Established 1981
Advanced Test Equipment Rentals
www.atecorp.com 800-404-ATEC (2832)

WARRANTY

WARRANTY: IRD Mechanalysis, Inc. warrants that all products manufactured by it are free of defects in materials and workmanship for a period of one (1) year from date of original shipment. The liability of IRD Mechanalysis, Inc. shall be limited to furnishing, but not installing, necessary parts for repair of a proven defective product or, at the option of IRD Mechanalysis, Inc., to repair of a proven defective product at its plant in Columbus, Ohio USA or any authorized repair center providing the product is returned at Buyer's expense. Buyer's remedy shall be limited to the receipt of necessary parts or optional repair and IRD Mechanalysis, Inc. shall in no case be liable otherwise. All indirect or consequential damages are specifically excluded.

The foregoing warranty does not apply to products showing abuse or damage; to products which have been altered or repaired by others except as authorized by IRD Mechanalysis, Inc.; to products which have been subjected to a corrosive or abnormal atmosphere; nor to product components (such as batteries, lamps, etc.) which have provided a normal service life.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE WHATSOEVER.

No statement or recommendation made or assistance given by IRD Mechanalysis, Inc. or its representatives in connection with the use or installation of any product sold by IRD Mechanalysis, Inc. shall constitute a waiver of any provision hereof or affect the liability as herein set forth.

USE OF EQUIPMENT: The Buyer shall not have any claim against IRD Mechanalysis, Inc. for any loss or damage of any kind or nature which may be incurred by the Buyer resulting from the use of IRD Mechanalysis equipment including but not limited to the shutdown or interrupted operation of any of the Buyer's equipment which has been tested, or is in the process of being tested, or monitored, or in the process of being monitored by IRD Mechanalysis' equipment.

CLAIMS FOR LOSS OR DAMAGE IN TRANSIT: The risk of loss or damage in transit shall be on the Buyer, and IRD Mechanalysis, Inc.'s responsibility with respect to such loss or damage shall be to supply the buyer with copies of the shipping documents necessary for the Buyer to establish its ownership in the goods.

All products should be inspected and operationally tested immediately after receipt by the purchaser. Claims for damages occurring in shipment must be made at once with the shipping carrier or insuring agent as applicable.

At the request and expense of the Buyer, IRD Mechanalysis, Inc. will render the Buyer every assistance in obtaining any documents which are issued in the country of delivery and/or of origin and which the Buyer may require for the purpose of exportation or importation and, where necessary, for their passage in transit through another country.

The Buyer will pay all costs and charges incurred in obtaining the documents mentioned in the preceding Clause and will also bear the cost of all other documents including Certificates of Origin, Export and Import Licenses and Consular fees and will further bear any customs duties and taxes that may be levied, whether by reason of exportation, importation or for any other cause.

SERVICE AND REPAIR INFORMATION: The Buyer must notify IRD Mechanalysis, Inc. in advance when returning products, for either normal or warranty covered repair. Product model and serial number should be included, along with details on the nature of the problem or service desired. Subsequent instructions will denote address of authorized service facility or the IRD Mechanalysis factory to which product should be shipped. When returning electronic products, all standard accessory equipment such as Pickups, Stroboscopic Light and Interconnecting Cables must be included to insure thorough checkout or repair calibration. Products and accessories should be packaged for shipment using conventionally acceptable methods.

Normal or warranty covered service or repair may be obtained at the Buyer's facility for products or installed systems which are impractical to ship. Charges for bona fide warranty service or repair will be limited to transportation and subsistence expenses for field representative. Additional charges reflecting current service or repair rates and cost of parts and materials may apply, in full or in part, for cases when in the judgment of the representative full warranty coverage is not justifiable. These additional charges will be applicable in full for normal (non-warranty) service or repair.

This Contract shall be governed and construed in accordance with Ohio, USA Law.

11-1-77

TABLE OF CONTENTS

Page

I INTRODUCTION 1-1

II DESCRIPTION
- 2.1 General 2-1
- 2.2 Front Panel Indicators and the Printer/Plotter 2-2
- 2.3 Front Panel Controls and Switches 2-3
- 2.4 Side Panel Connectors, Switches and Fuse 2-7
- 2.5 Description of Standard Accessories 2-9
- 2.6 Optional Accessories 2-12

III PREPARATION FOR OPERATION
- 3.1 General 3-1
- 3.2 AC Power Cable Connection 3-2
- 3.3 Strobe Light Cable Connection 3-2
- 3.4 Accelerometer and Velocity Pickup Cable Connections 3-3
- 3.5 Non-Contact Pickup/Signal Sensor Cable Connections 3-4
- 3.6 Non-Contact Displacement Accessory Cable Connections. . . 3-5
- 3.7 Monitor Output Cable Connections 3-6
- 3.8 Model 308 Cable Connections. 3-9
- 3.9 Calibrator Cable Connections. 3-9
- 3.10 Instrument Startup Checks 3-9
- 3.11 Charging Circuit Operation. 3-12
- 3.12 Loading Chart Paper 3-12

IV OPERATION
- 4.1 General 4-1
- 4.2 Frequency Spectrum Analysis 4-1
- 4.3 Manual Spectrum Analysis 4-1
- 4.4 Automatic Spectrum Analysis 4-4
- 4.5 Diagnostic Analysis 4-6
- 4.6 Amplitude vs. Time Analysis 4-9
- 4.7 Model 880 Operation with Monitor Outputs 4-12
- 4.8 SPIKE ENERGY™ Signal Measurement and Analysis 4-13
- 4.9 Sound (Noise) Measurement and Analysis 4-17
- 4.10 In-Place Single Plane Balancing 4-19
- 4.11 In-Place Two Plane Balancing. 4-26

V SERVICE
- 5.1 General 5-1
- 5.2 Field Maintenance 5-1
- 5.3 Ordering Replacement Parts 5-2
- 5.4 Obtaining Service 5-2
- 5.5 Customer Service Agencies. 5-3

TABLE OF CONTENTS Continued

APPENDIX

		Page
A	Specifications	A-i
B	Guideline Vibration Severity Charts	B-i
C	Use of SPIKE ENERGY Signal to Detect Defects in Rolling Element Bearings and Gears	C-i
D	Single Plane and Two Plane Calculator Programs for HP Calculator Model 41/CV/CX, and Sharp Pocket Computers Models PC-1261 and PC-1350	D-i
E	Manual Backdating Information	E-i

INDEX TO ILLUSTRATIONS

Figure	Description	Page
2-1	Front Panel Details	2-1
2-2	Left-Hand Side Panel Details	2-7
2-3	Right-Hand Side Panel Details	2-8
2-4	Standard Accessories for Model 880	2-11
2-5	Optional Accessories for Model 880	2-13
3-1	970, 544, 560 Pickup Cabling Configuration	3-3
3-2	Signal Sensor Input Cabling	3-4
3-3	Non-Contact Displacement Accessory Cabling	3-5
3-4	Non-Contact Monitor Cabling Configuration	3-6
3-5	Model 5802, 5806 Monitor Cabling Configuration	3-7
3-6	Model 1224, 1225, 1229/UNICEL II Monitor Cabling Configuration	3-8
3-7	Broad Spectrum Test Plot	3-11
3-8	Chart Paper Loading Guide	3-13
4-1	Typical Vibration History Data Sheet	4-2
4-2	Broad Mode Frequency Signature	4-5
4-3	Example Diagnostics Plot/Printouts	4-7
4-4	Model 880 Amplitude vs. Time Plots	4-11
4-5	Example SPIKE ENERGY Plots	4-15
4-6	SPIKE ENERGY Signal Scope Output Display	4-16
4-7	Original Unbalance Readings	4-20
4-8	Unbalance Readings with Trial Weight Installed	4-22
4-9	Sample Vector Diagram	4-25

INDEX TO TABLES

4-1	Units Selector Setting for Monitor Inputs	4-12
4-2	Linear Scale to dB Equivalence	4-18

I INTRODUCTION

The IRD Model 880 Spectrum Analyzer/Dynamic Balancer is a portable instrument designed for industrial use in detecting and resolving machinery vibration problems. Using the Model 880, an operator can perform many analysis techniques that are essential to obtain comprehensive vibration data. Also, precision in-place balancing can be performed using the Single Plane or Two Plane method.

The 880 instrument provides a number of features which simplify vibration analysis. The built-in printer/plotter generates complete vibration spectrum signatures from 600 to 600,000 CPM (10 Hz to 10,000 Hz) or from 60 to 60K CPM (1 Hz to 1,000 Hz). A 90-foot roll of plot paper will provide approximately 90 Broad or 60 Sharp spectrum plots. This instrument is fully microprocessor controlled, and automatically prints the setup settings used, respectively, on all plots that are generated. The plots are fully annotated with engineering units, filter bandwidth, and the full-scale amplitude and frequency scale values used. The overall (filter out) signal amplitude is sampled during the header line printing. This amplitude, along with the minimum and maximum vibration amplitude variation, are then printed. (In the TIME mode, at the completion of a plot, the minimum, average, and maximum amplitudes measured during the plot are printed.)

A unique form of vibration analysis can be performed by using the Diagnostics function. In this function, the first 16 peaks having amplitudes above 15% of the full-scale value are logged and are printed in tabular form following the spectrum plot (see explanation in Chapter 4). If RPM is displayed on the LCD, the Diagnostics printout will list selected RPM multiples and sub-multiples plus corresponding diagnostic causes of the vibrations. By analysis of the tabular information provided, and relating to corresponding diagnostic causes shown in the printout, the sources of the vibrations can be readily identified.

In addition to frequency signature analysis, the 880 instrument is capable of two other modes of operation. The first is the plotting of the overall amplitude vs. time. This can be extremely valuable during machine startup and coastdown to identify criticals, natural frequencies, resonances, and beats. The second capability involves plotting SPIKE ENERGY™ signal amplitude vs. time, which provides a hard copy record of the mechanical condition of rolling element bearings and gears. The special SPIKE ENERGY signal circuits detect ultrasonic energy bursts caused by microscopic defects in bearings and gears, and provide the operator with advanced warning of deterioration in these machine components.

To aid in balancing, the Model 880 includes function pushbuttons for generating Single Plane and Two Plane balancing formats on the built-in plotter/printer. These formats consist of a series of prompting messages which lead the operator through the proper balancing procedures in a step-by-step fashion. The formats also include item numbers along the edge of the printout which correspond to data entry points in calculator programs. The balancing information recorded on this printout should then be entered into the proper program for performing the balancing calculations.

The Model 880 uses analog Amplitude and Frequency meters to aid in interpreting vibration characteristics. Also, a digital LCD provides a high-accuracy readout of the frequency to which the filter is tuned, the vibration frequency, and the vibration amplitude. The switch settings, operating mode, and other types of indications are displayed on the LCD along with the numerical reading.

SPIKE ENERGY™ is a trademark of IRD MECHANALYSIS, Inc.

Other features of the Model 880 instrument include:

- A built-in sealed lead acid battery pack and internal charger.
- A built-in storage compartment for the Strobe Light and other accessories.
- Switch selectable English or Metric operation.
- Averaging in SPIKE ENERGY (g's SE) units.

The Model 880 is an excellent instrument for predictive maintenance programs in which periodic signature checks are desirable for critical machines. These signature checks, rather than overall (i.e., Filter Out) checks, enable a closer watch to be maintained and more advanced warning given of any change in the machine condition. The Model 880 is also useful for establishing "baseline" signatures, or for post-repair checks to verify that proper machine operation has been restored.

NOTE: This manual is updated to the configurations of the Model 880 instruments with Serial Number Prefix Letter U. See Appendix E for backdating information for the 880 instruments with Serial Number Prefix Letters ranging from A through T.

II DESCRIPTION

2.1 GENERAL

This chapter provides detailed descriptions of the instrument controls, indicators, and connectors. The descriptions for these items are listed in the following sections: Front Panel Indicators and the Plotter/Printer, Front Panel Controls and Switches, and Side Panel Connectors, Switches and Fuses. The Optional and Standard Accessories for the Model 880 are also described in this chapter. Specifications for the Model 880 are listed in **Appendix A.**

The front panel layout of the 880 instrument is shown below in Figure 2-1.

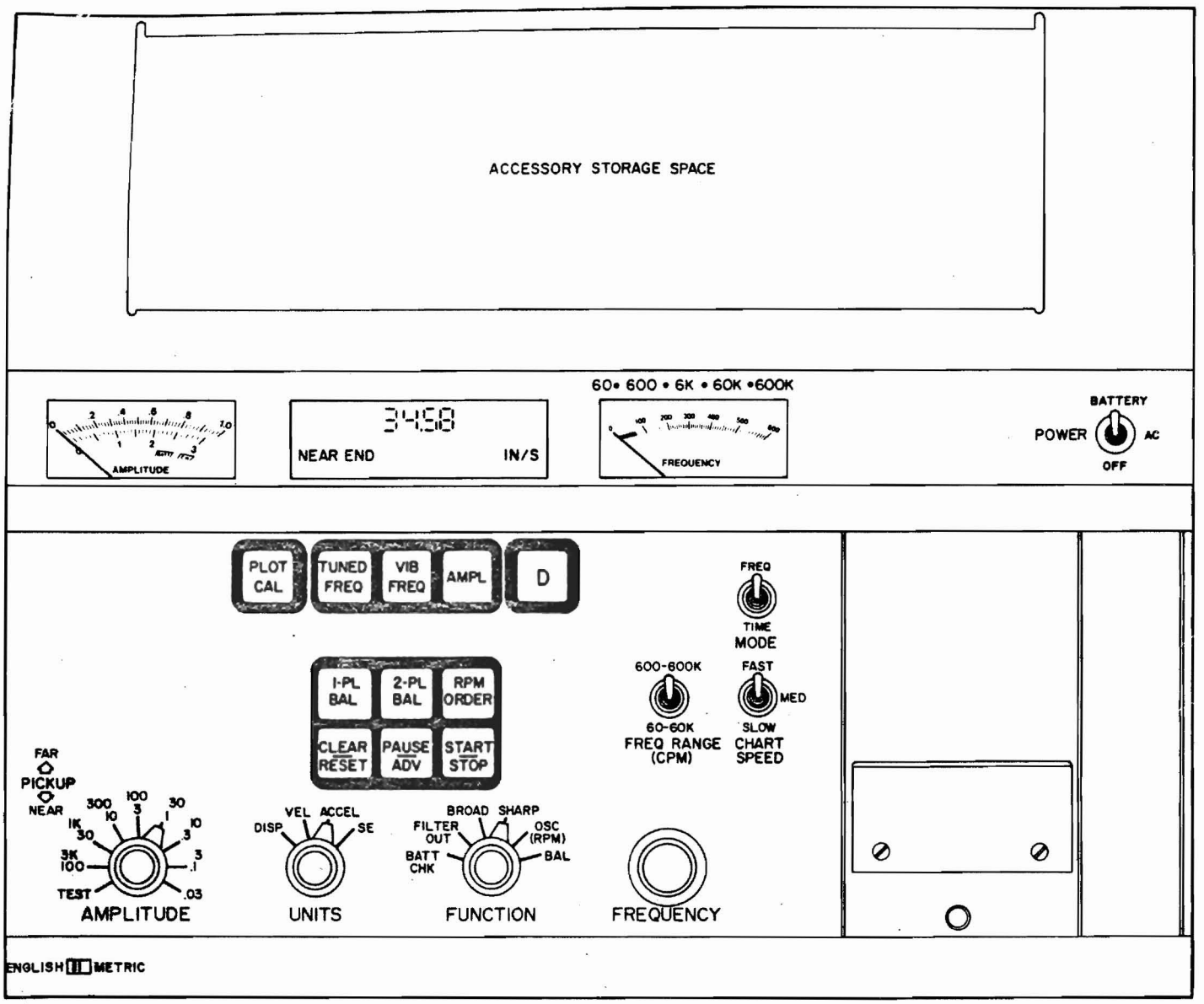
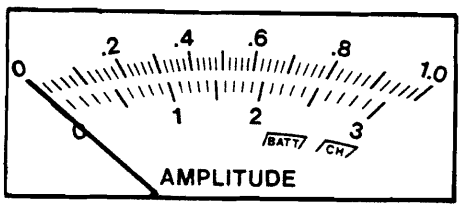


FIGURE 2-1 MODEL 880 FRONT PANEL DETAILS

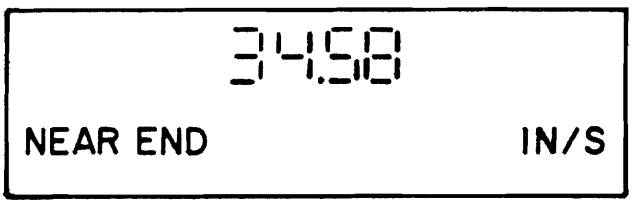
2.2 FRONT PANEL INDICATORS AND THE PRINTER/PLOTTER

AMPLITUDE METER



The **Amplitude** meter is used as an aid for interpreting vibration characteristics. Using this analog meter, beat frequency vibrations can be identified, and amplitude peaks can be quickly located. The meter displays the overall vibration signal strength in the FILTER OUT mode and the amplitude of filtered signals in the BROAD, SHARP or BALANCE modes. The amplitude is measured in displacement, velocity, acceleration, or SPIKE ENERGY units. The meter also provides an indication of the charging circuit operation and the battery charge level. In OSC function the meter indicates zero.

LCD DISPLAY
(Liquid Crystal Display)

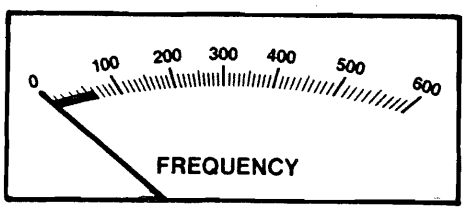


The **LCD** meter is an alpha-numeric display that reads out the precise frequency and amplitude values necessary for proper vibration analysis and balancing. The numeric display mode is controlled by the **TUNE FREQ, VIB FREQ,** or **AMPL** pushbuttons. The **LCD** also displays the following information:

- units of amplitude selected ("MILS", etc.)
- mode of measurement selected ("TUNE", etc.)
- low battery charge level warning ("LO BAT")
- vibration pickup selection ("NEAR END" or "FAR END")
- RPM data entry indication ("RPM")
- diagnostics mode operational ("d")

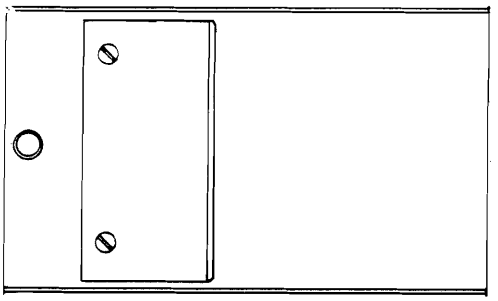
FREQUENCY METER AND RANGE INDICATORS

60• 600 • 6K • 60K •600K



The **Frequency** meter allows rapid filter tuning to a specific frequency and aids in analyzing vibration characteristics. Depending on the mode of operation, the meter indicates the dominant vibration (Filter Out) frequency or the frequency of any signals passed by the filter. In the OSC mode, the frequency that the filter is tuned to is indicated. Signal frequencies from 60 to 600,000 cycles per minute (CPM) may be measured, and the decade range over which the meter indicates is identified by a lit LED above the meter. The operation of the LED Range Indicators is controlled by the Frequency Tune control and the Frequency Range selector switch.

DIGITAL PLOTTER



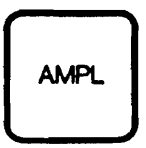
The built-in printer/plotter enables complete spectrum analysis to be provided automatically. Fully annotated frequency or time base plots are switch selected, and the time signature plots may be generated at three chart speeds. In addition, a Diagnostics printout and single or two plane balancing programs with prompting instructions can also be generated. The chart paper roll is accessible when the cover over the printer is removed.

2.3 FRONT PANEL CONTROLS AND SWITCHES

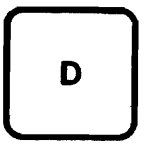
The **PLOT CAL** (or EVENT MARKER) pushbutton is used in Filter Out plotting in Displacement, Velocity, Acceleration, or SPIKE ENERGY to mark the plot at important points of interest. A short line is printed at the left edge of the plot each time this switch is pressed.

The **TUNED FREQ** pushbutton is pressed to display the frequency to which the filter is tuned on the LCD.

Depressing the **VIB FREQ** pushbutton in the Filter Out mode causes the **LCD** to display the dominant vibration frequency for either the 60 to 60K CPM range or the 600 to 600K CPM range. In the BROAD, SHARP, or BALANCE modes, the actual frequency of the signal passing through the filter will be displayed. If OSC is selected, the frequency of oscillation is displayed.



Depressing the **AMPL** pushbutton causes the **LCD** to display the overall vibration amplitude in the Filter Out mode. In the BROAD, SHARP or BALANCE modes, the amplitude of the signal passing through the filter will be displayed. If OSC is selected, the LCD is extinguished.



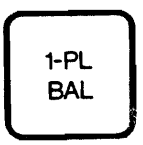
Depressing the **D** (Diagnostics) pushbutton sets up the instrument to analyze the next frequency signature to be generated. A "**d**" indication is displayed on the LCD when the Diagnostics function is operational. When the frequency signature is plotted, a tabular diagnosis is then printed which lists the probable causes of the vibrations, along with the vibration amplitude at selected multiples of the shaft RPM. The Diagnostics feature utilizes an entered RPM value to perform the analysis. The **D** pushbutton must be reset each time a diagnostic printout is desired.

Depressing the **RPM ORDER** pushbutton causes the reading on the LCD to be entered into the instrument memory as the shaft RPM value. When this occurs, an "**RPM**" indication will be displayed on the LCD. Each frequency and time signature that is generated by the built-in plotter will then list the entered RPM value on the printout heading. In addition, the locations of the first ten orders (harmonics) of the RPM frequency will be indicated with tick marks on the frequency spectrum printouts.

The **START/STOP** pushbutton is used to control the operation of the built-in printer/plotter. Depressing the pushbutton twice in succession will cause the plotting to start from the frequency to which the filter is tuned. After the headers have been printed, depressing the pushbutton again will stop the plot. Each time the plot is then started, the built-in plotter will print new headers on the strip chart. The **START/STOP** pushbutton is also used to restart an interrupted plot from the pause mode.

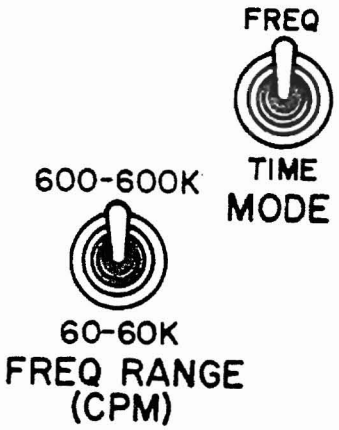
The **PAUSE/ADV** pushbutton controls the operation of the built-in plotter or external analog recorder. The paper advance mechanism is also activated with this pushbutton. Depressing the pushbutton once will cause the frequency signature, or time signature plots to pause. The plots are restarted by depressing the **START/STOP** pushbutton. The printer paper may be advanced anytime the plotter is not functioning by depressing the **PAUSE/ADV** pushbutton. The pushbutton may then be held as long as necessary to advance the paper.

The **CLEAR/RESET** pushbutton is used to terminate a one or two plane balancing program that is in progress. The balancing programs are then reset and will start from the beginning if the **1-PL** or **2-PL** pushbuttons are depressed. Depressing the **CLEAR/RESET** pushbutton also clears any RPM value stored in the instrument memory. When this occurs, the "**RPM**" indication on the LCD will extinguish. In addition, the pushbutton is used to clear the PLOT /CAL signal readings from the analog meters, and to cancel the Diagnostics printout.



The **1-PL BAL** pushbutton is used to generate a single-plane balancing format. The built-in plotter will print out prompting instructions which direct the operator through the proper series of steps for balancing a rotor. The format contains space for writing in the requested information, and at each step the printout pauses and must be restarted by depressing the **1-PL** pushbutton. The format includes important information at various stages to assist the operator in making the needed calculations. In addition, sequence numbers are printed along the chart paper to guide the operator in entering data into a calculator which is programmed to solve single-plane balancing equations.

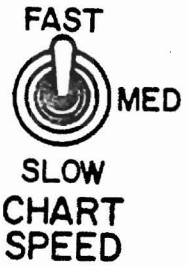
The **2-PL BAL** pushbutton is used to generate a two-plane balancing format. The format is printed out by the built-in plotter, and is similar to the **1-PL BAL** format. The printout provides prompting instructions and other information necessary to guide the operator through the two-plane balancing sequence.

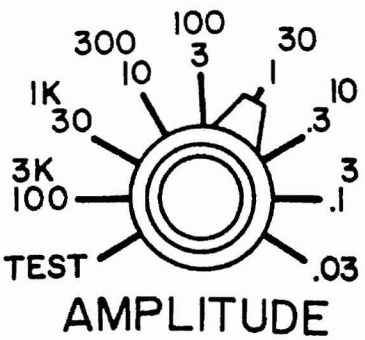


The **MODE** switch is used to select either a Frequency Plot or a Time Base plot.

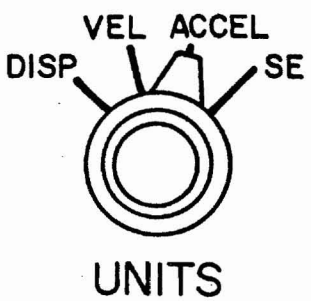
The **FREQ RANGE** selector switch controls the frequency band over which the filter will tune. The low band extends from 60 to 60K CPM and the high band extends from 600 to 600K CPM. The selector switch also controls the range of the **VIB FREQ** reading on the LCD, and the range of frequencies that are plotted.

The **CHART SPEED** switch is used to control the printer/plotter print rate when the TIME mode is used.



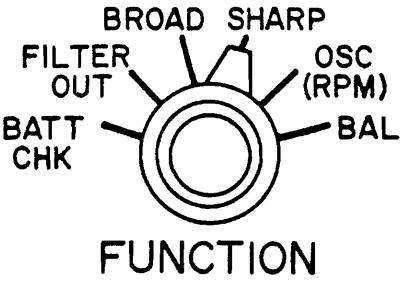


The **AMPLITUDE** selector is used to set up the full-scale amplitude range or to select the **TEST** mode. Eight overlapping ranges are provided. In English measure, full-scale values of .03 to 100 are selectable in units of mils pk-pk, inches per second pk, g's pk, or gSE. In metric measure, full-scale values of 1 to 3K are selectable in units of micrometers pk-pk, millimeters per second pk, g's pk, or gSE. The **red** numerals on the Amplitude control are to be used only when measuring in units of um and mm/s. For all other units (mils, in/s, g, gSE) the **black** numerals are used. The TEST position is used to test the operation of the instrument filter and other circuits. When the **POWER** switch is set to **BATTERY**, a 120 CPM or 1200 CPM internal test signal is generated. If the POWER switch is set to **AC**, the test signal has the same frequency as the AC input voltage, which is typically 3600 CPM (60 Hz) or 3000 CPM (50 Hz).



The **UNITS** selector is used to set up the input circuits for the type of pickup and units of measure. The units of measure for the mode used is indicated on the LCD display when the **AMPL** pushbutton is depressed. The units indicated on the display may be of English or metric measure, depending on the setup of the **ENGLISH/METRIC** switch. The pickups that may be used for the various units selected are described as follows:

UNITS	PICKUP TYPE	MEASURE
DISPLACEMENT	NCPU, 544, 560, 970	mils (micrometers metric)
VELOCITY	Model 544, 560, 970	in/sec (mm/sec metric)
ACCELERATION	Model 970	g's
SPIKE ENERGY	Model 970	gSE



FUNCTION

The **FUNCTION** selector is used to select the operation mode of the filter circuit and to check the condition of the internal battery. The FILTER OUT position is used to provide an unfiltered (overall) amplitude measurement of the vibration spectrum. The dominant vibration frequency and amplitude values are indicated on the analog meters and the LCD.

The BROAD, SHARP, and BAL positions are used to observe individual frequency components of the vibration signal. Each position provides filtering with a different degree of tuning selectivity. The BROAD mode bandwidth is 10% of the tuned frequency, and provides faster plotting. The SHARP mode bandwidth is 5% of the tuned frequency, and is used for detailed analysis of frequency peaks. The BAL mode bandwidth is 2.8% of the tuned frequency, and provides the tuning precision necessary for balancing.

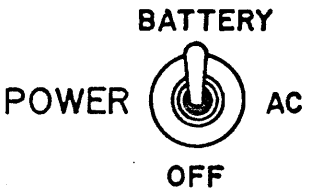
The OSC position is used to flash the strobe light at the frequency to which the filter is tuned. This mode is used for balancing, and for determining the correct RPM value needed to generate a Diagnostics printout. By properly adjusting the **FREQUENCY** tune control, the strobe light will freeze a rotating shaft when the flash rate is equal to the rotation speed of the shaft or other part.

The BATT CHK position is used to test the condition of the internal batteries. If the **POWER** switch is set to BATTERY, the Amplitude meter reading will indicate the condition of the battery.

FREQUENCY

The **FREQUENCY** tune control adjusts the filter tuning in all FUNCTION switch modes except BATT CK. The control is used to manually tune the instrument to a desired frequency peak or a balancing RPM value. The filter is tunable over four decade ranges. The upper three decades or the lower three decades are selected using the **FREQ RANGE** selector. The nominal frequency to which the filter is tuned is indicated on the LCD when the **TUNE FREQ** pushbutton is depressed. Also, the LED range indicators identify the decade range to which the filter is tuned.

The **ENGLISH/METRIC** switch is used for setting up the instrument to either English or metric units of measure. The appropriate units of amplitude for either setup will be indicated on the LCD display.



The **POWER** switch is a 3-position toggle switch used to connect battery or AC power to the instrument circuits. In the **AC** or **BATTERY** position, and with the AC power input cable connected to the instrument, a trickle charge current is supplied to the internal battery. The battery is thus kept at a high level of charge while the instrument is being operated. A depleted internal battery will receive full charge current when the POWER switch is set to **OFF** and the instrument is connected to AC power.

2.4 SIDE PANEL CONNECTORS, SWITCHES, AND FUSE

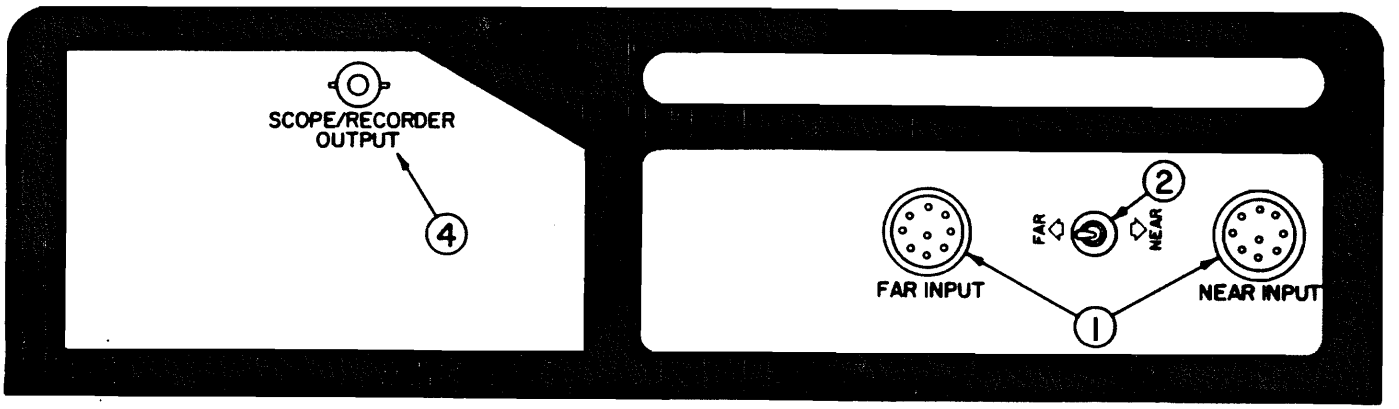


FIGURE 2-2 LEFT-HAND SIDE PANEL DETAILS

1) **VIBRATION INPUT CABLE CONNECTORS** (Fig. 2-2, Ref. 1)

Two VIBRATION PICKUP CONNECTORS are located on the left side panel, and are labeled FAR INPUT and NEAR INPUT. Each connector consists of a female twist-lock receptacle for installing the appropriate vibration pickup input cable.

2) **PICKUP SELECTOR** (Fig. 2-2, Ref. 2)

The PICKUP SELECTOR switch is located on the left-hand side panel between the VIBRATION PICKUP receptacles. The switch is used to connect the instrument input circuits to the selected vibration input receptacle (Near or Far).

3) **SCOPE/RECORDER OUTPUT CONNECTOR** (Fig. 2-2, Ref. 4)

The SCOPE/RECORDER output connector is located on the left-hand side panel. The BNC-type connector is used for the connection of an oscilloscope or a recorder/analyzer to the 880 instrument. Filtered or unfiltered output signals are provided, depending on the mode of the FUNCTION switch. Full-scale output voltage of 764 Mv RMS, with a source impedance of 150 ohms. The center pin of the BNC connector is the signal line, and the shell is grounded.

4) **AC INPUT SELECTOR SWITCHES** (Fig. 2-3, Ref. 2)

Two AC INPUT SELECTOR switches are located on the right-hand side panel. These switches must be set up to the positions corresponding to the value of the AC power input voltage connected to the instrument. Four input voltage ranges are provided, and the slide switch set-up positions for each range are shown on the panel.

CAUTION: Make certain that the AC INPUT SELECTOR switches are correctly positioned for the AC voltage range to be used before installing the AC Power Cable.

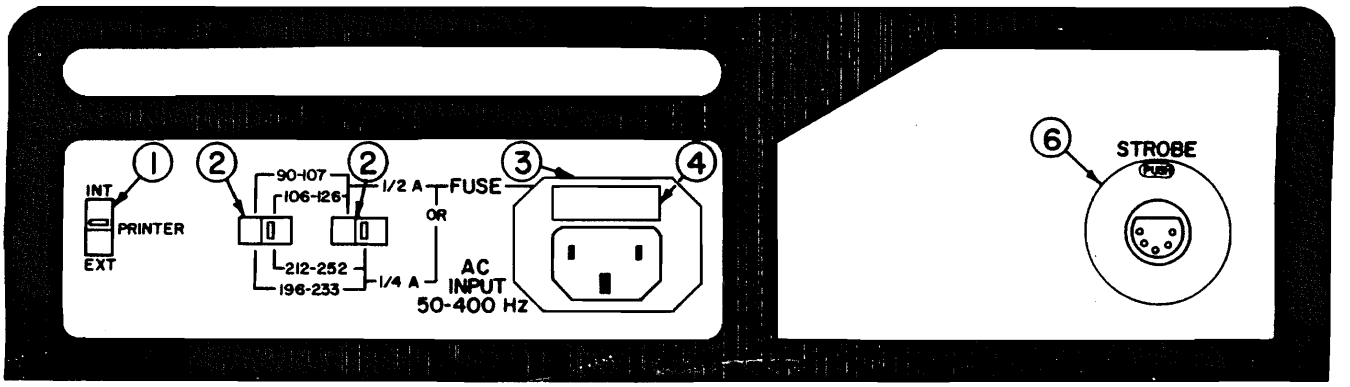


FIGURE 2-3 RIGHT-HAND SIDE PANEL DETAILS

5) **AC INPUT POWER RECEPTACLE** (Fig. 2-3, Ref. 3)

The AC INPUT POWER receptacle is an international standard 3-contact male connector (Belden No. 17252). The connector is rated for 15 amperes at 125 volts, or 6 amperes at 240 volts, and is designed for connection of 100, 120, 220, or 240 volts, 50 to 400 Hz single phase voltage using the AC Power Cable. Cable Part No. 19643 is supplied with instruments intended for connection to 90 to 132 volts AC.

6) **AC POWER FUSE** (Fig. 2-3, Ref. 4)

The AC Power Fuse is mounted in the fuse clip located above the INPUT POWER receptacle. This fuse protects the analyzer circuits from the AC power line voltage. A spare fuse is contained in the enclosed portion of the clip. A **1/2-ampere,** 3AG, Slo-Blo fuse, Part No. 28579 is used for 90 to 110 and 108 to 132 volts operation. A **1/4-ampere,** 3AG Slo-Blo fuse, Part No. 28578 is used for 198 to 242 and 216 to 264 volts operation.

CAUTION: Before installing the power cable, make sure that the line voltage and frequency are correct for the analyzer, and that the Input Selector Switches are set up as instructed in Section 3.2. Also, do not use a higher amperage fuse than specified, as serious damage to the instrument may result.

7) **STROBE LIGHT CONNECTOR** (Fig. 2-3, Ref. 6)

The STROBE LIGHT connector is located on the right-hand side panel, and is used for connecting the Model 571 Strobe input cable to the 880 instrument. The connector consists of a 5-pin spring-lock female receptacle. The strobe cable connector is disconnected from the instrument receptacle by pressing the "PUSH" tab and pulling the connector. **NOTE:** Only the Model 571 Strobe Light is to be used with the 880 instrument.

2.5 DESCRIPTION OF STANDARD ACCESSORIES

1) POWER INPUT CABLE (Fig. 2-4, Ref. 1)

The POWER INPUT CABLE is 10 feet (3.03 meters) in length, and connects the external AC power source to the Model 880. Analyzers designed for connection to 90 to 132 volts AC are supplied with cable P/N 19643. This 3-wire cable has an international standard female connector at one end, and a U.S.A. standard male connector at the other end.

2) ACCELEROMETER MODEL 970 (Fig. 2-4, Ref. 2)

The MODEL 970 ACCELEROMETER, P/N 19697, is a vibration transducer that is used to measure vibration acceleration, velocity, displacement, or SPIKE ENERGY units. This transducer provides an extended frequency range, and will withstand considerable physical shock (see **Appendix A** for Specifications). The Model 970 can be used in any position without a reduction of sensitivity or accuracy. It is sensitive only to the vibration along the long axis, and can be permanently mounted to a rotating machine using the 1/4-28 by 1/4 inch threaded hole, or held to any flat surface of the machine by a magnetic pickup holder, P/N 04332.

3) ACCELEROMETER PICKUP CABLE (Fig. 2-4, Ref. 3)

The ACCELEROMETER PICKUP CABLE, P/N 20431, is 12 feet (3.64 m) in length and connects the Model 970 input signal to the analyzer. This cable also connects a DC supply voltage from the instrument to the internal amplifier of the pickup. The twist-lock cable connector is installed at the **NEAR** or **FAR** twist-lock receptacle on the left side panel of the instrument. The threaded connector at the pickup end of the cable connects to the receptacle on the accelerometer.

If an extension of the cable is required, interconnect the standard cable and an optional extension cable to the accelerometer receptacle. Two lengths of optional extension cables are available: 25 feet P/N 21044, and 50 feet P/N 21048. Any combination of the three cables can be used to provide cable lengths of 12, 37, 62, 87 or 112 feet.

4) STRAIGHT PROBE (Fig. 2-4, Ref. 4)

The 9-inch STRAIGHT PROBE, P/N 01103, is used with the accelerometer for hand-held measurement in displacement, velocity, acceleration or SPIKE ENERGY units. The probe enables the measurements to be obtained at difficult places, and its use is standard for analyzing the SPIKE ENERGY signals. The probe fastens to the flat end of the accelerometer using the 1/4-28 by 1/4 inch threaded hole.

5) STROBE LIGHT (Fig. 2-4, Ref. 5)

The Model 571 STROBE LIGHT, P/N 28830, flashes once per RPM up to the frequency of 15,000 CPM, and then provides sub-multiple firing up to 600,000 CPM. The 2-position slide switch controls the power to the unit.

6) STROBE LIGHT CABLE (Fig. 2-4, Ref. 6)

The STROBE LIGHT CABLE supplied is 12 feet (3.7 meters) long, and is connected to the strobe light receptacle. Replacement cables, P/N 28836, are available from IRD MECHANALYSIS. Two cables can be connected in series to provide additional length.

7) PRINTER CHART PAPER

One 82 foot (25 m) roll of thermal CHART PAPER is provided. This paper is specially designed for use with the 880 instrument.

CAUTION: To avoid possible damage to the printer, only IRD Chart Paper (P/N 24444) should be used.

8) OPERATOR MANUAL (Fig. 2-4, Ref. 8)

The OPERATOR MANUAL, P/N 28838, provides complete instructions for setup and operation of the analyzer. Additional copies of this manual are available from IRD MECHANALYSIS.

9) SELF-STUDY TRAINING MODULE (not illustrated)

The Self-Study Training Module, Part No. 29177, consists of a Workbook, a set of color slides, a slide carousel, and two cassette tapes. The tapes are keyed to the color slides. One tape contains an audible cuing signal at each slide change point, and the other tape contains a 1000 Hz synch pulse of each change point for automatic slide changes.

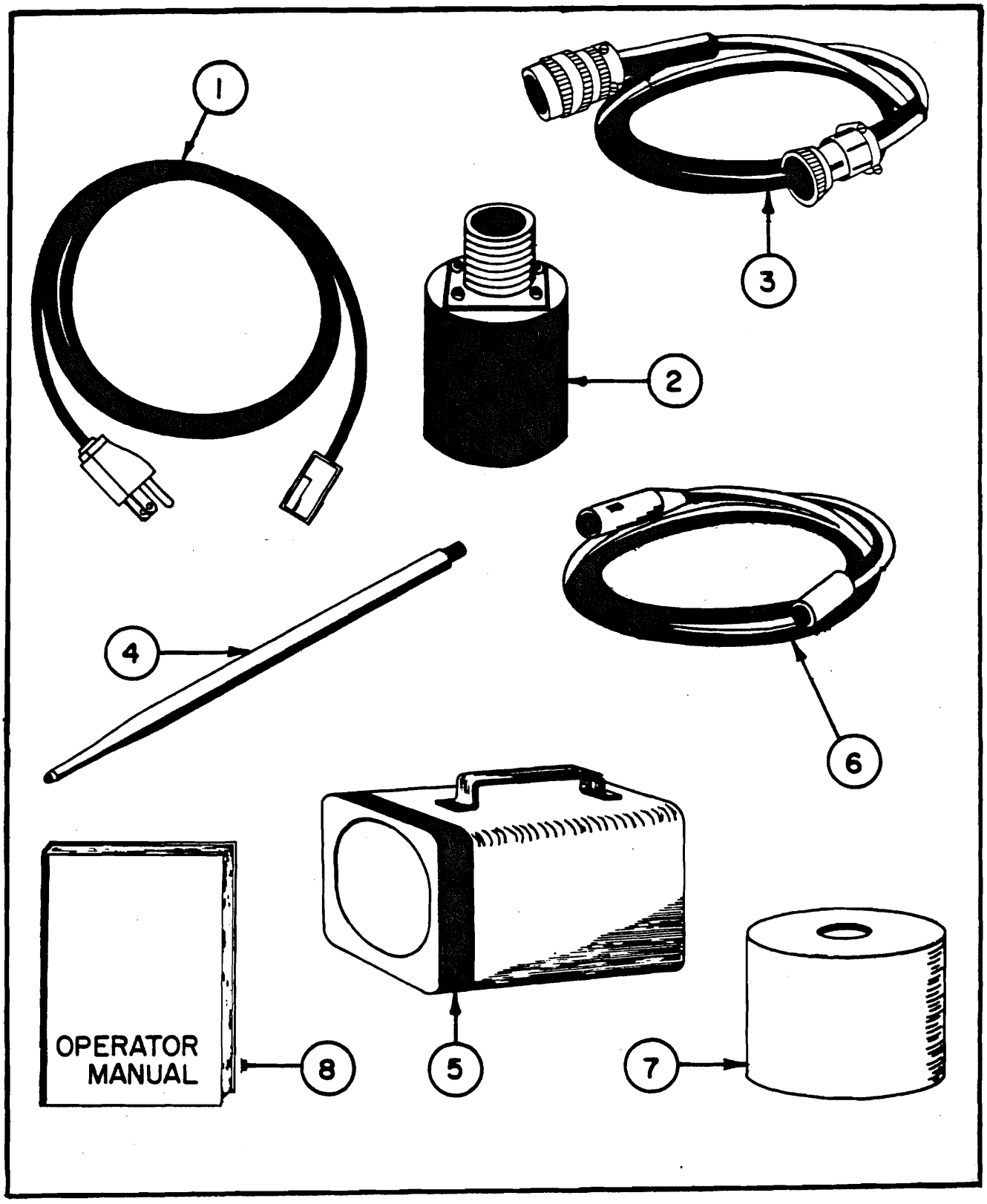


FIGURE 2-4 STANDARD ACCESSORIES FOR MODEL 880 INSTRUMENT

2.6 OPTIONAL ACCESSORIES

The OPTIONAL ACCESSORIES which are available for use with the Model 880 Analyzer/Balancer are shown in Figure 2-5, Page 2-13.

The following **Optional Accessories** are illustrated in Figure 2-5:

A. **Accessory Case** - P/N 25345.
B. **Chart Paper** - One (1) lot (48 rolls per lot), sold only by lot, P/N 24444.
C. **Calibrator** - P/N 21073.
D. **Vibration Chart Storage Notebook** - with 50 filler sheets, P/N 25864.
E. **Extra Notebook Filler Sheets** - pack of 100, P/N 25865.
F. **Velocity Transducer** - Model 544, P/N 4526.
G. **Pickup Cable** for Model 544 - 12-foot (3.7m), P/N 20433.
H. **Extension Pickup Cable for Model 544** - 25-foot (7.6m), P/N 21045.
I. **Extension Pickup Cable for Model 544** - 50-foot (15.2m), P/N 21049.
J. **Magnetic Pickup Holder for Model 544 or Model 970** - P/N 04332.
K. **Magnetic Shield for Model 544** - P/N 10449.
L. **Extension Cable for Model 970** - 25-foot (7.6m), P/N 21044.
M. **Extension Cable for Model 970** - 50-foot (15.2m), P/N 21048.
O. **Velocity Transducer, Low Frequency, Model 560** - P/N 24957.
P. **Pickup Cable for Model 560,** 12-foot (3.7m) - P/N 25136.
Q. **Extension Cable for Model 560,** 25-foot (7.6m) - P/N 25137.
R. **Extension Cable for Model 560,** 50-foot (15.2m) - P/N 25138.
S. **Cable,** Non-Contact Monitor Output with a BNC connector for connection to Model 880, 12-foot (3.7m) - P/N 24809.
(Monitor output sensitivity of 200 mv/mil or 8 mv/u m is required).
T. **Vibration/Sound Level Meter,** Model 308.
U. **Non-Contact Displacement Accessory, Single Channel,** (403 type) - P/N 29093.
V. **Non-Contact Displacement Accessory, Dual Channel,** (403 type) - P/N 29094.
W. **Extension Cable for Strobe Light,** 12-foot (3.7m) - P/N 28836.
X. **Cable for Non-Contact Signal Sensor** - with power lead and 3 spade lugs, 12-foot (3.7m) - P/N 29030.

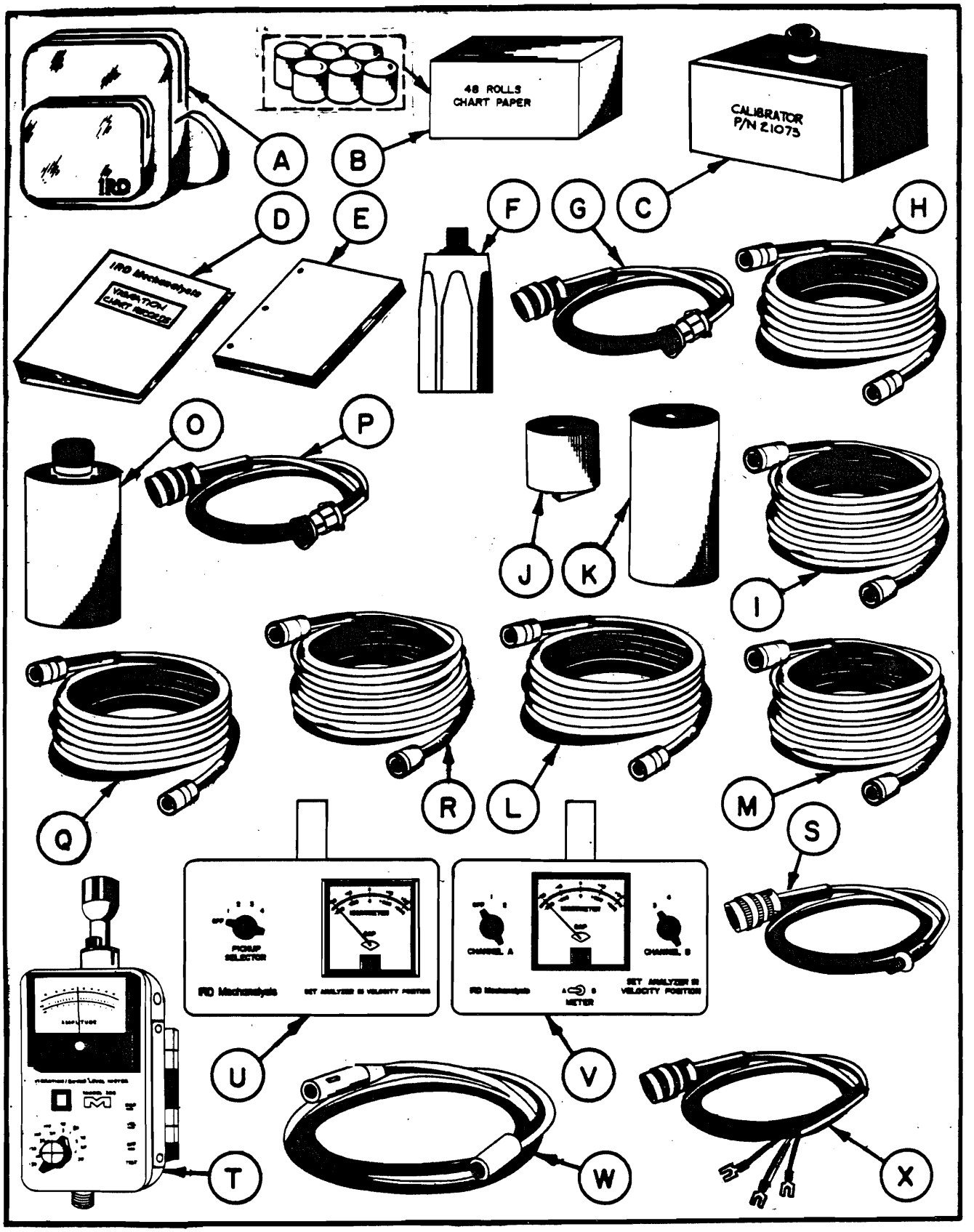


FIGURE 2-5 OPTIONAL ACCESSORIES FOR MODEL 880

III PREPARATION FOR OPERATION

3.1 GENERAL

This chapter describes the procedures for setting up the Model 880 instrument for operation. These procedures include instructions for connecting the pickups, monitors and other accessories, checking the instrument operation, and testing the battery condition and the charging operation. Instructions are also included for setup of the printer/plotter.

IMPORTANT:

Four methods are commonly used to hold transducers/pickups to rotating machines for vibration measurement, as discussed below. The measurement parameters Displacement, Velocity, Acceleration and SPIKE ENERGY are affected differently, although the comments given below apply to all parameters. Some holding methods provide greater accuracy than others; however, the most important consideration is to understand the limitations of each holding method (see the AVT Manual for details), and then select the most practical method for your measurements, and use this method consistently.

- Stud Mounting: This method is used for permanent installation of pickups, and is ideal for all vibration measurement parameters, because it yields optimum measurement accuracy and consistency. However, this method is generally not used for multi-point vibration measurements because of the mounting time required, or inaccessibility.

- Hand-Holding Without 9-Inch Probe: Although this method is faster than others, it is not recommended for the following two reasons: (1) No two persons can hold a pickup with equal or consistent pressure; (2) Very often, a pickup must be held to an uneven machine surface, and since machines always vibrate, it is very difficult to prevent the pickup from chattering or moving when hand-held.

- Hand-Holding With 9-Inch Probe: This method is often useful to access to difficult positions on the machine, or to perform a series of rapid measurements about the machine. The measurements can be performed with reasonable accuracy as long as the pickup is held with equal pressure. However, to perform vibration measurements where long plot times are required, holding the pickup/probe with even pressure for an extended amount of time may prove difficult.

- Holding With Magnetic Pickup Holder: This method provides reasonable accuracy. The pickup can be mounted quickly to flat or uneven places on the machine. Except for mounting at inaccessible places on the machine, the magnetic holder is recommended for all vibration measurements made with the Model 880 instrument. Magnetic Holder, I/N 04332 is used with the Model 544 and 970 Vibration Pickups.

3.2 AC POWER CABLE CONNECTION

Connect the female plug-in connector of the AC Power Cable to the AC INPUT power receptacle on the right side panel of the Model 880 instrument. Connect the 3-prong male connector at the opposite end to the fused AC power line of the proper voltage (90 to 264 volts, single phase, 50 to 400 Hz.)

CAUTION: Before connecting the AC power to the Model 880 instrument, make certain that the AC voltage supply is correct for the analyzer, and that the POWER INPUT SELECTOR switches are correctly set to the positions marked for the AC voltage to be used. Also, make sure that the AC POWER FUSE has the proper rating for this AC voltage.

3.3 STROBE LIGHT CABLE CONNECTION

Connect the male spring-lock connector of the Strobe Light Cable to the STROBE input receptacle on the 880 instrument. Then connect the female connector at the opposite end of the cable to the spring-lock receptacle on the Model 571 Strobe Light unit.

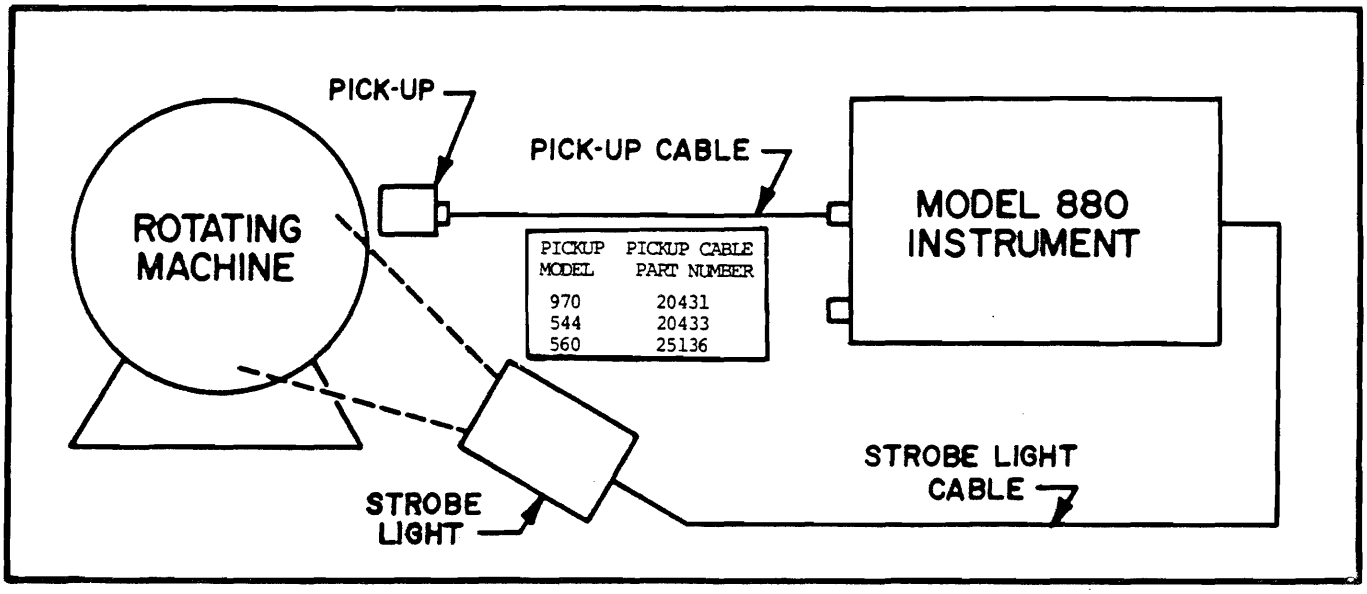


FIGURE 3-1 970, 544, 560 PICKUP CABLING CONFIGURATION

3.4 ACCELEROMETER AND VELOCITY PICKUP CABLE CONNECTIONS

The cabling diagram which shows the general Accelerometer and Velocity Pickup connections is given in Figure 3-1. The same procedures are used to connect the 970, 544, or 560 Pickups and cables to the 880 instrument. These procedures are described as follows:

a) Connect the threaded connector of the proper Pickup Cable to the receptacle on the Pickup to be used. The following table lists the cables that must be used with each Pickup:

PICKUP MODEL	CABLE PART NO.
970 ACCELEROMETER	P/N 20431
544 VELOCITY	P/N 20433
560 VELOCITY *	P/N 25136

* For measurement of low frequency vibration signals. See **Appendix A** for the specifications of the various pickups.

b) Connect the twist-lock connector at the analyzer end of the Pickup Cable to the PICKUP INPUT receptacle on the left side panel of the 880 instrument.

NOTE: Two pickup connector input channels (FAR and NEAR) are provided on the Model 880, and the channel to be used must be selected using the Pickup Selector switch.

c) If an extension cable is to be used, interconnect this cable between the standard cable and the Pickup. The threaded male receptacle on the extension cable is connected to the Pickup end of the standard cable, and the opposite end of the extension cable is connected to the Pickup receptacle.

NOTE: The extension cable Part Numbers for the various Pickups are listed in Section 2.4; OPTIONAL ACCESSORIES.

3.5 NON-CONTACT PICKUP/SIGNAL SENSOR CABLE CONNECTIONS

The cabling diagram showing the input connections of the Model 403 Non-Contact Pickup is given in Figure 3-2. The Part Number of the required Optional Signal Cable is also listed in Figure 3-2. Connect the proper signal cable wires with spade lugs to the SIGNAL and GROUND terminals on the 403 Signal Sensor. A third cable wire carries a -24 volt supply voltage from the Model 880, and if so used, this wire is connected to the -24V terminal on the Signal Sensor. Connect the twist-lock connector at the opposite end of the signal cable to the FAR INPUT or NEAR INPUT receptacle on the left side panel of the 880 instrument.

NOTE: The Model 880 is calibrated to operate with the Model 403 or other Signal Sensors having an output sensitivity of **200 mv/mil** (8.1 mv/um).

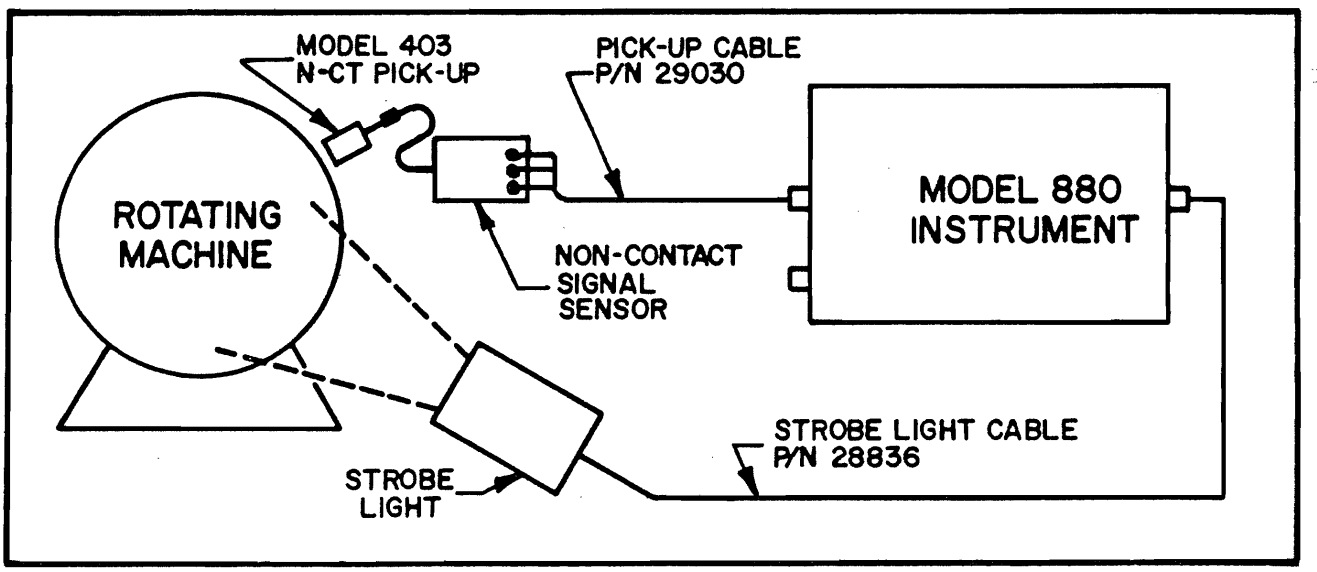


FIGURE 3-2 NON-CONTACT SIGNAL SENSOR INPUT CABLING

3.6 NON-CONTACT DISPLACEMENT ACCESSORY CABLE CONNECTIONS

The cabling diagram which shows how the Non-Contact Displacement Accessory is connected to the 880 instrument is given in Figure 3-3. This diagram applies to both the Single Channel and Dual Channel Accessories (P/N 28585 and P/N 28586, respectively.) Set up the Accessory cable connections as follows:

a) Connect the twist-lock connector of the **544 Pickup Signal Cable** (P/N 20433) to the appropriate PICKUP INPUT receptacle on the 880 instrument. Then install the threaded connector at the pickup end to the VIBRATION SIG. receptacle on the rear panel of the Accessory.

b) Connect one end of the **Non-Contact Pickup Cable** to the appropriate threaded pickup receptacle on the Accessory. Connect the opposite end of this cable to the threaded connector on the Pickup lead.

NOTE: The correct length of Pickup Cable must be used as designed for the Accessory, or the calibration of the unit will not be maintained.

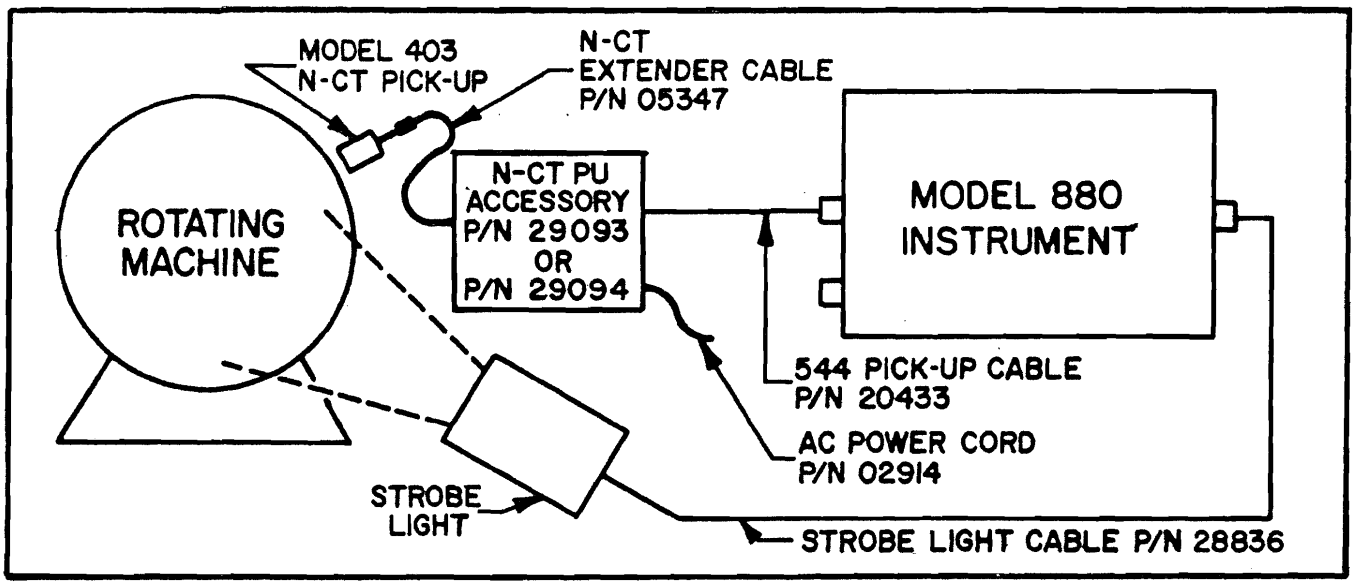


FIGURE 3-3 NON-CONTACT DISPLACEMENT ACCESSORY CABLING

c) Connect the female twist-lock connector of the **AC Power Cable** to the POWER INPUT receptacle on the Accessory rear panel. Connect the opposite end of this cable to the proper AC line voltage (105 to 129 VAC - 50/60/400 Hz, or if so specified, 210 to 258 VAC.) The U.S.A. standard 3-prong male connector may be used at this end if the voltage to be connected is 132 VAC or less.

CAUTION: Make certain that the Non-Contact Displacement Accessory is correctly designed and properly fused for the AC line voltage to be used.

3.7 MONITOR OUTPUT CABLE CONNECTIONS

The cabling diagrams which show how the 880 instrument is to be connected to various monitors are provided in Figures 3-4, 3-5, and 3-6. The procedures for connecting the monitor outputs to the Model 880 are described as follows:

1) **Non-Contact Monitor Connections** (Except UNICEL II, and Model 5802, 5806)

a) Connect the BNC connector of the signal cable listed in Figure 3-4 to the BNC receptacle on the panel of the monitor.

b) Connect the twist-lock connector at the opposite end of the signal cable to either INPUT receptacle on the left side panel of the 880 instrument.

NOTE: The Model 880 is calibrated to operate with non-contact monitors having an output sensitivity of **200 mv/mil** (8.1 mv/um).

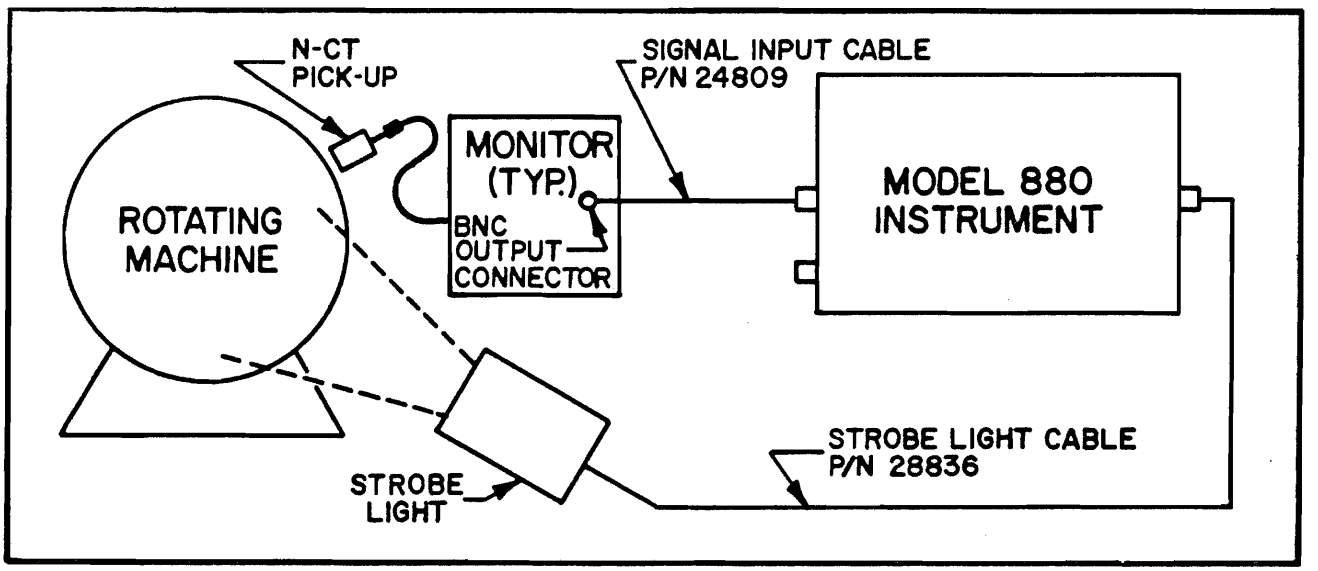


FIGURE 3-4 NON-CONTACT MONITOR CABLING CONFIGURATION

2) **Model 5802, 5806 Monitor Connections**

a) Connect the individual connector pins of the cable adapter (P/N 24332) to the common and signal output pin jacks on the monitor. Refer to Figure 3-5, Page 3-6.

b) Connect the female BNC receptacle at the opposite end of the adapter to the appropriate signal cable. The correct signal cable(s) to be used is determined by the type of pickup (960, 544, or Non-Contact) connected to the monitor.

c) Connect the twist-lock connector at the analyzer end of the signal cable to either INPUT receptacle on the left side panel of the 880 instrument.

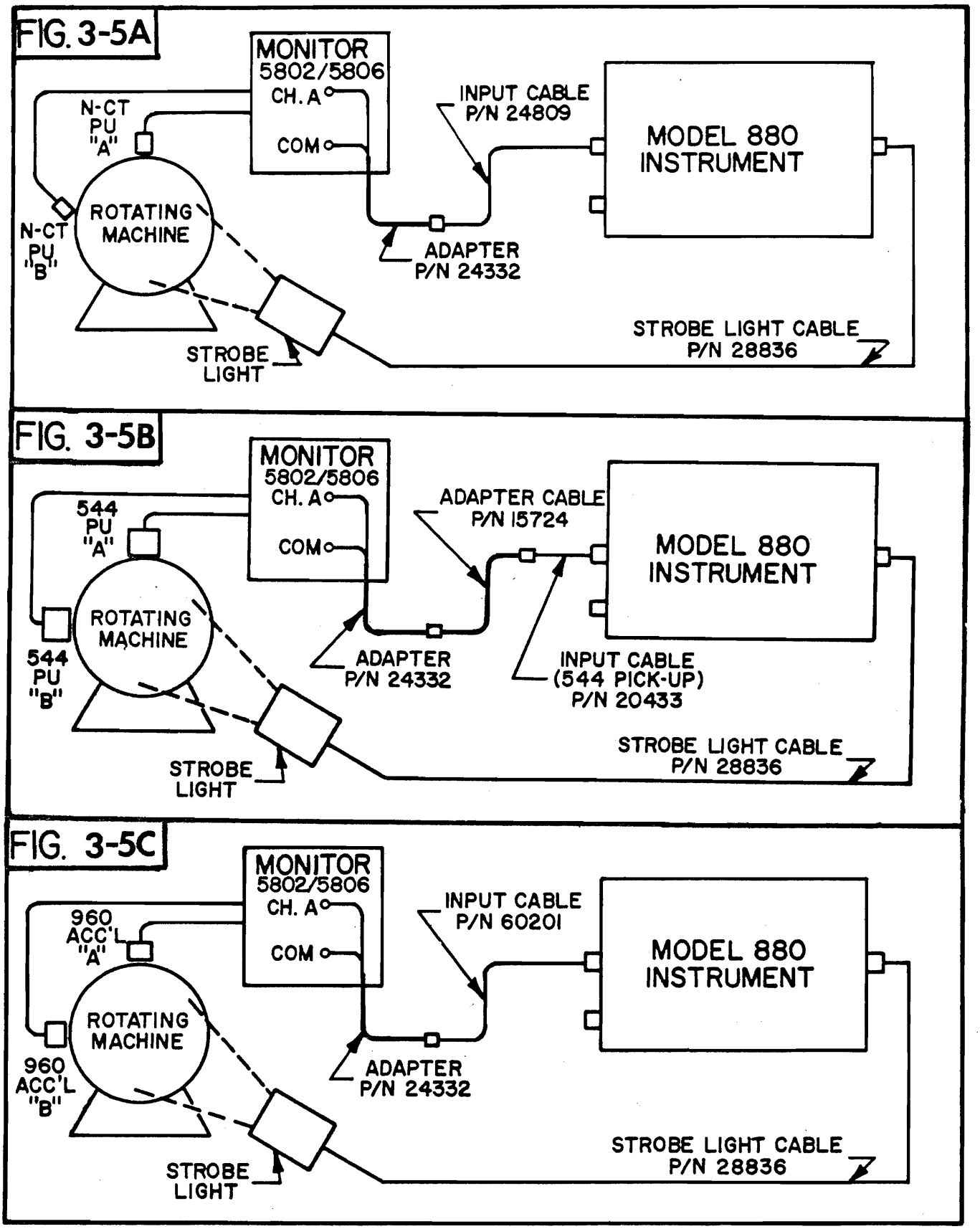


FIGURE 3-5 MODEL 5802, 5806 MONITOR CABLING CONFIGURATIONS

3.7 (Continued)

3) Model 1224, 1225, 1229 Monitor Connections

a) Connect the threaded connector of the 544 Pickup Signal Cable to the OUTPUT receptacle on the monitor, as shown in Figure 3-6A.

b) Connect the twist-lock connector at the opposite end of the PICKUP cable to either INPUT receptacle on the left side panel of the 880 instrument.

4) UNICEL II Monitor Connections

a) Connect the male BNC connector of cable P/N 15724 to the SIGNAL OUTPUT receptacle on the monitor as shown in Figure 3-6B.

b) Connect the male threaded connector at the opposite end of this cable to the threaded receptacle on one end of the 544 Pickup Signal Cable.

c) Connect the twist-lock connector at the analyzer end of the 544 Pickup Cable to either INPUT receptacle on the left side panel of the 880 instrument.

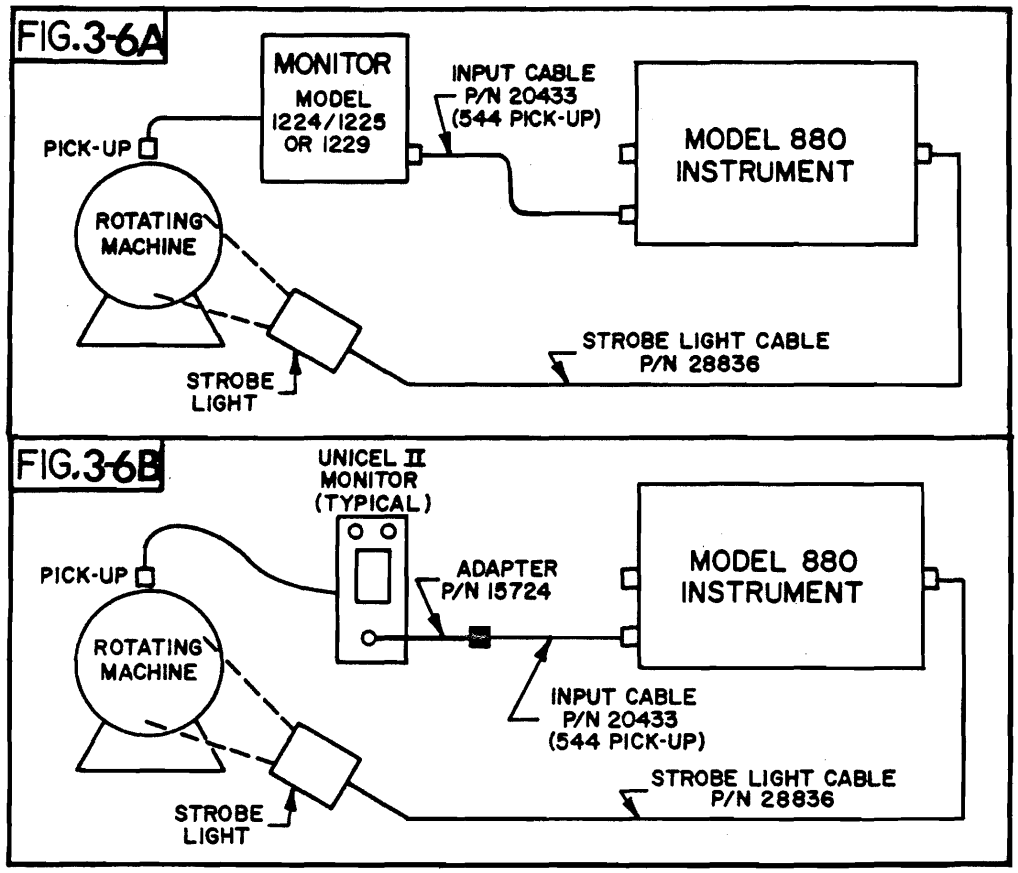


FIGURE 3-6 MODEL 1224, 1225, 1229/UNICEL II MONITOR CABLING CONFIGURATION

3.8 MODEL 308 CABLE CONNECTIONS

The optional Model 308 Vibration/Sound Level Meter is used when sound is to be analyzed rather than vibration. To set the Model 308 for use with the Model 880, instrument, connect the threaded connector of the **544 Pickup Cable** to the receptacle on the 308 Meter. Then connect the twist-lock connector on the opposite end of the cable to either INPUT receptacle on the analyzer.

3.9 CALIBRATOR CABLE CONNECTIONS

The optional calibration, P/N 21073, may be used to check the 880 instrument calibration for displacement, velocity, or acceleration measurements. To set up the calibrator for use with the Model 880, connect the threaded connector of the **970 Pickup Cable** to the receptacle on the calibrator. Then connect the twist-lock connector on the opposite end of the cable to either INPUT receptacle on the analyzer.

3.10 INSTRUMENT START-UP CHECKS

1) POWER-ON CHECK

The Model 880 performs diagnostic self-checks when the POWER switch is set to AC or BATTERY. These checks are performed in approximately 6 seconds and verify that the instrument indicators, the internal circuits, and the built-in plotter are functional. When the instrument power is turned on, the following functions occur:

a) The **LCD** displays all units, modes, and warning indications simultaneously. Also the numeric segment of the LCD will indicate the number "8" in all eight digits, as well as all decimal points and a colon.

b) The **LED Range Indicators** will sequentially flash on and off during the testing period. This action tests the operation of the indicators and the circuits which control them.

c) The **internal printer/plotter** will print out a start-up message which lists the model number of the instrument, the results of the microprocessor self-test, and instructions prompting the operator to check the instrument system as necessary. A typical start-up message is shown below:

```
IRD MODEL 880

COPYRIGHT 1987
IRD MECHANALYSIS

MICRO-P TEST: OK

CK BAT & SYSTEM
AS NECESSARY
```

2) BATTERY POWER CHECK

The internal battery of the Model 880 must be sufficiently charged in order for the instrument to operate properly in the BATTERY mode. Before using the instrument, always perform the following check:

a) Set the POWER switch to BATTERY.
b) Set the FUNCTION switch to BATT CHK.
c) Observe the Amplitude meter, and check that the meter needle registers in the BATT area or higher.

CAUTION: Do not operate the 880 instrument in the Battery Mode if the Amplitude meter needle registers below the BATT area.

3) TEST MODE CHECK

The Test Mode Check utilizes internal test signals generated by the instrument circuits and the AC power line. These square-wave signals are of a fixed amplitude and frequency, and are used to evaluate the performance of the signal conditioner, filter, and other circuits. With the AMPLITUDE switch set to TEST and the POWER switch set to BATTERY, 120 CPM and 1,200 CPM test signals are generated and are selected using the FREQ RANGE switch. When the POWER switch is set to AC, one test signal with the same frequency as the AC input voltage is generated (typically 3600 CPM or 3000 CPM). The Test Mode Check procedures are described as follows:

a) Set up the 880 controls as listed below:

880 CONTROL	CONTROL SETTING
AMPLITUDE	TEST
UNITS	DISP, VEL, or ACCEL
FUNCTION	OUT
FREQUENCY	ADJUST FULLY COUNTERCLOCKWISE

b) Set the POWER and FREQ RANGE switches to the positions listed in the following table. For each setup, the **Amplitude meter** must indicate an approximate reading of 80% full scale. Also, the **AMPL** and **VIB** mode LCD readings must closely match the corresponding analog Amplitude and Frequency meter readings. If the proper meter readings are obtained, the analyzer circuits are operating properly.

POWER	FREQ RANGE	TEST FREQ*	TEST AMPL
BATT	60-60K	120 CPM	80% F.S.
BATT	600-600K	1,200 CPM	80% F.S.
AC	600-600K	3,600 CPM**	80% F.S.

* small variations from these nominal frequencies can occur, and are normal.
** or 3,000 CPM for 50 Hz line frequency.

c) Set the FUNCTION selector to BROAD, and obtain **spectrum plots** for the three POWER and FREQ RANGE switch setups given in the table shown below for the BROAD filter setting. Initiate the plots individually by depressing the START/STOP switch. Each spectrum plot should include a primary component of 120, 1200, or 3600 CPM at approximately 70% of full scale, and the odd harmonics. If the plots are completed within the plot times listed in the table, the internal printer/plotter and associated circuitry are functioning correctly. An example spectrum test plot is shown in Figure 3-7. Similar test plots can be obtained for the SHARP and BALANCE modes to further check the Filter circuitry operation. The setups to be used for these modes are included in the table shown below.

POWER SOURCE	FREQ RANGE	TEST FREQ	FILTER POSN	PLOT TIME WITH HEADER	PEAK AMP
BATT	60-60K	120 CPM	BROAD	125 SEC	70%/FS
BATT	600-600K	1200 CPM	BROAD	35 SEC **	70%/FS
AC	600-600K	3600 CPM *	BROAD	35 SEC **	70%/FS
BATT	60-60K	120 CPM	SHARP	13-1/4 MIN	70%/FS
BATT	600-600K	1200 CPM	SHARP	95 SEC	70%/FS
AC	600-600K	3600 CPM *	SHARP	95 SEC	70%/FS
BATT	60-60K	— — —	BALANCE	-NOT AVAILABLE —	—
BATT	600-600K	1200 CPM	BALANCE	3.5 MIN	70%/FS
AC	600-600K	3600 CPM *	BALANCE	3.5 MIN	70%/FS

NOTE: Balance filter position frequency plots not obtainable for the 60-60K range.

* 3,000 CPM provided when 50 Hz line frequency is used.
** 4-3/4 minutes plot time required for SE units.

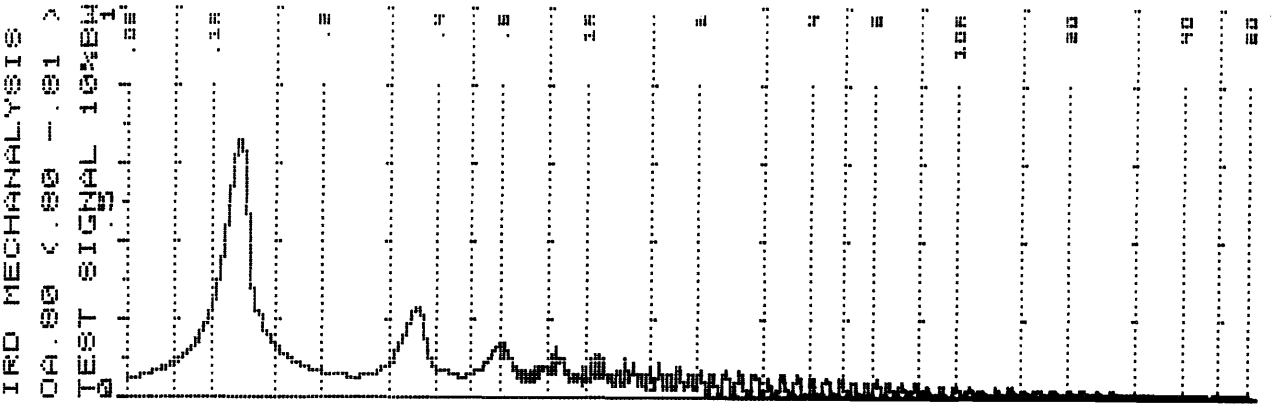


FIGURE 3-7 BROAD SPECTRUM TEST PLOT

3.11 CHARGING CIRCUIT OPERATION

The internal battery pack used in the Model 880 is a high quality sealed lead-acid type, and is capable of hundreds of charging cycles. For longest life, the battery pack should be maintained in a fully charged condition. The procedures by which the battery is charged are described as follows:

1) Trickle Charging

A trickle charge current is applied to the battery whenever the 880 instrument is connected to the AC voltage supply and the POWER switch is set to BATTERY or AC. The battery will then remain fully charged while the instrument is operating.

CAUTION: The 880 instrument must not be operated with the POWER switch set to BATTERY if the Battery Power Check procedure indicates a low charge condition.

2) High-Level Charging

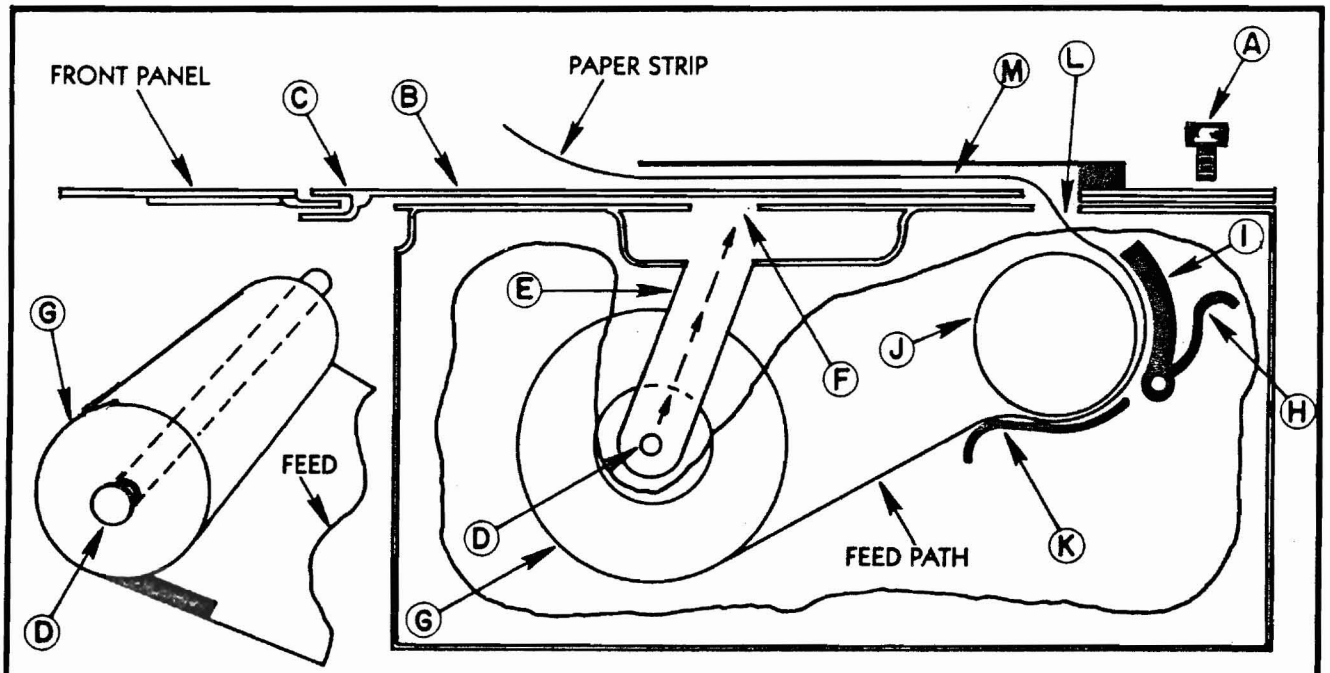
A depleted internal battery will receive full charging current when the 880 instrument is connected to the AC voltage supply and the POWER switch is set to OFF. This charging condition is indicated when the Amplitude meter needle registers in or above the "CH" area on the scale.

NOTE: When a completely depleted internal battery is being recharged, the Amplitude meter will initially indicate a low reading. The reading will then rise until the needle registers in the "CH" area. The charging circuits of the Model 880 require 12 to 16 hours to fully recharge a depleted internal battery.

The 880 instrument should be connected to the proper AC line voltage: 1) following each day's operation of the analyzer from battery power; 2) if the instrument has not been operated for a period of one month or longer.

3.12 LOADING CHART PAPER

To install a new roll of chart paper, first unscrew the thumb fastener and remove the cover plate. Lift out the old roll and load the new roll on the spindle, making sure the paper unrolls from under the roll. Lift the print head (which is spring-loaded against the friction roller) away from the roller to allow the paper to be fed under the roller and up past the head. Roll out some extra paper by hand turning the friction roller, and slip this paper out through the exit slot in the cover plate as it is being reassembled. See Figure 3-8, Page 3-13.



A. Thumb Screw	E. Guide Channel	I. Print Head
B. Face Plate	F. Insert Slot	J. Drive Roll
C. Flange	G. Paper Roll	K. Paper Guide
D. Support Axle	H. Release Arm	L. Exit Slot
		M. Exit Channel

FIGURE 3-8 CHART PAPER LOADING GUIDE

IV OPERATION

4.1 GENERAL

This chapter contains instructions for operating the Model 880 Analyzer/Balancer with the Model 970 Accelerometer, the optional Model 544 Velocity pickup, and other optional accessories. Included in this chapter are instructions for performing the following procedures:

- Frequency Spectrum Analysis
- Diagnostic Spectrum Analysis
- Amplitude vs. Time Plotting
- SPIKE ENERGY Measurement and Analysis
- Sound (Noise) Measurement
- Machine Balancing

Specifications of the Model 880 and major accessories are provided in **Appendix A.** Information on the significance of the measured vibration levels (of displacement, velocity, and acceleration) is provided in severity guideline charts in **Appendix B.** Procedures for evaluating SPIKE ENERGY signal characteristics are given in **Appendix C.** Instructions for using calculator balancing programs are given in **Appendix D.**

4.2 FREQUENCY SPECTRUM ANALYSIS

Vibration analysis is the process of measuring machinery vibrations, and determining the causes of these vibrations. Normally, machinery vibrations are complex, and consist of many individual frequency components that originate at different machine parts. The vibration analysis process consists of measuring the overall machine vibration, determining the amplitude and frequency of the individual vibrations within the measuring frequency spectrum, and relating the individual frequency components to specific machine parts to pinpoint the causes of the individual vibrations.

To determine the characteristics of the various vibrations, measure the overall signal amplitude, and tune the instrument filter to the individual frequency components. Tuning can be done manually with the Frequency Tune Control or automatically via the internal printer/plotter. Instructions for the Spectrum Analysis using either method are given in Sections 4.3 through 4.6 of this chapter.

4.3 MANUAL SPECTRUM ANALYSIS

A preprinted Data Sheet is available for recording the vibration analysis data. Draw a sketch of the machine on this sheet to identify all positions where measurements are obtained. Instructions provided on the back of the data sheet list the procedures to be used for the vibration analysis. A copy of the Data Sheet is shown in Figure 4-1 (Page 4-2). The manual vibration analysis is performed as follows:

IRD Mechanalysis

DATA SHEET DATE _____

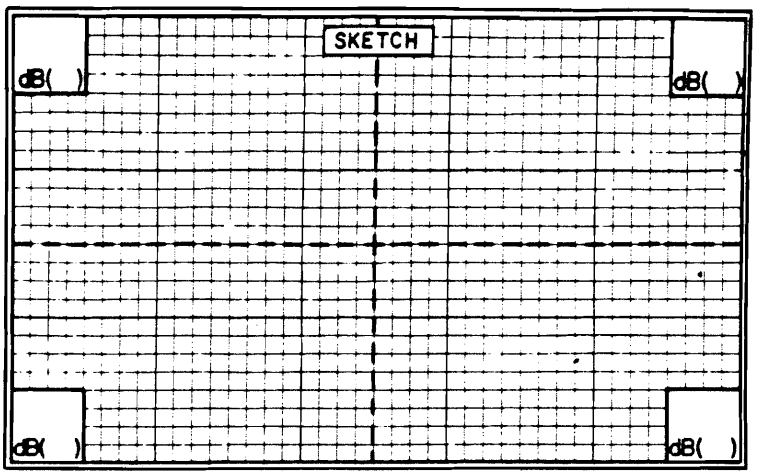
ANALYSIS OF: _____

LOCATION: _____

INSTRUMENTATION: _____

TEST CONDITIONS: _____

PERFORMED BY: _____



LEGEND: ➡ PICKUP POINT ⊣⊢ COUPLING
X PLAIN BEARING ⊛ ANTI-FRICTION BEARING

MEASUREMENT		OVERALL (FILTER OUT) VIBRATION						SPIKE ENERGY	FILTERED VIBRATION					
		DISPLACEMENT PK-PK		VELOCITY PK		ACCELERATION PK								
POINT	POS.	☐ MILS ☐ μM	CPM	☐ IN/SEC ☐ MM/SEC	CPM	g	CPM	gSE						
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													
	H													
	V													
	A													

FIGURE 4-1 TYPICAL VIBRATION HISTORY DATA SHEET

1) Set up the 880 instrument as described in Chapter 3. The instrument may be powered by the internal battery or AC line voltage.

2) Select the transducer to be used and attach it to the machine; or install the 9-inch extension probe to the 970 Accelerometer and place it at the measurement point.

3) Select the UNITS to be measured (displacement, velocity, or SPIKE ENERGY units) set the FUNCTION switch to Filter OUT, and set the FREQUENCY RANGE selector to 60-60K CPM, or 600 to 600K CPM. The PICKUP switch must be set to the input channel to be used (NEAR or FAR). **NOTE:** If the UNITS selector is incorrectly set for the type of pickup to be used, the LCD **AMPL** display reading will blank out, and the analog Amplitude meter will indicate a zero reading. See the description of the UNITS selector, Page 2-5, for a listing of the various pickups and the units that may be measured.

4) Adjust the AMPLITUDE selector to obtain an Amplitude meter indication within the upper 2/3rds of the meter scale. If the amplitude sensitivity is set too high, an overscale condition will exist, and the LCD reading will flash.

5) Set the FUNCTION selector to OUT. The overall vibration amplitude is indicated on the analog Amplitude meter. Press the AMPL pushbutton to display the amplitude on the LCD meter, and record this amplitude level on the data sheet.

6) To analyze each component of the vibration signal, set the FUNCTION switch to BROAD and depress the TUNED FREQ pushbutton.

7) Adjust the FREQUENCY TUNE control fully CCW to obtain a minimum frequency reading on the LCD. Then adjust this control clockwise while watching the Amplitude meter. When a frequency peak of interest is approached, the Amplitude meter will begin to indicate upscale, and the analog Frequency meter will also indicate on-scale.

8) Continue adjusting the FREQUENCY TUNE control until a peak indication is shown on the Amplitude meter. Then press the VIB FREQ pushbutton to display the peak frequency accurately on the LCD. Press the AMPL pushbutton, and record the above frequency and amplitude values on the data sheet. Greater resolution of peaks located close to one another can be provided by setting the FUNCTION selector to SHARP.

9) Return the LCD display to the TUNED FREQ mode, and continue the analysis of each vibration peak. Repeat the above steps for each position of the pickup on the machine.

4.4 AUTOMATIC SPECTRUM ANALYSIS

1) Prepare the Model 880 instrument for operation as shown in Chapter 3.

2) Select the vibration pickup to be used, and attach it to the machine as needed (see general guide on Page 3-1).

3) Set up the instrument selectors as follows:

UNITS:	DISP, VEL, ACCEL or SE as required
FUNCTION:	FILTER OUT
FREQUENCY RANGE:	60-60K CPM or 600-600K CPM
PICKUP:	NEAR or FAR, as used
MODE:	FREQUENCY

4) Adjust the **AMPLITUDE selector** for an Amplitude meter indication of approximately 2/3 of full scale. When the FUNCTION selector is set to OUT, the meter indicates the overall vibration amplitude, and after the AMPL pushbutton is depressed, the same amplitude level is read out on the Amplitude LCD.

NOTE: During all plotting the LCD goes blank.

5) To initiate a plot, set the FUNCTION switch to BROAD and press the START/STOP pushbutton once. A frequency signature plot is then generated automatically for the frequency range being used (i.e., 60-60K CPM, Step 3).

NOTE: If the UNIT selector setting is incorrect, or the FUNCTION selector is set to BATT CHK, OUT, or OSC, an **error condition** exists when the START/STOP pushbutton is pressed to start a plot, the message shown below is printed:

```
OPERATOR ERROR -
IMPROPER SWITCH
CONFIGURATION
```

6) The Frequency Signature plot header includes spaces for adding machine information (i.e., the pickup position, operating conditions, etc.). The header lists the overall (OA) amplitude, minimum amplitude of fluctuating signals, units of measure, Filter mode bandwidth, and the plot resolution rate.

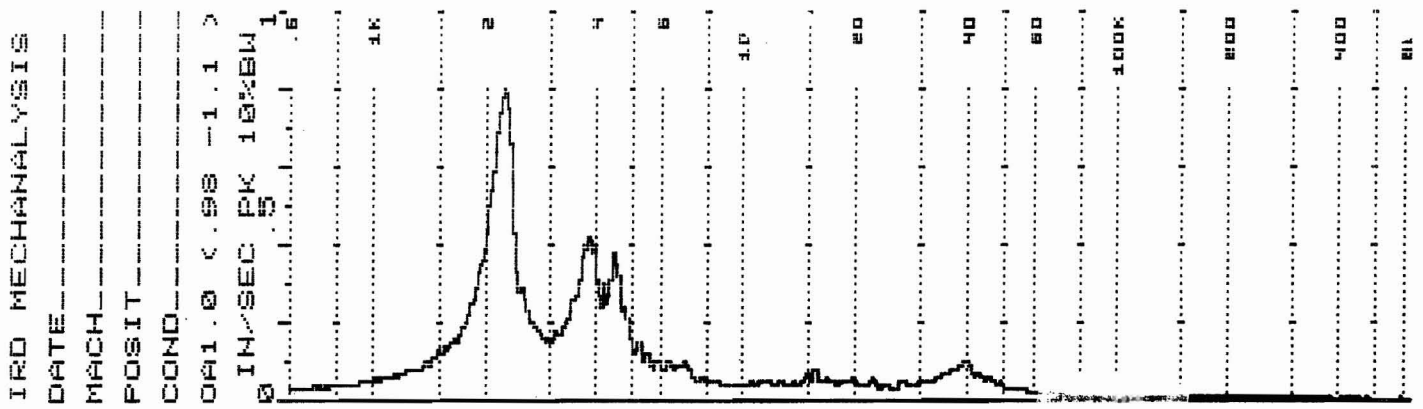


FIGURE 4-2 BROAD MODE FREQUENCY SIGNATURE PLOT

7) To improve the resolution at low amplitude peaks of interest in the signature plots, set the AMPLITUDE selector to a lower/more sensitive range. However, make certain that an overscale condition does not result from this (i.e., that the LCD does not flash). Do not attempt a signature plot if an overscale condition is indicated.

8) To begin a plot from a frequency higher than at the low end of either frequency range, first press the TUNED FREQ pushbutton. The frequency to which the filter is tuned is then displayed on the LCD. Next, adjust the FREQUENCY TUNE control such that your desired starting frequency for the plot displayed, then press the START/STOP pushbutton twice in succession.

NOTE: The START/STOP pushbutton must be pressed before the header printing is completed; if pressed after the header is completed, the plot will be terminated.

The plotting can be stopped momentarily, if desired, by pressing the PAUSE/ADVANCE pushbutton, and then restarted by pressing the START/STOP pushbutton.

9) To include **RPM Harmonic Markers** in the spectrum plot, first determine the precise RPM frequency to be entered. (Use the design RPM speed of the rotating machine part, or measure the RPM speed with the Strobe Light as covered in Steps 9a through 9e.)

a) Cable the Strobe Light to the 880 instrument as instructed in Chapter 3, then set the Strobe Light POWER switch to ON.

b) Set the 880 FUNCTION selector to OSCILLATE.

c) Press the VIB FREQ pushbutton, and set the FREQ RANGE selector to 60-60K CPM to provide optimum RPM accuracy. (The 600-600K CPM range and manually tuned frequency -- press TUNED FREQ -- can also be used to set the RPM value.)

d) Illuminate the rotating part with the strobe light, and adjust the FREQUENCY TUNE control to stop/freeze the rotating part.

e) Enter the frequency value displayed on the LCD as the RPM speed (i.e., press the RPM/ORDER pushbutton).

NOTE: When the tuned frequency is close to a known unbalance vibration peak, set the FUNCTION selector to SHARP, and press the VIB FREQ pushbutton. The LCD meter then displays the RPM frequency at optimum accuracy.

Following entry of the RPM frequency, the "RPM" legend is shown on the LCD, and the RPM frequency is printed in the headers of succeeding signature plots. In addition, marker lines are included in the plots at the RPM frequency point and the next nine harmonic frequency points.

To clear the above entered RPM value from the 880 memory, press the CLEAR/RESET pushbutton. (The RPM value is also cleared when the FREQ RANGE selector is set to a different range.)

4.5 DIAGNOSTIC ANALYSIS

The Diagnostic Analysis function provides important spectral information. Two versions of the analysis are available as follows:

To obtain the first version, omit Step 2 (do not display the "RPM" legend), but perform Step 3. When the "D" pushbutton is pressed, the letter "d" is displayed on the LCD, the first 16 peaks with amplitudes above 15% of full scale are detected and stored in the memory as the spectrum is plotted, a header line is then printed (lists DIAGNOSTICS, the units of measure, the Filter Bandwidth %, and the Chart Speed), followed by a 2-column list of the frequencies (CPM) and amplitudes (LVL) of the above 16 peaks.

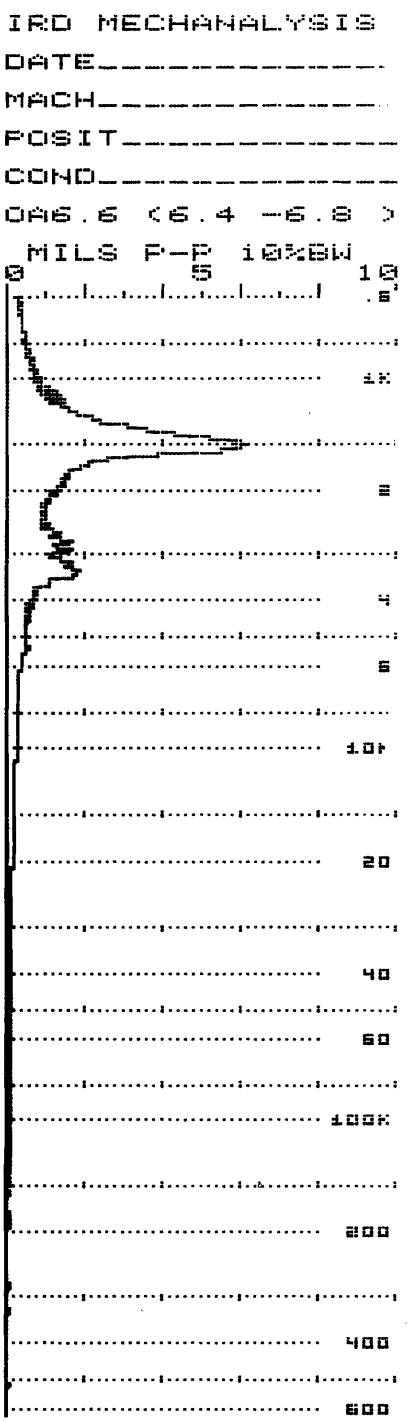
To obtain the second version, perform Steps 2 and 3 as instructed below. The "RPM" legend and the letter "d" are then displayed on the LCD; the first 16 peaks with amplitudes above 15% of full scale are stored in the memory; a header line is printed (lists DIAGNOSTICS, the units of measure, the Filter Bandwidth %, and the Chart Speed), followed by a 3-column list of each frequency (CPM), harmonic order (ORDR), and amplitude (LVL) of the 16 peaks; and a list of corresponding Most Likely Causes.

Example Diagnostics printouts of both versions are shown in Figure 4-3.

The procedures for obtaining a Diagnostics Analysis plot and printout are as follows:

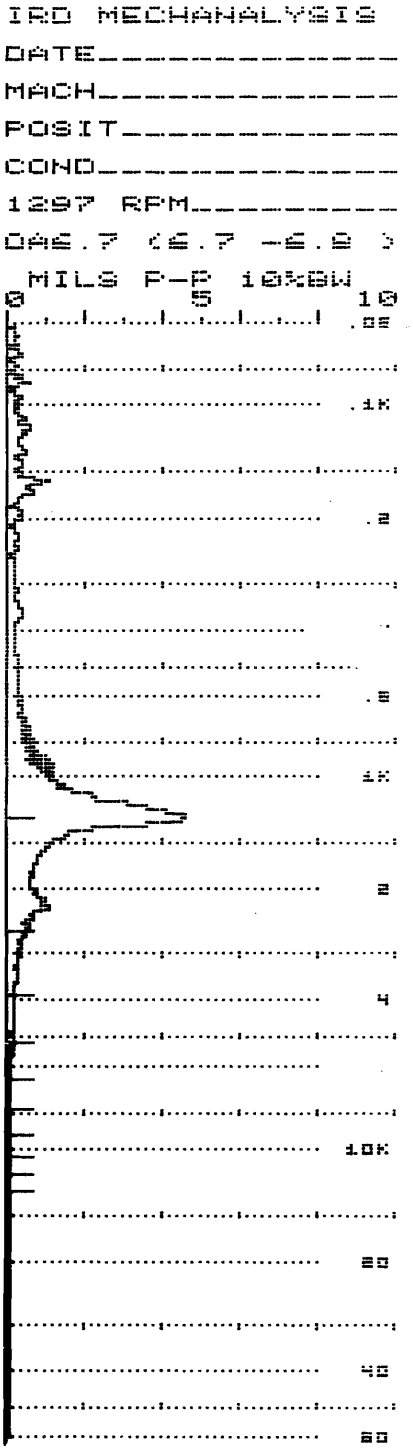
1) Set the 880 instrument as instructed in Steps 1 through 4 of Section 4.4.

2) Select the RPM frequency as instructed in Step 9 of Section 4.4. (If desired, other frequencies of interest can be entered as the RPM frequency to obtain an analysis of any needed frequency or harmonic.)



DIAGNOSTICS
MILS P-P 10XBW

CPM	LVL
1500	6.1
1850	1.6
2740	1.7
2880	1.7
3290	1.9



DIAGNOSTICS
MILS P-P 10XBW

CPM	ORDR	LVL
1265	.98	4.6

RPM	LVL*	MOST LIKELY CAUSE**
LESS THAN 1X	0.0	WHIRL BELTS
1X	4.6	UNBAL MISALIGN
2X	0.5	LOOSNS
3X	0.2	MISALIGN
4X	0.2	LOOSNS
5X &UP	0.1	BRG GEAR VANE

* IF HIGH LEVEL SEE LIKELY CAUSE

** CK IRD MANUAL FOR OTHER CAUSES

FIGURE 4-3 EXAMPLE DIAGNOSTICS PLOT/PRINTOUTS

NOTE: Perform Step 2 only when the Diagnostics Printout is to be included along with the above plot and print out information.

3) Set the FUNCTION selector to BROAD or SHARP, as desired, and press the "D" pushbutton. The letter "d" is then displayed on the LCD.

NOTE: The diagnostics plots are not available for partial spectrums (i.e., less than 60-60,000 CPM, or 600-600,000 CPM).

4) Press the START/STOP pushbutton to initiate a plot. To cancel the Diagnostics portion of the printout after the plot is started, press the CLEAR/RESET pushbutton. To terminate the plot, press the START/STOP pushbutton.

Operation in the Diagnostics mode is terminated automatically when the plot/printout is completed. To continue operation in this mode, repeat the above procedures.

4.6 AMPLITUDE VS TIME ANALYSIS

The Model 880 instrument has the capability of generating time base plots at three chart speeds on the built-in plotter. In the Filter Out mode, the analyzer samples the overall amplitude at periodic intervals and plots the amplitude as a point on the chart paper each time a sample is taken. The sampling rate is determined by the chart paper speed.The following table lists the approximate paper speeds for the different settings of the CHART SPEED selector:

CHART SPEED	PAPER SPEED	PLOT RATE POINTS PLOTTED
SLOW	0.65 IN (1.7 CM) PER MIN	ONE PER SEC
MED	3.25 IN (8.2 CM) PER MIN	FIVE PER SEC
FAST	13.0 IN (66 CM) PER MIN	TWENTY PER SEC

The Amplitude vs Time Analysis is performed as follows:

1) Set up the 880 instrument as instructed in Chapter 3.

2) Select the transducer/pickup for the measurements to be performed, and attach the pickup to the machine.

3) Set up the 880 controls as follows:

UNITS:	DISP, VEL, ACCEL, or SE units
FUNCTION:	FILTER OUT
PICKUP:	NEAR or FAR, as pickup is used
MODE:	TIME

4) Select the CHART SPEED that best matches the measurement objectives. For example, for vibration-trend study over a long measurement interval (30 minutes or longer), the SLOW chart speed should be used; to observe more rapid changes in the vibration levels, the FAST chart speed should be used; use the MED chart speed to show more clearly peaks located very close to one another.

5) Adjust the AMPLITUDE selector to obtain an Amplitude meter indication within the upper 2/3rds of the meter scale. When the vibration levels are to be measured as the machine is brought up to its normal RPM speed, a less sensitive range should be used because high vibration levels are often encountered at some RPM speeds during machinery startup.

6) Initiate a plot by pressing the START/STOP pushbutton.

NOTE: If the UNITS selector is incorrectly set, or if the FUNCTION selector is inadvertently set to BATT CHK or OSC, an **error message** will be printed soon after the START/STOP switch is pressed. Time Base plots can be obtained when the BROAD, SHARP, BALANCE, or FILTER OUT mode is used.

7) During a plot, if the signal amplitude exceeds the full-scale level, or decreases to too low a level for good resolution, the AMPLITUDE selector can be repositioned without terminating the plot. However, this type of change automatically interrupts the plot momentarily (a new amplitude scale and header is printed, and the average, minimum, and maximum amplitudes plotted since beginning the plot, or since its last interruption are also plotted).

NOTE: The capability of accepting changes without terminating the plot is provided only for AMPLITUDE and CHART SPEED selector changes.

8) To interrupt a plot momentarily, press PAUSE/ADVance pushbutton; to resume plotting press the START/STOP pushbutton. When this is done, the time count is repeated, and a new amplitude scale is printed.

9) Press the START/STOP pushbutton again to stop plotting. Example Time Base Plots are shown in Figure 4-4.

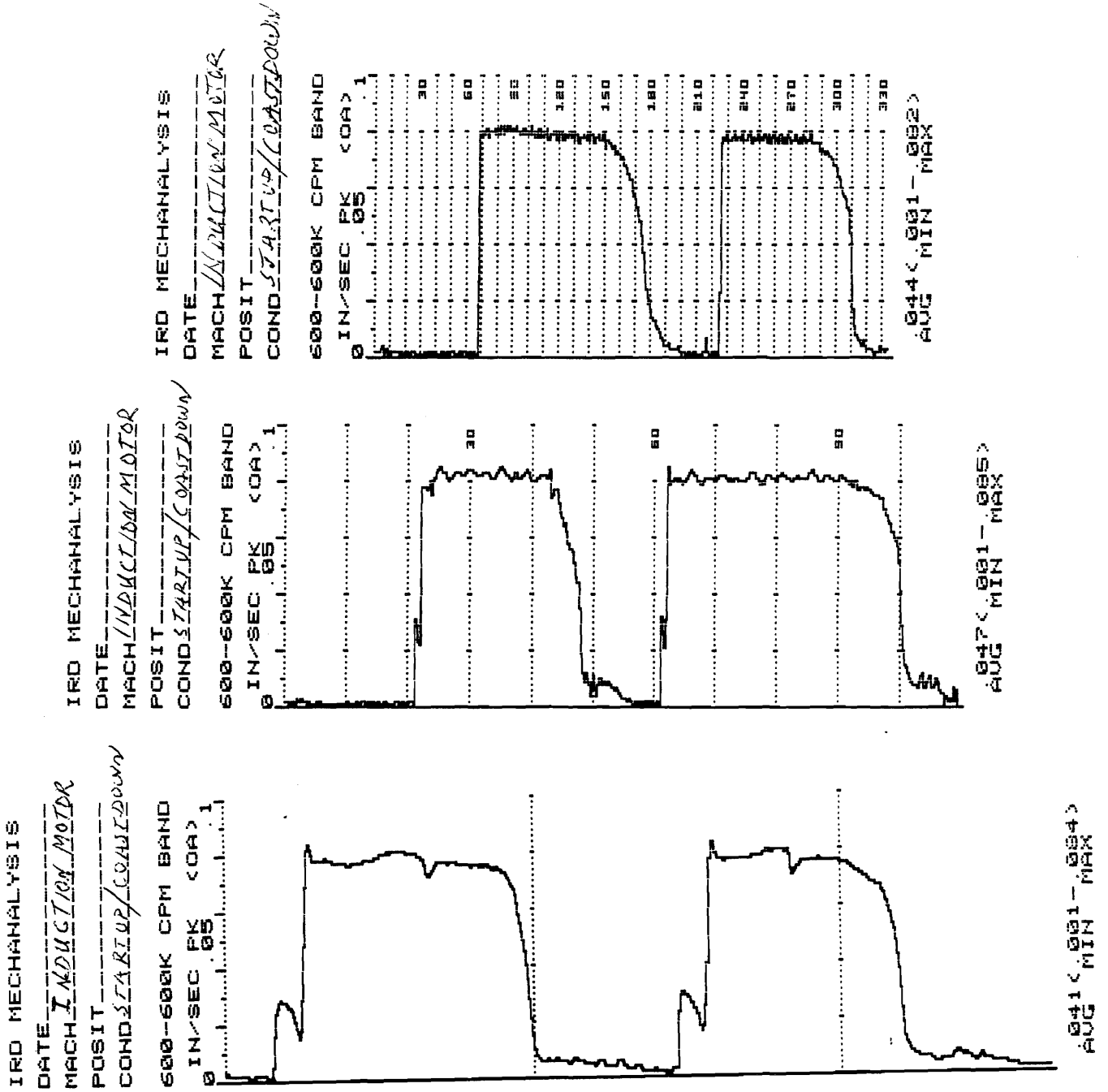


FIGURE 4-4 MODEL 880 AMPLITUDE VS TIME PLOTS

4.7 Model 880 OPERATION WITH MONITOR OUTPUTS

The Model 880 may be used to analyze and record the output signals from various types of monitors. Frequency Spectrum or Amplitude vs Time Analysis Plots may be generated as described in Sections 4.4 and 4.7. The following procedures must be performed to operate the Model 880 instrument with the monitors listed in Section 3.7, Page 3-5:

1) Set up the 880 instrument and the monitor cable connections as described in Chapter 3.

CAUTION: The correct type of input signal cable must be used for each monitor/pickup combination listed in Section 3.7.

2) Set the UNITS selector on the 880 instrument as specified in Table 4-1 for each monitor/pickup combination. The UNITS selector must be set only as described in this table; otherwise erroneous amplitude measurements will be indicated on the analyzer.

TABLE 4-1 UNITS SELECTOR SETTING FOR MONITOR INPUTS

PICKUP	MONITOR	SELECTOR SETTING
NCPU	Non-Contact Pickup Monitors W/200 mv/mil (8.1 mv/um) output	DISPLACEMENT
NCPU	Model 5802, 5806	DISPLACEMENT
544	Model 5802, 5806	DISPLACEMENT or VELOCITY
960	Model 5802, 5806	ACCELERATION, also; VEL, DISP, and SE
544	Model 1224, 1225 1229	DISPLACEMENT, or VELOCITY
*	UNICEL II	VELOCITY

* NOTE: For all pickups used with the UNICEL II Monitors, the Model 880 UNITS selector must be set to VELOCITY. The units of measure indicated on the LCD and the printouts are then disregarded, and the actual units are read from the particular monitor/pickup combination used.

3) Set up the other 880 instrument controls as required for performing a spectrum or Time Base Analysis and follow the procedures listed for generating the desired analysis plot.

4.8 SPIKE ENERGY SIGNAL MEASUREMENT AND ANALYSIS

1) PURPOSE OF SPIKE ENERGY SIGNAL ANALYSIS

The Model 880 instrument SPIKE ENERGY signal detection circuitry senses the amplitudes of very sharp impulses caused by impacts between bearing and gear elements with microscopic flaws. This circuitry also detects the rates of occurrence of vibration energy caused by defects in the bearing and gear assemblies. The three parameters, pulse amplitude, pulse rate, and high-frequency vibration energy are combined electronically into the single quantity called SPIKE ENERGY (g-SE) units, which provides a measure of the bearing and gear conditions. The term "g-SE" (i.e., acceleration SPIKE ENERGY units) indicates that SPIKE ENERGY measurement is more comprehensive than either g-peak, or g-RMS measurement.

2) SPIKE ENERGY SIGNAL AMPLITUDE MEASUREMENT

To following procedures are used to measure SPIKE ENERGY signal amplitude:

a) Set up the 880 instrument as instructed in Chapter 3. The Model 970 Accelerometer is used with the instrument to obtain SPIKE ENERGY printouts.

NOTE: The method used to hold/mount the accelerometer for SPIKE ENERGY measurement must be determined by the user. A general discussion of pickup mounting methods is provided on Page 3-1 (see the IRD AVT Manual for in-depth information on the pickup mounting methods and limitations). Select the most practical method for your measurements, and use this method consistently.

b) Set the UNITS selector to SE and the FUNCTION selector to filter OUT.

c) Mount the 970 Accelerometer on the rotating machine at the bearing journal or gear box to be checked.

d) Set up the AMPLITUDE selector for an Amplitude meter indication within the upper 2/3rds area of the meter scale.

NOTE: If the LCD Amplitude meter flashes, an "overscale" condition is indicated. To correct this condition, set the AMPLITUDE selector to the next lower sensitivity range (continue re-positioning this selector until the LCD stops flashing).

e) Check the Amplitude meter indication, the amount shown is the filter out SPIKE ENERGY amplitude level.

f) Repeat the above procedures to measure the SPIKE ENERGY amplitude at each additional position to be checked (i.e., bearing and gear housings, etc.). The measurement data obtained should be recorded and evaluated as instructed in Appendix C to determine the severity of the SPIKE ENERGY.

3) SPIKE ENERGY SIGNAL SIGNATURE

The measured SPIKE ENERGY signals can be filtered using either the BROAD or SHARP filter mode while generating a SPIKE ENERGY signature plot. By identifying the relationship of the peaks shown in the plot to corresponding machine bearings or gears, the multiple sources of the SPIKE ENERGY signal can be pinpointed to specific machine elements.

To obtain a SPIKE ENERGY signature plot, proceed as follows:

a) Set up the 880 instrument as instructed in Steps 2a through 2e, then set the MODE selector to FREQuency and the FREQ RANGE selector to 600-600K CPM.

NOTE: The 600-600K CPM range is normally used when obtaining SPIKE ENERGY signatures. However, the 60-60K CPM range should be used when the rotational/bearing frequency is below 600 CPM.

b) Set the FUNCTION selector to BROAD or SHARP. The SHARP setting can be used to provide better frequency resolution. If desired, the "frequency advance" procedure described in Section 4.4 (Step 8) can be used to reduce the plot time.

NOTE: When the BROAD filter mode and the 600 to 600K CPM range are used, an 8 x averaging rate is available, which is very useful when analyzing noisy vibration signals. Approximately 4-1/2 minutes of plot time is required for completion of an 8 x averaging plot. The 8 x averaging feature is provided only in Model 880 instruments with Serial Number prefix Letter U (is not available in earlier 880 instruments).

c) To provide harmonic markers in the above signature plot, follow the instructions listed in Section 4.5.

d) Press the START/STOP pushbutton to initiate the plot, if some of the peaks have low amplitude, the AMPLITUDE selector can be reset to a more sensitive range to increase the resolution; however, make certain that this does not cause an overscale condition (i.e., causes the LCD to flash).

CAUTION: Do not initiate a plot if the LCD is flashing as erroneous data could result in the plot.

4) SPIKE ENERGY SIGNAL DIAGNOSTICS

The Diagnostics function can also be used along with the SPIKE ENERGY signal mode for analysis, and is similar to the diagnostics provided when used in the Displacement, Velocity or Acceleration signal mode, with the exception that "possible causes" are not included.

To obtain a Diagnostics printout in the SPIKE ENERGY signal mode, set the UNITS selector to SE, and proceed as instructed in Section 4.5.

5) SPIKE ENERGY SIGNAL TIME BASE PLOT

Time Base Plots of SPIKE ENERGY signal amplitude are obtained and analyzed as follows:

a) Set up the 880 instrument as instructed in Chapter 3; in addition, install the 9-inch probe on the 970 Accelerometer, and connect the pickup cable between the 880 instrument and the accelerometer.

b) Set up the 880 instrument controls as follows:

UNITS SELECTOR: SE
FUNCTION SELECTOR: FILTER OUT
CHART SPEED SWITCH: MEDIUM (MED)
MODE SELECTOR: TIME

c) Set the AMPLITUDE selector to an average range position, such as 0.3 or 1.0 g-SE.

d) Press the START/STOP pushbutton to initiate a plot, and notice that the measured amplitude level is zero until the probe is held to a bearing or gear housing. Low frequency vibrations coupled from the operator's hands are filtered out by SPIKE ENERGY circuitry.

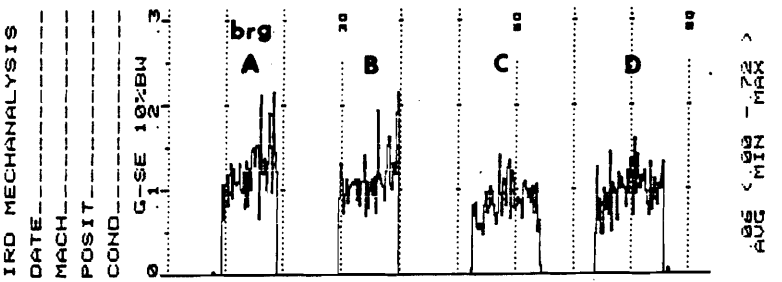


FIGURE 4-5A

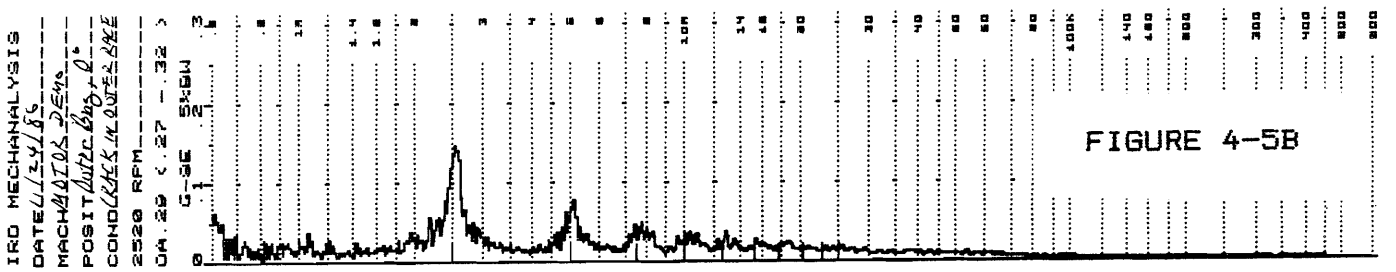


FIGURE 4-5B

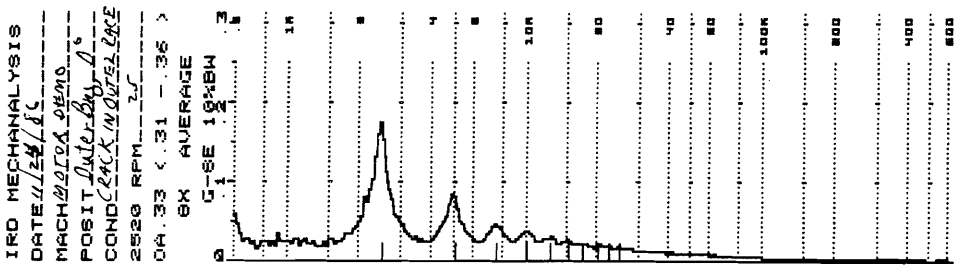


FIGURE 4-5C

FIGURE 4-5 EXAMPLE SPIKE ENERGY PLOTS

e) Hold the tip of the probe individually to each pre-selected measurement point on the machine bearings or gear housings for approximately 10 seconds, then remove the probe tip from the measurement point and pause an additional 10 seconds before proceeding to the next measurement point.

f) The sequential measurements obtained from various points on the machine (bearings and gear housings), produces a series of flat-topped peaks because each time the probe is removed from the machine, the g-SE signal level settles to zero. The flat top of the individual peaks indicates the SPIKE ENERGY signal amplitude at the corresponding bearing/gear housing measurement point. Example SPIKE ENERGY Time Base and Spectrum plots are shown in Figure 4-5 (Page 4-15).

When obtaining a SPIKE ENERGY Time Base Plot (Figure 4-5A), as the 970 Accelerometer is first brought into contact with the machine bearing housing (or other surface), a high-amplitude transient may be observed. This transient is caused by the impact of the probe, or magnet, aginst the machine surface, which creates a momentary SPIKE ENERGY signal. A similar transient may also be observed when the probe, or magnet, is removed from the contact.

The example SPIKE ENERGY spectrum plots shown in Figures 4-5B and 4-5C were obtained from identical input signals. Both plots show a fundamental SPIKE ENERGY peak at 2520 CPM plus additional peaks at harmonic frequencies. Both plots can be read easily; however, the plot in Figure 4-5C shows much sharper clarity. This type of plot is obtained by selecting the 10% filter bandwidth and 600-600 CPM range, which provides 8 x AVERAGING in the plotting.

6) OSCILLOSCOPE DISPLAY OF SPIKE ENERGY SIGNAL CHARACTERISTICS

If desired, the waveform of the SPIKE ENERGY signal voltage can be displayed on an oscilloscope for analysis. This display is obtained by connecting the output signal provided at the Model 880 SCOPE OUTPUT connector (on the left-hand side panel) to the oscilloscope as described in Chapter 3. A typical SPIKE ENERGY signal waveform is shown in Figure 4-6.

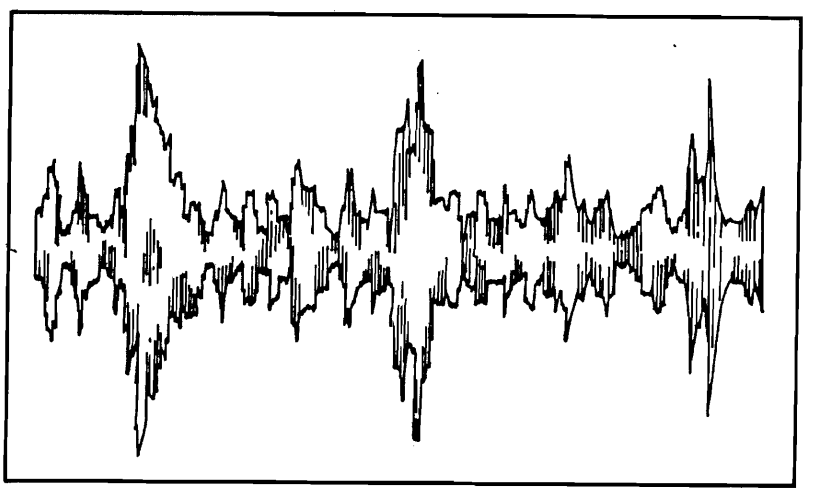


FIGURE 4-6 SPIKE ENERGY SIGNAL SCOPE OUTPUT DISPLAY

4.9 SOUND (NOISE) MEASUREMENT AND ANALYSIS

When used with the optional Model 308 Vibration/Sound Level Meter, the 880 instrument will analyze the amplitude and frequency of machinery noise. A **Sound Spectrum Plot** is generated as follows:

1) Set up the analyzer for operation as described in Chapter 3.

2) Locate the Model 308 Meter so that it is correctly positioned to measure the sound. See the Model 308 Operation Instruction Manual for further details.

3) Set up the 880 instrument controls as follows:

AMPLITUDE	1 (10 for metric)
UNITS:	VELOCITY
FUNCTION:	FILTER OUT
MODE:	FREQUENCY
FREQ RANGE:	600-600K CPM

4) Adjust the AMPLITUDE selector on the Model 308 to obtain a meter indication of 1/3 Full Scale to Full Scale on the Model 308 Amplitude meter. The Amplitude meter on the 880 instrument should indicate approximately the same filter-out reading as that on the Model 308.

5) Set the FUNCTION selector to BROAD (or SHARP), and depress the START/STOP pushbutton to start the plot.

6) Although the sound spectrum plot has units of **IN/SEC PK** printed on the heading, the actual amplitude levels recorded will be in **dB** (decibel) units. Also, the amplitude scale printed out will show a full scale value of 1. This should be corrected to read the dB value of the Model 308 unit AMPLITUDE selector position plus 10dB. For example, if the Model 308 unit AMPLITUDE selector is set to 80 dB, then the full scale value on the spectrum plot will be 90 dB. To mark the plot amplitude scale with the correct dB values, use the dB scale on the Model 308 meter or the approximate values listed in Table 4-2.

   In Table 4-2, the relationship between the linear scale of the 880 instrument spectrum plot (or amplitude meter) and the equivalent dB value is described. In general, the actual dB value to be read from the linear plot scale is calculated by subtracting the listed dB equivalence factor (for the particular scale percentage) from the full scale dB value determined above.

TABLE 4-2 LINEAR SCALE TO dB EQUIVALENCE

LINEAR SCALE PERCENTAGE	dB EQUIVALENCE FACTOR	EXAMPLE (FOR 90 dB FULL SCALE)
100% Full Scale	0 dB	90 dB
79 Full Scale	-2	88 dB
63 Full Scale	-4	86 dB
50 Full Scale	-6	84 dB
40 Full Scale	-8	82 dB
32 Full Scale	-10	80 dB
10 Full Scale	-20	70 dB

4.10 IN-PLACE SINGLE PLANE BALANCING

The Model 880 instrument may be used to perform precision Single Plane balancing. The built-in plotter generates prompting instructions which list the proper balancing procedures. The data that is then recorded on the printout by the operator may be processed using the Vector-Graphic analysis technique, or entered in sequence into a pre-programmed calculator. The general procedures for balancing are listed as follows:

1) Install a phase reference mark on the rotating machine shaft or wheel. If feasible, also install a stationary angle reference disc on the machine as shown in Figure 4-7, Page 4-18.

   The phase reference mark can consist of a chalk mark, or any distinctive machine mark, such as a shaft keyway. When the mark is placed at the end of a shaft, or wheel, it should originate at the center and extend radially to the outer edge. The same rotating speed must be used for all measurements performed during the balancing.

2) Fasten the Model 970 vibration pickup to the machine at the position selected close to the vibrating part having the greatest displacement. Either the horizontal or vertical mounting direction can be used, whichever provides the highest vibration reading.

CAUTION: The vibration pickup must remain at the same mounting position throughout the balancing operations.

3) Start the rotating machine and allow it to come up to the normal operating speed.

4) Set up the 880 instrument as described in Chapter 3, and adjust the controls as listed below:

   UNITS: DISP
   FREQ RANGE: 60-60K CPM
   FUNCTION: Filter OUT

5) Adjust the AMPLITUDE selector to obtain an Amplitude meter reading in the upper 2/3rds of the meter scale.

6) Depress the VIB FREQ pushbutton, and set the FUNCTION selector to OSC.

7) Adjust the FREQUENCY tune control to the RPM frequency of the shaft or moving part as follows:

   a) Turn on the strobe light, and flash the light onto the rotating shaft.

   b) While using the strobe, adjust the FREQUENCY tune control to produce a stationary image of the part.

   c) The frequency reading indicated on the LCD at this point is the correct RPM value.

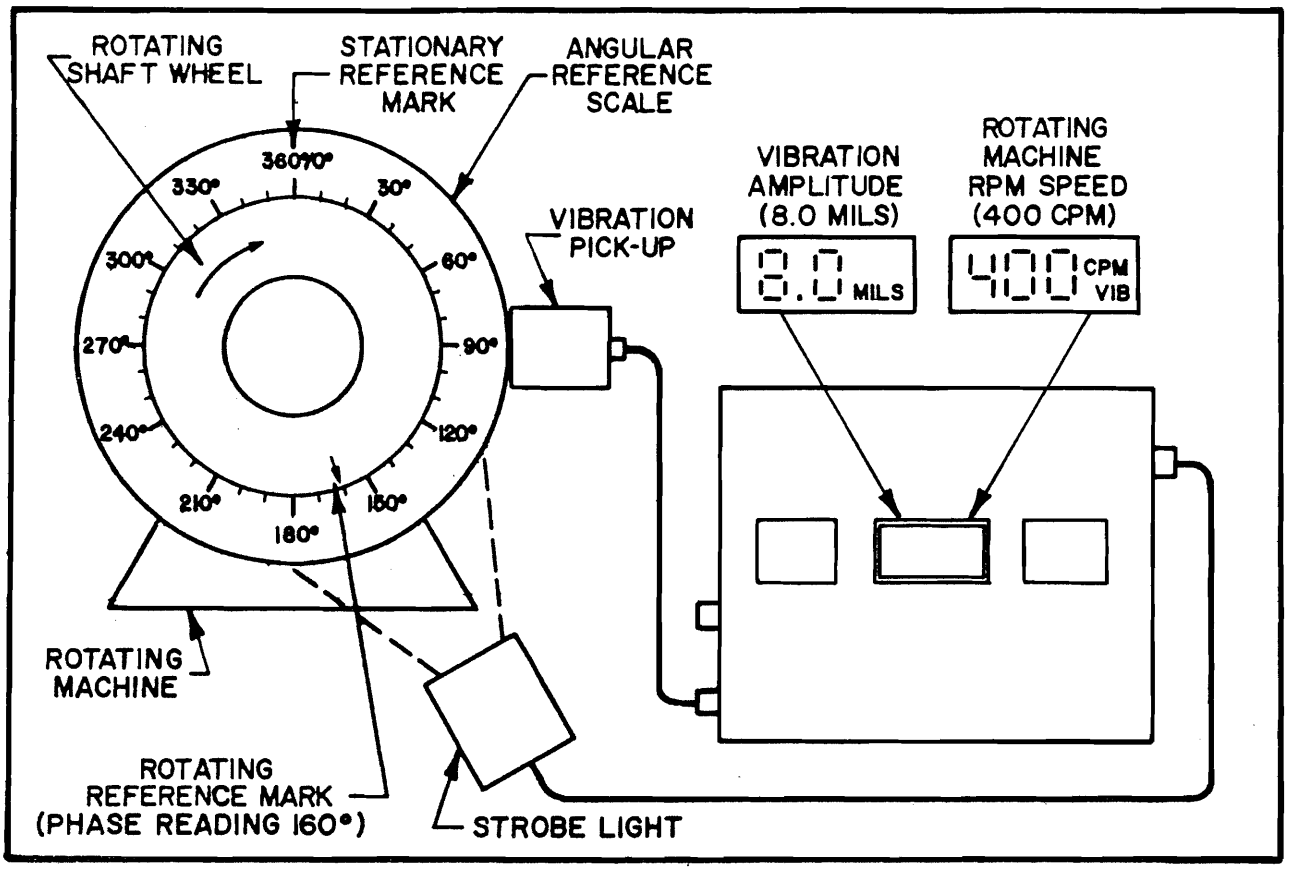


FIGURE 4-7 ORIGINAL UNBALANCE READINGS

8) Set the FUNCTION selector to BAL and depress the **I-PL** pushbutton. The built-in plotter will print out the first segment of the balancing procedure which is shown as follows:

```
BALANCE <1 - PL>
MACH I.D. FAN
SPIN ROTOR
ORIGINAL BAL
 160   DEG*   1
 8.0   MILS   2
*MEAS CW FROM
 STATNRY REF MRK
 TO ROTOR REF MRK
STOP ROTOR
```

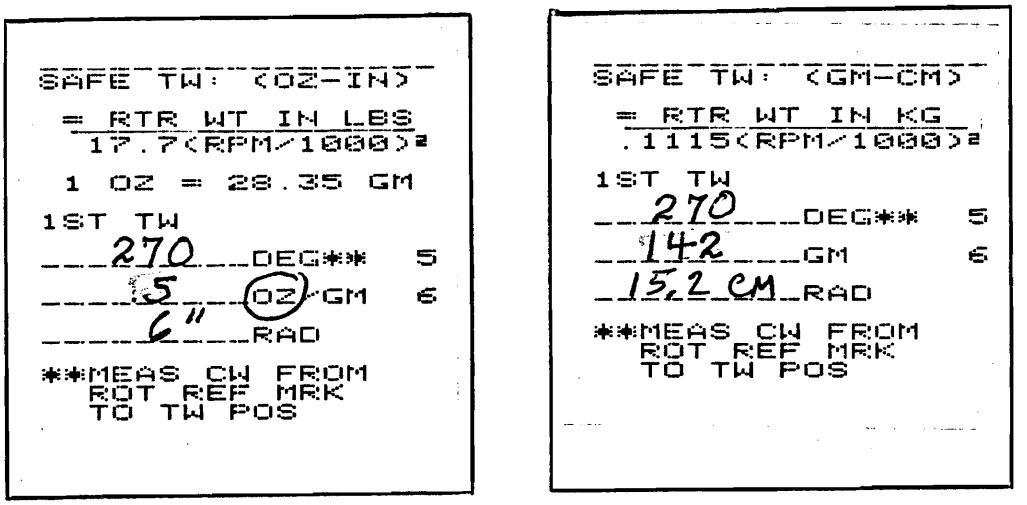
ENGLISH

```
BALANCE <1 - PL>
MACH I.D. FAN
SPIN ROTOR
ORIGINAL BAL
 160   DEG*   1
 203   UM     2
*MEAS CW FROM
 STATNRY REF MRK
 TO ROTOR REF MRK
STOP ROTOR
```

METRIC

9) With the machine operating at the balancing speed and the analyzer filter tuned to the precise RPM frequency, depress the AMPL pushbutton and observe the LCD display reading. If necessary, readjust the AMPLITUDE selector to obtain the proper level of reading on the analog Amplitude meter. Record this original unbalance amplitude (displayed in the LCD) and the angular reading of the phase reference mark on the printout. In Figure 4-7, sample readings of a 160° phase angle and 8.0 mil amplitude are shown.

10) Stop the rotating machine, and depress the **I-PL** pushbutton. The following segment of the balancing sequence will be printed out:



ENGLISH METRIC

11) Using the equation provided on the printout, calculate a safe trial weight and install a weight of this value on the rotor or shaft at any angular spot. The amount of weight used, the installation angle, and the radius from the machine shaft center is then recorded on the printout. A consistent radius value is generally used throughout the balancing steps to simplify the Trial Weight selection.

WARNING: FASTEN ALL BALANCING WEIGHTS SECURELY.

12) Restart the rotating machine and allow it to come up to the normal speed. Depress the I-PL pushbutton; the following segment of the procedure will be printed out:

```
SPIN ROTOR
1ST TW BAL
____110___DEG*    3
____3.1___MILS    4
STOP ROTOR
REMOVE TW
```

ENGLISH

```
SPIN ROTOR
1ST TW BAL
___110____DEG*    3
___79_____UM      4
STOP ROTOR
REMOVE TW
```

METRIC

13) Set the FUNCTION selector to OSC, and depress the VIB FREQ pushbutton. Recheck the tuning of the FREQUENCY tune control using the strobe light, and adjust if necessary. Set the FUNCTION selector back to BAL, and depress the AMPL pushbutton. Record the trial balance phase angle and amplitude on the printout.

In Figure 4-8, sample readings of 110° and 3.1 mils are shown.

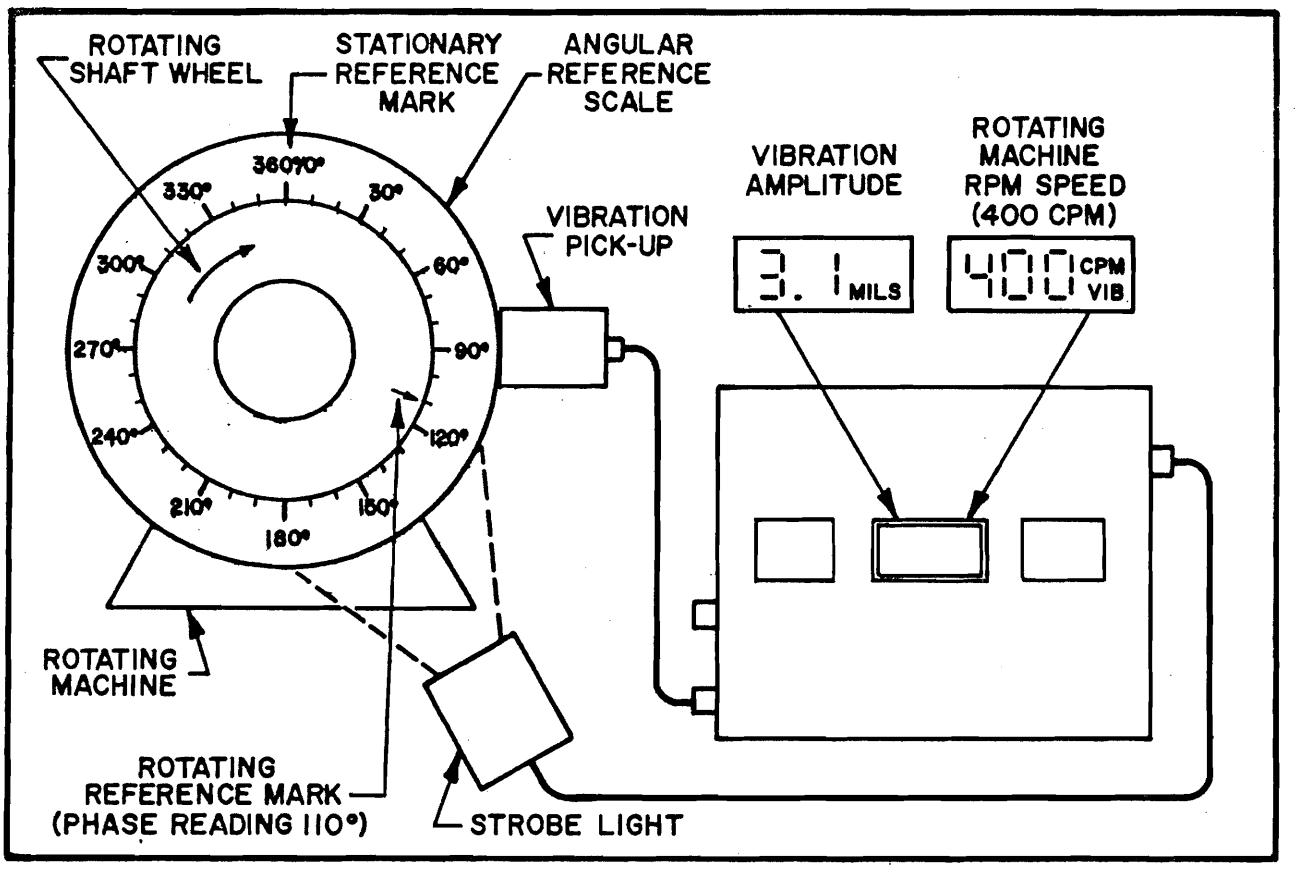


FIGURE 4-8 UNBALANCE READINGS WITH TRIAL WEIGHT INSTALLED

14) Stop the rotating machine, and remove the Trial Weight.

15) Calculate the required Correction Weight and the angle for installing the weight. To perform this calculation, the balancing data may be entered into a calculator program as described in **Appendix D**, or the Vector-Graphic technique may be utilized as follows:

a) On polar graph paper, construct a vector diagram similar to one illustrated in Figure 4-9. The original angle and weight values O (items 1 and 2) are used to draw Vector **O**, and the trial angle and weight values (items 3 and 4) are used to draw Vector **O+T**. The outer ends of Vectors **O** and **O+T** should be connected together and labelled Line **T**.

b) Using a protractor, measure the angular distance from Vector O to Line **T**. Then shift the Trial Weight by this angular distance in the opposite direction from the shift of the Phase Reference reading obtained in Step 13. For example, in Figure 4-9, the angular distance from Vector **O** to Line **T** is 20°, and in Figure 4-8 the Phase Reference Mark shifted from 160° (the original position shown in Figure 4-8) to 110°. Since the Phase Reference Mark shifted in the counter-clockwise direction, the correction weight must be installed 20° in the clockwise direction from the original position in Step 11.

c) Calculate the amount of Correction Weight required by multiplying the ratio of Vector **O** to the length of Line **T** (in terms of the measuring units being used) times the Trial Weight value as shown in the equation below:

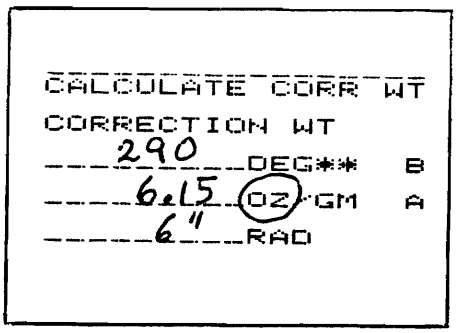
$$\text{CORRECTION WEIGHT VALUE} = (\text{TRIAL WEIGHT VALUE}) \times \frac{O}{T}$$

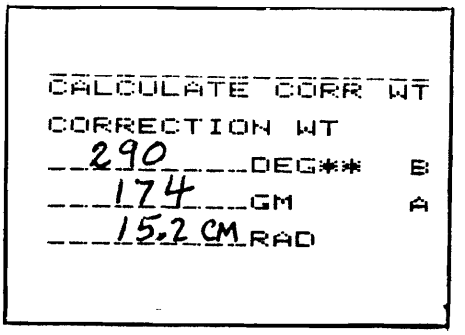
NOTE: In Figure 4-9, the length of Line **T** is 6.5 mils, and the length of Vector **O** is 8.0 mils. If the original Trial Weight weighed 5 ounces, then the final amount of correction weight required for balancing the rotating machine would be computed as shown in the following example:

(1) $\text{CORRECTION WEIGHT VALUE} = (5 \text{ ounces}) \times \frac{8 \text{ mils}}{6.5 \text{ mils}}$

(2) CORRECTION WEIGHT VALUE = 6.15 ounces.

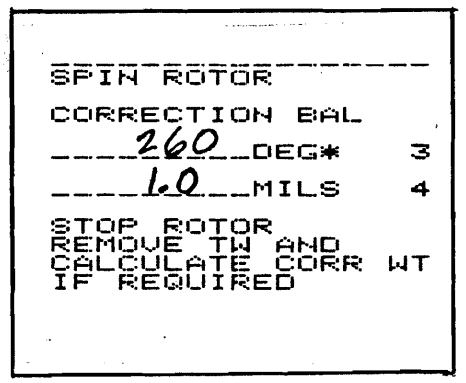
d) Depress the **1-PL** pushbutton, and record the correction weight data on the printout from the Vector-Graphic technique above, or from the calculator program. (See the printout at top of next page.)

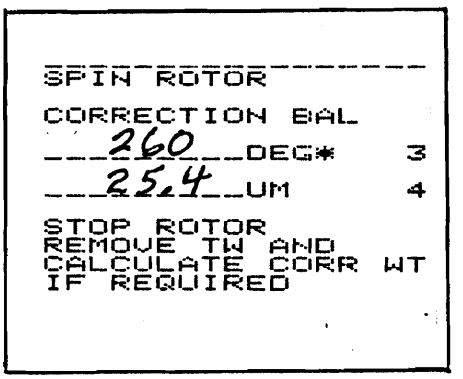




ENGLISH METRIC

16) Install the correction weight and bring the machine up to normal speed. Depress the 1-PL pushbutton, and record the balance information on the printout as shown below.





ENGLISH METRIC

17) Because the vector diagram may not be drawn with precise accuracy, the vector lengths may not correspond exactly to the vibration amplitudes. Therefore, compensate for possible error, one or additional TRIM BALANCE RUNS may be required to meet the required balancing tolerances. Calculate an additional correction, using the Vector-Graphic technique or calculator program. When performing a TRIM BALANCE using the Vector-Graphic method, the newest O+T value is to be compared to the original O value. Depress the 1-PL pushbutton and record the trim balance correction information on the printout shown at the end of Section 4.10.

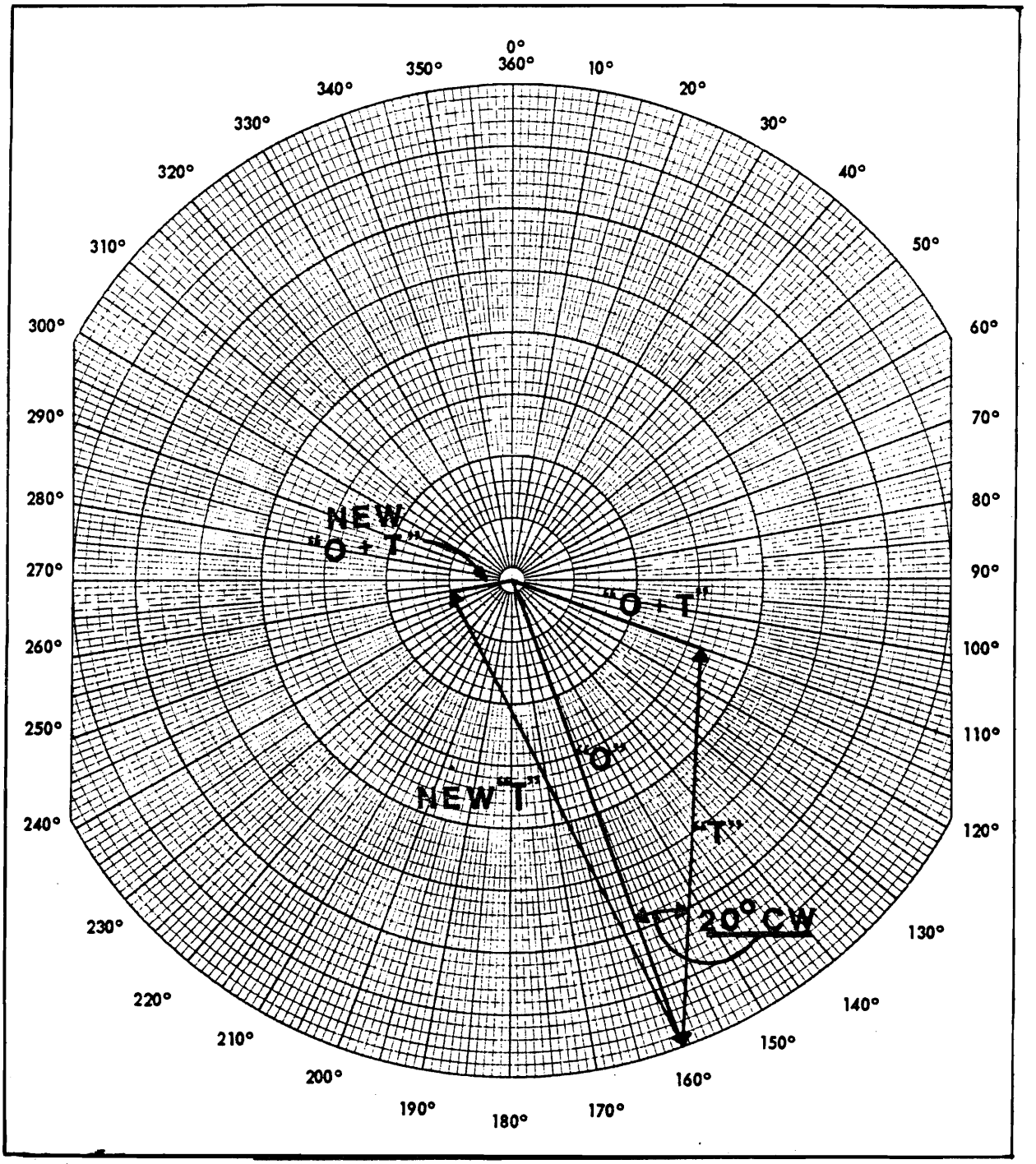
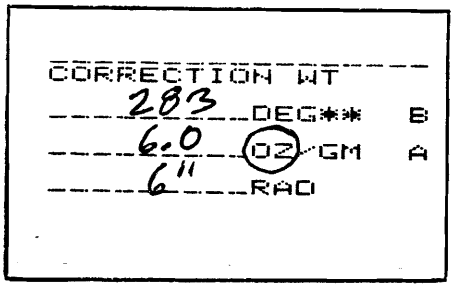
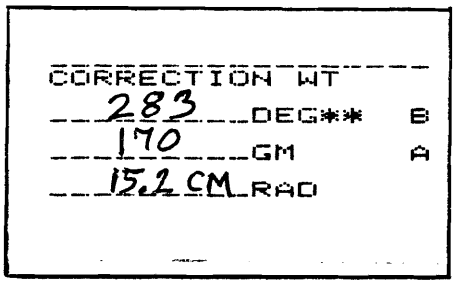


FIGURE 4-9 SAMPLE VECTOR DIAGRAM





ENGLISH METRIC

NOTE: Depress the CLEAR/RESET pushbutton to terminate or restart the balancing printouts.

Detailed instructions and in-depth training on balancing are available through the IRD MECHANALYSIS, Inc., Audio-Visual Training Programs. Information regarding the training programs can be obtained by contacting your nearest IRD MECHANALYSIS representative, or by writing to IRD MECHANALYSIS, Inc.

4.11 IN-PLACE TWO PLANE BALANCING

To perform the Two Plane Balancing sequence, the same procedures listed in Section 4.10 are used, with the exception that the **2-PL** pushbutton is depressed. The various printouts include prompting messages for obtaining the Near and Far end balance data, and for calculating the proper trial weight values. For additional information on Two Plane Balancing and the use of calculator programs to solve the balancing equations, refer to **Appendix D.**

V SERVICE

5.1 GENERAL

This chapter consists of basic trouble-shooting and maintenance information for the Model 880 Vibration Analyzer/Balancer. Generally, the operational checks, etc., required can be performed by the instrument operator. For complete service information, contact your nearest IRD MECHANALYSIS Customer Service Agency. See the addresses in Section 5.5 of this manual.

5.2 FIELD MAINTENANCE

Field Maintenance of the Model 880 instrument and accessories consist of the following operations which do not require the use of electronic test equipment:

A. Checking the interconnection cables for proper installation and operation.

B. Replacing the power fuses.

C. Checking the Model 880 instrument and accessories for proper setup.

Checking Interconnection Cables

Check the interconnection cables for correct installation (See Chapter III).

Check that all plug-in, twist lock, and threaded connectors are fully seated in the receptacles. The threaded connectors should be installed finger-tight.

Move the connector slightly to check for intermittent cables. Replace all worn, damaged, or intermittent cables. See the Part Numbers listed in Chapter II.

Replacing the Power Fuse

The AC Power Fuse is located above the AC Input Receptacle on the right-hand side panel. The fuse is contained in a snap-in clip which is easily removed using a sharp object. The fuse clip also has space for storing a spare fuse. The proper amperage fuse to be used for the AC voltage connected to the Model 880 is listed on the instrument panel adjacent to the AC Input Receptacle.

WARNING: Do not use a higher amperage fuse than listed as serious damage to the instrument could result. If the fuse blows repeatedly, return the instrument and accessories for service before using.

Checking Preparation and Setup

Instructions for preparing and setting up the Model 880 instrument and accessories for the standard operations are presented in Chapter III and IV. If satisfactory operation is not obtained, review these instructions, and make certain that the analyzer and accessories are prepared and set up correctly.

5.3 ORDERING REPLACEMENT PARTS

To order replacement parts, contact either your local IRD MECHANALYSIS Customer Service Agency, or the IRD home office; see addresses in Section 5.5. On your Purchase Order, specify the following information:

1. Model and complete Serial Number of instrument.
2. IRD MECHANALYSIS Part Number.
3. Name of part (capacitor, diode, resistor, etc.).
4. Reference Symbol (C101, D107, R321, etc.).

5.4 OBTAINING SERVICE

Before returning the instrument for repair, obtain service and shipping instructions from either your local IRD MECHANALYSIS Customer Service Agency, of the IRD home office (see addresses in Section 5.5). Package the instrument (and accessories (i.e., accelerometer, pickup cables, and extension cables) inside a strong carton. Each article must be well padded. In addition, information should also be included giving details as to the nature of the problem and the service desired.

5.5 CUSTOMER SERVICE AGENCIES

USA

IRD MECHANALYSIS, INC.
6150 Huntley Road
Columbus, Ohio 43229
Phone: 614/885-5376
Telex: 24:5318

IRD MECHANALYSIS, INC.
8969 Interchange Drive
Houston, Texas 77054
Phone: 713/667-0941

IRD MECHANALYSIS, INC.
Suite 207
2600 Warrenville Road
Downers Grove, Ill. 60515
Phone: 312/960-4065

IRD MECHANALYSIS, INC.
Suite 202
3130 Maple Drive, N.E.
Atlanta, Georgia 30305
Phone: 404/237-4875

IRD MECHANALYSIS, INC.
Suite A2
221 So. Chester Pike
Glenolden, Penn. 19036
Phone: 215/461-7060

IRD MECHANALYSIS, INC.
Suite 4
3377 Mount Diablo Blvd.
Lafayette, Calif. 94549
Phone: 415/283-2065

CANADA

IRD MECHANALYSIS LIMITED
333 Barton Street East
Stoney Creek, (Hamilton)
Ontario, Canada L8E 2L1
Phone: 416/662-7577
Telex: 061-8453
Telex: 851-617034 IRD MECH G

IRD MECHANALYSIS LIMITED
Room 301
524 17 Avenue, S.W.
Calgary, Alberta
Canada T2S 0B2
Phone: 403/228-5203
Telex: 03-824680

UNITED KINGDOM

IRD MECHANALYSIS (UK) LIMITED
Bumpers Lane
Sealand Industrial Estate
Chester, United Kingdom CH1 4LT
Phone: Chester 44/244/374914-5
Chester 44/244/317557-8

WESTERN EUROPE

IRD MECHANALYSIS, S.A.
Avenue Winston Churchill 98
B1180 Brussels, Belgium
Phone: 32/2/344.70.58
32/2/344.72.18
Telex: 846-61256 IRD BRU B

FRANCE

IRD MECHANALYSIS France S.a.r.l.
23a, Rue Brongniart
F92310 Sevres
France
Phone: (1) 534 42 96

AUSTRALIA

IRD MECHANALYSIS (AUSTRALIA)
PTY. LTD.
337 Pacific Highway
Crows Nest, NSW 2065
Australia
Phone: (02) 929 8122
Telex: AA 23193

INDIA

IRD MECHANALYSIS (INDIA) LTD.
47/48 Jolly Maker Chambers II
Nariman Point
Post Office Box 991
Bombay 400 021, India
Phone: 230430
Telex: 953-11-3209 CIPL IN

APPENDIX A

SPECIFICATIONS

Model 880 Microprocessor Analyzer-Balancer Instrument A-1

Model 970 Accelerometer Pickup A-3

Model 544 Velocity Pickup A-5

Model 560 Velocity Pickup A-7

SPECIFICATIONS, MODEL 880 MICROPROCESSOR ANALYZER-BALANCER INSTRUMENT

FREQUENCY RANGE
- 60 to 600,000 CPM (1 to 10,000 Hz)

TUNABLE FILTER RANGE
- 60 to 600,000 CPM in two ranges: 60 to 60,000 CPM and 600 to 600,000 CPM

TUNABLE FILTER CHARACTERISTICS
- Broad Filter: 10% BW (Q = 10) for fast plotting
- Sharp Filter: 5% BW (Q = 20) for high resolution
- Balance Filter: 2.8% BW (Q = 35) for Balancing
- Automatic Filter Sweep: 60-60,000; 600-600,000 CPM
- Manual Filter Tune: 60-60,000; 600-600,000 CPM

INTERNAL OSCILLATOR RANGE
- 60 to 600,000 CPM in two ranges: 60-60,000; 600-600,000 CPM

STROBOSCOPIC LIGHT
- High intensity strobe
- One flash per cycle to 15,000 CPM; submultiple firing to 600,000 CPM

DISPLACEMENT RANGES (SEE NOTE*)
- English: 0 to 100 mils in nine full-scale overlapping ranges: 0 to .03; 0 to 1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 mils peak-to-peak
- Metric: 0 to 3,000 micrometers in nine full-scale overlapping ranges: 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 micrometers peak-to-peak

VELOCITY RANGES (SEE NOTE*)
- English: 0 to 100 inches/sec in nine full-scale overlapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 inches/sec peak
- Metric: 0 to 3,000 millimeters/sec in nine full-scale overlapping ranges: 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 millimeters/sec peak (or RMS factory option)

ACCELERATION RANGE (with Model 970)
- English and Metric: 0 to 100 g's in nine full-scale overlapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 g peak (1 g = 386 inches/sec^2, or 980 cm/sec^2)

SE (SPIKE ENERGY) UNITS RANGE
- English and Metric: 0 to 100 g's SE in nine full-scale overlapping ranges: 0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 g's SE with special circuits designed to detect and analyze **SPIKE ENERGY** (SE) units.

TEST SIGNAL
- Internally generated test signal operates on AC or battery power—checks circuit operation in test. Test signal is synchronous to and in phase with the line power when switched to AC PWR.

BATTERY CHECK
- Digital "LO BATT" indicator
- Analog Meter display of battery voltage to indicate remaining battery operating time in BATT CK
- Analog Meter of battery voltage when charging (Power switch off) to indicate charge condition.

INPUTS
- Two input channels, switch selectable for analysis and balancing with four transducers (544, 560, 970 or non-contact inputs of 200 mv/mil (8 mv/um), or acoustic input from Model 308 Vibration/Sound Level Meter.

OUTPUTS:
- Built-in XY Printer/Plotter provides annotated frequency and time plots.
- Diagnostic tabular printout to aid in data interpretation.
- Harmonic Markers on spectrum plots to aid in identification of harmonic vibrations
- Display and Printout of RPM
- Printout of overall amplitude: average, maximum and minimum levels over 6 second sample period, at start of frequency plots.
- Printout of prompting messages to guide operator through single-plane and two-plane balancing.
- D.C. Power Output (−24 volts) to drive non-contact signal sensors.
- Analog Amplitude Meter
- Analog Frequency Meter
- Digital Amplitude Meter; covers range of 3½ digits (.0000 to 1500 English, or .0000 to 15K metric).
- Digital Frequency Meter; covers range of 60 to 600,000 CPM.
- Digital Display of Measurement Units: English: Mils P-P, in/sec Pk, g Pk. Metric: Micrometers P-P, mm/sec Pk, or RMS (factory option) g Pk.
- Scope/Tape Recorder AC Output Receptacle.
- Strobe Light Output Receptacle.
- XY Plotter Output Receptacle—DC outputs of amplitude, frequency, penlift and (zero-full scale) calibration.
- AC Power Outlet Receptacle.
- Signal overscale indication.

*NOTE: FOR DISPLACEMENT OR VELOCITY READINGS BELOW 200 CPM, OPTIONAL LOW FREQUENCY PICKUP (MODEL 560) IS RECOMMENDED.

TEMPERATURE RANGE
- 5° to +122°F (−15° to + 50°C) on AC power
- 5° to +122°F (−15° to + 50°C) on battery power (not charging)
- 5° to +122°F (−15° to + 50°C) charging.

OVERALL DIMENSIONS:
- Analyzer: 17" × 14" × 6½" (43.2 cm × 35.6 cm × 16.5 cm)

WEIGHT:
- Analyzer (with built-in battery): 32 lbs. (14.5 Kg)
- Analyzer (with built-in battery and standard accessories): 36 lbs. (16.4 Kg)

POWER REQUIREMENTS
- AC Power: 50 to 400 Hz; 90 to 250 volts, 25 watts.
- Battery Power: Built-in, replaceable sealed rechargeable Gel Cel battery pack; 10 hours operation of instrument; 2 hours minimum continuous operation of strobe at maximum flash rate.
- Battery Charger: Automatic charge whenever on AC Power with circuit to prevent overcharge. Maximum charging rate available when power switch is turned off.

STANDARD ACCESSORIES

1—Model 970 Accelerometer, P/N 19697
1—Straight Probe, P/N 1103
1—12 ft. (3.7 m) Pickup Cable for Model 970, P/N 20431
1—Model 571 Stroboscopic Light, P/N 28830.
1—12 ft. (3.7 m) Strobe Cable for Model 571 Strobe, P/N 28836
1—Power Cable, P/N 19643
8—Rolls Thermal Printer Paper, P/N 24444.
2—Fuses for 220 VAC Operation, P/N 28578
1—Self Training Module P/N 29177
1—Operating Instructions Manual, P/N 28838.

OPTIONAL ACCESSORIES
- Model 544 Vibration Velocity Pickup, P/N 4526
- 12 ft. (3.7 m) Pickup Cable for Model 544, P/N 20433
- Magnetic Pickup Holder for Model 544 and Model 970. P/N 4332
- Magnetic Shield for Model 544 Transducer, P/N 10449
- Non-Contact Displacement Accessories:
  - Single Channel, P/N 29093
  - Dual Channel, P/N 29094
- 12 ft. (5.7 m) Extension Cable for Strobe Light, P/N 28836.
- 25 ft. (7.6 m) Extension Pickup Cable for Model 970 Accelerometer, P/N 21044
- 25 ft. (7.6 m) Extension Pickup Cable for Model 544 Transducer, P/N 21045
- 50 ft. (15.2 m) Extension Pickup Cable for Model 970 Accelerometer, P/N 21048
- 50 ft. (15.2 m) Extension Pickup Cable for Model 544 Transducer, P/N 21049
- 12 ft. (3.7 m) Non-Contact Monitor Pickup Cable with BNC connector for connection to non-contact monitor outputs with sensitivity of 200 mv/mil (8 mv/um), P/N 24809
- 12 ft. (3.7 m) Non-Contact Signal Sensor pickup cable with spade lugs to connect to non-contact signal sensors with sensitivity of 200 mv/mil (8 mv/um), P/N 22874.
- 12 ft. (3.7 m) Non-Contact Signal Sensor Pickup Cable with spade lugs to connect to non-contact signal sensor, P/N 29030. Similar to P/N 22874, but with an added wire and spade lug to apply power (−24V) to the signal sensor.
- 3.3 ft. (1.0 m) power cable to enable Model 1080 or 1081 to receive power from Model 880, P/N 19644
- Model 560 Low Frequency Velocity Transducer, P/N 24957
- 12 ft. (3.7 m) Pickup Cable for Model 560, P/N 25136
- 25 ft. (7.6 m) Extension Pickup Cable for Model 560, P/N 25137
- 50 ft. (15.2 m) Extension Pickup Cable for Model 560, P/N 25138
- Model 308 Vibration/Sound Level Meter
- One lot (48 rolls per lot) of chart paper; sold only by lots, P/N 24444
- Calibrator, P/N 21073
- Vibration Chart Storage Notebook with 50 Filler Sheets, P/N 25864
- Package of 100 Extra Notebook Filler Sheets, P/N 25865
- Accessory Case, P/N 25345

® IRD is a registered trademark of IRD Mechanalysis, Inc.
TM SPIKE ENERGY is a trademark of IRD Mechanalysis, Inc.

THIS PAGE LEFT BLANK
INTENTIONALLY

MODEL 970 ACCELEROMETER SPECIFICATIONS

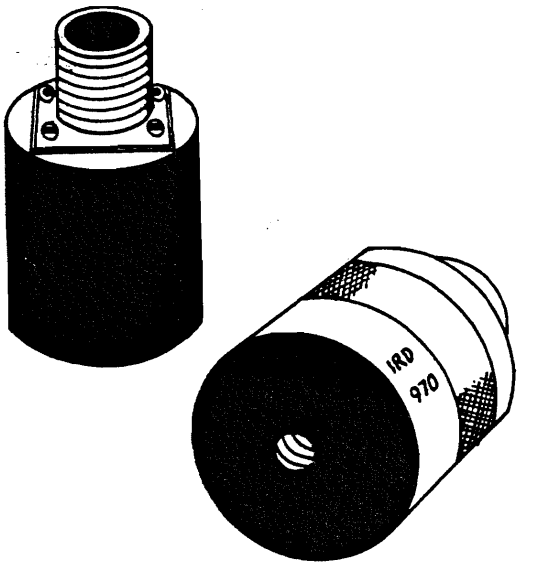
DESCRIPTION

The IRD Model 970 is a rugged low impedance accelerometer type vibration pickup for use with portable instruments on all types of rotating machinery.

The Model 970 has built-in electronics to provide low impedance output and eliminate the need for special low noise cables. The Model 970 is sealed against dust and moisture and operates up to a temperature of 250°.

A single 1/4-28 mounting stud is used for attaching the pickup to a flat machine surface. Insulated Mounting Adapters are available for those cases where ground potential problems may exist between the pickup mounting surface and instrument.

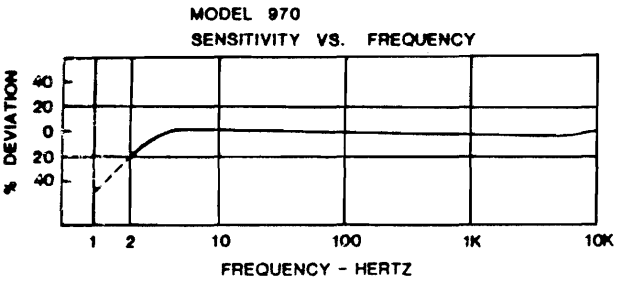
The Model 970 connect directly to IRD Model 810, 840, 880 and other IRD instruments designed to accept the 970. Operating power is obtained from the instrument.



SPECIFICATIONS:

Sensitivity: 50 mV/g Nominal

Frequency Response:



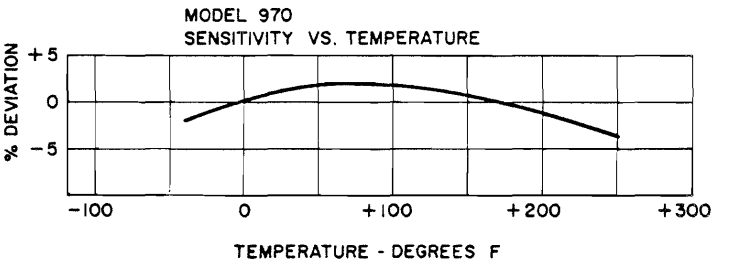
Mounted Resonant Frequency: 27K Hz Minimum

Maximum Usable Amplitude: (Undistorted) 180 g peak up to 1 k Hz
120 g peak at 5K Hz, or
70 g peak at 10 K Hz with ± 15v power supply and 25 ft. of 50 pF/ft. cable. Longer cables may be used with some reduction in maximum amplitude and/or high frequency response.)
(Maximum amplitude is reduced proportionally at lower supply voltage)

Maximum Vibration: (without damage) 1000 g peak sinusoidal vibration

Maximum Shock: (without damage) 2000 g peak (10 ms half-sine)

Temperature Response:



Orientation: Any

Tranverse Response: 5% Maximum, 3 % Typical

Magnetic Field Sensitivity: Less than .001 equiv. g/Gauss at 60 Hz

Residual Noise: Less than .0002 equiv. g broadband — transducer output.

Grounding: Case isolated from signal ground

Power Supply: Regulated ± 8 Vdc @ ± 1.2 ma max. to ± 15 Vdc @ ± 1.75 ma max.

Housing: 300 series stainless steel, waterproof, dustproof, welded case

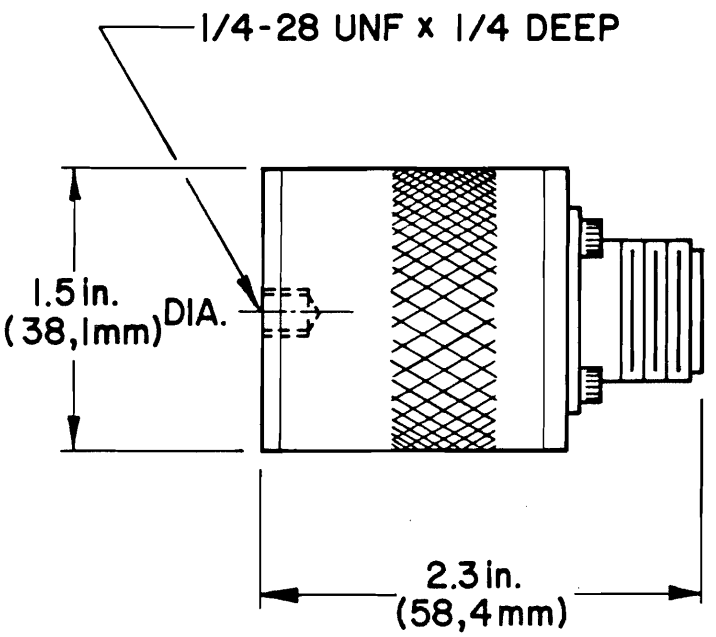
Connector: 4 Pin MS Type 12s-10P

Weight: 7.7 oz. (220 gr.)

Mounting: 1/4-28 Tapped Hole, 1/4" Deep

MODEL 970 ACCELEROMETER SPECIFICATIONS Continued

OUTLINE DRAWING



INSTALLATION NOTES

1. Mounting surface must be flat and smooth, mounting stud must be square with surface and must not exceed 1/4" length.
2. Install with light coating of silicone grease on mating surface, tighten to 30-50 inch-pounds torque.
3. Connector Pin A + DCV power supply, Pin B — DCV power supply, Pin C is signal and power supply common, Pin D signal output.

ACCESSORIES

Insulated Mounting Stud (See Spec Sheet 43-08).

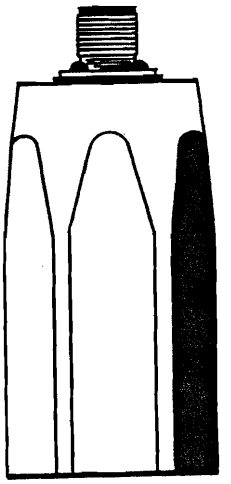
Magnetic Holder P/N 4332

Straight Probe P/N 1103.

MODEL 544 VELOCITY PICKUP SPECIFICATIONS

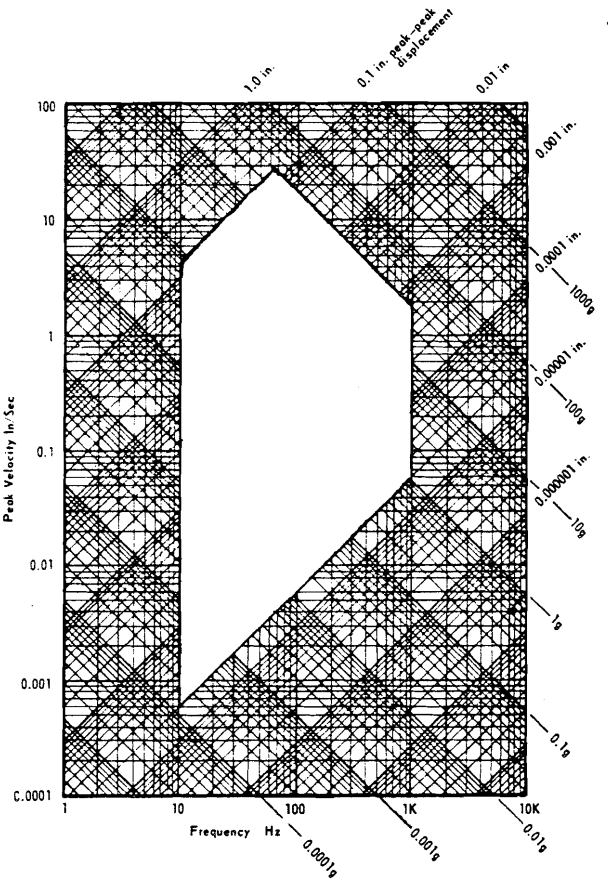
DESCRIPTION

The Mechanalysis Model 544 Vibration Pickup is a seismic velocity transducer, consisting of a moving coil in a permanent magnetic field, with eddy-current damping. This pickup is suitable for a wide variety of manual and continuous monitoring applications due to its high output, low impedance wide frequency response, and rugged construction. The anodized aluminum housing is waterproof, dustproof, and acceptable for use in Division 2 hazardous areas. A variety of accessories are available.



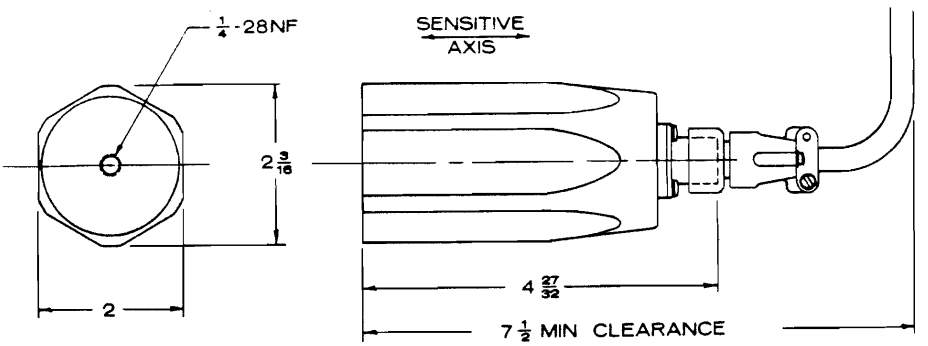
SPECIFICATIONS

Frequency Range:	10 Hz-1000 Hz
Sensitivity:	764 ± 10% mV RMS/in/sec (peak)
Temperature Range:	−40°F to +500°F (−40°C to +260°C)
Impedance:	R = 2K ohms; L = 0.7Hy
Damping Factor:	0.7 (critical)
Orientation:	Any
Transverse Response:	Less than 5% (average) between 10 Hz and 1000 Hz
Magnetic Field Sensitivity:	0.15 inches/sec/gauss
Housing:	Waterproof, dustproof
Connector:	2-pin 732S-10SL-4P
Weight:	21 oz.
Grounding:	Case and signal ground common
Mounting:	1/4-28 tapped hole, 1/4 deep
Max Amplitudes:	125 mils pk-pk to 70 Hz; 30g above 70 Hz



MODEL 544 VELOCITY PICKUP SPECIFICATIONS Continued

OUTLINE DIMENSIONS



INSTALLATION

1. Sensitive axis may be oriented in any direction
2. Mounting surface must be flat, smooth, at least 2 3/8 in. dia.
3. Mounting stud axis must be perpendicular to mounting surface
4. Pickup should be installed hand-tight
5. Connector pin A is signal ground and housing ground; pin B is signal.

ACCESSORIES (see Spec Sheets for detailed information)

1. Magnetic Shields—to reduce sensitivity to A.C Magnetic Fields by 100:1 P/N 10449 (See Spec Sheet 43-02)
2. Explosion-proof Enclosure—for installations in Division 1, Class I, Group D or Class II Groups E, F, G Hazardous Areas P/N 4224 (See Spec Sheet 72-01)
3. Safety Barrier—for intrinsically safe installations in Division 1, Class I, Groups B, C, D Hazardous Areas P/N 7685 (See Spec Sheet 43-02)
4. Straight Cable Connector P/N 4366 (Rated for continuous operation at 200°F or 93°C)
5. Straight Cable Connector P/N 15039 (Rated for continuous operation at 500°F or 260°C)
6. Right Angle Connector P/N 14797 (Rated for continuous operation at 200° F or 93° C)

MODEL 560 VELOCITY PICKUP SPECIFICATIONS

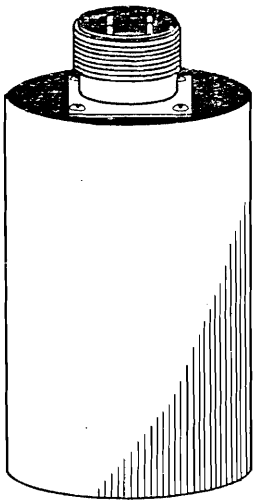
IRD Mechanalysis
VIBRATION PICKUP P/N 24957
MODEL 560

DESCRIPTION

The IRD Model 560 is a unique piezoelectric seismic velocity transducer designed specifically for low frequency applications. It has a flat frequency response ±10% from 1 Hz to 4.5 KHz. The high upper frequency limit makes it suitable for general machinery vibration measurements, as well as low frequency, while its built-in electronics provide a high output sensitivity and low impedance to enable it to drive long cables.

The low residual noise combined with low phase shift make it an ideal transducer for low speed balancing applications.

The Model 560 is designed to be waterproof, and is constructed of stainless steel with a ¼-28 tapped hole for stud mounting.

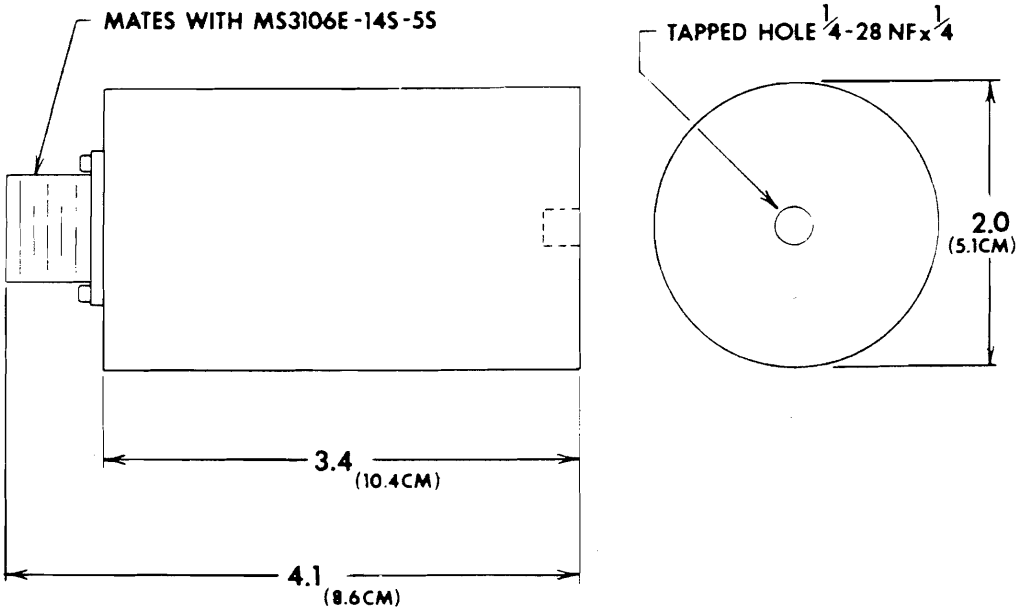


SPECIFICATIONS AT +75°F (+24°C)

Frequency Range:	Flat ±10% from 1 Hz to 4.5 kHz
Maximum Usable Amplitude (undistorted):	5 in/s peak
Residual Noise:	.0007 equivalent in/s broad band
Weight:	38 oz (1079 grams)
Size:	2" dia. O.D. 4" ht. (including receptacle)
Temperature Range:	−40°F to +250°F (−40°C to +121°C)
Output Units:	Velocity
Velocity Sensitivity:	1080 mv/in/s ± 5% at 100 Hz, or (764 mvRMS/in/s-pk)
Magnetic Field Sensitivity:	10^{-5} in/s/Gauss equivalent
Transverse Response:	5% maximum @ 10 Hz, 5 g peak
Max. Continuous Vibration:	250 g pk
Maximum Shock:	500 g pk
Mounting:	Centered ¼"-28 x ¼ deep hole
Mounted Natural Freq:	10K Hz minimum
Water Resistance:	Waterproof
Connector:	Top mounting, 5 pin M.S.
Grounding:	Case isolated from signal ground
Power Input:	±15 Vdc at ±5 mA maximum
Cable Drive Capability:	Drive 500 ft. (25,000 pF) cable without clipping of 1 kHz 5 in/s signal
Phase Shift:	10° at 7 Hz, 30° at 3 Hz maximum
Electronics:	Built-in amplifier

MODEL 560 VELOCITY PICKUP SPECIFICATIONS Continued

OUTLINE DIMENSIONS



INSTALLATION NOTES:

1. Mounting surface must be flat and smooth.
2. Install with light coating of silicone grease on mating surfaces.
3. Use ¼-28 stud mounting for permanent installation.
4. Use Magnetic Holder, P/N 4332, for temporary installation.

APPENDIX B

Guideline

Vibration Severity Charts

Page

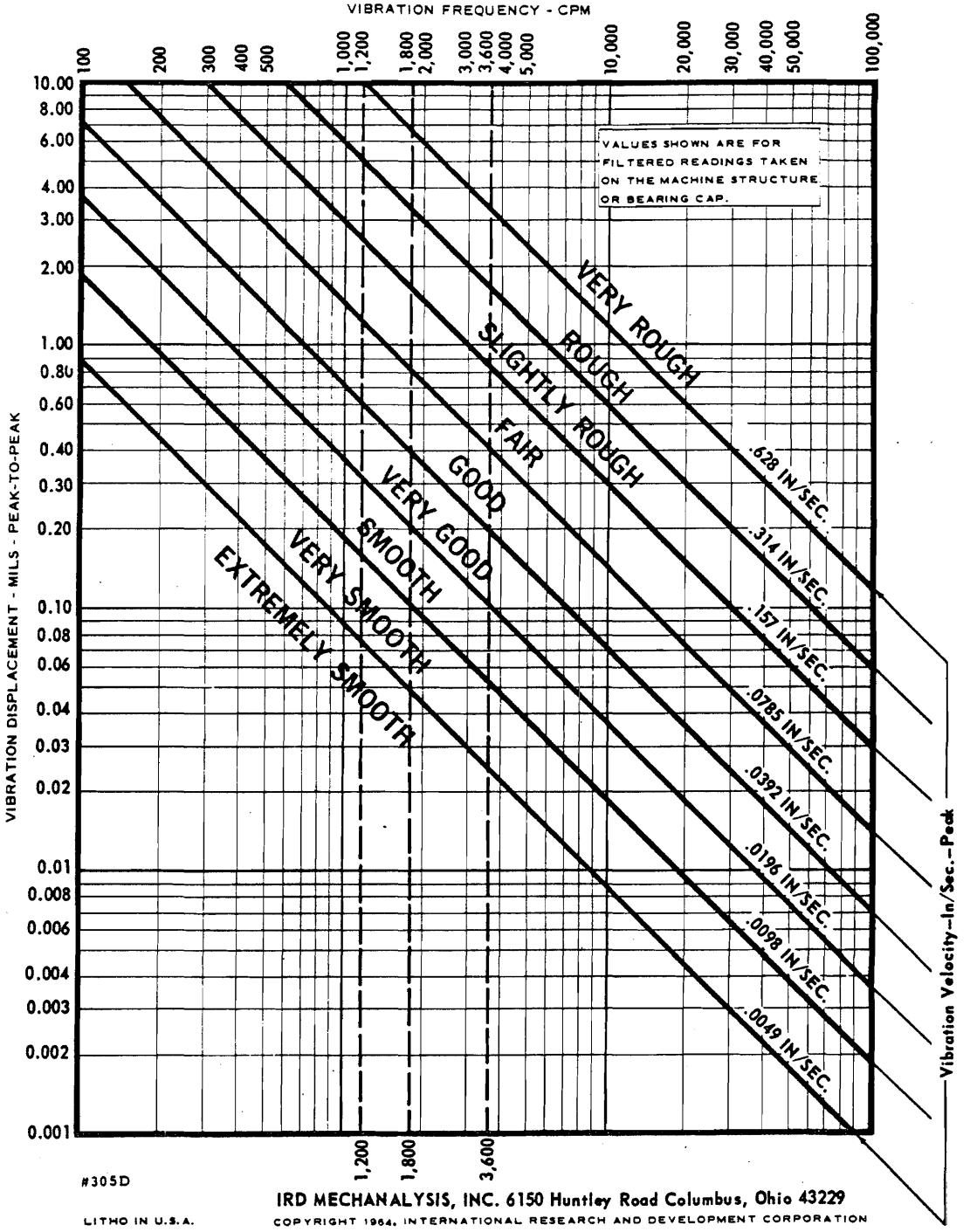
General Machinery Vibration Severity Chart in English B-1

General Machinery Vibration Severity Chart in Metric B-2

General Machinery Acceleration Severity Charge in English/Metric B-3

GENERAL MACHINERY
VIBRATION SEVERITY CHART

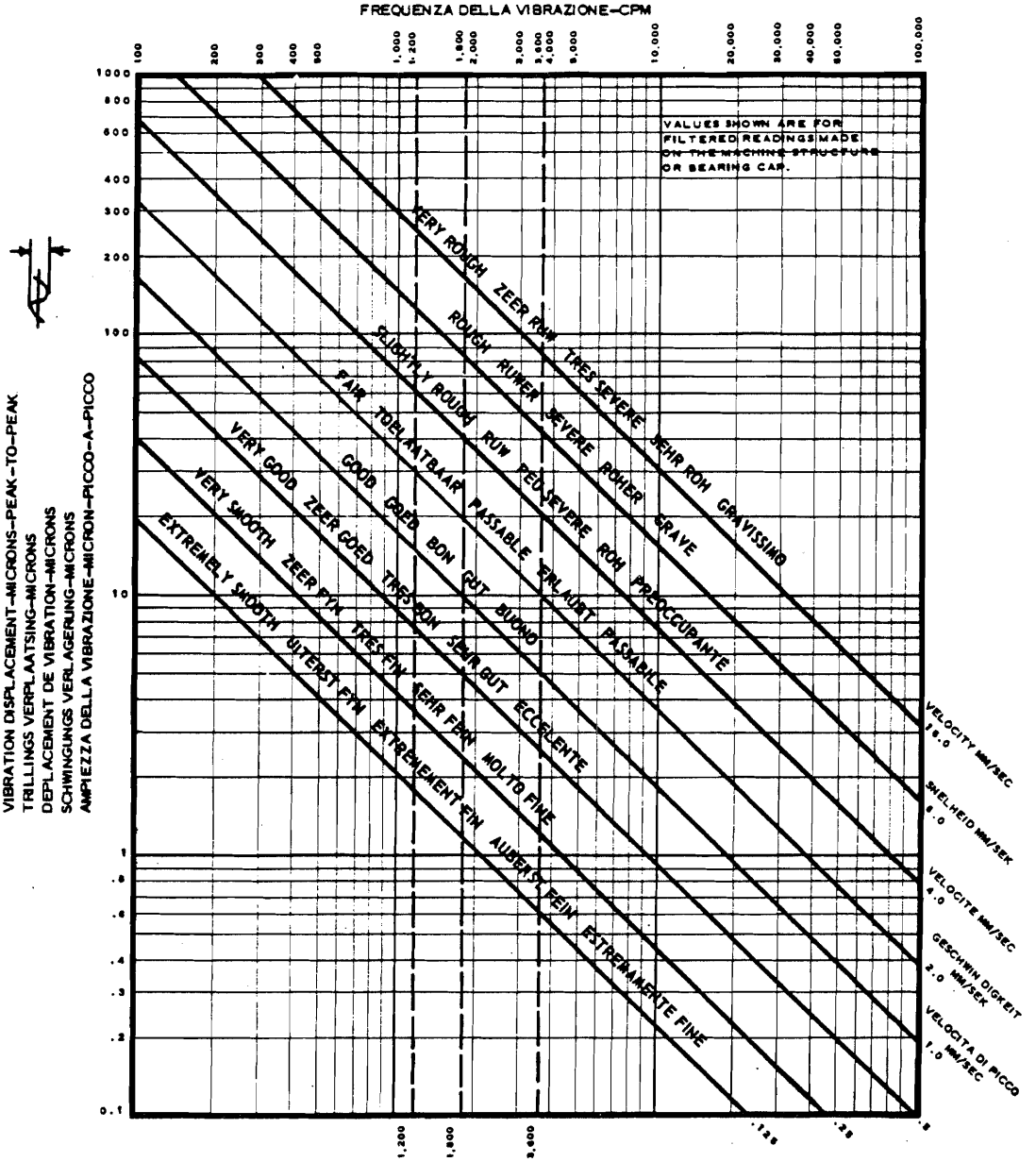
For use as a GUIDE in judging vibration as a warning of impending trouble.



GENERAL MACHINERY VIBRATION SEVERITY CHART IN ENGLISH

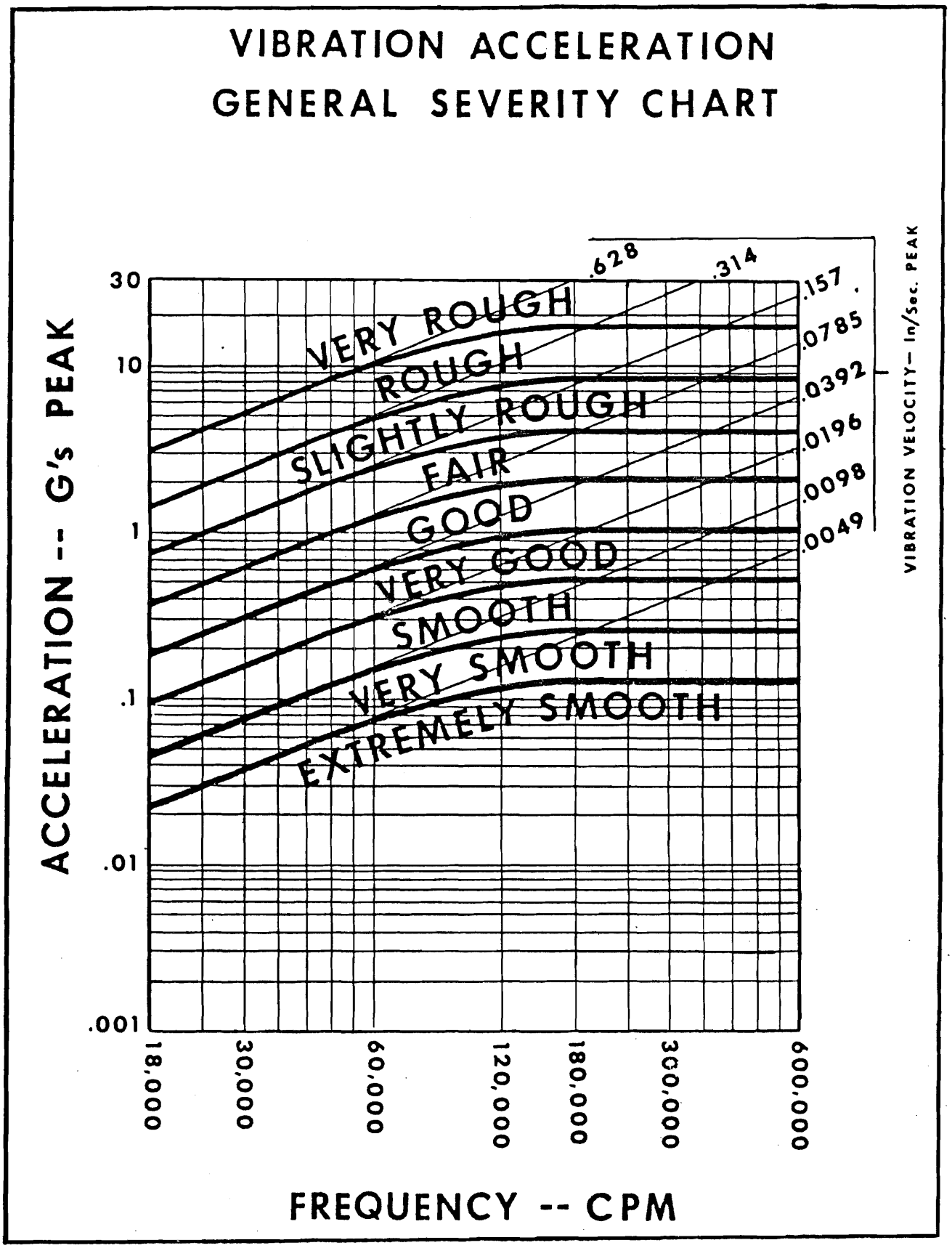
IRD-MECHANALYSIS INTERNATIONAL

GENERAL MACHINERY VIBRATION SEVERITY CHART
TRILLINGS STRENGHEIDSKAART VOOR ALGEMENE MACHINES
TABLEAU DE SEVERITE VIBRATOIRE POUR LES MACHINES EN GENERAL
SCHWINGUNGSSTRENGE TABELLE FUR ALLGEMEINE MASCHINEN
NOMOGRAMMA GENERALE DI PERICOLOSITA DELLA VIBRAZIONE



#305D–1 Copyright 1971 IRD MECHANALYSIS, INC. Columbus, Ohio. Subject to change without notice. Litho in USA.

GENERAL MACHINERY VIBRATION SEVERITY CHART IN METRIC



GENERAL MACHINERY ACCELERATION SEVERITY CHART IN ENGLISH/METRIC

APPENDIX C

Use of SPIKE ENERGY Signals to Detect Defects in Rolling Element Bearings and Gears

Page

SPIKE ENERGY Signal Detection Circuits C-1

Establishing a Bearing Defect Detection Program C-1

Gear Defects C-2

Other Sources of SPIKE ENERGY Signals C-2

Rolling Element Bearing g-SE Severity C-2

Rolling Element Bearing g-SE Severity Chart C-3

USE OF SPIKE ENERGY SIGNAL TO DETECT DEFECTS IN ROLLING ELEMENT BEARINGS AND GEARS

SPIKE ENERGY CIRCUITS

Energy is generated when repetitive transient mechanical impacts occur. Such impacts are typically generated as a result of surface flaws in rolling-element bearings or gear teeth.

This energy is conducted from its source through various paths to the other surface of the machine structure, and is seen as a small-amplitude vibration at the surface. Accelerometers coupled to the surface generate a corresponding electrical signal.

The accelerometer signal is processed by unique filtering and detection circuitry to produce a single "Figure of Merit" related to the intensity of the original impacts. This figure of merit is expressed in "gSE" units.

SPIKE ENERGY gSE readings are measurements which can with experience be correlated with the severity of the causal surface flaws. Even though gSE readings are affected by the nature of the conductive path between the impact source and the accelerometer, similar machine structures will provide a reasonable basis for comparison between the structures.

The gSE figure of merit has proven to be effective in detecting mechanical defects in meshing gears and rolling element bearings. The gSE measurement, when used in conjunction with conventional measurement of vibration velocity and acceleration, provides early indications of mechanical deterioration.

ESTABLISHING A BEARING DEFECT DETECTION PROGRAM

To establish a program for checking the condition of rolling element bearings, a "comparison" method can be used. That is, the g-SE levels of similar machines are measured and any levels which significantly depart from the average are singled out for further analysis, and closer watch, as potential bearing problems. This method rapidly leads to establishment of criteria levels which distinguish good and bad bearings. It should be noted that the g-SE levels depend on the machine rotational speed (RPM), and typically double for each doubling of RPM. From a vibration severity standpoint, however, it should be kept in mind that low speed bearings can usually tolerate more damage than high speed bearings, since low speed bearings tend to deteriorate more slowly than high speed types.

The use of "trending" is another way of detecting defective bearings. In this method, the machine bearings are measured periodically and their g-SE levels recorded. No change in the level over a period of time indicates a good bearing, while a significant upward trend indicates a deteriorating bearing.

* SPIKE ENERGY is a trademark of IRD Mechanalysis, Inc.

GEAR DEFECTS

A program to detect incipient gear defects can be established in the same manner as that described above for rolling element bearings.

OTHER SOURCES OF SPIKE ENERGY SIGNALS

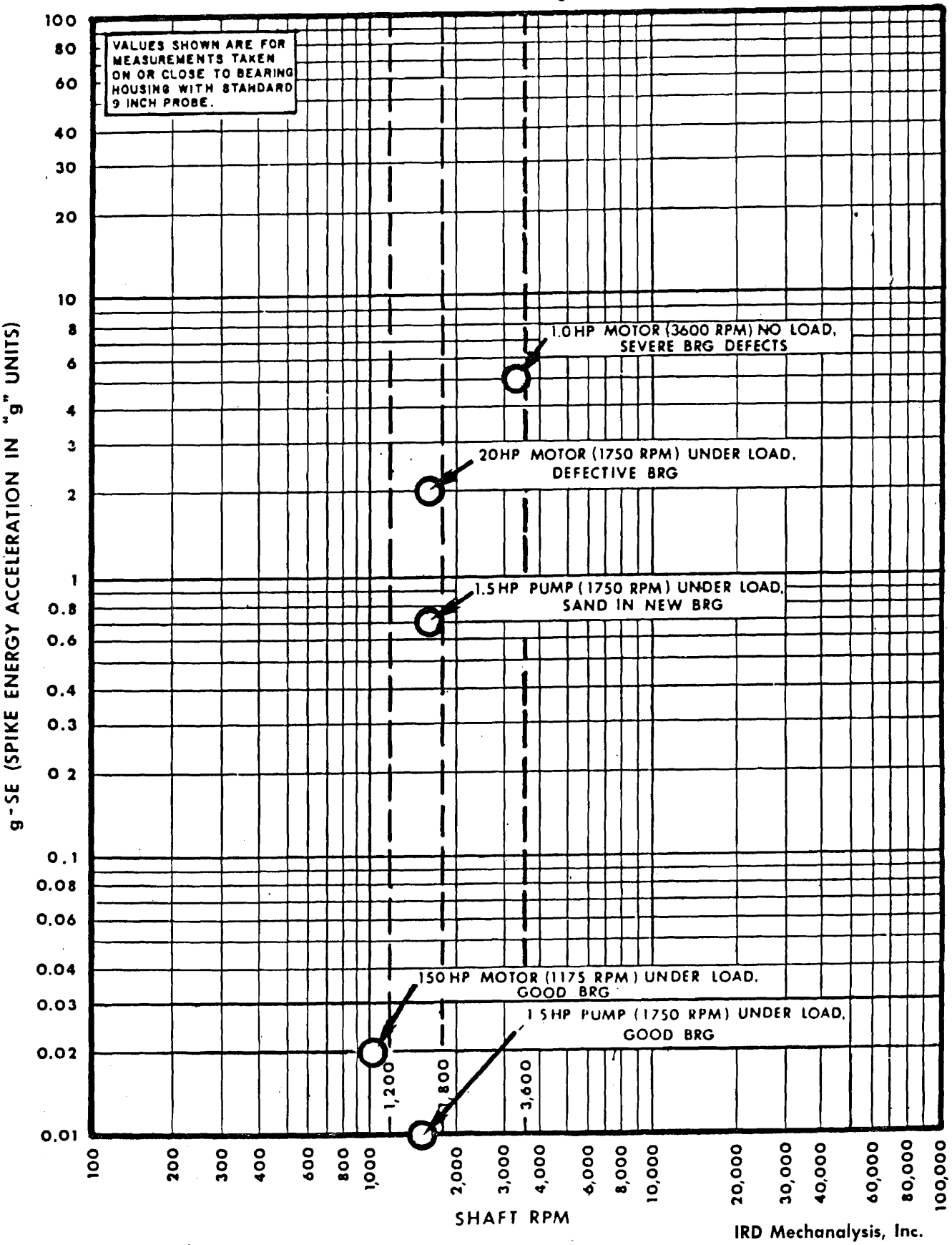
When taking bearing checks, it must be kept in mind that there are sources other than bearings which give off spike energy. Gears, cavitation, rubbing or striking of metal parts such as seals and coupling guards, are some of the more common sources which are likely to be encountered. These sources, if close to the bearing frequencies being measured, should be checked to avoid possible misinterpretation of the data.

ROLLING ELEMENT BEARING g-SE SEVERITY CHART

A "Rolling Element Bearing g-SE Severity Chart" is shown in the accompanying chart. This chart can be used as an aid in establishing g-SE severity criteria. No specific severity levels such as "smooth", "good", etc., have been assigned, since there are too many variables (bearing types, machine types, speed, loads, etc.) which can affect the levels measured. Some case histories, however, are plotted on the chart to provide an indication of the type of results which can be obtained.

By plotting the g-SE levels of the machines to be included with-in a bearing check program on a chart, severity criteria can be readily developed which are tailored to the individual machines involved. These charts are available from IRD MECHANALYSIS on Form No. 1925 (P/N 22756).

ROLLING ELEMENT BEARING gSE SEVERITY CHART



IRD Mechanalysis, Inc.
6150 Huntley Road
Columbus, Ohio 43229

©Copyright 1979

Form 1925/Item 22756

APPENDIX D

Single Plane and Two Plane Programs for
HP Calculator Model 41/CV/CX, and Sharp Pocket Computers
Models PC-1261 and PC-1350

The present availability of programmable pocket computers and calculators greatly simplifies the solution of time-consuming and sometimes difficult balancing problems. This Appendix provides program instructions for solving both "Two-Plane" and "Single-Plane" balancing problems. The computers or calculators to be utilized along with the instructions include the SHARP, Model PC-1261 or PC-1305 Pocket Computers, or the HEWLETT-PACKARD, Model 41/CV/CX programmable calculator. Instructions for Programming the computer or calculator are provided along with details for using the programs to solve actual Single-Plane or Two-Plane balance problems. Sample Problems are also included to enable you to check your complete program before attempting to balance your machine. We strongly recommend that you thoroughly read and study the owner's manual/handbook supplied with your computer or calculator before proceeding with the actual programming.

See Application Report No. 118 for "Balancing Program Instructions" for the SHARP, PC-1261 or PC-1350 Pocket Computers. See Application Report No. 117 for "Balancing Program Instructions" using the HEWLETT-PACKARD, Model 41C/CV/CX Programmable Pocket Calculator.

APPENDIX E
Manual Backdating Information

This Appendix consists of Backdating Information for Model 880 instruments with Serial Number Prefix Letters ranging from A through T. To use this manual with any of these instruments, use the descriptions and procedures provided in this Appendix in place of similar writeups provided in Chapters 1 through 4 of the manual.

USE IN PLACE OF PARAGRAPHS 2 & 3 ON PAGE 1-1 IN MANUAL.

The Model 880 contains a number of features which greatly simplify vibration analysis. The built-in plotter/hard copy printer eliminates the need for an external XY Plotter in most instances. The plotter/printer is capable of generating a complete vibration spectrum signature from 600 to 600,000 CPM (10 Hz to 10,000 Hz) in 25 seconds. Because the Model 880 is fully microprocessor controlled, the settings of the selector switches are automatically recorded on the printout each time a plot is generated. The error-free printout is fully annotated with the correct engineering units and the filter bandwidth setting, as well as the amplitude and frequency scale values. Also, the overall (Filter Out) signal amplitude is sampled while the heading is being generated, and this value along with the minimum and maximum variation of the amplitude is then printed.

A unique form of vibration analysis is afforded by using the Diagnostics function. This function generates a Diagnostic table, after the frequency signature is plotted, which lists the vibration amplitude values at selected multiples of the machine RPM. In addition, the RPM and harmonic frequencies are "tagged" with markers along the baseline of the spectrum. By analyzing the amplitudes of the peaks which correspond to the markers, the specific source of the vibrations can be more readily identified.

USE IN PLACE OF PAGE 1-2 IN MANUAL.

Other features of the Model 880 instrument include:

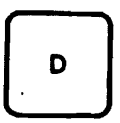
- A built-in sealed lead acid battery pack and internal charger.
- A built-in storage compartment for the Strobe and other accessories.
- Switch selectable English or Metric operation.
- A single pushbutton function switch to generate calibration signals for an external XY Recorder.
- Spectrum plotting over the 60-60K CPM and the 600-600K CPM frequency ranges.

The Model 880 is an excellent instrument for predictive maintenance programs in which periodic signature checks are desirable for critical machines. These signature checks, rather than overall (i.e., Filter Out) checks, enable a closer watch to be maintained and more advanced warning given of any changes in the machine condition. The Model 880 is also useful for establishing "baseline" signatures, or for post-repair checks to verify that proper machine operation has been restored.

2.3 FRONT PANEL CONTROLS AND SWITCHES

USE THE PLOT/CAL, D, AND TUNED FREQ PUSHBUTTON WRITE UPS SHOWN HERE INSTEAD OF THOSE SHOWN ON PAGE 2-3 OF MANUAL.

The **PLOT CAL** pushbutton is used to produce the external zero and full scale calibration signals. These signals are needed to set up an external analog plotter for use with the 880 instrument. Either calibration signal is generated by sequentially depressing the pushbutton. The zero and full scale amplitudes will then be indicated on the analog meter, and the numerical LCD reading will extinguish. The frequency meter and range LED's will indicate the appropriate frequencies if OSC function is selected.



Depressing the D (Diagnostics) pushbutton sets up the instrument to analyze the next frequency signature to be generated. A "d" indication is displayed on the LCD when the Diagnostics function is operational. When the frequency signature is plotted, a tabular diagnosis is then printed which lists the probable causes of the vibrations, along with the vibration amplitude at selected multiples of the shaft RPM. The Diagnostics feature utilizes an entered RPM value to perform the analysis. The D pushbutton must be reset each time a diagnostic printout is desired.

Depressing the **TUNED FREQ** pushbutton causes the LCD to display the frequency to which the filter is tuned. In addition, the TUNED FREQ pushbutton deactivates the operation of the PLOT CAL pushbutton, and sets up an external analog recorder to start plotting from the filter tune frequency.

USE IN PLACE OF PARAGRAPHS ON MODE & CHART SPEED SWITCHES (PAGE 2-5 IN MANUAL).

The CHART SPEED selector switch is used to control the rate of printing by the built-in plotter. The selector is functional only when time signatures are being plotted.

The MODE switch is used to select frequency or time-base plotting. Time signature plots are generated on the built-in plotter. External plotters which have an internal time base can also be used for time plots.

USE IN PLACE OF FIG. 2-2 ON PAGE 2-7/MANUAL. ALSO, USE THIS PARAGRAPH FOR EXTERNAL XY PLOTTER.

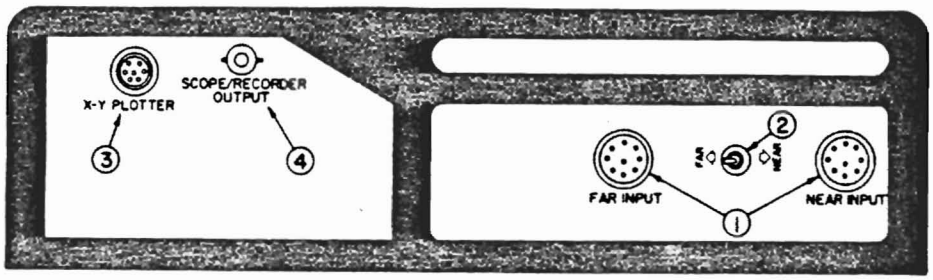


FIGURE 2-2 LEFT-HAND SIDE PANEL DETAILS

3) XY PLOTTER CONNECTOR (Fig. 2-2, Ref. 3)

The XY PLOTTER connector is located on the left-hand side panel. The connector is a female twist-lock type, and is used for installing the signal cable of an optional XY Plotter to the 880 instrument. A 7-contact receptacle is used (Amphenol No. 67-02E, size 12-7 insert, and No. 20 contacts). Details on the operation and repair of the optional XY Plotter (Analog Recorder) may be found in the manual supplied with the Plotter.

USE IN PLACE OF FIG. 2-3 ON PAGE 2-8 OF MANUAL, AND USE BELOW PARAGRAPH FOR THE XY PLOTTER SETUP.

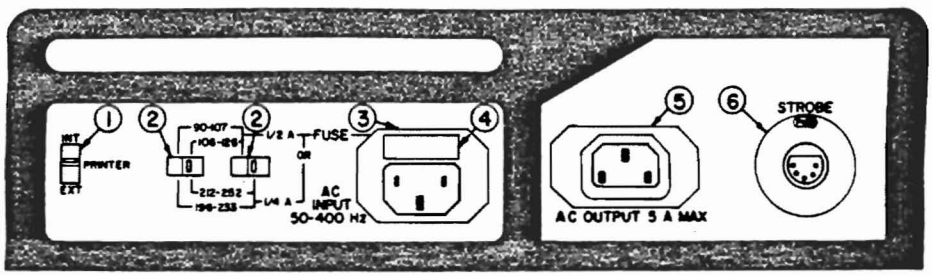


FIGURE 2-3 RIGHT-HAND SIDE PANEL DETAILS

5) INT/EXT PRINTER SETUP SWITCH (Fig. 2-3, Ref. 1)

The INT/EXT setup switch is located on the right-hand side panel, and is used for selecting instrument operation with the built-in plotter or with an optional external XY Plotter. When the switch is in the **INT** position, the built-in plotter is fully functional. When the switch is in the **EXT** position, the external plotter is functional, and may be calibrated using the PLOT CAL pushbutton. When the EXT position is selected, only error messages and the 1-PL and 2-PL balance format are operable on the built-in printer. **NOTE:** The Diagnostics printout and the 1-plane or 2-plane printouts are only generated by the built-in plotter.

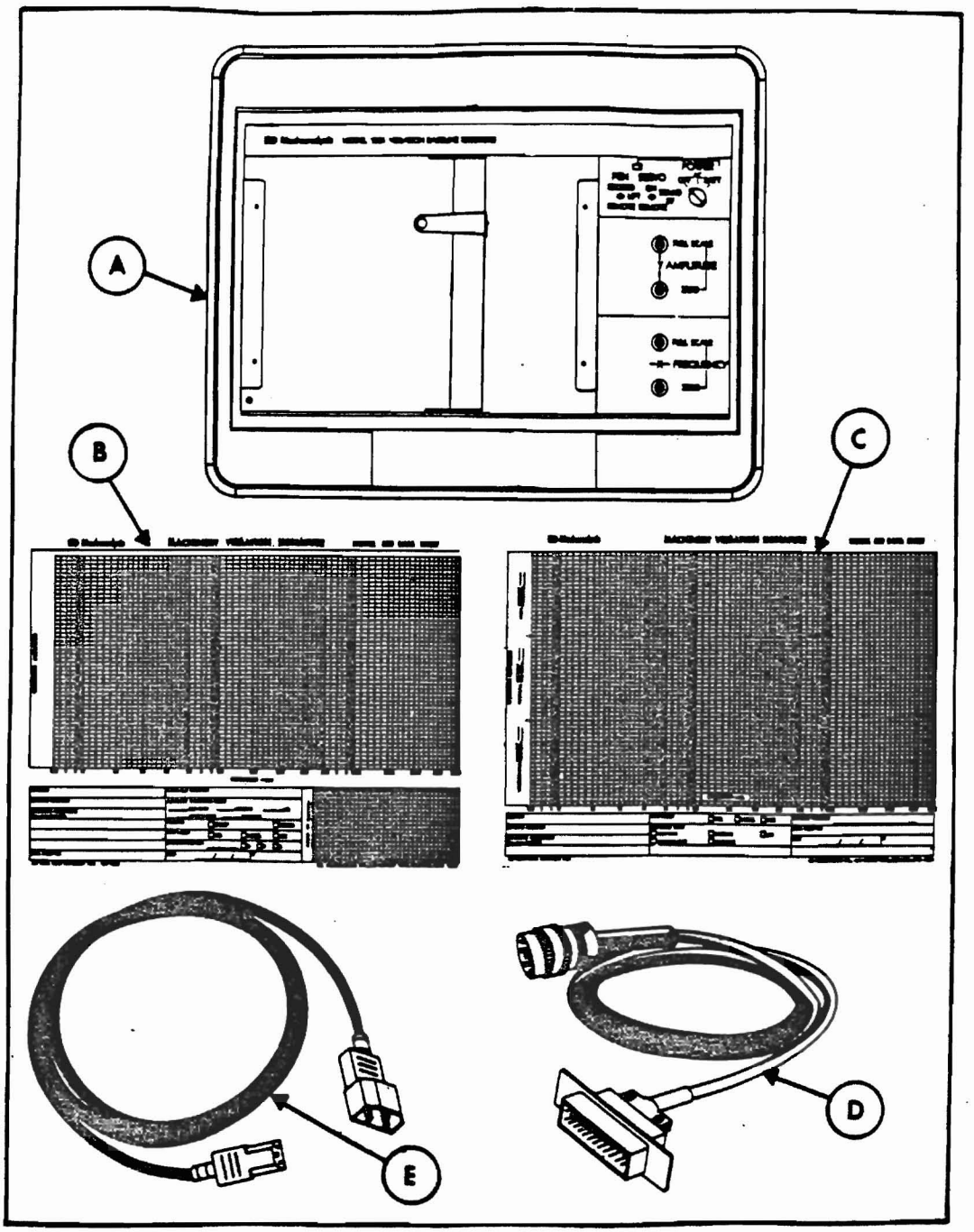


FIGURE 2-6 OPTIONAL ACCESSORIES FOR MODEL 880 (Cont'd.)

USE THIS FIG. 2-6 AND NOTES A THRU E FOR OPTIONAL ACCESSORIOES (THESE NOT SHOWN IN MANUAL).

The following additional Optional Accessories are shown in Figure 2-6, Page 2-15:

A. XY Plotter, Model 1081 - P/N 15842 (AC/Battery Power, for Amplitude vs Frequency Plots).

B. Data Sheet, Signature Plot (Sold only in lots of 30 pads, 25 sheets per pad) - P/N 21388.

C. Data Sheet, Triaxial Plot (Sold only in lots of 30 pads, 25 sheets per pad) - P/N 22172

D. Adapter Cable - for connecting Model 880 signal output to a Model 1080 or 1081 XY Plotter, 5-foot cable length (1.54m) - P/N 21047

E. Power Cable - 3.3-foot (1.0m) for connection of Model 880 AC power output to an XY Plotter, Model 1080 or 1081. Cable has international standard male and female connectors - P/N 19644.

3.3 STROBE LIGHT AND XY PLOTTER CABLE CONNECTIONS

USE THIS PARAGRAPH 2 IN SEC. 3.3 OF MANUAL FOR XY PLOTTER CABLE CONN.

1) Connect the male spring-lock connector of the **Strobe Light Cable** to the STROBE input receptacle on the 880 instrument. Then connect the female connector at the opposite end of the cable to the spring-lock receptacle on the Model 571 Strobe Light.

2) The Model 880 instrument output signals may be connected to the Model 1080 or 1081 XY Plotter input using the optional Adapter Cable (P/N 21047). The 7-pin, twist-lock connector on this cable is connected to the X-Y PLOTTER receptacle on the Model 880 instrument. The plug-in, in-line connector at the opposite end is connected to the INPUT receptacle on the XY Plotter. Additional instructions for connecting the XY Plotter cables to the Model 880 are described in the Instruction Manuals which accompany these optional accessories (Manual P/N 12250 for the Model 1080 XY Plotter, and Manual P/N 15846 for Model 1081 Plotter.)

---

c) Set the FUNCTION switch to BROAD, and print out **spectrum plots** for the three POWER and FREQ RANGE switch setups listed in the following table. Initiate each plot by depressing the START/STOP pushbutton. Each spectrum plot should include the primary component (120, 1.2K, or 3.6K CPM) at approximately 0.7 of full scale and odd harmonics. If these plots are obtained within 25 seconds, the built-in plotter and associated analyzer circuits are functioning properly. Figure 3-7 shows an example of a spectrum test plot. **NOTE:** Similar spectrum plots can also be obtained in the SHARP and BALANCE modes to check the operation of the filter in these modes.

USE THIS FIG 3-7 AND AND PARAGRAPH C, (IN MANUAL, FIG. 3-7 IS MODIFIED AND PARAGRAPH C IS NOT SHOWN).

POWER	FREQ RANGE	TEST FREQ	PEAK AMPL
BATT	60-60K	120 CPM	70% F.S.
BATT	600-600K	1,200 CPM	70% F.S.
AC	600-600K	3,600 CPM*	70% F.S.

* or 3,000 CPM for 50 Hz line frequency.

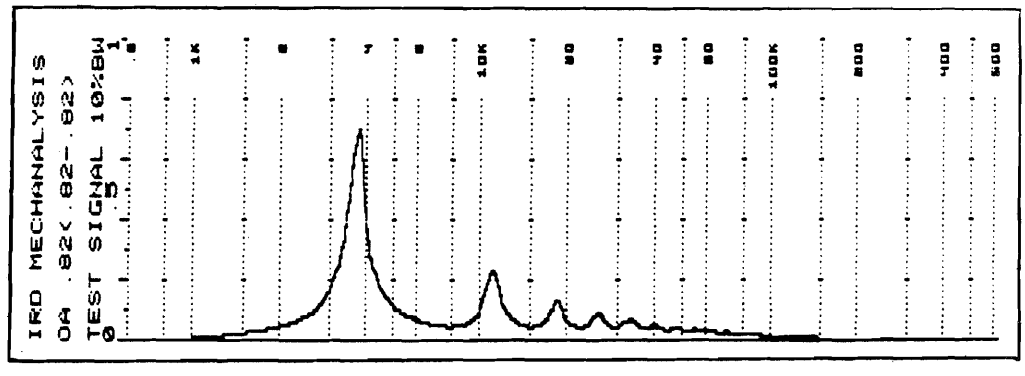


FIGURE 3-7 BROAD SPECTRUM TEST PLOT

4.2 FREQUENCY SPECTRUM ANALYSIS

Machine vibrations are generally complex and may consist of many frequencies from different sources. Vibration analysis is the process of measuring the vibrations of a machine to determine the amplitude and frequency of each component in the spectrum, and then relating the characteristics of these components to pinpoint the cause of the machine vibrations.

USE THIS PARAGRAPH 2 IN SECTION 4.2 IN MANUAL FOR EXTERNAL XY PLOTTER.

To determine the characteristics of the various vibrations, the overall signal amplitude should be measured and the analyzer filter tuned to the individual frequency components. This tuning process may be accomplished manually using the Frequency Tune control, or automatically using the built-in Plotter or optional external XY Recorder. In Sections 4.3 through 4.6, instructions are provided which describe these methods of performing a Spectrum Analysis.

4.5 DIAGNOSTIC ANALYSIS

USE THIS SECTION 4.5 IN PLACE OF SEC 4-5 IN MANUAL FOR DIAGNOSTIC ANALYSIS.

The Model 880 instrument Diagnostics function adds important information to frequency spectrum plots. The Diagnostic printout contains heading information and a listing of analysis data. This data includes the amplitude levels at selected multiples of the RPM frequency, and the corresponding possible causes of the vibration. In addition to entering the actual RPM frequency, other frequencies of vibration may be entered and an analysis performed at the harmonics of these frequencies. The procedure for generating a Diagnostics printout is described as follows:

1) Set the 880 instrument and controls as described in Section 4.4, Steps 1 through 4.

2) Determine the proper RPM frequency and enter this value as explained in Section 4.4, Step 9. The RPM function must be entered to obtain diagnostics.

NOTE: For an accurate analysis to be performed, it is important that the RPM frequency (or other selected frequency) entered be as precise as possible.

3) Set the FUNCTION switch to SHARP, and depress the "D" pushbutton. The LCD will indicate when the Diagnostics function is operational by displaying a **"d"** to the left of the numerical reading.

NOTE: Diagnostic printout is NOT available for a partial spectrum plot (i.e. any plot less than 600 to 600,000 CPM, or 60 to 60,000 CPM).

4) Depress the START/STOP pushbutton to start the plot. To cancel the Diagnostics after the plot has started, depress the CLEAR/RESET pushbutton. The plot may be terminated by depressing the START/STOP pushbutton a second time. A typical Diagnostics printout is shown in Figure 4-3.

NOTE: The diagnostics function will be automatically cancelled after each signature. To repeat the diagnostics, simply press "D" again.

DIAGNOSTICS
IN/SEC PK 10%BW

RPM	LVL*	MOST LIKELY CAUSE**
LESS THAN 1X	.07	WHIRL BELTS
1X	.29	UNBAL MISALIGN
2X	.06	LOOSENS
3X	.03	MISALIGN
4X	.02	LOOSENS
5X &UP	.01	BRG GEAR VANE

* IF HIGH LEVEL SEE LIKELY CAUSE

** CK IRD MANUAL FOR OTHER CAUSES

FIGURE 4-3 MODEL 880 DIAGNOSTICS PRINTOUT PLOT

DIAGNOSTICS PROCEDURES CONTINUED.

CAUTION: The printer switch must be properly set before starting a plot.

5) Depress the 880 PLOT/CAL pushbutton, and adjust the X and Y zero calibration controls on the XY Plotter to properly position the pen. Depress the pushbutton a second time, and adjust the X and Y Full Scale calibration controls on the Plotter. Repeat this calibration process as required by repetitively depressing the PLOT/CAL pushbutton and adjusting the corresponding calibration controls on the external XY Plotter. Additional instructions for operating the Plotter may be found in the Manual supplied with this Plotter.

6) To start the plot, set the FUNCTION switch to BROAD (or SHARP) and depress the START/STOP pushbutton. Depressing this pushbutton once will automatically set up the plotter to start plotting from the low end of either frequency range (60-60K CPM or 600-600K CPM).

NOTE: To start the plot from a selected frequency, depress the TUNED FREQ pushbutton after calibrating the XY Plotter. Adjust the FREQUENCY tune control to obtain the desired frequency reading on the LCD. Set the FUNCTION switch to BROAD (or SHARP), and depress the START/STOP pushbutton twice in succession.

7) To stop the plot after it has started, depress the START/STOP pushbutton. The plotter pen will return to the TUNE FREQUENCY position on the chart. If the CLEAR/RESET pushbutton is then depressed, the pen will return to the low end of the frequency range.

NOTE: The pen will momentarily lift and hesitate at 20K CPM in the 600 to 600K CPM frequency range, and at 2000 CPM on the 60 to 60K CPM range.

IN SEC 4.6 OF MANUAL, USE STEPS 1 THRU 9 PLUS THIS STEP 10.

10) To produce Amplitude vs Time plots on an external XY Plotter, set up the 880 instrument and the external plotter as described in Section 4.6, Steps 1 through 5. See the Operation Manual supplied with this external Plotter for additional operating instructions.

NOTE: The external XY Plotter used must have an internal time base. The plotting rate is determined by the time base selected on this plotter.

USE THIS SECTION TO OBTAIN A PLOT ON THE XY PLOTTER, THESE INSTRUCTIONS ARE NOT INCLUDED IN THE MANUAL.

4.6 AUTOMATIC SPECTRUM ANALYSIS WITH OPTIONAL EXTERNAL PLOTTER

1) Set up the 880 instrument for operation with the external plotter as described in Chapter 3.

2) Set up and adjust the 880 instrument controls as described in Steps 1 through 4, Section 4.4.

3) Place the graph (chart) paper to be used on the XY Plotter.

4) Set the INT/EXT printer switch on the left-hand side panel of the Model 880 to EXT.

CAUTION: The printer switch must be properly set before starting a plot.

5) Depress the 880 PLOT/CAL pushbutton, and adjust the X and Y zero calibration controls on the XY Plotter to properly position the pen. Depress the pushbutton a second time, and adjust the X and Y Full Scale calibration controls on the Plotter. Repeat this calibration process as required by repetitively depressing the PLOT/CAL pushbutton and adjusting the corresponding calibration controls on the external XY Plotter. Additional instructions for operating the Plotter may be found in the Manual supplied with this Plotter.

6) To start the plot, set the FUNCTION switch to BROAD (or SHARP) and depress the START/STOP pushbutton. Depressing this pushbutton once will automatically set up the plotter to start plotting from the low end of either frequency range (60-60K CPM or 600-600K CPM).

NOTE: To start the plot from a selected frequency, depress the TUNED FREQ pushbutton after calibrating the XY Plotter. Adjust the FREQUENCY tune control to obtain the desired frequency reading on the LCD. Set the FUNCTION switch to BROAD (or SHARP), and depress the START/STOP pushbutton twice in succession.

7) To stop the plot after it has started, depress the START/STOP pushbutton. The plotter pen will return to the TUNE FREQUENCY position on the chart. If the CLEAR/RESET pushbutton is then depressed, the pen will return to the low end of the frequency range.

NOTE: The pen will momentarily lift and hesitate at 20K CPM in the 600 to 600K CPM frequency range, and at 2000 CPM on the 60 to 60K CPM range.