INSTRUCTION MANUAL

Hand-Arm Vibration Card

VX-54WH

RION CO., LTD.

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Organization of this manual

This manual describes operation of the 3-Axis Vibration Meter VM-54 when the program supplied on the Hand-Arm Vibration Card VX-54WH has been installed. The manual contains the following sections.

Outline

Gives basic information on the Hand-Arm Vibration Card VX-54WH.

Controls and Functions of VM-54

Identifies and explains the name and function of keys, connectors and other parts of the VM-54.

Preparations

Explains how to connect the accelerometer and make printer settings.

Reading the Displays

Explains graphics and character-based information that appears on the main display and sub display of the unit.

Power-On/Off

Explains how to turn the unit on and off.

Measurement

Describes the basic steps for measurement.

Memory Card

Explains how to use the memory card for data storage.

Reading and Writing Memory Card Data

Explains how to read and write measurement data stored on memory card.

Printing

Explains how to print out measurement data.

Output Connectors

Explains the output connectors of the unit.

Reference Information

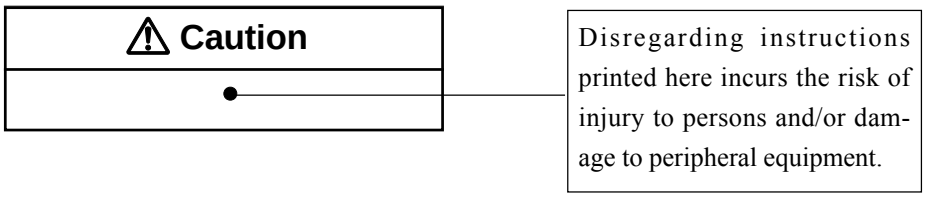
Provides information on external power switching, the Input connector, and frequency response characteristics.

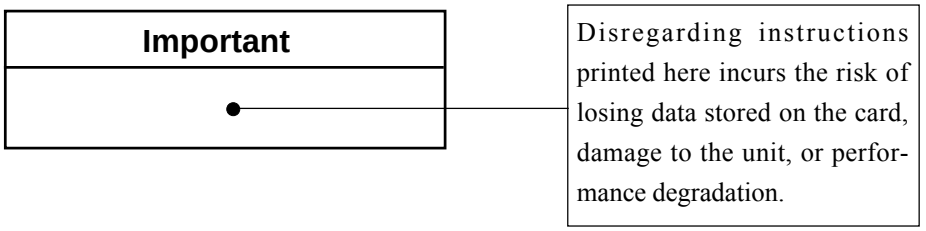
Specifications

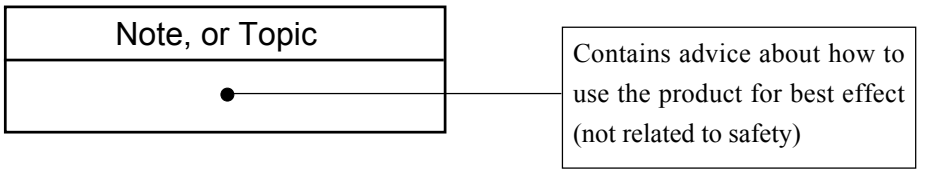
Lists the technical specifications of the card.

FOR SAFETY

In this manual, important safety instructions are specially marked as shown below. To prevent the risk of death or injury to persons and severe damage to the card or peripheral equipment, make sure that all instructions are fully understood and observed.







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Precautions

- Operate the card only as described in this manual.
- Take care not to drop the card and protect it from shocks and vibration.
- The permissible ambient temperature and humidity range for operation of the card is -10 to +50ºC, 90% RH.
  Do not use or store the card in locations that may be subject to extreme temperature or humidity, to splashes of water, high levels of dust, or to direct sunlight. Also avoid air with high salt or sulphur content, gases, and the vicinity of stored chemicals.
- Do not initialize the card in a computer.
- Exposure of the card to static electricity or to water may result in loss of program data and stored data. If there is a possibility that your body carries static electricity, first touch a grounded metal object or discharge static electricity by other suitable means before handling the card.
- Never insert any object such as pieces of wire, conductive plastic etc. into the card connector, to prevent the risk of damage.
- Do not try to disassemble or modify the card.

Contents

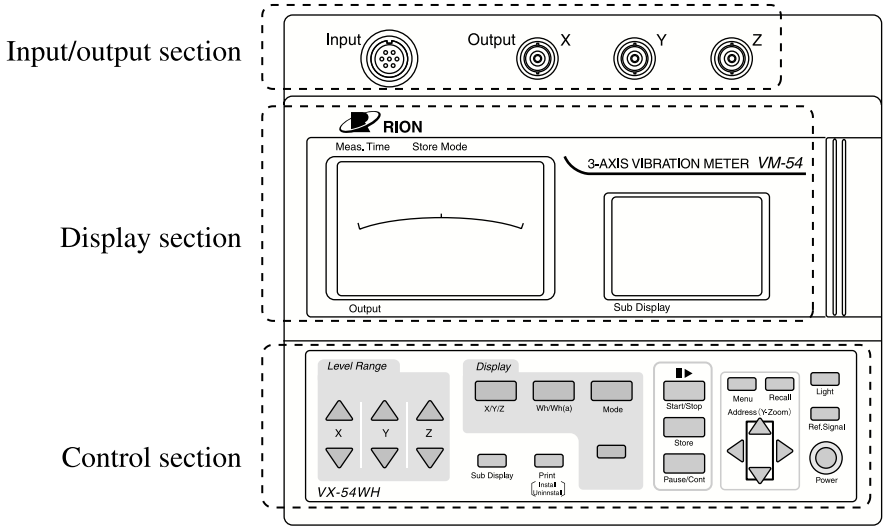
Outline

The Hand-Arm Vibration Card VX-54WH is an option program card for the 3-Axis Vibration Meter VM-54. By installing the program data from the card in the VM-54, the vibration meter can be used to make hand-arm vibration measurements applicable to ISO 5349-1: 2001, ISO 5349-2: 2001, ISO/DIS 8041: 2003, JIS B 7761-1: 2004, and JIS B 7761-2: 2004. For measurements, the compact piezoelectric accelerometer PV-97C or similar can be used, with an attachment to link it to hand-held tools. Measurement is performed for the three axes simultaneously, and data can be stored on memory card (CompactFlash card), which makes it possible to handle large amounts of data. BNC output connectors provide AC signals for the three axes which can be used for monitoring on external equipment. If the FFT Analysis Card VX-54FT is installed, FFT analysis can be carried out using the Wh frequency weighting characteristics for hand-arm vibrations.

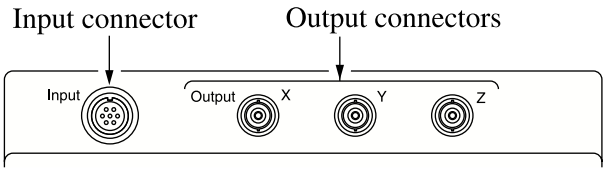
Controls and Functions of VM-54

This section explains the controls and functions of the VM-54 with the template sheet supplied with the VX-54WH attached.

Front panel



Input/output section



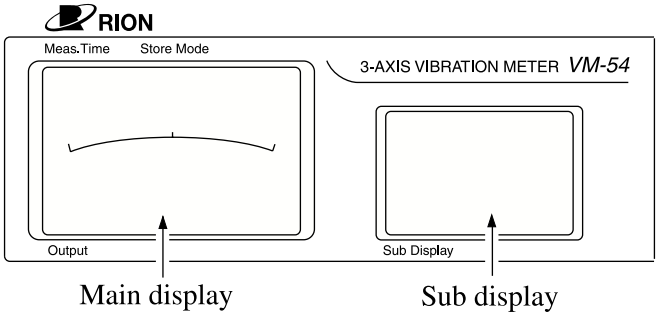
Input connector

To connect the optional piezoelectric accelerometer PV-97C or another piezoelectric accelerometer, use the supplied 3-Channel Preamplifier VP-80 between the accelerometer and the Input connector. The connection between the VP-80 and the VM-54 can also be extended using the optional EC-04 cable.

Output connectors

These are BNC connectors which carry an AC output signal for the X, Y, and Z axis.

Display section



Main display

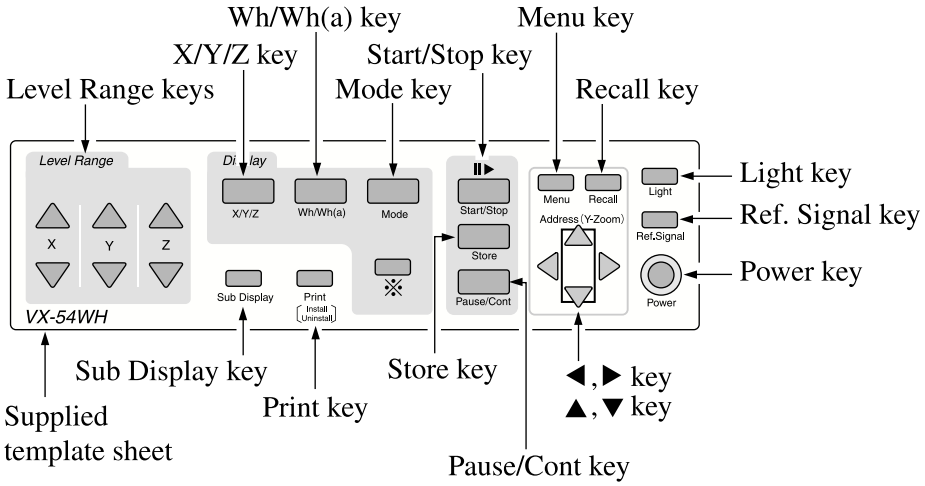
Shows the measurement value and setting information.

Sub display

Shows the 3-axis bar graph screen, 3-axis numeric screen, processing value screen, and other measurement screens, as well as menus and the recall screen.

Control section

Attach the supplied template sheet to the VM-54, as described in the section "Preparations" on page 9.



Note
Protective film The unit is shipped with a protective film covering the operation panel. When using the unit, you can remove this film.

Level Range keys

These keys control the level range for the X, Y, Z axis.

The ▲ key switches the level range up, and the ▼ key switches the level range down.

X/Y/Z key

Switches the vibration axis (X, Y, Z) to be shown on the display.

With each push of the key, the display cycles through the settings in the order X → Y → Z → X etc.

Wh/Wh(a) key

Serves to select the frequency weighting characteristics. This setting applies to all three channels.

Wh: Frequency weighting characteristics

Wh(a): Bandwidth limiting filter of frequency weighting characteristics

Mode key

Switches the measurement mode.

Each push of the key cycles through instantaneous value → processing value (RMS) → MTVV (max) → instantaneous value ...

Start/Stop key

Serves to start and stop the measurement. During processing, the ▶ symbol is shown on the display.

During auto store operation, pressing the key stops auto store.

Menu key

Pressing this key brings up a menu screen on the sub display.

Each push of the key cycles through menu screens 1/5, 2/5, ... 5/5. Pressing the key again at menu screen 5/5 closes the menu display and returns to the measurement screen. .

The menu can also be closed by pressing any other key except the Light key, Power key, ▲, ▼, ◀, ▶ keys, and Print key.

Recall key

This key serves to call up data stored on memory card. Recalled data are shown on the sub display.

Light key

This key turns the backlight for the main display and sub display on. This is convenient when using the unit in a dark location. To turn the backlight off, press the key again.

When the unit is operating on battery power, the backlight will automatically turn itself off after 10 minutes. When the unit is powered from an external power supply, the backlight will not automatically turn off.

Current consumption increases by a factor of about 2 when the backlight is on.

Ref. Signal key

This key serves for level matching between the unit and equipment connected to the Output connectors. The reference signal level is as shown below.

AC: 79.58 Hz 1 Vrms

The sub display shows the 3-axis bar graph screen while the reference signal is being output.

Pressing the Ref. Signal key immediately after power-on, while the initialization screen is still shown, will cause the software version to be displayed.

Power key

Serves to turn the unit on and off.

Hold down the key for at least one second to turn power on or off.

After switching the unit off, wait at least five seconds before turning power back on again. Otherwise the unit may not start up properly.

▲, ▼ keys

These keys serve to select the address for storing data.

When the sub display is showing a menu screen, the keys serve to select a menu item.

(Y-ZOOM is used for zooming the FFT screen when using the optional FFT Analysis Card VX-54FT.)

◀, ▶ keys

When the sub display is showing a menu screen, these keys serve to change the setting of the selected item.

Pause/Cont key

Serves to pause and resume the measurement.

Store key

When manual store is selected, this key serves to store instantaneous value data and processing result data on a memory card. The stored data reflect the Wh/Wh(a) frequency weighting setting. During auto store, the key serves to start and stop the auto store operation.

Unnamed keys (shown with an ※ symbol)

Pressing these keys has no effect.

Print key

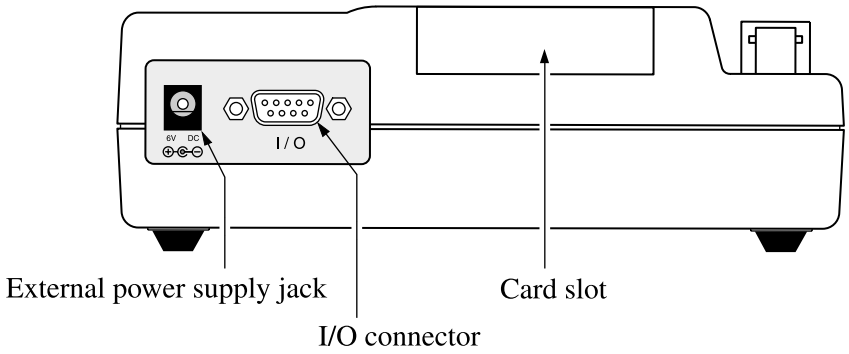
This key serves for printing out measurement data on an optional printer.

Sub Display key

Switches the function mode of the sub display.

With each push of the key, the display cycles through the bar graph screen, 3-axis measurement screen, and other screens.

Right side view



External power supply jack

The optional AC adapter NC-98A (for 100 to 240 V AC) can be connected here to power the unit from an external source.

I/O connector

The optional printer DPU-414, CP-10, or CP-11 can be connected here, using a special cable.

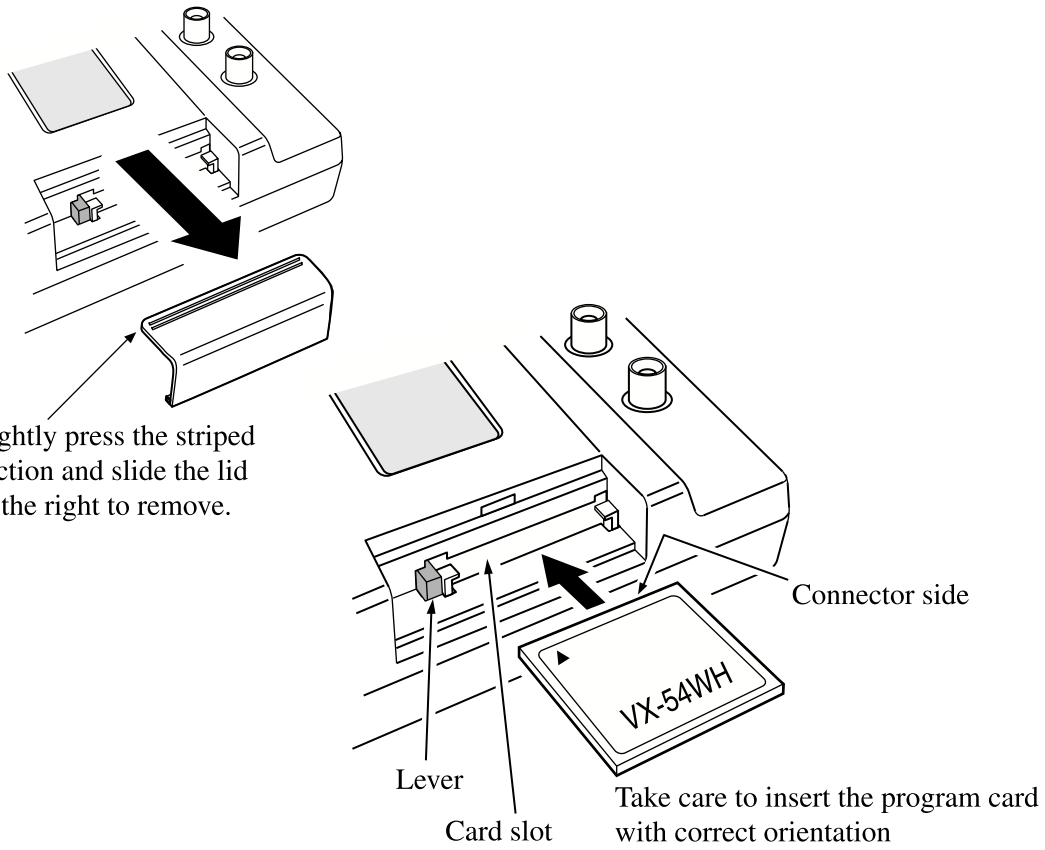
Card slot

The program card VX-54WH and other memory cards can be inserted in this slot.

Preparations

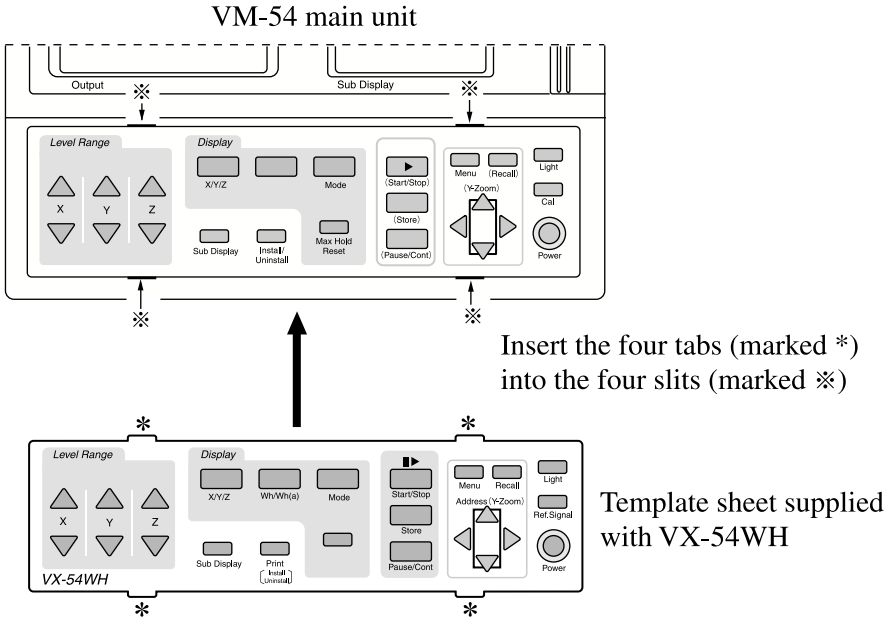
Installing the Hand-Arm Vibration Card VX-54WH

Important
Make sure that power is turned off before inserting the program card.
If the power is interrupted during installation or uninstallation, the unit may malfunction. When performing the procedure while powering the VM-54 from batteries, make sure that the batteries are fresh. When performing the procedure while powering the VM-54 from the AC adapter, make sure that batteries are inserted as a backup power supply. Also take care not to subject the unit to shocks during this procedure, because this can result in power interruption.

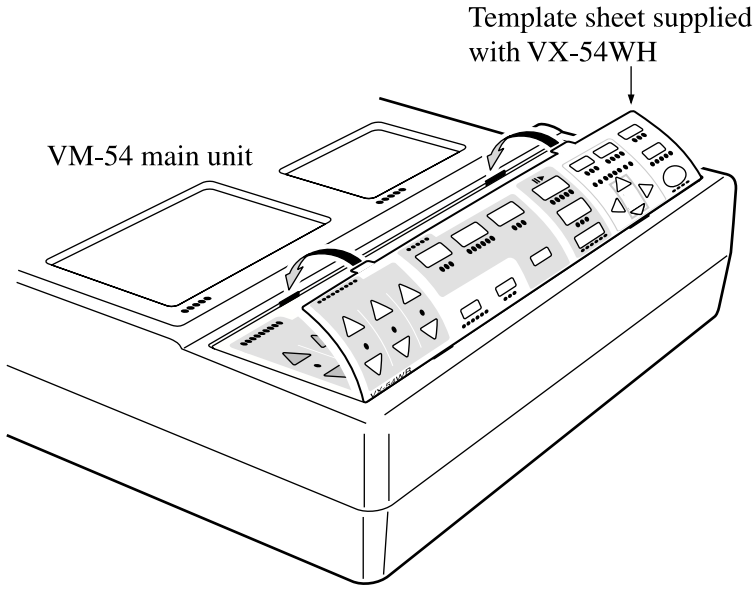


Attaching the template sheet

Install the template sheet supplied with the VX-54WH on top of the operation panel of the VM-54.



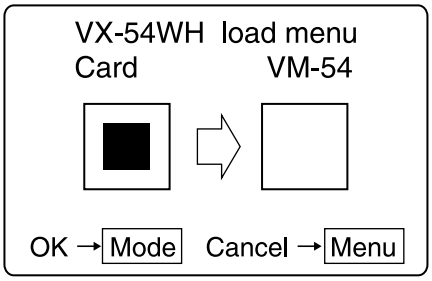
Slightly bend the template sheet as shown below.



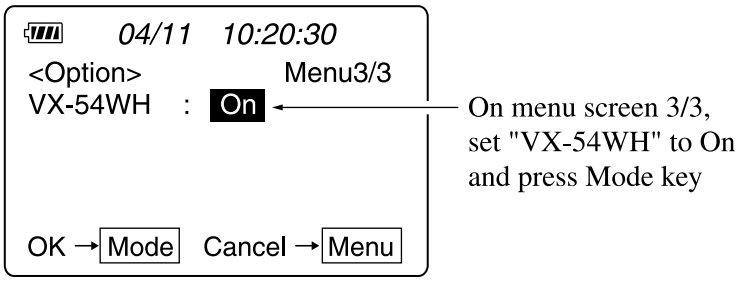
Program Installation

Install the program data of the Hand-Arm Vibration Card VX-54WH in the 3-Axis Vibration Meter VM-54 as follows.

1. Insert four fresh IEC R14 (size C) batteries into the VM-54, or connect the AC adapter NC-98A.
2. Insert the VX-54WH card into the VM-54.
3. While holding down the Print (Install/uninstall) key, press and hold the Power key for at least one second.
4. When the power comes on, the following indication appears.



5. Press the Mode key to start the installation. When the installation is complete, the VX-54WH program will be available. To start the program, set the "VX-54WH" item on the VM-54 menu screen 3/3 to On and press the Mode key.
   On menu screen 3/3, set "VX-54WH" to On and press Mode key.

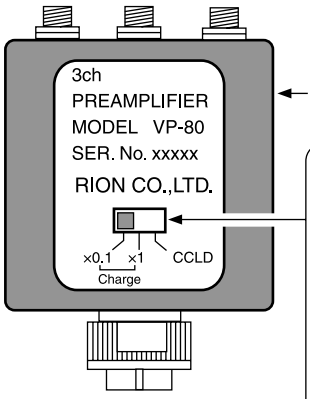


Once installed, the program data will remain in the VM-54 and the program can be used until uninstalled, without the VX-54WH needing to be inserted. However, to install and use another program, the installed VX-54WH card program must be uninstalled first.

Connection of piezoelectric accelerometer

1. Turn power off.
2. Connect the 3-Channel Preamplifier VP-80 to the VM-54. If the connection is to be extended, use the extension cable EC-04.
3. Connect the piezoelectric accelerometer PV-97C or another piezoelectric accelerometer to the 3-Channel Preamplifier VP-80.
4. Set the slide switch on the name panel of the 3-Channel Preamplifier VP-80 to "×0.1" or "×1", as required..
5. When set to "×0.1", divide the rated sensitivity of the accelerometer by 10 when setting the sensitivity item on menu screen 2/5 (use 1/10 of the rated sensitivity values).

Note
To measure large vibrations, use the "×0.1" setting.

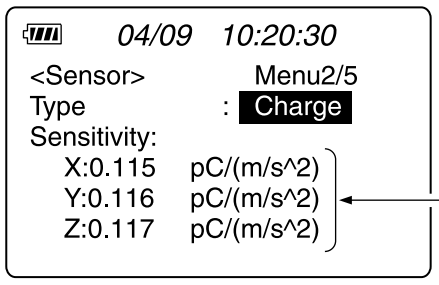


3-Channel Preamplifier
VP-80 (optional)

Make setting with slide switch

Charge
×0.1: Sets the charge amplifier gain for a connected charge output type accelerometer to a factor of 0.1.
×1: Sets the charge amplifier gain for a connected charge output type accelerometer to a factor of 1.
CCLD: This position is for use with an accelerometer that has a built-in preamplifier.

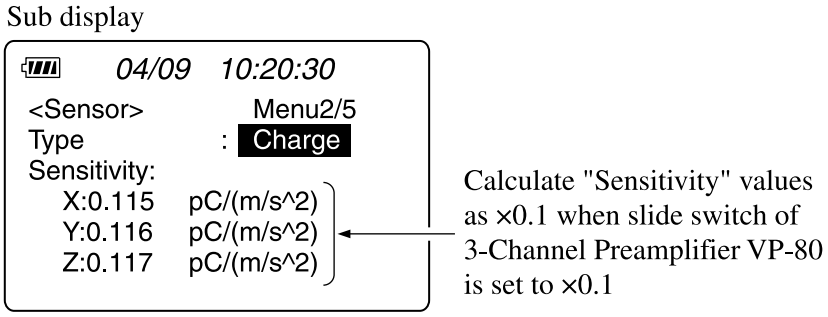
Sub display



Calculate "Sensitivity" values as ×0.1 when slide switch of 3-Channel Preamplifier VP-80 is set to ×0.1

Menu screen 2/5

3-Channel Preamplifier VP-80 setting



Menu screen 2/5

About the 3-Channel Preamplifier VP-80 (optional)

The 3-Channel Preamplifier VP-80 is to be used when connecting a charge output type accelerometer or integrated preamp type accelerometer. Depending on the type of sensor, the slide switch on the name panel of the 3-Channel Preamplifier VP-80 must be set to the required position. The Sensitivity item on menu screen 2/5 also must be set to match the 3-Channel Preamplifier VP-80. Take care to establish the correct settings. Otherwise correct measurement is not possible.

If a piezoelectric accelerometer is used and the gain of the 3-Channel Preamplifier VP-80 is set to ×0.1, set the accelerometer sensitivity item on menu screen 2/5 to 1/10 of the rated accelerometer sensitivity.

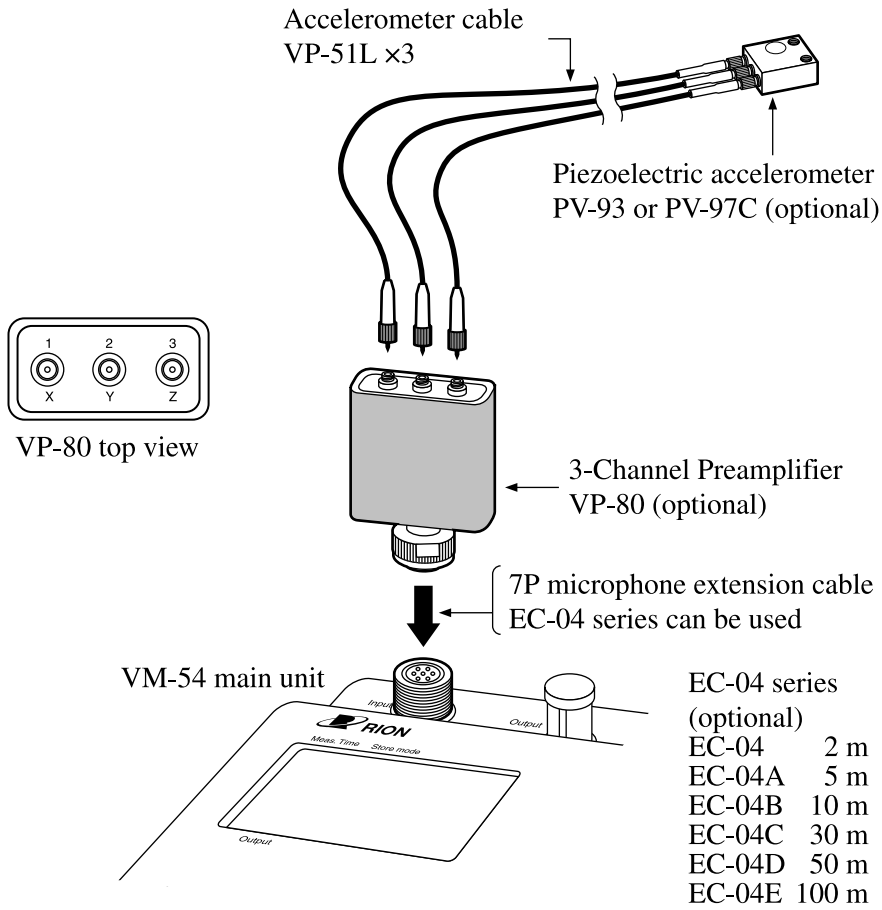
Note
The VP-80 slide switch setting applies to all three channels. For example, when the Charge "×1" position is selected, the charge amplifier gain for all three channels is ×1.

Connection of piezoelectric accelerometer (3-axis accelerometer) PV-97C/PV-93 (optional)

1. Insert the plug of the cable supplied with the accelerometer into the connector of the accelerometer, and turn the locking ring clockwise to fasten the plug.
2. Insert the plug at the other end of the cable into the Input connector on the 3-Channel Preamplifier.

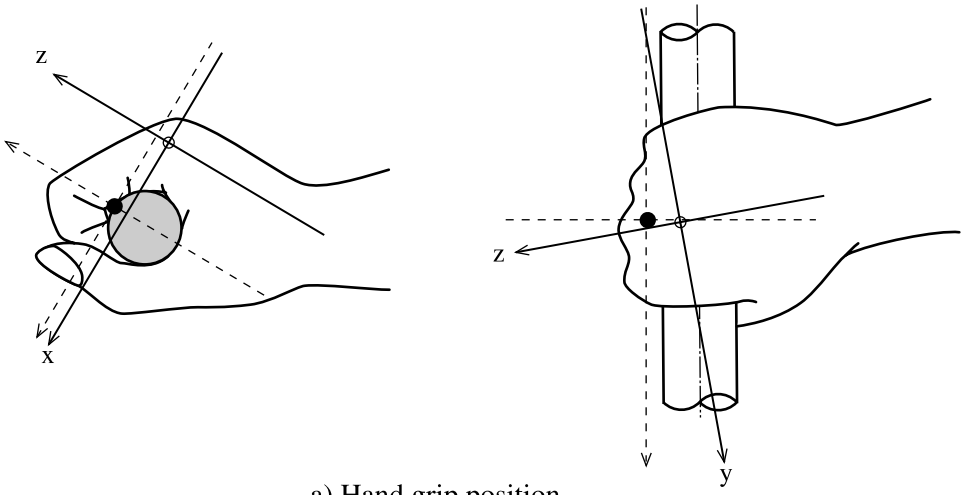
Important
The accelerometer is a highly delicate precision device. Never drop it or subject it to shocks.
Do not carry or swing the accelerometer by the cable, because this can cause the cable to break.

3. Connect the 7P output connector of the 3-Channel Preamplifier VP-80 to the Input connector on the VM-54, and turn the locking ring clockwise to fasten it.
   If necessary, an extension cable can be used between the VP-80 and the VM-54.

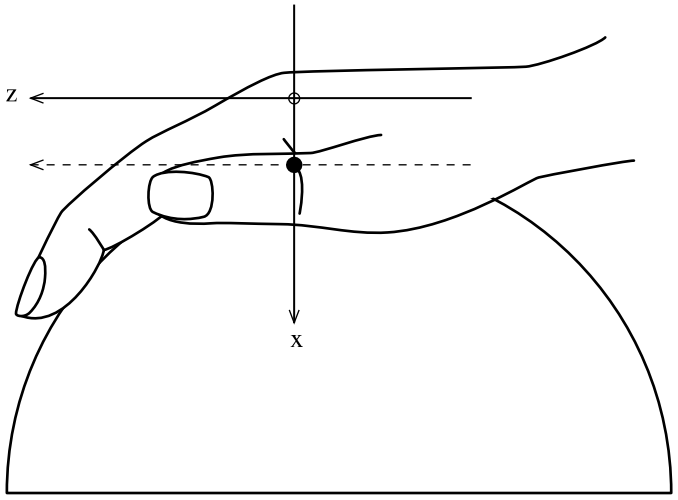


Note
When performing measurement using a vibration direction (coordinate) system such as shown on the following page, make sure to connect the input channels of the VP-80 correctly, according to the accelerometer sensitivity axis.

Vibrations transmitted to the hand are usually measured using an orthogonal coordinate system such as shown below.



a) Hand grip position

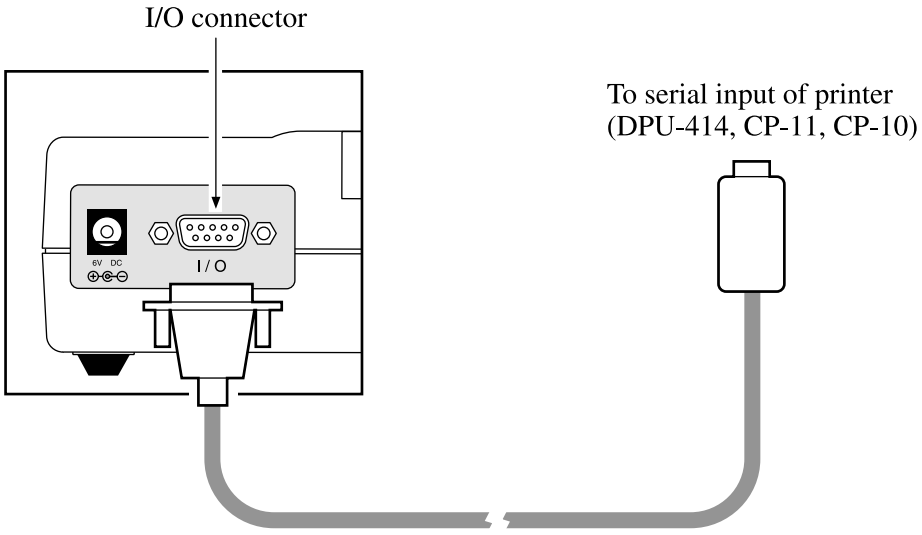


b) Palm position

Connection to a printer (DPU-414, CP-11, CP-10)

The printer is optional.

Use a commercially available serial cable (straight cable) to connect the I/O connector on the side of the VM-54 to the serial input of the printer (DPU-414, CP-11, CP-10).



Cable:	Straight serial cable (commercially available)
Connector on VM-54:	D-sub 9-pin male
Connector on printer:	D-sub 25-pin female (For DPU-414, conversion adapter supplied with DPU-414 must be used.)

Setting the VX-54WH for the connection with DPU-414

Use the menu 3/5 to set the baud rate of this unit to 19200 bps.

Setting the software DIP switches of the DPU-414

Set the power switch to ON while keeping the ON LINE switch.

When printing starts, release the switch. The current settings are printed out.

To choose the “ON” setting, press the ON LINE switch.

To choose the “OFF” setting, press the FEED switch.

You should also refer to the instruction manual for the thermal printer DPU-414.

The procedure for changing DIP switches settings is described below.

Dip SW-1

1 (OFF)	:	Input = Serial
2 (ON)	:	Printing Speed = High
3 (ON)	:	Auto Loading = ON
4 (OFF)	:	Auto LF = OFF
5 (ON)	:	Setting Command = Enable
6 (OFF)	:	Printing
7 (ON)	:	Density
8 (ON)	:	100 %

Dip SW-2

1 (OFF)	:	Printing Columns = 80
2 (ON)	:	User Font Back-up = ON
3 (ON)	:	Character Select = Normal
4 (ON)	:	Zero = Normal
5 (ON)	:	International
6 (ON)	:	Character
7 (ON)	:	Set
8 (ON)	:	=Japan

Dip SW-3

1 (ON)	:	Data Length = 8 bits
2 (ON)	:	Parity Setting = No
3 (OFF)	:	Parity Condition = Even
4 (OFF)	:	Busy Control = XON / XOFF
5 (OFF)	:	Baud
6 (ON)	:	Rate
7 (ON)	:	Select
8 (OFF)	:	= 19200 bps
Continue ?	:	Push'-line SW'
Write ?	:	Push' Paper feed SW'

DIP SW setting complete !!

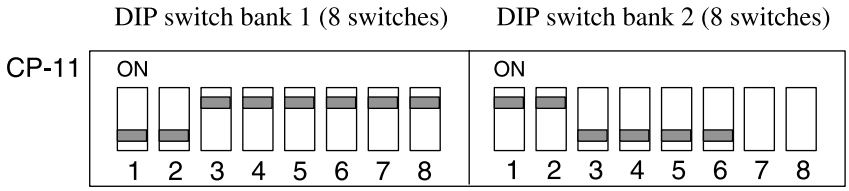
For details, please refer to the Instruction manual of the DPU-414.

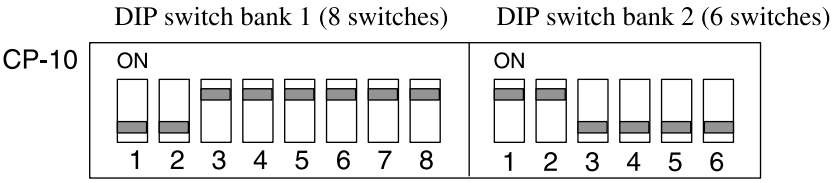
Setting the VX-54WH for the connection with CP-11/CP-10

Use the menu 3/5 to set the baud rate of this unit to 9600 bps.

Setting the DIP switches of the CP-11/CP-10

Set the DIP switches show below.



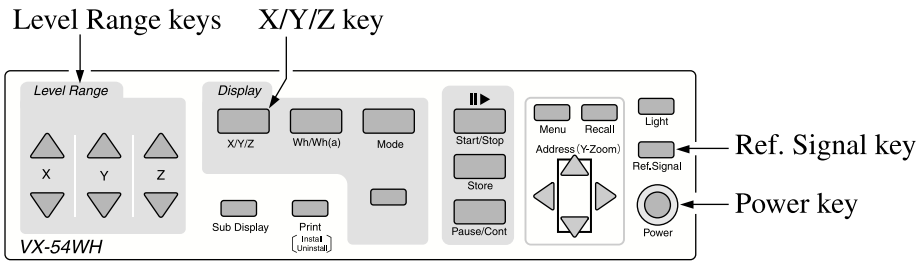


Important
Switches 7 and 8 of DIP switch bank 2 of printer CP-11 are set at the factory and should not be changed. Otherwise correct printing may not be possible.

Supplying a reference signal to external equipment

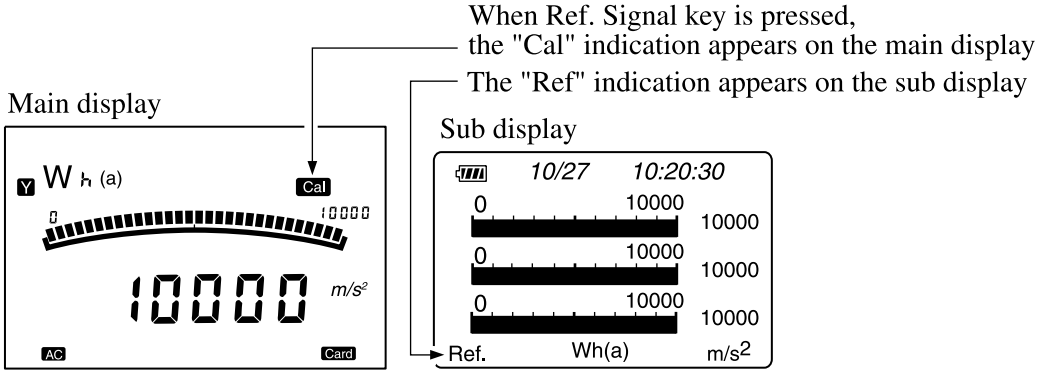
Before recording measurement values on external equipment, supply a reference signal as follows.

1. Press the Power key to turn the unit on.



2. Press the Ref. Signal key.
   The main display and sub display show the reference signal output screen.
   On the main display, you can use the X/Y/Z key to switch the vibration axis for checking.
   The sub display is fixed to the 3-axis bar graph screen, which lets you check all three axes simultaneously.

Note
While the reference signal is being output, the level range cannot be changed.



Reference signal output screen example

During reference signal output, the Output connectors carry the following signal, which corresponds to the range full-scale output.

79.58 Hz, 1 Vrms (AC)

Use this signal to calibrate an external device such as a level recorder or analyzer that is to be used for measurement.

3. Press the Ref. Signal key once more to cancel the reference signal output screen.

Note
When the level range setting is a "3" sequence (0.03, 0.3, 3 etc.), the range full scale value is 0.031624, 0.31624, and 3.1624 respectively.

Reading the Displays

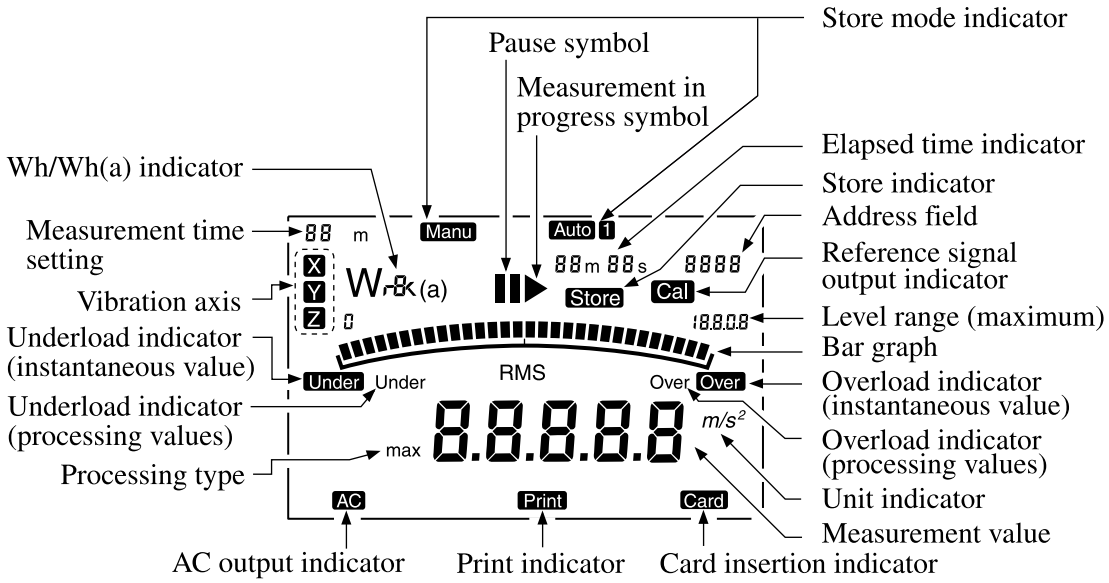
The VM-54 has two LCD panels. The left-side panel is the main display and the right-side panel is the sub display.

The main display shows the measurement value (instantaneous value, processing value) for the selected vibration axis (X, Y, Z), as well as setting information.

For the sub display, 3-axis bar graph, 3-axis numeric screen, menu screens, and recall screen can be selected, depending on the measurement mode.

Main display

The illustration below is for demonstration purposes only. In actual use, not all display elements will be visible at the same time.



Pause symbol

Appears when the unit is in pause mode.

Measurement in progress symbol

Flashes during measurement.

Store mode indicator

The indication **Manu** appears here during manual store.

The indication **Auto** **1** appears here during auto store.

Elapsed time indicator

Shows the elapsed time during measurement.

Store indicator

Appears when data are being stored on memory card.

Address field

Shows the address. Not shown during auto store.

Reference signal output indicator

Appears when the Ref. Signal key was pressed and the reference signal is being output.

Level range (maximum)

Shows the maximum (full-scale) value for the bar graph, as set with the level range keys.

When the level range setting is a "3" sequence (0.03, 0.3, 3 etc.), the range full scale value is 0.031624, 0.31624, and 3.1624 respectively.

Bar graph

A bar graph corresponding to the measurement value is shown here. The display is based on the exponential average using a time constant of 1 second, and the display update frequency is 100 ms.

Overload indicator (instantaneous value)

Appears when overload in the instantaneous value was detected.

Overload indicator (processing values)

Appears when overload during processing was detected. The indication remains on until the start of the next processing measurement.

Unit indicator

Shows the unit.

Acceleration: m/s^2

Measurement value

The measurement result is shown here. The display update frequency is 1 s. The indication represents the RMS value of the instantaneous value with $\tau = 1$ s.

Card insertion indicator

Appears when a memory card is inserted in the card slot.

Print indicator

Flashes while data are being sent to the printer.

AC output indicator

Shows that the outputs supply an AC signal.

Processing type

Shows the kind of processing function that has been selected with the Mode key.

RMS: RMS value of measurement interval (measurement duration governed by processing function)

max: Maximum value (MTVV) of instantaneous value (RMS with $\tau = 1$ s) within measurement time

Underload indicator (processing values)

Appears when underload during processing was detected. The indication remains on until the start of the next processing measurement.

Underload indicator (instantaneous value)

Appears when underload in the instantaneous value was detected.

Vibration axis

Shows which vibration axis is currently selected for measurement value display.

The axis is selected with the X/Y/Z keys.

Measurement time setting

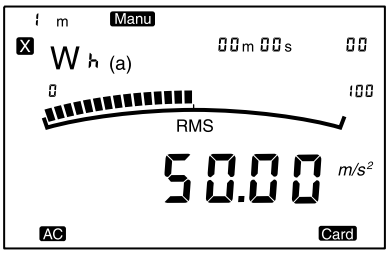
Shows the time set with the "Meas. Time" item on menu screen 1/5.

For settings of 30 seconds and under, only the numerals are shown.

Wh/Wh(a) indicator

Wh: Frequency weighting characteristics

Wh(a): Bandwidth limiting filter of frequency weighting characteristics

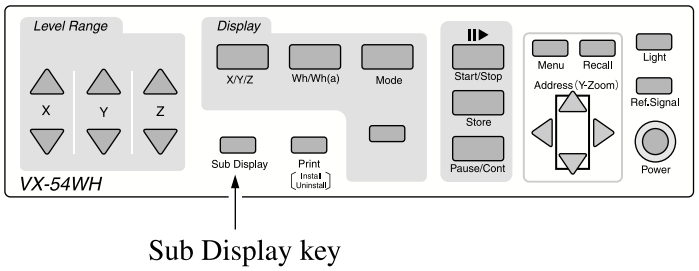


Main display screen example

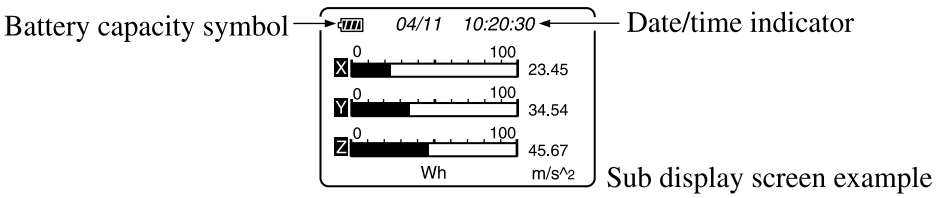
Sub display

The sub display employs a dot-matrix type LCD which allows various display functions.

The Sub Display key serves to switch between these functions. The screen also changes according to the operation mode.



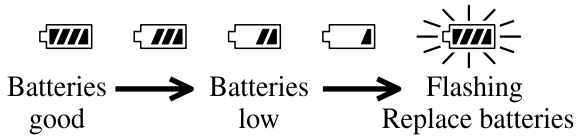
The battery capacity and date/time indications also appear on the sub display.



Battery capacity indication

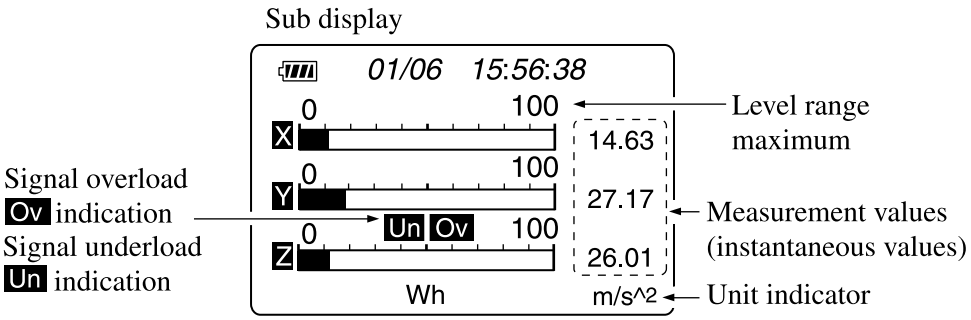
When the unit is operating on battery power, you should periodically check the battery capacity indicator. The number of black segments decreases as the batteries get weaker. When the display starts to flash, correct measurement is no longer possible. Replace the batteries with a fresh set.

While the unit is powered from the AC adapter, the battery capacity indication is always at maximum.



3-axis bar graph display

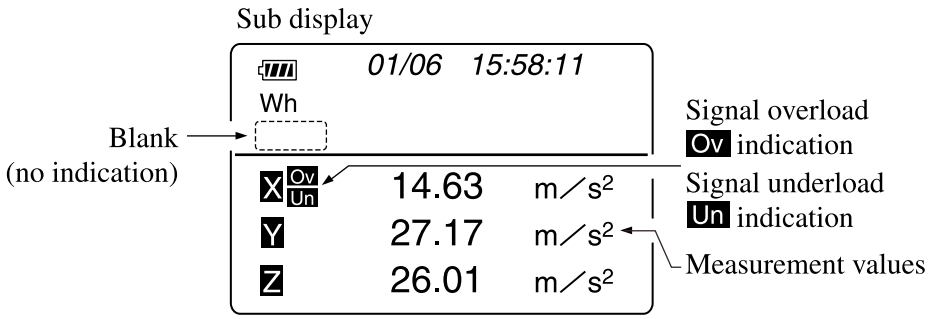
This screen shows bar graphs for all three axes and the instantaneous values simultaneously. Processing values are not shown.



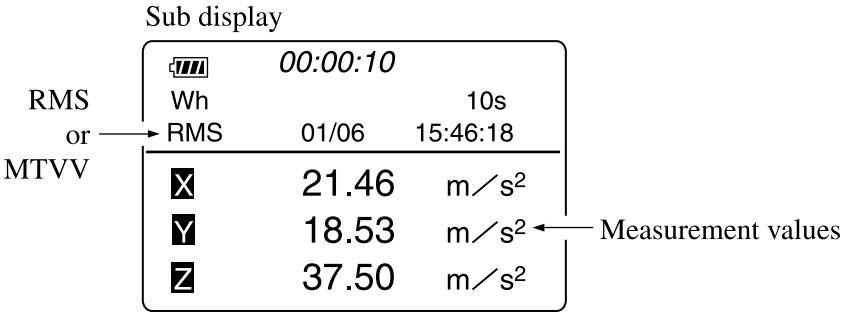
3-axis bar graph screen example

3-axis numeric screen

The measurement values for the 3 vibration axes are shown as a numeric readout. The Mode key serves to switch between instantaneous value and processing values (RMS, MTVV).



3-axis numeric screen example
(instantaneous value)



3-axis numeric screen example
(processing value)

Blank: RMS of instantaneous value (τ = 1 s)

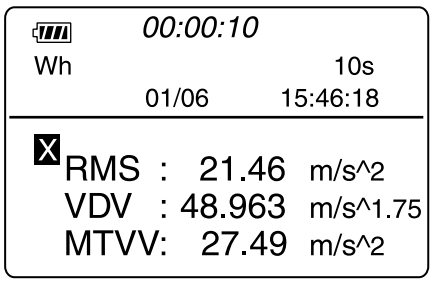
RMS: RMS value of measurement interval (measurement duration governed by processing function)

MTVV: Maximum of instantaneous value (RMS with τ = 1 s) within measurement time

Processing value display

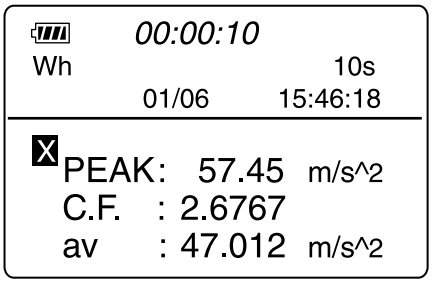
Shows the processing values for the selected channel.

Sub display



Processing value screen example

Sub display



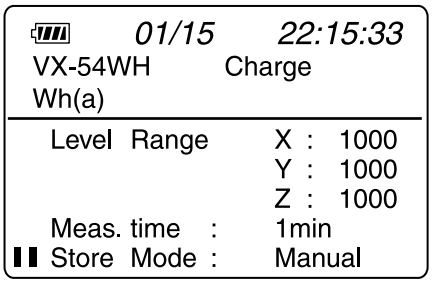
Processing list screen example

Note
Unless the Start/Stop key is pressed, the processing value display will be zero.

Settings screen

The settings for sensor, level range etc. are shown on this screen, for confirmation.

Sub display



Settings screen example

Menu screens

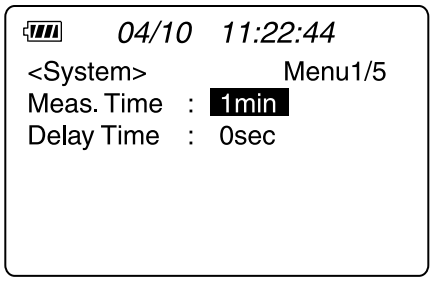
The VM-54 has five menu screens which are shown on the sub display and which are numbered 1/1 to 5/5. The Menu key lets you cycle through the screens.

To select an item on a menu screen, you use the ▲ and ▼ keys.

To change the setting of an item, you use the ◀ and ▶ keys.

Menu screen 1/5

Sub display



Menu screen 1/5

Meas. Time (Measurement time)

Selects the measurement time. Available settings are 1 to 30 seconds in 1-second steps, 1 minute, 10 minutes, 30 minutes, 1 hour, 4 hours, 8 hours, and 12 hours.

Regardless of the measurement time setting, the Start/Stop key can always be used to stop the measurement before the end of the measurement time.

Delay Time

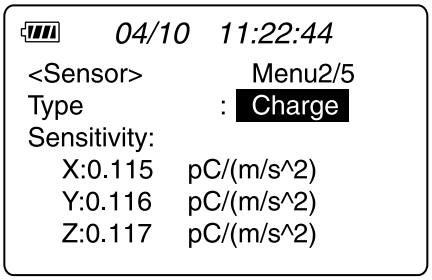
Selects the delay between pressing the Start/Stop key and the actual start of processing or auto store. Available settings are 0 seconds, 10 seconds, 30 seconds, and 1 minute.

For example, when the delay time is set to 10 seconds, processing or auto store will start 10 seconds after the Start/Stop key was pressed.

During the delay (standby) interval, the main display counts down the remaining time until the start.

Menu screen 2/5

Sub display



Menu screen 2/5

Type (accelerometer type)

Selects the connected accelerometer.

Charge: Charge output type piezoelectric accelerometer is connected.

CCLD: An accelerometer with built-in preamplifier is connected.

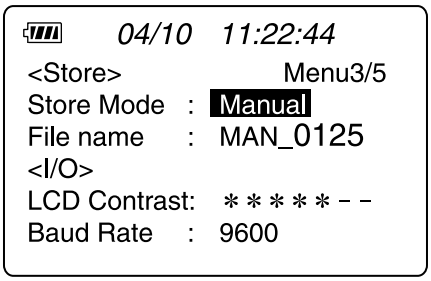
Note
If the accelerometer type has been set incorrectly, correct measurement is not possible. Be sure to check this setting before starting a measurement.
When using the VP-80 (optional), check the position of the Charge switch on the VP-80.

When the Charge or CCLD position is selected, the sensitivity setting must be made for the respective channels.

Important
When the Charge position is used and the slide switch on the VP-80 is set to "×0.1", set the sensitivity item to 1/10 of the rated accelerometer sensitivity. Example: An accelerometer rated for 5.00 pC/m/s^2 is used and the slide switch of the VP-80 is set to ×0.1. Enter "0.500 pC/m/s^2" as sensitivity value.

Menu screen 3/5

Sub display



Menu screen 3/5

Store Mode

This shows the store mode (Manual/Auto1).

File name

A four-digit number can be specified as file name. The setting is changed two digits at a time.

LCD Contrast (Sub display contrast)

The number of asterisks (∗) corresponds to the contrast setting.

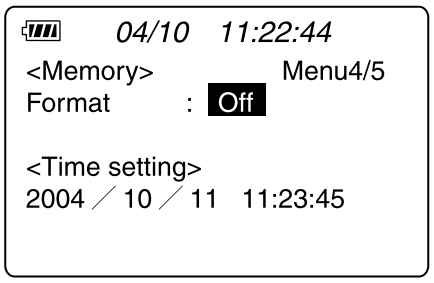
Baud Rate (Printer transfer speed)

Sets the speed for data transfer to a printer.

Available settings are 4800 bps, 9600 bps, and 19200 bps.

Menu screen 4/5

Sub display



Menu screen 4/5

Format

When a memory card is inserted, this option clears all data on the card. (This does not perform a physical format.) See "Clearing data stored on memory card" on page 57.

Time setting (Date/time setting)

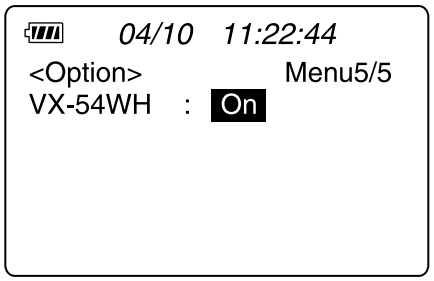
Lets you set the year, month, day, hours, minutes, and seconds.

When you press the Start/Stop key, the internal clock is set to the selected date and time and starts to run.

Even if a wrong setting is made, it will not become active unless the Start/Stop key is pressed.

Menu screen 5/5

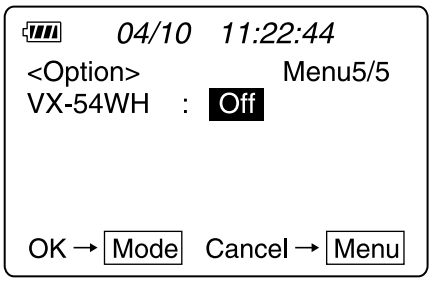
Sub display



Menu screen 5/5

Use the ◀ or ▶ key to set the VX-54WH option to On or Off. The display changes as follows.

Sub display



Menu screen 5/5

Off: The 3-Axis Vibration Meter VM-54 will start up with its standard program.
If this is the setting you want, press the Mode key. (See next page.)

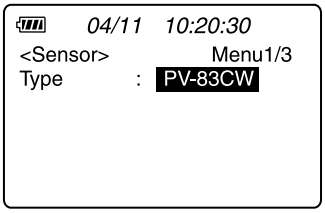
To cancel the setting, press the Menu key.

Note
When you change from the VX-54WH to the VM-54 standard program, or from the VM-54 to the VX-54WH program, level range and other settings will be initialized.

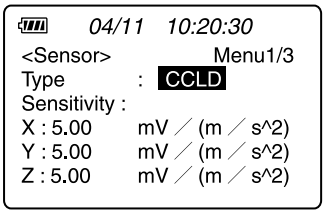
When the "VX-54WH" item was set to Off and the Mode key was pressed to start the 3-Axis Vibration Meter VM-54 with its standard program, the menu configuration will be as shown below.

On menu screen 3/3, setting the "VX-54WH" item to On and pressing the Mode key will cause the unit to revert to the original VX-54WH program after the initialization screen is shown.

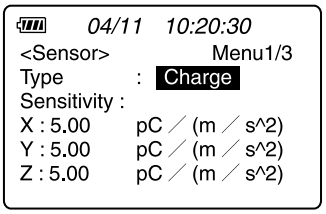
3-Axis Vibration Meter VM-54 menu screens



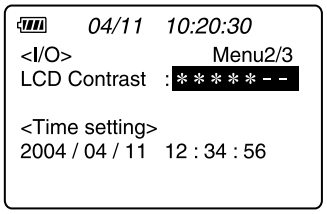
Menu screen 1/3



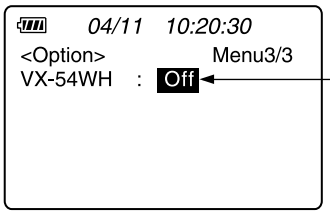
Menu screen 1/3



Menu screen 1/3



Menu screen 2/3



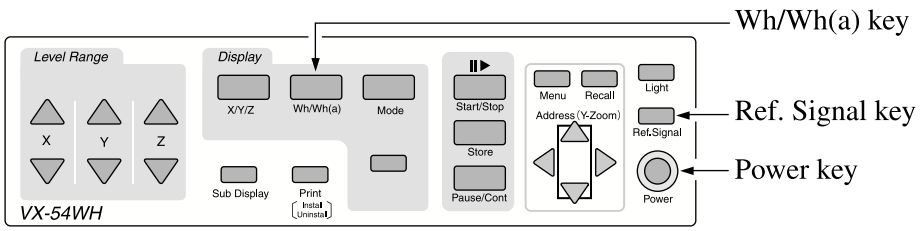
Set to "On" and press Mode key to start VX-54WH program

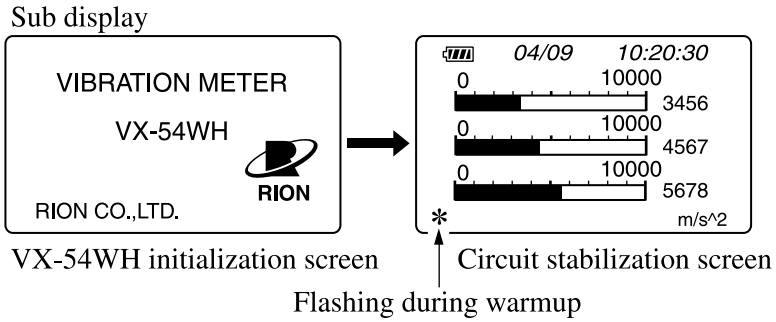
Menu screen 3/3

Power-On/Off

Power-on

Hold down the Power key for about 1 to 2 seconds until the sub display shows the power-on screen. When the screen appears, release the Power key.
The initialization screen is shown, followed by the circuit stabilization screen. Then the measurement screen appears.

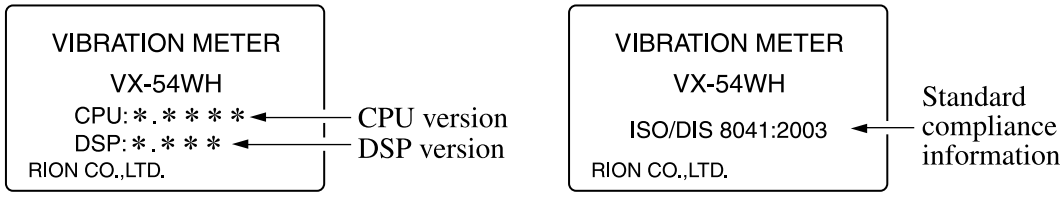




Note
During initialization and circuit stabilization, the * symbol in the lower left corner of the sub display flashes (for about 30 seconds). The interval between power-on and the condition where regular measurement is possible is called the warmup time.

If you press the Ref. Signal key immediately after pressing the Power key, CPU and DSP version information is shown for several seconds, and then the circuit stabilization screen appears.

If you press the Wh/Wh(a) key immediately after pressing the Power key, standard compliance information is shown.



Power-off

Hold down the Power key for about 1 to 2 seconds until the sub display shows the power-off screen. When the screen appears, release the Power key.

Sub display screen during power-off

Note
After turning the unit off, wait at least 5 seconds before turning power back on again.

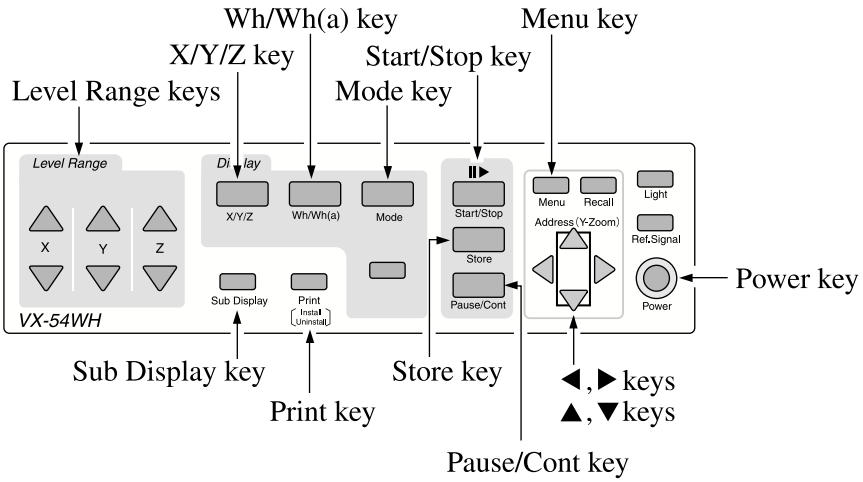
Measurement

Manual store

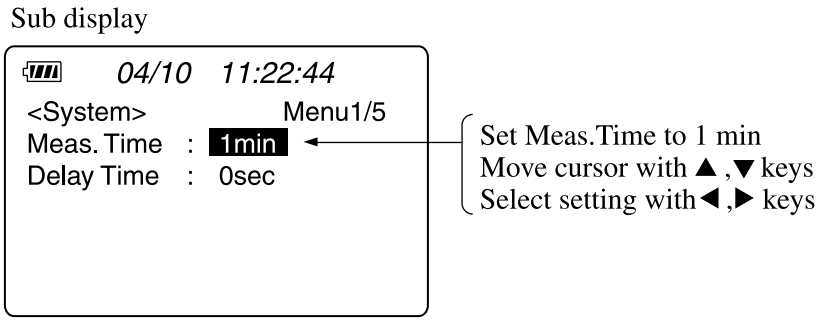
The following items are measured for a preset measurement time: RMS, max (MTVV), VDV, PEAK, C.F., av. The measurement covers three vibration axes simultaneously.

The explanation assumes that preparations for measurement have been completed, and that the piezoelectric accelerometer PV-97C is used as sensor. If wishing to store data on memory card, insert a memory card before turning power to the unit on.

1. Press the Power key to turn the unit on.

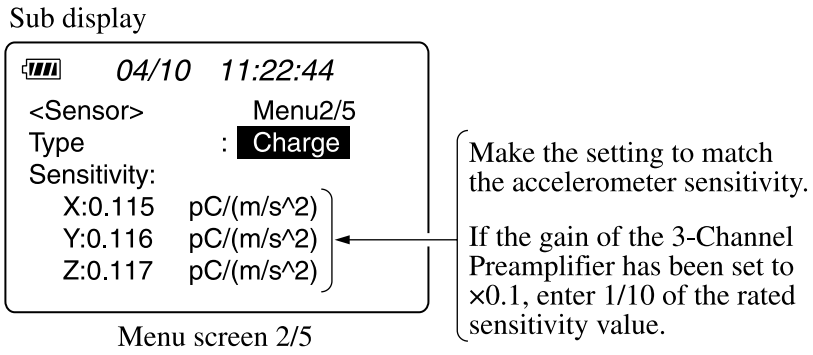


2. Press the Menu key to call up menu screen 1/5.
3. Set the "Meas. Time" (measurement time) item to "1 min".
4. Make the "Delay Time" setting.



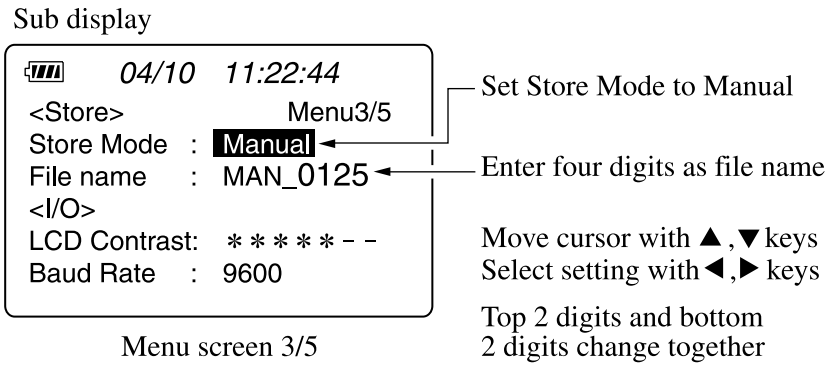
Menu screen 1/5

5. Press the Menu key to call up menu screen 2/5.
6. Set the Sensor "Type" item to "Charge".
   Verify that the VP-80 and PV-97C are connected to the Input connector.



Menu screen 2/5

7. Press the Menu key to call up menu screen 3/5.
   Set the "Store Mode" item to Manual.
   When wishing to save the data, assign a file name.



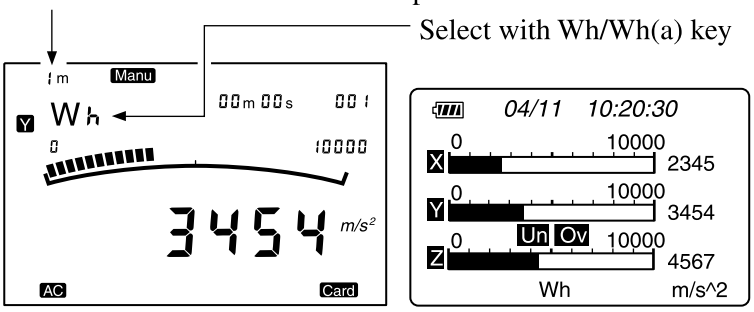
Menu screen 3/5

8. Close the menu screen and go to the instantaneous value measurement screen by pressing the Mode key.
9. Use the Sub Display key to select the screen to be shown on the sub display. Normally, select the 3-axis bar graph screen.
10. Use the Wh/Wh(a) key to select the frequency weighting characteristics.
    Wh: Selected frequency weighting characteristics apply
    Wh(a): Only bandwidth limiting filter of selected frequency weighting characteristics applies

Note
Wh and Wh(a) cannot be measured simultaneously.

Shows measurement time selected in step 3

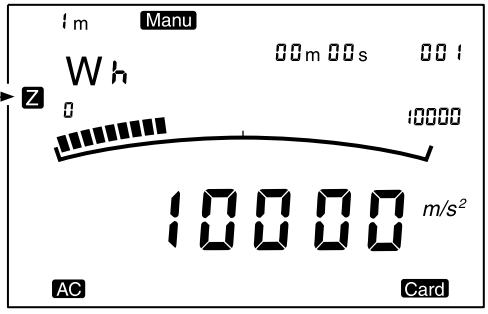
Select with Wh/Wh(a) key



Main display Sub display

11. Use the X/Y/Z key to select the vibration axis to be shown on the main display.

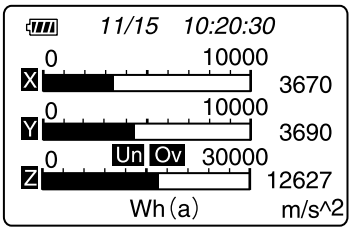
Select vibration axis with X/Y/Z key



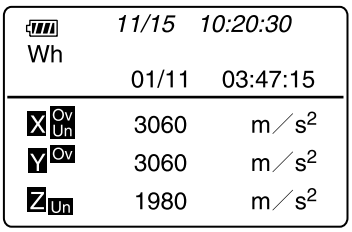
Main display

12. Use the Level Range keys to select the level range. If Ov (Over) or Un (Under) is displayed, change the level range setting.
    The level range setting affects the 3-axis bar graph screen.

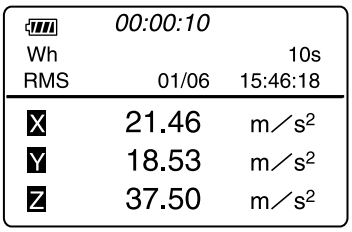
Sub display



3-axis bar graph screen example



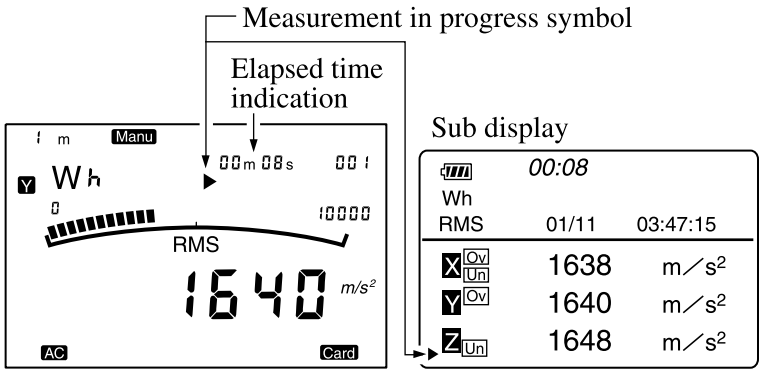
3-axis numeric screen example
(instantaneous value)



3-axis numeric screen example
(processing value)

13. When you press the Start/Stop key, processing starts. At the same time, the sub display switches to the 3-axis numeric screen showing RMS values. During processing, the ▶ symbol flashes and the elapsed time is displayed. When the measurement time set in step 3 has elapsed, the measurement is terminated automatically. It is also possible to stop the measurement before that by pressing the Start/Stop key.

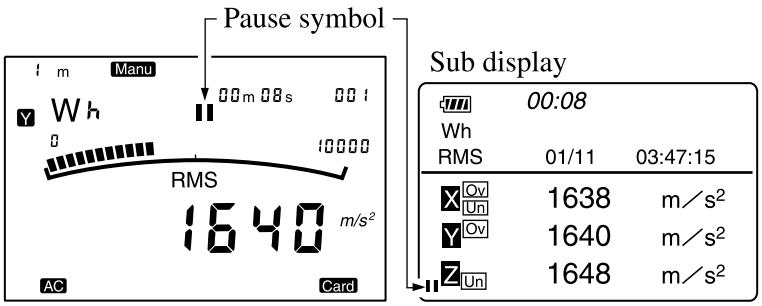
Note
When a processing measurement is started, previous processing data are cleared.
When a delay time was set, a countdown to the actual start of measurement appears on the main display.



Main display

3-axis processing value numeric screen (RMS)

Note
Pause By pressing the Pause/Cont key during measurement, you can interrupt and resume the measurement. While the unit is in pause mode, a pause symbol (❚❚) is shown.

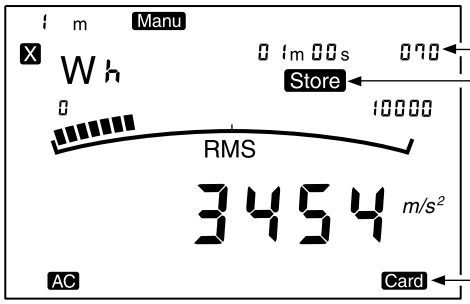


Main display

14. Use the Mode key or the Sub Display key to switch between RMS, MTVV (max), and processing list screen.
    If "Ov" (Over) is shown, the result comprises overload data. If "Un" (Under) is shown, the result comprises underload data.

Note
During processing, the effective value (RMS) for the measurement time is measured, along with the maximum value (MTVV), VDV, Peak, Crest Factor, and av for the three vibration directions. The Mode key can be used to switch between these.
Overload or underload for the instantaneous value is shown as Over, Under, Ov, or Un. If Overload or underload is included in the measurement result, this is shown as [Over], [Under], [Ov], or [Un].

15. To store measurement data, press the Store key. The indication Store appears on the main display, and the 3-axis processing result data (RMS, MTVV (max), VDV, PEAK, C.F., av) are stored instantly on the memory card. If no memory card is inserted, data are not stored.
For details on storing data, see the section "Memory Card" on page 51.



Main display

Note
The address setting range for each file is 1 to 100. If an address with existing data is specified, data will be overwritten. To prevent losing data that you want to keep, change the file name and address specification.
If the store procedure is carried out while processing is stopped with the Start/Stop key, only the instantaneous value data are stored. The processing value fields are all zero.
The stored data are the instantaneous value and processed value reflecting the selected frequency weighting characteristics.

Auto store

Measurement with auto (Auto1) store

In this mode, the RMS, PEAK, C.F., VDV, and av values for the three axes are stored on the memory card, using a sampling period of 1 second.

The piezoelectric accelerometer PV-97C is used as sensor.

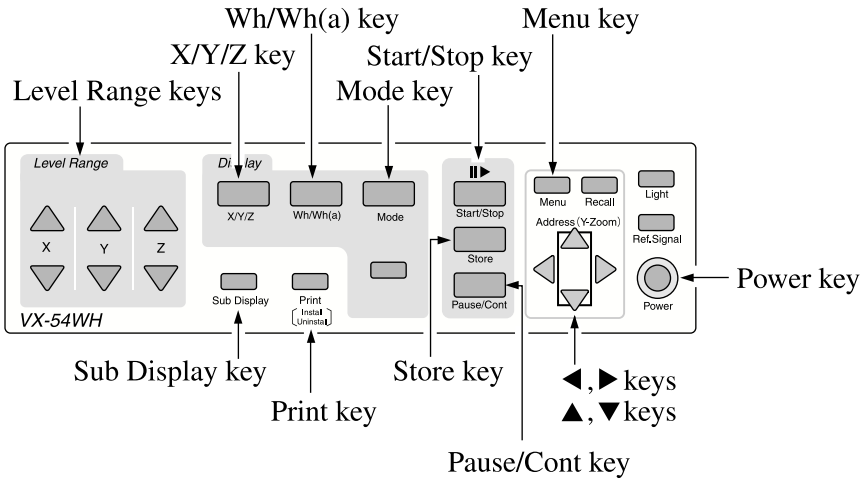
When the measurement time is set to "1 min", the RMS, PEAK, C.F., VDV, and av values for one minute are stored on the memory card.

The explanation assumes that preparations for measurement have been completed.

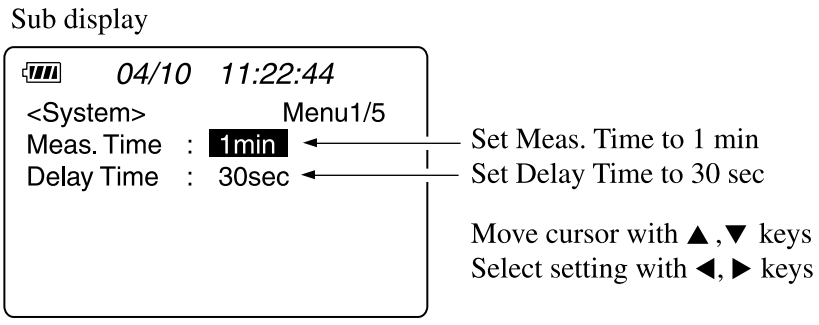
Insert the memory card before turning power on.

Important
If the power is cut off during the storing process, data on the CF card may be corrupted. By keeping fresh batteries in the unit also while it is being powered from the AC adapter, you can have the batteries act as a backup power supply in case the AC power is interrupted.
When formatting a CF card whose data were corrupted, be sure to use FAT 12/16 formatting and perform a Scandisk operation in the computer. Otherwise data stored later will also be corrupted.

1. Press the Power key to turn the unit on.
2. Press the Menu key to call up menu screen 1/5.



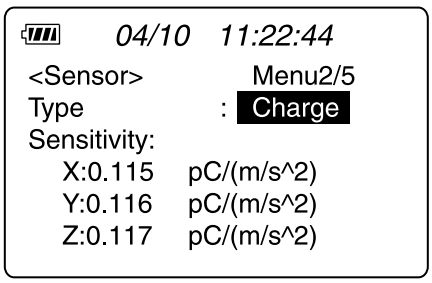
3. Set the Meas. Time (measurement time) to "1 min" for this example. Also set a Delay Time, using "30 sec" for this example. The Delay Time item specifies the interval until the actual start of auto store. Select the Freq. Weight (frequency weighting) setting for each channel.



Menu screen 1/5

4. Press the Menu key to call up menu screen 2/5.
5. Set the Sensor "Type" item to "Charge".
   Verify that the 3-Channel Preamplifier VP-80 and the piezoelectric accelerometer PV-97C are connected to the Input connector.
   If the slide switch of the 3-Channel Preamplifier VP-80 has been set to ×1, use the rated sensitivity of the accelerometer to set the Sensitivity value. If the setting is ×0.1, use 1/10 of the rated sensitivity to set the Sensitivity value.

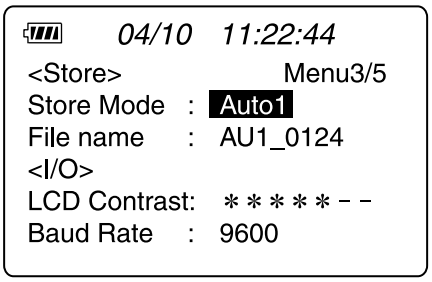
Sub display



Menu screen 2/5

6. Press the Menu key to call up menu screen 3/5.
   Set the "Store Mode" item to Auto1 and assign a file name.
   The file name can be any four-digit number.

Sub display



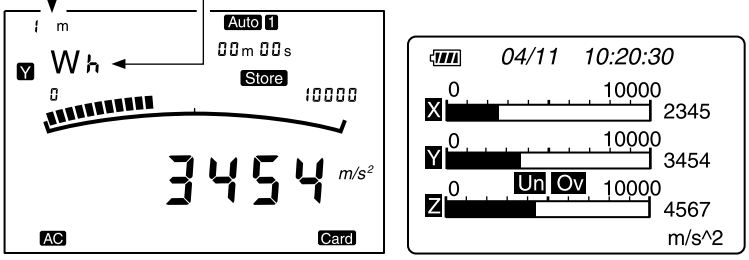
Menu screen 3/5

7. Close the menu screen and go to the instantaneous value measurement screen by pressing the Mode key.
8. Use the Sub Display key to select the screen to be shown on the sub display. Normally, select the 3-axis bar graph screen.

9. Use the Wh/Wh(a) key to select the frequency weighting characteristics.
   Wh: Selected frequency weighting characteristics apply
   Wh(a): Only bandwidth limiting filter of selected frequency weighting characteristics applies

Measurement time as set in step 3 is shown

Select with Wh/Wh(a) key

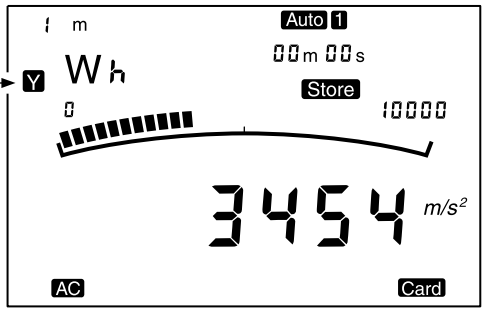


Main display Sub display

Note
Wh and Wh(a) cannot be measured simultaneously.

10. Use the X/Y/Z key to select the vibration axis to be shown on the main display.

Use X/Y/Z key to select vibration axis for display



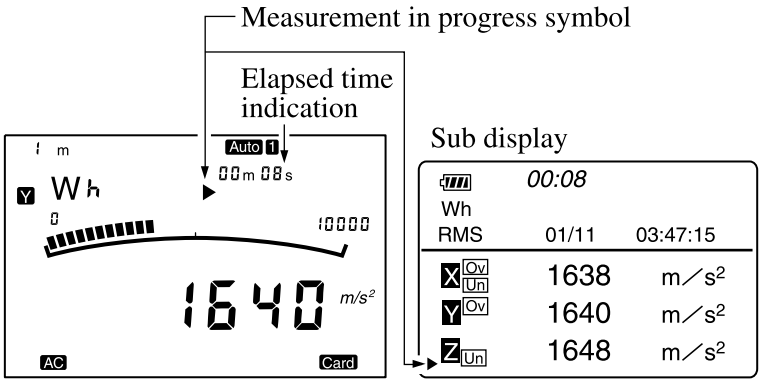
Main display

11. Use the Level Range keys to select the level range. If Ov (Over) or Un (Under) is displayed, change the level range setting.
    The level range setting affects the 3-axis bar graph screen.

12. When you press the Store key, auto store is initiated. Actual operation starts after the delay time has elapsed.
    When auto store starts, the sub display switches to the 3-axis numeric screen showing RMS values.
    During auto store, the measurement in progress (▶) symbol and the Store indicator are flashing. When the measurement time set in step 3 has elapsed, the measurement is terminated automatically. It is also possible to stop the measurement before that by pressing the Start/Stop key.

Note
If a store data file with the same name already exists, the confirmation message "Same file exists!! Overwrite?" appears.

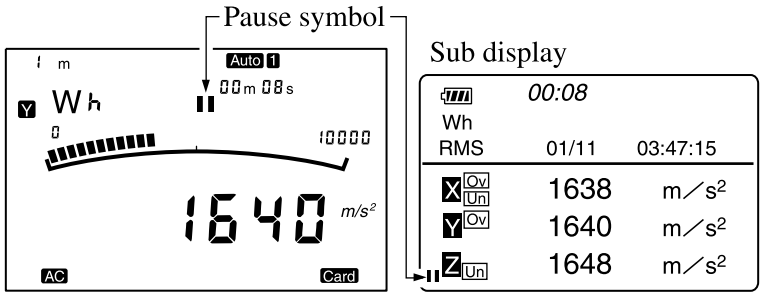
Note
When a delay time was set, a countdown to the actual start of auto store appears on the main display.



Main display

3-axis processing value numeric screen (RMS)

Note
Pause By pressing the Pause/Cont key during measurement, you can interrupt and resume the measurement. While the unit is in pause mode, a pause symbol (❚❚) is shown.



Main display

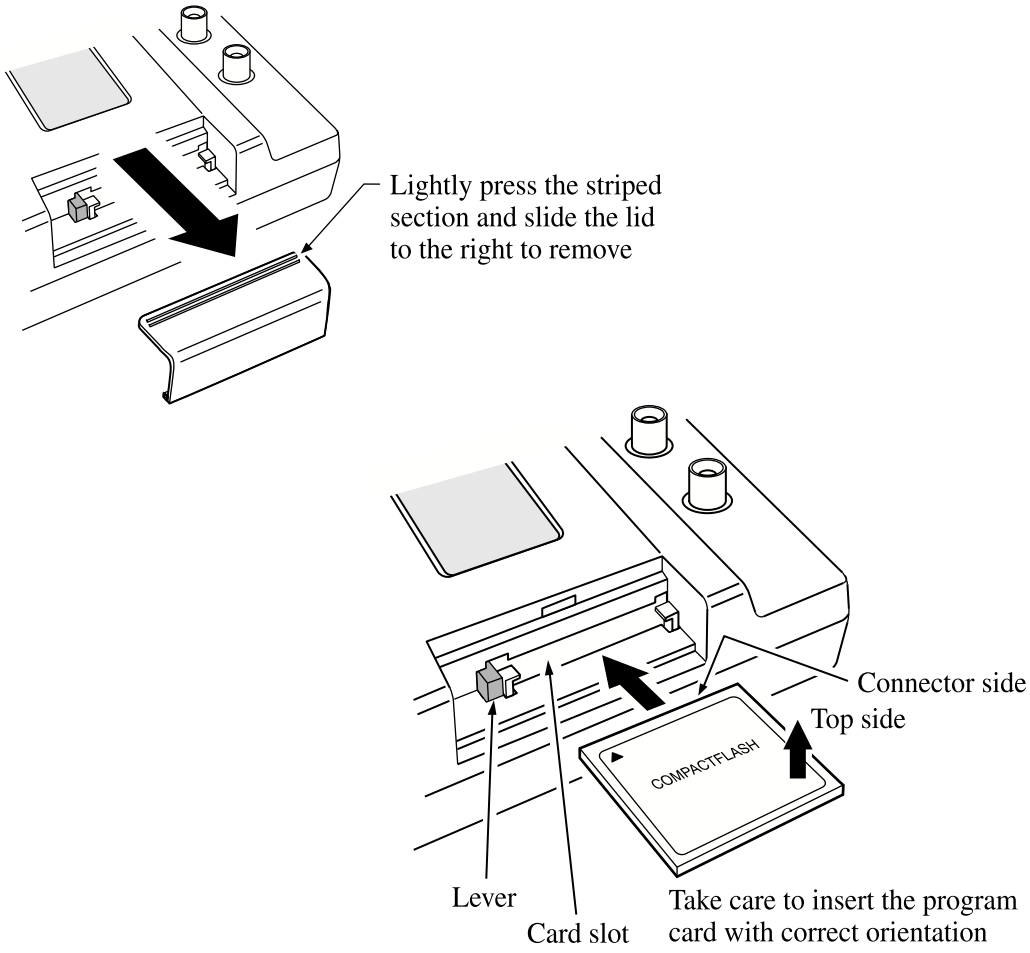
Memory Card

Inserting and removing the memory card

Open the cover of the card slot and insert the memory card.

To remove, press the lever in until the card pops out.

Important
Make sure that power is turned off before inserting or removing the card.



To remove the program card, press the lever.

Storing

The VX-54WH allows Auto1 store and manual store (instantaneous value and processing value data at the store point). During manual store, one file can contain up to 100 data sets and takes up about 40 kB.
In Auto1 store mode, store data for 12 hours will take up about 6 MB.

Memory cards

For this unit, you should use the memory cards that are optional from Rion.

The type of memory card used in the unit is called CompactFlash™ card.

Memory cards even from the same manufacturer and of the same type can differ in specifications. Some memory cards may therefore not function properly in the unit. Be sure to use memory cards supplied by Rion.

Note
Do not format the memory card in a computer.

Memory card store data format

The data stored on the memory card are in CSV format. A structure of folders and files is created on the memory card.

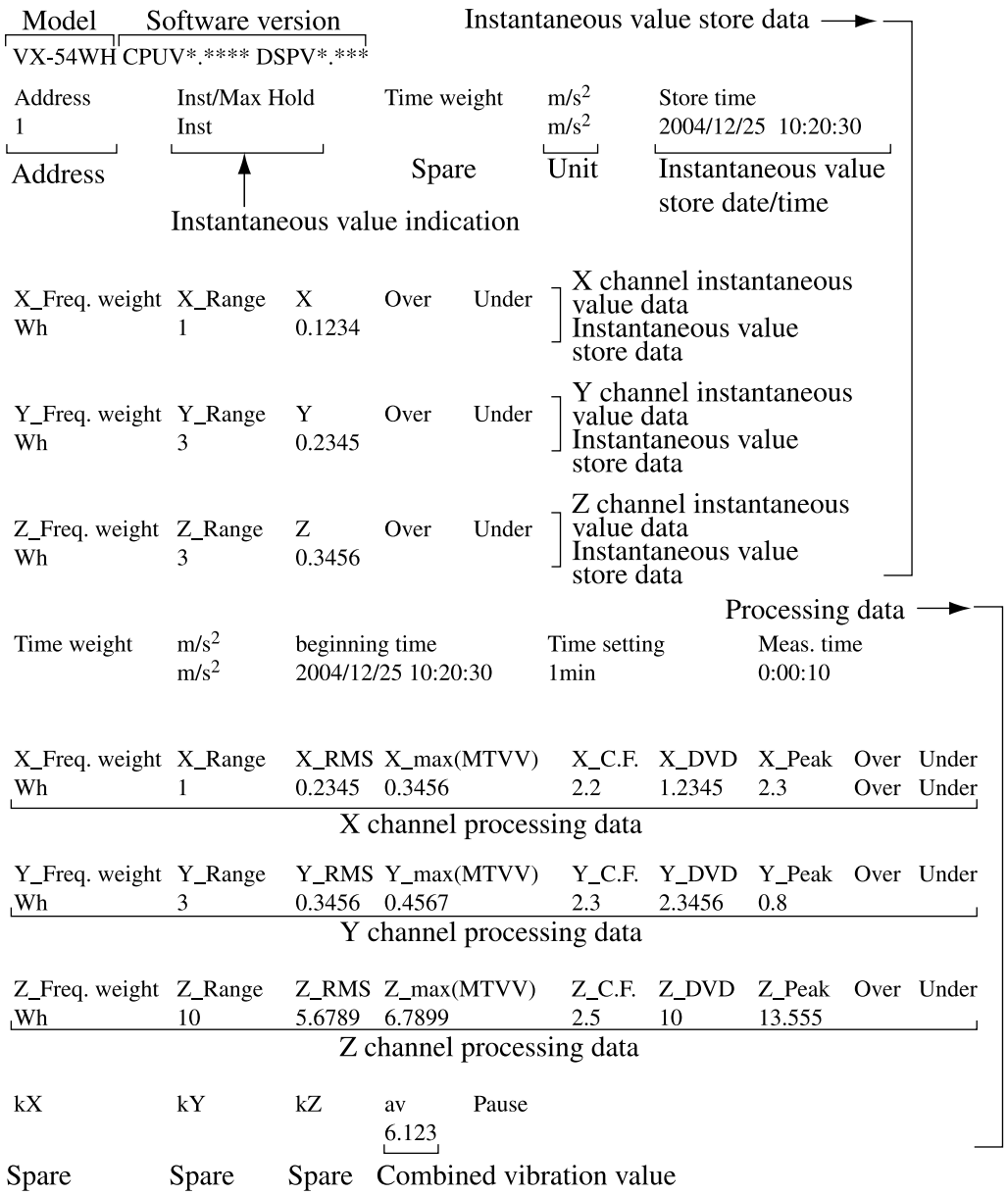
The file and folder structure is as shown below.

Manual store

CompactFlash card — \VX54WH— \MAN_**** — MAN_****.csv
(Memory card)

**** stands for a number specified via a menu item

File description



Auto1 store
CompactFlash card — \VX54WH — \Au1_**** ┬ Au1_0000 . csv
(Memory card) └ Au1_head . csv

**** stands for a number specified via a menu item

File description

X_RMS(1s)	X_C.F.	X_VDV	X_Peak	X_Over	X_Under
0.3456	1.5	0.4567	0.5201		
0.4567	1.6	0.5678	0.7070	Over	
0.5678	1.7	0.6789	0.9654		Under

X channel 1 second data

Y_RMS(1s)	Y_C.F.	Y_VDV	Y_Peak	Y_Over	Y_Under
0.4567	1.6	0.5678	0.7070		
0.5678	1.7	0.6789	0.9654		
0.3456	1.5	0.4577	0.5233		

Y channel 1 second data

Z_RMS(1s)	Z_C.F.	Z_VDV	Z_Peak	Z_Over	Z_Under	av	Pause
0.5678	1.7	0.6789	0.9652			0.789	
0.3456	1.5	0.4567	0.52			0.5678	
0.4567	1.6	0.5678	0.731			0.6789	

Z channel 1 second data Combined vibration value Pause information

Header

VX-54WH		Model
V*.****		Software version
V*.***		Software version
File name	Au1_****	File name
File number	1	File number
Data number	55	Data number
X_Range	3000	X channel level range
Y_Range	100	Y channel level range
Z_Range	30	Z channel level range
X_Frequncy-weight	Wh	X channel frequency weighting
Y_Frequncy-weight	Wh	Y channel frequency weighting
Z_Frequncy-weight	Wh	Z channel frequency weighting
kX		Spare
kY		Spare
kZ		Spare
Time setting	10min	Selected measurement time
Measurement time	0:00:55	Actual measurement time
Sampling	1	Sampling time (s)
Start Time	2004/1/1 8:30:00	Store start time
Stop Time	2004/1/1 8:30:55	Store end time

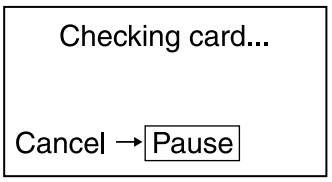
Reading and Writing Memory Card Data

Reading data stored on memory card

Data stored on the memory card can be called up on the sub display as follows. Make sure that the memory card is inserted in the card slot of the VM-54.

1. Turn power on.
2. Press the Recall key.
   The message "Checking card" appears, and then the card recall menu is shown on the sub display.

Sub display

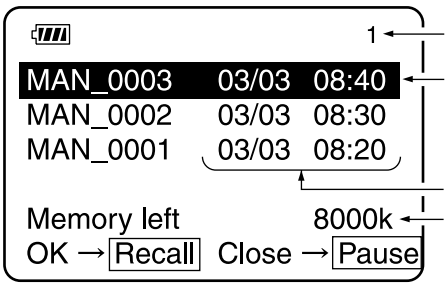


Flashes while memory card data are read
(Duration depends on memory card data volume)

Note
The duration for which the above message is shown depends on the volume of data on the memory card. In some cases, the message may only be shown very briefly.

3. Use the ▲ and ▼ key to change the recall menu page number, until the page with the desired recall data is shown.

Sub display



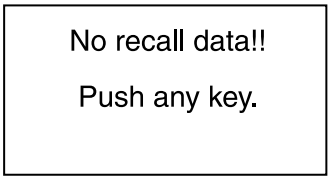
Recall menu page number
Four-digit number shown as memory card file name
Store date/time
Remaining capacity (Byte)

Recall menu screen

Note

When there are no data that can be recalled, the message shown below appears.
Press any key except the Power key to cancel the message.

Sub display

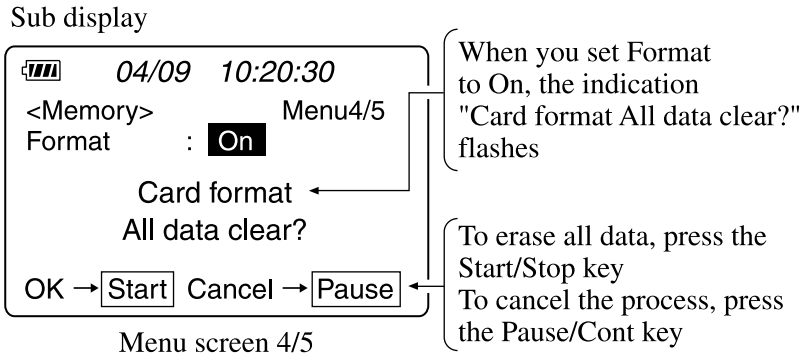


4. Use the ▲ and ▼ keys to select the desired recall data (file name), and press the Recall key.
   The selected recall data are shown on the sub display.
5. Use the ▲ and ▼ keys to select the address number in which the desired data are stored.
   The stored measurement data appear on the sub display.
   If there are no data, "--.-" or "zero" is shown.
6. When recalling data stored in manual mode, use the X/Y/Z key and the Sub Display and Mode keys to select the channel and display the various measurement data.
   When recalling data stored in Auto1 mode, use the X/Y/Z key and the Sub Display key to select the channel and display the various measurement data.
7. To terminate the Recall mode, press the Recall key once more and then press the Pause/Cont key on the recall menu screen.

Clearing data stored on memory card

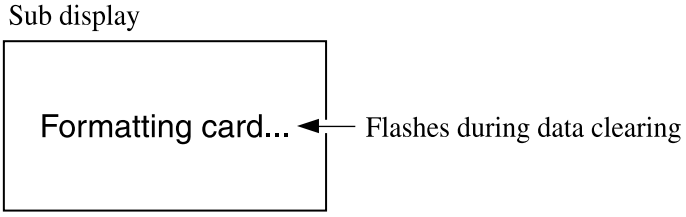
To clear all data stored on a memory card, proceed as follows. Make sure that the memory card is inserted in the card slot.

1. Turn power on.
2. Use the Menu key to bring up a menu screen on the sub display panel.
3. Use the Menu key to bring up menu screen 4/5.



Menu screen 4/5

4. Set the "Format" item to "On".
   If it is OK to proceed with the data clearing process, press the Start/Stop key.



During the clear operation, the message shown below appears.
When the operation is completed, the message disappears and the "Format" item on menu screen 4/5 returns to "Off".

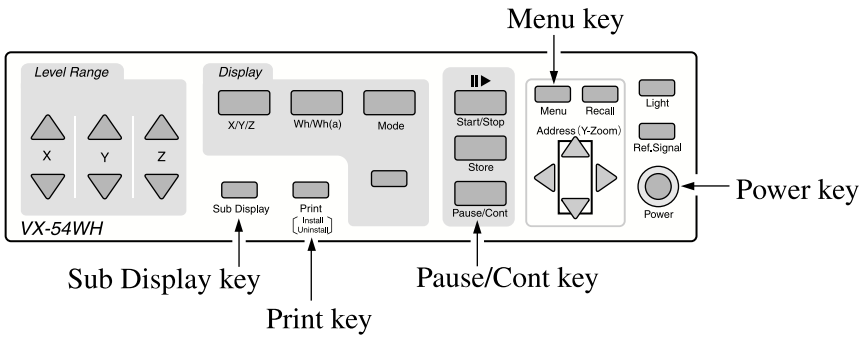
Note
It is not possible to clear only specified address data or specified file data. Only bulk clearing (formatting) of all files on the memory card is possible. This process does not perform a physical format.

Printing

An optional printer (DPU-414, CP-11, or CP-10) can be connected to the unit to produce hard copy of measurement values.
Available functions include printing of instantaneous value data during pause, printing of instantaneous value data and processing result data during processing pause, recall data hard copy printing, and sub display hard copy printing.
For details on using the printer, please refer to the documentation of the respective model. The following explanation assumes that preparations as described in the chapter "Preparations" have been completed.

Sub display hard copy

1. Turn power to the printer on and set it to the online state.
2. Press the Power key of the VM-54 to turn the unit on.
3. Press the Sub Display key to bring up the sub display screen you want to print. You can select the 3-axis bar graph screen, 3-axis numeric screen, processing value screen, or parameter setting check screen.
   If you want to print the menu screen, press the Menu key to bring up the menu screen.
   If you want to print the recall screen, press the Recall key to bring up the recall screen.
4. Press the Pause/Cont key to set the unit to pause mode.
   If the menu screen or recall screen is displayed, this step is not necessary.
5. Press the Print key to produce a hard copy of the sub display screen.



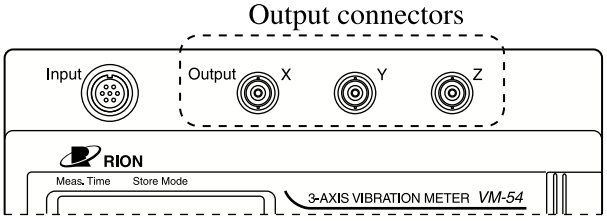
Output Connectors

AC Output

These connectors provide an AC output signal.

Output voltage: 1 Vrms ±20 mVrms (at range full-scale)
Output impedance: approx. 100 Ω
Load impedance: 10 kΩ or higher
Output connector type:
BNC
Suitable cable: BNC-BNC cable NC-39A (1.5 m), optional

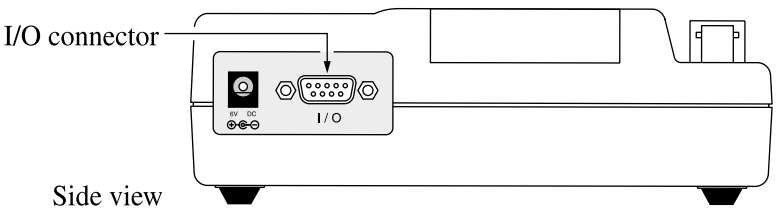
The output in reference signal output mode is 79.58 Hz, 1.0 Vrms. See the section "Preparations" on page 19.



I/O connector

The I/O connector allows data output to a printer.
The specifications for the connection cable are listed below.

Cable type: Generic straight serial cable
Connector on VM-54: D-sub 9-pin male
Connector on printer: D-sub 25-pin female (for DPU-414, using connector supplied with DPU-414)
Compatible printers: DPU-414, CP-11, CP-10 (optional)



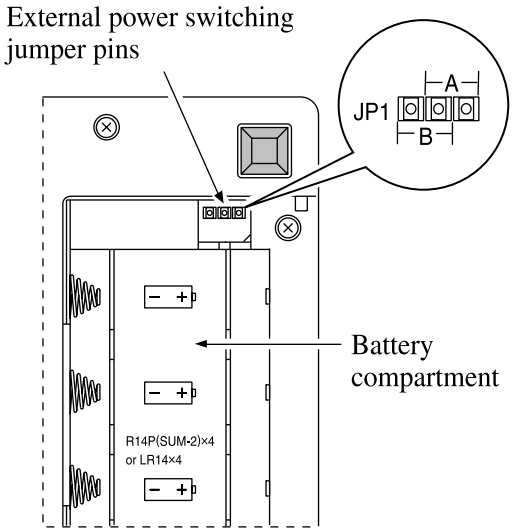
Reference Information

About the external power switching jumper pins

The VM-54 is turned on by holding down the Power key for at least one second, but the on/off status can also be controlled by an external power supply without using the Power key.

Changing the setting of the external power switching jumper pins

1. Turn power off and disconnect the AC adapter or remove the batteries.
2. Open the battery compartment lid on the bottom panel.
3. Change the position of the jumper on the external power switching jumper pins from position A to position B.



Jumper pin position

Side A: 

Normal position (unit on/off is controlled by Power key)

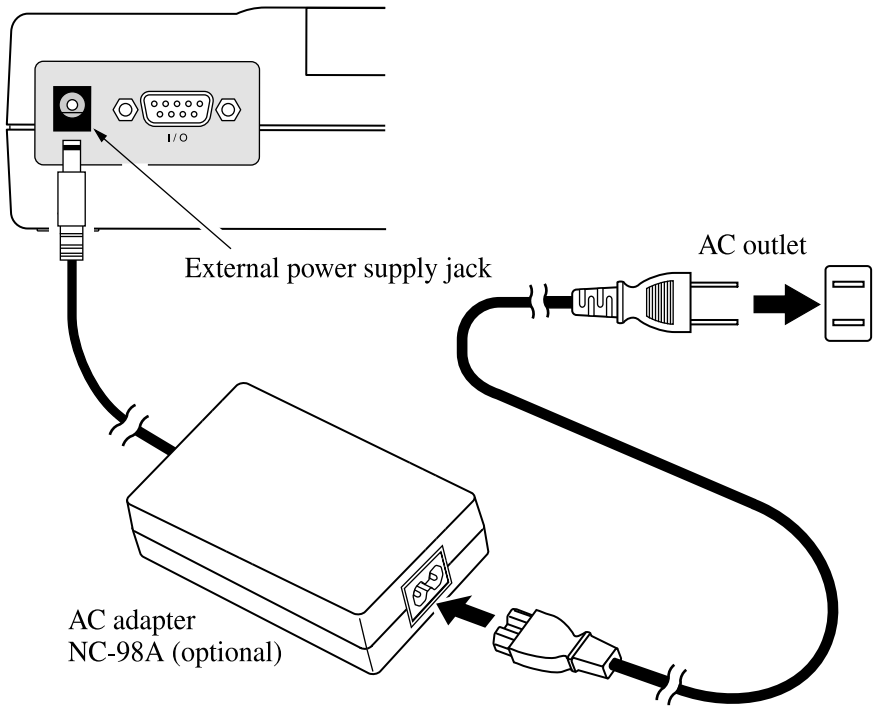
Side B: 

Unit operates in conjunction with external power supply

⚠ Caution
The external power switching jumper pins are small and pointed. Take care not to hurt your fingers.

Important
Never connect any equipment to the external power switching jumper pins. Otherwise damage may occur.

4. When you connect the AC adapter (option) and thereby supply power to the VM-54, the unit will automatically be turned on.
   This also applies when the unit is powered from batteries.



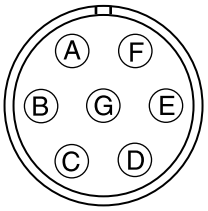
Important
Do not use any other kind of AC adapter except the NC-98A. Otherwise damage may occur.

Note
The optional AC adapter NC-98A is for 100 to 240 V AC.

Note
When you use it in foreign countries, a plug adapter is needed for proper connection. (not supplied from RION)

Input connector

The input connector is a Tajimi Electronics connector 1108-23A10-7F wired as shown below.



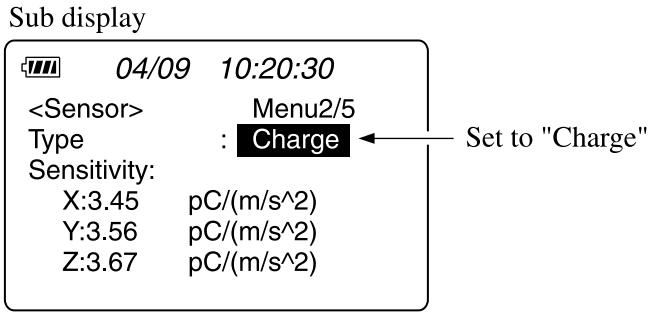
Top view

A: +12 V
B: Ground
C: Z channel signal input
D: -12 V
E: X channel signal input
F: Y channel signal input
G: +7 V

Important
Do not connect anything else besides the 3-Channel Preamplifier VP-80 or EC-04 series extension cable to this connector. Otherwise damage may occur.

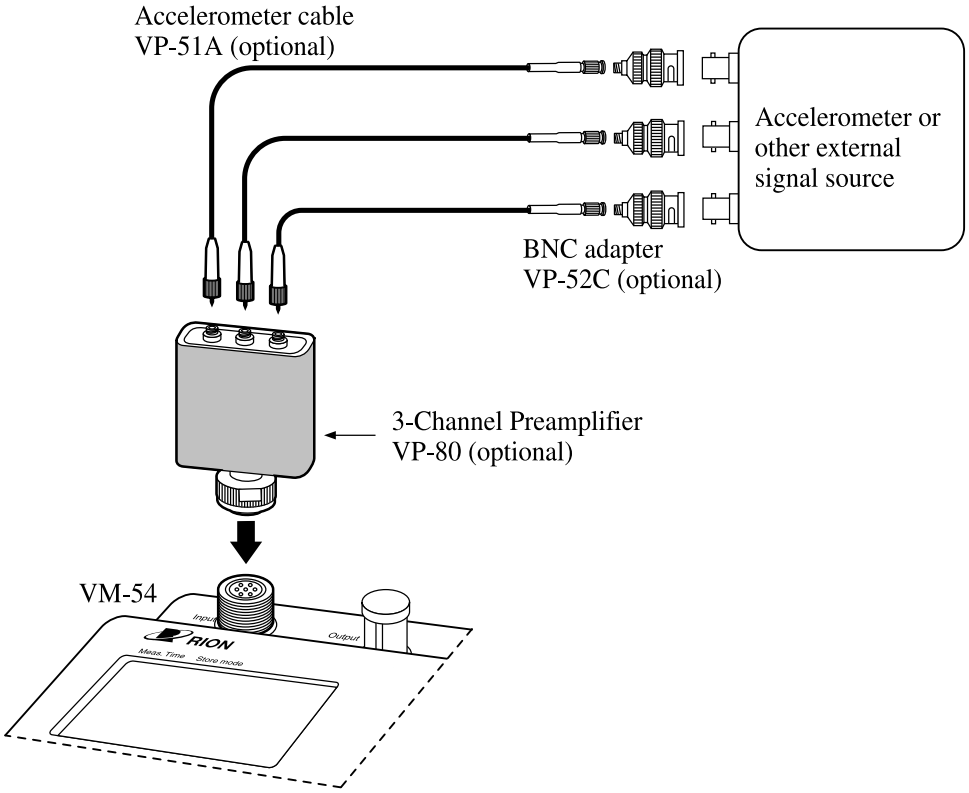
Supplying an electrical signal to the VM-54

1. Set the input selector on the VP-80 to "CCLD" and connect it to the VM-54.
2. Start up the VM-54 and set the sensor type to "Charge" on menu screen 2/5. Do not use the "CCLD" setting here.



Menu screen 2/5

3. Use the accelerometer cable VP-51A and BNC adapter VP-52C to supply an electrical signal to the input of the VP-80.



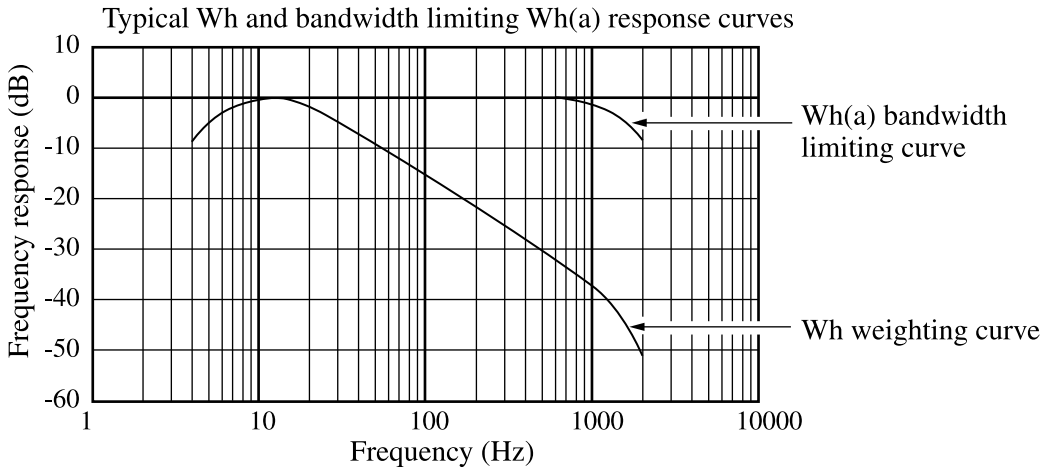
Calibration example using an exciter

The following arrangement can be used to calibrate the accelerometer with an exciter. The service department of Rion Corporation also provides a calibration service.

- Sine wave signal oscillator
- Power amplifier DC-300A series II (Manufacturer: Crown)
- Exciter VG-100(Vertical-direction exciter) (Manufacturer: AR Brown)

  APS-129(Horizontal-direction exciter) (Manufacturer: AR Brown)
- Reference accelerometer PV-03 (Manufacturer: RION)
- Vibration meter VM-83 (Manufacturer: RION)

Wh/Wh(a) Frequency response characteristics (typical characteristics)



Measurement values obtained with VX-54WH

Instantaneous value: RMS with *t* = 1 s

$$a_w(t_0)=\left[\frac{1}{\tau}\int_{t_0-\tau}^{t_0} a_w^2(t)dt\right]^{\frac{1}{2}}$$

$a_w(t)$: Instantaneous value
τ: Shift average integral time (s)
t: Time (integral variable)
t_0: Observation time (instantaneous value time)
Based on t= 100 ms, the unit calculates the instantaneous value as the RMS value with t = 1 second.

Bar graph: Exponential average of time constant = 1 second

Processing value RMS: RMS value of measurement time T (measurement duration for processing)

$$a_w=\left[\frac{1}{T}\int_0^T a_w^2(t)dt\right]^{\frac{1}{2}}$$

$a_w(t)$: Processing value RMS
T: Measurement time (s)

Processing value max (MTVV):

Maximum of RMS value for integral time (t = 1 s) in measurement interval (measurement duration for processing)

av: Combined vibration value

$$av = \sqrt{a^2_{wx} + a^2_{wy} + a^2_{wz}}$$

Where a_{wx}, a_{wy}, a_{wz}: Compensated acceleration value (RMS) for three axes

The combined vibration value is used for comfort evaluation purposes.

VDV: Vibration Dose Value

$$VDV = \left[\int_0^T a_w{}^4 (t)\, dt \right]^{\frac{1}{4}}$$

Where $a_w(t)$: Instantaneous value of translational or rotary vibration acceleration to which frequency weighting was applied

T: Continuous measurement time (s)

Inherent noise in reference environment conditions (23°C, 50% RH)

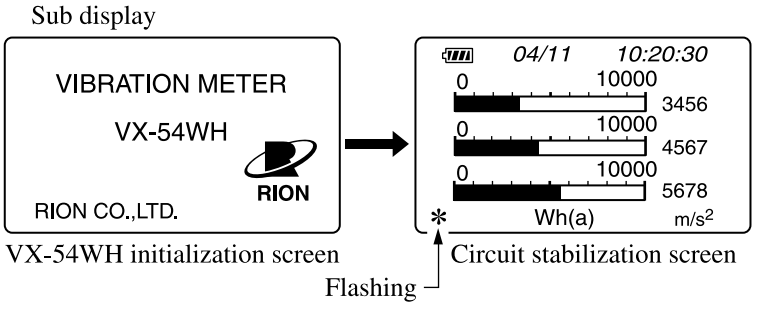
	Frequency weighting characteristics	Inherent noise
With PV-97C connected	Wh Wh(a)	0.05 m/s^2 or less 0.1 m/s^2 or less

Maximum peak value for accelerometer measurement

Accelerometer	Maximum peak value	Remarks
PV-97C	Approx. 42000 m/s^2 peak	VP-80 gain setting 1/10

Warmup time

This unit requires a warmup time of about 30 seconds after power-on. During warmup, a * symbol is flashing in the lower left corner of the sub display. During the warmup period, correct measurement is not possible.



Specifications

Hand-Arm Vibration Card VX-54WH

Software format and media

Check-in/out method (after program installation, Hand-Arm Vibration Card VX-54WH may be removed from 3-Axis Vibration Meter VM-54)

Media: CompactFlash

Supplied accessories

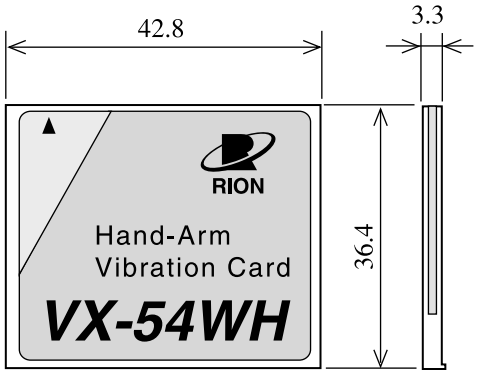
Template sheet	1
Instruction manual	1
Inspection certificate	1

Optional accessories

3-Channel Preamplifier	VP-80
3-Axis Vibration Meter	VM-54
Piezoelectric accelerometer	PV-93, PV-97C
Extension cable	EC-04

VM-54 case

Soft carrying case with shoulder strap for VM-54



Unit: mm

Dimensional drawing of Hand-Arm Vibration Card VX-54WH

Specifications for 3-Axis Vibration Meter VM-54 with Hand-Arm Vibration Card VX-54WH program installed

Applicable standards

ISO 5349-1: 2001
ISO 5349-2: 2001
ISO/DIS 8041: 2003
JIS B 7761-1: 2004
JIS B 7761-2: 2004

Input

Number of channels: 3
Connection of charge output type piezoelectric accelerometer or integrated preamplifier type accelerometer (CCLD) available via 3-Channel Preamplifier VP-80

Nominal measurement frequency range

8 to 1000 Hz

Frequency weighting characteristics

Wh or flat, with only bandwidth limiting part of Wh characteristics

Measurement functions

Acceleration (m/s^2)
Instantaneous value [RMS with integral time 1 s (τ = 1 s)]
3-channel simultaneous measurement

Processing functions

RMS:
RMS value of measurement time (measurement duration for processing)
MTVV:
Maximum Transient vibration value 1 s (τ = 1 s)
Crest Factor
Peak
VDV:
Vibration Dose Value
Synthesized vibration value:
Synthesized acceleration value (RMS) for axes in orthogonal coordinate system

Measurement time settings

1 to 30 seconds in 1-second steps, 1 minute, 10 minutes, 30 minutes, 1 hour, 4 hours, 8 hours, and 12 hours (maximum 12 hours)

Level range

With piezoelectric accelerometer

Sensitivity unit is mV/(m/s^2) for CCLD setting and pC/(m/s^2) for Charge setting

When sensitivity setting is in 0.0100 to 0.0999 mV/(m/s^2) range

30, 100, 300, 1000, 3000, 10000 m/s^2

When sensitivity setting is in 0.100 to 0.999 mV/(m/s^2) range

3, 10, 30, 100, 300, 1000, 3000, 10000 m/s^2

When sensitivity setting is in 1.00 to 9.99 mV/(m/s^2) range

0.3, 1, 3, 10, 30, 100, 300, 1000 m/s^2

When sensitivity setting is in 10.0 to 99.9 mV/(m/s^2) range

0.03, 0.1, 0.3, 1, 3, 10, 30, 100 m/s^2

Reference level range

10

Reference frequency

79.58 Hz

Measurement value detection circuit

Digital processing type

Displays

Main display (segment type LCD)

Instantaneous value or processing value for one axis, display update cycle 1 s

Bar graph, display update cycle 100 ms

Other display

Sub display (128 × 64 dot matrix LCD)

3-axis instantaneous value, processing result, menu, etc.

Data storage
Auto store on CompactFlash card
Manual store on CompactFlash card
Auto1 store:
RMS value, Peak, VDV, C.F., av for every second
Manual store:
Instantaneous value when Store key is pressed, processing value (RMS, MTVV, Crest Factor, VDV, Peak, synthesized vibration value)

Signal output connectors
BNC connectors:
AC output for X, Y, Z (with selected frequency weighting)
Range full scale:
1 Vrms
Maximum output voltage:
3 Vrms
Distortion:
1% or less (at reference range, reference frequency, reference input level)

Sensitivity fluctuation under usage environment temperature/humidity
±2% (main unit only, at reference range, reference frequency, reference input level)

I/O connector
9-pin D-sub male (for printer output)

Printer functions
Printing of sub display contents during menu, pause, and recall display

Ambient conditions for use
-10 to +50ºC, max. 90% RH (no condensation)

Power supply
Four IEC R14 (size "C") batteries or AC adapter NC-98A (optional)
Operation voltage range 4.2 to 6.7 V

Battery life
16 hours or more continuous operation (with alkaline batteries, PV-97C and VP-80 connected, backlight off, at room temperature)

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