IRD Mechanalysis® Limited

(Formerly Mechanalysis (India) Ltd)

The Vibration People®

IRD811D

Digital Vibration / Spike Energy™

Detector Operation & Maintenance

v2.3 Sept 15

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IRD Customer Details
Date Purchased:
IRD Serial Number (s):
P.O. ref:
Organization:
End User:
Next Calibration Due:

IRD Mechanalysis Limited

www.irdmechanalysis.com

IRD Mechanalysis® Limited continues to be the industry leading provider of Condition Management Solutions. With over 30 years experience in machinery vibration and associated condition monitoring technologies, the company designs and manufactures proven instrumentation suitable for rugged industrial environments. A comprehensive range of products and services are available from the offices below.

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1. INTRODUCTION

1.1 Purpose & Scope of Manual

This instruction manual describes the IRD Mechanalysis® Model IRD811D Vibration/Spike Energy Detector . Also included in this manual are complete instructions on the preparation, setup and operation of this instrument. Specifications of the Model IRD811D and the standard accessories are provided in the subsequent chapters. Information on the significance of the measured vibration amplitude levels in displacement, velocity and acceleration are provided in the guideline severity charts attached at the end of the manual. The procedure for evaluating SPIKE ENERGY measurements is also attached.

Figure 1 Periodic Vibration measurements save valuable machine downtime

The Model IRD811D Digital Vibration/Spike Energy Detector is a compact, portable instrument, which can be hand-held for taking vibration measurements. This instrument measures machinery vibration in units of displacement, velocity or acceleration. In addition, it also measures the SPIKE ENERGY signals associated with bearing and gear defects over a very wide range of frequency.

The operating conditions which may eventually cause the breakdown of a rotating machine can be detected from the measurements provided by the Model IRD811D Digital Vibration/Spike Energy Detector (Figure 1). Periodic measurements of machine vibration combined with a time log of the vibration levels, provide the basic information needed for an effective Predictive Maintenance Program for rotating machinery. If significant increases develop in the machine vibration levels, then trouble is indicated in the machine. These troubles can then be pinpointed to specific parts of the machine and scheduling can be more conveniently arranged for effecting repairs.

IRD Mechanalysis® Limited offers complete training on vibration measurement, analysis and balancing in principal cities throughout India. For details on the training programs and other services that are available, contact the nearest office of IRD Mechanalysis® Limited. Detailed address and contact numbers are given in this Manual.

Getting you Started

2. DESCRIPTION

2.1 GENERAL

Thank you for investing in **IRD Mechanalysis® Vibration Meters**. We trust that like many thousands of users before you will continue to enjoy optimum value from your wise investment. IRD Mechanalysis® Limited (IRD) is an independent System Integration Company that designs and manufactures

This chapter contains description of the Model IRD811D Digital Vibration/Spike Energy Detector and optional accessories available for use with the instrument. The standard package, depicted pictorially in Figure 2, contains following accessories:

Standard Accessories	Part Number	Quantity
Sensor Accelerometer, model IRD511, Standard, 2-10KHz, 100mV/g, Top Exit, Mil 2 Pin, 1/4"-28UNF Female Mounting Thread with National Traceable Cal. Cert.	M5111005001000	1
Stinger Al 225mm Straight for Sensor	M24827	1
Cable Assembly for model IRD811D with D & Mil 2Pin Spec Female Connectors for model IRD511 Accelerometer- 1.5m, rubber insulated, shielded. (Spare cable for automatic replacement with re-order form)	M60022	2
Magnetic Portable Base, IRD500 Series Accels	M24828	1
Carrying Case for model IRD811D	M25346	1
Manual Operating for model IRD811D in English	M43082	1
IRD Mechanalysis Training coupon		1
Optional Accessories	**Part Number**	**Quantity**
Shaft Fish Tail Stick - Absolute Vibration IRD500 Series Sensors	M24824	1
Meter Vibration/Spike Energy Detector model IRD811D - Instrument only when exchanged by NSC	M81112	1

Figure 2 Standard package for IRD811D Digital Vibration/Spike Energy Detector

2.2 DESCRIPTION OF CONTROLS, INDICATOR AND CONNECTORS

This section contains description of the instrument controls; digital indicator and connector on the instrument (refer Figure 3).

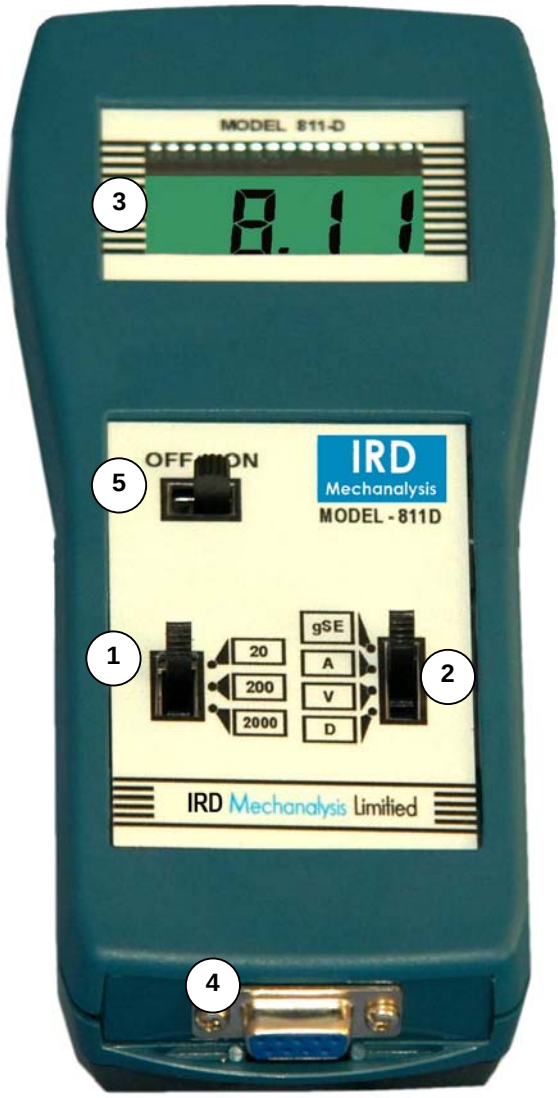


Figure 3 IRD811D instrument Front Panel details

1) AMPLITUDE SELECTOR

The Amplitude Range Selector is used to select the full-scale amplitude range to be displayed on the digital indicator. The amplitude ranges extend from 20 to 2000 microns Pk-Pk or mm/sec Pk or g Pk and gSE (Spike Energy). For good and accurate results, you should select the smallest possible range to avoid the inherent electronic noise*.

2) MODE SELECTOR

The Mode Selector is used to select the desired units of measure which are described below:

i) Displacement (D):

Provides measurement in DISPLACEMENT (microns Pk-Pk) using an accelerometer.

* see specification for expected noise

ii) VELOCITY (V):
Provides measurements in VELOCITY (mm/sec Pk) using an accelerometer

iii) ACCELERATION (A):
Provides measurements in ACCELERATION (g Pk) using an accelerometer.

iv) SPIKE – ENERGY (gSE):
Provides measurement of SPIKE-ENERGY unit of Acceleration (gSE) of bearings, gears and other machine parts using an accelerometer.

3) DIGITAL INDICATOR
The Digital Indicator indicates the vibration amplitude and the condition of the internal batteries is indicated with a 'LOBAT' message on the lower end when the batteries are drained and need to be replaced.

4) SENSOR SIGNAL INPUT RECEPTACLE
The SENSOR SIGNAL INPUT receptacle is a 9 Pin 'D' type connector. It is located at the bottom end of the instrument and is used for connecting the sensor cable from the accelerometer.

5) POWER SWITCH
The Power Switch is used to connect the internal battery supply to the instrument circuits. When set to OFF, the internal power is disconnected. This switch is set to ON for normal operation.

Note:
If the 'LOBAT' indication appears then the batteries need to be replaced before the instrument is put to use. Instructions on replacement of the batteries are given in the next chapter.

2.3 DESCRIPTION OF ACCESSORIES

2.3.1 STANDARD ACCESSORIES

The standard accessories of the IRD811D Digital Vibration/Spike Energy Detector are shown in Figure 4 and briefly described in this section.

A) IRD511 ACCELEROMETER:

An accelerometer (Part number M5111005001000) is used to measure vibration of the machine. It is sensitive to vibrations along the long axis and can be fastened to rotating machinery with a stud. It can also be used with a Magnetic Base or Hand-held with or without the 9" (229 mm length) Straight Stinger.

B) SENSOR CABLE:

The Sensor Cable (Part number M60022) connects the accelerometer, vibration signal to the 9Pin 'D' type connector at the bottom end of the instrument. In addition, this cable also carries the DC supply voltage to the internal amplifier of the Accelerometer.

Figure 4 IRD811D standard accessories

C) STRAIGHT STINGER

The Straight Stinger (Part number M24827) is 9" (229 mm length) and connects to the threaded hole at the flat end of the accelerometer. It is used to reach inaccessible locations on a rotating machine.

D) BATTERY SET

Two nos. of 9V, 100 mAH dry cells (Part number M30642) required for powering on the instrument comes as standard with the meter package.

E) MANUAL OPERATING:

The Operating Manual (Part number M43082) provides information on setup and operation of the IRD 811D Digital Vibration/Spike Energy Detector. Additional copies of the manual are available from IRD Mechanalysis® Limited.

F) CARRYING CASE (not shown):

The Carrying Case (Part number M25346) is a rugged storage case which provides space for carrying or storing the instrument along with all the standard accessories.

2.3.2 OPTIONAL ACCESSORIES

The optional accessories for IRD811D are as follows:

Optional Accessories	Part Number	Quantity
Shaft Fish Tail Stick - Absolute Vibration MIL500 Series Sensors	M24824	1

3. PREPARING FOR USE

3.1 UNPACKING THE INSTRUMENT

Carefully remove the Instruments from for transit packaging and ensure that all accessories supplied agree with the supply Invoice.

3.2 FITTING THE BATTERIES

The IRD811D Digital Vibration/Spike Energy Detector requires two 6F22 type 9V batteries.

Always disconnect batteries from the instrument during long periods of disuse

The battery life depends on the battery type and quality use but 8 hours continuous used, is a practical guide. However, high quality alkaline batteries will extend this time to fit the batteries, side open the battery compartment on the rear of the instrument and connect the batteries to the battery snappers provided.

With suitable batteries correctly connected, switch ON the instrument the display should now show recognizable figures.

If the 'LOBAT' message appears the batteries are probably discharged / drained.

Providing the 'LOBAT' message s absent, measurements should be to the stated specification. If the batteries have only just reached the end of their service life, a few more measurements are possible. To test this, turn the instruments off for a short period. The batteries may recover enough during this period to extinguish the 'LOBAT' warning legend and allow some additional confident measurements to be made.

3.3 CONNECTING THE SENSOR:

The IRD811D Digital Vibration/Spike Energy Detector accepts input from an accelerometer. The sensor is connected to the instrument through an interconnecting sensor cable. Once the sensor is connected, turn ON the instrument and agitate the sensor to ensure the system is operating properly.

NOTE:
That without the sensor connected a residual reading might be shown. This is mostly 'sensor' at the unconnected input with some residual noise.

4. OPERATION AND CALIBRATION

4.1 OPERATION:

All switches are accessible on the front panel of the instrument and slide to the required setting under light finger pressure. Figure 5 shows the location of the switches.

The instrument is turned ON using of the Power Switch (Switch A). The Range Selector Switch (Switch B) is used for selecting the required range. The desired parameter is selected using the Mode Selector Switch (Switch C). The Switch provides selection of gSE-SPIKE ENERGY, A-Acceleration, V-Velocity, D-Displacement.

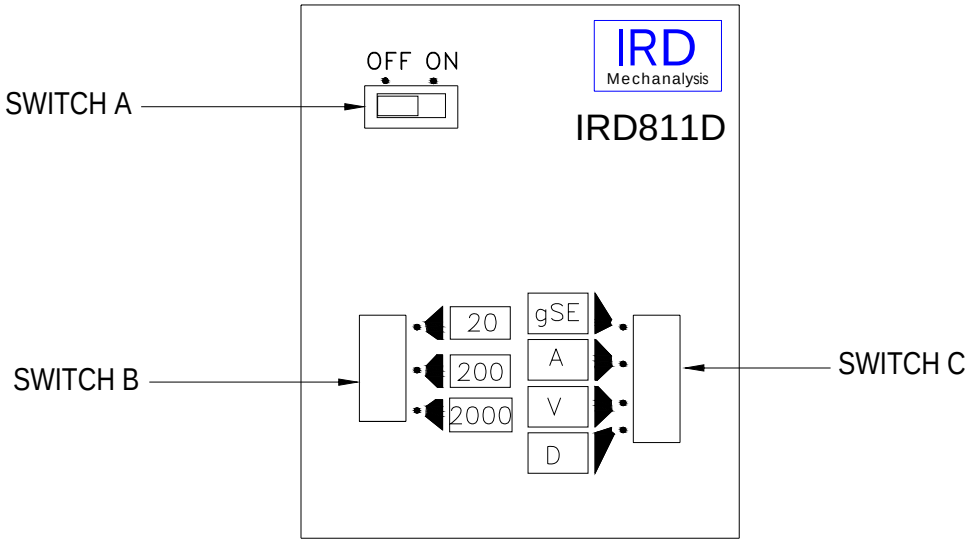


Figure 5 Location of switches on IRD811D front

4.2 CALIBRATION

The calibration procedure described herein is supplied for the customer information. No attempt to disassemble or calibrate the unit should be made except by an experienced, qualified technician using the proper test equipment. IRD Mechanalysis® assumes no responsibility for the operation or units repaired or calibrated outside the factory or at an unauthorized service centre.

4.2.1 EQUIPMENT NEEDED

The IRD811D Digital Vibration/Spike Energy Detector is calibrated for nominal sensitivity of the sensor used. Standard calibration procedure consists of applying a precise (calculated) signal to vibration meter input terminals (to simulate the sensor) and adjusting the potentiometer on the respective circuit board to obtain the expected reading on the display.

Equipment required for calibration

1) Function Generator
2) Digital Multi-meter

NOTE:
Ensure the Instruments used for calibrations are calibrated with references traceable to National / International Standards.

4.2.2 METER CALIBRATION PROCEDURE (Refer Figure 6 the PCB layout)

1) Ensure that all the Printed Circuit Boards are completely assembled and correctly wired, cleaned and lacquered.
2) Use new 9V Dry Cell (2 Nos.)

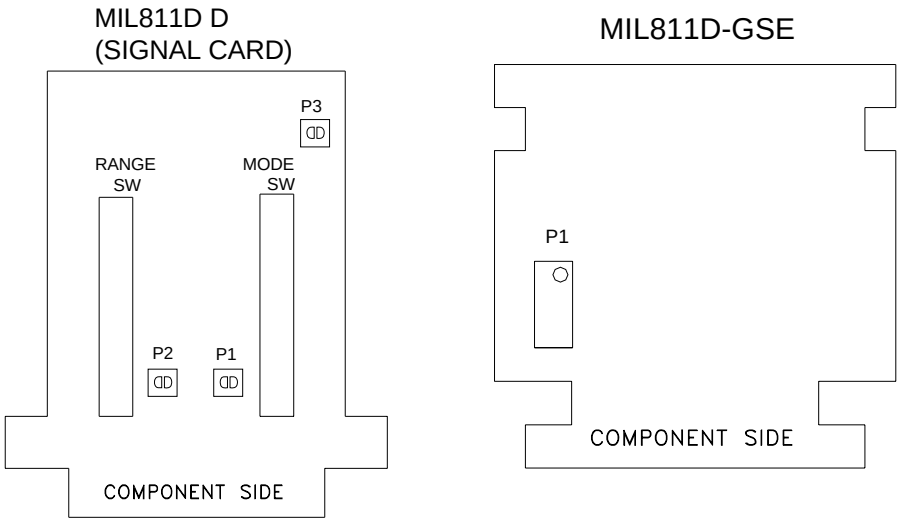
A) DISPLAY PCB CALIBRATION

1) Switch on the Instrument
2) Connect voltmeter (+) at pin 36 of IC1 on display Board and (-) to Chassis ground.
3) Adjust trim pot (1K Ohm) P1 and display PCB (811D) until reading on voltmeter is 100mV DC.

B) SIGNAL PCB CALIBRATION

Sensitivity of the accelerometer used along with this vibration meter is 100 mV/g PK.

1) SET Frequency on the Function Generator to read 100 Hz and Amplitude to 70.7mV RMS.
2) SET Range Switch to 20 and Mode Switch to Acceleration (A) mode, SET POT P1 on signal card (811DS) to read 1.00 on display.
3) SET Range Switch to 20 and Mode Switch to Velocity (V) mode, SET POT P2 on signal card (811DS) to read 15.60 on display.
4) SET Range Switch to 200 and Mode Switch to Displacement (D) mode, SET POT P3 on signal card (811DS) to read 49.7 on display.
5) SET Frequency on the Function Generator to read 10KHz and Amplitude to 35.40mV RMS. SET Range Switch t0 20 and Mode Switch to gSE mode. SET POT P1 on gSE CARD (811DGSE) to Read 0.50 on display.
6) Seal all pots.



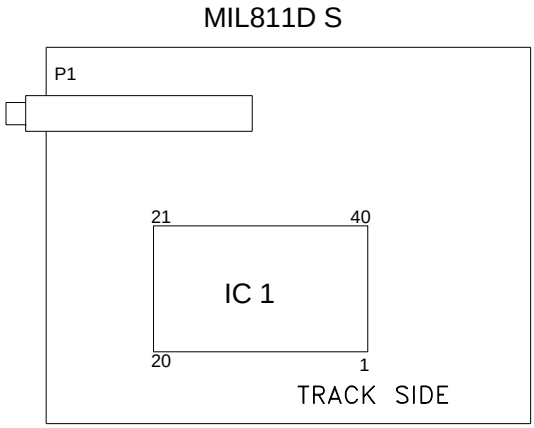


Figure 6 IRD811D PCB layout

C) LOW BATTERY CHECK

Using a variable DC Power Supply connected DC Voltage to the battery snappers; reduce the DC Voltage to 11VDS. A 'LOBAT' indication should appear on the display increase the supply to 18V DC 'LOBAT' indication should disappear.

4.2.3 SENSOR CALIBRATION

The calibration of the accelerometer can be done at the state of the art Calibration Lab at IRD Works, Mumbai (Figure 7).

Figure 7 State of the Art IRD Calibration Lab, Mumbai

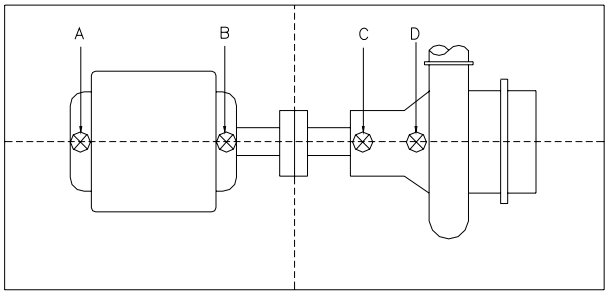
This Lab has a state of the art TransCal system from Beran Instruments UK. It is an automatic digital sensor calibration system. It undertakes calibration of a sensor throughout its frequency range. The master reference sensor is traceable to National Standards. Calibration Certificates are generated and stored for each sensor tested. IRD has constructed an environmentally controlled environment for all sensor calibration tests. This service could be availed by all users irrespective of sensor manufacturer. Further details could be obtained from the IRD regional office or IRD Mumbai office.

4.3 VIBRATION MEASUREMENT

The vibration should be measured in the vertical, horizontal and axial planes of each bearing housing. The machine vibration levels are the indicated on the Digital Display. All pertinent rotating machine information along with the vibration readings should be recorded on a data sheet similar to that shown in Figure 8. The recorded data is used to determine the general operating condition of the machine. The data sheet also provides a permanent record of the machine condition.

APPLICATIONS

BASELINE PUMP DATA SHEET



CHECKED | PERIODIC VIBRATION CHECKS | PERIOD : WEEKLY

DISP.: ____ VEL.: ____ ACCEL.: ____

VIBRATION TREND CHART (0 2 4 6 8 10)

DATE	BY	A(H)	B(H)	C(H)	D(H)	E( )	F( )	G( )	H( )
1/22	CJ	0.19	0.15	0.21	0.12				
1/29	CJ		0.14	0.21					
2/6	CJ		0.15	0.22					
2/19	CJ		0.18	0.3					
2/20	CJ		0.5	0.6					
2/21	CJ	0.12	0.11	0.19	0.10				
2/22	CJ		0.10	0.13					
3/2	CJ		0.11	0.14					
3/9	CJ		0.12	0.16					
3/19	CJ		0.13	0.16					
3/28	CJ		0.17	0.22					
3/30	CJ		0.20	0.34					
4/8	CJ		0.23	0.29					
4/15	CJ		0.26	0.33					

MACHINE: 12 BOILER FEED PUMP

LOCATION: LOWER LEVEL

OPERATING COND.: NORMAL

INITIAL VIB. LEVELS DISP.: ____ VEL.: ACCEL.: ____

	A	B	C	D	E	F	G	H
HORIZONTAL (H)	.19	.19	.21	.12				
VERTICAL (V)	.12	.11	.16	.08				
AXIAL (A)	.08	.08	.11	.08				

VIBRATION LIMITS:

A: 0.6 B: 0.6 C: 0.6 D: 0.6

E: ____ F: ____ G: ____ H: ____

Figure 8 A typical vibration measurement datasheet

4.4 DETERMINING VIBRATION SEVERITY

Vibration measurements without a standard for comparison are seldom of any use. There needs to be some guide to show how much is too much. Table 1, provides a guide for Machine Tool Vibrations. The values listed merely indicate the range in which satisfactory parts have been produced. Actual tolerances must be determined by your own experience as to what vibration levels permit the meeting size and finish tolerance.

For general machinery, the vibration severity chart shown in Figure 9 may be used. Please note that vibration displacement and vibration acceleration values are for a specific frequency of vibration while velocity readings may be used regardless of the frequency.

Table 1 Tentative guide to vibration tolerances for machine tools

Type of machine	**Displacement of vibration as read with sensor spindle bearing housing in the direction of cut**
Grinders	**Tolerance Range**
Thread Grinder	0.25 - 1.5 microns
Profile or contour Grinder	0.75 - 2.0 microns
Cylindrical Grinder	0.75 - 2.5 microns
Surface Grinder (Vertical Reading)	0.75 - 5.0 microns
Gardner or Besly type	1.25 - 5.0 microns
Centreless	1.0 - 2.5 microns
Boring Mill	1.5 - 2.5 microns
Lathe	5.0 - 2.5 microns

These values come from the experience of IRD personnel who have been trouble shooting machine tools for over 10 years with the IRD equipment. They merely indicate the range in which satisfactory parts have been produced and will vary depending upon size and finish tolerance.

NOTE:
The above tolerance ranges consist of machine vibration displacement values at which acceptable parts can generally be produced and are supplied as a guide for judging the indicated vibration as a warning of impending trouble. The measurements were obtained with the vibration sensor mounted on the spindle bearing housing in the direction of the machine cutting.

The units in which vibration severity may be measurement displacement, velocity or acceleration – are interrelated to one another. Displacement is used for measuring the condition of slower speed machinery, particularly where displacement standards have been established or where excessive unbalance is present. However, Velocity measurements provide a measure of the combined effects of vibration frequency as well as displacement and can be universally applied regardless of machine speed or type of trouble. This type of measurement provides a direct indication of the vibration severity and is generally the best indicator of the machine balance or condition. Acceleration is generally used when vibration occurs at high frequencies and often where the frequency of the source is many times the shaft RPM.

The vibration amplitude should be obtained in velocity and in whatever other units are desired. Measurements in displacement or acceleration will provide an indication of the vibration severity only if the dominant frequency of the machine vibration is known. Since

the vibration velocity is consistent with rotational speed, vibration severity measured in terms of vibration velocity is most common. If the vibration severity value read from the chart is too high, then trouble may be indicated with the machines as explained in Section 4.5. As already explained, acceleration as vibration severity parameter is used when vibration occurs at many times shaft RPM, usually due to rolling element bearing excitation, gear defects or aerodynamic problems such as cavitation. One such acceleration severity chart is shown in Figure 10.

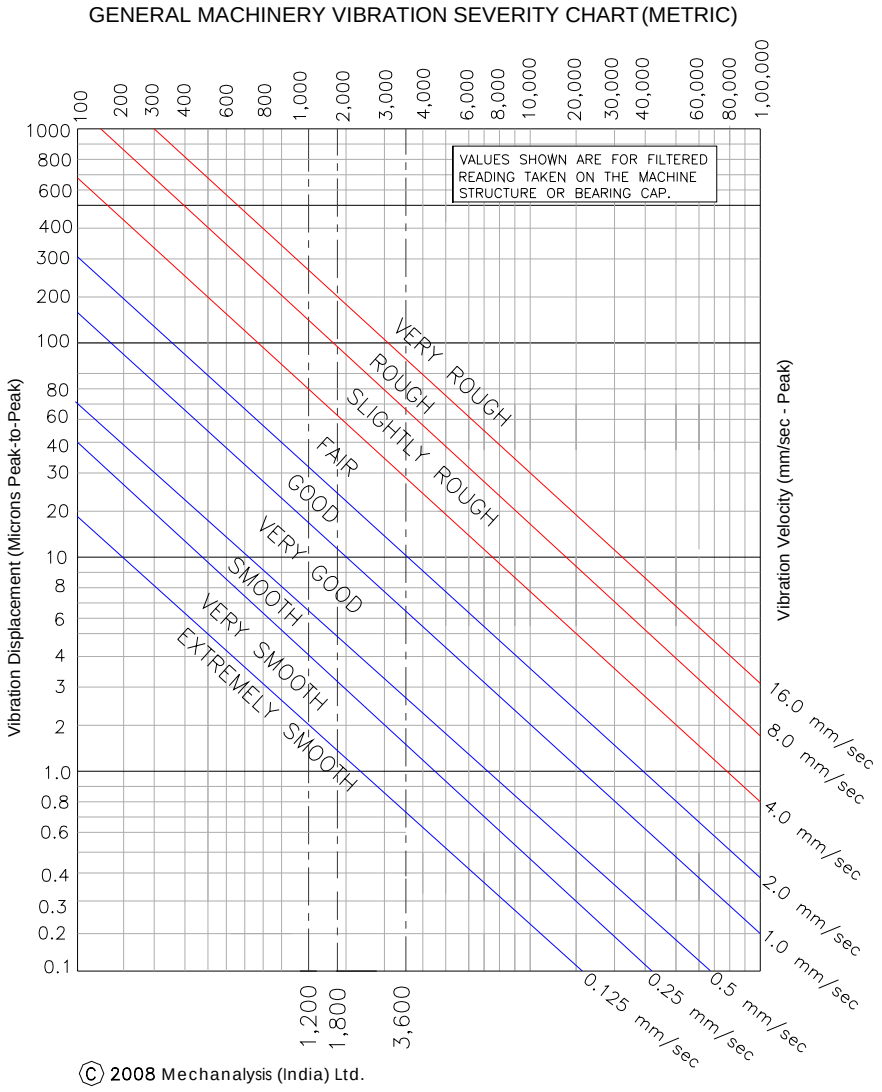


Figure 9 A general machinery vibration severity chart (Metric)

The SPIKE ENERGY mode circuits are used for the detection of deteriorating and defective rolling element bearings and gear teeth. These circuits are completely independent of those which measure the RMS vibration components in the displacement, velocity or acceleration modes. The SPIKE ENERGY signal level is indicated on the Digital Display for machine which operates from 600 to 3600 RPM, a SPIKE ENERGY level of 0.5 g or higher (as measured with the sensor and the extension probe attached) may indicate that the corresponding bearing or gear is defective.

Whether or not the bearing or gear is defective must be verified by experience and observation of the machine trends, since individual machines may have different vibration response characteristics. The acceptable level of SPIKE ENERGY amplitude for machines

whose operating speed is outside the 600 to 3600 RPM range should also be developed individually from comparisons to similar machines and from careful study of the vibration amplitude trends of the machine.

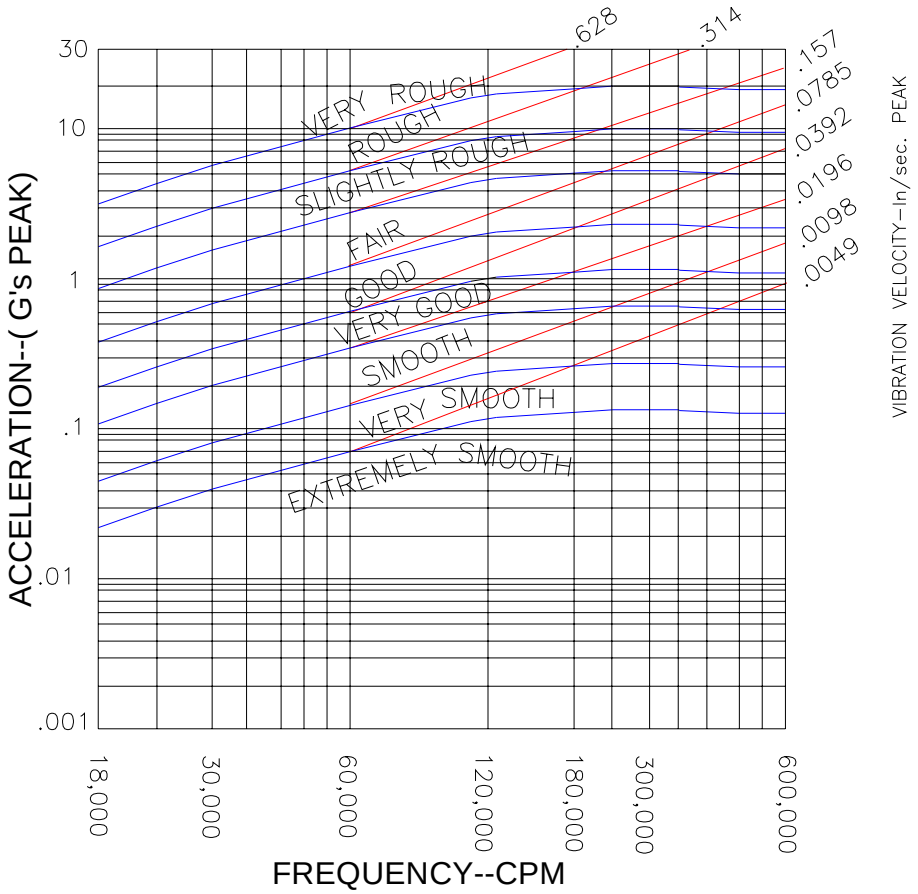


Figure 10 General Machinery Acceleration Severity Chart

4.5 DETERMINING DOMINANT VIBRATION FREQUENCY

If a single is dominant in the machine vibration, the Model IRD 811D Digital Vibration/Spike Energy Detector can be used to determine what this dominant frequency is. If the vibration level indicated on the Digital Display does not fluctuate more than 5% of the full-scale value, the dominant vibration frequency can generally be computed by dividing the vibration displacement level into the vibration velocity level and multiplying the resulting quotient by the constant 19,090 as shown in Equation 1, which is as follows:

$$\text{Dominant Frequency (CPM)} = \frac{\text{Velocity V (millimeters/second} \times 19.120 \text{ (Metric units)}}{\text{Displacement (D) micrometers}}$$

NOTE:
In English units, velocity is measured in inches per second peak; and displacement is measured in mils, peak to peak. In Metric units, velocity is measured in millimeters per second peak; and displacement is measured in micrometers, peak to peak.

For example, if a given belt-driven blower has a motor speed of 1750 CPM, and a fan speed of 2600 CPM; and vibration readings of 0.255 in/sec peak (velocity) and 1.85 mils, peak to peak (displacement) are obtained at the fan bearing; then the dominant vibration frequency would be computed from Equation 1 as follows:

$$\text{DOMINANT FREQUENCY (CPM)} = \frac{0.255 \text{ in/sec} \times 19.099}{1.85 \text{ mils}}$$

Hence, DOMINANT FREQUENCY = 2633 CPM

Since the dominant vibration frequency (2633 CPM) is closer to the fan speed (2600 CPM) than to the motor speed (1750 CPM) the fan is more likely the cause of the excessive vibration.

The dominant vibration frequency can also be determined from the vibration frequency chart in Figure 11 by relating the vibration velocity and displacement values obtained on the Digital Display to this chart. The dominant vibration frequency value can often be used to determine the machine part causing the vibration. This frequency could occur at the rotating speed of the faulty part, at a multiple of the rotating speed or at some other frequency.

In the blower example discussed above, if the vibration is measured at either motor bearing the vibration will include the motor vibrations plus all others transmitted via the drive belt and the blower structure from the fan. Or if the vibration is measured at the fan bearing, the vibrations include the fan vibrations plus all others transmitted by the drive belt and blower structure from the motor. To ensure adequate definition of the machine vibration, the measurements should generally be obtained from each bearing housing.

Generally the dominant frequency will be equal to the rotating speed of the part causing the vibration, assuming that the trouble is unbalance. In any event the dominant vibrating frequency will normally be some multiple of RPM of the part. After determining the dominant frequency, the type of machine fault present in the machine could be ascertained from table 2.

Table 2 Dominant machine excitation frequencies and most likely causes

DOMINANT FREQUENCY	MOST LIKELY TROUBLE
1 X RPM	Unbalance and / or misalignment If axial vibration is large Check for bent shaft or Misalignment
2 X RPM	Looseness, misalignment
3XRPM	Misalignment
Many times RPM	Suspect roller or ball bearings or gears
Less than 1XRPM	Oil whirl (Less than ½ RPM)
Synchronous (AC Line frequency)	Electrical problems
2X Synch. Frequency	Torque pulses
Many times RPM (Harmonically related)	Bad gears Aerodynamic forces Hydraulic forces Mechanical looseness Reciprocating forces
High frequency (Not harmonically related)	Suspect antifriction bearings

NOTE:
This table is just a guideline for root cause analysis of a machine problem. There are many other causes of vibration not listed. To pinpoint all but the simplest requires a thorough analysis and interpretation of the vibration patterns of a machine using a IRD Vibration Analyzer.

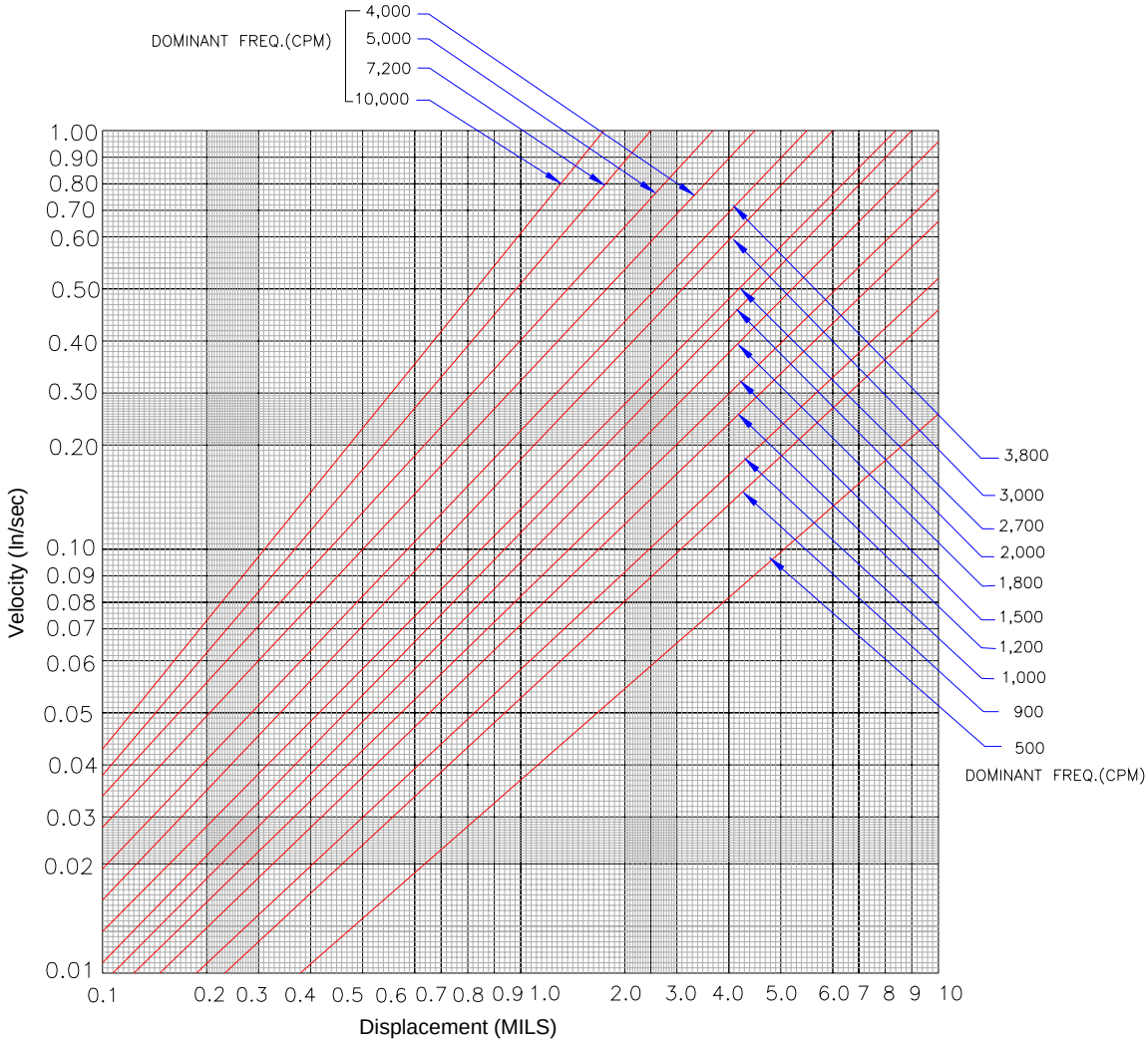


Figure 11 Dominant Vibration Frequency Chart

4.6 IN-SITU BALANCING

Imbalance is the most common cause of vibration in rotating machines and the vibration resulting from imbalance can be measured. This section contains instructions for in-situ balancing of rotating machines using a Model IRD811D instrument. To balance a rotating machine using the following method, the machine must be stopped and restarted several times.

Locations for attaching balancing weights are provided on many types of rotating machines and the locations for mounting these weights are generally included in the

manufacturer's specifications. On some machines, methods such as bolting or welding the weights to various machine parts are used. In addition, provision for the removal of existing weights for balancing are provided in some cases.

NOTE:
If possible, a Vibration Analyzer / Dynamic Balancer such as a IRD VB1000, VB1000b, VB2000, VB3000 or VB7 could be used for the balancing since these instruments contain a tunable filter and an external strobe light which provides separation of the various vibration frequency components. However, the machine can be balanced with a Model IRD811D instrument under the following conditions.

Before taking up the balancing of a machine rotor, following nee to be ensured:

- **Unbalance must be the main cause of the vibration** (check to make certain that other causes such as misalignment of couplings or bearings, bent shafts, defective anti-friction bearings, defective gears, or mechanical 100 sense etc are not present before attempting to balance.

- **The vibration indication must be steady** (the meter indicator must not fluctuate or drift more than ± 5% of full scale).

- **The dominant frequency of the vibration must be equal to the rotating speed of the part to be balanced.**

If the above three conditions are met, the machine can be single-plane balanced as follows:

Balancing Procedure

1. Install the accelerometer/Sensor at or near the machine bearing having the highest vibration (long axis of the sensor must be positioned in the same direction as the rotating machine vibration displacement).

2. Measure and record the original unbalance vibration amplitude as value "O".

3. Stop the rotating machine, then prepare a Trial Weight "TW" and install this weight at a known angle and radius (record the weight value.)

4. Restart the rotating machine and allow it to come up to the normal operating speed.

5. Measure and record the new unbalance vibration value as value "TI".

6. Stop the rotating machine then move the Trial Weight 180° from the original position (Step 3) at the same radius value.

7. Restart the rotating machine and allow it to come up to the normal operating speed.

8. Measure and record the new unbalance vibration value as value "T2".

9. Construct a vector diagram as illustrated in Figure 12 by using the “O”. “T1” and “T2” value obtained in Step 2, 5 and 8 for the rotating machine being balanced. (A scaling of 0.4 inch per mil of unbalance is used in this figure).

10. In the vector diagram, project a vertical line through the original circle and label the intersection at 0° as Point “A” and the intersection at 180° as Point “B”.

11. At the same scaling used in Step 9, draw an arc at radius “T1” from Point “A”, as illustrated (using the “T1” value obtained in Step 5).

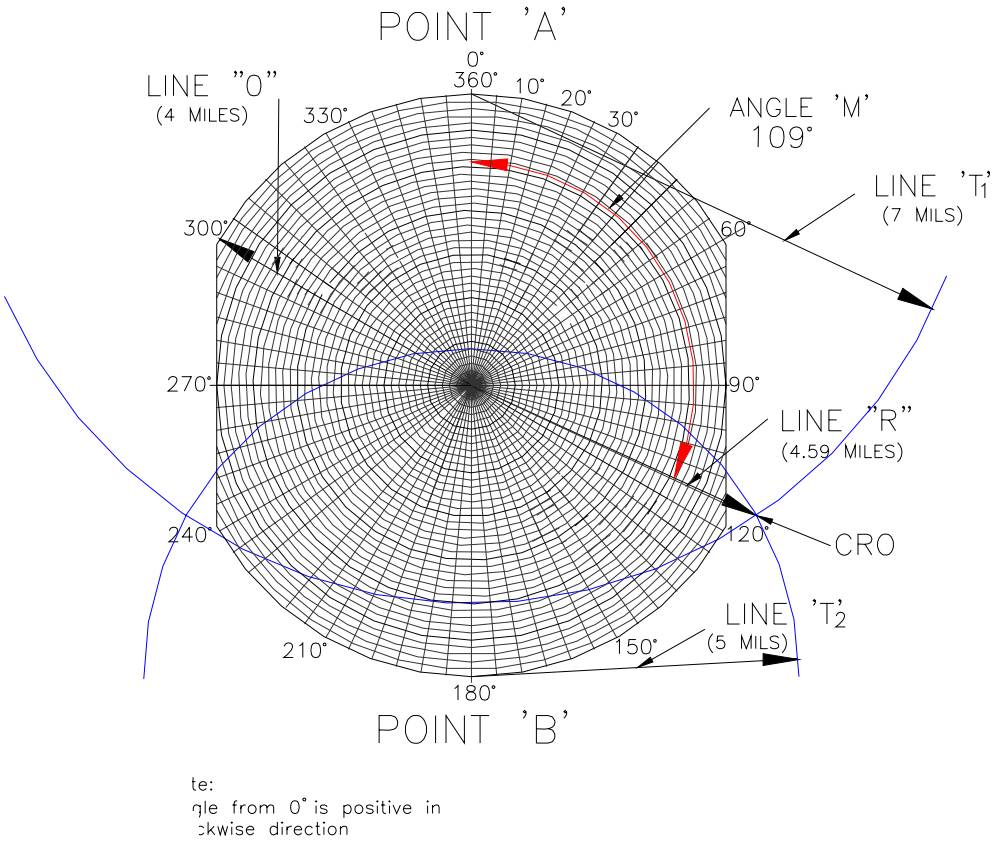


Figure 12 Sample Balancing Vector Diagram

12. At the same scaling used in Step 9, draw an arc at radius “t2” from Point “B” as illustrated (using the”T2” value obtained in Step 8).

NOTE:
The radius lines projected in Step 11 and 12 will cross one another at two points located an equal angular distance from Point “A”.

13. Project a straight line from the center of the vector diagram to either cross-over point of the radius-line projections drawn in Steps 11 and 12 and label as Line “R”.

14. Compute the final amount of correction weight required from Equation 2 which follows :

EQUATION 2:

$$\text{REQUIRED CORRECTION WEIGHT} = \frac{\text{'O'}}{\text{R}} \times \text{"TW"}$$

(Value "O" was obtained in Step 2, value "TW" in Step 3 and value "R" in Step 13).

NOTE:
In Figure above the "O" value is 4 mils (original unbalance), the "TW" value is 20 grams and the "R" value (unbalance at the intersection of the two arcs) is 4.59 mils. If these values were obtained for the rotation machine being balanced, then the amount of correction weight required for balancing the machine would be computed from Equation 2 as follows:

Required correction weight = $\frac{4.0 \text{ mils} \times 20 \text{ grams}}{4.59 \text{ mils}}$

⇒ **Required correction weight** = 17.4 grams

15. With a protractor, measure the angular distance from where Line "R" and the two arc lines intersect to Point "A". The angle at which Line "R" is drawn is angle "M" and in Figure equals 109°.

16. Fabricated a correction weight to the gram weight computed from Equation 2 and install on the rotating machine at the point located clockwise from the original "TW" position (see Step 3) by angle "M" degrees, at the same radius used in Step 3.

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

18. Measure the machine unbalance, if the desired balancing is obtained, then the proper correction weight is installed otherwise, proceed with Step 19.

19. Stop the rotating machine then move the weight counter-clockwise from the original "TW" position (see step 3) by the angle "M" degree value determined in Step 15.

20. Restart the rotating machine and allow it to come up to the normal rotating speed.

21. Measure the machine unbalance. If the desired degree of balance is obtained and if the correction weight(s) is properly installed, the balancing procedure is now completed.

As an additional aid in establishing g-SE level criteria for good and bad bearings, general experience indicates that when making bearing checks of machines in the 600 to 3600 RPM range with the 9-inch probe, a g-SE level of 0.5 or greater is of ten an indictor of a defective bearing. This number should of course be used with caution since many factors can affect the level measured, such as bearing type, machine type, etc, it should also be noted that where greater sensitivity to bearing defects is desired, the transducer can be flush mounted (i.e. without 9-inch probe) to the bearing housing; or alternately a magnetic holder may be used. In all cases the probe or transducer should contact the bearing housing with a light, steady pressure in such a manner that no chatter occurs.

NOTE:
The g-SE levels will vary depending upon the method of attachment used. Thus, the severity-criteria developed must be related to the attachment used.

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 signals. 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 Figure 13. This chart can be used as an aid in establishing g-SE severity criteria. No specific severity levels such as “smooth”, “good”, etc is assigned. Since many variables (bearing types, machine types, speed, loads, etc.) can affect the levels measured. Some case histories, however, are plotted on the chart to illustrate the type of results which can be obtained. By plotting the g-SE levels of your machines included in the bearing-check program on a chart, severity criteria can be readily developed for the individual machines.

NOTE:
In case of continuing vibration problems, IRD online monitors and protection systems are right solutions. For detailed options and specifications, please contact IRD regional office in your region or IRD Works in Mumbai, the contact details are given at the start of this manual.

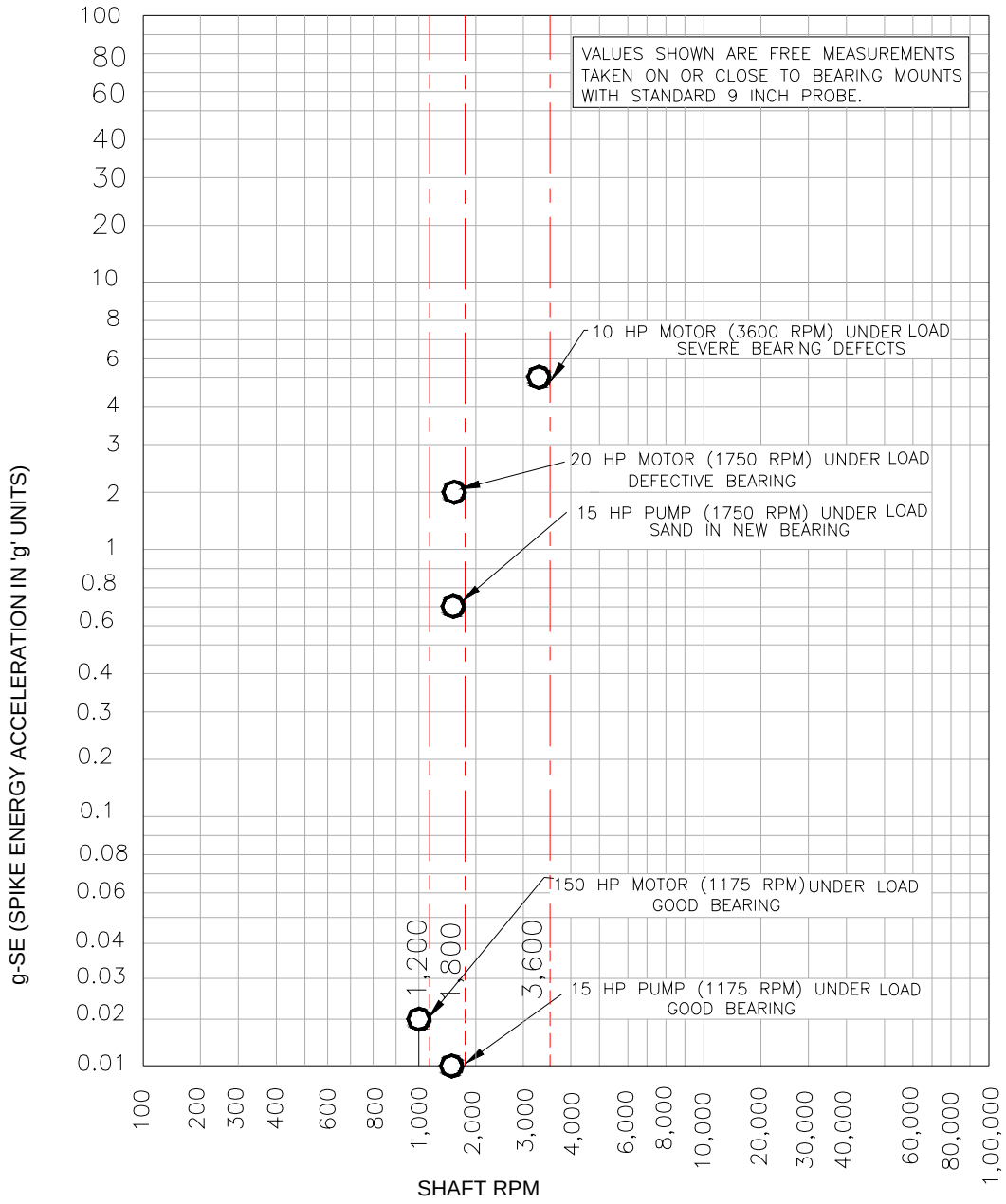


Figure 13 Rolling Element Bearing gSE severity chart

5. APPENDIX 1

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

SPIKE ENERGY CIRCUITS

The SPIKE ENERGY detection circuits are designed to sense the amplitude of the microsecond range pulses caused by impacts between bearing elements which have microscopic flaws. In addition to detecting pulse amplitude, these circuits also detect the rate of occurrence of the pulses and the amplitude of the high frequency random broad band vibratory energy associated with bearing defects. These three parameters of pulse amplitude, pulse rate and high frequency random vibratory energy are electronically combined into a single quantity "g-SE" which is a measure of bearing condition. The term "g-SE" (i.e. acceleration units of SPIKE ENERGY) has been selected to indicate that this type of measurement is more comprehensive than g-peak and g-RMS measurements.

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 level which significantly departs from the average are singled out for further analysis and closer watch, as potential bearing problems. This method rapidly leads to the establishment of criteria levels which distinguish good and bad bearings. It should be noted that the g-SE levels depend on the machine rotation 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.

NOTE:
For low speed machine vibration applications say below 500 RPM, contact IRD Mechanalysis® for Acoustic Emission (AE) systems which go down to 0.25 RPM.

6. SPECIFICATIONS

6.1 IRD811D Digital Vibration/Spike Energy Detector (Accelerometer) Part Number M81102

The IRD Mechanalysis model IRD811D portable digital vibration meter is suitable for most industrial applications with an easy to read digital display. Hand held it measures machinery vibration in terms of displacement (microns), velocity (mm/sec), acceleration (g) and Spike Energy™ (gSE™). Its integrated circuit technology provides wide dynamic range and long battery life.

From precision bearing inspection to plant-wide maintenance, the IRD811D has the sensitivity for measuring fractions of a micrometer to 2000 microns. Also, the widely acclaimed IRD Spike Energy™ (gSE™) circuit is included. The broadband measurement of gSE™ enables detection and measuring of "bursts" of spike energy at ultrasonic frequencies. Bearing defects developing such as micro spalls, cracks and lack of lubrication can be quickly identified thus preventing unscheduled plant outage.

BILL OF MATERIALS	Qty	Part Number
IRD811D Digital Vibration Meter	1	M81102
Accelerometer Multi-purpose, model IRD511 - 100 mV/g, 2.0 Hz - 10 kHz, top connector	1	M51100
Cable Assembly for model IRD811D to IRD511 Accelerometer sensor - 1.2m (4ft), rubber insulated, shielded	2	M60022
Magnetic Portable Base, IRD500 Series Accelerometers	1	M24828
Stinger, Al 225mm long for Sensor	1	M24827
Carrying Case	1	M25346
Battery Set, 2 Nos. of 9V, 100mAH Dry Cells	1	M30642
Manual Operating	1	M43082

Optional Accessories		Part Number
Shaft Fish Tail Stick - Absolute Vibration for IRD544		M24824
Manual Training - IRD MVT 1		M51001

SPECIFICATION

Measurement Ranges	
Displacement:	- 20 microns, 200 microns, 2,000 microns pk-pk
Velocity:	- 20 mm/sec, 200 mm/sec, 2,000 mm/sec pk
Acceleration:	- 20 g, 200 g, 2000 g pk
Spike Energy™	- 20 gSE™, 200 gSE™, 2000 gSE™
RMS	- Available on request
Frequency Range	
Displacement:	- 300 CPM to 24,000 CPM (5 Hz to 400 Hz)
Velocity:	- 300 CPM to 150,000 CPM (5 Hz to 2,500 Hz)
Acceleration:	- 300 CPM to 600,000 CPM (5 Hz to 10,000 Hz)
Accuracy **of instrument**	- 1% of Full Scale Reading (FSR)
Equivalent Input **Noise** is signal output with no measurement input.	Displacement 10-15 microns in 2000 range, Velocity 0.2 in 200 range and accleration 0.2 in 200 range. These noise do not create any problem when you measure vibration on machine and select right range
Input / Output	- Accelerometer, LC Digital Display (3½ Digit)
Power Requirements	
Internal Batteries:	- Battery Set, 2 Nos. of 9V, 100mAH Dry Cells
Environmental	
Operating temp:	- 0°C to +55°C
Storage temp:	- -18°C to +60°C
Weight & Dimensions	
Instrument only:	- 0.4Kg, 175mm (L) x 80mm (W) x 54mm (H)
Carrying Case:	- 2.0 Kg (inc. meter and standard accessories)

The Vibration People of IRD Mechanalysis can be contacted at the following branches or your local distributor:

Mumbai	Delhi	Kolkata	Chennai	International
Tel: +91(0)22-2852-0178	Tel: + 91(0)11-2237-3916	Tel: +91(0)33-2355-2062	Tel: +91(0)44-2823-0726	Tel: +91-22-2852-0178
Fax: +91(0)22-2852-1814	Fax: +91(0)11-2237-0778	Fax: +91(0)33-2355-9214	Fax: +91(0)44-2823-4702	Fax: +91-22-2852-1814
mumbai@irdmech.com	delhi@irdmech.com	kolkata@irdmech.com	chennai@irdmech.com	export@irdmech.com

6.2 IRD511 Accelerometer

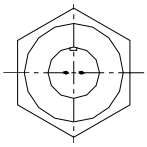
The IRD Mechanalysis model IRD511 is a standard accelerometer for measuring vibration on industrial rotating machinery. It has a top exit Mil 2 Pin Connector. This sensor is primarily used with portable vibration meters. A magnetic round base is available as optional accessory for portable vibration measurements.

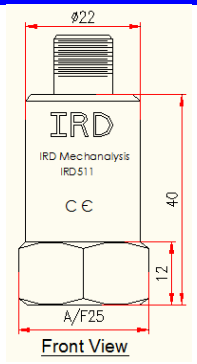
Applications: Applies to most Process Plants using Compressors, Blowers, Conveyors, Cooling Tower Fans, ID, FD, PA Fans, CW Pumps, Gear Boxes, Motors, Paper Machinery, Turbines etc.

Supplied Accessories	Qty	Part Number	Optional Accessories	Qty	Part No.
Sensor Mounting Adaptor Stud, M6	1	M60154	Cable 15 m Length with Mil 2-Pin connector		M60048
Calibration Certificate	1	CCIRD511	Magnetic Portable Base, IRD500 Series Accels	1	M24828

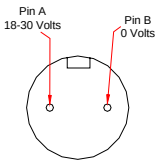
Dimensions & Connections

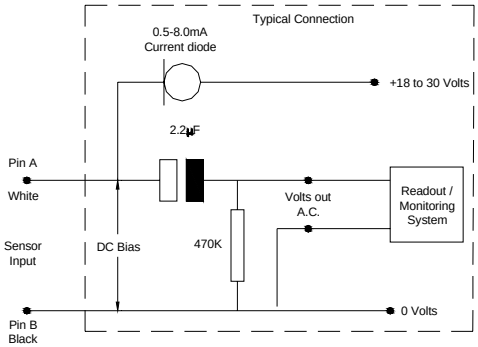
Plan View





Side View





Technical Performance

Mounted Base Resonance	22 kHz (nominal)
Sensitivity	100 mVg ± 10% Nominal 80 Hz at 22°C
Frequency Response	2 Hz to 10 kHz ± 5% 0.8 Hz to 15 kHz ± 3 dB
Isolation	Base isolated
Measurement Range	± 80g
Transverse Sensitivity	Less than 5%

Electrical

Electrical Noise	0.1 mg max
Current Range	0.5 mA to 8 mA
Bias Voltage	10 – 12 Volts DC
Settling Time	2 seconds
Output Impedance	200 Ohms max
Case Isolation	$>10^8$ Ohms at 500 Volts

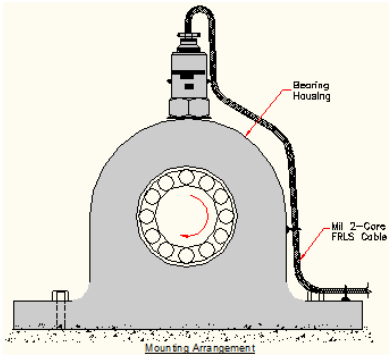
Environmental

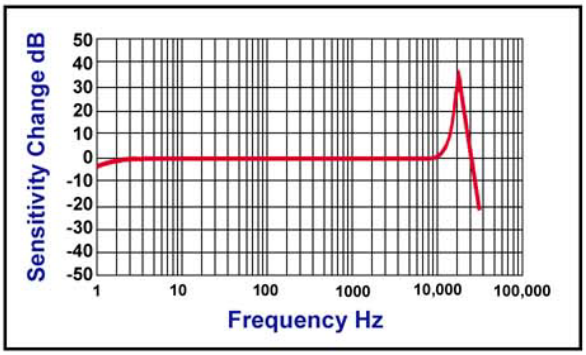
Operating Temperature Range	-55 to 140°C
Sealing	IP67
Maximum Shock	5000 g
Emissions	EN61000-6-4:2001
Immunity	EN61000-6-2:1999

Mechanical

Case Material	Stainless Steel
Sensing Element /Construction	PZT / Compression
Mounting Torque	8 Nm
Weight	110 gms (nom)
Maximum Cable length	1000 meters
Connector	2-pin Mil-C-5015
Mounting	¼" – 28 UNF Female
Options	Filters, Other sensitivities, Various connector assemblies Other Mountings

Mounting & Frequency Response





Part Number Selector

M = IRD Mechanalysis Product Prefix

Product Series IRD511
Accelerometer Standard, Top Exit

Cable/Conn Type
08 – Fire Retardant connector
50 – Mil 2 Pin Connector
54 – M12 Connector

Integrated Cable Length
000 – not applicable

M	5	1	1	1	0	0	5	0	0	1	0	0	0

Sensor Output
010 – 10 mV/g
030- 30 mV/g
050 – 50 mV/g
100 – 100 mV/g
250 – 250 mV/g
500 – 500 mV/g

Mounting Threads
01 – ¼"-28 UNF Female
02 – ¼"-28 UNF Male
05 – Quick Fit Female
06 – M6X1mm Male
08 – M8X1.25mm Male
10 – M10X1.5mm Male
12 – M12X1.75mm Male

Note on Sensor Output

- Most machinery applications are suitably covered by a sensor with a sensitivity of 100mV/g. However, you may wish specify different sensitivities because of the unique dynamic range of the particular machine to be monitored.
- A high sensitivity sensor, 500mV/g or 1V/g would be used for those machines operating at low speeds (say below 600 rpm) with high mass structures where vibration levels signals will inherently be of a low amplitude .
- For high dynamic ranges such as a high speed gearbox, you would use a lower sensitivity e.g. as low as 10mV/g, 50mVg etc.
- To ensure sensors are matched to specialised applications we recommend a detailed vibration analysis is undertaken first
- IRD Mechanalysis Consultancy Services can assist you in the best sensor solution.

The Vibration People of IRD Mechanalysis can be contacted at the following branches or your local distributor:

Mumbai	Delhi	Kolkata	Chennai	International
1/5, Marol Co-op. Industrial Estate Ltd, Off. Mathuradas Vasanji Rd. Marol, Andheri (East), Mumbai 400 059	Sagar Deep, Plot No.11 LSC Saini Enclave, Vikas Marg New Delhi 110 092	153/A, 2nd Floor VIP Road Kolkata 700 054	7-C, Chesney Nilgiri Apts 65, Commander-In-Chief Rd Chennai 600 105	1/5, Marol Co-op. Industrial Estate Ltd, Off. Mathuradas Vasanji Rd. Marol, Andheri (East), Mumbai 400 059 India
Tel: +91(0)22-2852-0178 Fax: +91(0)22-2852-1814 sales@irdmech.com Service@irdmech.com	Tel: + 91(0)11-2237-3916 Fax: +91(0)11-2237-0778 salesNR@irdmech.com	Tel: +91(0)33-2355-2062 Fax: +91(0)33-2355-9214 salesER@irdmech.com	Tel: +91(0)44-2823-0726 Fax: +91(0)44-2823-4702 salesSR@irdmech.com	Tel: +91-22-2852-0178 Fax: +91-22-2852-1814 sales@irdmech.com Service@irdmech.com

Keeping you Going

7. Support Services

Keeping you going is a IRD Mechanalysis® commitment. Product support is an essential aspect of any progressive business. IRD Mechanalysis® Limited (IRD) is no exception; the company has been supporting former IRD, then Entek well as IRD's products for the past 25 years. Indeed the acceptance and usage of these products by Indian industry is directly attributed to the dedicated support IRD has provided. IRD continues to invest in Customer Support. Just 'keeping you going' is not enough; we have facilities to ensure systems match world standards. Our instruments and systems are calibrated to National Standards.

National Service Centre, Mumbai

The very nature of industrial electronic instruments, both portable and permanent, demands regular calibration. From time to time it becomes necessary to repair of damaged items such as cables, sensors, power supplies and occasionally electronic circuitry etc. IRD Mechanalysis® is well equipped for such eventualities

When equipment is in need of repair, a reliable repair centre that is responsive, convenient, and cost effective is required. IRD Mechanalysis® Ltd offers in-house as well as site calibration (traceable to National Standards) and repair services. This also covers our partner's product range; IRD also supports many obsolete products where components are still available or have been indigenised.

As the original equipment manufacturer (OEM), we are the most knowledgeable and the qualified to service our products. Supported by more than 50 combined years of technical service experience, our repair technicians provide the highest quality service for your IRD products. At our **National Service Centre** in Mumbai we stock a comprehensive supply of spare parts to ensure a quick turnaround.

BENEFITS and FEATURES

For IRD Mechanalysis® Ltd's customers, the **National Service Centre** offers the following:

- Fast in-house turnaround options
- Expert factory technical assistance
- Industry competitive repair charges
- In-house calibration of vibration sensors (traceable to National Standards)
- Regular cleaning and calibration to extend product life and reliability
- Instrument hire during repair period to minimize programme interruption
- 1 Year warranty on Product Exchange Programme
- Fixed Price Repair – Whole Product 3 months warranty
- 90-day parts warranty on all repair and calibration services

PRODUCTS SUPPORTED

The **National Service Centre** has the capability to support the following products:

- Data Collectors: IRD817, IRD818, IRD890, IRD Fast Track®, dataPAC®1000, dP1250, dP1500; Enpac® series. Also Commtest VB series of vibration analysers and profiler
- Portable Instruments: IRD306, MIL306, MIL306C, MIL306D, MIL306DD, IRD308, IRD350, IRD355, IRD360, IRD810, IRD811, MIL811, MIL811D, IRD820, IRD838, IRD870, IRD880, IRD885
- Protection Monitors: 5802, 5806, 5815, 5915, 5800 Cards, 6100, 6600 Series, MIL8700 Series, MIL8800 Monitor
- Machinery Diagnostic Systems: Beran 766, 767, 768
- Machinery Protection Transmitters: IRD7100 Series, IRD7200 Series, IRD7300 Series
- Balancing Systems: 245, 246, MILB50 and MILB150

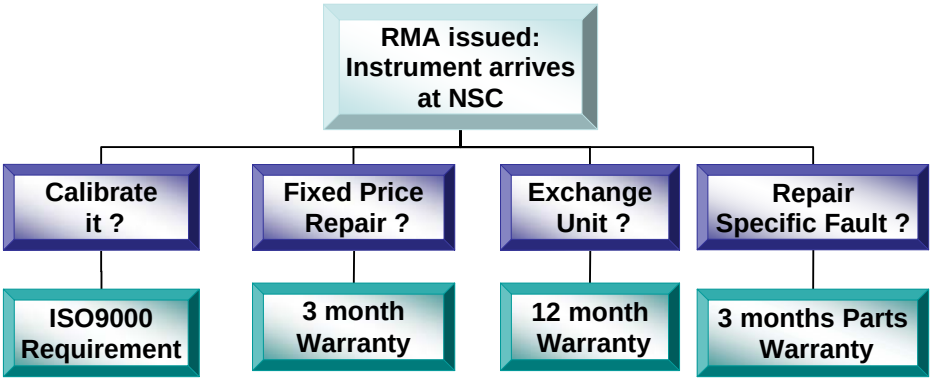
™ dataPAC, Enpac, and Fast Track are trademarks or registered trademarks of IRD Mechanalysis

Turnaround time and repair capabilities are dependent upon condition of equipment and spare parts availability at the time of the product assessment.

How the National Service Centre Optimises Clients Investments

- Annual Maintenance and Calibration ensures years of trouble free operation to maximize the investment in your condition monitoring equipment.
- A complete in-house supply of spare parts assures quick turnaround for product repairs.
- State of the art Sensor Calibration automatically over the full frequency range traceable and up to date to National Standards of the UK.
- IRD Mechanalysis® Ltd's ISO 9001 certification guarantees quality repairs and service.
- Our highly qualified Repair Centre technicians, supported by more than 50 combined years of technical service experience, give you the best available service and results.
- As the only authorized service centre for IRD Mechanalysis Ltd Products, our **National Service Centre** provide the most knowledgeable, experienced and committed support for all of our products.
- We offer a IRD Product Exchange Programme, Fixed Price Repair or Standard Repair and Calibration Only Services: the applicable warranty benefits are given below:

Service Options & Process



HOW TO GET SERVICE?

1. Before dispatching any instrument, cable, sensor etc it must be given an RMA number issued by the **NSC,** see below
2. For a Return Material Authorization number (RMA) this can be downloaded from our web site: www.irdmechanalysis.com
3. To discuss any instrument servicing issues please call Tel: +91(0)22-2852-0178 or one of our Regional Offices
4. Alternatively Email us at : service@irdmech.com
5. Complete the RMA and fax back to IRD Mechanalysis® at Fax: +91(0)22-2832-1814
6. When the RMA has been issued, the Client sends the instrument with all accessories together with the Purchase Order making reference to the RMA Number.
7. Upon receipt, IRD will evaluate the instrument and make a recommendation to the Client (if no instructions on type of service have been received earlier).
8. Only when the repair has been completed and payment has been received, will the instrument be returned to the Client.
9. Warranties will apply depending on the Repair Category option

LOCATIONS

National Service Centre
1/5, Marol Co-op. Industrial Estate Ltd,
Off. Mathuradas Vasanji Rd,
Marol
Andheri (East)
Mumbai
400 059
INDIA
Tel: +91(0)22-2852-0178
Tel: +91(0)22-2859-6214 / 6573
Fax: +91(0)22-2832-1814
Email: service@irdmech.com
Email: sales@irdmech.com

Head Office (Registered)
47 – 48 Jolly Maker Chambers II
Nariman Point
Mumbai
400 021
INDIA
Tel: + 91(0)22-2202-7430
Fax: +91(0)22-2285-0480
Email: ceo@irdmech.com
www.irdmechanalysis.com

RMA (Return Materials Advisory) Form

ATTN: IRD Mechanalysis Ltd, National Service Centre, 1/5 Marol Co-op, Industrial Estate Ltd, Off Mathurdas Vasanji Road, Marol, Andheri (E), Mumbai 400 059, India. +91(0)22-2852 0178 / 2906

FAX BACK RMA FORM: +91(0)22-2852 1814 or Email to : service@irdmech.com

Product Model:	Serial No:
Fault details (if applicable): Please tick appropriate box	

Warranty		Calibration		Fixed Price Repair		Exchange Units		Standard Repair	

This is to advise that we are planning to dispatch the above instrument for Calibration / Repair, as detailed above, on (date):_____

Customer's Purchase Order No:		**Date:**	
P.O. Value: Rs. (if agreed)			
AMC Contract No (if applicable)**:**			

A purchase order must be provided before inspection will commence unless an AMC Contract is in place.

When NSC receives the Return Material Authorisation it will issue an RMA number. Only then send in the instrument with its RMA Nos tagged on the instrument for tracking purposes. A PO must accompany the instrument referencing the RMA Nos.

Please complete the details below to enable us to process your requirements as quickly as possible.

MUST BE COMPLETED IN ALL CASES			
Invoice Address		**Delivery Address**	
Company:		Company:	
Department		Department	
Address:		Address:	
City		City	
State		State	
PIN		PIN	
Contact Name:		**Contact Name:**	
Telephone:		Telephone:	
Mobile:		Mobile:	
Fax:		Fax:	
Email		Email	
		Users Name:	
		Designation	
		Signature	
		Date	

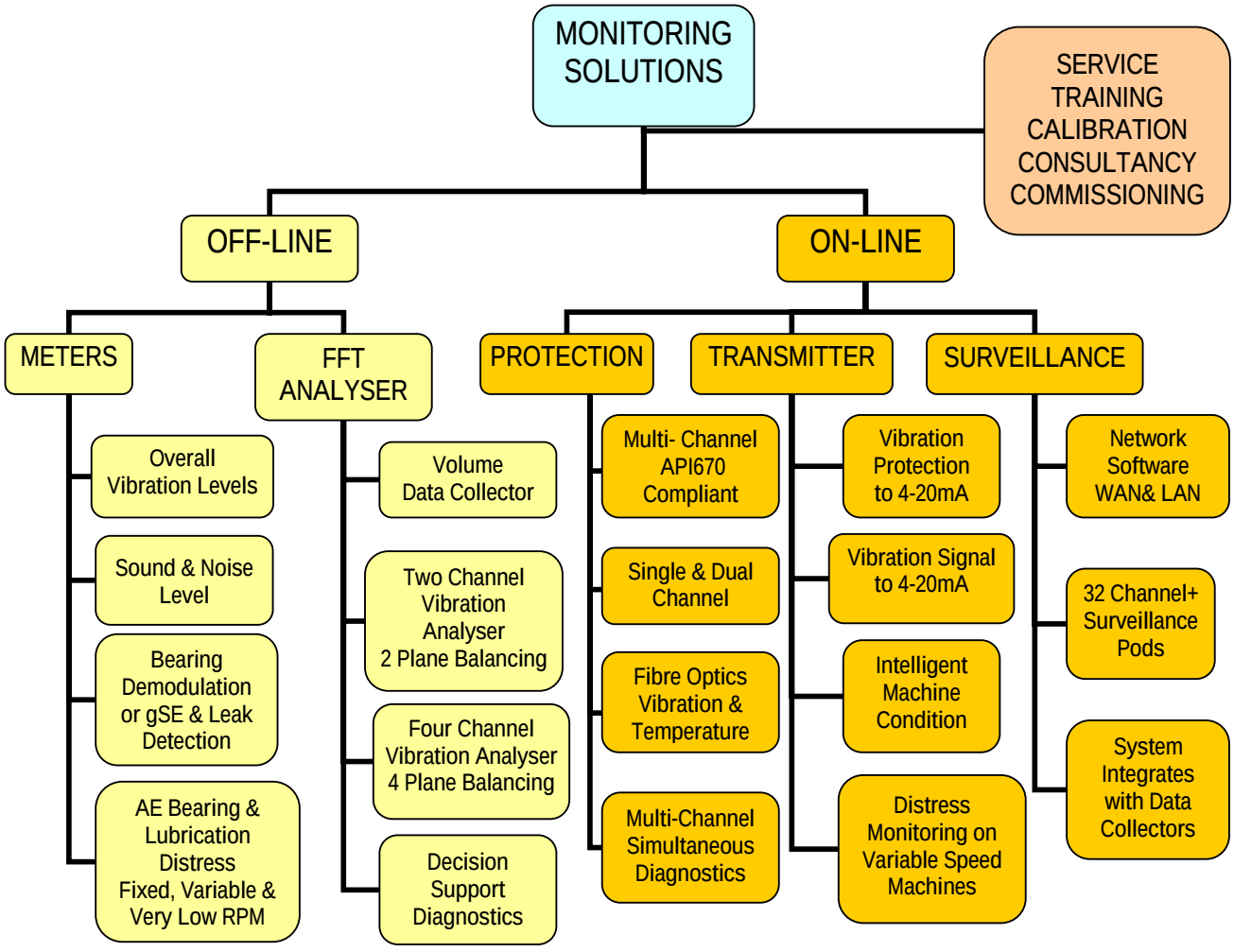
NSC RMA NUMBER ISSUED: RMA/

Taking you Further

8. Vibration Based Condition Monitoring Solutions

IRD Mechanalysis Ltd (IRD) is a leading provider of condition management solutions with over 30 years experience in machinery vibration measurement. IRD is credited with pioneering the concept of vibration based condition monitoring programmes in India. With the advent of computerization, IRD has established and maintained over 250 automated vibration based CM systems and has a user base of over 2200 major Producers and OEMs in India. IRD will continue to introduce new technologies to match your needs and reduce the cost of Condition Management. IRD is now rapidly expanding its International Export Division globally.

We take you further by providing reliable, easy to use, rugged and a comprehensive range of vibration monitoring products & solutions (as depicted in the chart given below) and enable you to enhance your productivity and investment. We look forward to your continued support and patronage.



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