

Introduction:

The DSP Logger MX 300, is developed for taking data of many parameters. In order to get this, it uses a DSP processor of high processing capacity of digital signals. The analog/digital converters of the DSP Logger MX300 work in 16 and 24 bits.

As Main Memory, the instrument has a 16 Mb Flash Memory, which manage data according this distribution:.

Memory Used	Data File
12MB	Collector
512KB	Phase analyzer
512KB	Balancing
1MB	Readings out of route
512KB	Process parameters

Once the MX 300 is ON, the screen shows a presentation during about 30 seconds. Pressing any key this period is shortened.

Programs:

The MX 300 has 5 different independent operative programs. Depending on what version of software is installed inside the equipment, it will not be possible to use some of them.

Each one of these programs may be actualized using the communication port RS232 or a USB port. Although the programs are independents, any change in the calibration of the instrument will affect all of them.

Once the MX 300 is ON, a screen will shows a list of all programs inside. To reach any of them, two different ways may be used:

- 1) By using the navigation keys and confirming with ENTER key
- 2) Pressing twice the Program number key



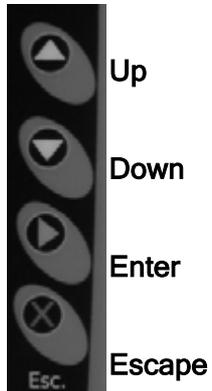
1	2	3
Data Logger	Phase Analyzer	Balancing
4	5	6
Out of Route Readings	Auxiliary Readings	Configuration

Keyboard:

The MX 300 has 23 keys for operation and use of the instrument, giving a very useful set of tools to apply for the predictive diagnosis.

Navigation keys:

Are located both sides of Display, in duplicated rows, with the same functions: Arrow up, Arrow down, Enter and Escape. These keys are engaged with the menu in the lower part of the display. When a module is entered, these keys activate the basic functions of it.

**Auxiliary Keys:**

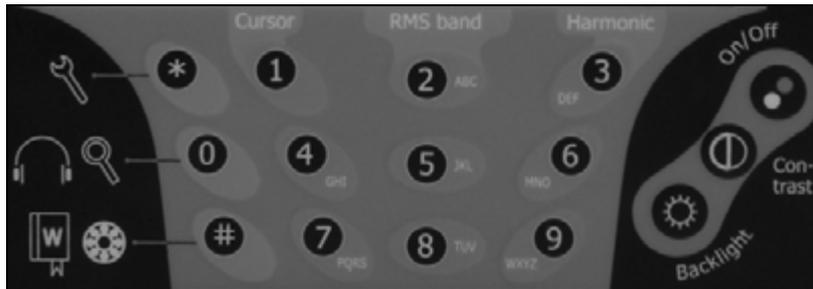
They are the three keys located in the lower right end. They manage the Turning on/of of the MX 300 (On/Off), the display contrast (Contrast) and light intensity of display (Backlight)



Main Keyboard:

This alphanumeric keyboard is used to enter names or codes of machines to be tested, and comments in the module Out of Route.

When Measures of Spectrum are performed, it is possible to activate a set of tools pressing the [*] key, such as Cursor (1), RMS for each band (2), Harmonics (3), Zoom of y-axis (navigation keys) and Zoom of x-axis (0 and navigation keys). The zoom of x-axis is only available for spectrums of medium and high resolution (2000 or 4000 lines).



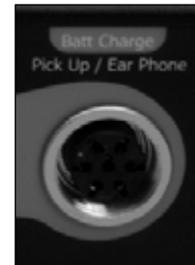
While vibration is measured, it is possible to activate the volume control of the headphones by using the [0] key. Using the [#] key it is possible to access the dictionary of characters.

Batteries charger:

The MX 300 has a pack of Ni-Cd batteries which are not affected by “chemical memory”. The batteries can be re-charged under any state of charge.

The connection for batteries charge is located in the upper part of the panel, by the input connectors.

It is recommended to have fully charged batteries before start with a long run of tests.



The battery charger works during about 200 minutes maximum, depending on the state of charge of batteries at the beginning of charge.

To verify the state of charge, it is necessary to unplug the charger. With the charger plugged and charging, the indicator always will display full charge.

The indication of charge condition is showed in almost all screens of the instrument. The positive or negative changes of state of charge of batteries can be seen in steps:



If after any charge, the indicator doesn't show full charge, unplug and plug again the charger in order to repeat the period. Each period of charge is indicated by a blinking of the led in the charger.

In addition to the indicator of charge level of batteries, the converter AD gives the battery level in Volts, which can be seen in the screen of configuration of the MX 300.

Display Control:

The MX 300 has a control for regulation of contrast of the display, which under environment conditions of warm or cold can modify its brightness.



The contrast adjustment can be (+) or (-), using the same key. Each time the key is pressed, the direction of change is inverted.

VERY IMPORTANT:

In the case that batteries get fully uncharged, may be that after full charge, the display shows a full blue color when the instrument is turned On.

This is because the display contrast has been re-set and it is in 0. In such case, press the CONTRAST key during about 40 seconds until icons of starting appear again.

Because the display has a high backlight under solar light exposure, it may be a good procedure to turn off the display in order to enlarge the autonomy of the batteries.

During times when the MX 300 is not used, the display may be turned off, in order to save about 60% of the batteries charge, without turn off the complete instrument. In normal conditions of use (It is, with display ON), the batteries deliver a working autonomy of 8 hours.



Connection panel:

The connection panel for sensors and accessories is located in the upper lateral part of the MX 300.

When the sensors are coupled to the instrument, it is recommended to verify a tight threaded connection of them.

For connection to RS232 and DB25, the coupling must be assured by using the screws for such purpose.



Connector type DB9 is used for input and output of data from and to a PC. Besides, this connector may be used to load the MX 300 with actualized and/or additional software.

Sensor 1 Input Main Sensor for data collection of vibrations.

Sensor 2 Input of Secondary Sensor for data collection of fase and balancing in two planes.

Bat Charge, Pick Up, Head Phone Battery Charger input, optic sensor input for phase measures, and headphone system output.

Conector tipo DB25 for auxiliary connections.

Data Logger module:

The access to the Data Collector Module is made by using navigation keys located both sides of the display (arrow Up and Down) and pressing ENTER key (green color), or directly pressing twice the [1] key of the main keyboard.

Once the module is accessed, the display will show the Option Screen or Main Menu. This screen shows in the upper left corner, the date of setting of the instrument MX 300. If for any reason the clock has been stopped, the programs drive the operator directly to **Configuration** in order to reset day and time. In case of failure of the internal battery, the instruments have to be sent to the local dealer for its replacement. After such service, the date and time data can be re-entered and the instrument will continue working normally.

This screen shows the following options too:



1 Operate

2 Download

3 Upload

4 Exit

These options can be accessed by using the navigation keys or the

alphanumeric keyboard.

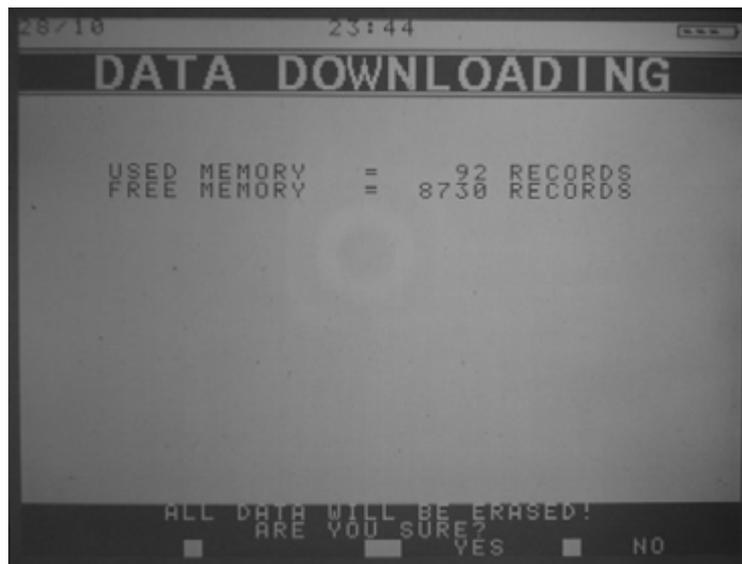
Download:

This application allows to receive the Plants and Routes configured previously in a PC, and that have been chosen to check the vibrations.

The operation order of the MX 300 is very important in order to get a successful transfer.

At the time of transfer of one or more Plants and Routes previously programmed, it is important to verify the Transfer Program in the PC (this is, communication port and speed). Once completed such verification, press **RECEIVING** in the keyboard. A legend in the screen will warn regarding the deletion of existing data in the MX 300.

Accepting, the routes previously loaded in the memory will be deleted. For such reason the data collector will ask for a second confirmation (which is got by pressing any number key in the keyboard):



After some seconds for deleting, the display will show a message of ending of the operation. Pressing any numeric key, the system will remain waiting for reception of data from the PC.

The data may be sent from the PC, and a data list will show the evolution of the process.

At the time of receiving data from the PC, It is recommended to follow the sequence of operations of to **activate** the command RECEIVING and **after**, the command SENDING:

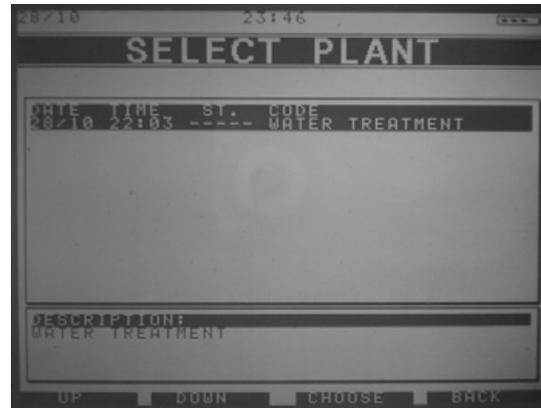
If for any reason this sequence fails or some of two devices remained inactive, an error message will be shown on the screen.



Operating :

Once the data from the PC have been received, the access to the information can be got entering to OPERATING.

Entering to the application, the screen of PLANT SELECTION is opened, showing the configuration list received, showing the condition of "No measured" (- - -).



When entering to one Plant, the screen **Route Selection** will be shown, and there, one route must be chosen.

In the list of routes, the detail of each selected route will be shown in the lower part of the screen.

The description of the route and the frequency of taking of measures will be detailed.



Besides showing the List of equipment in the Route, particular conditions and description of each selected equipment are detailed.

In the lower part of the screen of **Selected Points**, the detail and description of each point is showed. In this detail, it is possible to see comments, brand of the bearings and complementary data, (if them were loaded from the PC).

Each one of these windows has information about charge level of the batteries, date and time.

The **Menu of Operations** of the MX300 is showed in the lower part of the screen, from left to right, linking the options of the menu with the navigation keys as follow :



Up	Function of increase of volume, Zoom control and records confirmation. General navigation.
Down	Function of decrease of volume, Zoom control. General navigation.
Enter	Records Confirmation, programs selection, muting of headphones.
Escape	Functions cancellation, windows closing and general navigation.

The easiest way to operate the MX 300 is by using the AUTOMATIC option. With this operation, the collector will perform the measurements of each point in the programmed order in the PC, until complete all measurements in the first equipment. After confirmation by the operator, the measures will continue with the first point of the second equipment in the list, and so on until completing the measures in the last equipment in the Route.

The option AUTOMATIC can be cancelled in any stage and retaken in any point of the Route.

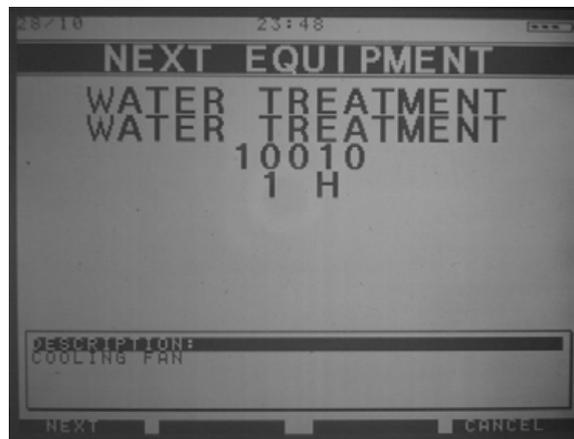
Using the option MENU it is possible to perform any particular measure without activating the option AUTOMATIC.

Operation in AUTOMATIC mode:

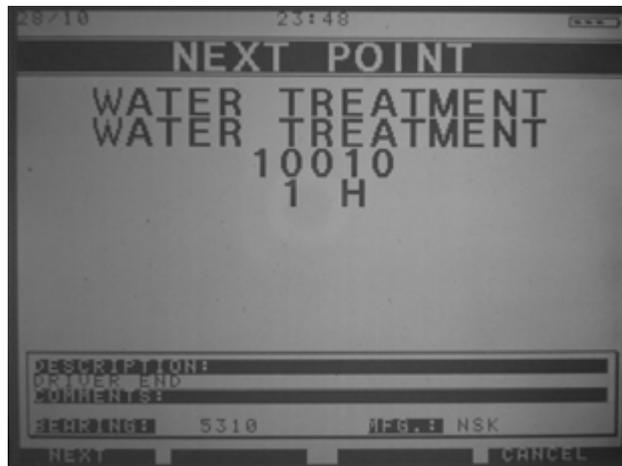
Entering in the window ROUTES SELECTION, it is possible to activate the option AUTOMATIC pressing the TOOLS key [*]. The screen will show a request for confirmation and the system will report about the Route and equipment where the measure will begin.



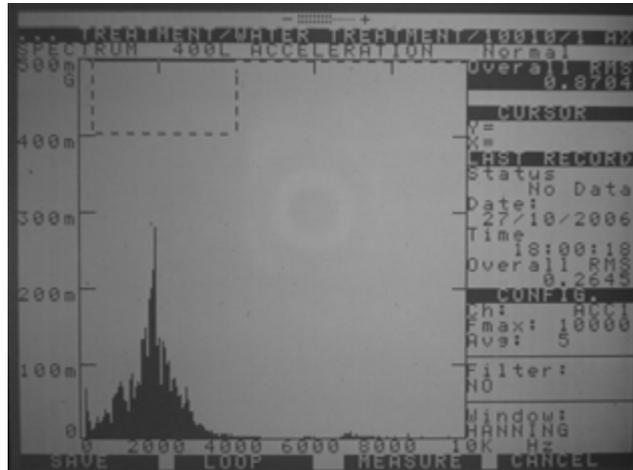
When accepting, the display will show the equipment where the measures will start automatically.



When accepting with the FOLLOWING command, the display will indicate the first point to be measured in the first equipment of the Route.



When accepting with the command FOLLOWING, the collector will start to measure in the first point.

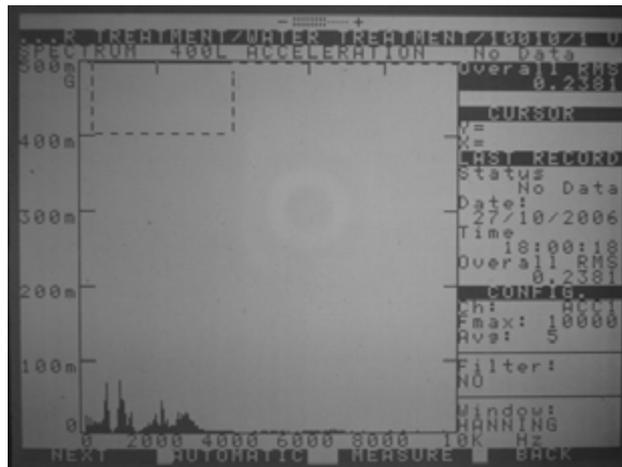


Once the measurement is completed, the operator has the option of reading the historic value for that point and eventually to repeat the measure in that point.

In order to check historic values for that point, the command **CANCEL** must be activated by pressing the **ESCAPE** key.

In order to repeat the measure, the command **MEASURE** must be activated by pressing the **ENTER** key.

Once the measure has been taken, in order to continue in the **AUTOMATIC** mode, the command **RECORD** must be entered, by using the **UP** key



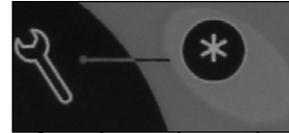
Doing this way, the measure will be recorded. By pressing the **UP** key, the next point of measure will be selected.

For an easier operation, the options selected by using the **UP** keys (left or right), may be activated using the **[4]** and **[6]** keys.

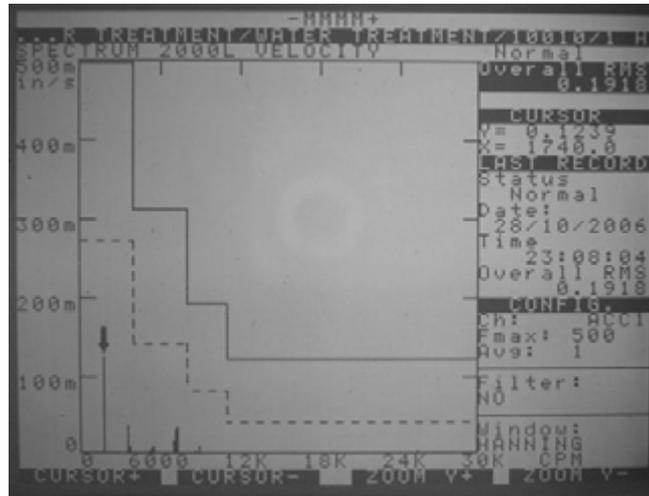
In order to interrupt the **AUTOMATIC** mode, the **ESCAPE** key must be pressed and the system will retake the **MANUAL** mode.

Tools for spectrums :

Once the spectral measurement was taken, many tools for analysis are available by pressing the [*] STAR key.



When the function is activated, are enabled the functions shown in the lower part of the screen and the functions Cursor and Harmonics (by keyboard).

**Functions on screen:**

CURSOR +	Move from 0 to full scale the line of the cursor.
CURSOR -	Move back up to 0 the line of the cursor.
ZOOM Y +	Increase the amplitude axe
ZOOM Y -	Decrease the amplitude axe.

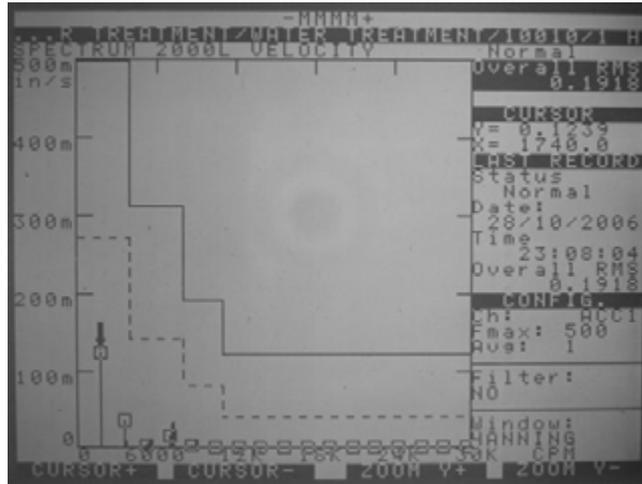
Keyboard functions:

Cursor: This tool puts automatically a cursor in the component of higher amplitude of the spectrum

RMS band: Gives the information of RMS value of the spectrum for each alarm band defined in the configuration of the point.

(It is not available in the hardware)

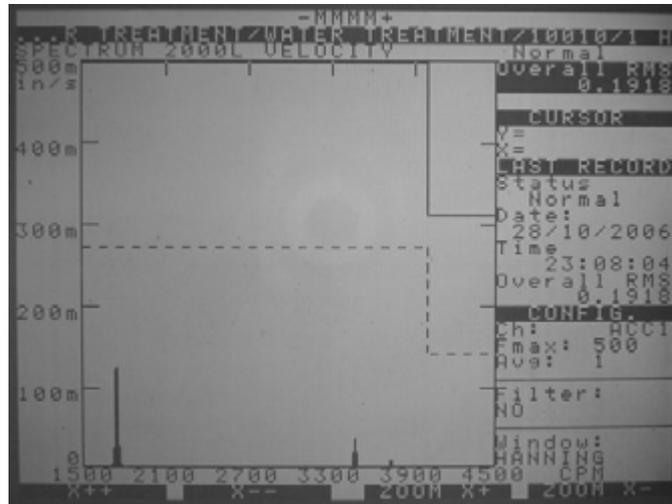
Harmonic: Shows the harmonic spectral components respect to the cursor position (have to be activated)



When the function is activated with the tool key, the Zoom of frequency axis is available too.
Must be activated with the [0] key



This function is enabled only in spectra of medium and high resolution (2000 or 4000 lines). In this way, it is possible to get a very high definition in order to find and separate spectral components of frequencies too similar.



Screen functions :

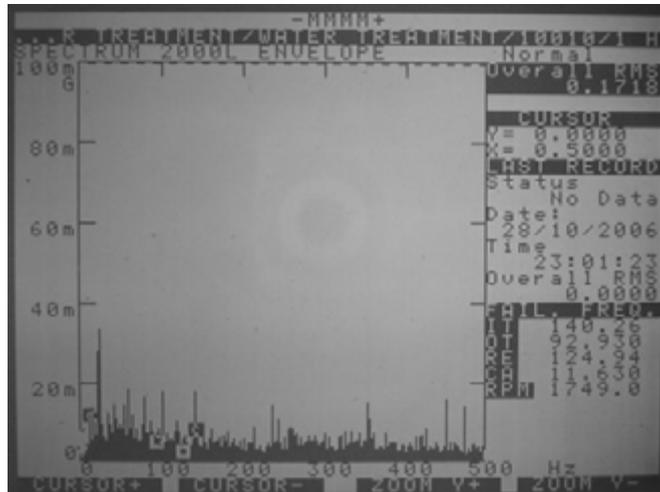
ZOOM X +	Enable Zoom of X
ZOOM X -	Unable the Zoom of X
X ++	Move the activated Zoom in increasing direction of frequency
X --	Move the activated Zoom in decreasing direction of frequency

To close this application, the [0] key must be pressed

Frequency of bearings failures:

In the spectra of acceleration envelope it is possible to see the frequencies of bearing failures, pressing the [#] key. (It is necessary that bearing data have been loaded during the configuration of the tested point).





The frequencies of bearing failures detected in the spectrum will be seen in the screen.

PI	Frequency corresponding to Internal Tread.
PE	Frequency corresponding to the External Tread.
ER	Frequency corresponding to the Rotating Element.
JA	Frequency corresponding to the Cage.

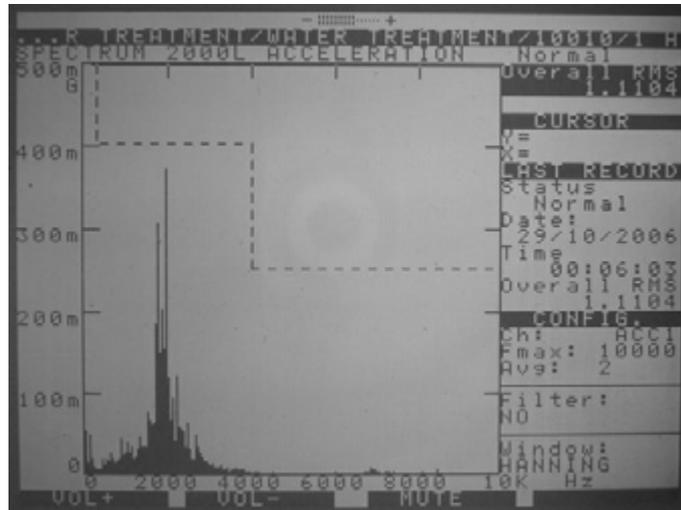
Headphone Volume Control:

In any step of measurements, it is possible to adjust the headphone volume control when they are used, by pressing the [0] key, (the TOOL key must be not activated).



Once the Volume Control is activated, it can be adjusted using the Arrow **Up** or Arrow **Down** keys.





The indication of volume adjustment appears in the upper part of the screen.



The muting of the headphone is activated by pressing the ENTER Key, and is indicated in the upper part of the screen by means of the letter **M**.



Sending :

Once the route is fully or partially completed, the collected data can be sent to the PC in order to store the new data in the Data Base of that Plant, and proceed with the diagnostic.

If by any reason some equipment were not checked, the collected data from the tested equipment can be downloaded and continue in another time with the routine of measurements of the non-checked equipment. Any route can be loaded during any period of time, but once one equipment has been checked, it will change its condition of **No Measured** to the condition of **OK**, **Warning** or **Emergency**. By this implementation, the checked equipment are disabled for checking in the AUTOMATIC mode.

In cases where the condition of an equipment is indicated as **Not Completed**, only will be possible to activate the AUTOMATIC function in points identified as **No Measured**.



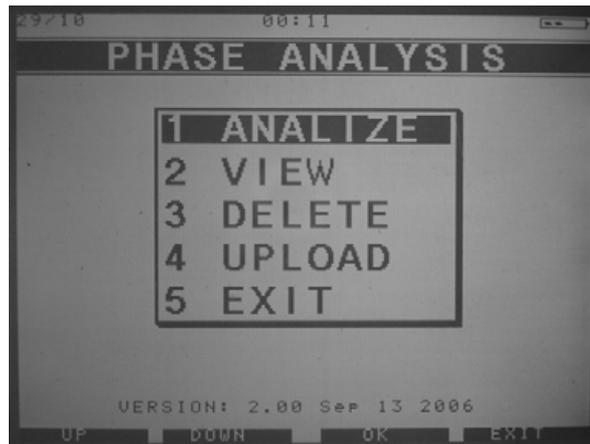
When the application SENDING is activated the program will show a screen with indication of amount of data measured and amount of data transferred.



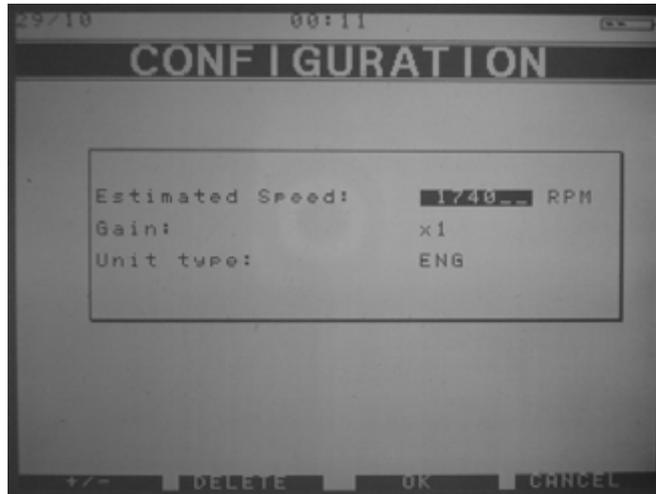
Once the process is completed the operator must press any key. In order to obtain a successful result of downloads, it is important that the process and order of steps be correct. Additional information about this matter can be found in Chapter 3 of the Owner's Manual. Before pressing **SENDING** in the collector, the command **RECEIVING** must be activated in the PC. If for any reason this sequence fails, or some of these devices have not been activated, some error messages will appear in the screen.

Module of Phase Analysis

In the main screen, select the option 2, this is, PHASE ANALYSIS. The new screen shows the following options:



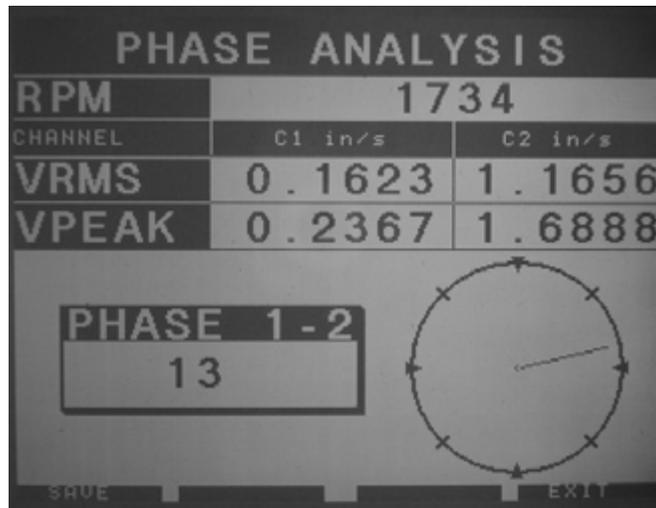
- 1- Analyze
- 2- View
- 3- Delete
- 4- Upload
- 5- Exit

Configuration:

- a) Estimated speed : The estimated rotation speed of the machine must be entered, following the instructions in the screen bottom and using the keys located both sides of the screen.
- b) Gain: Normally, a x1 value shall be used. The value x10 is available too for using with signals of very low amplitude.
- c) Unit type: Metric units (MET) and/or english units (ENG) are available
- d) According instructions in the screen bottom, press the red cross key (EXIT), and next, confirm OK by pressing the green arrow key.
- e) The PHASE ANALYSIS screen will appear.

Measures

Both sensors must be installed in place, this means, on the zones to be analyzed. The system will filter the real waves, in order to compare just the waves corresponding to the fundamental frequencies (this is, only 1X) The value of measured phase, will be the angular difference between the two filtered waves, this is, this is, the ones corresponding to the rotation frequency.



The measures showed in the screen are :

- Real RPM .
- Overall de velocidad RMS y 0-Pico de ambos canales.
- Digital value and polar value of the phase difference measured.

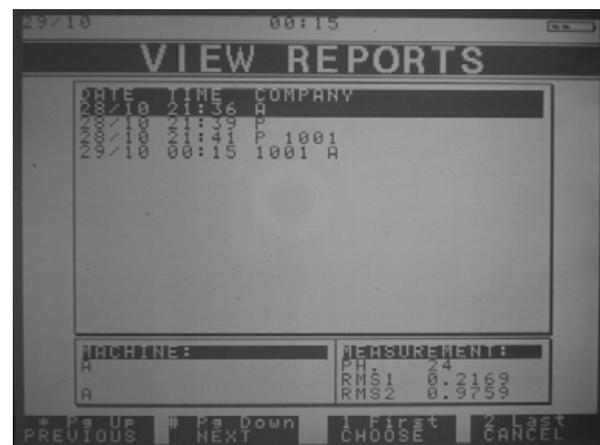
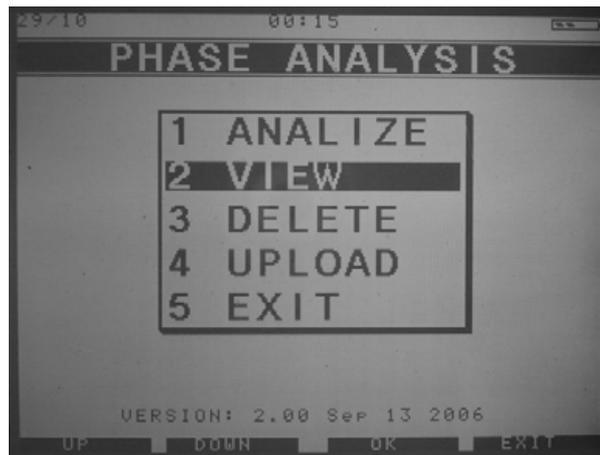
Saving the measures

In order to save the value of measures, follow the instructions in the screen bottom, this is, arrow up key for Save.

The MEASUREMENT DATA screen appears. Fill the MACHINE and POINT blanks. It is mandatory to fill them in order to continue the sequence.

When finish, press the green arrow key to confirm (OK).

The PHASE ANALYSIS screen will appears.



2- VIEW

In the PHASE ANALYSIS screen :

View Reports: Shows the saved data of measures (Phase difference).

In the screen bottom, there are instructions for the case of many measures stored.

3- DELETE

Delete measurement: Se disponen de dos opciones: para borrar una, o todas las mediciones.

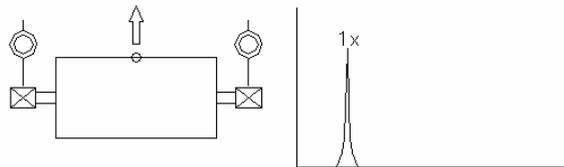
4- EXIT

Al dar el OK a esta opción, se regresa al menú principal.

Diagnostic with phase analysis

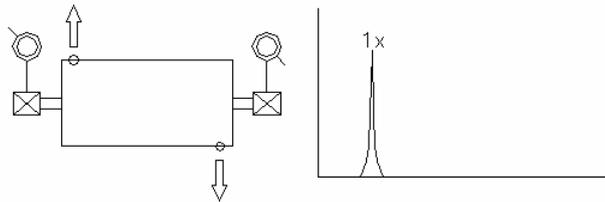
UNBALANCING OF FORCE

- It amplitude increases with the square of velocity
- It take place in phase and constant
- The 1X is always present and prevails in the spectrum (radial).
- It is cured by using one central weight.



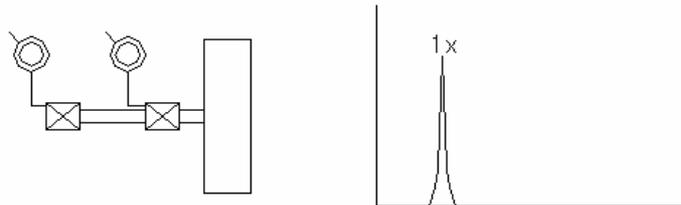
UNBALANCING OF COUPLE

- Its amplitude increases with the square of velocity
- It take place unphased in 180° and constant
- The 1X is always present and prevails in the spectrum, radial and axial.
- It is cured by using two weights in separated planes



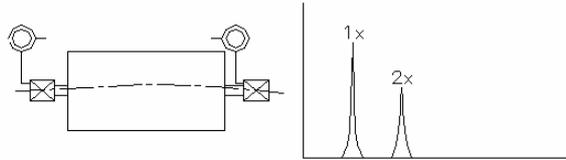
UNBALANCING OF A JUTTED ROTOR

- Its amplitude increases with the square of velocity
- It take place axially phased, radial and may not be constant
- The 1X is always present and prevails in the spectrum.
- It is cured by using weights in one or two planes



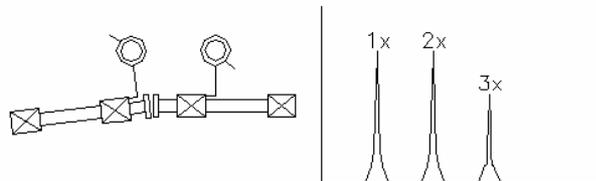
BENDED AXIS

- The 1X prevails if the axis is bended in the central zone. The 2X prevails if bended towards supports.
- The readings are unphased 180° in each component.
- There are bigger amplitudes in the axial direction.



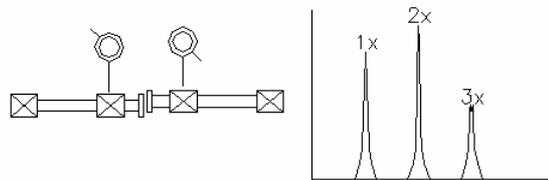
ANGULAR MISSALIGNMENT

- It is detected by the presence of high axial amplitudes
- In the spectrum may prevail the 1X, 2X or 3X depending on the kind of coupling, stiffness or others.
- The readings are unphased 180° in the coupling.



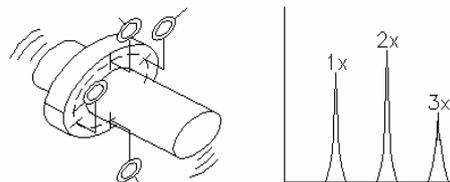
PARALLEL MISSALIGNMENT

- It is detected by the presence of high radial (vertical) amplitudes
- In the spectrum frequently prevails the 2X .
- It depends chiefly of the kind of coupling.
- The readings are unphased 180° in the coupling.



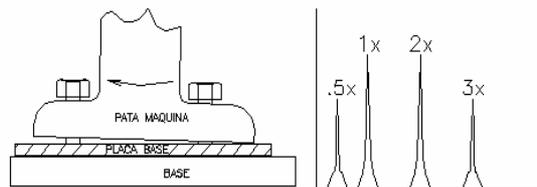
CROSSED BEARING IN THE SHAFT

- It is detected by the presence of high axial amplitudes
- In the spectrum normally prevails the 2X .
- The axial readings are unphased 180° both sides (horizontal or vertical).



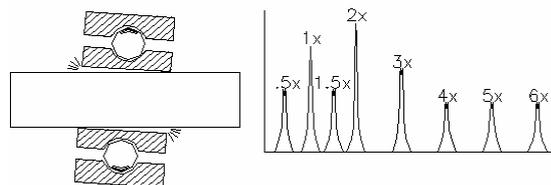
LOOSE ANCHORING GROUND (BOLTS)

- In the spectrum may prevail the 2X . May appears a 0.5 X if the looseness is important.
- It is highly directional.
- The readings are unphased 180° between equipment and foundation.



LOOSE BEARINGS IN THE SHAFT

- In the spectrum prevails the 2X, with multiple harmonics. May appears a 0.5 X and harmonics.
- It is highly directional.
- The readings are unstable.



Balancing Module

Balancing in one plane

Introduction:

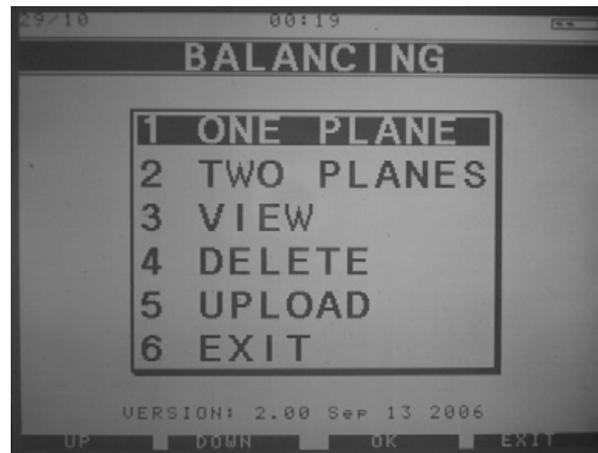
This procedure is for determining the value and angular position of the counterweight that will equilibrate the rotating force which produce the unbalancing.

In order to get this, two measures must be taken : amplitude and phase of the component of 1xRPM produced by the unbalancing.

One of these measures will be taken in the original conditions of the unbalancing. The another, after one random weight has been installed on the rotating element.

After that, the system will give a correction factor by which the added weight must be modified, and the angle value to change the original position of the added weight.

In order to engage this module, the access icon to the **BALANCING** Module must be selected using the navigation keys located both sides of the screen (Arrow up and Arrow down), and accepting with the ENTER key (green), or directly by pressing twice the [3] key of the main keyboard..



Procedure:

In order to perform this procedure, it is necessary to use two sensors: one **accelerometer sensor** connected to port **SENSOR 1**. (It is important to consider this point because this port is the one assigned **for measurements**) . The another sensor is an **Optical Sensor**, connected to the port **Pick Up**, and aimed to the path of a reflective device attached in a convenient point of the rotating part to be balanced.

To proceed, choose the option **Balancing**. The display will show the screen for programs selection for this application.

Once the kind of balancing to be performed has been selected (**one plane** for this example), in the display will appear the configuration window for balancing, with a serial of editable fields.



Company/Equipment : in these fields may be entered the Company name and the equipment to be balanced, which after will appear in the balancing report.

Amount of blades :this field is used when the testing weight will be installed in a certain amount of blades. The module will indicate how the weight will be partitioned between two consecutive blades.

Unit: this field allows to select the kind of unit to be used for measurements, or millimeters per second or inches per second.

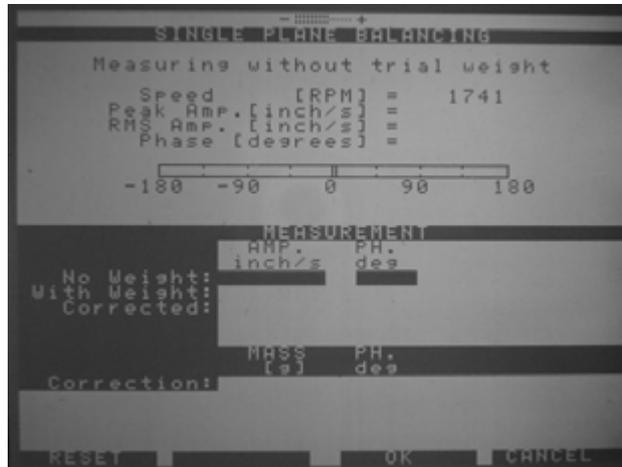
Testing Weight: The amount in grams of the testing weight to be added to the rotor, must be entered. If no value is entered, the system will consider as testing weight a value 1, and the result will be a correction factor by which the real weight added must be multiplied in order to get the final result.

Position: (location of the testing weight respect to the reference). It is very important to consider that **the position "0" (reference) is determined by the reflecting device, when it activates the led indicator of the optical sensor.** The displacement respect "0" will be **negative if it is in coincidence with the rotating direction, and positive if it is contrary to the rotating direction.**

For example, if the weight must be located at 30° from the point where the reflecting device is attached and in the same direction of rotation, the value to be entered must be -30° .

Once the configuration has been completed, press "End" [ESCAPE]. The system will ask if the balancing will be made with that parameters. Press "Accept" [ENTER] to close the configuration screen.

After this, the screen shows the graphic(spectrum) representing the unbalanced rotor. Press "Measure" [ENTER] to proceed with the measure. Once completed, press "Record" [ARROW UP] for recording or "Cancel" [ESCAPE] if recording is not needed. Doing any of these actions, the screen of calculation will appear:



1.- Measure without weight : it is the measure of amplitude and phase of the vibration 1xRPM of the machine in the original conditions of unbalancing.

To do this, press the “Measure” key (the values of rpm of the running machine will be seen) and press **“Accept”** [ENTER]. The value of rpm keeps as reference at the right side of the screen, and the system automatically starts to measure again until the rpm coincide with the reference. At this time, in the screen will appear the vibration velocity expressed in 0 to Peak and RMS, and the phase of the vibration.

To record the measure, press **“Accept”** key, and the measure will appear in the list of measures, filling the space **“No Weight”** . Automatically the cursor will move to the space **“With Weight”**



Stop the rotor, add a test weight, taking care that its value and position be the same that the ones loaded during the configuration. Start the rotor again, at the same velocity.

2.- Measure with weight :

The measure is performed following same steps detailed in item 1



3.- Correction:

The correction involves to modify the test weight value (in grams) and its angular position. **Before to install the correction weight, the test weight must be retired.**

Note: *if for any reason the recorded values of weight and position of the test weight needs to be changed, press [1] key in the main keyboard when the system **IS NOT MEASURING**. The system will compute the correction values using the new recorded data.*

Once the two measures have been completed, the correction values will appear in the screen showing two values:

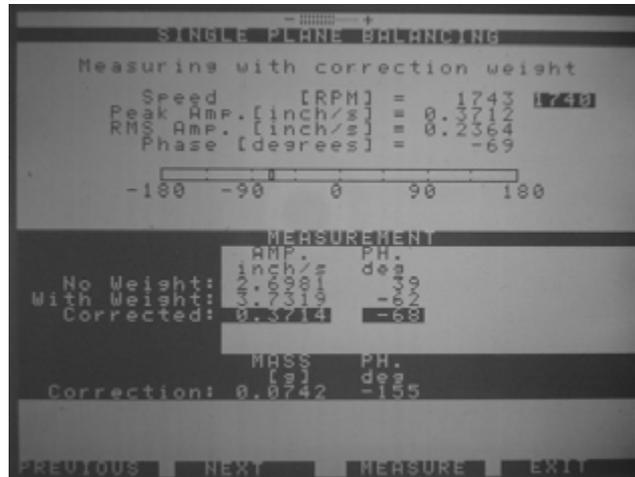
a.- Mass Correction : The screen will show directly the mass in grams (if the test weight was recorded), or a factor value by which the test weight must be multiplied to obtain the corrected weight.

b.- Correction of angular position: The angular position of the correction weight will be always referred to the reflection device (0° or reference). If the showed value is **negative**, the weight must be moved in the rotating direction, and if the showed value is **positive**, the weight must be moved in the opposite direction of rotation.

If the amount of blades of the rotor was entered, the system will indicate exactly how to share and where to locate the weights between two contiguous blades. Must be considered that the blade #1 must coincide with the 0° (reference, which is defined by the position of the reflecting device), and the following weight have to be located in opposite direction of the rotor rotation.

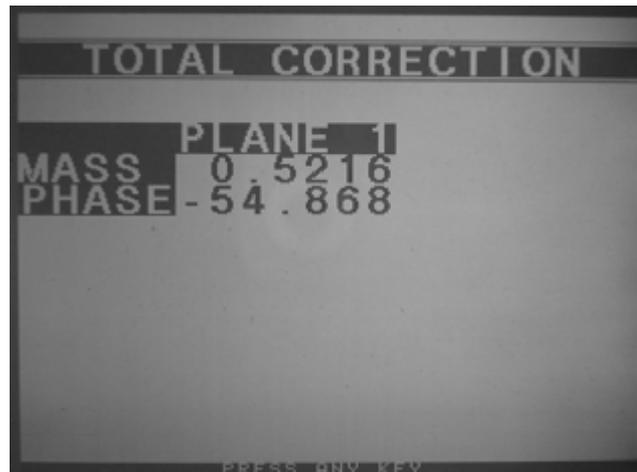
4.- Successive corrections :

It would be possible that more than one correction must be done in order to get a correct balancing. To do this, just repeat the same steps described before, considering that the new indication of corrections will show the amount of mass to be added to the testing weight and the place of location. As an example, if the second correction shows MASS[g] = **14** and FASE [degr] = **67**, must be added 14 grams to the weight and locating it 67° in opposite direction of the rotor rotation, counted from the reference 0° (defined by the location of the reflecting device).



5.- Total correction:

Once the balancing has ended, the [ESC] key must be pressed. The system will ask about to confirm the end of the balancing, and if it is correct, press [ENTER] key. After that, the screen “Total Correction” appears, where the system shows as a resume of all steps done, an unique final value.



It must be considered that the total correction will result in the same value of final vibration got if the successive corrections were made following exactly the procedure in all steps.

Pressing any key after this, the display shows the graphic(spectrum) representing the unbalanced rotor. Press “Measure” [ENTER] to proceed with the measure. Once completed, press “Record” [ARROW UP] for recording or “Cancel” [ESCAPE]. When any of these steps are performed, the system will ask about to save a report of the balancing, so, press ENTER to record it or ESCAPE to return to the main menu with no recording of report :

Balancing in two planes

Introduction:

Almost all rotors has their masses distributed along the shaft. In these cases, besides to appear an unbalancing force, may be present a couple that tends to rotate the axis around the center of mass of the rotor.

The combined effect of this couple together the unbalancing force is called **Dynamic Unbalancing** because it tends to move the inertia axis respect the rotation axis.

To balance this kind of rotors implies to add correction counterweights in two planes so the mass distribution tends to align the inertia axis with the rotation axis.

Once the operations have ended, the system will show automatically the correction factors for the test counterweights in order to get the final counterweights.

Three sensors are needed to accomplish this procedure:

- two *accelerometer sensors* suitably plugged to the available Ports. **Sensor 1 is for measures in the plane 1 and Sensor 2 is for measures in the plane 2**
- one *optical sensor* plugged to the port **Pick Up**, whose orientation must coincide with the path of a reflecting device installed on the axis of the rotor to be balanced.

Procedure :

Get the option **Two Planes** of the Main Menu of the balancing module and make the configuration using the same procedure used for the option **One Plane**, excepted that it will be necessary to complete data of the testing weight for the Plane 2.

The two configuration planes will be named as plane 1 and 2. When the configuration screen is left, it is directly reached the spectrum graphic of the plane 1 of the unbalanced rotor. Press “Measure” [ENTER] to make the measurement and “Record” [Arrow Up] for recording it. If it is not needed to save the measure, press “Cancel” [ESCAPE]. Once completed any of these operations, automatically the system starts to measure in the plane 2. After proceeding in the same way, the calculation screen is got:

1.- Measurement without testing weight on planes 1 and 2:

The amplitude and phase will be measured in both planes, and the values registered, as per indicated in balancing in one plane.



2. Stop the machine, install the testing weight in the plane 1 and start again to the same rotating velocity.

3. Measurement in planes 1 and 2 with testing weight in plane 1:

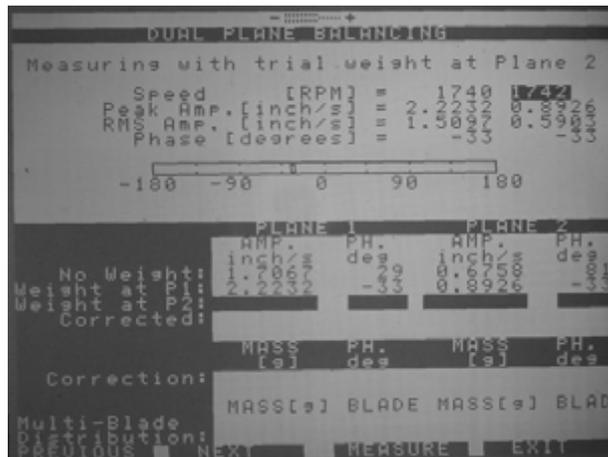
Idem 1.



4. Stop the machine, remove the testing weight in plane 1, install the testing weight in plane 2 and start again at the same rotation velocity.

5. Measurement in planes 1 and 2 with testing weight in plane 2 :

Item 1.



Note: if would be necessary to change the recorded data of weight and position of one or both testing weights, press [1] or [2] key in the main keyboard to modify the values for planes 1 or 2 respectively, when the system **IS NOT MEASURING**. The system will compute the correction values using the new recorded data.

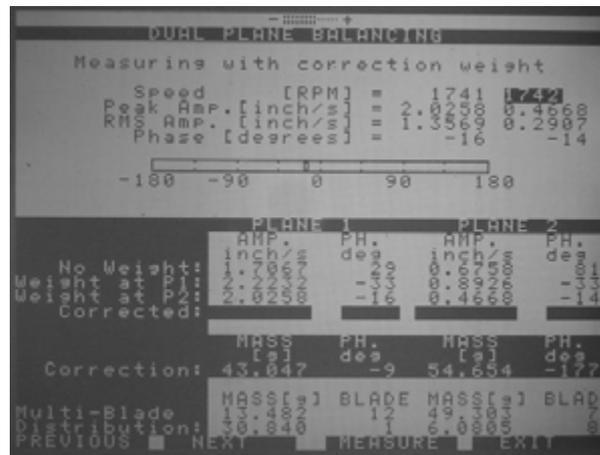
6. Getting correction factors :

Automatically, after register the last measurement, the system gives the correction factors to apply to testing weights and their new location.

7. Making the correction of testing weights:

Multiply each testing weight by its corresponding correction factor and put them in each corrected angular position.

The correction of the angular position will be in the **direction of rotation** if the value of the factor is **negative**, and in the **opposite direction of rotation** if the value is **positive**



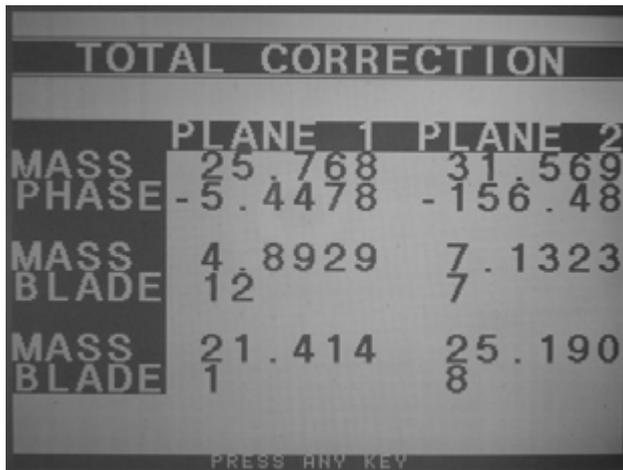
8. Successive Corrections :

As described in point 4 of the procedure of balancing in one plane, it is possible to make as corrections as needed. It is important to follow precisely the indications and procedures for each plane of the successive measurements.



9. Total correction :

It is valid what is stated in point 5 of Balancing in One Plane



Note:

If the balancing signal (sinusoidal wave) is affected by harmonics, it is possible that indications “Noise 1” or “Noise 2” appear during the taking of measures. If this happens, the RESET (Arrow Up) key must be pressed to eliminate the indication.

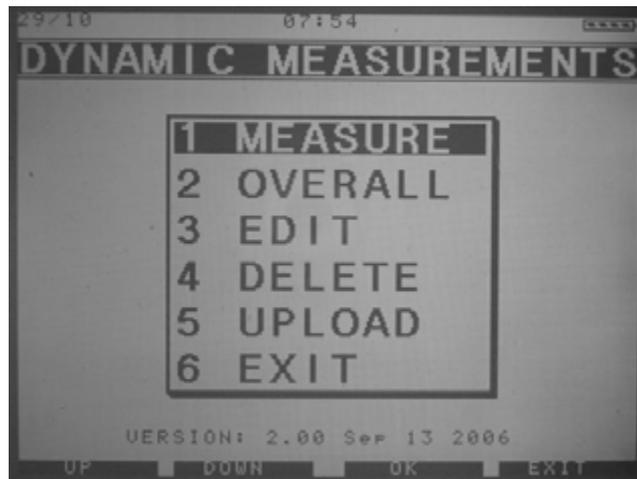
Pressing any key, appears the spectrum graphic of the balanced rotor, with a measure for each plane.

For measuring the graphic of spectrum of the balanced rotor, press any key to reach the screen. Press “Measure”[ENTER] to proceed with the measure, and after “Record” [ARROW UP] for recording, or [ESCAPE] if the operator doesn’t want recording values. In any of these options, the system will ask it is wanted to save a report of the balancing performed. Press {ENTER] to save or [ESCAPE] to get the main menu without saving the report.

Off Route Measures:

It is possible to make Off Route measurements in order to get data from equipment not included in the routine previously defined in the PC.

To reach this module, select the icon to the module **Off Route Measurements** by pressing the navigation keys at both sides of the display [Arrow Up and Arrow Down], accepting with the [ENTER] key (green), or directly pressing twice the [4] key in the main keyboard.



This application allows to record any vibration measurement, in wave form, in global values, or spectra of 400, 2,000 and 4,000 lines of definition. Besides, if suitable accessories are available, it is possible to measure spectra of electric currents from the driver of the tested equipment, and displacement signals (0-10V) coming from transmitters in the equipment.

Once the Off Route Module is selected, a screen appears showing:

Measuring : Allows to perform a new measurement

Editing : Allows to edit a measurement already performed. The written blank fields and measurements can be edited.

Deleting : Allows to delete one or all off route measurements already performed

Sending : Allows to transmit the performed measurements to a PC.

Ending : Exit from the Off Route Module

How to perform a measurement:

Once the option **Measuring** is selected, many blank fields of codification appear, identifying the equipment and the measurement positions. The characters can be typed by pressing the alphanumeric keyboard or some of the options of the dictionary included in the MX 300, (by pressing the [#] key).



Date and time are saved automatically, according to the DSP configuration.

To move across the blank fields, the navigation key must be used.



When it is needed to send data to the PC, the blank fields of Equipment and Point are important and mandatory, because such data will be stored in a data base named OFF ROUTE. In this condition, the software in the PC will include these new equipment in the route. When future measurements will be performed in these new points and equipment, the new measurements will be added to the historical data. It is recommended to identify in the Comments of the report, the different alternatives.

Once this information is completed, the display will show a screen where the parameters of the measurement must be configured.



Parameters

Measuring:

There are many options to select : Wave form, Spectra of 400, 2,000 or 4,000 lines of definition, Global Values (RMS, 0 to Peak or Peak to Peak)

Variable to be measured: Allows to choose between different variables of vibration, such as Acceleration, Velocity, Envelope, Displacement, Alternating Current (AC) or General Amplitude.

Maximum Frequency : Selects the cutting frequency of the measurement. At this point, must be considered that for measuring a spectrum of 400 lines, the available frequencies are: 50Hz, 100Hz, 200Hz, 500z, 1Khz, 2Khz, 5Khz y 10Khz. For spectra of 2,000 and 4,000 lines, the maximum frequencies available are : 100Hz, 200Hz, 500z, 1Khz, 2Khz, 5Khz, 10Khz y 20 Khz

Averages : Allows to assign averages to measurements. The system will perform measurements according the amount of averages assigned, will compute the averages and finally will show the result. There are available the following options : 1 (no average computed), 2, 5 , 10, 20 and 50 averages.

Input : allows to select the input for the sensor or variable to be measured:

Kind of measurement and/or Sensor	Input to configurate
Vibration with accelerometers	Acceleration
Electrical Current	Alternative Current
Desplacement/movable coil	Displacement
Voltaje 2VRMS Max.	Auxiliar CA

Chanel: enables the input from **Sensor 1** or **Sensor 2**

Filter : Allows to set different values of frequency for band filters, to choose from :

NO, ALLOWS HIGHS, 1250Hz-2500Hz, 2,5Khz-5Khz, 5Khz-10Khz, 10Khz-15Khz, 15Khz-20Khz.

Window: allows to choose from different options of windows that process the wave (see definitions and concepts in the following topic "**Kind of Windows**").

There are three kind of windows to choose from :

- Rectangular Window
- Flattop Window
- Hanning Window

After these options have been selected, the measurement window is showed. The equipment will perform the measurement according to the chosen configurations, having access to the menu for saving the measures or measure again. The tools for diagnostic include in the module are available too, by using the appropriate keys.

Once this configuration is completed, the program will ask for confirmation. After this confirm, will appear a window with the selected

measurement in blank. Pressing [ENTER], the system will perform the measurement according to the selected parameters.

Kinds of Windows :

Hanning Window

The Hanning window, also called "Hanning weighting," is a digital manipulation of the sampled signal in an FFT analyzer which forces the beginning and ending samples of the time record to zero amplitude. This compensates for an inherent error in the FFT algorithm which would cause the energy at specific frequencies to be spread out rather than well defined in frequency. The Hanning window causes a distortion of the wave form used by the analyzer to calculate the spectrum, and this results in the measured levels being too low. When processing continuous data, this effect is compensated for, but an error is introduced if the Hanning window is used for transient data.

Rectangular Window

In the FFT analyzer, the rectangular window is actually no window at all. It is also called rectangular weighting, or uniform weighting, and is used when the signal to be analyzed is a transient rather than a continuous signal. See also Hanning Window.

Flattop Window

The flattop window is a special window used in some FFT analyzers in addition to the more common Hanning window and rectangular window. The flattop window does not allow as fine a frequency resolution as the Hanning window, but it will accurately measure the amplitude level of a signal at any frequency, even if the frequency is between the lines of the FFT analysis. It is used in transducer calibration systems to increase amplitude accuracy.

FFT (Fast Fourier Transform).

The FFT is an algorithm, or digital calculation routine, that efficiently calculates the discrete Fourier transform from the sampled time waveform. In other words it converts, or "transforms" a signal from the time domain into the frequency domain.

There are some relations between the time record length, the time between samples, the frequency span f and the frequency resolution. The most important relation here is that the frequency resolution is inversely proportional to time record length. Therefore, high-resolution spectrum analysis of necessity takes a long time to collect the time record.

FFT Analyzer

The FFT analyzer is a device that uses the FFT algorithm to calculate a spectrum from a time domain signal, and is the most common type of spectrum analyzer available today. The FFT analyzer is a very useful device, and is available in a great variety of models with varying complexity. It is the heart of any machinery predictive maintenance program.

Making Averages

The MX 300 has other important function, by which it can perform averages of spectra referred to time easily. Normally, the signal of vibration of a rotating machine is not completely pure, always has some random noise superposed. Because the noise is not predictable, it will change the form of the spectrum, and in many cases, can produce an important distortion of it.

Making an average of a serial of spectra, the noise gradually will take smoother shape and the peaks of the main spectra (generated by the main vibration) will stand out and will be detected with higher precision. An important concept is that the making of spectra averages smooths the noise, but does not reduce it level.

The MX 300 perform a kind of average named **Linear Average**. It is computed by making the sum of values of spectrum and dividing the result by the amount of spectra. This is made for each line of the spectrum and the aftermath is a real arithmetic average, line by line.

Threshold % : It allows to modify and adjust the sensitivity of the external trigger when a natural frequency test is performed.

The desired value is entered through the keyboard, and may be between 0 and 100%. A 0 value disables the function and 100 value gives the most sensitivity.

Slope : is applied for resonance tests.

Factor : used for accelerometer sensors, allows to define and adjust two types of sensibilities, 100 mv/g and 500 mv/g.

Guide for configuration of measures :

In order to guide the user in the operation of the data logger, the MX 300 has an array of screens as sample of conventional configurations.

Measurement of spectrum of acceleration

```
Function:      SPECTRUM 400L
Variable:     ACCELERATION
Max. Freq.:   10 KHz
Averages:     1
Channel:      1
Gain:         x 1
Filter:       NO
Window:       HANNING
Threshold %:  0
Slope:        POSITIVE
Factor:       100 mV/G
Unit type:    ENG
Clamp:        1 mV/A
```

Spectral Measurement of velocity

```
Function:      SPECTRUM 400L
Variable:     VELOCITY
Max. Freq.:   500 Hz
Averages:     1
Channel:      1
Gain:         x 1
Filter:       NO
Window:       HANNING
Threshold %:  0
Slope:        POSITIVE
Factor:       100 mV/G
Unit type:    ENG
Clamp:        1 mV/A
```

Spectral Measurement of current with clamp meter

```

Function:      SPECTRUM 400L
Variable:      CURRENT
Max. Freq.:   200 Hz
Averages:     1
Channel:      1
Gain:         x 1
Filter:       NO
Window:      HANNING
Threshold %:  0
Slope:       POSITIVE
Factor:      100 mV/G
Unit type:   ENG
Clamp:       1 mV/A

```

Spectral Measurement of envelope

```

Function:      SPECTRUM 400L
Variable:      ENVELOPE
Max. Freq.:   500 Hz
Averages:     1
Channel:      1
Gain:         x 1
Filter:       2500-5000HZ
Window:      HANNING
Threshold %:  0
Slope:       POSITIVE
Factor:      100 mV/G
Unit type:   ENG
Clamp:       1 mV/A

```

Measurements for testing of natural frequency

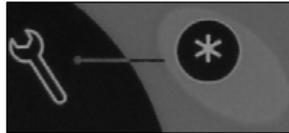
```

Function:      SPECTRUM 400L
Variable:      VELOCITY
Max. Freq.:   100 Hz
Averages:     1
Channel:      1
Gain:         x 1
Filter:       NO
Window:      HANNING
Threshold %:  10
Slope:       POSITIVE
Factor:      100 mV/G
Unit type:   ENG
Clamp:       1 mV/A

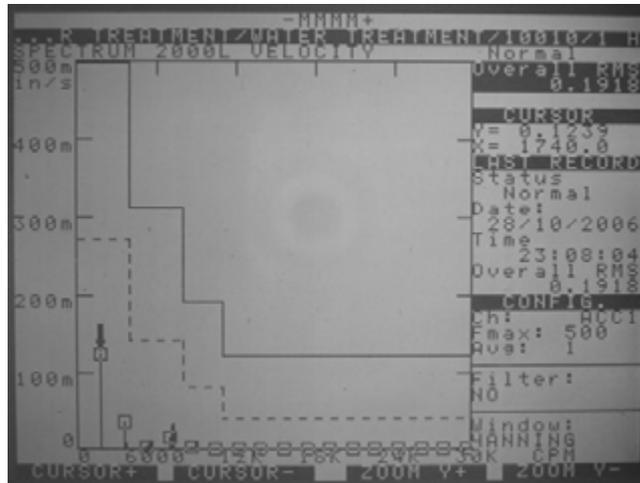
```

Spectra Tools :

Once the spectral measurement has been taken, there are tools for analysis that can be activated pressing the [*] key.



When the function is activated by [*], are available the functions detailed in the lower part of the screen, and the keyboard functions Cursor and Harmonics.

**Screen Functions :**

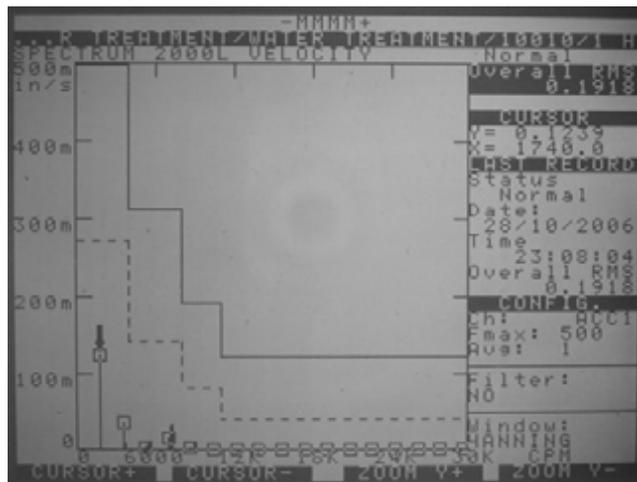
CURSOR +	Moves the cursor line from 0 to full scale.
CURSOR -	Moves the cursor line to 0
ZOOM Y +	Amplifies the amplitude axis.
ZOOM Y -	Minimize the amplitude axis.

Keyboard functions :

Cursor : this tool puts a cursor automatically in the component of highest amplitude of the spectrum.

RMS Band : Gives information of the RMS value of the spectrum for each alarm band defined in the point configuration. (it is not available in hardware).

Harmonic: shows harmonic spectral components respect the position of cursor (must be activated).

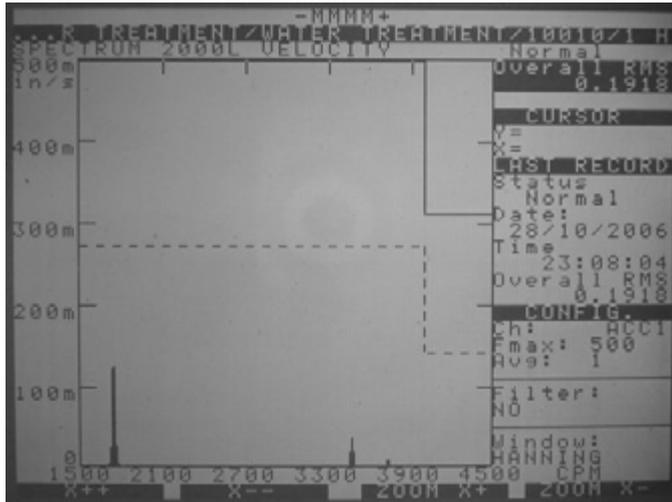


When the function is activated with [*] key, the Zoom of frequencies axis will be available too, which can be activated pressing the [0] key



This function is only available in spectra of medium and high resolution [2,000 and 4,000 lines]. This is useful for getting a very high definition

to locate and identify components of spectrum with frequencies to close.



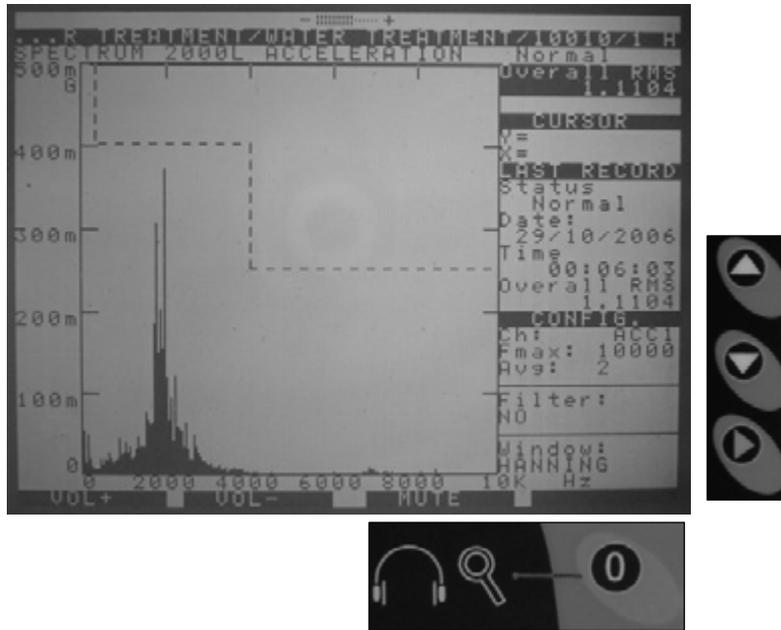
On screen functions :

ZOOM X +	Enables the Zoom of x-axis
ZOOM X -	Disables the Zoom of x-axis
X ++	Moves the activated Zoom in the increasing direction of frequency
X --	Moves the activated Zoom in the decreasing direction of frequency

To exit this function, press the [0] key

Volume Control of Headphones:

When a headphone is used, its volume can be modified in any condition of measurements, pressing the [0] key (the tool [*] key must be not activated).



Once the volume control has been activated, the regulation is made using the **[Arrow Up]** and **[Arrow Down]** keys.

The indication of volume is shown in the upper zone of the screen.



The muting of volume is activated pressing **[ENTER]** key, and is indicated by **M** in the upper zone of the screen.



Editing :

The option **Editing** of module Off Route allows to see all measurements performed and recorded in this module. This list is arranged by date, so, for finding a recorded measurement, just must be found the date when the measurement was performed and its code.



For searching between the measurements it is possible to use the navigation keys **[Arrow Up]** and **[Arrow Down]** or using the following keys of quick access :



[*] key : Previous page

[#] key : Next page

[1] key : First page

[2] key : Last Page

For choosing an equipment, press **[ENTER]** key. For exiting, press **[ESCAPE]** key.

When a measurement is edited, the blank fields may be modified, showing the new values of measurements. Date and time will not be modified.

Deleting measurements :

This function allows to delete one or more performed measurements. When an option is selected, the system allows to delete one or all measurements.

For deleting one or more measurements **in the data base**, the first step is to search in the list that appears when the option DELETING ONE MEASUREMENT is selected.



Once it has been selected, the system will ask for confirmation. The deleting is activated by pressing [ENTER]

For deleting all measurements of the Data Base of OFF ROUTE, it is necessary to select that option and confirm it pressing any key, which will be indicated in the screen.



Process Variables:

With the MX 300 it is possible to perform Off Route measurements and measurements of Process Variables too, which can be recorded as data not included in the previous routine.

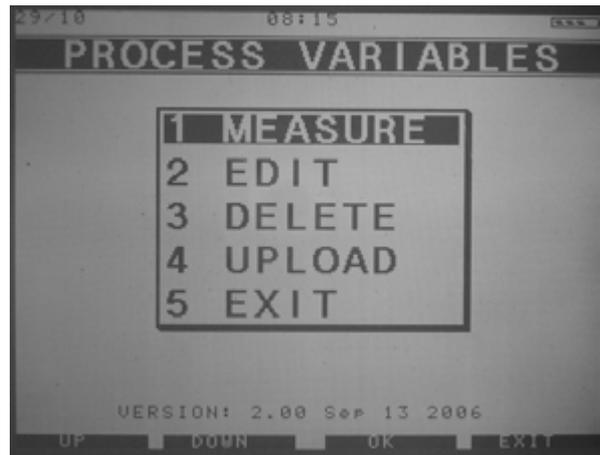
To reach this module, select the access icon to the module **Process Variables** using the navigation key [Arrow Up] and [Arrow Down], accepting with [ENTER] key (green), or directly by pressing twice the [5] key of the main keyboard.

There are five types of possible measurements.

This application allows recording any measurement of:

- Temperature, using infrared sensors or dual accelerometers of temperature and vibration.
- Displacement, with signals DC 0-10V
- Any Parameter or Variable with signals of 4-20 mA
- Any parameter or Variable with signal of DC 0-10V

Once the module OFF ROUTE has been selected, appears a menu with the following options:



Measuring : Allows to perform a new measurement.

Editing : Allows editing a measurement already performed. The written blank fields and the performed measurements can be modified.

Deleting : Allows to delete one or all Off Route performed measurements.

Sending: Allows sending to a PC the performed measurements.

Ending : exits the module Off Route measurements.

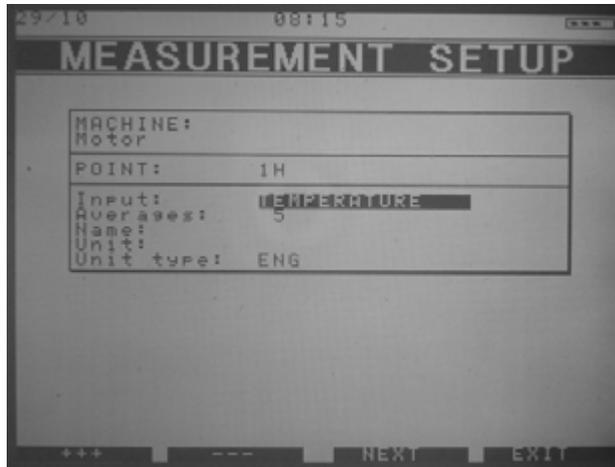
Each measurement must be associated to a named equipment, because the name of the point is automatically designed as a process.



The screenshot displays a handheld device screen titled "MEASUREMENT DATA". At the top, the date and time "29/10 08:15" are shown. Below the title, there are four input fields: "DATE:" with the value "29/10/2006 08:15:24", "MACHINE:" which is empty, "POINT:" with the value "PROCESS", and "COMMENTS:" which is empty. At the bottom of the screen, there are four buttons labeled "NEXT", "DELETE", "OK", and "CANCEL".

How to perform a measure:

Once entered the name of an equipment and completed the sequence, the screen will show the different alternatives of measure and selection of this module.



Input : can be selected the variables to be measured. There are different sensitivity among the external transmitters, for this reason, the module defines some of them specifically, such as :

Infrared Temperature Transmitter : 1 mV/degree

Dual Temperature Transmitter : 10 mV/degree

Averages : Allows to define how will be computed the average of the measurements.

Name : Allows entering the name of the variable. It is with no restrictions and can be entered through the keyboard.

Units : Allows entering the unit of the variable to be measured. It is with no restrictions and can be entered through the keyboard.

Connections :**16 bits**

2(two) Accelerometers (50-100-500mv/g, selected by software)

Clamp meter (10-100-1000A, selected by software)

2 (two) Displacement (0 -10V o 10Vpp)

Auxiliary Inputs (1Vrms , connected in AC)

Optional: 1 Voltage Input (400VAC RMS, 50/60Hz)

Optical sensor for RPM measures

24 bits

Infrared sensor for remote temperature measures.

Input for universal thermocouple.

Passive Temperature Sensors (Pt100) and Active (0-100° C)

Process signals(4-20mA), with unit definition and offset control

DC Voltage (0-10V), with unit definition and offset control

Displacement (0-10V), with unit definition and offset control

DC Auxiliary Voltage (0-2.5V) with unit definition and offset control.