmac can supply a 0 to 100% scale remote panel meter (PN A11347) to connect in series with the 140 to display the 4-20 mA signal.




MODEL 1112

## Wiring

In vibration monitoring applications, the two-wire Model 140 Transmitter is energized from a 14 to 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 represents the vibration amplitude variable.

The 140 wiring requires a single pair of twisted wires for signal transmission loop. Wiring properly installed is virtually unaffected by radio frequencies or electromagnetic interference (RFI/EMI).

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 local environment and safety requirements. In hazardous locations, the proper circuitry protection and fittings should be used. Weather resistant or rain tight fittings should be used to protect the 140 wiring from a humid and corrosive atmosphere.

## 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.

http://www.mtl-inst.com csinfo@mtl-inst.com

## SECTION 4 - OPERATION

### Output

When installed with an adequate power supply, the Model 140 provides a 4-20 mA current signal that is proportional to the velocity of the vibration in inches per second peak. Velocity readings for a Percent of Output and the mA Value can be determined using the information found in the Model 140 System Output Table.

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

**Model 140 System Output Table**

| % 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 severity in velocity (inches per second, in/sec, ips) provides the best protection for equipment operating the 600 to 12,000 RPM range. Acceptable vibration levels are based on a number of considerations. Some of the equipment's factors to consider are:

- Type • Size
- Location • Mounting
- Speed • Service
- Operating Environment

There are several standards available to use as a guide for setting vibration limits. For example, two are the international standard 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 RPM.

| VIBRATION VELOCITY | MACHINERY CLASS | | | |
|---|---|---|---|---|
| Vibration (ips) | Class 1 | Class 2 | Class 3 | Class 4 |
| 0.01 ips | GOOD | GOOD | GOOD | GOOD |
| 0.02 ips | GOOD | GOOD | GOOD | GOOD |
| 0.03 ips | GOOD | GOOD | GOOD | GOOD |
| 0.06 ips | FAIR | GOOD | GOOD | GOOD |
| 0.08 ips | FAIR | FAIR | GOOD | GOOD |
| 0.1 ips | ROUGH | FAIR | FAIR | GOOD |
| 0.2 ips | N/A | ROUGH | FAIR | FAIR |
| 0.4 ips | N/A | N/A | ROUGH | FAIR |
| 0.6 ips | N/A | N/A | N/A | ROUGH |
| 0.8 ips | N/A | N/A | N/A | N/A |
| 1.0 ips | N/A | N/A | N/A | N/A |

## SECTION 5 - 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 = 0.3183 V ÷ f**
**V = π f D**
**A = .0162 V f**

Where:
D = Displacement inches peak to peak
V = Velocity inches per second (ips) peak
A = Acceleration g's peak
f = Frequency Hertz (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 (in/sec)?

V = π f D
V = (3.14) (1800 RPM ÷ 60) (.002 inches)
V = 0.188 ips
(See the Table below)

**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 |

**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 |

## SECTION 6 - FREQUENTLY ASKED QUESTIONS

**No Output (less than 4 mA):**

The minimum circuit voltage of 14 VDC must be observed to ensue 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 circuits via the transmitter power leads or into the monitor circuitry.

It is recommended that instruments be connected to a 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 contact solenoid or relay will help suppress transient surges.

## SECTION 7 - SPECIFICATIONS

**Model 140 (and 140-T) Technical Specifications**

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

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

Frequency Range:

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

Supply Voltage

14 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:

$R_L = 50 (V_S - 14)$ ohms

Isolation: 500 V / Circuit to Case

Electrical Connection:

24 " Wire (Red and Black) AWG#20
Model 140-T has Terminal Strip

Temperature Range:

-20°C to 85°C [-4°F to 185°F]

Environmental Rating

Standard non-controlled NEMA 4
Weatherproof

Circuitry: Solid State Circuitry
Encapsulated in Epoxy Compound

Case: Coated Steel

Mount: 1/4"-20 Stud x 3/8" deep

Weight: 6 oz. [172 grams]

## SECTION 7 - INTRINSIC SAFETY CONTROL DRAWING




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  $Ci = 0.04\ \mu fd$

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

$C_a \geq C_i + C_{cable} = 0.13\ \mu fd$

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

| REVISIONS | | |
|---|---|---|
| REV | DESCRIPTION | DATE |
| - | created from 11812 | 8 SEP93 |
| A | Added Model 140T | 24SEP93 |

| UNLESS OTHERWISE SPECIFIED | | |
|---|---|---|
| FRACTION | DECIMAL | |
| UP TO 6" +/- 1/64 | .X +/- .1 | |
| 6 TO 24" +/- 1/32 | .XX +/- .01 | |
| OVER 24" +/- 1/16 | .XXX +/- .005 | |

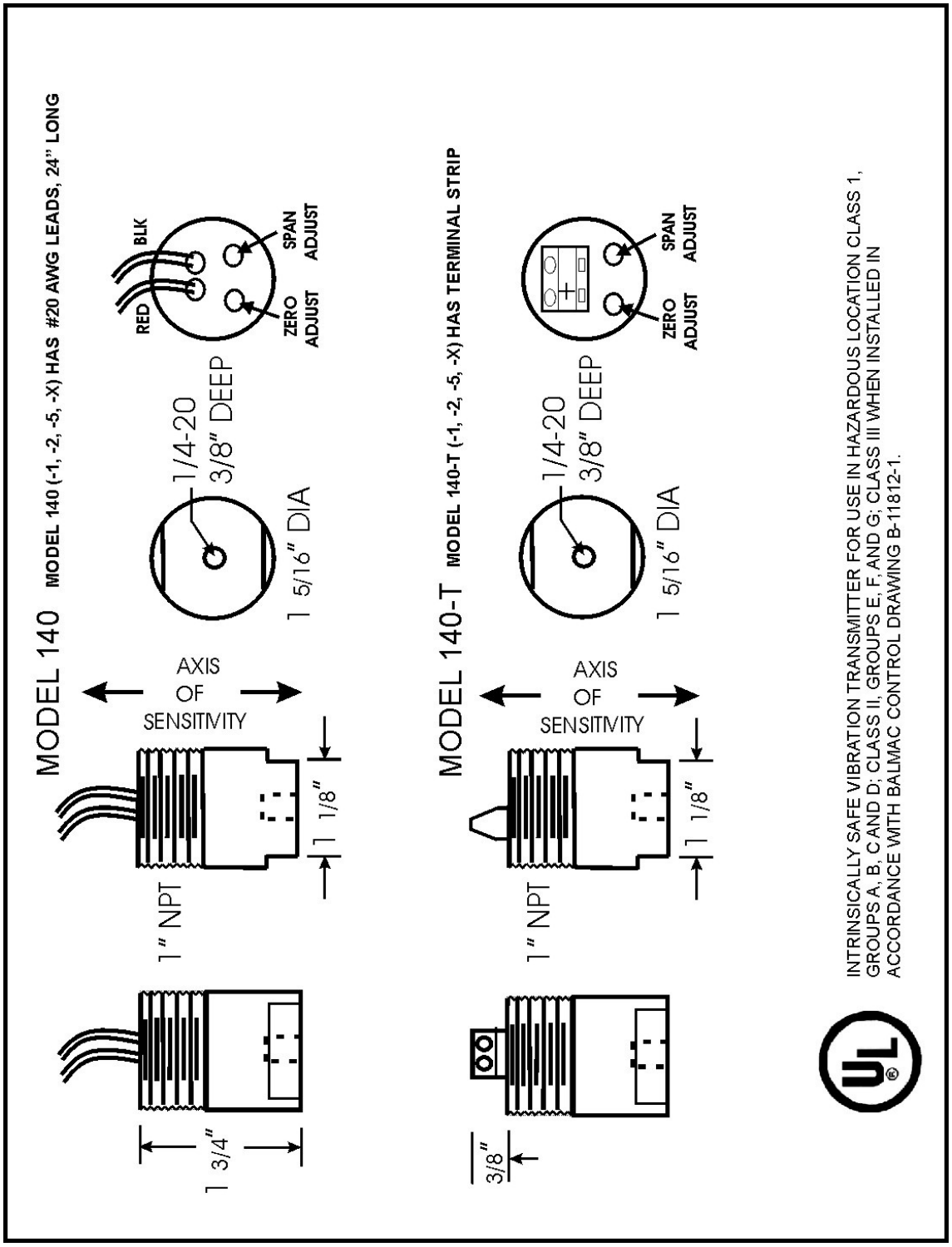
BALMAC, INC.

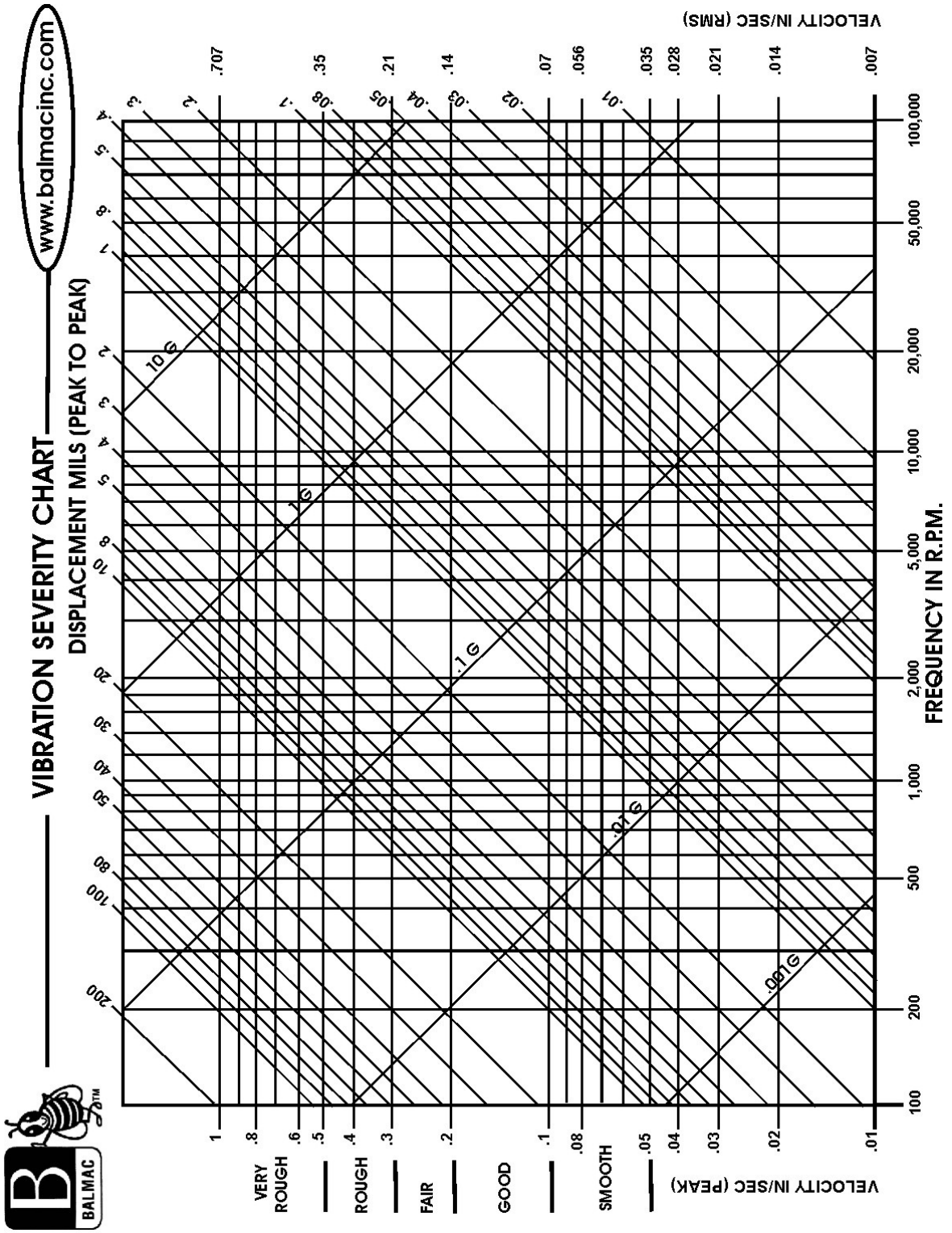
TITLE: CONTROL DRAWING

MODEL: 140/140T

| DATE | DWG NO. | REV. |
|---|---|---|
| 8SEP93 | B-11812-1 | A |
| DRAWN BY: dlt | SCALE: NONE | SHEET 1 OF 1 |

## SECTION 7 - DIMENSIONAL DRAWINGS

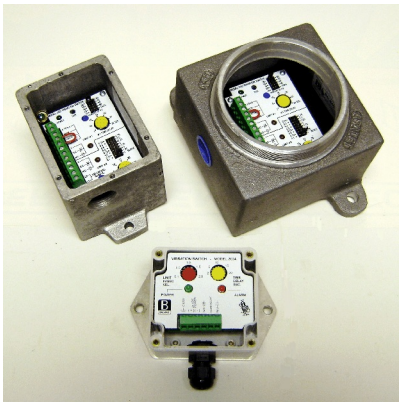



VIBRATION SEVERITY CHART
www.balmacinc.com
DISPLACEMENT MILS (PEAK TO PEAK)
VELOCITY IN/SEC (RMS)
VELOCITY IN/SEC (PEAK)
FREQUENCY IN R.P.M.
VERY ROUGH
ROUGH
FAIR
GOOD
SMOOTH
.01 G
.1 G
1 G
10 G
.001G
.707
.35
.21
.14
.07
.056
.035
.028
.021
.014
.007
1
.8
.6
.5
.4
.3
.2
.1
.08
.05
.04
.03
.02
.01
100,000
50,000
20,000
10,000
5,000
2,000
1,000
500
200
100
BALMAC

# Balmac Inc. - Providing Vibration Measurement Solutions to Industries Around the World Since 1976

For more than 34 years, Balmac Inc. (located in the Columbus, Ohio area) has provided economical solutions for vibration and balancing problems for customers worldwide. Our experience, and our commitment to new product development, has resulted in vibration and balancing instruments that are practical, easy to use and designed for years of service. Balmac Inc's customer support includes comprehensive technical literature, manuals, guides and a qualified staff of experts to help you solve your applications issues.

## Hand-Held Vibration Meters



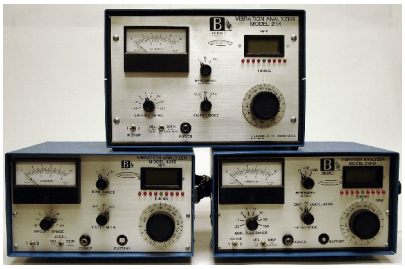
Vibration monitoring using hand-held meters is a simple, effective practice that helps manufacturers, service contractors and maintenance departments protect assets. Applications for vibration monitoring include manufacturing, HVAC, automotive, oil, gas and pipelines, construction, medical, power generation, marine and pharmaceuticals.

## Vibration Switches

Reliable, continuous machinery protection from excessive vibration for blowers, cooling towers, fans, motors and rotating machinery. Automatic Alarm and/or Shut Down. User adjustable Limits and Time Delays. Solid-state electronic reliability.

## Vibration Monitors and Monitoring Systems

Economical vibration monitoring Model 140 and 191 Series Transmitters use "industrial standard" two-wire, 4-20 mA signal proportional to vibration. Used with Balmac Model 1112 Monitors, PLCs, DCS and other commercial control systems. Model 401 Monitor is dedicated, two channel vibration monitor with local display



## Vibration Analyzer / Balancers and Portable Balancers

For decades, the Vibration Analyzer/Balancer with Strobe Light has been the workhorse for maintenance personnel performing vibration analysis or dynamic balancing. Analyzer/balancers are known for rugged reliability and the tunable filter and Strobe Light are easy to use and more convenient than digital filters and laser photo tachs. Now, Balmac has added LED technology to the standard strobe in the Model 4216 to provide enhanced illumination with adjustable intensity while increasing longer portable operating times.

BALMAC INC.
8205 Estates Pkwy, Ste N
Plain City, OH 43064-8080 USA

614-873-8222 Fax 614-873-2519
sales@balmacinc.com

balmacinc.com