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INSTRUCTION MANUAL

VIBRATION MONITOR

MODEL 610B

Rev	Date	Drawing No.	Serial No.
B	5/14/87	1220	440 & UP

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DRAWING LIST

NAME: Vibration Monitor

MODEL: 610B

DESCRIPTION:	P/L#	REMARKS
Vibration Monitor, Chassis Assembly	1218G	
Vibration Monitor, Chassis Schematic	1219G	
Vibration Monitor, Instruction Manual	1220B	
Front Panel, Vibration Monitor	1279-1	
Rear Panel	1214-1	
PC Mounting Rail	1290-3	
Side Brace	1211	
Cover	1652-1	
*Side Plate-rack mount	1900-1	
*Handle, Side Panel	3671-1	
P. C. Board Assy, Vibration Monitor	1215G	
P. C. Board,Vibration Monitor	1216	
P. C. Board Schematic, Vibration Monitor	1217G	
DVM Meter Assembly	1620	**
DVM Meter Schematic	1621	
DVM Indicator & Conv. Assy	1599	
DVM Indicator & Conv. P.C. Board	1600	
DVM Indicator & Conv. Schematic	1601	Ref. 1621
DVM Accessory Assy.	1602	
DVM Accessory P.C. Board	1603	
DVM Accessory Schematic	1604	Ref. 1621

* (Use either TTI 1900-1 or TTI 3671-1 - Never Both)

** (This assembly appears in Models 500A,500B,610B,E,F,G,M.)

NOTE: N/C & A Revision documents S/N 101 to 439.
B Revision documents S/N 440 & Up.

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VIBRATION MONITOR

SYSTEM

General

The Vibration Monitor is designed for application where signals from accelerometers are to be monitored. A rear panel INPUT switch selects either (PICO-COULOMB) or (MILLIVOLT) INPUT. Through this INPUT switch, either a charge or a voltage output-type accelerometer can be accommodated. For either type accelerometer, a 1-110 pC/g or mV/g sensitivity adjust allows the pick-up to be normalized for 10 millivolts /g at the ACCEL OUTPUT jack. This acceleration signal is integrated to velocity and normalized for 10 millivolts RMS/peak in/sec and brought out at the VEL OUTPUT jack. The velocity signal is again integrated and normalized to 5 millivolts RMS/mil DA and brought out at the DISPL OUTPUT jack.

The unit has a 3 1/2 digit meter to indicate the input level of the parameter selected by the SELECTOR switch-ACCEL-g, VEL-PEAK/IN/SEC, or DISPL-P-P MILS.

System Description

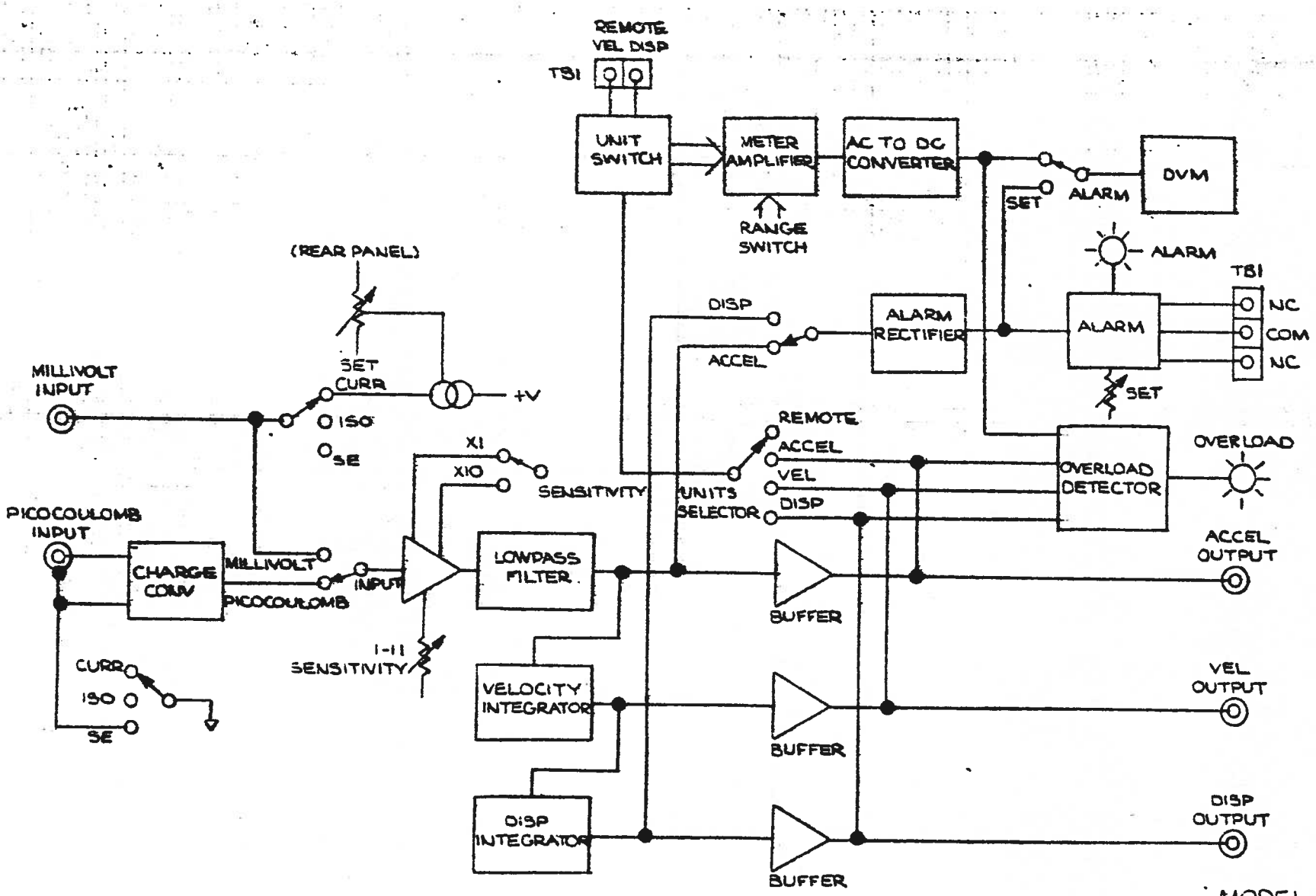
Block Diagram Figure 1-1 is a simplified functional diagram showing the signal flow.

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The unit will accept inputs from either a charge output accelerometer at the (PICO-COULOMB) INPUT or a voltage output (built-in electronics) at the (MILLIVOLT) INPUT. When the accelerometer with built-in electronics is used, the current is supplied by the Monitor. The acceleration signal from either type pickup is normalized by the SENSITIVITY switch and control, then buffered and brought out at the ACCEL OUTPUT jack. The acceleration signal is integrated, buffered, and brought out at the VEL OUTPUT jack. This velocity signal is integrated, buffered, and brought out at the DISPL OUTPUT jack.

The ACCEL, VEL, or DISPL signals are the input to the SELECTOR switch. One is selected and fed to the Range Amplifier where the RANGE switch scales the level. The signal is then rectified and the DC voltage drives the digital voltmeter to indicate the level of the selected parameter. The levels of the three outputs and the input to the digital meter are simultaneously monitored by an Overload Detector to alert when an overload condition exists.

The alarm circuit operates either from acceleration or displacement, selected by a front panel switch, with a separate AC to DC converter. The output is on the RELAY contacts and also, illuminates the ALARM LED.



MODEL 610
VIBRATION MONITOR
BLOCK DIAGRAM
FIGURE # 1-1

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VIBRATION MONITOR

PERFORMANCE TEST

This performance test procedure should be run to verify that the unit is performing within the manufactured specification. The unit uses integrated circuits and very stable parts and should not require calibration more often than once every six months, unless a part fails. In the event that a reading is out of tolerance, the unit may require calibration. (See Section 4 of this manual.)

Test Equipment

Equivalent test equipment can be substituted.

1.	AC-DC Voltmeter	Fluke Model 8000A
2.	Voltage to Charge Converter	Trig-Tek Model 2030
3.	Function Generator	Trig-Tek Model 345A

Procedure

Connect the line cord to AC power. Place the POWER switch to the ON position and observe that the LEVEL METER light illuminates.

1. Place the INPUT switch on the rear panel to (PICO-COULOMB) ACCEL, the SENSITIVITY switch to X10, the SE-ISO switch to SE, and the 10 mV/g-100 mV/g switch (rear panel) to 10 mV/g.

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2. Place the METER UNITS switch to ACCEL, the RANDOM-SINE switch to SINE, and the RANGE switch to 100 g's.

3. Turn the SENSITIVITY Dial on the front panel fully counterclockwise. Dial must indicate 1.0.

4. Connect the function generator to the (PICO-COULOMB) ACCEL INPUT via the voltage-to-charge converter. Set the generator for approximately 500 Hz and 707 ± 4 millivolt RMS.

5. Connect the AC voltmeter to the ACCEL OUTPUT jack.

6. Observe an indication of 707 ± 14 millivolts RMS on the AC voltmeter.

7. Place the 10 mV/g-100 mV/g switch on the rear panel to 100 mV/g.

8. Observe an indication of 7.07 ± 0.3 volts RMS on the AC Voltmeter.

9. Return the 10 mV/g-100 mV/g switch to 10 mV/g.

10. The front panel meter should indicate 100 ± 3 g's.

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11. Place the SENSITIVITY switch on the rear panel to X1. Turn the SENSITIVITY Dial to 10.0 position.

12. Observe an indication of 707 ± 14 millivolts RMS on the AC voltmeter. The front panel meter should indicate 100 ± 3 g's.

13. Hold the ALARM switch down and adjust the ALARM LEVEL control until the front panel meter indicates about 107 g's.

14. Release the ALARM switch and turn the ALARM LEVEL control counterclockwise until the ALARM light comes on.

15. Depress the ALARM switch and observe an indication of 100 ± 5 g's on the front panel.

16. Connect the DC voltmeter to DC output jack.

17. Observe an indication of 10.0 ± 0.3 volts on the DC voltmeter.

18. Set the generator frequency for 5 Hz. (Do not change the level of the generator.)

19. Observe an indication of 100 ± 3 g's on the front panel meter. The OVERLOAD light may blink because the displacement is overloaded.

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20. Set the generator frequency for 5 kHz. (Do not change the level of the generator.)

21. Observe an indication of 100 ± 3 g's on the front panel meter.

22. Set the generator frequency for 61.4 ± 0.1 Hz. (Same level as before, 707 ± 4 millivolts RMS).

23. Connect the AC voltmeter to VEL OUTPUT jack, and place the METER UNITS switch to VEL position. (The PEAK IN/SEC LED should illuminate.)

24. Observe an indication of 1000 ± 30 millivolts RMS on the AC voltmeter. The front panel meter should indicate 100 ± 3 IN/SEC.

25. Set the generator frequency for 139.9 ± 0.2 Hz. (Same level as before, 707 ± 4 millivolts RMS.)

26. Connect the AC voltmeter to DISP OUTPUT jack, and place the METER UNITS switch to DISP position. (The P-P mils LED should illuminate.)

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27. Observe an indication of 500 ± 15 millivolts RMS on the AC voltmeter. The front panel meter should indicate 100 ± 3 mills.

28. Set the generator level for 223 ± 2 millivolts RMS at about 500 Hz.

29. Place the METER UNITS switch to ACCEL position and the RANGE switch to 31.6 g range.

30. Observe an indication of 31.6 ± 0.9 on the front panel meter.

31. Place the SINE-RANDOM switch to RANDOM.

32. Observe an indication of 25.0 ± 0.8 on the front panel meter.

33. Set the generator level for 22.3 ± 0.01 millivolts RMS.

34. Place the RANGE switch to 3.16 g range.

35. Observe an indication of 2.50 ± 0.08 on the front panel.

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VIBRATION MONITOR

OPERATION

The front panel of the Vibration Monitor provides a digital indication of the amplitude of Acceleration in g's inches/second peak in Velocity, and Displacement in mils DA (double amplitude). The UNITS or REMOTE are selected by a four-position switch labeled SELECTOR; the fourth position is REMOTE. When the SELECTOR switch is placed in the desired units, a LED, found directly below the digital meter, will be illuminated indicating which unit has been selected. When the SELECTOR is in the REMOTE position, ACCEL, VEL, or DISPL units can be selected by the two REMOTE INPUTS on TB1 labeled VEL and DISPL. When both are minus five volts, ACCEL units are selected. When VEL is plus five volts, VEL units are selected, and when DISPL is plus five volts, DISPL units are selected. The REMOTE inputs are intended to be driven from the CH1, CH2 HIGH outputs from the Model 801 Compressor to automatically switch units when the Compressor changes control parameters by switching from Channel 1 to Channel 2 or vice versa.

A five-position RANGE switch selects the full-scale range of the parameter selected. Please note there are two scales, one printed in black and one printed in red. The black scale refers to the units of acceleration and velocity, and the red scale indicates units of displacement; i.e., the red scale covers the full scale

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ranges from 10 mils to 1,000 in DA, the black scale covers the ranges from 3.16 to 316 inches per second peak, or g's. Directly below the g's LED is the g's switch with two positions, SINE and RANDOM. The random position scales the DVM to indicate TRMS g's at the input.

On the far left side of the front panel is a calibrated ten-turn dial labeled SENSITIVITY 1-10 mV/g or 1-10pC/g. This dial adjusts the sensitivity of the acceleration input. The two acceleration input jacks are found on the rear of the chassis; one for direct accelerometer outputs of pico-coulombs, the other for millivolt outputs from accelerometers with built-in charge amplifiers. These two inputs on the rear of the chassis are labeled MILLIVOLT, and PICO-COULOMB. A switch labeled INPUT allows the operator to select the correct input for the type accelerometer in use. When the PICO-COULOMB position of the INPUT switch is selected, a switch with SE-ISO positions allows selecting either SE (single ended) input with the common side tied to signal ground, or ISO (isolated) where the input is floating. When the MILLIVOLT input is selected, a switch with CURR-OFF positions permits selecting the current supply to power the pickup. When the current is selected, it can be set using the CURR ADJ potentiometer next to the switch. Directly below the INPUT switch is another switch labeled SENSITIVITY with two positions, labeled X1 and X10. This sensitivity switch works in

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conjunction with the SENSITIVITY dial on the front panel. When the X1 position is selected, the dial sensitivity is 1-10 mV/g or pC/g; when the X10 position is selected, the dial sensitivity is 10-100 mV/g or pC/g.

To the left of the input jacks and switches there are two BNC connectors and a switch labeled FILTER. When the filter IN position is selected, an internal filter can be inserted in series with the acceleration signal before it is double integrated to velocity and displacement. Thus, the three parameters acceleration, velocity, and displacement are filtered when a filter is used.

In the middle of the rear panel are three AC output connectors. These are labeled ACCEL, VEL, and DISP. These outputs are always present and are normalized as follows: 10 mV/g,or 100 mV/g (rear panel switch), 10 mV rms/in/sec peak, and 5 mV rms/mil DA, respectively.

The meter is calibrated as follows:

INPUT	g's SWITCH	METER INDICATES	OUTPUT
1 g TRMS	RANDOM	1 g	10 mV TRMS
		(rear panel switch)	100 mV TRMS
1 g peak	SINE	1 g	7.07 mV rms
		(rear panel switch)	70.7 mV rms
1 in/sec/peak	SINE	1 inch/second	10 mV rms
1 mil (DA)	SINE	1 mil	5 mV rms

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In the event the meter circuit or any of the three outputs are overloaded, the front panel LED, labeled OL, will be illuminated and flash. A further explanation may be of benefit here. There are four separate cases that will cause an overload indication:

a. if the meter range is too low;

b. if the acceleration output is overloaded;

c. if the velocity output is overloaded; or,

d. if the displacement output is overloaded.

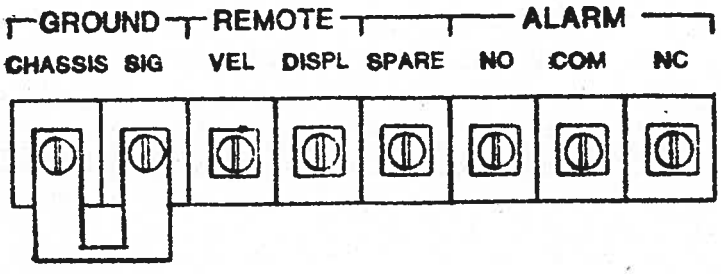
Please note that the three outputs, ACCEL, VELOCITY, and DISPLACEMENT, are always functioning, although the front panel meter is only showing the amplitude of the one that is selected by the front panel SELECTOR switch. Therefore, if the meter range is correct, but any one of the three outputs become overloaded, an overload condition will be indicated.

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To the far right on the front panel is a LED light, a screwdriver adjustment, and a toggle switch labeled ALARM. The alarm is designed to come on when a preset level from 0 to 100 g's is exceeded. The preset level can be set by holding the SET (momentary switch) in the SET position and setting the screwdriver adjustment for the desired level on the digital meter. When this preset level is exceeded, the LED illuminates and the ALARM contacts at the terminal strip TB1 close. To RESET, press the SET switch to the SET position.

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TERMINAL STRIP



1. The signal and chassis grounds are separate; normally, they will be strapped together. They are separated for the convenience of the operator to obtain the best grounding system.

2. Remote VEL and DISPL terminals allow remote control of the units when REMOTE is selected by the front panel UNITS switch.

	REMOTE	
UNITS	VEL	DISP
Accel	Open	Open
Vel	+5	Open
Displ	Open	+5

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3. The ALARM contacts are marked. The NO and COM will close when there is an alarm.

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VIBRATION MONITOR

CALIBRATION PROCEDURE

The Vibration Monitor adjustments are all accessible from the top when the cover is removed, and the location of the various adjustments is provided by Figure 4-1. The following procedure provides a method for setting each adjustment.

Test Equipment

Equivalent test equipment may be substituted.

1.	AC-DC Voltmeter	8000A Fluke
2.	Voltage-to-charge converter	Model 2030 Trig Tek Inc. (1000pf ± 1%)
3.	Frequency counter	1900A Fluke
4.	Function Generator	Model 701LM Sweep Oscillator Trig Tek Inc.

Test Procedure

Remove the top cover of the Vibration Monitor unit and connect the power cord to AC power. Place the POWER switch to the ON position. Set the RANGE switch to the 316/1000 in range and the METER UNITS switch to ACCEL. Place the INPUT switch on the rear panel to (PICO-COULOMB) ACCEL and the SENSITIVITY switch to X10. Place the sensitivity pot on the front panel to 1.0. Place the 10 mV/g-100mV/g switch on the rear panel to 10 mV/g.

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Common Mode Adjustment

1. Connect the generator output signal to the input and common of the voltage-to-charge converter. Connect the charge converter output to the (PICO-COULOMB) ACCEL INPUT jack. Set the generator for 5 V rms at approximately 100 Hz.

2. Connect the AC Voltmeter to the ACCEL OUTPUT jack.

3. Set the INPUT switch to ISO.

4. Set the CM ADJ R1 for a minimum indication on the AC voltmeter which should be less than 30 millivolts rms.

5. Return the INPUT switch to SE.

X1 Sensitivity Adjust

1. Connect the signal to the (PICO COULOMB) ACCEL INPUT via the voltage-to-charge converter. Set the generator for approximately 100 Hz and 500 $\pm$ 3 millivolts RMS indication on the AC voltmeter at the ACCEL OUTPUT jack.

2. Place the SENSITIVITY switch to the X1 position.

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3. Set the X1 ADJUST R2 for a 5.000 ± 0.025 V rms indication of the AC voltmeter.

4. Set the generator level for 1.000 ± 0.003 V rms.

5. Turn the SENSITIVITY dial on the front panel clockwise until the dial indicates 10.00 (one turn from the clockwise end of the pot).

6. Set the GAIN ADJ R4 for a 1.000 ± 0.005 V rms indication on the AC voltmeter at the ACCEL OUTPUT jack.

7. Place the SENSITIVITY switch on the back panel to X10.

8. Turn the SENSITIVITY dial fully counterclockwise. Dial must indicate 1.00.

9. Set the DIAL CAL ADJ R3 for a 1.000 ± 0.005 V rms indication on the AC voltmeter at the ACCEL OUTPUT jack.

Velocity and Displacement Adjust

1. Set the generator for 61.4 Hz ± 0.1 Hz and a .707 ± 0.004 V rms indication on the AC voltmeter at the ACCEL OUTPUT jack.

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2. Connect the AC voltmeter to the VEL OUTPUT jack. The X1-X10 switch (rear panel) is at X10 and the SENSIVITITY Dial at 1.0.

3. Set the VEL ADJ R5 for a 1.000 ± 0.005 V rms indication on the AC voltmeter.

4. Set the generator frequency for 139.9 Hz ± 0.2 Hz.

5. Connect the AC voltmeter to the DISP OUTPUT jack.

6. Set the DISPL ADJ R7 for a 500 ± 2 mV rms indication on the AC voltmeter.

Unit and Meter Full-Scale Adjust

1. Connect a DC voltmeter to the DC OUTPUT jack on the rear panel. Place the METER RANGE switch to 316 g's and remove the input signal.

2. Set the DC ZERO ADJ R16 for an 0 ± 5 mV indication on the DC voltmeter.

3. Connect the AC voltmeter to the ACCEL OUTPUT jack.

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4. Connect the generator to the input and set it for approximately 500 Hz and a 2.23 ± 0.02 V rms indication on the AC voltmeter.

5. Set the DC FS ADJ R10 for a 10.00 ± 0.01 Volt indication on the DC voltmeter at the DC OUTPUT.

6. Set the function generator for 61.44 ± 0.1 Hz. The indication on the Ac voltmeter should be 2.23 ± 0.02 Volts.

7. Connect the AC voltmeter to the VEL OUTPUT jack. It should indicate 3.16 ± 0.025 V rms. The OVERLOAD light may blink because the displacement is overloaded.

8. Place the METER UNITS switch at the VEL position.

9. Set the VEL FS ADJ R8 for 10.00 ± 0.01 Volts indication on the DC voltmeter at the DC OUTPUT.

10. Set the generator for 139.9 ± 0.1 Hz.

11. Connect the AC voltmeter to the DISP OUTPUT jack. It should indicate 1.58 Volts rms. (See Velocity and Displacement Adjust.)

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12. Set the generator frequency for a 5 ± 0.05 V indication on the AC voltmeter at the DISPL OUTPUT.

13. Place the METER UNITS switch to the DISP-MILS position and the SINE-RANDOM switch to SINE position.

14. Set the DISP FS ADJ R9 for a 10.00 ± 0.01 Volts indication on the DC voltmeter.

15. Set the meter FS ADJ R1 on the front panel DVM for a 1000 mil indication on the front panel DVM.

16. Place the METER UNITS switch to ACCEL.

17. Connect the AC voltmeter to the ACCEL OUTPUT jack and set the generator level for a 2.23 Volt indication on the AC voltmeter. The indication on the DC voltmeter should be 10.00 ± 0.05 Volts.

18. Set the X3 ADJ R2 on the front panel DVM for a 316g indication on the front panel DVM.

19. Place the SINE-RANDOM switch to RANDOM.

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20. Set the RANDOM ADJ R13 for a 250g indication on the front panel DVM.

21. Place the SINE-RANDOM switch to SINE.

Range Adjustments

1. Set the generator level for an 0.707 ± 0.004 rms indication on the AC voltmeter at the ACCEL OUTPUT jack.

2. Connect the DC voltmeter to TP14 (Pin 14 of IC6).

3. Set the ALARM ADJ R12 for a 1.00 ± .01 Volt indication on the DC voltmeter. Meter should read 100 g's.

4. Select the 100g range.

5. Set the X3 ADJ R14 for a 10.00 ± 0.01 Volts indication on the DC voltmeter at the DC OUTPUT jack and a 100 g indication on the front panel DVM.

6. Select the 31.6g range.

7. Set the generator level for an 0.223 ± 0.002 V rms indication on the AC voltmeter at the ACCEL OUTPUT jack.

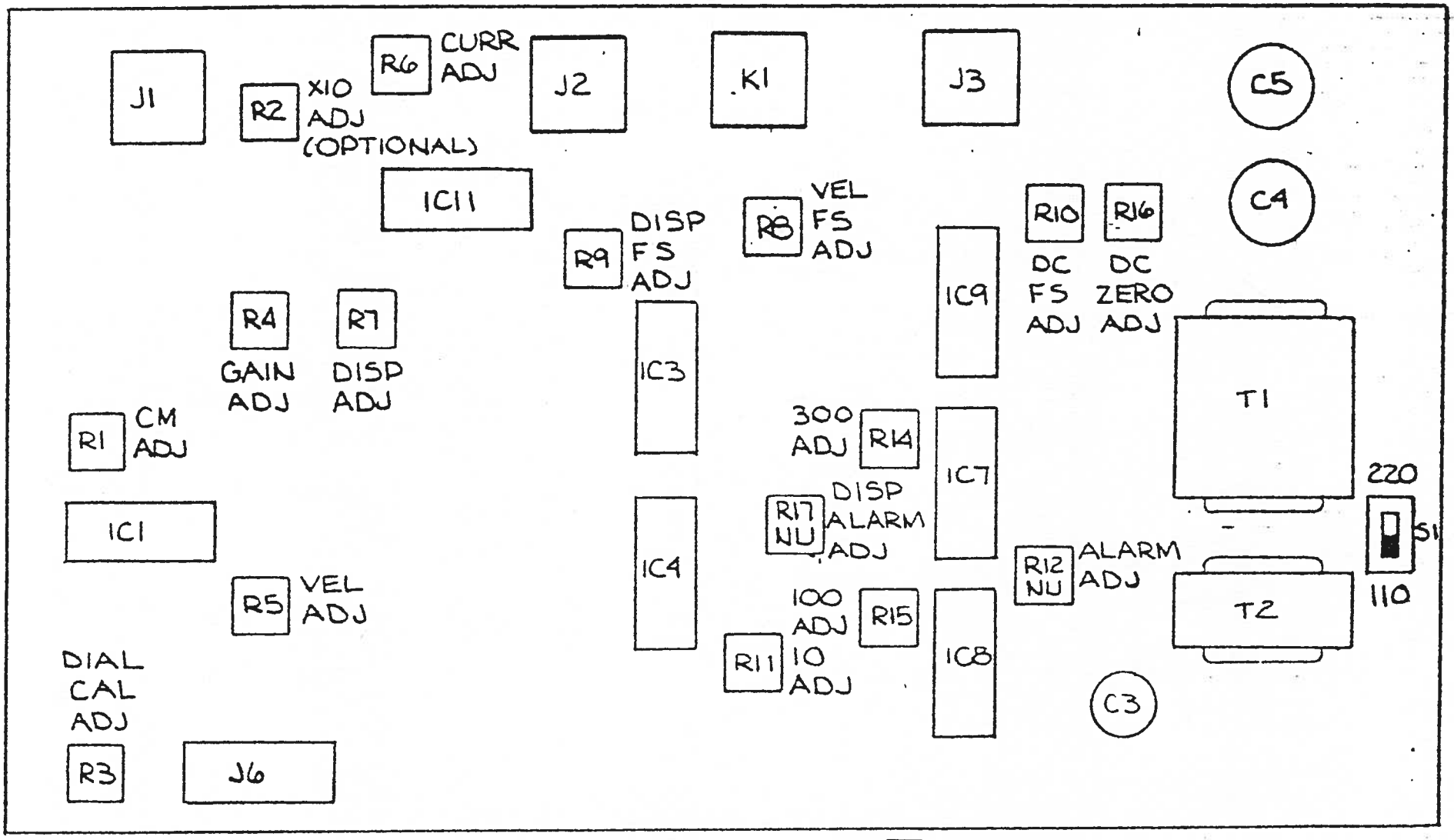
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8. Set the X100 ADJ R11 for a 10.00 ± 0.01 Volt indication on the DC voltmeter at DC OUTPUT jack and 31.6g on the front panel DVM.

9. Set the generator level for a 22.3 ± 0.01 millivolts indication on the AC voltmeter at the ACCEL OUTPUT jack.

10. Place the RANGE switch to a 3.16g.

11. Set the X10 ADJ R15 for a 10.00 ± 0.01 indication on the DC voltmeter and 3.16g on the front panel DVM.



MODEL 610
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ADJUSTMENT LOCATION
DRAWING
FIGURE #4-1

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VIBRATION MONITOR

CIRCUIT DESCRIPTION

The circuits for the Vibration Monitor are all contained on the main printed circuit board except the DVM Assembly 1620. The main board assembly circuits are shown on Schematic 1219 and the DVM Assembly on Schematic 1621.

Charge Converter

The input to the charge converter is from the (PICO COULOMB) ACCEL INPUT jack to E6 and E7 via R21 and C11 to the input Pin 2 of operational amplifier AR1. To accomplish a floating input, the common side of the circuit is maintained off (signal) ground. The charge conversion is accomplished by the AC voltage feedback across C13. The DC gain of the circuit is established via two paths, one R22 and R27, the other R24 and R28. The output is restored to a single-ended configuration referenced to signal ground by the common-mode amplifier 1/4 of IC1; the single-ended charge converter output is at TP10.

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Low Pass Filter

The signal from Pin 7 of IC1 is filtered by the low pass filter made up of two sections of quad amplifier IC10 and components. The filter is a four section butterworth design with a -3 dB cutoff frequency of 5 kHz. Other cutoff frequencies can be accomplished by changing the resistive component of each section according to the chart shown on the schematic.

Current Supply

The current supply circuit uses the regulated 20 Volts supplied to a pair of FETS Q1 and Q2 connected to provide a constant current output at Pin 4 of J1. This circuit, adjustable by R6, provides from 5 - 10 mA current with up to 18 Volts compliance.

X10 and Variable Sensitivity Amplifiers and Acceleration Buffer Amplifier

The signal from the low pass filter at Pin 7 of J1, or from the current supply Pin 5 of J1, is selected by the INPUT switch S2.

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This signal is then fed to the X10 sensitivity amplifier through the SENSITIVITY switch S5 where the sensitivity control setting is multiplied by either X1 or X10 as selected by S5. The X10 position of S5 routes the signal via Pin 6 of J1 to the low-gain setting of X10 amplifier, 1/4 of IC2. The X1 position of S5 routes the signal via Pin 3 of J1 for an X10 increase in the gain of the X10 sensitivity amplifier. The output signal is fed via R4 and R35 to the INPUT Pin 13 of IC1 which is the variable sensitivity amplifier. A front panel potentiometer sets the voltage feedback across R42. The full travel of the sensitivity pot varies the gain of the amplifier approximately 11:1. The output of the variable sensitivity amplifier is Pin 14 of IC1 and when properly adjusted to the input pickup, is normalized for 10 mV/g input. This signal is brought out via the acceleration buffer amplifier AR2 to Pin 5 of J2. The 10 mV/g - 100 mV/g switch, mounted on the rear panel, provides either 10 mV or 100 mV/g sensitivity at the acceleration output.

Accel-Vel Integrator and Velocity Buffer Amplifier

The signal at the variable sensitivity amplifier is fed to the acceleration-to-velocity integrator, via C17, to the adjustment R5, to be used to set the proper gain relationship between the acceleration voltage and the velocity voltage. The integration is

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accomplished by the capacitor C60 in the AC feedback of the integrator amplifier, 1/4 of IC1. The DC feedback path is R44. A multi-section, high-pass filter is accomplished by the combination of C60 and R44; R45, R47, and C21; and C17 and R43 in series with R5. These three sections are selected to provide a -6 dB/oct response above 5 Hz and then roll off at approximately -12 dB/oct below 3 Hz. The velocity output with a sensitivity of 10 mV rms for 1 peak in/sec is at Pin 1 of IC1. This signal is brought out via the Velocity Buffer Amplifier AR7 to Pin 8 of J2.

Vel-Displacement Integrator and Displacment Buffer Amplifier

The input to the Displacement Integrator is from the Velocity Integrator output across C39 to the adjust R7 used to set the relationship between the Velocity Input Voltage and the Displacement Output Voltage from the Integrator. The integration is accomplished by the AC feedback capacitor C52 across the operational amplifier 1/4 of IC2. The amplifier DC feedback is across R118. The circuit uses three high-pass sections made up of R118 and C52, R120 and C40, and C39, R117 in series with R7 to roll the output off at approximately -12 dB/oct below 5 Hz. The output at Pin 14 of IC2 is calibrated for 5 mV rms for 1 peak-peak mil of displacement. This signal is brought out via the Displacement Buffer Amplifier AR8 to Pin 4 of J2.

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Units Selector

The acceleration, velocity, or displacement signal is selected by the Unit Selector as the input to AR3. They are at Pin 2 of IC3, Pin 10 of IC3, and Pin 10 of IC4, respectively. The velocity input is selected when the control line at Pin 14 of J6 is at +5. The proper voltage scaling is set for velocity by R8 and displacement by R9.

X1, X100 Selector

This circuit selects either R60, or R11 and R59 as the input of AR4. When the control line at Pin 14 of J4 is at -5, R60 is the input to AR4 to set the gain at one. When the control line at Pin 14 of J4 is +Volts, R11 and R59 are in parallel with R60. This sets the gain of AR4 at ten. The amplified signal is at Pin 6 of AR4.

X1, X3, X10 Selector

The X1, X3, X10 Selector circuit selects R70, R14 in series with R71, or R15 in series with R69 as the input to AR6.

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When the X3 line Pin 13 of J4, and the X10 line Pin 12 of J4 are both at -5 Volts, the input to AR6 is across R70 for a circuit gain of 1. When the X3 line is at +5 Volts, R14 and R71 are placed in parallel with R70 to provide a circuit gain of 3.16. When the X10 line is at +5 Volts, R15 and R69 are placed in parallel with R70 to provide a gain of 10. The AC acmplifier output at Pin 6 of AR6 is at TP7.

Rectifier and DC Amplifier

The signal at TP7 from the AC amplifier circuitry is the input to the Rectifier made up of two sections of IC9. The gain of IC9(3) linearizes the characteristics of diode CR16 to provide a second input to amplifier IC9(4), one across R161, the other across R82. The phase and gain from each input is such to cause a full-wave rectified version of the input signal at TP8. Operational amplifier IC9(1) and circuit is connected as an inverting amplifier with a capacitor C30 across the feedback resistor R86 to provide a filter to reduce the ripple of the full-wave rectified signal at Pin 1 of IC9. Adjustment R10 allows setting the gain to provide a 10 V DC output for the full-scale input of each selected range. The DC output of IC9(1) is at TP9, and is also brought off the board at Pin 1 of J2.

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Overload Amplifier

The Overload Amplifier has input from four places: the Acceleration output, the Velocity output, the Displacement output, and the DC Amplifier output. The inputs are across CR21, CR22, CR23, and CR17, respectively. When any of these inputs reach the preset levels, the output of the overload amplifier IC9 Pin 7 goes positive. This positive voltage drives Pin 4 of IC15, the flasher unit, which causes the overload light to flash on and off to warn of an overload condition.

Alarm Circuit

The normalized acceleration signal is the input to the AC to DC Converter made up of AR6 and IC6 and circuitry. The proper gain is set by the ALARM ADJ R12. This DC voltage is the input to the alarm. The alarm circuit has the comparator circuit made up of IC6(2) and components. The level from the front panel alarm set potentiometer is compared with the DC signal from the AC-DC Converter. The output Pin 7 of IC6 stays positive until the signal from the AC-DC converter exceeds the alarm set level. When this occurs, the comparator output goes negative, causing the integrator output to go positive at a rate set by C42 and R112. When the integrator output Pin 8 of IC6 reaches the level to turn on transistor Q3, it pulls in the relay K1. The current to operate K1 also lights the front panel LED.

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Power Supply

The input to the power supply is from the power buss at E1 and E2 to the primary of T1 and T2. The secondary of T2 drives the full-wave rectifiers CR1 and CR2 which is filtered by C3 and has its output at TP5. This voltage drives the LED displays, and is the input to the 5 Volt regulator U1.

The Secondary of T1 drives the full-wave rectifiers for the +15 Volt and -15 Volt supplies which are filtered by C4 and C5, respectively. The +15 Volt supply is regulated by U2 and has its output at TP1; the -15 Volts supply is regulated by U3 and has its output at TP2. The +5 Volt supply has the filtered voltage at C3 as its input to Regulator U1 and the +5 Volt output is at TP4. The -5 Volt supply has the -15 Volts as its input to Regulator U4 and the -5 Volt output is at TP3.

The primary is split to accommodate either 110- or 220-Volt rms operation. A slide switch near transformers T1 and T2 labeled S1 provides a means of selecting 110 or 220 operation.

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DVM CIRCUIT AND INDICATOR (LEVEL) Assembly 1620

The DVM circuitry is packaged on two printed circuit boards. The two boards are held together by the interconnections between the two boards made through SIP connectors.

The DVM consists of an analog to digital converter with BCD to seven segment decoders built-in, and the indicators.

The analog to digital conversion is accomplished by integrated circuit U3. The complete converter is in the one chip except four capacitors: capacitors C2 and C4 are for the automatic zeroing, C5 is the integrating capacitor, and C1 is the timing element for the internal oscillator, which is used to time the converter. The input to the converter is at Pin 7 of J1. The voltage divider, made up of R8, R7, and R2, provides a range change when Pin 10 of J1 is grounded. This is used for scaling the 3 Volt of 300 mV ranges. The three digits of data at the end of conversion is latched in memory and is connected to the displays by individual lines.

The Polarity information is on Pin 20 of U3, which drives the polarity indicator on the display. The over range, which is the 200 count and up, blanks all the digits except the over range digit "one" stays on to indicate overload.

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Circuit Description - Vibration Monitor

The indicator board contains indicators U1 and U2 and U3 which have three digits, over range and polarity indication. The data is displayed on 0.6 inch high LED's. Also on the indicator board is DS 1, 2, 3, and 4. These are LED lights to be used for optional display purposes with the input lines via J1.

PARTS LIST SECTION 6

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Chassis Assembly Model 610B
Vibration Monitor

PARTS LIST NO. 1218G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY				
1.		Vibration Monitor Chassis Assy	TTI	1218G		1				
2.		Vibration Monitor Chassis Schem	TTI	1219G	(Ref)					
3.		Vibration Monitor Instr. Manual	TTI	1220B	(Ref)					
4.										
5.		Vibration Monitor PC Board Assy	TTI	1215G			1			
6.										
7.		Front Panel	TTI	1279-1			1			
8.		DVM Assembly	TTI	1620				1		
9.										
10.	R2	Potentiometer 5K	Spectrol	43P-502					1	
11.		Pot Adapter	SPE	6-1-0	(Ref. R2)			1		
12.	S7	Switch	Alco	MTA 306F				1		
13.	R1	Potentiometer 5K	Spectrol	536-5K-502				1		
14.		Dial	Spectrol	16-1-11	(Ref. R1)			1		
15.	S1,6	Switch	Alco	MTL 106D				2		
16.	S3	Switch, Rotary	CTS	T226	D2D0606N			1		
17.	S4	Switch, Rotary	CTS	T206	D4G0205N			1		
18.		Knob	Alco	PKAP70B-1/4	(Ref.S3,4)			2		
19.	DS1	LED	AND	AND114R				1		
20.	XDS1	LED Holder	AND	AND175R				1		

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Chassis Assembly Model 610B
Vibration Monitor

PARTS LIST NO.
1218G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
21.	J4,6	Ribbon Cable 16 Pin	CA	CAS16-P04-241-DO-018		2
22.	J5	Ribbon Cable 16 Pin	CA	CAD16-P04-241-DD-004		1
23.	R3	Resistor 3.01K 1%		RN55D-3011F	(Ref. S6)	1
24.	J7	Not Used				
25.						
26.		Rear Panel	TTI	1214-1		1
27.	J2,3	Ribbon Cable 8 Pin	CA	CAS08-P04-241-DO-010		2
28.	J1	Ribbon Cable 16 Pin	CA	CAS16-P04-241-DO-010		1
29.		Connector	Microtech	R50-4	Insul	1
30.		Connector	Amphenol	31-010		8
31.	R5	Resistor 180K 5%	R-Ohm	R25-184J	(Ref. S12)	1
32.	R4	Resistor 13.7K 1%		RN55D-1372F	(Ref. S12)	1
33.						
34.	F1	Fuse 1/4 Amp Slo Blo	LF	313.250		1
35.	XF1	Fuse Holder	LF	342004		1
36.	S2,5,8,10,11	Switch	Alco	MTL 106D		5
37.	S12	Switch	Alco	MTL 206N		1
38.	TB1	Terminal Strip	Beau	73208		1
39.		Jumper Strip	Beau	7833		1
40.						

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Chassis Assembly Model 610B
Vibration Monitor

PARTS LIST NO. 1218G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY				
41.		Line Cord	Belden	17237				1		
42.		Line Cord Retainer	Heyco	SR5N4				1		
43.	R6	Potentiometer 5K	Spectrol	43P-502					1	
44.		Pot Adapter	Spectrol	6-1-0	(Ref. R6)			1		
45.		PC Mounting Rail	TTI	1290-3			2			
46.		Side Plate	TTI	3714-1,-2			1pr			
47.		Spacer	Kulka/Smith	2332			3			
48.										
49.		Cover	TTI	1652-1			2			
50.		*Side Panel-rack mount	TTI	1900-1			2			
51.		*Side Panel-handle	TTI	3671-1			2			
52.										
53.										
54.										
55.										
56.		*Note: Use Item #50 or #51; never both.								
57.										
58.										
59.										
60.										

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Model 610B,E

Vibration Monitor PC Board Assembly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY				
1.		Vibration Monitor PC Board Assy	TTI	1215G		1				
2.		Vibration Monitor PC Board	TTI	1216			1			
3.		Vibration Monitor PCB Schematic	TTI	1217G	(Ref 1219G)					
4.										
5.	AR1*	Operational Amplifier	NS	LF356N	(Low Offset)			1		
6.	AR2,3,7,8	Operational Amplifier	TI	TL081CP	ORANGE or better			4		
7.	AR4-6	Operational Amplifier	NS	LF411N				3		
8.										
9.	C16,18,22,23,29	Capacitor 10pf	Arco	DM15-100D				5		
10.	C61-63	Capacitor 47pf 5%	Arco	DM15-470J				3		
11.	C13*	Capacitor 1000pf 1%	Arco	DM15-102F				1		
12.	C32	Capacitor 1500pf 5%	Arco	DM19-152J				1		
13.	C33	Capacitor 3900pf 5%	Arco	DM19-392J				1		
14.	C34	Capacitor 5000pf 5%	Arco	DM19-502J				1		
15.	C67-70	Capacitor .001uf	CRL	CE-102				4		
16.	C31	Capacitor .01uf 1%	IMB	RA2A103F				1		
17.	C28,52	Capacitor .018uf 1%	IMB	RA2A183F				2		
18.	C41,53,54,64-66	Capacitor .022uf 5%	CRL	UK25-223				6		
19.	C1	Capacitor .02uf 1000V	Sprague	5GAS20				1		
20.	C11,12,35-38	Capacitor .1uf 1%	IMB	RA2A104F				6		

*Factory Selected Part

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Vibration Monitor PC Board Assembly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION			MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
21.	C6-10,17,42	Capacitor	2.2uf	35V	Kemet	T353		7
22.								
23.	C14,15,19-21,24-27,30,39,40,43,	Capacitor	10uf	35V	Kemet	T353		21
24.	44,47-49,56,58, 59,60							
25.								
26.	C45,46,50,51,55, 57	Capacitor	100uf	6.3V	Kemet	T353		6
27.	C5	Capacitor	470uf	35V	Rubycon	TW470-35		1
28.	C3	Capacitor	2200uf	16V	Rubycon	TW2200-16		1
29.	C4	Capacitor	2200uf	35V	Rubycon	TW2200-35		1
30.								
31.	CR1-8,19	Diode				1N4005		9
32.								
33.	CR9-18,20-23, 25-28,29B,30,	Diode				1N914B		22
34.	31,33							
35.	CR32,34	Not Used						
36.	CR35	Jumper						
37.	L1	Inductor			Nytronics	SWD 100		1
38.	R3	Potentiometer	100 Ohm		Spectrol	63P-101		1
39.	R11,15	Potentiometer	2K		Spectrol	63P-202		2
40.	R2,8,12,13	Potentiometer	5K		Spectrol	63P-502		4

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Model 610B,E

Vibration Monitor PC Board Assemly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
41.	R7	Potentiometer 10K	Spectrol	63P-103		1
42.	R1,4,9,10,14	Potentiometer 20K	Spectrol	63P-203		5
43.	R5,16	Potentiometer 50K	Spectrol	63P-503		2
44.						
45.	R19,46,49,88,90, 105,120,123,201A	Resistor 39 Ohm 5%	R-Ohm	R25-390J		9
46.						
47.	R21,23,65	Resistor 1K 5%	R-Ohm	R25-102J		3
48.	R64,128,131,159	Resistor 2K 5%	R-Ohm	R25-202J		4
49.	R95-98	Resistor 3.6K 5%	R-Ohm	R25-362J		4
50.	R109,143,146	Resistor 4.7K 5%	R-Ohm	R25-472J		3
51.	R81,84	Resistor 5.1K 5%	R-Ohm	R25-512J		2
52.	R114	Resistor 6.8K 5%	R-Ohm	R25-682J		1
53.	R110,138	Resistor 10K 5%	R-Ohm	R25-103J		2
54.	R126,134	Resistor 16K 5%	R-Ohm	R25-163J		2
55.						
56.	R51,52,54,55,57, 61,62,72-75,80,	Resistor 20K 5%	R-Ohm	R25-203J		22
57.	107,127,130,132, 139,145,150-153					
58.						
59.	R200B	Resistor 20K 5%	R-Ohm	R25-203J		1
60.	R124,133	Resistor 27K 5%	R-Ohm	R25-273J		2

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Model 610B,E

Vibration Monitor PC Board Assembly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION			MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
61.	R117	Resistor	47K	5%	R-Ohm	R25-473J		1
62.	R87,113	Resistor	56K	5%	R-Ohm	R25-563J		2
63.	R89*	Resistor(Nominal)	56K	5%	R-Ohm	R25-563J		1
64.	R38	Resistor	75K	5%	R-Ohm	R25-753J		1
65.								
66.	R67,68,91,103, 112,125,129	Resistor	100K	5%	R-Ohm	R25-104J		7
67.	R45,47,119,121	Resistor	150K	5%	R-Ohm	R25-154J		4
68.	R147	Resistor	200K	5%	R-Ohm	R25-204J		1
69.	R99	Resistor	390K	5%	R-Ohm	R25-394J		1
70.	R100	Resistor	560K	5%	R-Ohm	R25-564J		1
71.	R26	Resistor	750K	5%	R-Ohm	R25-754J		1
72.	R22,36,102	Resistor	1M	5%	R-Ohm	R25-105J		3
73.	R44,118	Resistor	2.7M	5%	R-Ohm	R25-275J		2
74.	R28	Resistor	3M	5%	R-Ohm	R25-305J		1
75.	R25	Resistor	5.1M	5%	R-Ohm	R25-515J		1
76.								
77.	R77,148,149	Resistor	10M	5%	A-B	RCR07G 106JS		3
78.								
79.	R24,27	Resistor	22M	5%	A-B	RCR07G 226JS		2
80.	R115,116	Not Used						

*Factory Selected Part

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Model 610B,E

Vibration Monitor PC Board Assembly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION			MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
81.	R20,66	Resistor	464 Ohm	1%	Piher	PM25-4640		2
82.	R48	Resistor	1.5K	1%	Piher	PM25-1501		1
83.								
84.	R59,69,82,104, 111,122	Resistor	10K	1%	Piher	PM25-1002		6
85.	R141	Resistor	12.1K	1%		RN55D-1212F		1
86.	R37	Resistor	17.4K	1%		RN55D-1742F		1
87.	R142	Resistor	18.2K	1%		RN55D-1822F		1
88.								
89.	R78,79,83,92,93, 108,135-137,140, 161	Resistor	20K	1%	Piher	PM25-2002		11
90.								
91.	R33,53	Resistor	27.4K	1%		RN55D-2742F		2
92.	R94	Resistor	28.7K	1%		RN55D-2872F		1
93.	R50	Resistor	30.1K	1%		RN55D-3012F		1
94.								
95.	R40,56,71	Resistor	40.2K	1%		RN55D-4022F		3
96.	R32,85,106	Resistor	49.9K	1%	Piher	PM25-4992		3
97.	R58	Resistor	60.4K	1%		RN55D-6042F		1
98.	R63	Resistor	90.9K	1%		RN55D-9092F		1
99.	R35	Resistor	95.3K	1%		RN55D-9532F		1
100.								

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Model 610B,E

Vibration Monitor PC Board Assembly

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
101.	R29-31,34,42,60, 70,76,86	Resistor 100K 1%	Piher	PM25-1003		9
102.	R43	Resistor 130K 1%		RN55D-1303F		1
103.	R101	Resistor 196K 1%		RN55D-1963F		1
104.	R39	Resistor 301K 1%		RN55D-3013F		1
105.						
106.						
107.	IC1,2,6,9,10	Operational Amplifier	TI	TL084CN		5
108.	IC15	Timer	NS	LM555CN		1
109.	IC3-5,7,8,11-13	Quad Analog Switch	Motorola	MC14066bcp		8
110.	IC14	7 Segment Decoder	Motorola	MC14001bcp		1
111.						
112.	J1-3	Not Used				
113.						
114.	K1	Relay	Original	OUD-SS-124		1
115.						
116.	Q1	Transistor		2N4393		1
117.	Q2	Transistor		2N2222A		1
118.	XQ3	Transipad	Delbert Blinn	101-000-NY		1
119.						
120.	S1	Switch	Switch Craft	C56-206L2		1

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Vibration Monitor PC Board Assembly

Model 610B,E

PARTS LIST NO. 1215G

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
121.	T1	Transformer	EWC	DPC34-700P		1
122.	T2	Transformer	EWC	DPC12-800P		1
123.	TP6 & Up					A/R
124.						
125.	U1,5	Voltage Regulator	Motorola	MC7805CT		2
126.	U2	Voltage Regulator	Motorola	MC7815CT		1
127.	U3	Voltage Regulator	Motorola	MC7915CT		1
128.	U4	Voltage Regulator	Motorola	MC7905CT		1
129.						
130.						
131.	XAR1-8,XIC15	Socket 8 Pin	Wells	802-0081642		9
132.	XIC1-14	Socket 14 Pin	Wells	802-0141642		14
133.	XJ4-6	Not Used				
134.						
135.						
136.						
137.						
138.						
139.						
140.						

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DVM Indicator and Converter Assy

Sheet 1 of 2

PARTS LIST NO. 1599A

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY				
1.		DVM Indicator & Conv. Assembly	TTI	1599A		1				
2.		DVM Indicator & Conv. PC Board	TTI	1600			1			
3.		DVM Indicator & Conv. Schematic	TTI	1601A	Ref 1621C					
4.										
5.		Screw, 6-32 X 1/4 Panhead						2		
6.		Standoff, 6-32 X 5/8	H.H.Smith	8836				2		
7.		Screw, 6-32 X3/16 Flathead						2		
8.										
9.	DSR *	LED	AND	AND114R				*		
10.	XDSR *	LED Holder	AND	AND175R				*		
11.										
12.	R1,2	Resistor 20 Ohm 5%	R-Ohm	R25-200J				2		
13.	R3-5	Resistor 330 Ohm 5%	R-Ohm	R25-331J				3		
14.										
15.										
16.	U1,2	Digital Display	Hewlett Packard	HDSP-5521				2		
17.	U3	3 1/2 Digit A/D Converter	Intersil	ICL 7107cpl				1		
18.										
19.	XU1,2	Socket 20 Pin	CA	CA20STL-TSD	(Mod to 12 pin) (Mod to 15 pin)			4		
20.	XU3	Socket 40 Pin	Wells	802-7401642				1		

*Factory selected part, up to 4.

Form 1717

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DVM Accessory Assembly

Sh 1 2

PARTS LIST NO. 1602A

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY				
1.		DVM Accessory Assembly	TTI	1602A		1				
2.		DVM Accessory PC Board	TTI	1603			1			
3.		DVM Accessory Schematic	TTI	1604A	Ref 1621C					
4.										
5.										
6.	C1	Capacitor 100pf 5%	Arco	DM15-101J				1		
7.	C3	Capacitor .022uf	CRL	UK25-223				1		
8.	C4	Capacitor .047uf 1%	IMB	RA2A473F				1		
9.	C2	Capacitor .1uf 1%	IMB	RA2A104F				1		
10.	C5	Capacitor .22uf 1%	IMB	RA2A224F				1		
11.	C6-9	Capacitor 2.2uf 35V	Kemet	T353				4		
12.										
13.	R1,2	Potentiometer 2K	Spectrol	43P-202				2		
14.										
15.	R10,12-14	Resistor 330 Ohm 5%	R-Ohm	R25-331J	(R12 on bottom)			4		
16.	R6	Resistor 3K 5%	R-Ohm	R25-302J				1		
17.	R11,15,16	Resistor 4.7K 5%	R-Ohm	R25-472J				3		
18.	R17	Resistor 10K 5%	R-Ohm	R25-103J				1		
19.	R3,5	Resistor 100K 5%	R-Ohm	R25-104J				2		
20.	R9	Resistor 470K 5%	R-Ohm	R25-474J				1		

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DVM Accessory Assembly

Sheet 2 of 2

PARTS LIST NO. 1602A

FIND NO.	REFERENCE DESIGNATION	DESCRIPTION	MFG NAME OR CODE	ORIG MFG PART NO.	REMARKS	INDENTURED QTY PER ASSY
21.	R4	Resistor 2.49K 1%		RN55D-2491F		1
22.	R7	Resistor 10K 1%		RN55D-1002F		1
23.	R8	Resistor 90.9K 1%		RN55D-9092F		1
24.						
25.						
26.	Q1-3	Transistor		2N2222A		3
27.		Transipad	Delbert-Blinn	101-000NY		3
28.						
29.	U1	Voltage Regulator	Motorola	MC7805CT	(on bottom)	1
30.		Standoff, Swage	H.H.Smith	4263	(on bottom)	1
31.						
32.	VR1	Constant Current Diode	Analog Devices	AD589KH		1
33.						
34.						
35.	XJ1	Socket 16 Pin Hi Pro	CA	CA16S-TSD		1
36.		Socket 36 Pin	CA	CAS36P100-230-430*	(mod 1 pc 15 pin 1pc 12 pin)	1
37.						
38.						
39.		*on bottom.				
40.						

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This warranty is in lieu of all other warranties, express or implied, including (but not limited to) any implied warranties or merchantability or fitness for a particular purpose and in no case shall TTI liability exceed the original purchase price of the equipment

TERMS AND CONDITIONS

Payment Terms are 5% 10 days, N30 days.
All shipments are FOB Garden Grove, CA 92841.
All prices are in U.S. Dollars.
Credit Cards Accepted, Minimum Order of $50.00
Delivery of most units not in stock is 60 days ARO.
Calibration of all units is NIST Traceable and meets the requirements of ANSI/NCSL Z540-1, ISO 10012-1, and MIL STD 45662A.

Trig-Tek, Inc. provides CALIBRATION AND REPAIR service for ALL Trig-Tek, Inc. products. It is recommended that periodic calibration be performed on all instruments to assure proper operation and performance to manufacturers standards and specifications.

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