PA175
Piezoelectric
Transducer
Signal Conditioner

1.0 General

1.1 Description

The PA175 Piezoelectric Transducer Signal Conditioner is a plug-in unit of the Validyne MC170 High Density Multi-Channel Modular Transducer Control System, hereafter referred to as the "Module Case."

When installed in the module case, the PA175 furnishes 1.8mA DC constant current to a remote impedance converter. The PA175 accepts signals as low as 10mV/g to develop ±10V AC and 0 to +10V DC, proportional to peak value of the sine waves.

The carrier supply in the MC170 is used to develop a high compliance voltage for the constant current circuit to guarantee operation with most low current impedance converters.

Front Panel switched Gain and low pass Filter plus "AC", "DC", and "Cal." test points allow complete operation without removal from the module case.

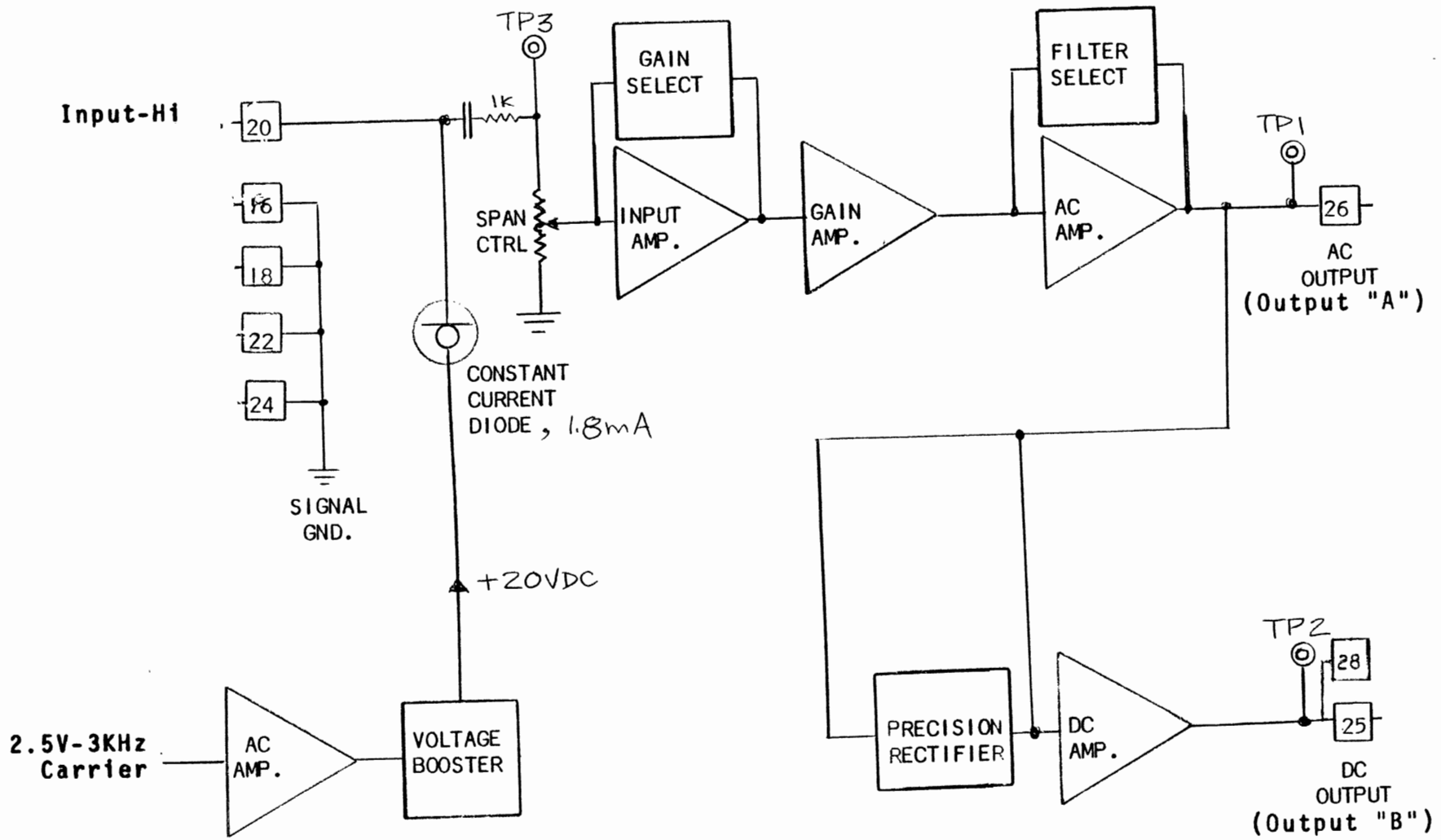


FIG. 1.2.1 FUNCTIONAL BLOCK DIAGRAM, PA 175

Validyne ENGINEERING CORPORATION

2.0 Specifications

2.1 Electrical

Input Impedance:	51K ohms
Current Source:	1.8mA, Constant Current; 17.2V DC Compliance
Gain:	Front Panel Switch Selectable; X25, 50, 100, 250, 500, 1000
Gain Vernier:	Continuously Variable 0% to 110% of Gain Step
Output Voltage:	A Output: ±10V pk, ±4mA B Output: 0 to +10V DC, Equal to Peak of an AC Output Signal at +4mA Current
Frequency Response:	5Hz to 2KHz, Plus Front Panel Switch Selectable Low Pass Filter, at 50Hz, 200Hz NOTE: Operation at Bandwidths up to 20KHz Available (Consult Factory)
Temp., Operating:	0°F to +150°F
Power Supply:	±15V DC, Supplied by MC170 Module Case
Test Points:	Front Panel Mtd., #1 = A Output, +10V AC #2 = B Output, $\overline{0}$ - +10V DC #3 = Calibrate Signal Input

2.2 Mechanical

Size:	2.76"H X 0.4"W X 7.5"D (7.01cm X 1.016cm X 19.05cm)
Weight:	6 oz. avdp (168 grams)

3.0 Installation and Operation

3.1 Installation in the MC170

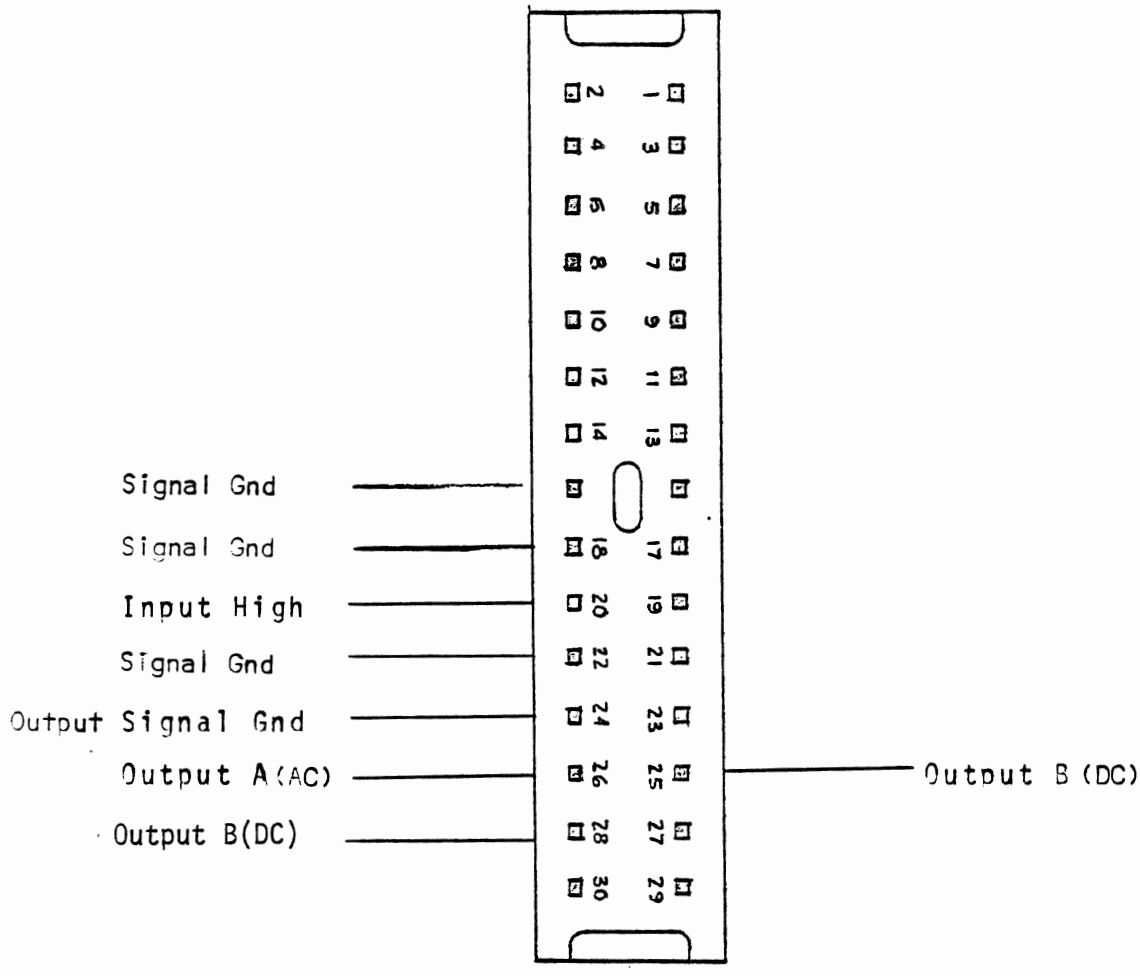
The PA175 may be installed in any one of the 25 channel slots in the MC170. The module may be inserted or removed with power ON without damage to the module or the module case.

Wiring to the external impedance converter is connected to the rear wiring plane. DC power, carrier supply, and signal and power grounds are bussed in the MC170, and are automatically connected on insertion. The signal and power grounds are connected in the PS176 power supply, and should not be connected at the module to prevent ground loops.

3.2 Input/Output Connections

See page 9.

Input and Output Connections: (Accessible through Printed Circuit Board Connector at Rear of MC170 Module Case.)



Printed Circuit Board Connector

As Viewed from Rear of MC170 Module Case

(WIRE-WRAP TERMINAL VERSION)

Fig. 3.2.1. PA175 INPUT/OUTPUT CONNECTIONS

3.3 Front Panel Controls

1. GAIN SWITCH - A screwdriver operated 6 position switch which selects overall gain of the PA175. Gain steps are 25X, 50X, 100X, 250X, 500X, 1000X.

2. GAIN VERNIER - A multi-turn screwdriver adjust pot which scales the input signal to 0-100% of the gain set on the GAIN SWITCH.

*3. FILTER SELECT - A screwdriver operated, 6 position switch which selects the low pass filter frequency on the PA175 output. Frequencies are 50, 200, or 2000Hz. Other frequencies up to 20KHz are available from the factory.

4. AC OUTPUT TEST POINT - Connected to the output of the AC channel. May be viewed with an oscilloscope using the ground pin on the PS176 Module.

5. DC OUTPUT TEST POINT - The DC output may be viewed with an oscilloscope or voltmeter. Presents a DC voltage proportional to an average of the peak values of the AC output.

6. CALIBRATE/INPUT MONITOR - A test point where input calibration signals are applied. Signals should be referenced to ground at PS176 Power Supply GND test point.

   The CAL test point may also be used as a monitor terminal to determine the amplitude or wave shape of the input signal. The signal observed at the CAL test point will be 2% lower in amplitude than the input signal.

*NOTE: The Filter Select switch is a rotary, detented 6 position switch with no internal stops. When the switch is in any of the three un-marked positions (as determined by the arrow on the actuating screw head and indexing lines on the front plate), the filter frequency will be 2KHz.

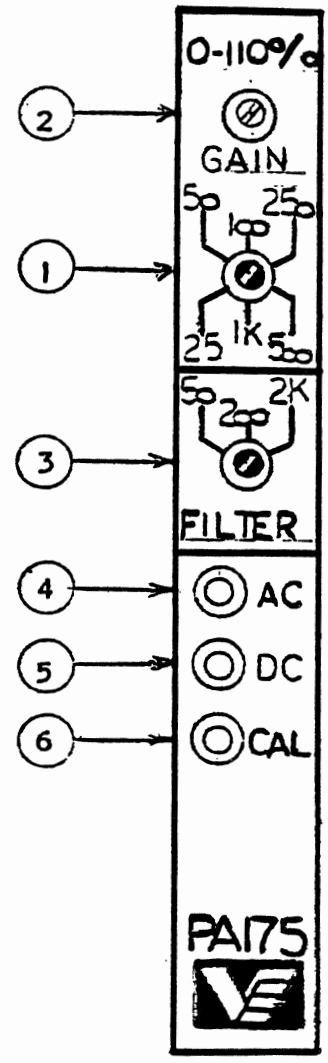


Figure 3.3.1

Front Panel Controls

3.4 Calibration

The PA175 may be calibrated by applying a low-level AC signal between the CAL test point on the front panel, and ground which is available at the PS176 power supply front panel.

If a hard wired calibration is desired, connect the AC cal signal between High Input and Signal Ground at the rear connector. (See Figure 3.2.1 for terminal designations.)

A 1K resistor is used to isolate the CAL test point from the High Input Connection. This prevents any possible effects from reaching the impedance converter constant current source.

NOTE: FOR ACCURATE CALIBRATION, REDUCE THE AC INPUT TO THE TEST POINT BY 2% OF THE ORDINARY INPUT CAL SIGNAL. For cal inputs to the P.C. connector, disregard the 2% factor.

EXAMPLE: Assume that the accelerometer/impedance converter delivers 13.7mV/g peak, and the PA175 is to be calibrated for 1V/g peak or 10 volts peak out for 10g peak acceleration input.

The AC input (at any frequency above 5Hz and within the range determined by the low pass filter selector) should be determined as follows:

1. Accelerometer output sensitivity = 13.7mV/g peak

2. Full scale output desired = 10g peak

3. Input signal to calibrate for 10g pk = 137mV pk

4. RMS input = to 137 mV pk = .707 x 137 = 96.9 mV RMS

5. Cal Input Signal = input x .98 = 95 mV RMS

NOTE: Using RMS equivalents allows measurement of the cal signal with a digital voltmeter or other RMS reading instrument.

6. Output, AC for 10g pk input, 13.7mV/g = 10V peak, or, using DVM, 7.07 Volts RMS

7. Output DC, which reads average PEAKS, reads +10V DC

To adjust PA175 gain controls to achieve 10V out for 137mV in., calculated overall gain required. $G = \frac{10.00Vp}{0.137Vp} = 73.$

Select the 100X gain step, and turn the gain vernier control CCW until the output reads the desired value. The AC and DC outputs may be different by as much as 2% based on component tolerances, and filtering on the DC amplifier.

4.0 Principles of Operation

The PA175 delivers 1.8mA from an FET-type constant current diode to an external impedance converter.

A portion of the 3KHz carrier signal which is available at the P.C. connector is amplified, rectified, filtered, and added to the +15V DC power to furnish a +20V DC supply for the constant current source. The input may swing as high as +17 volts with no effect on the current source.

The AC signal is amplified in 2 stages and delivered to the AC output amplifier which contains a 2-pole switch-selectable low pass filter in the feedback loops.

The output of the AC amplifier is full wave precision rectified in the DC amplifier, which is scaled to deliver +10V DC output when the output of the AC amplifier is + or - 10V AC peak. This output represents the average of the peak readings on a DC scale. This average scale factor is based on sine wave inputs.

Power for the PA175 is supplied by the MC170 Module Case.

8465

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
A	SEE DCN	3-21-79	JLF ED
B	SEE DCN	7-31-79	JLF ED
C	SEE DCN	4-24-81	ED

S1 GAIN SWITCH

A	B	C	D	E	GAIN
					1000
X					500
	X				250
		X			100
			X		50
				X	25

S2 FILTER

A	B	C	D	FREQUENCY
				2K HZ
	X		X	200 HZ
X		X		50 HZ

X = CLOSED

LOW PASS FILTER AND OUTPUT AMPLIFIER

INPUT AMPLIFIER

2ND STAGE AMPLIFIER

B + BOOSTER

AC VOLTMETER

INPUT 20 — C1 6.8μF 35V — TP3 — R25 1K — R1 50K CW — IC1A 4136 — R2 4.99K — C5 39μF 10V — CR1 E507 — R3 196K — R4 187K — R5 59K — R6 16.2K — R7 5.11K — S1 1111-A-A (A 1000, B 500, C 250, D 100, E 50, 25)

16 — 18 — 22 — SIGNAL GND 24 — ⚠3

IC1B 4136 — R8 133K — R9 4.99K — C6 39μF 10V — +15V — -15V

R10 110K — R11 110K — IC1C 4136 — R12 1K 5% — TP1 — 26 AC OUTPUT

S2A 111-A-W — C2 .039 — S2B — C3 .01 — C4 1000pF — S2C — S2D — C8 .018μF — C9 .0047μF — C10 500pF — C7 100pF — R13 220K 5%

+20 VDC

R14 39K 5% — R15 33K 5% — 2.5V 3K HZ 3 — IC2A 1458 — +15V — -15V

C11 6.8μF 35V — CR4 IN914 — R16 1K 5% — CR5 IN914 — C14 6.8μF 35V — C15 6.8μF 35V — +15V

+15V INPUT 8 — C12 2.2μF 20V — +15V

POWER GND 10 — C13 2.2μF 20V

-15V INPUT 12 — -15V

R17 20K — R18 20K — C16 15μF 20V — R19 20K — R20 10K — R21 31.6K — CR6 IN914 — CR7 IN914 — IC1D 4136 — R23 12K 5% — IC2B 1458 — R22 1K 5% — TP2 — 25 DC OUTPUT — 28 — R24 6.8K 5%

1. CONNECTOR PIN DESIGNATORS: A = COMPONENT SIDE, B = TRACE (BOTTOM) SIDE. CONNECTOR PINS ARE ON BOTH SIDES WHEN 'A' OR 'B' NOT INDICATED.
⚠3 SIGNAL GROUND.
2. CAPACITOR VALUES ARE IN MICROFARADS.
1. RESISTOR VALUES ARE IN OHMS ±1% 1/8 WATT.
NOTES: UNLESS OTHERWISE SPECIFIED:

HIGHEST REF DES USED							
C16	CR7	IC2	R25	S2	TP3		
REF DES NOT USED							
CR2, CR3							

TOL. UNLESS NOTED: DEC. XXX ±.005; FRAC & DEC. XX ±1/64; ANGLES ±1°. DIAMETERS WITH SAME ℄ SHALL BE CONCENTRIC WITHIN .005 TIR. SURFACES MUST BE FLAT WITHIN .002 PER IN. MAX FILLET .015 UNLESS NOTED. DEBURR EDGES .005 MAX UNLESS NOTED. SURFACE FINISH ▽ UNLESS NOTED. DRILLED HOLE TOL PER ANDI0387.

Validyne ENGINEERING CORPORATION, NORTHRIDGE, CALIFORNIA 91324

SCALE			
DWN	ED	9-27-79	MODEL AP175
CK'D	JLF	12-7-79	MAT'L
APPVD.			FINISH
TITLE	SCHEMATIC		

RED 'A' SIZE

8465 C

USING THE VIBRATION NOMOGRAPH

The Nomograph

Four logarithmic scales compose the nomograph:

1. Frequency: Horizontal Scale
2. Velocity: Vertical Scale
3. Acceleration: Diagonal downward left to right
4. Displacement: Diagonal upward left to right

A vibration of simple harmonic motion (a pure sinusoidal wave shape) exhibits these four quantities. With any two of these quantities being known, the remaining unknown quantities may be determined from the nomograph.

For example:

GIVEN: 1 g acceleration, 0.001" peak to peak displacement

TO FIND: Frequency and velocity

ON NOMOGRAPH: Find point of intersection of peak acceleration 1 g line (diagonal downward left to right) with peak to peak displacement 0.001" line (diagonal upward left to right). Read frequency 150 cps (vertical scale) and peak velocity 0.45 in/sec. (horizontal scale)

Conversion Factors

Values on the nomograph are peak to peak values for displacement and peak values for acceleration and velocity. Whenever average, RMS, or peak values are required, the following conversion factors must be applied.

MULT. BY → To Obtain	Multiply Numerical Value of: Average	RMS	Peak	Peak to Peak
Average	1.000	.900	.636	.318
RMS	1.111	1.000	.707	.354
Peak	1.571	1.414	1.000	.500
Peak to Peak	3.142	2.828	2.000	1.000

RELATIONSHIP OF VIBRATORY DISPLACEMENT, VELOCITY AND ACCELERATION

	INSTANTANEOUS VALUES	PEAK VALUES	UNITS
Displacement	$d = d_o \sin 2\pi ft$	d_o	inches—single amplitude
Velocity	$v = (2\pi f)\, d_o \cos 2\pi ft$	$6.28\, d_o f$ or $3.14\, Df$	inches/sec.—peak; where $D = 2d_o$ and is peak to peak amplitude
Acceleration	$a = -(2\pi f)^2 d_o \sin 2\pi ft$	$39.4\, d_o f^2$ or $19.7\, Df^2$	inches/sec² peak
	$G = \dfrac{-(2\pi f)^2 d_o \sin 2\pi ft}{g}$	$0.102\, d_o f^2$	G = acceleration in gravities, i.e. "g's"; g = 386 in/sec² = 32.2 ft/sec²
	$G =$	$0.0511\, Df^2$	

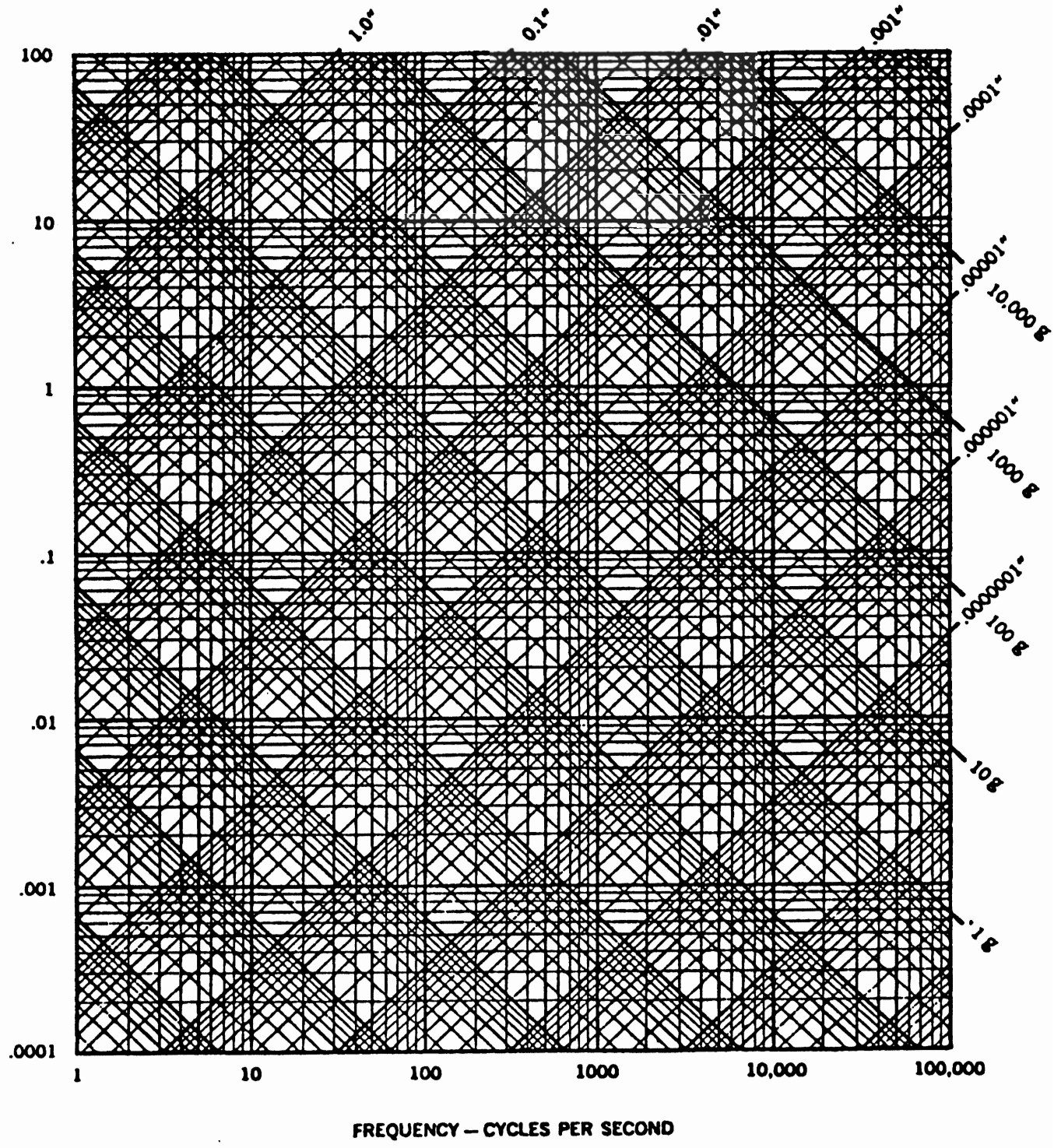


Figure 5.1 - Vibration Nomograph

WARRANTY

VALIDYNE ENGINEERING CORPORATION warrants equipment of its own manufacture to be free from defects in material and workmanship under normal conditions of use and service.

VALIDYNE will rework or replace any item found to be defective on as return to VALIDYNE within the time specified below:

1. Pressure Transducers and Pressure Transmitters (including transducers supplied as part of Digital Manometer Systems) within three (3) years of its original purchase.

2. Electronics products (Transducer Indicators, Carrier Demodulators, plug-in SignalCondioners, Module Cases, etc.) within one (1) year of its original purchase.

3. OEM Transducers within one (1) year of its original purchase.

Buyer is requested to secure authorization of VALIDYNE, and to describe defect prior to return of equipment under warranty. Shipment to VALIDYNE shall be at Buyer's expense, with return at VALIDYNE's expense. NON-VERIFIED problems or malfunctions, whether warranty or not, are subject to a $100.00 evaluation charge.

The warranty carries no liability, either expressed or implied, beyond our obligation to rework or replace, at VALIDYNE's option, the unit which carries the warranty to the original purchaser. Prices, specifications, and designs are subject to change without notice. This warranty is void if the product is subjected to misuse, accident, neglect, or improper application or operation.

Out of Warranty Rework

Units returned to VALIDYNE for rework which are out of warranty will be subject to the following conditions:

1. A description of the problem or malfunction shall accompany the unit returned for rework, or be communicated to VALIDYNE prior to shipment. Otherwise there will be a minimum evaluation and/or calibration charge of $100.00.

2. Unit will be reworked automatically if the charge is less than 65% of current list price, unless other specific instructions are received. Above 65% VALIDYNE will request authorization by Buyer.

3. If a quotation is required before proceeding with rework, unit should be accompanied by a document so stating, or communicated to VALIDYNE prior to shipment. A $100.00 evaluation charge will be invoiced for this service.

4. Shipping charges in both directions are the responsibility of the Buyer for all out of warranty returns.

Warranty on Rework

Warranty coverage on rework is 90 days on work done, or to the end of the original warranty period, whichever is longest.

8626 Wilbur Avenue - Northridge, CA - 91324
818-886-2057 - Toll Free 800-423-5851 - Automatic Fax 818-886-6512