



xms

Specification

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1. XMS - eXtended Monitoring Software

Definition

XMS is the description for the totality of a number of various modules of a modern software package for the evaluation of measured vibration data in relation with process values. The measured data is acquired by XMS alternatively through a vibration measuring instrument (only VIBROTEST 60) and/or a permanently-installed On-line data acquisition unit.

XMS provides early damage identification in machines for

- § Prevention of catastrophic damage
- § Decrease in the number of unscheduled machine shutdowns
- § Reduction of spare parts inventory through sufficient advance notice for outside suppliers
- § Shortening repair time due to easier early recognition of damaged components

This specification describes the functions and makes it possible to select those modules that are required for an application. A corresponding software package is thus individually compiled for the desires and requirements of the user by a building-block approach.

Operating system

XMS runs under any of the following operating systems:

- § MS-WINDOWS 2000
- § MS-WINDOWS NT Version 4.0 – Service pack 6
- § MS-WINDOWS XP

Computer equipment

In principle it is recommended that the latest computer standard be utilised. At the time of the creation of this specification the following data was valid:

Minimum equipment / recommended equipment

- § Processor: Pentium III / Pentium IV
- § RAM: 128 MB / 512 MB
- § Sample frequency: 500 MHz / 2,4 GHz
- § HDD: 2 GB / 4 GB free space
- § CD-ROM drive
- § Omni-drive Professional or other PC-Card drive (PCMCIA)
- § Interfaces: none (off-line) , for on-line network connection recommended
- § Graphic card: 65,000 colours (16 Bit), small script, resolution: 1024 x 768 or better
- § Monitor: Colour 15" / 21"
- § Keyboard
- § Mouse
- § Colour printer

The **NTFS** file system should be installed on this computer.

Modularity

The following list provides an overview of the currently available modules. A more detailed description is provided on the pages that follow.

- § **Basic Module B01**
Database (off-line/on-line) and basic functions
(B01 is always required and is in the defining sense non-operational in isolation)
- § **Interface Module I01**
Unload VIBROTEST 60 Reports (off-line)
- § **Interface Module I02**
Load and unload VIBROTEST 60 Routes (off-line)
- § **Interface Module I03**
Log-in of OPC data sources, e.g. SIMS cm or VC-6000 (on-line)
- § **Analysis Module A10**
Trend Analysis of Overall measurements, Harmonics, Bearing Condition Units, Process values, Manual entries
- § **Analysis Module A11**
Measured values as functions of speed and time.
Overall values and Bearing Condition Units as $f(n)$ and $f(t)$; Harmonics as $f(n)$ and $f(t)$.
- § **Analysis Module A20**
Spectra, Cepstra, Envelope analysis spectra
- § **Analysis Module A21**
Constant Percentage Bandwidth Spectra - CPB
- § **Diagnosis Module D10**
Rolling-element bearing database and FFT Symptom–marker
- § **Process Visualization P10**
Measurement visualization via OPC-Server technology (on-line)
(Visualization of measured data, no data storage)

DEMO mode

The XMS can be tested with some functional restrictions without any time limitation. The following functions are not available in the test mode:

Offline operation

- § Printout of reports (a print preview is possible)
- § Exporting of data
- § Copying of diagrams to the Clipboard
- § Only the first 5 Points in a Route can be loaded and unloaded

Online operation

- § Measurements display in Process visualization components will be set inactive after 3 minutes (black display)
- § The relays reset function for connected instruments cannot be executed
- § The service program which acquire and store on-line measurements cannot be started.
- § For test purposes an OPC Data Access DEMO Server is available. This DEMO Server simulates not connected *SIMS/VC6000*-devices.



2. Basic Module B01 Database and basic functions

Task

The Basic Module provides the platform for all modules including a data base for all measured values and does not operate in isolation. In combination with its respective „responsible“ modules it fulfils the following functions:

Functions

- § Initialisation of all modules that operate on the Basic Module platform
- § Database management
- § Report system
- § View management

The program has a **software copy protection** feature.

Cross-referencing between the various modules and module functions provides a **context-sensitive user operation** that reduces to a minimum the number of mouse-clicks and operating steps in the navigation of the software.

Any arbitrary screen display can be printed out using the convenient **print function**.

A number of **standard report forms** that can be requested are integrated into XMS. A simple Report builder is integrated for creation of **additional customised Reports**.

A selection of **machine templates** with prescribed measuring tasks, recommended limit value settings (observing current standards), frequency ranges, etc. are automatically integrated into **new additions to a database** to simplify and speed up addition of new machines into existing Plants.

The **adaptation of the user-interface** to individual requirements of the user is supported by:

- § Adding, renaming, re-sorting and deletion of freely-definable Views
- § Random composition of a View content by integration of a graphic tool with the functions “Insert, Arrange, Edit and Delete“ of
 - o Diagrams with random linking to measured values
 - o Status lights
 - o Texts
 - o Standard shapes (arrows, rectangles, ...)
 - o Sensitive fields that execute a hyperlink with a mouse-click
 - o PDF Files (sketches, specifications)
 - o jpg.files (photos)
 - o OLE (Object Linking and Embedding) links
 - o Internet links
 - o Machine drawing editor
- § Replacement of a number of graphic elements (e.g. logos) with your own graphics and Bitmaps
- § Integration of machine photos / machine sketches
- § Extensive diagram design functions through changes in size and position, colour assignment, line thickness, line style, ...
- § Random diagram combinations

3. Interface Module I01

Unload VIBROTEST 60 Reports

Task

The Interface Module I01 provides the following functions:

- § Interface and communication between the PC-card of the VIBROTEST 60 and the XMS database for archiving measurements stored in the form of Reports.
- § All necessary functions to permit reading of individual measurements in the existing database.
- § The option of assigning individual Reports to already defined measurement Points or newly created measurement Points during the unload procedure.

Application

Random measurements are stored on the inserted PC-card of the VIBROTEST 60 in the form of „Reports“. After inserting the PC-card into the PC-card drive (Omni drive Professional) of the computer, the measurements are unloaded into the database of XMS. During unloading of the measurements into the database, a dialogue menu enquires to which measurement Point the measurement is to be assigned. If the measurement Point does not exist in the database, a new measurement Point can be created in advance in the database. The proven 4-level hierarchy of Plant, Machine Group, Machine, Point is utilised for this.

The assignment of measurements to measurement Points is carried out by a combination of the functions of this module and the database management functions of the Basic Module B01.

Measurements from Routes and Route instructions using the VIBROTEST 60 as a data-collector cannot be unloaded using this module. The interface Module I02 is used for this purpose.

Once saved under the correct Point description in the database, the data can be analysed, using the broad range of analysis tools available in the various analysis modules of the software, deleted or exported.



4. Interface Module I02

Loading and unloading of VIBROTEST 60 Routes

Tasks

The Interface Module I02 provides the following functions:

- § A communication interface between the PC-card of the VIBROTEST 60 instrument and the XMS database for archiving stored measurements in the form of “Routes”.
- § Loading and unloading of measurement Routes that have been created and defined in the XMS.
- § Automatic measurement Point assignment in the database during the Route unload procedure.

Application

This module offers the interface for communication between the portable measuring instrument VIBROTEST 60 in data-collector mode (Module 6) and the XMS database. Utilising the Plant hierarchy and the saved measurement Point setups, database, user-specific measurement Routes and Route instructions are created. The measurement Routes and Route instructions are loaded to a PC-card and processed at regular intervals by the VIBROTEST 60. Finally the measured data is unloaded and assigned to the respective measurement Points in the database.

Functions

When **creating a Route**, various measurement Points in the database are combined into what are commonly called Routes. Entire Plant, Train, Machine or Point descriptions are inserted into the Route list using mouse-clicks. Using Drag and Drop, the Points can be arranged into any sequence in the Route list to adopt the optimum measurement Point sequence.

The created **Routes** are **loaded to a PC-card** using the Interface Module IO2 “Load and Unload VIBROTEST 60 Routes”.

A **Reset** function allows the Load / Unload cycle to be interrupted. A Route that has been loaded to a PC-card but which cannot be unloaded, e.g. because of damage to the card, can be loaded to another PC-card after a reset so that the normal operation of data-collection on the Route can continue.

After the Route is completed this module provides the interface for **unloading** the complete **Route** with measurements and Comments into the XMS database for further processing. When loading and also unloading, you are able **to jump directly** from the dialogue (Load/unload report) of recorded events **to an associated measurement Point in the database with one mouse-click**. If, for example, a limit violation is identified during the unload, the user can jump from the event table directly to the Point in violation and examine in the diagram to what extent the alarm limit has been exceeded.

The **assignment of the measured data** from the Route to the correct location in the database is done automatically during the unload procedure.

A **number of reports** about the structure and arrangement of Routes and the results of Route measurements are contained in the XMS.

Route management is supported by a **Route calendar** and when required the due Routes can be automatically displayed when XMS is started. Interface Module I03

5. Interface Module I03

Log-in of OPC data sources and data storage

Tasks

The Interface Module I03 provides the following functions:

- § Facility to log-in an OPC data source (e.g. SIMS cm or VC-6000) to the XMS (on-line),
- § Read and display the configuration (setup) and the logbook of all connected data sources,
- § Reset the relays in SIMS cm or VC-6000 instruments (global relay reset)

Application

This module offers the interface for communication between the permanently installed SIMS cm (Smart Integrated Monitoring System) or VC-6000 monitoring system and the XMS. **The SIMS cm and the VC-6000 is linked to the XMS through an OPC Client/Server technology connection.** The link to the PC, in which the XMS is installed as an OPC Client, can be made directly through cable (e.g. RS-232) or through a network (Ethernet, TCP/IP).

The user is thus in a position to **remotely display** the setup information and events that have occurred – e.g. logbook entries such as **alarm violations, setup changes or OK-fault messages** – at all SIMS monitoring instruments connected in the network.

Note: To be able to link the XMS with SIMS cm or VC-6000 monitoring instruments, the OPC Server (software) must always be locally installed in a PC or on a network server.

6. Analysis Module A10 Trend Analysis

Tasks

The Module A10 provides all the necessary functions to execute and display trend analyses. A graphic display over a time period is offered for the following measurement types:

- § Overall values
- § BCU (Rolling-element bearing condition)
- § DC values (process values such as temperature, pressure, ...)
- § Manually-entered data (manually entered in data-collector mode)

Functions

The module provides a simultaneous trend analysis of **up to 10 measurement types** from the above list of measurement types over a selectable time period in one or more diagrams.

Up to **4 independently scaled Y-axes** can be used in one diagram. In this way different measurement types can be simultaneously displayed with one diagram.

The ordinates and abscissae can be displayed with a **linear or logarithmic** (lin, log) scale.

With the **extrapolation function** the trend display graphic can be extended to a future time span.

Moving through the measured data is done in a simple way with the help of the Navigator function, a virtual "joystick". The **Navigator buttons** have the following functions:

- § Page in time for a measurement Point,
- § Page from Point to Point in a Machine (at Machine hierarchy-level)
- § Changing the measurement type for the same measurement Point. The context-sensitive operation offers only those measurement types for selection that have actually been stored for the selected measurement Point.

Practical **Cursors** help in a detailed investigation of the trend diagram:

- § A Single cursor with a readout area for cursor values permits an accurate display of the measured value and the date of measurement at any position on the trend curve. Interpolation between the actual measured values is possible.
- § A freely adjustable Delta cursor allows simple determination of the absolute changes in the trend over any desired time period.
- § A **Text cursor** permits the entry of text at a cursor placed at some location on the trend curve for a comment on the printout.

The amplitude and date on the trend curve at the location of the cursor can be numerically displayed in a **cursor readout window**.

Zoom and Shift functions on both axes of the trend diagram permit localised areas of the diagram to be expanded for detailed investigation.

Alarm levels defined in the database can be overlaid onto the trend curve diagram.

The individual measurements are **date- and time-stamped** by the instrument at the time of storage on the PC-card.

7. Analysis Module A11

Measured values as functions of speed and time

Application

This module provides all the functions for display and execution of an analysis of:

- § a continuously recorded Overall value and/or Bearing Condition measurement (BCU)/Bandpass measurement over some predefined speed range of the machine or over a time period (hours, minutes, seconds).
- § the 1st harmonic and one additional order, recorded over a predefined speed range of the machine (Tracking analysis) or over a time period (hours, minutes, seconds).

Note: Measurements over some predefined speed range of the machine always require a suitable reference sensor for acquiring the speed signal.

These types of measurements are used for analysing changes in the respective measured values over some relatively short time span, or a predefined speed range of the machine. Some typical applications are:

- § Investigations of the resonance behaviour of machines
- § Reaction of the machine to temperature changes
- § Reaction of the machine to short-term overloads
- § Analysing short-term events
- § Acceptance tests at a test stand

Functions

The functions correspond in principle to those of the Analysis Module A10 for the analysis of Overall values.

With the measurement of harmonics as a function of machine speed (as a run-up or coast-down curve) or time in addition to the amplitude (of the narrow-band value) the phase angle of the vibration is also displayed Analysis. This measurements can be displayed in a Bode-diagram and/or a Polar-diagram(Nyquist).

8. Module 20

Spectra, Cepstra, Envelope Analysis curves

Tasks

This module provides the functions for analysis and diagnosis of Spectra, Cepstra and Envelope Analysis curves such as BCS (BearCon Signature) and SED (Selective Envelope Detection).

Functions

With this module the following **displays** are possible:

- § Single spectrum from a measurement Point; (Cepstrum as added-information)
- § Multiple display of spectra from up to 10 selectable measurement Points in a 2-D diagram (Cepstrum as additional information)
- § Multiple display of spectra from the same measurement Point measured at different times. (Cepstrum as additional information)
- § Cascade diagram (3-D) of multiple spectra from a measurement Point
- § 3-D Contour plot of multiple spectra from a measurement Point (amplitudes are characterised by different colours)

In 2-D diagrams various **Cursors** are available for assessment purposes:

- § Single cursor
- § Sideband cursors
- § Harmonics cursors
- § Delta cursor, adjustable in position and width
- § Text cursor to add a text comment to the cursor position in the diagram
- § SFT cursor; Single Frequency Trend analysis in the additional info window

Details about the cursor position, e.g. amplitude / frequency / date / time / Delta-values are displayed in a separate numeric cursor readout window. The cursor properties can be set up according to the user's requirements.

In the case of a cascade diagram (3-D) more complex cursor functions are available for analysis and interpretation of the diagram. The view orientation for the cascade diagram can be altered by rotating the diagram. This makes it possible to identify components that may be difficult to see.

Zoom and Shift functions are available on both axes to aid with a detailed investigation of every area of the spectrum. Both axes of the diagram can also be displayed with a **linear or logarithmic** (lin, log) scale, and the X-axis units can be switched between Hz and cpm.

The „**Navigator**“ has the following functions in this module:

- § Page in time through different spectra from the same measurement Point
- § Page through spectra from different Points on the same Machine.
- § Switch from the currently displayed measurement type (e.g. spectrum) to another measurement type (e.g. BCS, SED) and activation of retro-calculations (e.g. Cepstrum from Spectrum, SFT from Spectra, etc.) for the same measurement Point.

In all frequency spectra **monitoring bands** and **alarm spectra derived from reference spectra** can be defined with interactive graphic adjustment using the mouse.

Note: The Module D10 allows an overlay of typical symptom markers (e.g. rolling-element bearing damage frequencies). This supports the search in a spectrum for typical frequencies (lines) caused by damage (symptoms) from various machine elements such as rolling-element bearings, gears, drive-belts, couplings, etc.



9. Analysis Module A21 Constant Percentage Bandwidth spectra - CPB

Tasks

Display and assessment of CPB (Constant Percentage Bandwidth) spectra from different measurement Points and display of different CPB-spectra from a measurement Point measured at different times.

Application

CPB-spectra are used for selective monitoring of various frequency ranges with just one measurement. Thus they are especially suitable for acquisition with the use of data-collectors (VIBROTEST 60 Module 6).

CPB is a type of spectrum the frequency range of which is divided into a number of “bands”. The relative width of each band is constant and is referred to the centre frequency of the respective band. The band width can be selected between 6%, 23% or 70%. The rms value (i.e. the energy content) of the measured signal within each band is assessed.

Compared to a normal FFT-spectrum the frequency resolution is higher at low frequencies and lower at high frequencies. At the lower frequencies a finer resolution is needed for detecting harmonic signals such as in unbalance, rotor instability, misalignment and coupling problems. At the higher frequencies, a coarser resolution is sufficient for detecting periodic impulse signals and random noise produced by rolling-element bearing faults, lubrication problems, gear-meshing problems, blade-pass frequencies and leaking seals. The X-axis is always displayed with a logarithmic (log) scale to allow a higher frequency range to be displayed at one time.

Functions

With the Analysis Module A21 it is possible to display a single CPB-spectrum in a two-dimensional diagram. Thus a number of diagrams can be simultaneously arranged on the screen.

The „**Navigator**“ controls the following functions in this module:

- § Page in time through different CPB-spectra from the same measurement point
- § Page through CPB-spectra from different measurement Points on the same Machine.
- § Switch from the currently displayed measurement type (e.g. CPB-spectrum) to some other measurement type (e.g. Spectrum, BCS, Cepstrum, ...) from the same Measurement Point in the additional info window.

Various **Cursors** are available

- § Single cursor
- § Delta cursor with adjustable position and width in the diagram.
- § Text cursor for entry of text at the cursor location

Details about the cursor position, e.g. amplitude / frequency / date / time / delta values are displayed in a separate cursor numeric readout window. The cursor properties can be altered to suit the requirements of the user.

Zoom and Shift functions on both axes of the CPB-spectrum diagram permit localised areas of the diagram to be expanded for detailed investigation.

10. Module D10

Bearing database and FFT symptom marker

Tasks

Support for the interpretation resp. analysis of spectra and BCS / SED envelope analysis spectra.

Application

Based on the geometric data of the machine elements and the service speeds of machines, typical vibration frequencies, for example from rolling-elements bearings, gears, drive belts, or couplings, are calculated and inserted into the XMS database for the relevant measurement Points. With the assessment of measured spectra or envelope curve spectra these are then overlaid in the form of lines in the spectrum of the measurement Point under examination.

Functions

§ Preparation of a **rolling-element bearing database**:

The data from over 8,000 rolling-element bearings from various manufacturers is integrated into the XMS. For each bearing type the factors are included and are used in a simple multiplication equation with the rotational speed of the inner race (rotor) so that the damage frequencies for the inner race, outer race, rolling-element and cage can be automatically calculated and stored for the relevant measurement Point. Data from bearings of the following manufacturers is integrated:

- o Barden
- o Fafnir
- o FAG
- o INA
- o Linkbelt
- o MRC
- o NSK
- o RHP
- o SKF
- o Timken
- o Torrington

§ For bearings not in the database either these factors or the geometric data of the bearing can be manually entered. These are then always available in the **user's own rolling-element bearing database** for interpretation and analysis of the spectra or envelope curve spectra. The user's rolling-element bearing database can easily be edited by the well known Microsoft spreadsheet-program Excel.

§ For machine elements such as gearwheels, belts, couplings, etc. frequency factors can also be entered. These can be stored specifically for the measurement Point.

§ Individual frequencies can be stored for each measurement Point. This allows you to comfortably store, for example 4 (typical) bearing damage frequencies plus factors for unbalance, a coupling fault, a gear-mesh frequency and aero-dynamic vibrations for a fan with electric motor drive at all the relevant measurement Points.

§ With the help of the FFT symptom-marker the calculated frequencies can be overlaid on the displayed spectrum (Analysis Module A20).

Note: The machine service speed at the respective measurement Point must be available for calculation of the damage frequencies. This can be done by direct measurement when the spectrum is being measured, or by manual entry into the XMS database at measurement Point or Machine level.

11. Process Visualization Module P10

Online measurement visualization through OPC-Server technology

Tasks

The Module P10 provides the following functions:

- § On-line visualization of process measured data using configurable display types
- § Pre-configured linking of SIMS cm/VC-6000 data sources using the B&K Vibro OPC-Server
- § Linking with other data sources (measuring instruments) using another OPC-server

Application

With the process visualization a powerful tool is available to the user for online visualization of measured data. The online connection to XMS is also realized here with OPC Client/Server technology, where the XMS is used as the Client. The process visualization provides various configurable display types which can be used as components inserted in the Views of XMS in any combination. Measured data, e.g. machine vibrations, can be remotely brought to the screen to be displayed and observed for changes in the values over time. The number of measurement channels that can be visualized this way is virtually unlimited.

Functions

All display components **indicate**, by means of **traffic-light colour changes**, any **violation of two definable**, bi-directional **alarm limits**. A total of up to four limits can be monitored.

The PV components are configurable as

- § **Analogue indicator instruments with circular or segmented display,**
- § **Columns displays,**
- § **Bargraph displays,**
- § **Multi-channel trend displays,**
- § **Digital numeric displays,**

and can be individually set up as desired for

- § **Measurement value,**
- § **Units,**
- § **Signal detection,**
- § **Hint text for the mouse pointer,**
- § **Title and**
- § **Scaling.**

Measurements can be **updated** every day, hour, minute or second and an OPC status display on each component provides information about the measurement quality (integrity).

Note: To be able to link the XMS with online monitoring instruments, the OPC Server (software) must always be installed in the local PC or in the network server.



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