Condition Monitoring CMUK™

Acoustic Emission specialists

Acoustic Emission Condition Monitoring Analyzer (ACMA)

User Manual

RV-2.1.0.1

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PATENTS

Key aspects of the ACMA and sensor functionality and design are covered by Overseas Patents.

MAINTENANCE

The ACMA contains no user serviceable parts. All maintenance and service on the Product must be carried out by CMUK otherwise the warranty may be invalidated. CMUK cannot accept any liability whatsoever for any loss or damage caused by service or maintenance by unauthorized personnel.

SPARES & CALIBRATION

Available direct from : All Countries Local distributers.

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Contents

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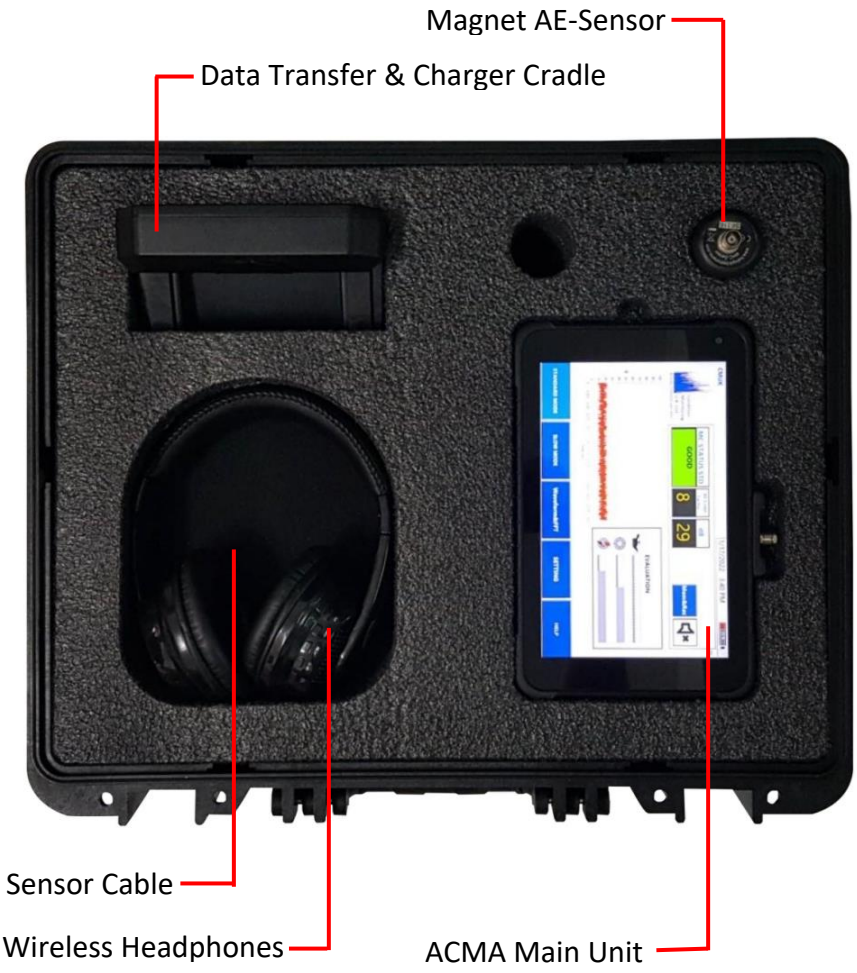
ACMA STANDARD KIT CONTENTS

The following items are included as part of the standard kit.



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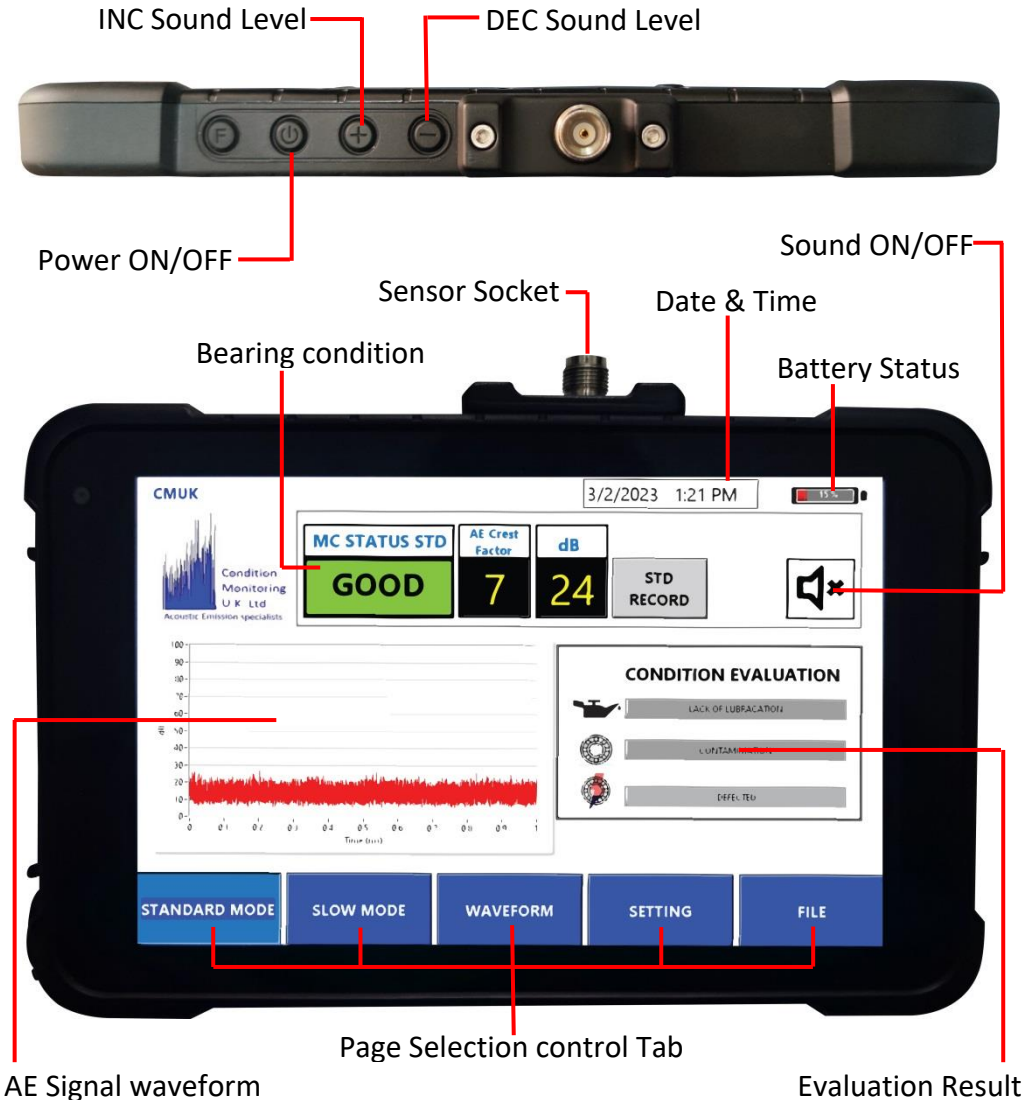
LAYOUT OF CONTROLS AND CONNECTIONS



Key Button	Function
STANDARD MODE	Select Main panel for machine speed >60 RPM
SLOW MODE	Select accurate mode for slow speed machine<60 RPM
WAVEFORM	Use for waveform and FFT monitoring
SETTING	Parameter setup page
FILE	List of inspection point and recorded file name
STD RECORD	Measurement data record command button
Sound ON/OFF	AE demodulated sound at headphones ON/OFF

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I - 1 SAFETY & THE ENVIRONMENT

1.1 Wear PPE (Personal Protective safety equipment) appropriate to the area and potential hazards where measurements are to be made.

1.2 The AE sensor sensing face contains a **very strong magnet** and should never be positioned in the vicinity of sensitive electrical or electronic equipment (for example; pacemakers or other sensitive medical equipment) or magnetic storage media such as hard disk drives.

1.3 Do not use the device on or near exposed moving parts. Never override safety systems in order to gain access to operating machinery. Take care to avoid physical injuries when taking measurements.
Never use if there is a risk of the cable and / or carrying strap becoming entangled with exposed rotating / moving machine parts.

1.4 The Measurement point could reach extremes of temperature when placed on HOT or COLD machines. Take precautions to avoid skin damage when the sensor placing the sensor.

1.5 Never use the sensor and ACMA device on live electrical surfaces.To avoid the risk of personal injury, only use the device on electrically grounded (earthed) machinery.

1.6 Always follow the GREASE/GEL/OIL supplier's instructions on its use, particularly with regard to skin irritant effects or contamination of the environment, nearby processes or product.

1.7 The device is **NOT** approved for use in **HAZARDOUS ATMOSPHERES.** Do not us e in the presence of explosive gases or highly inflammable liquids. It is NOT certified within the meaning of ATEX, Ex, IS etc.

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I-2 INTENDED USE OF THE ACMA

The **ACMA** is intended to be used to assist in the identification of degradation and faulty machinery, particularly motors, pumps, fans, gearboxes and shaft support bearings. The ACMA signal processing incorporated has been very extensively evaluated and demonstrated across a wide range of industries and an outstanding ability to detect machinery degradation has been established.

However, no Condition Monitoring technique can guarantee to provide early warning of all possible fault types, the applicability of the ACMA to a wide range of rotating machines has been successfully demonstrated. This manual provides practical advice on the use of the ACMA and general guidelines for interpreting its readings in accordance with the findings of previous experience. No such general guidelines can be guaranteed to provide the information required in all cases. It is recommended that the ACMA be used to complement existing methods and procedures for dealing with the service, maintenance and repair of machinery. The ACMA is intended to provide additional information to assist in making service and maintenance decisions.

The CMUK Limited accepts no responsibility or liability for any consequential loss howsoever arising from the use of the AMCA instrument.

MAINTENANCE

The ACMA touch screen of main unit shall require cleaning after normal use. If the case becomes soiled, wipe clean with a soft cloth or tissue. The magnet sensor sensing face should be kept clean and free of grit and debris. The sensing face can be degreased as necessary using a mild detergent. Do not use aggressive chemicals. It is recommends that the device (instrument & sensors) are serviced, checked and calibrated regularly through an authorised CMUK service provider.
The recommended recalibration period is every 1year. The device contains no user serviceable parts. Do not attempt to dismantle. Contact CMUK authorized dealer for service and repair.

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CALIBRATION & SERVICE

The ACMA instrument and Acoustic Emission sensor incorporate special design features to stabilize their response and can be expected to give accurate measurements over a long period of time. Nevertheless it is wise to periodically check their calibration. CMUK Limited offer a recalibration service and recommend that both the ACMA instrument and the sensor should be re-calibrated every 1year.

Moreover, the calibration should be checked under the following circumstances:

- The sensor or instrument has been dropped or otherwise damaged.
- The sensor or instrument has been exposed to extreme temperatures.
- All measured values have unexpectedly reduced *.

* IMPORTANT : If measured readings are different or if readings of AE-Crest Factor and dB Level do not reduce to 1 or 0 when the sensor is stationary hanging in free space then it may be that the sensor lead is damaged. To check for this temporarily replace the sensor lead with the spare sensor lead supplied with the ACMA unit. If this cures the problem then discard the damaged lead and order a replacement form CMUK Local distributor.

WASTE ELECTRICAL AND ELECTRONIC (WEEE)

The device falls within the scope of the EU WEEE directive. Within the EU, the device may only be disposed of through a WEEE registered recycling scheme. Kittiwake Holroyd can assist, provided the device is not contaminated with toxic chemicals, biological material, bacteria or radioactive materials.

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I - 3 FAMILIARISATION WITH THE ACMA INSTRUMENT

I - 3.1 Schematic of ACMA controls and connections

I - 3.2 measurement options

The **ACMA** instrument uses technology which is known as Acoustic Emission or AE. In particular the ACMA is not sensitive to low frequency activity such as that associated with vibration or audible sound.

The instrument provides information related to the mechanical condition of rotating machinery. It does this by detecting high frequency stress waves (at approximately 90-100 kHz) associated with energy loss mechanisms such as friction and impacts that are naturally produced by machinery in poor condition.

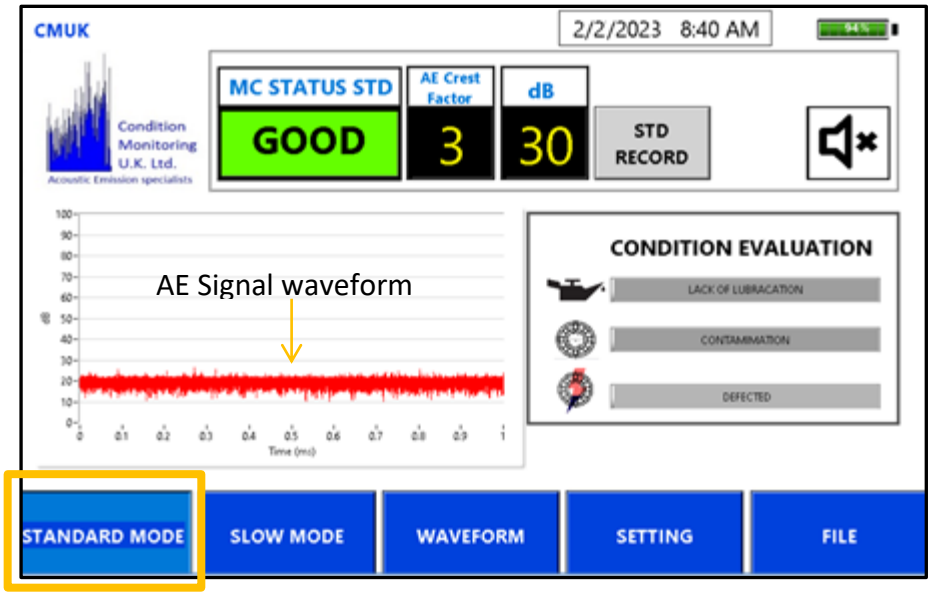
The ACMA instrument can be applied to a wide variety of machine types including motors, pumps, fans gearboxes and shaft support bearings. It can be useful in the detection of bearing faults (including faults on plain, ball and roller bearings) and pitting on gear teeth provided there is a good sound path to the gearbox casing.

When using the ACMA to take a measurement a special AE magnet sensor is temporarily coupled to the surface of the bearing housing on a machine of interest. The ACMA can be operated in various modes of operation, as following;

- **Standard Mode (AE Crest Factor & dB)**

The standard mode is best suited to monitoring rotating machinery rotating at speeds above 50 rpm. In this mode there is no need to make any adjustments when monitoring machinery of different types, size, design or operating speed. The ACMA automatically processes the signals in terms of two parameters called ***AE Crest Factor*** and ***dB Level***.

Pressing " **STANDARD MODE** " Tab on touch screen display then the standard mode monitoring page will display as picture below.



This mode provides measurement parameter results of both parameters and machine condition status. The AE signal time waveform allows you to visualize the machine operation condition. In case of machine in abnormal condition then the condition Evaluation bar graph can be used to imply three problem categories that includes; Lack of lubrication , Lubrication contamination and start of bearing defect.

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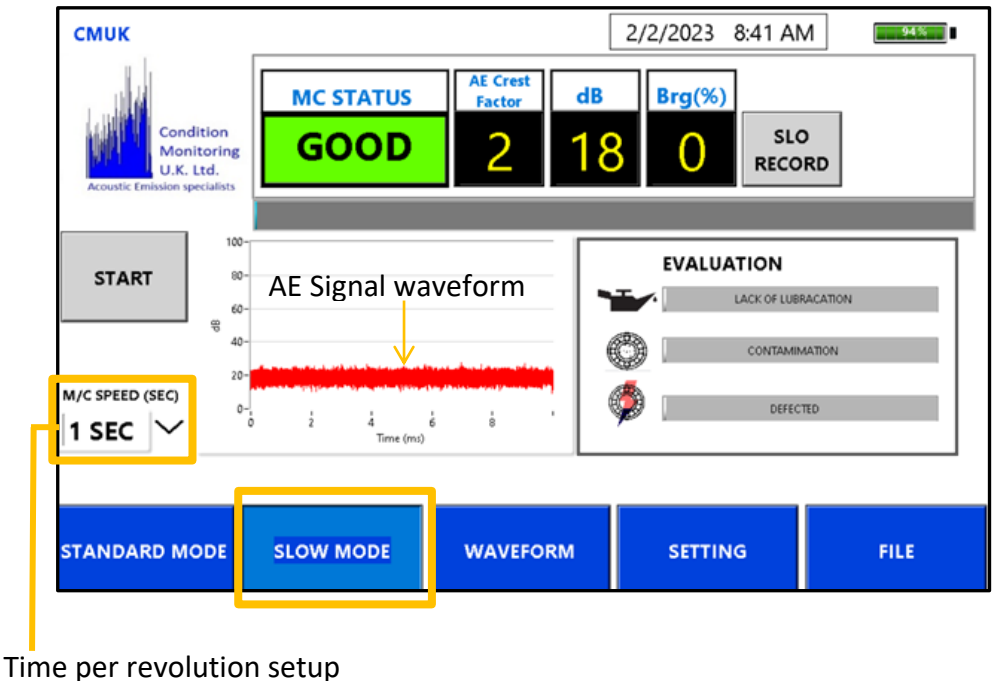
b) Slow Mode (dB, Peak, Intensity & Extent)

This mode of operating is suitable for monitoring machine operating at rotational speeds down to ~6 rpm (10 seconds per revolution). In order to make a slow mode measurement it is first necessary to enter the number of seconds it takes the machine to perform one revolution.

In this mode the ACMA will automatically processes the signals in terms of high accuracy **AE Crest Factor , dB Level** and ***Brg(%)*** that imply of Bearing Health.

To enter this mode pressing " **SLOW MODE** " Tab on touch screen display then the slow mode monitoring page will display as picture below.



Time per revolution setup

This mode provides precisely measurement parameter results from 10 revolutions for AE Crest Facter and "Brg%" that imply percentage of bearing degradation condition. The AE signal time waveform allows you to visualize the machine operation condition.

In case of machine in abnormal condition then the condition Evaluation bar graph can be used to imply three problem categories that includes; Lack of lubrication, Lubrication contamination and start of bearing defect.

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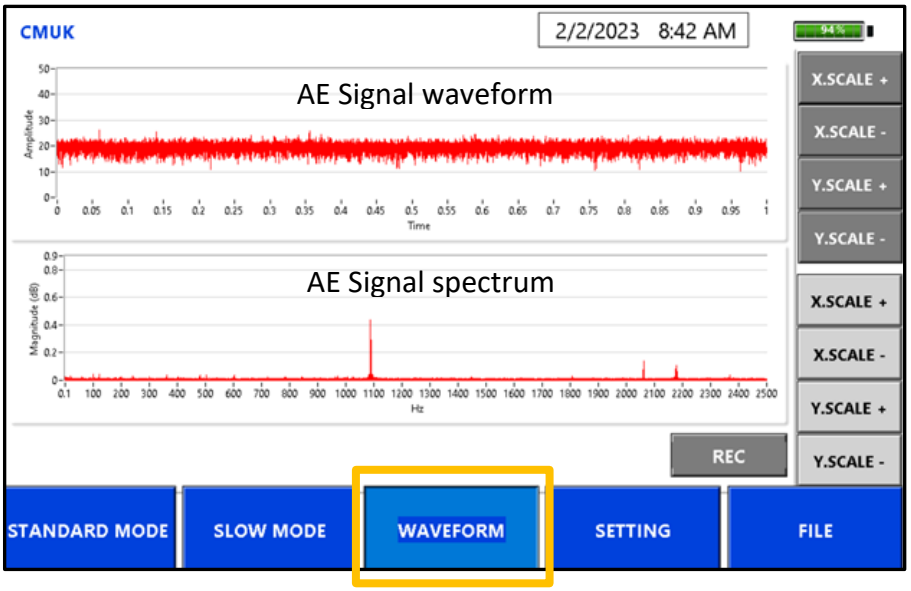
C) AE Signal Waveform & Spectrum (FFT)

To visualize the real time AE signal Waveform & Spectrum mode can be accessed by pressing " **WAVEFORM** " Tab on touch screen display then the slow mode monitoring page will display as picture below.



In this mode the ACMA is able to store the data by pressing " **REC.** " frequency spectra of the AE envelope signal. Such frequency spectra are later accessed via the ***Synce ACMA Win*** software and viewed in a special version of AE Ultaspan-FFT software that is supplied with the ACMA.

Each AE envelope spectrum covers the frequency range of 0 Hz to 1000 Hz and is representative of 10 second period sampled at 2048 times per second.

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I - 3.3 Basic operation of the ACMA instrument

a) Plug the AE sensor into the ACMA and switch on the headphones. Then press the ON button and hold until LED Power indication turn on and wait until the system ready (approximately 30-45 Sec.) After the Standard Mode screen will be displayed then the ACMA is ready for taking measurement.

b) Apply a drop of a viscous fluid (such as a grease appropriate to the local environment) onto the sensor front face and couple the sensor to a bearing housing measurement point.

c) Allow time for the readings to settle down.

d) To simulate machine friction rub the bearing housing gently with a paper tissue. Observe the effects on the displayed readings of ***AE Crest Factor*** and ***dB*** *Level* and the characteristic 'sshhh' sound in the headphones. Press the Sound Button to toggle the volume of the headphones between ON/OFF

e) Please note that if ***AE Crest Factor*** increases to 10 then MC status SUSPECT appears beside the reading. This changes to ALARM when it reaches 20 and DANGER when it reaches 30.

f) Observe that when the *dB Level* must not less than 5. A low signal level may result from a poor sensor coupling or even a machine that isn't running (Note that on slowly rotating machinery it can be quite normal for the *dB Level* to be less than 5 dB).

g) To simulate impacts occurring within machinery drop several grains of sugar, salt or similar particles onto the plate. Observe the effect on the displayed readings of *Distress* and *dB Level* and the characteristic multiple 'clicks' heard on the headphones.

h) Observe that although the headphones are very sensitive to rubbing and impacts on the steel plate they are not responsive to other audible noises and vibrations which may be present nearby.

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I - 4 GETTING STARTED

a) General guidance

Observe flat location on machine for sensor mounting points are used to improve the reproducibility of measurements particularly avoid the surface condition of the machine is not very smooth or flat. Where possible locate a monitoring point as close as practical to each bearing (ensuring the sensor will not foul when attached to the stud and that the stud will not interfere with future strip-down and repair operations). Bear in mind that high frequency waves are not easily transmitted across joints between different materials or through soft materials such as rubber or plastics. If there are competing sources of activity present e.g. from an adjacent machine, high pressure jets, cavitation or process noises then position the monitoring pad as close to the bearing as possible but as distant as possible from these unwanted sources.

b) Some common monitoring positions :

Shaft and roller support bearings
Position for sensor monitoring point at anywhere on each bearing housing. If possible choose a flat (or near flat) part of the surface.

Motors
For most motors two monitoring pads are used, one for the drive end and one for the non-drive end bearings. If the non-drive end has a flimsy cover plate over the fan do not mount the pad onto this but adjacent to it (e.g. on the cooling fins where there is a break in the fin pattern). The monitoring pad can be oriented radially or axially (i.e. on the end or side of the motor) depending upon access.

Pumps

On simple centrifugal pumps the bearings are often external and readily accessible. Mount a monitoring pad on each bearing. If possible choose a flat (or near flat) part of the surface. On multi-stage pumps access may be more difficult and it may be necessary to refer to engineering drawings to identify where the bearings are being supported. If the pump is supported on a Michelle bearing this can also be monitored with a monitoring pad bonded to the side of the bearing housing.

Gearboxes

On large gearboxes individual bearings associated with each shaft can often be identified. Mount one monitoring pad immediately adjacent to each bearing access plate (this allows the area of distress to be located). On smaller gearboxes use two monitoring pads one adjacent to the input shaft and one adjacent to the output shaft. On very small gearboxes use only one monitoring pad centrally located on the gearbox body.

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Axial compressors
For a two bearing design the monitoring pads should be positioned at either end of the compressor. They can be oriented radially or axially depending upon access.

In-duct fans
Mount externally, either on the ends of or immediately adjacent to the spiders supporting the internal fan. Use one pad for the front support and one for the back support (except on very small fans).

I - 4.1 Taking a reading
To achieve consistent readings the following procedure should be followed when using the ***ACMA*** :

a) Clean the sensor front face and the face of the monitoring pad using a clean cloth.

- Apply a small drop of clean viscous fluid (such as a grease appropriate to the local environment) to the monitoring pad or the sensor front face.

c) Bring the sensor towards the surface of the machine at an angle of approximately 45 degrees so that the edge of the front face touches first. Then pivot the sensor over so that contact is made across the sensor face (this method is preferred because of the very strong magnetic face).

d) Twist the sensor slightly; it should rotate smoothly without any feel of roughness (repeat steps (a) to (c) if grit can be felt in the coupling).

e) If the ACMA isn't already switched on then switch it on either for taking off route readings or on route readings (see Section I -3.2). If in 'Route' display respond appropriately to the hierarchical questions until the desired measurement position on the route is reached (as described in Section I - 5).

f) For Standard Mode readings :
Observe the measured values of *AE Crest Factor* and *dB Level* and check that they have reached steady levels (this should take about 15 seconds). It is normal for the reading to be initially high when the sensor is placed onto the machine or the instrument is switched on. If *AE Crest Factor* and dB Level do not reach a steady value but continue to vary this can be the earliest indication of a machine problem arising. Use the STD REC key to record data at the most representative value prior to storing it. If appropriate use the headphones to assist in the diagnosis of any machine in Suspect (i.e. *AE Crest Factor* > 10) condition.

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g) For Slow Mode readings :
To use super slo mode it is necessary to enter the time in seconds it takes for the item being monitored to make 1 revolution (i.e. the period of revolution in seconds). This does not have to be exact, always round up to the nearest full second (eg if period = 3.4 seconds select 4 seconds as the time per revolution).

On slow speed machinery it is usual for signal levels to be very low (dB levels of 0 are not uncommon at slow speeds). Because of this it is especially important that the AE sensor, and the lead connecting it to the ACMA instrument is not moved since such movement may cause artificial signals to be generated from friction and triboelectric noise.

h) When removing the sensor after taking a measurement hold the body of the sensor (not the sensor lead) and pivot it so that one side of the front face breaks away. With the sensor at an angle of approximately 45 degrees pull the sensor body away from the machine surface. Do not pull on the sensor lead when doing this.

- The sensing face needs to be acoustically coupled (with suitable grease or oil) to a static part of a machine's external casing containing the bearing to be monitored. Positioning and orientation of the sensor is not critical although highest signal levels will be detected in the immediate vicinity of the bearing - avoid flimsy cowls, guards and nameplates. Make sure the surface is clean and free of grit and debris.

- Do not move the sensor during measurements and ensure nothing is touching the sensor as this can affect the readings.

- AE Crest Factor® readings may appear artificially high if the sensor case catches on anything or the sensing face moves on the machine surface during the measurement.

- To avoid measurement errors, use the magnetic sensing face to attach the sensor rather than holding it

- If a high reading is observed, it is recommended that a second measurement is taken to confirm the first result.

- For consistency, repeatability and trending, measurements should be made at the same point(s) on any particular machine.

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Troubleshooting

The simplest form of troubleshooting with the ACMA is to use the headphones to better understand the nature of the problem in the following ways :

i) Interpret the likely cause from the nature of the signal (e.g. the singular ‘click of a cracked race, the periodic ‘shh’ of a shaft rub or the ‘frying bacon’ sound of generalised damage).

ii) Understand the operational conditions (e.g. of speed, load, tightness etc.) that aggravate the condition.

iii) Localise the source by moving the sensor around the component and looking for where it is loudest.

Sometimes further insight into the nature or cause of a problem can be gained from looking more closely over a longer time period at what aggravates the condition. To do this in a more systematic way than just listening on the headphones use the Auto Log function to record one or more sequences of successive values

With rotating machinery it is often the case that the source of detectable signal (e.g. an impact or a rub has repetition associated with it (e.g. at once per rev, ball spin or ball passing frequency etc..).

Formachinery rotating at speeds greater than 60 rpm the Capture Spectrum facility enables the data for such a frequency spectrum to be stored so that repetition frequencies can be viewed and analysed in the PC domain (see Capture Spectrum in Section I - 3.2(d)).

I - 5.7 Communications with a PC

In order for a communications link to be effected between the ACMA and a PC via the Docking Cradle interface it is essential for ACMA to be switched on and the LAN communication cable to be connected between the two devices.

In addition the ACMA Sync software must be loaded and opened on the PC and its ‘Setup’ set to the COM port to which the ACMA is connected. When wishing to communicate between the ACMA and the PC recommend that the ACMA instrument should be in the Main menu.

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I - 6 INTERPRETING STANDARD MODE READINGS (ACMA & dB Level)

When used in standard mode the ACMA characterises the AE signal in terms of the two parameters *AE Crest Factor* and *dB Level*.

AE Crest Factor

This measurement parameter gives early warning that an item is in *AE Crest Factor*. The way in which it is derived is a commercial secret but in broad terms it is a summation of the clicks, crunches, whistles and groans which are generated by defective rotating machinery. It is very sensitive and can detect inadequate lubrication at an early stage allowing remedial action before significant permanent damage has been done. Because it is so sensitive it is important not to over react and strip down a machine on the basis of a single high *AE Crest Factor* reading.

One major advantage of the *AE Crest Factor* parameter is that for the vast majority of rotating machinery a *AE Crest Factor* reading of 5 or less equates to very good condition and a *AE Crest Factor* reading of 10 or less is satisfactory condition.

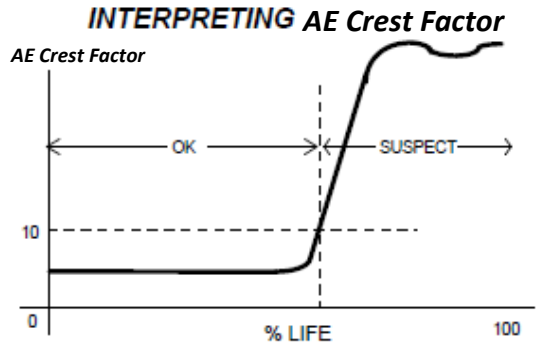
This makes it easy to identify rotating machinery in *AE Crest Factor* even if no previous measurements have been made. In general we refer to machinery running with a *AE Crest Factor* greater than 10 as having a 'Suspect' condition.

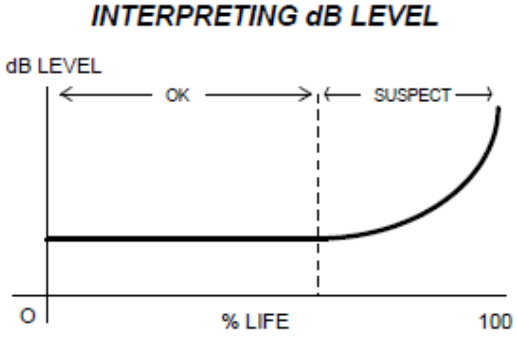
dB Level

This is a measure of the mean level of the high frequency signal and does depend on machine type, size and speed etc.. It must therefore be used comparatively. That is the *dB Level* reading should be compared with that on other identical machines or with previous readings taken on the same machine (at the same speed).

In general the trend of *dB Level* with time is a particularly useful indicator of the rate of deterioration of machinery which is in a 'Suspect' condition.

An idealised plot of how *AE Crest Factor* and *dB Level* vary throughout the life of a typical machine throughout the operational life of a component is shown below :





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I - 8 USING THE HEADPHONES

The headphones output is a de-modulated version of the high frequency AE signal. Although the AE signal is purely at high frequency the modulations in its amplitude are at audio frequencies and can therefore be heard through headphones. For low level signals the Headphones output can be increased by pressing the VOLUME key. This key toggles between high and low settings. The default setting when the ACMA is switched on is at the low level.

Listening on the headphones, whilst subjective, is often useful to :

- Provide a secondary means of confirming that a Problem exists.

- Help in the identification of the fault type.

- Further localise the fault position whilst moving the sensor to different points on the machine.

- Listen to very slowly rotating or slowly reciprocating machinery.

Note : Since the audio circuitry is automatically switched on when the headphones are connected the use of the headphones increases the current being drawn from the batteries.
