USER'S MANUAL

HG904

A Portable Dual-Channel

Microprocessor-Based

On-site Balancer

Spectrum Analyzer

Vibration Data Collector

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The only difference between HG904 and HG907 is that HG904 can be used together with Machinery Condition Monitoring software (WaveSoft) .In the following contents of this manual we use the word “HG904” in most case for both of HG904A and HG907

CONTENTS

1 GENERAL

Imbalance is one of the main causes of machine vibration. It is estimated that about 50 percent of all the faults are caused by imbalance of rotors. The best mean for getting rid of mechanical imbalance is on-site balancing. HG904 Machinery Analyzer/Balancer is especially useful for this purpose. It can measure the intensity of the vibration; diagnose vibration cause by analyzing the frequency spectrum. It can also be used to measure the rotation speed and vibration phase, and to calculate the imbalance weight and location.

Dual channel vibration analyzer

Phase GDT-2 sensor

Features:

- Easy to use
- Vector illustration, the balancing process and result are shown clearly at a glance
- Storage of 10 rotors balancing data
- Selectable of trial mass remove or remain
- Decompose of balancing result to two assigned location
- Trial weight range calculated according to the weight of rotor, rotation speed, radius and required balance grade
- Trial mass validity judged automatically
- Measuring RPM, amplitude and phase
- On-site 400 lines FFT spectrum and diagnosis function
- Dual-channel simultaneous data collection
- Hardware envelop demodulation for bearing and gear diagnosis
- Transfer function for measuring natural frequency
- Waveform and spectrum display by large LCD
- Storage of vibration values and vibration waveform

Operation condition

- Temperature range: from 5°C to 50°C
- Relative humidity: ≤ 85%, unsaturated
- Without caustic gases
- Without strong electric-magnetic field & strong impact

Safety

The HG904 are not permitted to contact with running part of machine.

Specifications

- Rotation speed range for dynamic balancing: 70-60,000 r/min
- Auto-range and manual-range selectable
- Measuring accuracy of vibration: 5 %
- Sensors: Piezoelectric accelerometer, Magnetoelectricity velocity, Eddy displacement and etc.
- 8^{th}-order ellipse anti-aliasing filter, RPM band-pass filter
- Input signal: Accelerometer, and voltage
- Amplitude spectrum analysis: 100 lines to 400 lines (zoom), Hanning windowed
- Frequency span of spectrum analysis: 100, 200, 500, 1K, 2K, 5K, 10KHz(only for 1-channel sampling)
- Data storage: 400 waveforms of 1024-points and 400 data sets
- Amplitude ranges & Frequency Response for overall vibration measurement:

	Amplitude ranges	Frequency Response
Displacement	0.003 – 5 mm peak-peak	10 – 500 Hz
Velocity	0.2 – 200mm/s true RMS	10 – 1000 Hz
Acceleration	0.5 – 250m/s^2 peak	20 – 5000 Hz
Envelope	0.1 – 20unit true RMS	5-1000Hz from 15-40 KHz
Voltage	0.1 – 10V peak-peak	10 – 10000 Hz

- Notepad: 10 condition codes for visual inspection
- Output: USB for communication with PC
- Power: Ni-MH rechargeable battery for 8 hours continuous operation, low battery warning
- Operating Environment: 0~55 ^oC, 90% humidity non-condensing
- Rotating speed measurement with photocell sensor
- Dynamic Range: 60dB with 48dB adjustable gain range
- Dimensions: 21×13×4 cm; Weight: 1.2 kg (Include batteries)

2 BALANCE PRINCIPLES

2.1 What is 1-plane rotor imbalance?

Rigid rotor works under the speed far less than its first-order critical rotate speed and its deformation can be neglected. When the quality of the rigid rotor nearly focuses on a disc, namely the ratio of its axial length and its diameter is less than 0.5; we can do 1-plane balance on it and gain satisfactory result.

But for the flexible rotor, the deformation cannot be neglected. So its method of balance differs from rigid rotor. However, the rotor with single imbalance plane can also be balanced according to the method of 1-plane balance of rigid rotor. For above, whether the rigid or flexible rotor, its quality of imbalance always focuses on one disc, so both of them can be balanced according to the method of 1-plane rotor balance. In the plant and manufactory, such rotating machines are ubiquitous, such as pump, ventilator etc.

2.2 Principle of 1-Plane Balancing

HG904's 1-plane balance adopts the method of influence coefficient, which is also called balance method of 1-plane phase measuring. Just as its name implies, it's desirous to do the measurement with the phase of rotation-speed vibration when measuring the vibration amplitude of rotor. The rotation-speed vibration can be indicated as vector. The process of 1-plane balance is as follows:

(1) Measure and gain the initial rotation-speed vibration vector (A0) under the

normal operation condition.

(2) Load the proper trial mass (M) on the rotor and then measure vibration vector (A01) under the condition of the same rotate speed.

(3) Calculate the balance mass (Q) which should be load on the rotor according to the following formula:

$$Q = - M \times A0 / (A01 – A0)$$

During the balancing, all the vibration should be measured under the same rotate speed because of the imbalance force of rotor relates with the rotate speed.

2.3 Principle of 2-planes balancing

Almost all the balance of single span rotor can be achieved through the method of 2-planes dynamic balance. As a matter of fact, 1-plane dynamic balance is only one special example of 2-planes dynamic balance.

When doing 2-planes dynamic balance, two planes of adding mass and two points of vibration measure are needed. HG904's 2-planes dynamic balance also adopts the method of influence coefficient. But the difference from 1-plane dynamic balance is that the vibration of two measurement points should be measured when adding trial-mass to one of the planes. That's so-called interact effect. 2-planes dynamic balance has four influence coefficients.

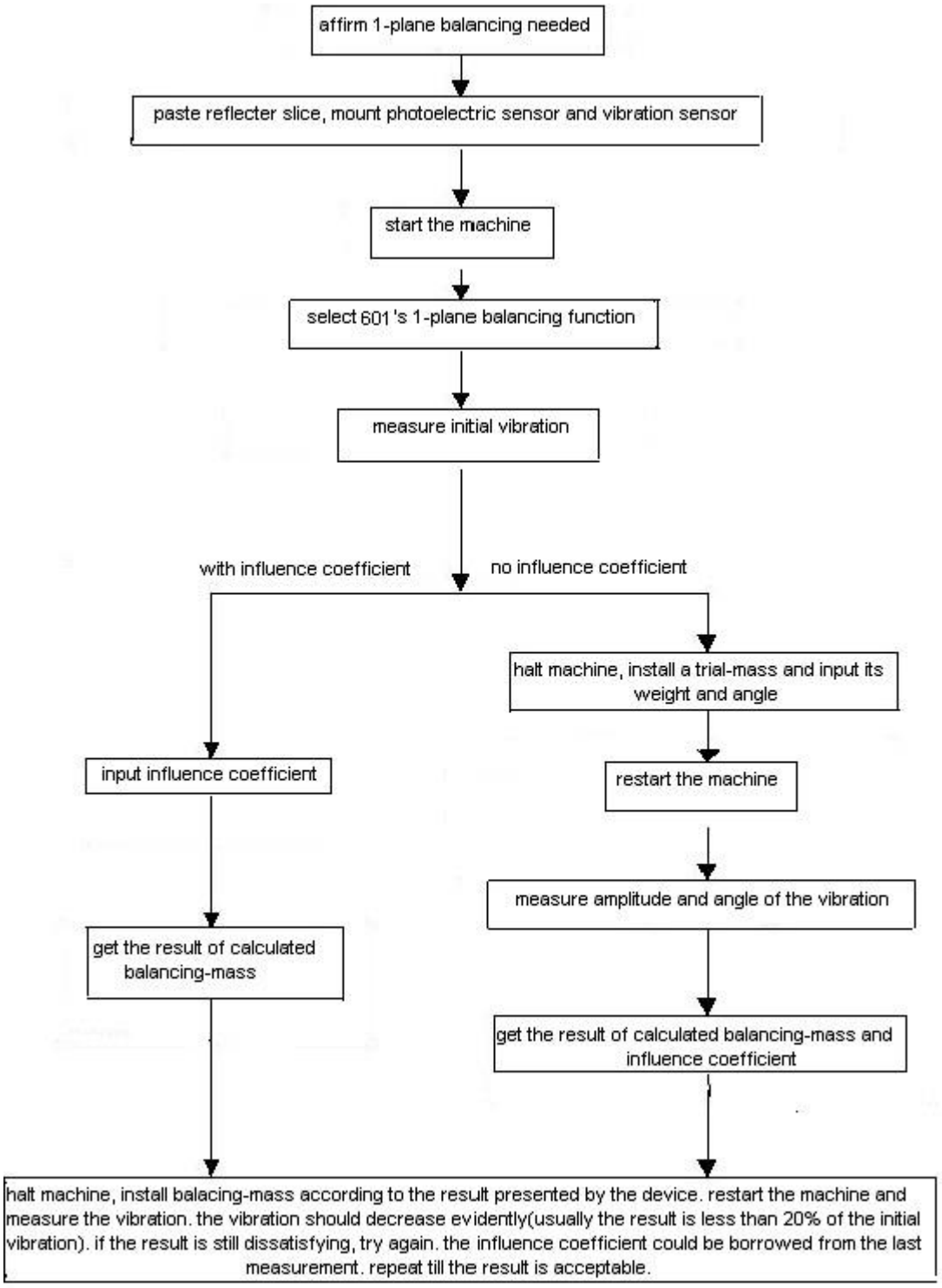
The steps to do 2-planes dynamic balance is as followings:

(1) Measure initial value of two measurement points.

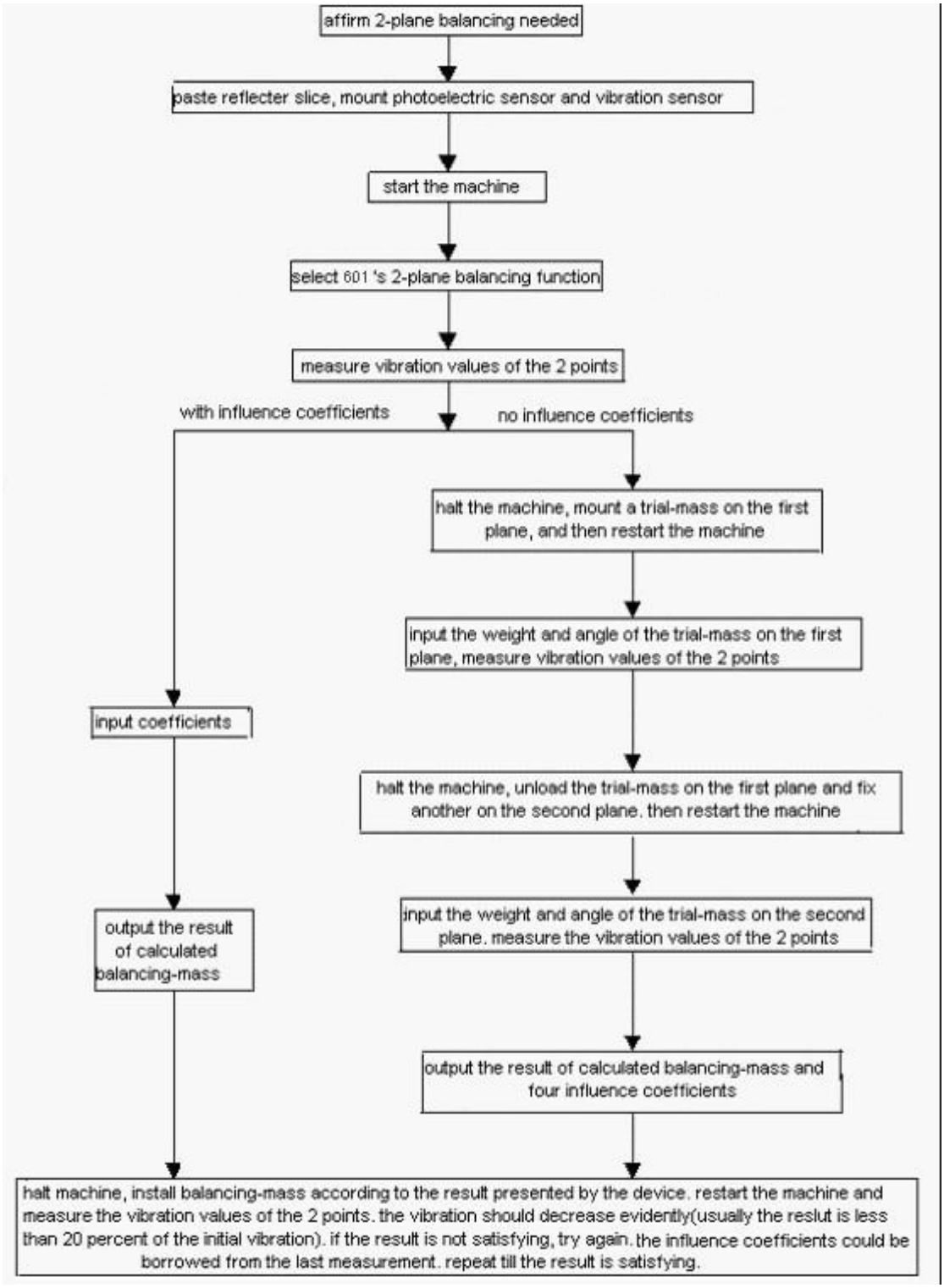
(2) Load trial mass to first plane, then measure the vibration of two measurement points respectively.
Load trial mass to second plane, and then measure the vibration of two measurement points respectively.

(3) Get conclusion of the correction mass.

If the influence coefficient is known, it can be input directly and the above step (2) can be omitted.



1- Plane balancing



2-Plane balancing

3 BALANCING PREPARATION

Before using HG904 for balancing, the following must be done firstly:

<1> **Confirm Dynamic Balance Needed**

Affirm that machine has fault of imbalance and that it can be eliminated by the method of balancing. Once the machine has heavy vibration, we should do frequency analysis with the vibration signals firstly. Generally, the probability of imbalance is higher. So, when the vibration includes a high rotation-frequency spectrum peak and less harmonic frequency peak, meantime without evidence of other faults, very possible it is the fault of imbalance.

<2> **Mount Sensors**

Vibration Sensors: It should be disposed in the horizontal direction (or vertical if horizontal not possible) on the bearing base, or on the base frame. Because dynamic balance is vector calculus, the position and direction of the sensor should keep unchanged in the balancing process.

Photoelectric sensors: Paste a reflecting or unreflecting adhesive paper (according to the condition of the rotor's surface) to a visible place of the rotor or its axis. Photoelectric sensor can give HG904 1 electric pulse per turn of the running rotor. Not only the rotate speed can be measured but also the vibration signals can be compared with pulse signals. So the phase of the rotation-frequency vibration can be obtained. During the balancing process, the position of the reflecting adhesive paper, the position and direction of the photoelectric sensor should keep unchanged.

<3> **Connect Sensor Cables**

The photoelectric sensor should be connected to the Tacho/Trigger socket of **HG904**. For 1-plane balancing, 1 vibration sensor should be connected to the Accelerometer Channel A or Voltage Channel A socket. For 2-plane balancing, a second accelerometer should be connected to the Accelerometer Channel B or Voltage Channel B socket.

<4> **Start Machine**

Start the machine and wait till it reaches its normal rotation speed (could be measured with the RPM measurement function).

NOTICE:

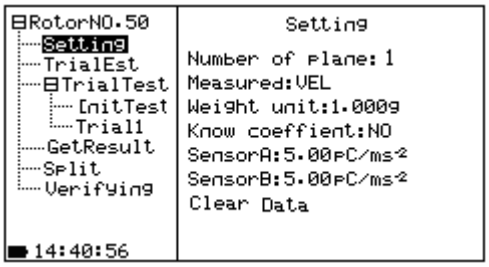
1. **Because of the strong pull force of the magnetic mount, when remove the sensor from the measurement surface, use your hand carefully. Do not remove the sensor by dragging the cables.**
2. **Before measurement, the sensitivity of the sensors must be inputted to HG904 correctly.**
3. **The *internal/external* trigger switch should be set to "external".**

4. BALANCING OPERATIONS

4.1 1-Plane Balancing

4.1.1 WITHOUT INFLUENCE COEFFICIENT:

Step 1:Setting Parameters



Press 【**On/Off**】on the panel for a moment, the balancing page appears. Then you can set the parameters.

Line 1 on the left: Change rotor number. The note displays "**Which Rotor to Balance**"(It means which rotor you will choose to Balance,HG904/HG907 contains 200 arrays ,each arrays describe kinds of data during the balancing). You can press 〖◅〗or 〖▻〗to change rotor number ,or you can input rotor number .The method of input numbers is that you press 【**In**】at first, then input numbers with number keys, press 【**ENTER**】or 【↓】at last to affirm it and the cursor goes to the next position automatically. Press ↑ or ↓ key to move the cursor between lines on the left (the following are the same).

Line 2 on the left: To set parameters, the note displays "**Enter Menu Key**", press 【**MENU**】to right to set parameters.

Line 2 on the right: To choose the operation mode,the note displays "**How Many Plane to Balance**". You press 〖◅〗or〖▻〗to choose 1 or 2(indicating that 1-plane balancing or 2-plane balancing is to be performed). Here please choose "1".

Line 3 on the right: To choose the measuring mode, there are four modes such as ACC(acceleration),VEL(velocity),DISP(displacement) and VOL(voltage).The note displays "**Enter to Select**", press 〖◅〗or〖▻〗to choose the measuring mode, The displayed is the selected.

Line 4 on the right: Input the weight of a trial unit. This is useful if some fixed weight unit is used during the balancing. The method of input numbers is the same as above.

Line 5 on the right: Tell whether the influence coefficients are known. The note displays "← → **to Select**", press 〖◅〗or 〖▻〗to choose YES or

NO (indicating that the influence coefficients are known or unkown), Here please choose NO.

The displayed is the selected.

Line 6 on the right: Input sensitivity of sensor A. The note displays "**Input Sensitivity of Sensor A".**The sensitivity can be usually obtained from the sensor certificate. The method of input numbers is the same as above.

Line 7 on the right: To Clear Data of the Rotor. The note displays"**Enter to Clear".** Press 【**ENTER**】, **fomat all** is shown in the 7th line and **only erase this rotor** is shown in the 8th line.Press 【↑】or【↓】 to choose **fomat all** or **only erase this rotor**,then Press【**ENTER**】, the following warning is shown:

Are you sure
to format all?
YES NO

Press 〖◁〗or 〖▷〗to choose **YES** or **NO**.

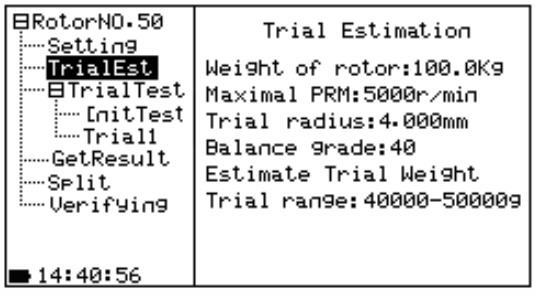
If you want to clear the rotor datas displayed,choose **only erase this rotor** and press **ENTER,** then choose **YES** and press **ENTER** to erase the rotor datas displayed, the measured data will be cleared, the balance grade and the sensor sensitivities will change to default values at the same time "**successfully erase this rotor"** is showed.

If you want to clear all the rotor datas measured,choose **fomat all** and press **ENTER,** then choose **YES** and press **ENTER** to clear all the rotor datas measured, the measured data will be cleared, the balance grade and the sensor sensitivities will change to default values at the same time "**successfully fomat"** is shown.

If you don't want to clear any data,choose **NO** and then press **ENTER** to return directly without clearing anyting.

Before a balancing operation is performed, each line of this page must be rightly configured. You may skip a line by press ↑ or ↓. Press ↓to go to the next item.

Step 2: Estimate weight of trial, and then fix a trial mass on plane I



Line 3 on the left: Calculate the weight range of trial mass according to the formula recommended by the ISO. The note displays "**Enter Menu Key"**, press

【**MENU**】to right.

Line 2 on the right: The note displays" **Input How Heavy**". The method of input numbers is the same as above.

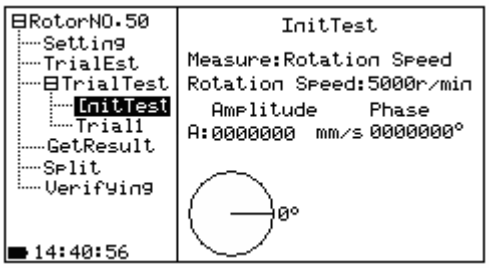
Line 3 on the right: The note displays" **Maximal Rotation Speed**". The method of input numbers is the same as above.

Line 4 on the right: The note displays" **Input Radius of Trial Mass**" . The method of input numbers is the same as above.

Line 5 on the right: The note displays" **Enter to Select**". Choose the required balance grade according to ISO1940 with 〖◅〗or〖▻〗. **4000→1600 →630→250→100→40→16→6.3→2.5→1.0→0.4→4000** are shown circularly. The displayed is the selected.

Line 6 on the right: The note displays" **Calculate Trial Range**". Press 〖Enter 〗to calculate weight range of trial mass and the result is shown in the 7th line. Stop the machine, fix a trial mass on plane I according to the calculation, and then restart the machine.

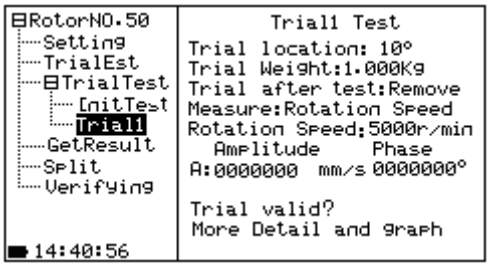
Step 3: Initial measurement:



Line 5 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗to right.

Line 2 on the right:All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 2nd line .When the cursor is in the 2nd line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 3rd line will update continually. And **Amplitude&Phase** is shown in the 2nd line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 3rd line (rotation speed) and in the 5th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement.

Step 4: Trial 1 measurement:



Line 6 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Line 2 on the right: The note displays" **Input Angel**". The method of input numbers is the same as above.

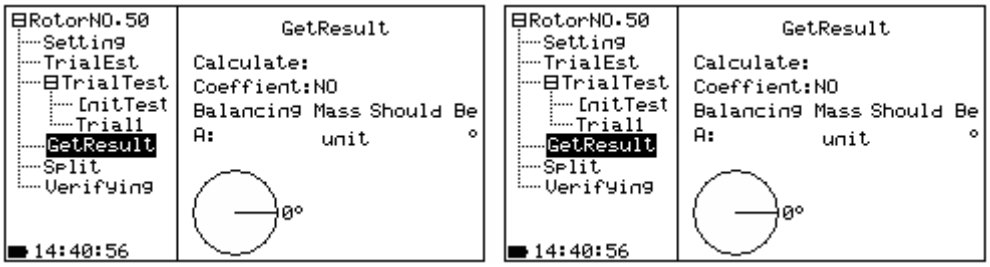
Line 3 on the right: The note displays" **Input Trial Mass Weight**". The method of input numbers is the same as above.

Line 4 on the right: The note displays "**← → to Select"**, press 〖◅〗or 〖▻〗 to choose **Remove** or **Remain** The displayed is the selected.

Line 5 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 5th line .When the cursor is in the 5th line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 6th line will update continually. And **Amplitude&Phase** is shown in the 5th line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 6th line (rotation speed) and in the 8th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement.And the valid of trial is shown in the 9th line,**Valid** means you can goto the next step, **Remove ,add** indicating that you should add a new trial at another angle, **Remove** indicating that you should add this trial at another angle.Stop the machine, adjust the trial mass accordingly to the note. Repeat the trial I measurement.

//Line 10 on the right: The note displays "**Enter to See".**

Step 5: calculate influence coefficients and balancing mass

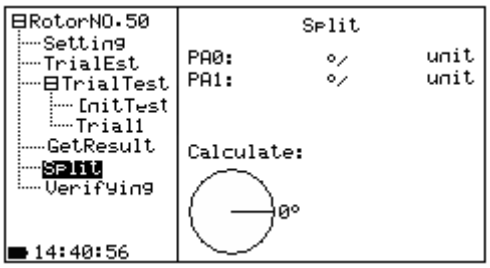


Line 7 on the left: The note displays" **Enter Menu Key**". Press〖MENU〗to right.

Line 2 on the right: The note displays" **Enter to Calculate**",all the places showing values are vacant. If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above.Press 【**ENTER**】, the balancing mass is calculated and shown in the 5th line. The location of balancing mass is also shown with vector chart. Press 【↑】or【↓】to move cursor on the right.

Line 3 on the right: The note displays" **Enter to See Coeffient**".Press 【**ENTER**】to Coeffient page to see influence coefficients.The cursor is in the 1st line, the note displays" **Enter to Return**".Press 【**ENTER**】to the former page.

Step 6: discompose vector



Line 8 on the left: The note displays" **Enter Menu Key**". Press〖MENU〗to right.

Firstly, the vector of balancing mass can be found in the vector graph just on the circle.Then find two proper angles at each side of the vector of balancing mass .

Line 2 on the right: The note displays" **Input Angle**". Input the first angle PI1 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

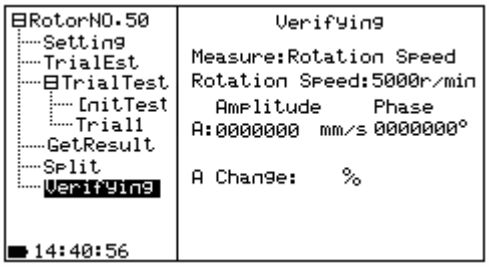
Line 3 on the right: The note displays" **Input Angle**". Input the first angle PI1 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

Line 4 on the right: The note displays" **Enter to Calculate**". Press 【**ENTER**】then HG904 calculates. The weights of the balancing masses to fix on the selected angles are shown on the right side of the 2nd and 3rd lines. Assure that the sums of the two angles depart from the balancing mass should be less than 180 degree.

Stop the machine, fix balancing mass on the rotor according to the result presented by HG904. The balancing mass is removed or remained should consist with the settings. Restart the machine. When the rotation speed becomes steady, press

【↓】to the next item.

Step 7: Verification

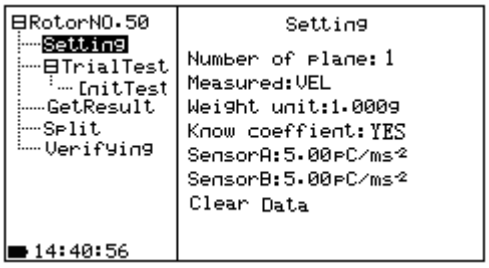


Line 9 on the left: The note displays" **Enter Menu Key**". Press〖MENU〗to right.

Line 2 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 2nd line .When the cursor is in the 2nd line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 3rd line will update continually. And **Amplitude&Phase** is shown in the 2nd line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 3rd line (rotation speed) and in the 5th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement. The 6th line displays how much the vibration of point I has changed. The user could see whether the result is usable. If the result is not acceptable, repeat the operation. The influence coefficients could be borrowed from the last measurement.

4.1.2 WITH INFLUENCE COEFFICIENTS:

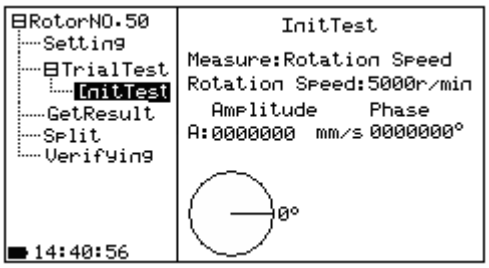
Step 1: Setting Parameters



The operation of lines except line 5 is the same as 1-plane balancing without influence coefficients.

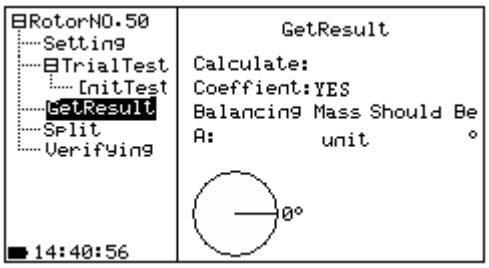
Choose **YES** in the 5th line.

Step 2:Initial measurement:



The operation of lines is the same as 1-plane balancing without influence coefficients.

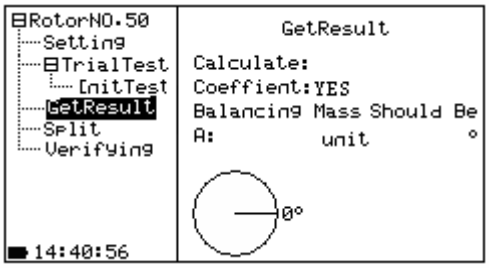
Step 3: input influence coefficients



The operation of lines except line 3 is the same as 1-plane balancing without influence coefficients.

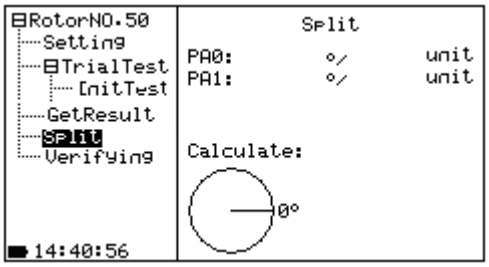
Line 3 on the right: The note displays" **Enter** to See Coeffient".Press 【**ENTER**】to Coeffient page to input influence coefficients. The method of input numbers is the same as above.The cursor is in the 1st line, the note displays" **Enter** to Return".Press 【**ENTER**】to the former page.

Step 4: calculate



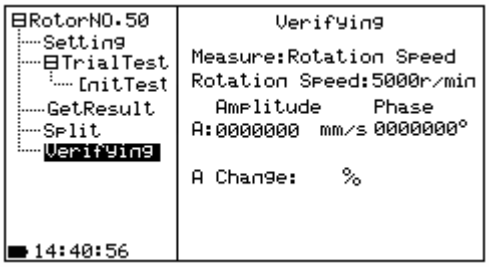
The operation of lines is the same as 1-plane balancing without influence coefficients.

Step 5: discompose vector



The operation of lines is the same as 1-plane balancing without influence coefficients.

Step 6: verification



The operation of lines is the same as 1-plane balancing without influence coefficients.

4.2 2-PLANES BALANCING

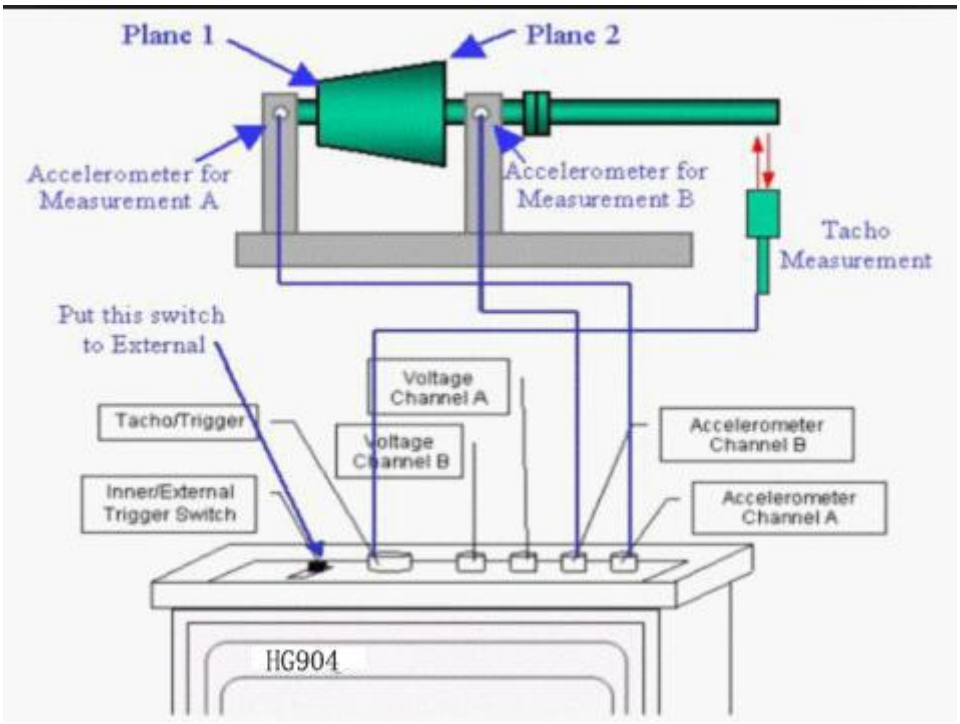
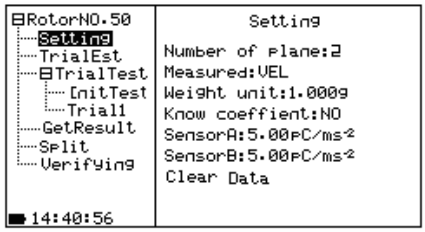


Illustration of accelerometer location and cable connection

4.2.1:WITHOUT INFLUENCE COEFFICIENTS:

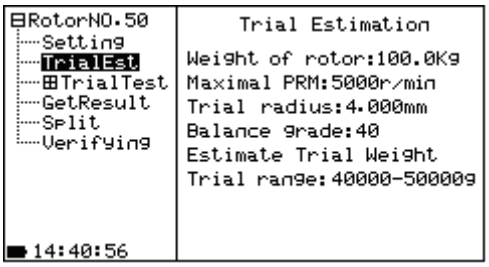
Step 1: Setting Parameters



The operation of lines except line 2 is the same as 1-plane balancing without influence coefficients.

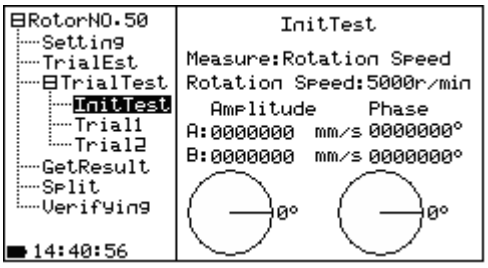
Choose **2** in the 2nd line.

Step 2: Estimate trial mass, and then fix a trial mass on plane I



The operation of lines is the same as 1-plane balancing without influence coefficients.

Step 3: Initial measurement:

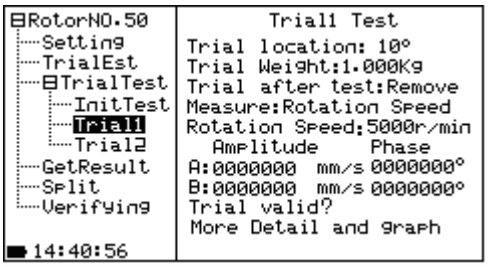


Line 5 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Line 2 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 2nd line .When the cursor is in the 2nd line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 3rd line will update continually. And **Amplitude&Phase** is shown in the 2nd line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 3rd line (rotation speed) ， in the 5th line and in the 6th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and

phase all become stable, press **ENTER** for a moment to finish the measurement.

Step 4: fix a trial mass on plane I and measure the vibration



Line 6 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Line 2 on the right: The note displays" **Input Angel**". The method of input numbers is the same as above.

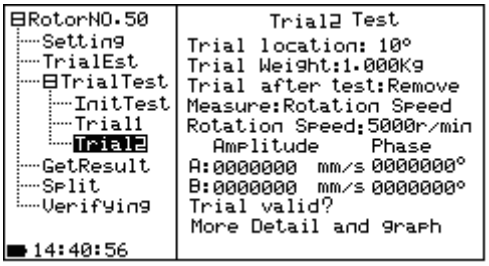
Line 3 on the right: The note displays" **Input Trial Mass Weight**". The method of input numbers is the same as above.

Line 4 on the right: The note displays "**← → to Select"**, press 〖◅〗or 〖▻〗 to choose **Remove** or **Remain** The displayed is the selected.

Line 5 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 5th line .When the cursor is in the 5th line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 6th line will update continually. And **Amplitude&Phase** is shown in the 5th line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 6th line (rotation speed) ，in the 8th line and in the 9th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement.And the valid of trial is shown in the 10h line,**Valid** means you can goto the next step, **Remove ,add** indicating that you should add a new trial at another angle, **Remove** indicating that you should add this trial at another angle.Stop the machine, adjust the trial mass accordingly to the note. Repeat the trial I measurement.

//Line 11 on the right: The note displays "**Enter to See".**

Step 5: fix a trial mass on plane I and measure the vibration



Line 6 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Line 2 on the right: The note displays" **Input Angel**". The method of input numbers is the same as above.

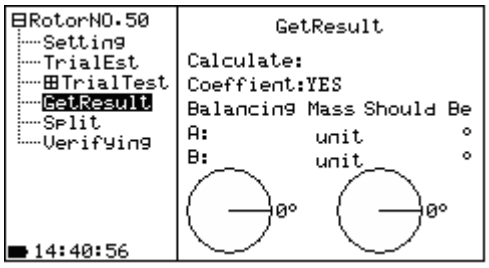
Line 3 on the right: The note displays" **Input Trial Mass Weight**". The method of input numbers is the same as above.

Line 4 on the right: The note displays "**← → to Select"**, press 〖◅〗or 〖▻〗 to choose **Remove** or **Remain** The displayed is the selected.

Line 5 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 5th line .When the cursor is in the 5th line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 6th line will update continually. And **Amplitude&Phase** is shown in the 5th line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 6th line (rotation speed) ，in the 8th line and in the 9th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement.And the valid of trial is shown in the 10h line,**Valid** means you can goto the next step, **Remove ,add** indicating that you should add a new trial at another angle, **Remove** indicating that you should add this trial at another angle.Stop the machine, adjust the trial mass accordingly to the note. Repeat the trial I measurement.

//Line 11 on the right: The note displays "**Enter to See".**

Step 6: calculate influence coefficients and balancing mass

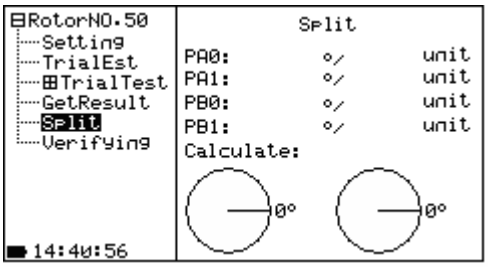


Line 8 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Line 2 on the right: The note displays" **Enter to Calculate**",all the places showing values are vacant. If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above.Press 【**ENTER**】, the balancing mass is calculated and shown in the 5th line and in the 6th line. The location of balancing mass is also shown with vector chart. Press【 ↑ 】or【 ↓ 】to move cursor on the right.

Line 3 on the right: The note displays" **Enter to See Coeffient**".Press 【**ENTER**】to Coeffient page to see influence coefficients.The cursor is in the 1st line, the note displays" **Enter to Return**".Press 【**ENTER**】to the former page.

Step7: discompose vector



Line 8 on the left: The note displays" **Enter Menu Key**". Press 〖MENU〗 to right.

Firstly, the vector of balancing mass can be found in the vector graph just on the circle.Then find two proper angles at each side of the vector of balancing mass .

Line 2 on the right: The note displays" **Input Angle**". Input the first angle PI1 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

Line 3 on the right: The note displays" **Input Angle**". Input the first angle PI2 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

Line 4 on the right: The note displays" **Input Angle**". Input the first angle PII1 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

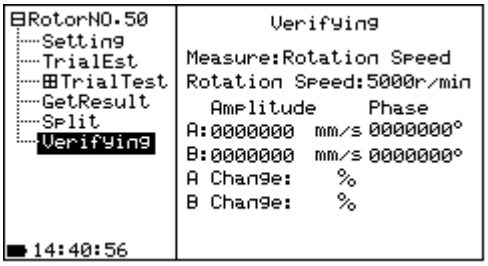
Line 5 on the right: The note displays" **Input Angle**". Input the first angle PII2 (the first angle is at the anti-clockwise side of the balancing mass vector). The method of input numbers is the same as above.

Line 6 on the right: The note displays" **Enter to Calculate**". Press

【**ENTER**】then HG904 calculates. The weights of the balancing masses to fix on the selected angles are shown on the right side of the 2nd , 3rd , 4th and 5th lines. Assure that the sums of the two angles depart from the balancing mass should be less than 180 degree.

Stop the machine, fix balancing mass on the rotor according to the result presented by HG904. The balancing mass is removed or remained should consist with the settings. Restart the machine. When the rotation speed becomes steady, press 【 ↓ 】to the next item.

Step 8: Verification

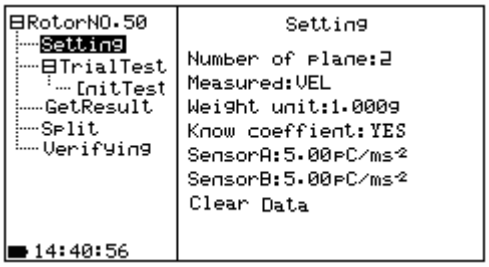


Line 9 on the left: The note displays" **Enter Menu Key**". Press〖MENU〗to right.

Line 2 on the right: All the places showing values are vacant If you hope to see some measurement, move the cursor to there, and then the value is displayed. You can also input the value. The method of input numbers is the same as above. **Rotation Speed** is shown in the 2nd line .When the cursor is in the 2nd line,the note displays"**Enter to Measure**". Press **ENTER**, to measure the rotation speed. The RPM value on the right side of the 3rd line will update continually. And **Amplitude&Phase** is shown in the 2nd line .When the rotation speed becomes stable, press **ENTER** for a moment, the HG904 begins measuring vibration. The data in the 3rd line (rotation speed) ，in the 5th line and in the 6th line (the left is amplitude while right is phase) will update continually. When the rotation speed, amplitude and phase all become stable, press **ENTER** for a moment to finish the measurement. The 7th line and the 8th line displays how much the vibration of point I has changed. The user could see whether the result is usable. If the result is not acceptable, repeat the operation. The influence coefficients could be borrowed from the last measurement.

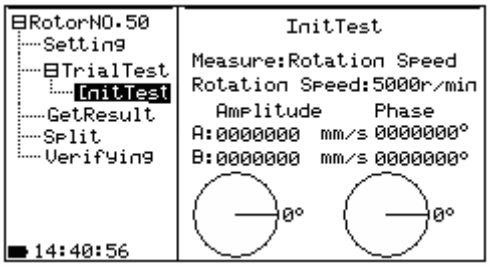
4.2.2 WITH INFLUENCE COEFFICIENTS:

Step 1: Setting Parameters



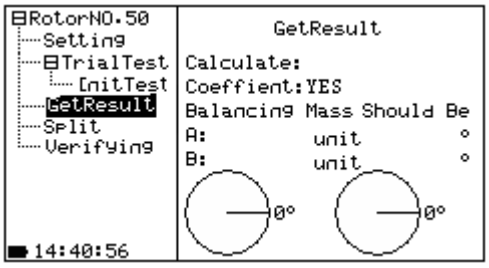
The operation of lines is the same as 2-plane balancing without influence coefficients.

Step 2:Initial measurement:



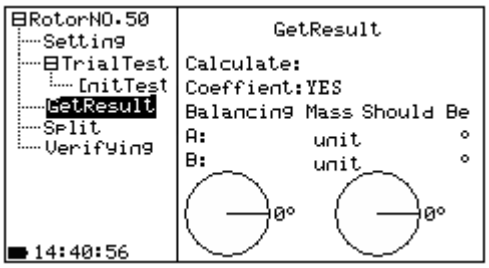
The operation of lines is the same as 2-plane balancing without influence coefficients.

Step 3: Input influence coefficients



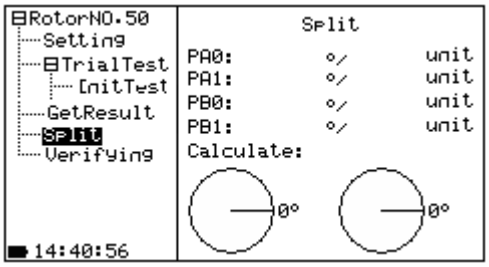
The operation of lines is the same as 1-plane balancing with influence coefficients.

Step 4: Calculation



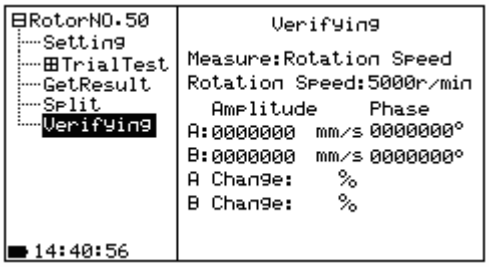
The operation of lines is the same as 2-plane balancing without influence coefficients.

Step 5: discompose vector



The operation of lines is the same as 2-plane balancing without influence coefficients.

Step 6: Verification



The operation of lines is the same as 2-plane balancing without influence coefficients.

5. VIBRATION ANALYZER / DATA COLLECTOR

HG904 is a user-friendly instrument capable of recording and analyzing vibration information. In the Free-Shot mode, you can measure ENVE, ACC, VEL and DIS (The sensor connected in the "Accelerometer" socket) or VOL (The sensor connected in the "Voltage" socket) and display new measured and old data comparatively.

In the Ext-Trig mode, HG904 must have a trigger impulse signal connected in the "Trigger/RPM" socket, and the vibration signal is recorded only when the trigger impulse signal appears. Different from the Free-shot, user can get position-related information. Furthermore, you can measure rotate speed and balance a rotor.

The HG904 keyboard has 20 buttons. Among them, 〖collector〗、〖Note〗、〖Menu〗、〖In〗are the buttons for data collector . 〖W.Meas〗、〖W.Spect〗、〖W.Save〗、〖Zoom〗、〖W.Recall〗、〖W.Transfer〗、〖Speed〗、〖Menu〗、〖In〗are the buttons for analyzer . 〖ENTER〗、〖Δ〗、〖◁〗、〖▽〗、〖▷〗are auxiliary buttons.

Notice:

1. If the device is not used for minutes, it will power off automatically. When the device is in the mode of measuring rotation speed, it won't automatically shut off. The user may push down the 〖On/Off〗button to shut it off. The data will be automatically saved when the device is shut off.

2. If the HG904 has not been used for a long time, it should be charged firstly and its memory should be formatted. The user may format the memory according to the

screen of Setting parameter. The HG904 should be shut off when being charged. It costs about 8 hours from empty power to full.

(1) Data collector

Only HG904 can be used as data collector. After pressing **On**, the screen appears:

Notice:

1. If nothing is shown in the screen, press "Off", and then press "On" for a moment again.

2. The instrument has 2 channels, A and B (auxiliary). The function of data collector only operates on channel A. Wave measuring on channel B or on the both channels could only be done by the function of signal analysis.

3. The function of data collector may be used as spectrum analysis of channel A.

4. How to fix the sensor will influence measurement in the way:

Screw: highest precision, best frequency range, best fidelity;

Magnetic base: moderate precision, frequency range and fidelity;

Hold the probe: lowest precision, frequency range and fidelity;

5. When collecting data or waveforms, the user should check up if every parameter is correctly set and if the sensors are fixed correctly.

6. After setting parameter, the measurement must be performed immediately. Otherwise, the parameter you set may be lost.

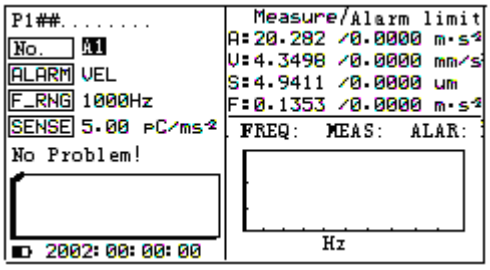
Screen of "Data collecting":

The functions of data collecting menu include:

- Setting parameters for alarming and waveform saving.
- Measuring vibration and displaying the results.
- Showing the state of measurement with NEW/OLD flag.
- Calculating the frequency spectrums automatically.

Before use HG904 to collect data, you should set parameter as following:

(1.1) Find the sequence number and measuring point



Press 〖On/Off〗, and then press 〖collector〗 to into the collector page.

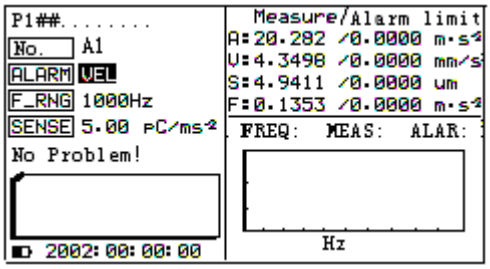
The sequence number is 1 after the memory is formatted and it is displayed on the top left of the screen. The range of sequence number is from 1 to 200.

The digits behind the sequence number are the name of measuring point. After the

memory is formatted, the names of measuring points is P0##……. Each name of measuring point is made up of 16 digits. You may use computer software WaveSoft to set the measuring point name.

You may manually move the cursor to name of measuring point with ↓ or ↑ and use 〖◅〗 or 〖▻〗 to change it.

(1.2) Set alarm mode



The purpose of the "Alm-mode" in the second line is:

- To decide which parameter to be used for raising the alarm;
- To decide which parameter to be used for spectrum calculating.
- To save 100-line spectrums for this parameter.

There are five options of alarm parameters: **ACC** (acceleration), **VEL** (velocity), **DIS** (distance), **HFA** (high frequency acceleration) and **VOL** (voltage). Move the cursor to the place after "Alm-mode", then select the parameter by ← or →.

Notice: The parameter set here is also used for the dynamic balancing.

The definition of overall vibration value may be briefly explained as:

DIS (Displace) ----- Equivalent Peak-to-peak value, the maximum vibrating distance between the positive amplitude and the negative one of the vibration. DIS is usually used on the occasion where the gap of the machine parts is critical. Its unit is μm= 1/1000 mm.

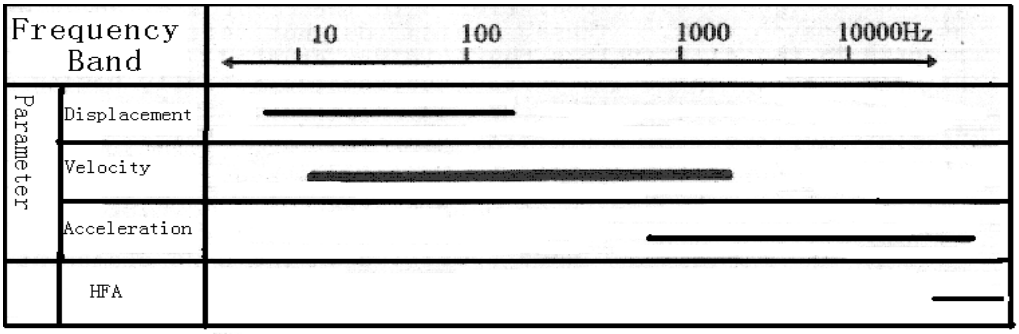
VEL (Velocity) ----- True root-mean-square (rms.) of velocity, often written as V_{rms}. It is usually used for the evaluation of machine condition. Its unit is mm/s.

ACC (Acceleration) ----- Equivalent peak value of acceleration, A_p, which equals to the value of root-mean-square acceleration (A_{rms}) multiplying 1.414. Its unit is m/s^2.

ENVE (HFA=High Frequency Acceleration Envelope) ----- RMS of the envelope signal of high frequency acceleration after filtering off low frequency (<1kHz).

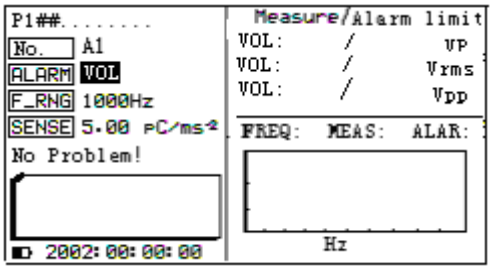
VOL (Voltage) ----- VOL adopted when using other sensors that output voltage signals. Its unit is V.

To select a suitable parameter for fault diagnosis, the user must consider its sensitivity to frequency range as listed in the following. The most important principle to choose is to provide the biggest information.

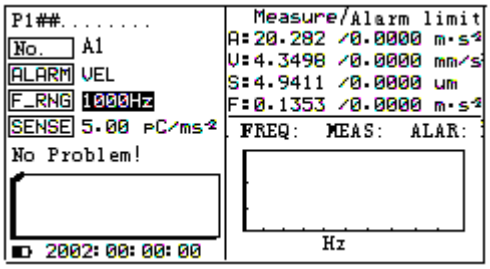


If you select **HFA,**please read the latter explain.

If you select Vol, the following is shown:



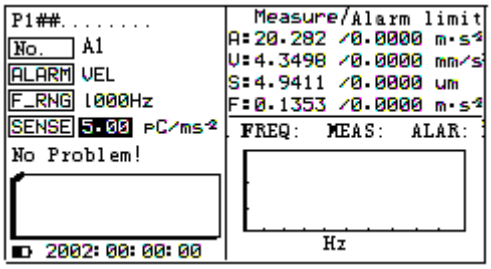
(1.3) Set frequency range



The frequency range in the 3rd line is used for spectrum analysis.

In HG904, the frequency range is used for FFT frequency spectrum analysis. The options are as the following:**100Hz**, **200Hz**, **500Hz**, **1000Hz**, **2000Hz**, **5000Hz**, **10000Hz**. Use ↑ or ↓ to move cursor to the 3rd line, then modify it by ← or →.

(1.4) Set the sensitivity of the sensor



Different accelerometer has different sensitivities. Before using HG904, the user must affirm that the value of the sensor sensitivity in HG904 is the same as that the sensor manufactures presented. Press ↑ or ↓ to move cursor to the place behind "SENCE" in the 4th line. Press 〖In〗, then nothing is displayed in the cursor. Use number keys to input the right sensitivity, and then press **Enter** or 【↓】 to confirm.

(1.5) The display of overall vibration value

The measured vibration values are at the lower part in the screen. When accelerometer is used, the "ALARM" is among **ACC**(acceleration), **VEL**(velocity), **DISP** (distance) and **HFA**(high frequency acceleration). Press 〖In〗 to begin measuring, the display of vibration value in the screen is as the following:

	NEW data	OLD data
ACC:	/	$m \cdot s^2$
VEL:	/	mm/s
DIS:	/	μm
HFA:	/	$m \cdot s^2$

When the "ALARM" is **VOL** (voltage), press 〖In〗 to begin measuring. The measurement result is shown in the screen as the following:

NEW data		OLD data
VOL:	/	V_P
VOL:	/	V_{rms}
VOL:	/	V_{PP}

When the memory has just formatted and no measurement has been taken, the data under **New data** will be empty. The column **Old data** will include the values that the computer has transferred or the values have measured before the memory is formatted. After a measurement is finished, the column **new data** displays the new measured values.

Notice: The comparison of "new" and "old" data is valid only when a new measurement has been taken and you have not changed the point name to another.

(1.6) Measurement

Firstly, fix the accelerometer to measurement location and connect the cable well. After power on the HG904; confirm that all parameters are properly set. Then press 〖On/Off〗, press 〖Collector〗, confirm the parameters in the collector page, then press **[In]** to measure. Now the alarm line in the fifth line is changed to "**Wait ……**". After a while the screen displays the overall values of **ACC**, **VEL**, **DISP** and **HFA** in the column of "New data" successively.

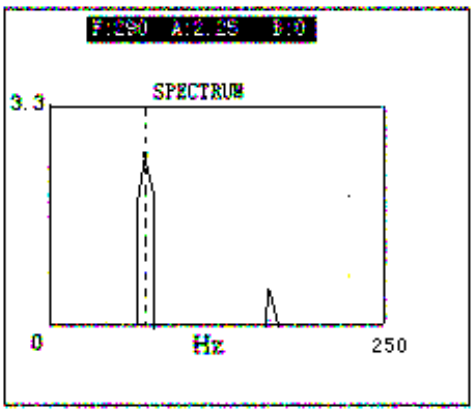
When "**AlARM**" is "**VOL**", it displays the "**Peak**", "**Rms**" and "**P-P**" of the measured voltage successively.

After the measuring value is displayed, the device begins to calculate the frequency spectrum. Then the screen displays one of the following measurement results in the fifth line:

No Problem Found
Not A stable signal
Signal Too Strong
Signal Too Weak

Notice: Don't press any key or move the sensor before measurement results are obtained. Otherwise, the result of frequency spectrum analysis will be incorrect.

(2) Data Collect Spectrum



You will see the amplitude FFT spectrum of channel A, the real line.

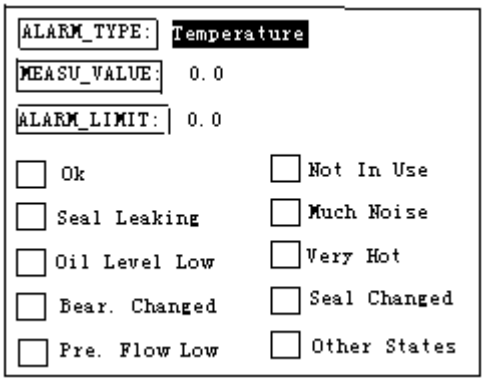
Use ← or → to read the frequency and amplitude of spectrum.

The user may look at the spectrum details by first move cursor to a specific frequency and then press “ZOOM” key.

(3) Use Notebook

Machinery vibration is usually related to other operation parameters. For example, the pressure of lubricating oil and the temperature of bearing reflect the state a bearing, and influence the vibration of a machine. The high temperature of motor winding usually indicates short circuit or overloaded and influence the vibration of a machine. To comprehensive evaluation of machinery condition, it is very important to record the parameter change together with vibration.

The function of **Notebook** is to save these technological parameters. When press 〖Note〗. The screen displays the following.



Now the type of the parameter could be changed by ← or →. Options include:

Temperature

Pressure

Load or Current

Other Parameter

Use ↑or ↓ to move the to the line of "ALARM_LIMIT", then press 【**In**】, the space is cleared. Now input the value by the number keys. Then press **Enter** or 【 ↓ 】 to confirm.

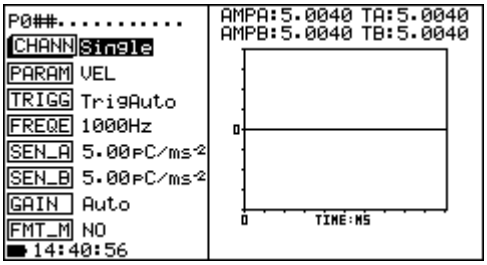
The user may also save vague observations of machinery condition in the last line. The HG904 has ten vague observation code options:

0: Ok
1: Not In Use
2: Seal Leaking
3: Much Noise
4: Oil Level Low
5: Very Hot
6: Bear Changed
7: Seal Changed
8: Pre. Flow Low
9: Other States

At the place behind "Note", select it by 〖Δ〗 or 〖∇〗.

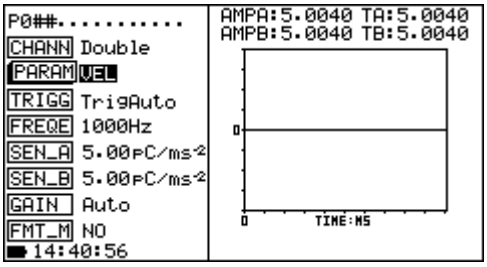
(4) Set Parameter For Analysis

Press 〖W. Meas〗to set up all parameters for signal analysis. The display is like the right figure:



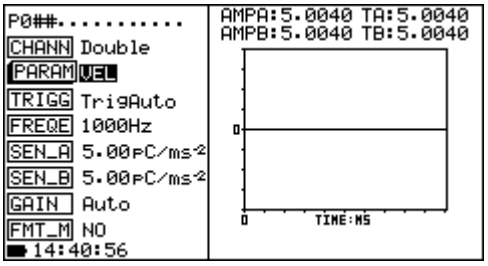
The first line shows the present **point name**, which is determined by the "Collector" menu.

CHANN



CHANN has two options of "SINGLE" and "DUAL", i.e., single channel and dual channel. You may select it by ← or → key.

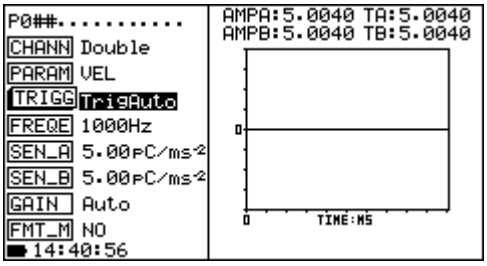
PARAM



PARAM has four options: **ACC ,VEL DIS** and **VOL**. Select it by ← or → key.

When the input mode is **SEN**, **Wave-Mode** has four options, i.e., **ACC** (acceleration), **VEL** (velocity), **DIS** (distance) and **ENVE** (high frequency acceleration envelope). If input mode is **VOLT**, the wave mode can only be **VOLT**.

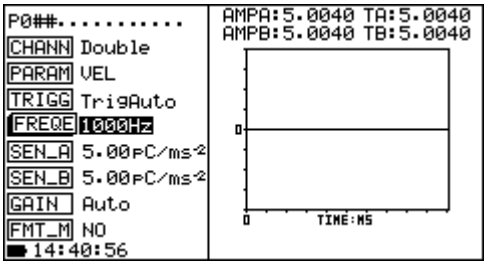
Trigger mode



TRIGG has two options of "**Yes**"(having trigger) and "**No**"(free sampling). When "**Yes**" is chosen, you must really have trigger signal. Otherwise, the instrument will always wait for triggering before collecting until you power off it.

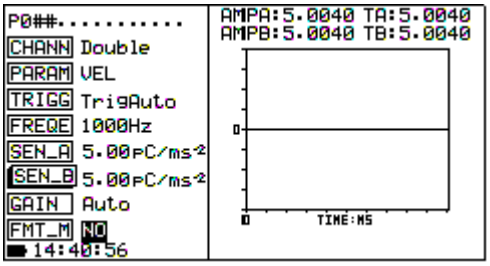
Notice: Switch the "**Inner/External Trigger Switch"** to External if you are using a tacho sensor.

Freq-Range



FREQE has 7 options for single channel: 100Hz, 200Hz, 500Hz, 1000Hz, 2000Hz, 5000Hz, 10000Hz and 6 options for dual channel: 100Hz, 200Hz, 500Hz, 1000Hz, 2000Hz, 5000Hz. Use ← or → to select a suitable one.

SEN_A and SEN_B

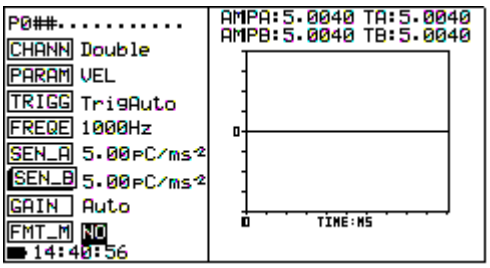


SEN_A is the accelerometer sensitivity of channel A, while **AEN_B** is that of channel B. Press ↑ or ↓ to move the cursor to the place then press **In**. Then input by number

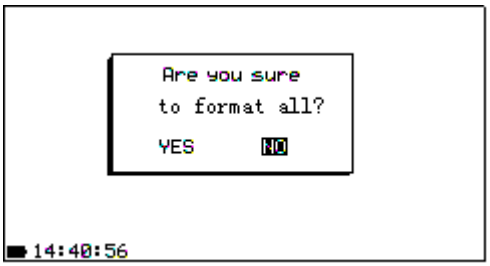
keys. Press **Enter** or ↓ to confirm.

Format Memory:

Press ↑or ↓ to **FMT_M**:



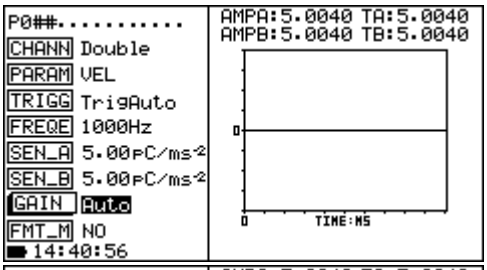
Press **Enter** then the following is shown:

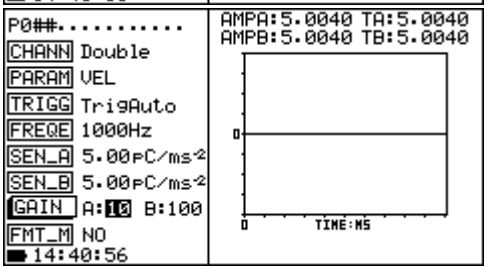


Press **Enter** again**.**All waveforms will be cleared and all parameters will be reset to the defaults. HG904 will name all points with natural sequence. The sensitivity of sensor and the alarm multiple factor will be reset to the default value (5.00 and 3.00). The screen will return to the menu of **Collector**.

The last line is **Auto-Range** or **Man-R** (Manual Range). Man-R means you may manually control the measurement range for single and dual channel measurement. This is especially useful when you need to measure an unstable signal.

The method of operation is as the following.





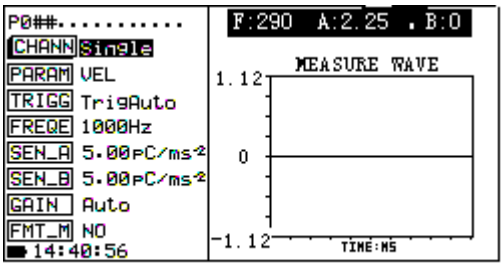
Firstly press 〖Δ〗or〖∇〗to GAIN, then press 〖Δ〗or〖∇〗to choose the mode.

CHA:A CHB:B means that channel A signal may be amplified 10 times while channel B amplified 20 times..

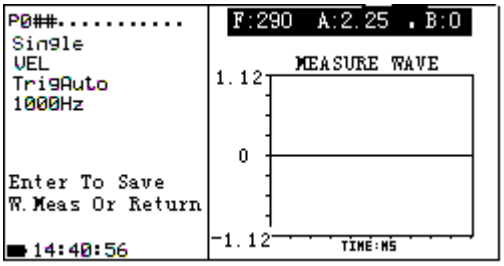
Notice: The range of amplifying multiple is from **A** to **I**.

(5) Measurement of Vibration Waveform

Connect the sensor cable to the socket of HG904, and fix the sensor to the object that will be measured. After power on, select a point name in the **Collector** menu. Secondly,press 〖On/Off〗and 〖collector〗, confirm all parameters of the **Setting** menu. After pressing 〖In〗, HG904 starts to measure waveform and displays the waveform continuously. The display is as the following graph:

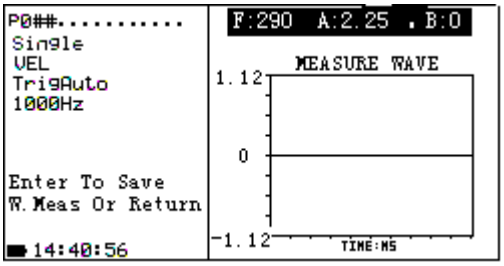


You may press 〖In〗 for a while to stop the measurement and the refresh of waveform display. Then, you may press ← or → to see the other part of the waveform (totally 10 screens for the whole).



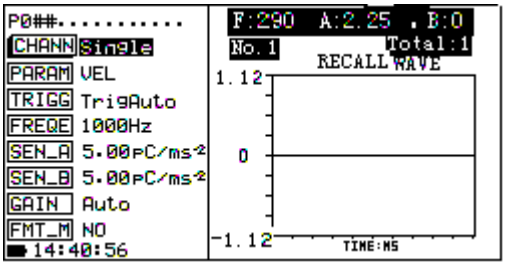
(6) Save waveform

Only the just measured waveform can be saved. The method is to press **W-Save** to enter the menu as the following.



After confirm that every thing is OK, press **Enter**. After waveform is saved, the screen displays the save number of the waveform. HG904 may save 600 waveforms. The screen will display **Memory Overflow** when the space is full.

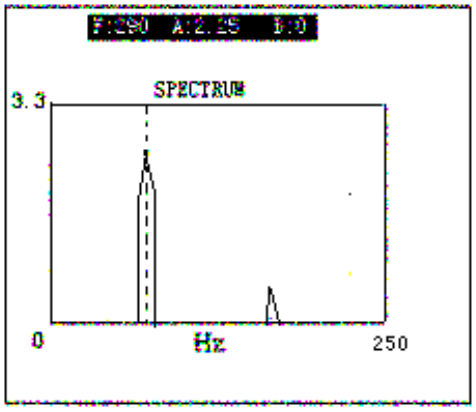
(7) Recall Saved Waveform



This function is to display the waveform stored in HG904 so that the user can observe and analyze it like the wave measured. Press〖W.Recall〗. Press ↑ or ↓ key, the user may change the stored waveform while press ← or → to see the other part of the waveform (totally 10 screens for the whole waveform).

Notice: The recalled waveform number increases no matter what button that you press, ↑ or ↓. If it reaches the biggest number, it will return to the smallest in circles.

(8) Spectrum Analysis



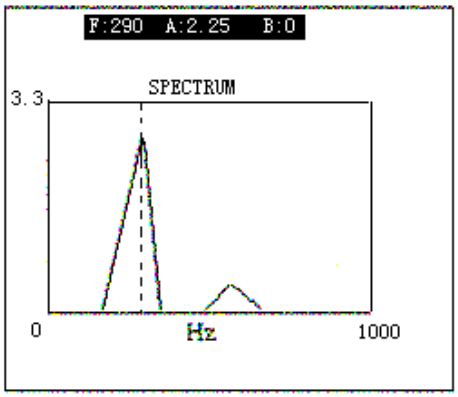
Once a waveform is measured, you may analyze the frequency spectrum at once by press 〖W.Spect〗.

If you just **recall a waveform** with 〖W.Recall〗and then press 〖W.Spect〗, you will see the spectrum of the stores waveform.

The screen of spectrum displays as the following graph. The original location of the cursor is in the place of zero frequency. Press □ or □ to move the cursor. The frequency and the amplitude of the cursor location is displayed at the right of the screen.

// If you want to see spectrum of another channel of dual channel mode, press **Channel** key.

(9) Spectrum Zoom



You may observe the details of amplitude spectrum by ZOOM function. After moving the cursor to a interesting frequency, press **Zoom** to see the 4 times detailed spectrum.

//(10) Transfer Function

Transfer function is the spectrum in proportion to the ratio of output and input signal amplitudes (B/A) in every frequency.

Notice: valid only for dual channel measurement.

(11) Rotation Speed Measurement

HG904 measures rotation speed by using a photoelectric sensor to detect the light reflected from a piece of reflecting paper on the rotating axis. The measuring method is as the following:

1). Connect the photoelectric tacho sensor with HG904, and make the lighting end of the sensor to aim at the piece of reflecting paper affixed on the rotating axis.

2). Press〖On/Off〗, power on HG904. Press 〖Speed〗.

Speed(r/min)	****
Freq.(Hz)	****

//If you want to stop the measurement of rotational speed, press 〖ENTER〗 for a while, then release it.

The rotational speed may be saved with waveform in order to diagnose machinery faults. The method is to measure the rotational speed first and then measure the vibration.

(12) Special Explanation

Acceleration envelope analysis

HG904 use high-pass filter and the demodulation method to separate the envelope

signal. Press〖collector〗or 〖W.Meas〗, You may measure the RMS value of envelope as well as analyze its waveform and spectrum by selecting ENV as "ALARM" and press 〖In〗 to measure.

Measure by eddy displacement sensor or velocity sensor

Connect the sensor with the VOL input socket and use VOL as "Input mode" in "ALARM" in "Collector" menu.

Save collector data and waveform

The storage of data obtained by "Collector" is automatic. After you have measured, HG904 will save the overall vibration value and 100-line spectrum at the moment you change to another point. Because the new data and the old data (reference value or alarming value) occupy the same space of memory, the old data will lose after you saved the new one.

Press 〖W.Save〗 to save the waveform in order to transfer it to computer for detailed further analysis.

Battery Charge

HG904 use chargeable batteries. The battery can be fully charged within about 6 hours. The battery could run for about 12 hours continuously if they are fully charged.

Maintenance

HG904 is 5-years warranted except battery, sensors and cables. The warrant of piezoelectric accelerometer is 3 month.

Calibration

The HG904 sensors need to be calibrated circularly. Usually the period is 1 year.

Service

If something wrong, please record fault symptom and communicate with HUATEC Group Corporation.

APPENDIX

BALANCE GRADE OF RIGID ROTORS

(Abstracted from ISO 1940/1-1986 Requirement of balance grade of rigid rotors—machine vibration)

Balance grade	G (mm/s)	Examples of the rotor type
G4000	4000	Rigidly fixed crooked-axis transmission set of low-RPM diesel engine, with odd amount of gases, specially used for ship
G1600	1600	Rigidly fixed crooked-axis transmission set of great 2-stroke engine.
G630	630	Rigidly fixed crooked-axis transmission set of great 4-stroke engine Flexibly fixed crooked-axis transmission set of diesel engine specially used for ship
G250	250	Rigidly fixed crooked-axis transmission set of high-RPM 4-gas diesel engine.
G100	100	Crooked-axis transmission set of high-RPM diesel engine with 6 or more gases The whole engine of a truck or an auto (diesel or gas engine)
G40	40	Wheels, flange, transmission axis of an auto Flexibly fixed crooked-axis transmission set of high-RPM 4-stroke engine with 6 or more gases Crooked-axis transmission set of an auto, a truck
G16	16	Transmission axes with special requirements (axle-rotating axes, all-way axes) Parts of crusher Parts of agricultural machine Engines of auto, truck and locomotive (the whole of diesel or gas engine) Crooked-axes transmission set of provider with 6 or more gases under special conditions.
G6.3	6.3	Parts of master engine Tub wheel of centrifugal machine Roller of paper-machine, roller of presswork Fan Rotor of assembled aviation turbo line Flywheel Pump wheel Parts of lathe and general mechanical General or great armature without special requirements (the height of electricity's axes center is at most 80mm) Small armature which is often yielded a great deal and used under the conditions of not being sensitive to vibration or there is sets for isolate vibration. The whole of a engine with special demands.
G2.5	2.5	Rigid rotor of turbine generator Disks and drums of a computer Turbo compressor Transmission set of a lathe General or great armature with special demands
G1	1	Transmission set of tape recorder and gramophone (photograph) Transmission set of grinding machine. Small armature with special demands
G0.4	0.4	Main axes, grinding wheel and armature of a precise grinding machine Gyroscope