INSTRUCTION MANUAL

VIBRATION LEVEL METER

VM-51

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The VM-51 conforms to the standards specified by the Weight and Measure Act and the Japanese Industry Standard for vibration level meters (JIS C 1510-1976). It is designed to measure ground and floor vibrations and to evaluate vibration levels which are weighted according to human vibration sensitivity characteristics.

Expression of vibration level and vibration acceleration level

The VM-51 uses quantifiers "Lv" for vibration level and "Lva" for vibration acceleration level for display indications. Also the same conventions are followed in this manual.

PRECAUTIONS

- Operate the unit as described in this manual.

- Observe the following precautions before using the unit:
  - Make sure that all connections are properly established.
  - Check the setting of all switches and controls, and make sure that the unit is operating normally.

- Use the unit only under the following ambient conditions:
  Temperature 0 to 40°C, relative humidity less than 90%

- Do not store or use the unit in locations where the unit may be subject to
  - splashes of water or high levels of dust,
  - air with high salt or sulphur content, or other gases or chemicals,
  - high temperature, high humidity, or direct sunlight,
  - directly transmitted vibrations or shock.

- Observe the following precautions after using the unit:
  - Always switch off the power.
  - When disconnecting cables, always hold the plug and do not pull the cable.
  - Store accessories, cables etc. together with the unit.

- Do not disassemble the unit or attempt internal alterations.

- Be sure to perform regular maintenance.

- In case of malfunction, do not attempt any repairs. Note the condition of the unit clearly and contact the supplier.

CONTENTS

Hands-on Introduction

Before starting to use the VM-51 for actual measurements, take a few minutes to familiarize yourself with the unit.

1. Set switches and controls as follows.
   ① Power switch: Off
   ② Level Range selectors: 100
   ③ Function selector: Lv (VL)
   ④ Display selector: 1s
   ⑤ Display axis selector: Any position

2. Insert four IEC R14 (size C) batteries into the battery compartment on the bottom of the unit.
   Optional AC adapter may also be used. Connect the adapter plug to the external power jack (DC6V) on the rear panel. (☞ p.8)

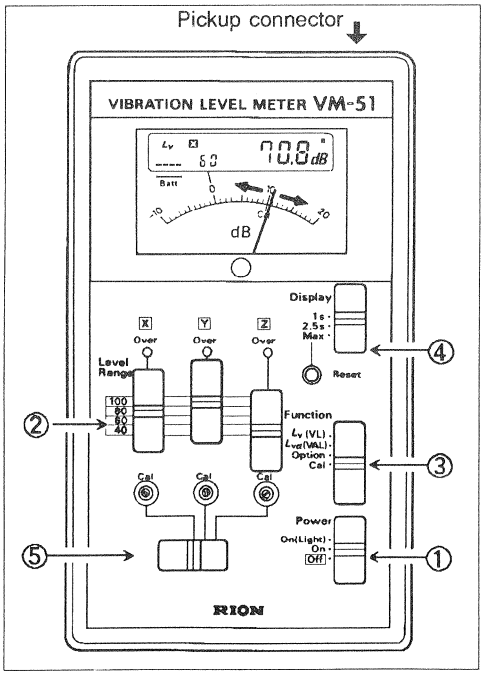
3. Place the accelerometer (pickup) on the table or a suitable surface. Connect the accelerometer cable to the EC-02 cable (connection cable) and fasten the connector with the locking ring.

4. Connect the EC-02 cable to the Pickup connector on the front panel of the VM-51 (☞ p.7), and set the Input Select switch to "Pickup".

5. Set the Power switch to "On".
   The digital display shows a vibration level value, and the meter needle momentarily deflects fully and then returns gradually.

6. Lightly tap the accelerometer.
   The vibration is shown by the meter and the digital display. If overload occurs, the overload indicator for the respective axis lights up and the indication "Over" appears on the digital display.

7. Set the Function selector to "Cal".
   The meter needle deflects to about "10" (for "110") and the digital display shows approximately "110" (☞ p.9).

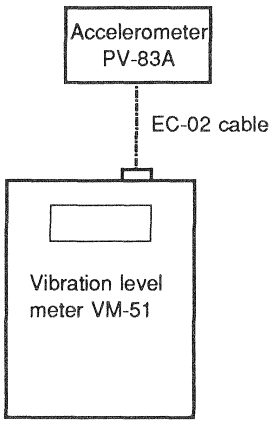


SYSTEM CONNECTIONS

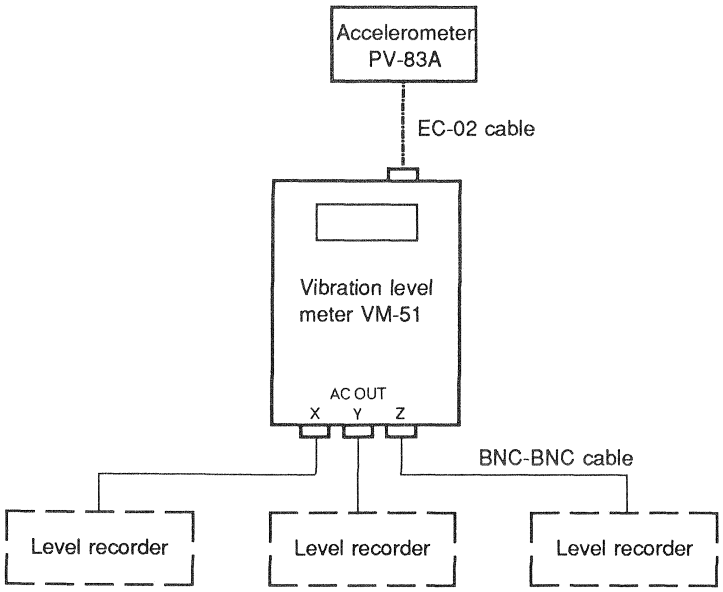
System Connection Diagrams I

Connections for measurement with one or several VM-51 units

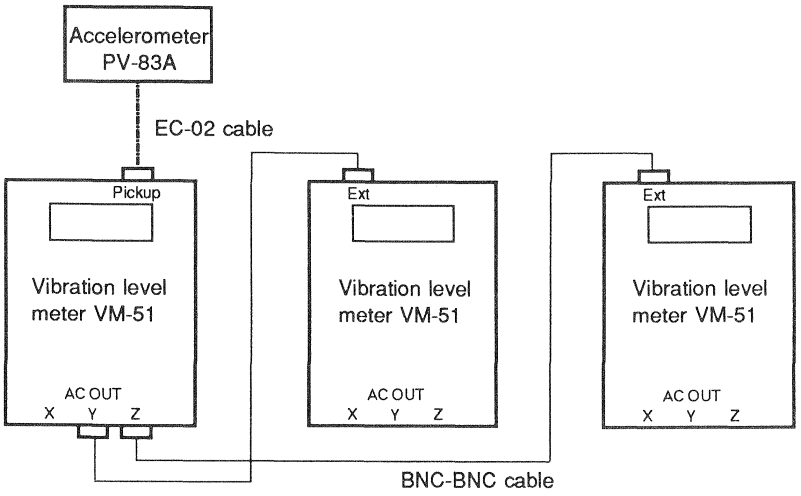
- Single-axis measurement (X, Y, or Z) (☞ p.15)



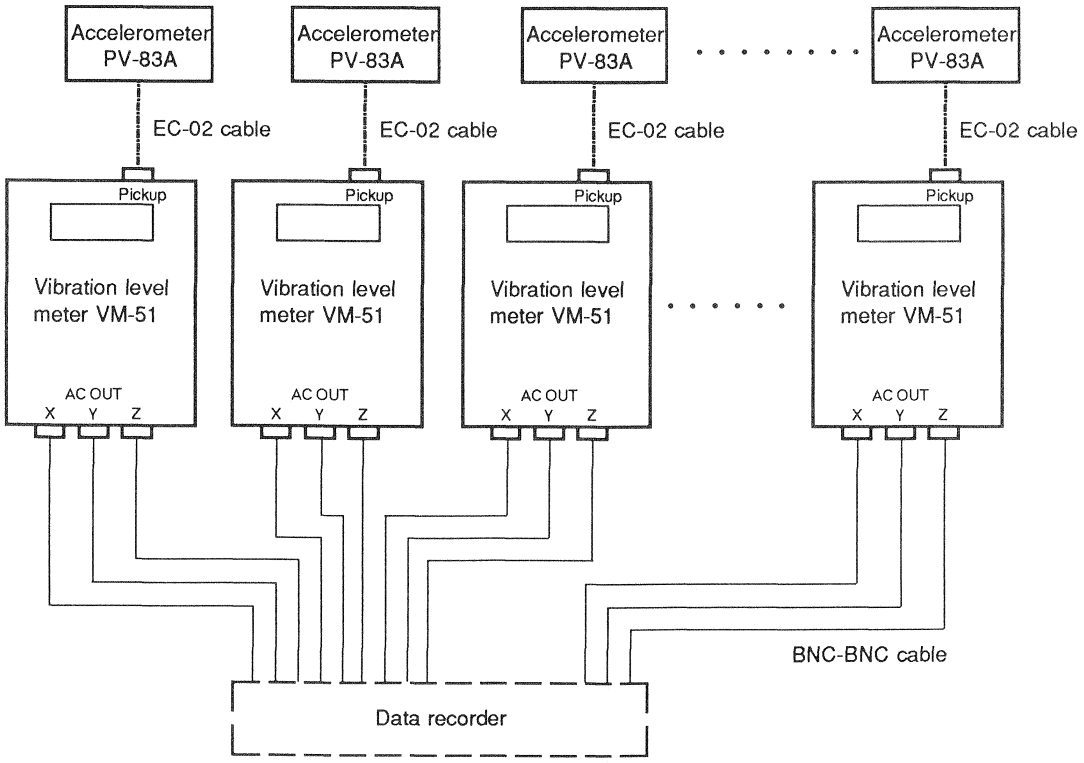
- Three-axis simultaneous level recording (☞ p.16)



- Three-axis simultaneous measurement and data monitoring on three VM-51 units (☞ p.19)

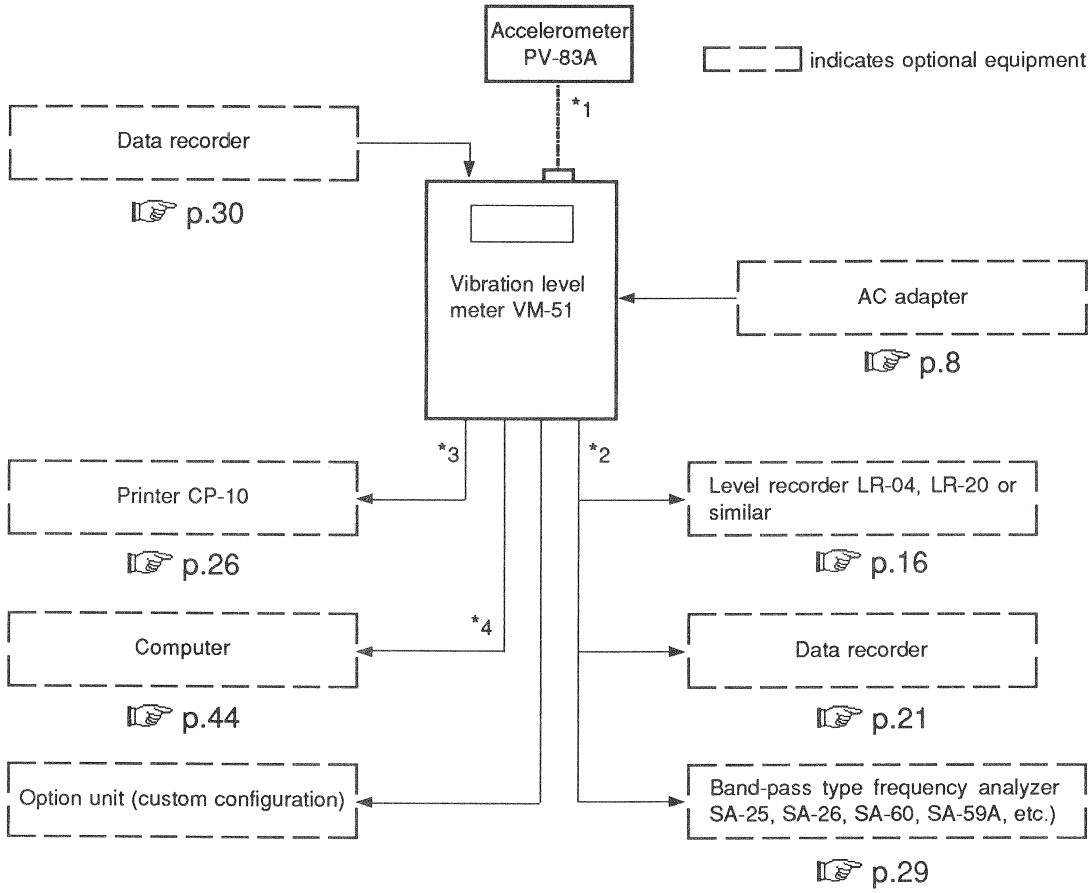


- Three-axis, multiple-point measurement (☞ p.21)



System Connection Diagrams II

Connection of peripheral equipment for measurement, recording and analysis



*1 EC-02 cable
Accelerometer connection cable supplied with the VM-51 (length 3 m). The following optional cables are available:
EC-02A (5 m)
EC-02B (10 m)
EC-02C (30 m, with reel)
EC-02D (50 m, with reel)
EC-02E (100 m, with reel)
- Even with long cable runs, there is no deterioration of sensitivity or frequency characteristics.

*2 BNC-BNC cable
*3 CC-86 cable (for printer connection)
*4 CC-80 cable (for RS-232-C interface connection)

PREPARATIONS

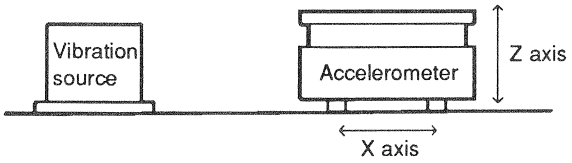
Contents of this section

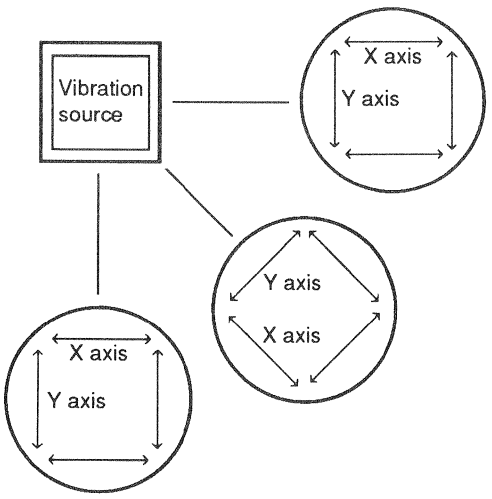
Accelerometer Placement

a) Determining the vibration axis

Environmental vibrations are normally measured at one point, in two horizontal planes (front/back and left/right) and one vertical plane. This means that complex vibration phenomena are reduced to three axes (X, Y, Z), for easier observation.

The axes are defined as follows (facing the vibration source).
Horizontal front/back: X axis
Horizontal left/right: Y axis
Vertical: Z axis





b) Accelerometer placement

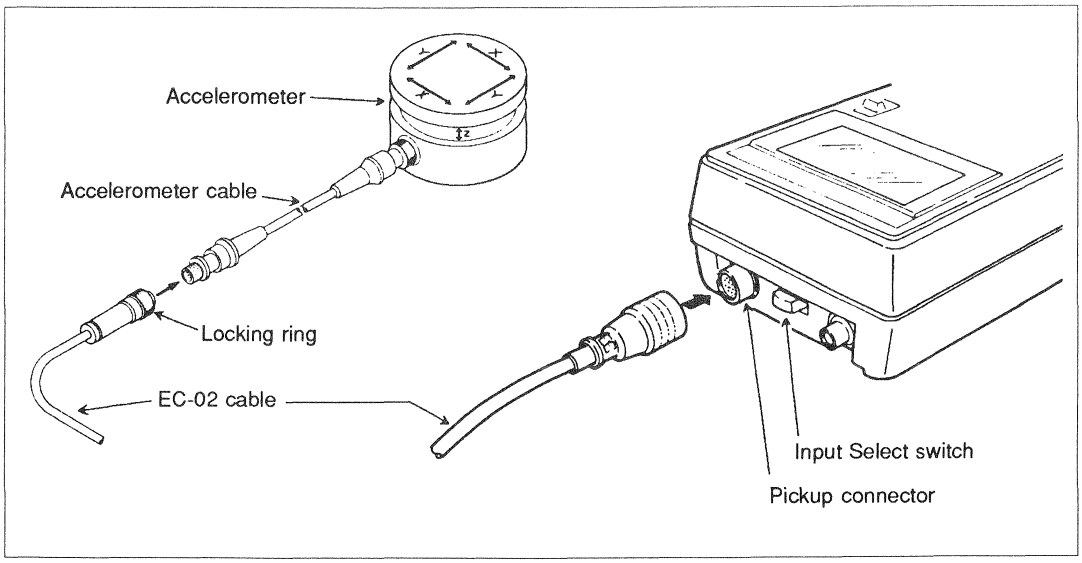
- On hard surfaces
  On hard surfaces such as concrete, asphalt, wood, or solid ground, choose a level and flat area and place the accelerometer on the surface.

- On soft surfaces
  For measurements on soft ground, you should first harden the surface, for example by treading the ground with your feet. (For measurements on a grassy surface, the grass should be cut first.) Then place the accelerometer on the ground and push it slightly into the surface.
  Extremely soft surfaces such as sand, or thick carpeting within buildings should be avoided.

Accelerometer Connection

1. Connect the accelerometer cable to the EC-02 cable and fasten the connector with the locking ring.

2. Connect the EC-02 cable to the Pickup connector on the front panel of the VM-51, and set the Input Select switch to "Pickup".
   Besides the 3-meter EC-02 cable supplied with the VM-51, Rion offers five other optional cables with different lengths. Choose a cable which is best suited for the particular application.



Battery Insertion

1. Set the Power switch to "Off".

2. Open the lid of the battery compartment on the bottom of the unit by lightly pressing both sides of the lid inward.

3. Insert four fresh batteries, observing correct polarity as indicated inside the battery compartment.

4. Close the battery compartment lid.

AC Adapter Connection

The unit can also be powered from optional AC adapter.

1. Set the Power switch to "Off".

2. Connect the DC cable from the adapter to the external power jack (DC6V) on the rear panel and plug the power cord of the adapter into an AC outlet.

CALIBRATION

Be sure to perform calibration before each use of the unit. For extended measurements, calibration should also be performed between measurements.

During calibration, a calibration signal (31.5 Hz, sine wave, 316 mVrms) is supplied at the AC Out connectors. When using a level recorder, waveform recorder, or data recorder to record measurement results, this signal can serve to adjust the pen position or the reference level.

1. Set the Power switch to "On".

2. Set the Function selector to "Cal".
   The level range is automatically set to "100".

3. Confirm that at least one segment of the battery voltage indicator (Batt) on the digital display is visible and not flashing (☞ p.14).

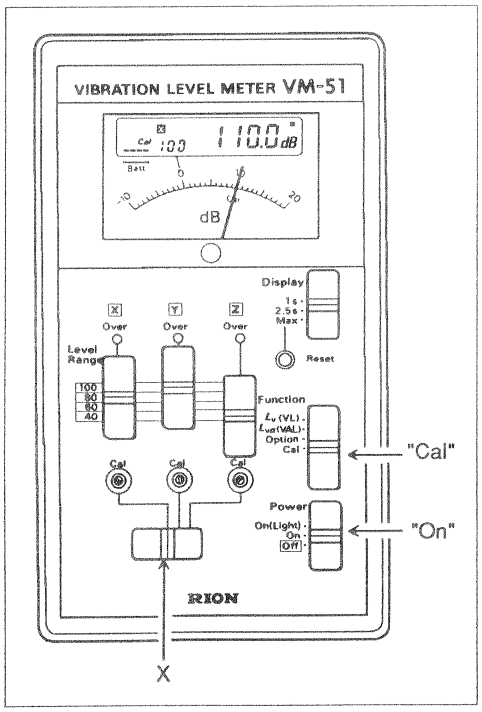
4. Set the display axis selector to "X".

5. Adjust the X-axis calibration control so that the meter needle is at the "Cal" mark.

6. Choose the "Y" and "Z" positions with the display axis selector and perform calibration in the same way.

7. Set the Function selector to "Lv (VL)" or to "Lva (VAL)".

8. Set the Level Range selector for each axis to "100".

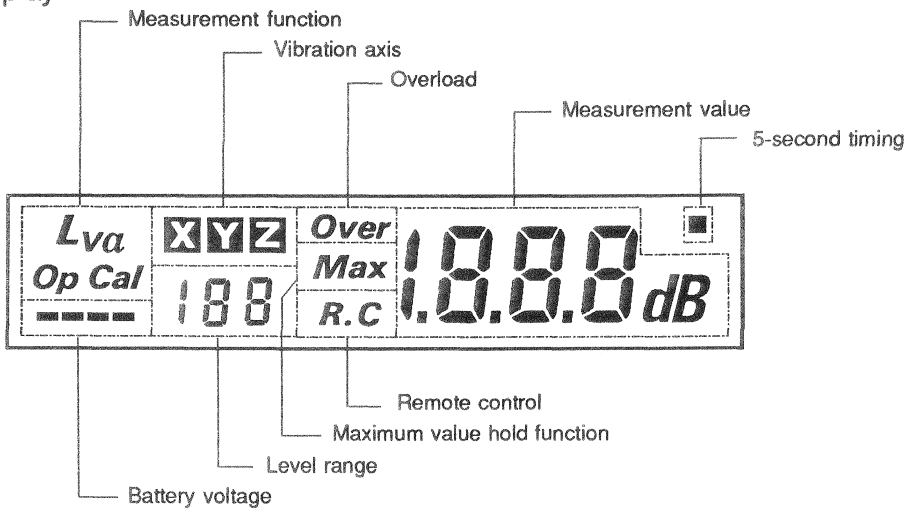


MEASUREMENT

Contents of this section

Reading the Display

- Digital display



Measurement function

Shows which function was selected with the Function selector.

Display	Lv	Lva	Op	Cal
Meaning	Vibration level	Vibration acceleration level	Option	Calibration

Battery voltage

Shows the battery voltage with four bar-graph segments. For details on the indication and battery life, please refer to page 14.

Vibration axis

Shows the axis (direction) of the vibration whose value is being shown on the display, depending on the setting of the display axis selector.

Level range

Shows which actual vibration level corresponds to the 0-dB point on the meter. Depends on the setting of the Level Range selector for the currently displayed axis.

Overload

If the input level exceeded the full-scale point by 15 dB or more, this indication appears for the selected display cycle (1 or 2.5 seconds) (☞ p.36).

Maximum value hold function

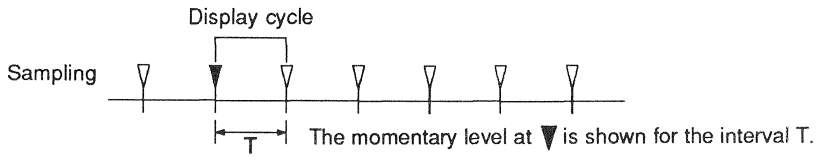
When the Display selector is set to "Max", this indicator appears and the digital display shows the maximum value.

Remote control

Appears when the unit is being controlled via the RS-232-C interface. While "R.C" is displayed, the VM-51 panel controls except for the Power switch are inactive.

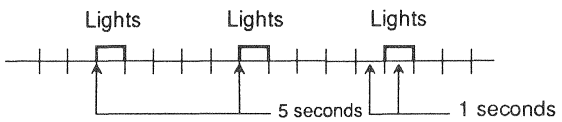
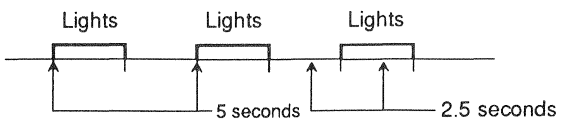
Measurement value

Measured values are shown on this 3-1/2-digit display. If the measured value is more than 5 dB below the lower indication limit of the meter, the indication "Lo" is shown. The momentary level is sampled at the intervals determined by the selected display cycle, and the display is updated accordingly. The same value is therefore shown from one sampling point until the next.



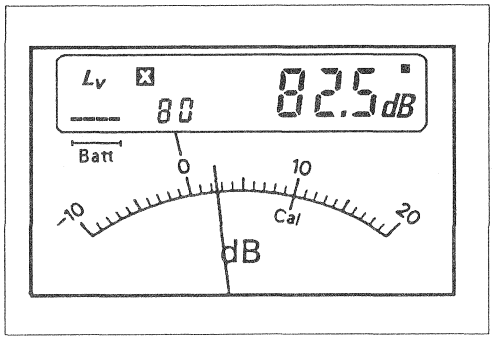
5-second timing

Lights up in 5-second intervals. The duration for which the indicator appears depends on the setting of the Display selector.

Display selector	Indicator pattern
1 s, Max	
2.5 s	

• Analog meter

The 0-dB point of the meter corresponds to the selected level range. If for example the Level Range selector is set to "80", the meter range is 70 to 100 dB. The example at right shows a vibration level of 82.5 dB in the X direction.



• Battery voltage display and battery life

20°C

Display		Battery voltage	Remaining battery life (hours)		
			Battery type	Without backlight	With backlight
– – – –	4 segments lit	High	M	14 to 22	10 to 14
			A	29 to 36	25 to 32
– – –	3 segments lit		M	9 to 14	8 to10
			A	23 to 29	19 to 25
– –	2 segments lit		M	4 to 9	4 to 8
			A	7 to 23	8 to 19
–	1 segment lit		M	1 to 4	1 to 4
			A	1 to 7	1 to 8
– – – –	4 segments flashing		M	1	1
		Low	A	1	1

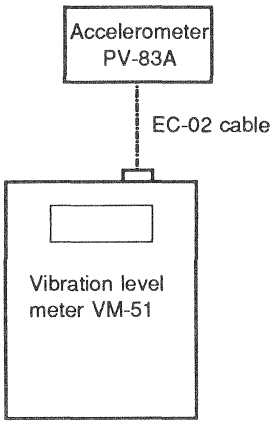
M: Manganese batteries A: Alkaline batteries

- The above values are approximations.
- After the indicator has started flashing, the unit can still be used for a maximum of about one hour (printer operation and control via the RS-232-C interface are not possible). However, the batteries should be replaced as soon as possible.
- The actual battery life will vary, depending on the battery type and the operating conditions.
- When used at a temperature of 0°C, battery life will be about 1/3 to 1/2 shorter than at 20°C.

Single-axis Measurement

X, Y, or Z axis measurement with one accelerometer and one VM-51

- Accelerometer placement
  Place the accelerometer at the measurement location, as described on page 6.



- Connections
  Connect the accelerometer to the VM-51, using the supplied EC-02 cable or an extension cable (☞ p.7).

- Calibration

  1. Perform calibration for all three axes (☞ p.9).

  2. Set the Level Range selector for each axis to "100".

- Measurement

  1. Set the Function selector to the desired position: Lv (VL) for vibration level measurements, and Lva (VAL) for vibration acceleration level measurements.

  2. Set the display axis selector to the desired position: X or Y for horizontal-plane measurements, or Z for vertical-plane measurements.

  3. Set the Level Range selector to a suitable range.

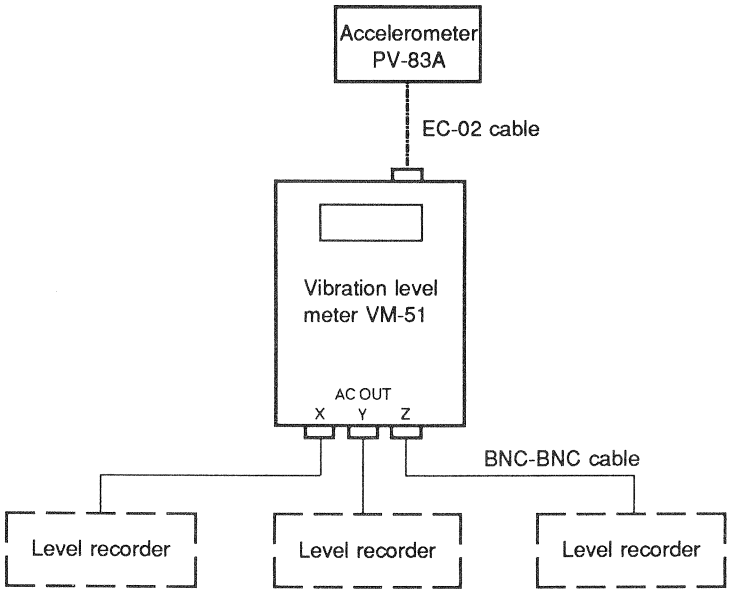
  4. Read the display indication and note the data, together with information on the vibration axis.

  5. Select a different vibration axis and set the Level Range selector to a suitable range.

  6. Measure and record vibration for the new axis in the same way.
     Data recording example
     Lv (VL) Z: 60 dB
     Lva (VAL) X: 72.5 dB Y: 73.0 dB Z: 69.0 dB

Three-axis Simultaneous Recording

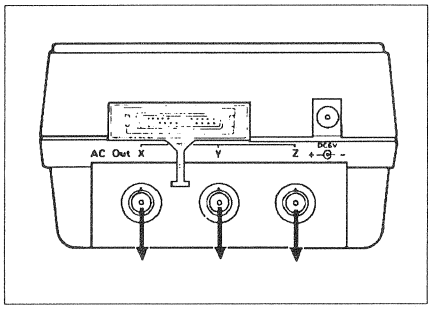
Simultaneous recording of X, Y, and Z data on three level recorders LR-04 with one accelerometer and one VM-51



- Accelerometer placement

  Place the accelerometer at the measurement location, as described on page 6.

- Connections



1. Connect the accelerometer to the VM-51, using the supplied EC-02 cable or an extension cable (☞ p.7).

2. Connect the three level recorders to the AC Out connectors (X, Y, and Z) of the VM-51, using BNC-BNC cables.

• Calibration

For details regarding operation of the level recorder, please refer to the instruction manual of the recorder.

1. Turn on the level recorders and set to AC input, 50 dB recording level range, then activate pen operation.

2. Perform calibration of the X axis (☞ p.9).

3. While still in the calibration condition, adjust the input sensitivity of the X-axis level recorder so that the pen is at a position 10 dB below the maximum scale.

4. Perform the same steps for the Y and Z axis.

5. Set the Level Range selectors for each axis to "100".

• Measurement and recording

1. Set the Function selector to the desired position: Lv (VL) for vibration level measurements, and Lva (VAL) for vibration acceleration level measurements.

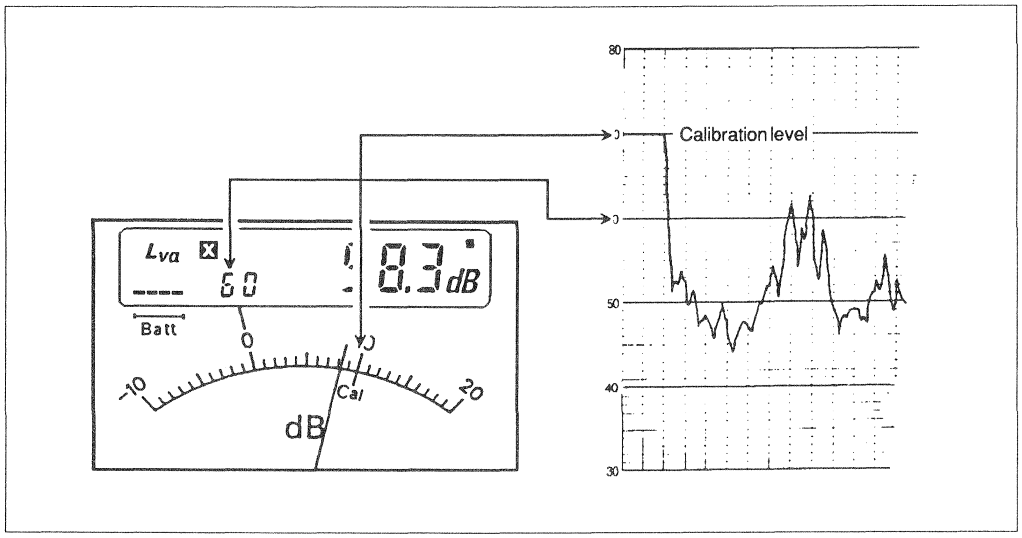
2. Set the Level Range selector for each axis to a suitable range.
The relationship between the Level Range selector setting and the maximum scale point of the level recorder is as shown below.

Level Range selector	100	80	60	40
Maximum scale point on level recorder paper (dB)	120	100	80	60

3. Select the paper speed of the level recorder (1 or 3 mm/s are suitable) and set the pen response (averaging time constant) to "VIB LEVEL".

4. Start recording.

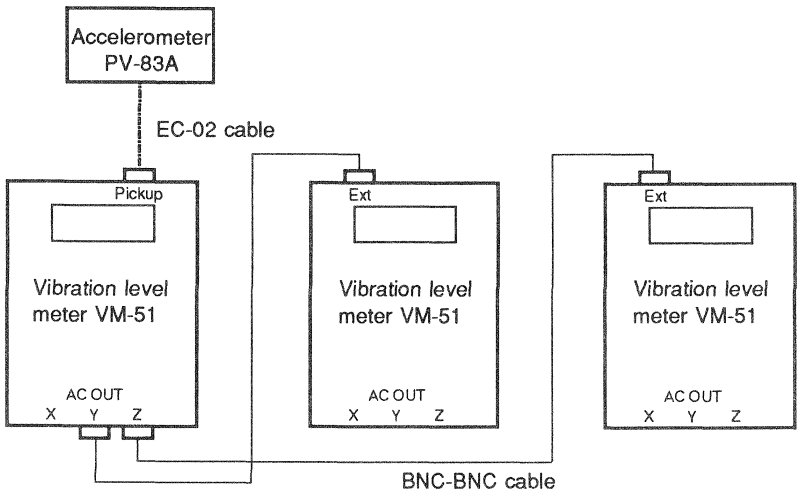
5. Note any necessary information on the recording paper (such as measurement axis, vibration source, distance to vibration source, time, weather conditions, etc.).



Example for Level Range selector setting "60"

Three-axis Simultaneous Measurement

Simultaneous measurement of X, Y, and Z axes with one accelerometer and three VM-51 units



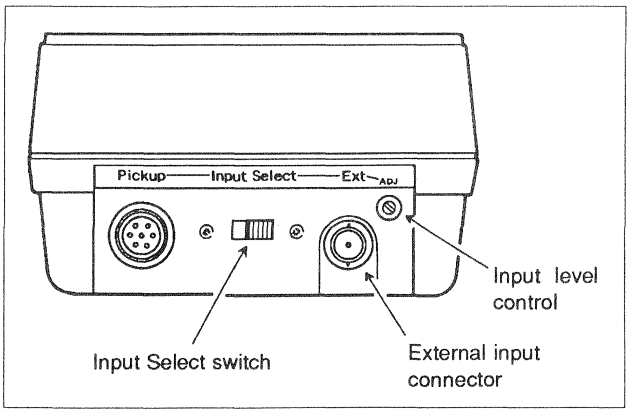
- Accelerometer placement
  Place the accelerometer at the measurement location, as described on page 6.

- Connections

1. Connect the accelerometer to the first VM-51, using the EC-02 cable or an extension cable (☞ p.7).

2. Connect the Y output connector (AC Out) of the first VM-51 to the External input connector on the second VM-51, using a BNC-BNC cable. Set the Input Select switch on the second VM-51 to "Ext".

3. Connect the Z output connector of the first VM-51 to the External input connector on the third VM-51, using a BNC-BNC cable. Set the Input Select switch on the third VM-51 to "Ext".



• Calibration

1. Perform calibration for the three axes (X, Y, Z) on all three VM-51 units (☞ p. 9).

2. Set the Level Range selectors on all three VM-51 units to "100".

• Input level adjustment

1. Set the switches on all three VM-51 units as shown below.
   The meter needle on the second and third VM-51 unit fully deflects to the maximum.

Switch	1st unit	2nd unit	3rd unit
Function selector	Cal	Lva	Lva
Display axis selector	X	Y	Z

2. Adjust the input level control on the second and third VM-51 units so that the meter needle is at the "Cal" mark.

• Measurement

1. Set the Function selector on the first VM-51 unit to "Lv (VL)" or "Lva (VAL)" (this setting determines the type of measurement).

2. Set the Level Range selectors on the first VM-51 unit to a suitable range. Leave the Level Range selectors on the other two VM-51 units at the "100" setting.

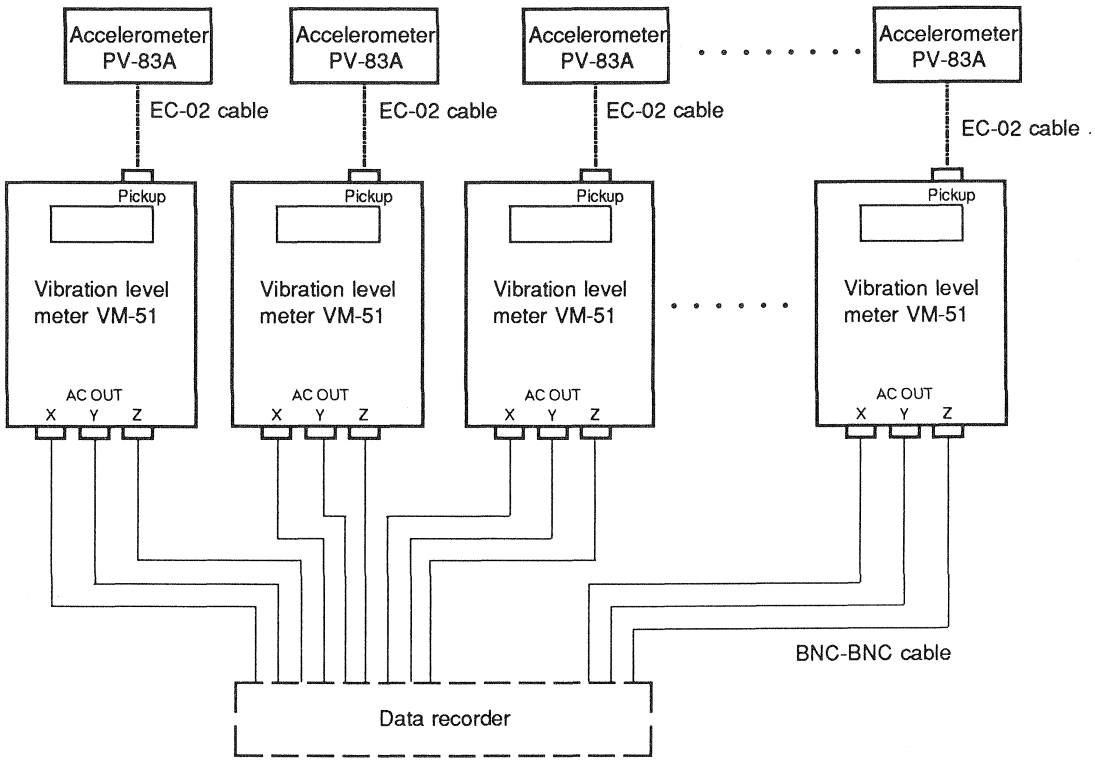
3. Determine the measurement value from the meter indication, as shown in the table below, and note the value together with the vibration axis.

VM-51	Axis	Measurement value
1st unit	X	Meter indication of first unit
2nd unit	Y	Meter indication of second unit + (Y axis level range setting of first unit) – 100
3rd unit	Z	Meter indication of third unit + (Z axis level range setting of first unit) – 100

Data recording example
Lv (VL) X: 53.5 dB Y: 55.0 dB Z: 48.0 dB

Three-axis, Multiple-point Measurement

Measurement with several accelerometers and VM-51 units and recording of data on a data recorder



- Accelerometer placement
  Place the accelerometers as described on page 6.

- Connections

1. Connect the accelerometers to the VM-51 units, using the EC-02 cables or extension cables (☞ p.7).

2. Connect the X, Y, and Z outputs of all VM-51 units to the data recorder, using BNC-BNC cables.

Note:
- When wishing to record certain axis vibration data only, connect only the corresponding output to the data recorder.
- Make a note of which input channels of the data recorder were used for the various measurement points and vibration axes.

• Calibration

1. Perform calibration for the three axes (X, Y, Z) on all VM-51 units (☞ p.9).

2. Leave the units in the calibration mode and record the calibration signal at an identical level in all channels of the data recorder for at least 30 seconds. (See the note below.)

3. Set the Level Range selectors on all VM-51 units to "100".

• Measurement

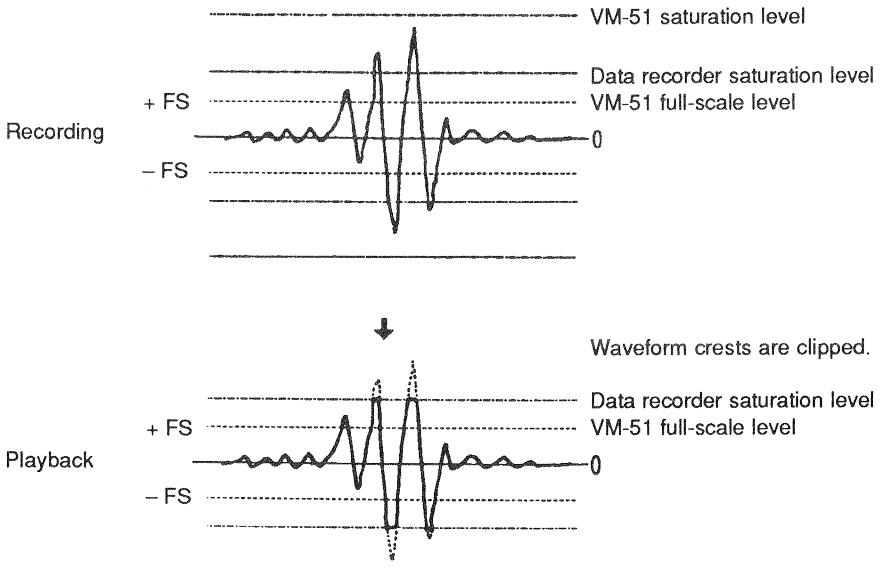
1. Set the Function selectors on all VM-51 units to "Lva (VAL)".

2. Set the Level Range selectors on all VM-51 units to a suitable range. Make a note of the selected setting.

3. Start the data recorder.

Note: When measuring shock vibrations, the AC output may momentarily exceed the full-scale level although the visible meter deflection is low. Take this fact into consideration when setting the data recording level.
The VM-51 saturation point is 15 dB above the full-scale level, but normal data recorders reach saturation already at about 3 dB above the full-scale level.

Example for wrong level setting



Reference

Determining the acceleration from the vibration acceleration level

The vibration acceleration level Lva uses a flat frequency response without compensation for vibration sensitivity characteristics. This level can therefore be converted into acceleration values (m/s^2, cm/s^2 or Gal). Because the reference acceleration (0 dB) of environment vibration level meters is 10^{-5} m/s^2 rms, the relationship between vibration acceleration level and the acceleration can be expressed by the equation below. The graph based on this equation permits easy conversion of vibration acceleration level into acceleration values.

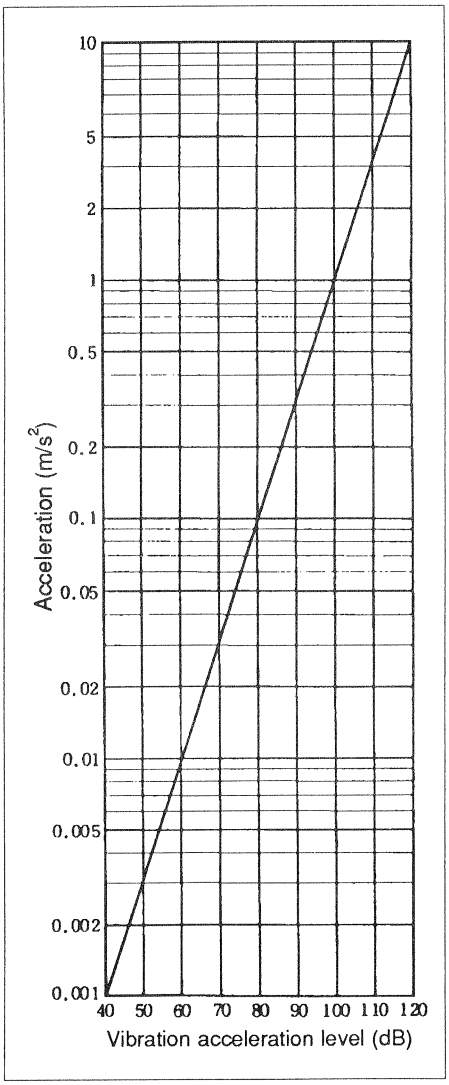
$$Lva = 20\log_{10}\frac{a}{a_0} \quad (dB)$$

a: Acceleration (m/s^2 rms)
a_0: Reference vibration acceleration (10^{-5} m/s^2 rms)

Acceleration general and actual units

General unit: m/s^2
Actual units: cm/s^2, Gal, G
1 $cm/s^2 = 1 \times 10^{-2}$ m/s^2
1 Gal = 1 $cm/s^2 = 1 \times 10^{-2}$ m/s^2
1 G = 9.80665 m/s^2

Vibration acceleration level - acceleration conversion chart ➡



RECORDING AND ANALYSIS

Contents of this section

Recording

Printing measurement results with printer CP-10

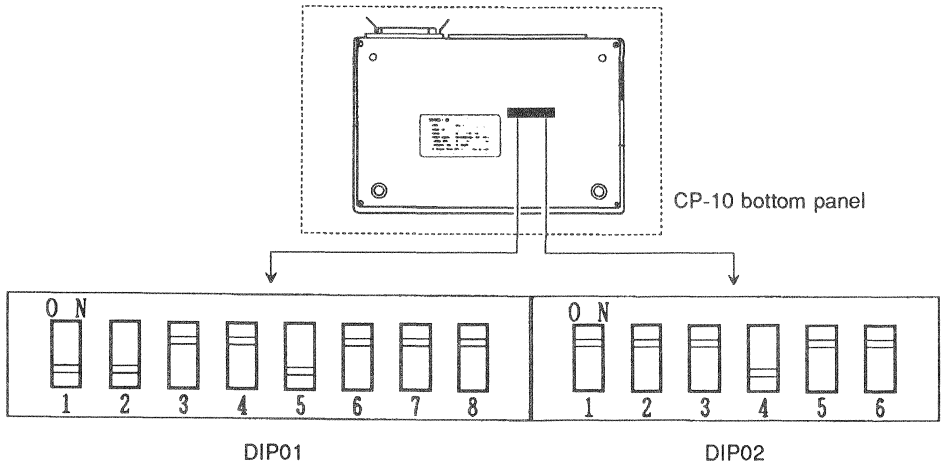
The VM-51 can be connected to the Rion printer CP-10 for printout of measurement data. Data are printed every 5 seconds when the 5-second timing indicator lights up, consisting of the measured value at that point.

Note:
- If the battery voltage indicator of the VM-51 is flashing, the printer cannot be used.
- When the battery voltage of the VM-51 becomes low (only one or two segments of the battery voltage indicator are lit), the probability of printout errors increases. Use the AC adapter or replace the batteries as soon as possible.

- DIP switch settings of the CP-10
  For details on operation of the CP-10, please refer to the instruction manual of the printer.

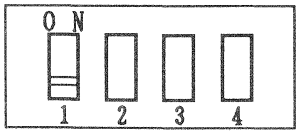
1. Set the power switch of the CP-10 to "OFF".

2. Set the function selection dipswitches DIP01 and DIP02 on the bottom as shown below.



• DIP switch settings of the VM-51

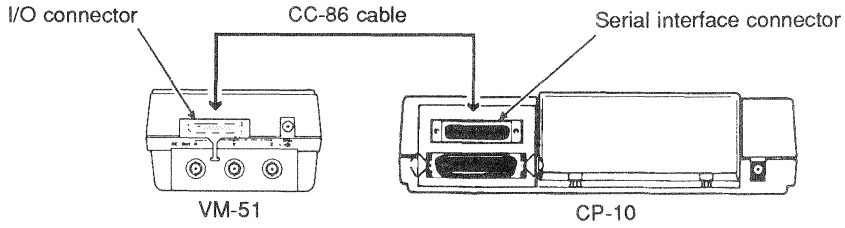
1. Set the Power switch to "Off".
2. Remove the lid of the battery compartment and take out the batteries (☞ p.8).
3. Set switch 1 as shown below.



The setting of switches 2, 3, 4 has no effect.

4. Reinsert the batteries and replace the battery compartment lid.

• Connection
Connect the I/O connector on the rear panel of the VM-51 to the serial interface connector of the CP-10, using the CC-86 cable.



• Printing

1. Set the power switch of the CP-10 to "ON".
2. Press the On/Off-line switch of the CP-10 to the on-line condition.
3. Set the Power switch of the VM-51 to "On".
After a few seconds, an identification title is printed. Every five seconds, the data shown below are printed.
   - [1] Selected function
   - [2] Vibration axis
   - [3] Measurement value
   - [4] "Over" (overload) or "Lo" (below scale) condition
   - [5] "Max" (when Display selector is set to "Max")

4. To stop printout, press the On/Off-line switch of the CP-10 to the off-line condition.

5. Set the power switch of the CP-10 to "OFF".

Printout example

```
VIBRATION LEVEL METER

VM-51

RION CO. LTD

TOKYO JAPAN


Lv ,X, 70.4dB,Lo  ,
Lv ,X, 70.0dB,Lo  ,
Lv ,X, 70.0dB,Lo  ,
Lv ,Y, 70.0dB,Lo  ,Max
Lv ,Y, 70.0dB,Lo  ,Max
Lv ,Y, 75.7dB,Over,Max
Lv ,Z, 29.8dB,    ,
Lv ,Z, 22.0dB,Lo  ,
Lv ,Z, 10.0dB,Lo  ,
Cal,Z,108.7dB,    ,
Cal,Y,110.0dB,    ,
Cal,X,110.3dB,    ,
Cal,Z,110.2dB,    ,
Opt,Z, 29.3dB,    ,
Opt,Z, 47.2dB,    ,
Opt,Z, 47.1dB,    ,
Opt,Z, 47.1dB,    ,
Opt,Z, 47.2dB,    ,
Lva,Z, 86.5dB,    ,
Lva,Z, 53.8dB,    ,
Lva,Z, 93.7dB,Over,
Lva,Z, 66.3dB,    ,
```

↑ 1 ↑ 2 ↑ 3 ↑ 4 ↑ 5

Frequency Analysis

Frequency analysis with 1/3-octave band analyzer SA-59A

The Rion 1/3-octave band analyzer SA-59A can be used to analyze the frequency distribution of measured vibrations.

- Connection
  Connect the AC Out connector of the VM-51 for the desired vibration axis to the input connector of the SA-59A, using a BNC-BNC cable.
  For details on operation of the SA-59A, please refer to the instruction manual of the SA-59A.

- SA-59A settings
  Set the SA-59A to the calibration mode.
  Function: AP (all pass)
  Frequency range: 1-800 Hz
  Time constant: 0.6 s (VL)

- Calibration

1. Perform calibration for the three axes (X, Y, Z) of the VM-51 unit (☞ p.9).

2. Adjust the input attenuator of the SA-59A so that the meter of the SA-59A indicates 0 dB.

- Frequency analysis

1. Set the Function selector of the VM-51 to Lva (VAL).

2. Set the Level Range selector on the VM-51 for each axis to a suitable range.

3. Select the center frequency on the SA-59A.

4. Determine the 1/3-octave band acceleration level according to the table on the next page.

5. Connect the AC Out connector for other vibration axes to the SA-59A, using a BNC-BNC cable, and perform analysis in the same way.

Level Range selector of VM-51	1/3-octave band level (dB)
40	50 + SA-59A meter indication
60	70 + SA-59A meter indication
80	90 + SA-59A meter indication
100	110 + SA-59A meter indication

Example
VM-51 Level Range: 60
SA-59A center frequency: 10 Hz
Meter indication of SA-59A: –20

In this example, the 1/3-octave band acceleration level for a center frequency of 10 Hz is 70 + (–20) = 50 dB.

Note: 1/3-octave band acceleration level values under 20 dB should be disregarded, as there is a high probability of residual noise affecting the measurement.

♦ Recording of frequency analysis

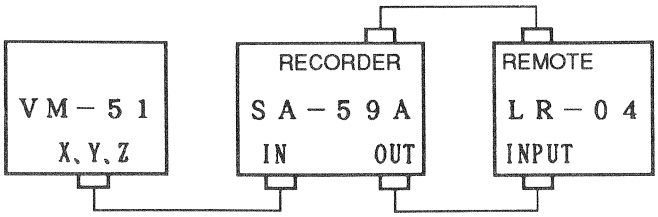
Using a level recorder (LR-04), the results of the frequency analysis can be plotted.

• Connection

1. Connect the AC Out connector of the VM-51 for the desired vibration axis to the input connector of the SA-59A, using a BNC-BNC cable.

2. Connect the output connector of the SA-59A to the input connector of the level recorder LR-04, using a BNC-BNC cable.

3. Connect the recorder connector of the SA-59A to the remote control connector of the LR-04, using the cable supplied with the SA-59A.



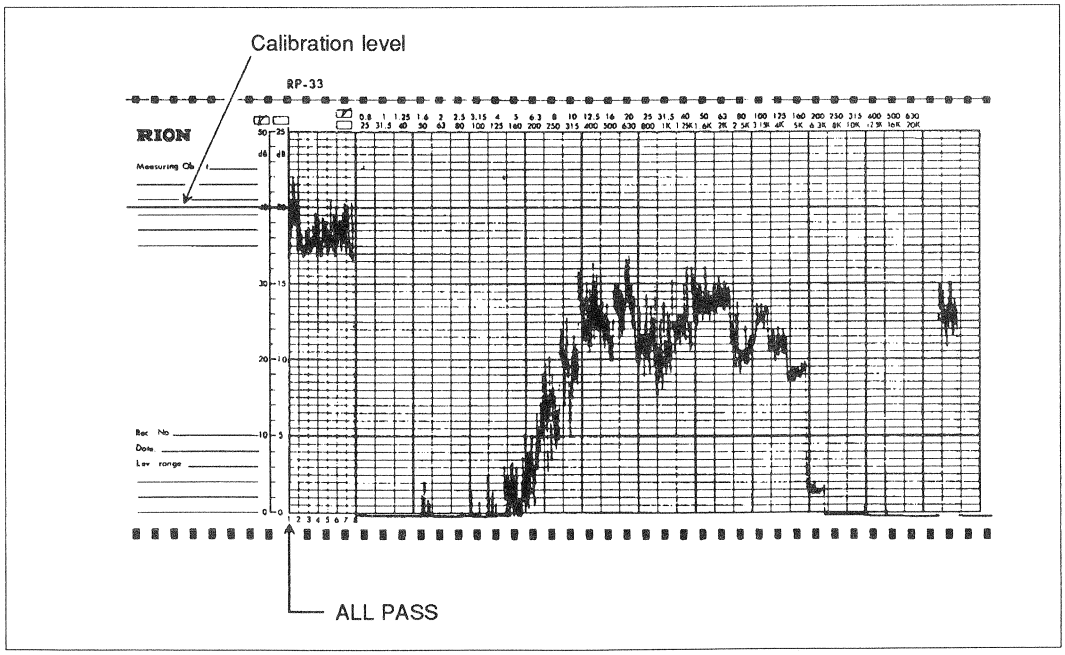
- SA-59A settings
  Set the function selector to "REC".

- LR-04 calibration and pen position adjustment

  1. With the VM-51 and SA-59A in the calibration mode, adjust the input level of the LR-04 so that pen position is at a point 10 dB below the full-scale position.

  2. Advance the paper so that the pen is at the ALL PASS position (first vertical line).

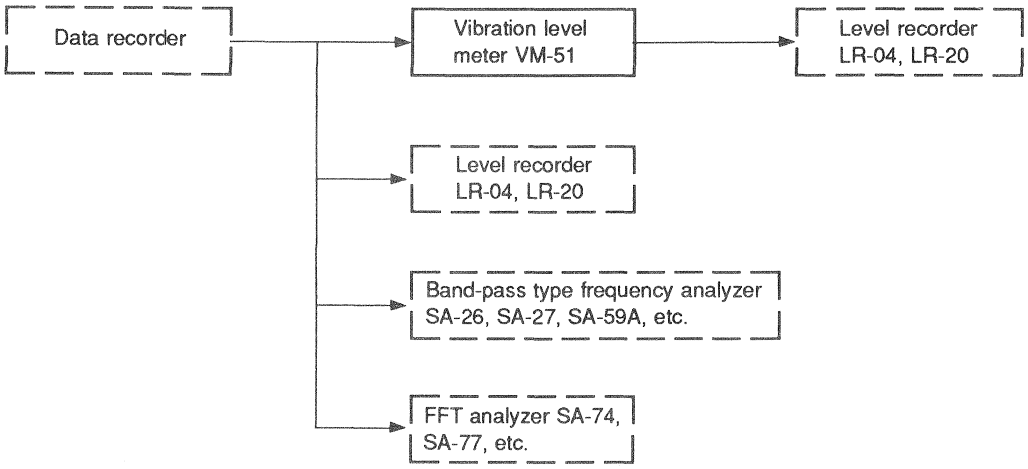
- Recording
  Press the start/reset button of the SA-59A to start recording.



Recording of frequency analysis with LR-04

Playback with a Data Recorder

Vibration acceleration data stored on a data recorder can be played back for frequency analysis, waveform recording, or reading of vibration levels with the VM-51.

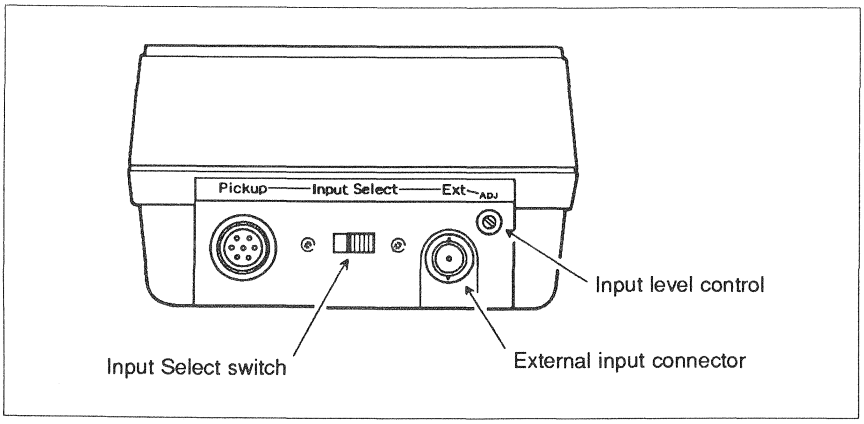


The following example explains the use of the VM-51 for reading vibration levels.

- Connection

1. Connect the data recorder output to the External input connector of the VM-51, using a BNC-BNC cable.

2. Set the Input Select switch to "Ext."



- Calibration

1. Set the Level Range selector to the same position that was selected when recording the data.

2. Set the Function selector to "Lva (VAL)". (The display axis selector may be set to any position.)

3. Play back the calibration signal recorded on the tape and adjust the input level control of the VM-51 so that the meter needle is at the "Cal" mark.

- Playback

1. Set the Function selector to "Lv (VL)".

2. Set the display axis selector to the same vibration axis that was selected when recording the data.

3. Set the data recorder to the playback condition and read the meter indication. This is the vibration level.

4. If desired, record the vibration level on the level recorder (☞ p.16).

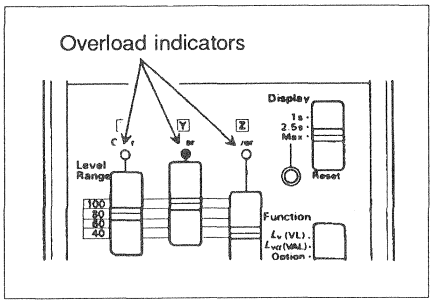
OTHER FUNCTIONS

Contents of this section

Overload Indication

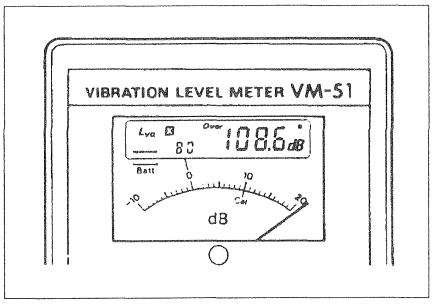
The VM-51 has two types of overload indication.

- LED indication
  When input overload occurs in any of the X, Y, Z axis directions, the corresponding LED above the Level Range selector lights up.

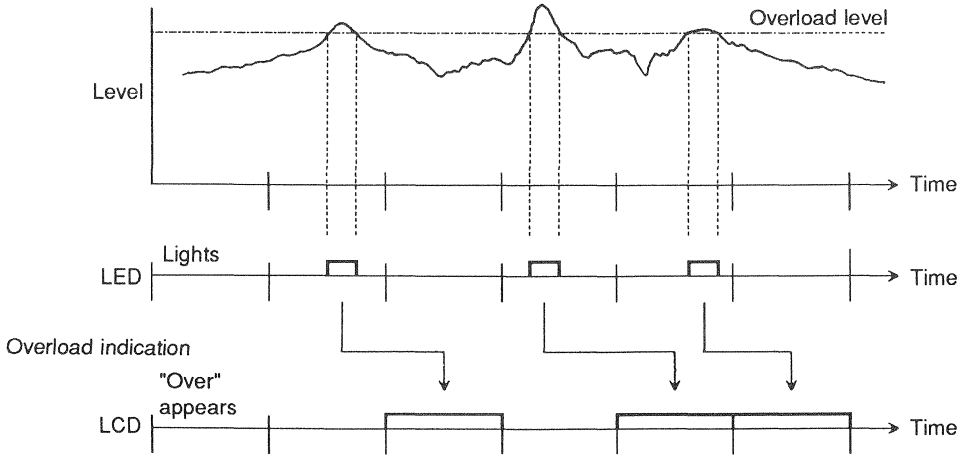


Overload is occurring in the Y axis direction.

- LCD "Over" indication
  When input overload has occurred during a display cycle for a certain axis, the digital display shows the indication "Over" together with the measured value of the next display cycle. The displayed value therefore has possibly been affected by the overload condition.

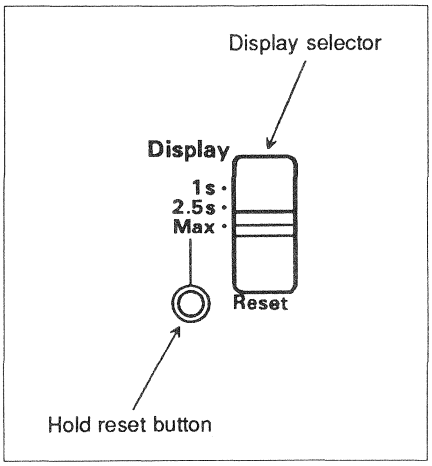


Overload is occurring in the X axis direction.



Maximum Value Hold

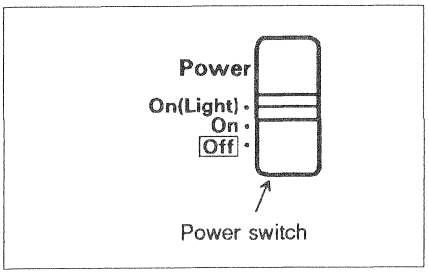
The maximum value hold function can be used to determine the maximum value within a certain predetermined time interval or to check vibrations which occur intermittently. This function is activated by setting the Display selector to "Max". To release the function, press the hold reset button.



Note: The maximum value hold function only applies to the values shown on the digital display and does not affect the analog meter indication, the DC output at the I/O connector, or the AC output.

Display Backlight

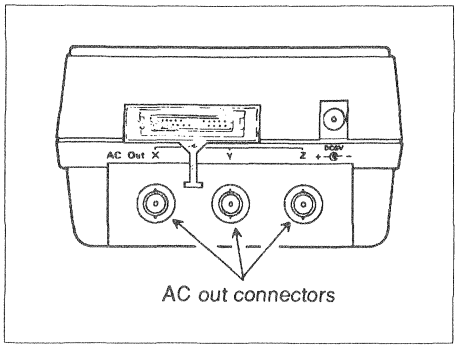
The digital display of the VM-51 has a backlight which can be switched on for easier reading at night or in dark locations.
To turn on the backlight, set the Power switch to the "On (Light)" position.



Note: When the backlight is turned on, the power consumption of the VM-51 increases by about 50 percent. The battery life therefore becomes accordingly shorter (☞ p.14). The backlight should therefore only be switched on when it is necessary for reading the LCD.

AC Output

The VM-51 possesses separate output connectors for the X, Y, and Z directions.

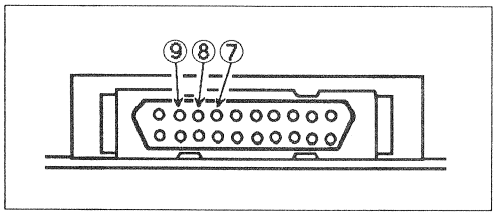


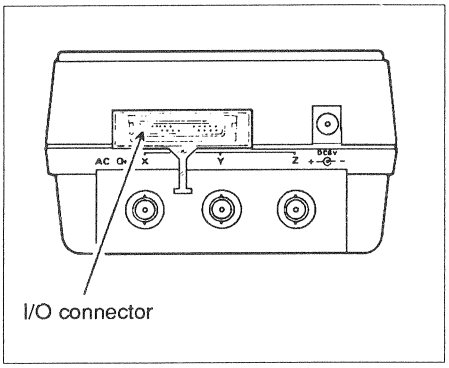
The AC output is 1 Vrms at the meter full-scale point. The load impedance should be 10 kΩ or more.

DC Output

The DC output is a log-converted DC signal supplied at the I/O connector. This signal has a dynamic range of 60 dB. For each 10 dB level change, the signal voltage changes by 0.5 V. The load impedance should be 10 kΩ or more.

Pin 7: DC signal output
Pins 8, 9: Ground
Connector type: D05-20H-R (JAE)





The table shows the relationship between input signal, meter indication and DC output voltage.

Input signal (dB)	Meter indication (dB) Level Range selector				DC output	
	40	60	80	100	Output voltage (V)	Tolerance (dB)
FS+15	–	–	–	–	3.25	±0.5
FS+10	–	–	–	–	3.0	
FS	60	80	100	120	2.5	
FS–10	50	70	90	110	2.0	
FS–20	40	60	80	100	1.5	
FS–30	30	50	70	90	1.0	
FS–35	–	–	–	–	0.75	
FS–40	–	–	–	–	0.5	±1.0
FS–45	–	–	–	–	0.25	

FS: Full-scale

CONTROLS AND FUNCTIONS

Face Panel

Overload indicator LEDs

Light up independently for X, Y, Z axis direction when overload occurs (☞ p.36).

Level Range selector

Sets the measurement range for each axis (X, Y, Z).

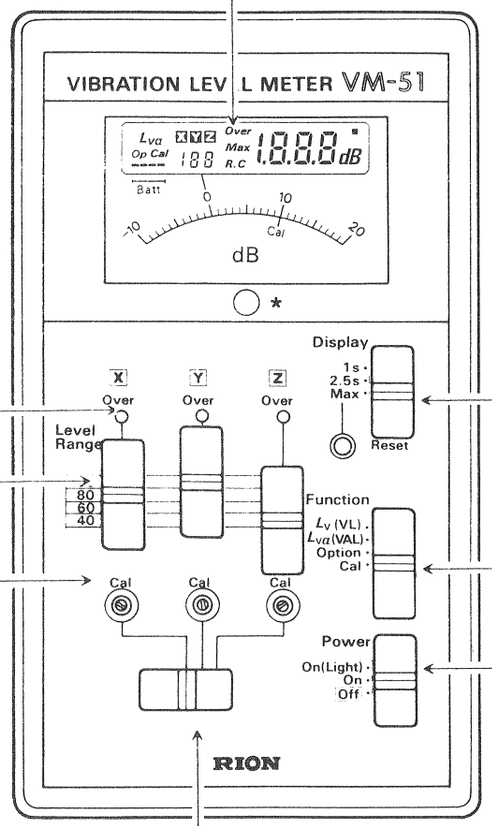
100 Digital display: 85 to 135 (dB)
Analog meter: 90 to 120 (dB)
80 Digital display: 65 to 115 (dB)
Analog meter: 70 to 100 (dB)
60 Digital display: 45 to 95 (dB)
Analog meter: 50 to 80 (dB)
40 Digital display: 30 to 75 (dB)
Analog meter: 30 to 60 (dB)

Calibration controls

Screwdriver controls for calibration of X, Y, Z axis (☞ p.9).

Display axis selector

Selects which vibration axis is to be shown on the display.
X: X axis
Y: Y axis
Z: Z axis



Display

Digital display: See page 12
Analog meter: See page 14

Display selector

Selects the display cycle.
1 s: Displayed values are updated every second.
2.5 s: Displayed values are updated every 2.5 seconds.
Max: Maximum value is held on the display. The display cycle is 1 second (☞ p.37).

Function selector

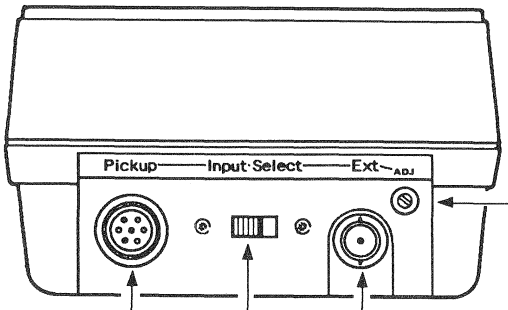
Selects the measurement function of the VM-51.
Lv (VL): Vibration level measurement
Lva (VAL): Vibration acceleration level measurement
Option: For custom configuration
Cal: Calibration (☞ p.9)

Power switch

Serves to turn the unit on and off and to activate the LCD backlight.
On (Light): Unit is turned on and LCD is backlit (☞ p.38).
On: Unit is turned on.
Off: Unit is turned off.

* Zero adjustment screw
While the unit is turned off, this screw can be used to adjust the meter needle base point (–10). Normally, no adjustment is required.

Front Panel



Input level control

Screwdriver control which serves to match the VM-51 to the level of an external input signal (☞ p.19, 33).

External input connector

Serves for input of a signal from external equipment such as a data recorder, etc. (☞ p.19, 32).

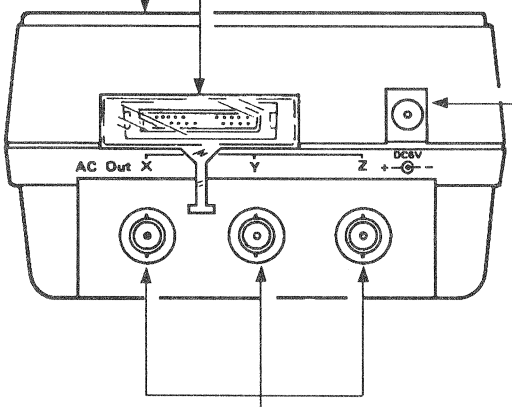
Input Select switch

Switches the unit between the input from the Pickup connector or the External input connector (☞ p.7, 19, 32).

Pickup connector

Serves for connection of the accelerometer PV-83A (☞ p.7).

Rear Panel



Battery compartment

Contains four IEC R14 (size C) batteries (☞ p.8).

I/O connector

Serves for connection of the printer CP-10 or a computer (☞ p.26). The DC output signal also is supplied from this connector (☞ p.40).

External power jack

For connection of the optional AC adapter (☞ p.8).

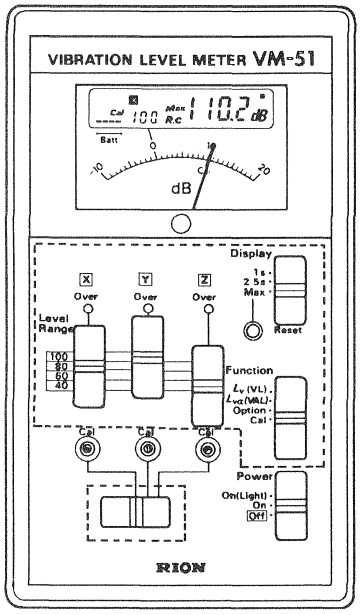
AC Out connectors

Carry AC signals corresponding to vibration in the X, Y, Z axes (☞ p.39).

Unit Control via RS-232-C Interface

RS-232-C Interface Outline

The VM-51 has a built-in RS-232-C interface which can be used to externally control all functions of the unit except power on/off switching. Measurement results and informations on switch settings etc. can also be transmitted via the RS-232-C interface.



Functions within the dotted line can be controlled.

RS-232-C Interface Specifications

Transmission configuration:	Half-duplex
Baud rate:	1200 bps
Data word length:	8 bit
Stop bits:	2
Parity check:	None

3-line connection (signal send, signal receive, ground)

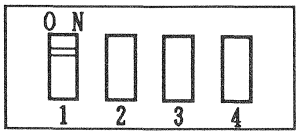
Note: When writing a program for communicating with the VM-51, pay attention to the fact that the VM-51 uses half-duplex configuration.

DIP Switch Settings, Connections

1. Set the Power switch of the VM-51 to "Off".

2. Remove the lid of the battery compartment and take out the batteries (☞ p. 8).

3. Set switch 1 as shown below.



The setting of switches 2, 3, 4 has no effect.

4. Reinsert the batteries and replace the battery compartment lid.

5. Use the CC-80 cable to connect the I/O connector on the VM-51 to the RS-232-C interface connector on the computer.

6. Set the Power switch of the VM-51 to "On".
   The test pattern (character string) shown below is sent to the computer.

ASCII codes

CR	LF																				
V	I	B	R	A	T	I	O	N	␣	L	E	V	E	L	␣	M	E	T	E	R	CR	LF
CR	LF																				
␣	␣	␣	␣	␣	␣	␣	V	M	–	5	1	CR	LF								
CR	LF																				
␣	␣	␣	␣	R	I	O	N	␣	C	O	.	␣	L	T	D	CR	LF				
CR	LF																				
␣	␣	␣	␣	T	O	K	Y	O	␣	J	A	P	A	N	CR	LF					
CR	LF																				

After the test pattern transfer is complete, the VM-51 is ready to receive commands or send measurement data etc.
When the VM-51 enters the remote control condition, the indication "R.C" appears on the digital display. The unit now can be operated only via external commands. The switches on the VM-51 (except for the Power switch) are inactive.

Note:

- If the battery voltage indicator of the VM-51 is flashing, the RS-232-C interface cannot be used.
- When the battery voltage of the VM-51 becomes low (only one or two segments of the battery voltage indicator are lit), the probability of transfer errors increases. Use the AC adapter or replace the batteries as soon as possible.

Command List

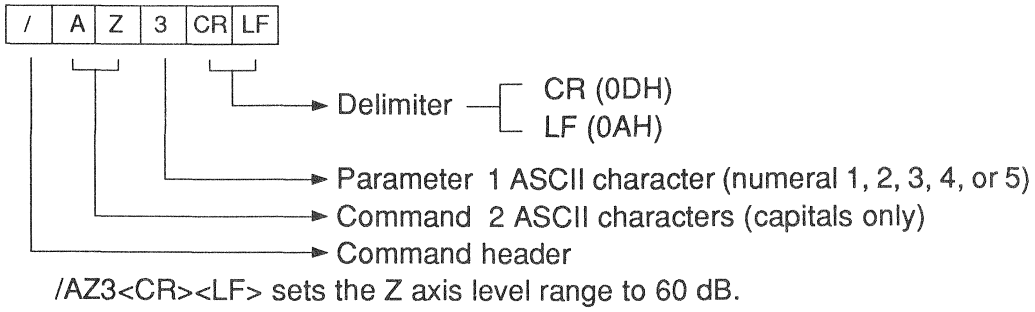
Parameter — Default setting — Effective in remote control condition — Effective in local control condition

Command			Meaning		
/AX	1	○	Level range X : 100 dB		○
	2		: 80 dB		○
	3		: 60 dB		○
	4		: 40 dB		○
/AY	1	○	Level range X : 100 dB		○
	2		: 80 dB		○
	3		: 60 dB		○
	4		: 40 dB		○
/AZ	1	○	Level range Z : 100 dB		○
	2		: 80 dB		○
	3		: 60 dB		○
	4		: 40 dB		○
/FU	1	○	Function : Lv (VL)		○
	2		: Lva (VAL)		○
	3		: Cal (*)		○
	4		: Option		○
/CH	1		Display axis : X		○
	2		: Y		○
	3	○	: Z		○
/TC ♠	1	○	Display cycle : 1 s		○
	2		: 2.5 s		○
	3		: Max		○
	4		Max. hold reset		○
/RD ♣	1		Measurement value (ASCII code, 9 characters) Example: 124.5, ␣ 0v		○
	2		Status A (ASCII code, 9 characters) Example: BAT4 ␣ , 100		○
	3		Status B (ASCII code, 9 characters) Example: AX1AY2AZ3		○
	4		Status C (ASCII code, 9 characters) Example: FU1CH3TC1		○
/MD	1		Set VM-51 to local control.		○
	2		Set VM-51 to remote control.	○	○
	3		Set VM-51 to default condition.		○
	4		After receiving this command, measurement results are sent at 1-second or 2.5-second intervals without a protocol (1-second interval if Display selector is set to "1 s" or "Max", 2.5-second interval if selector is set to "2.5 s").		○

* Becomes AX1, AY1, AZ1, TC1 during calibration, reverts to original status after calibration.
♠ Functions correspond to panel switch settings.
♣ Valid only in remote control condition.

Command Format, Data Format

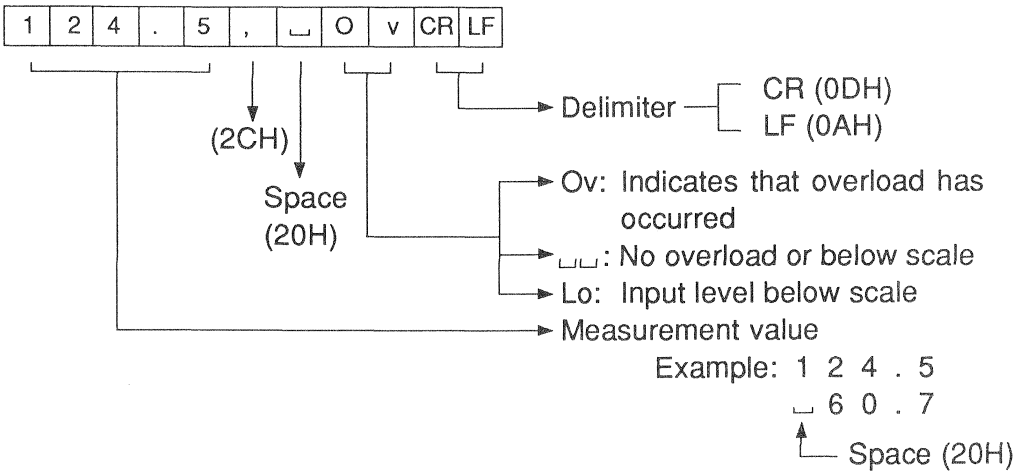
• Command format (computer to VM-51)



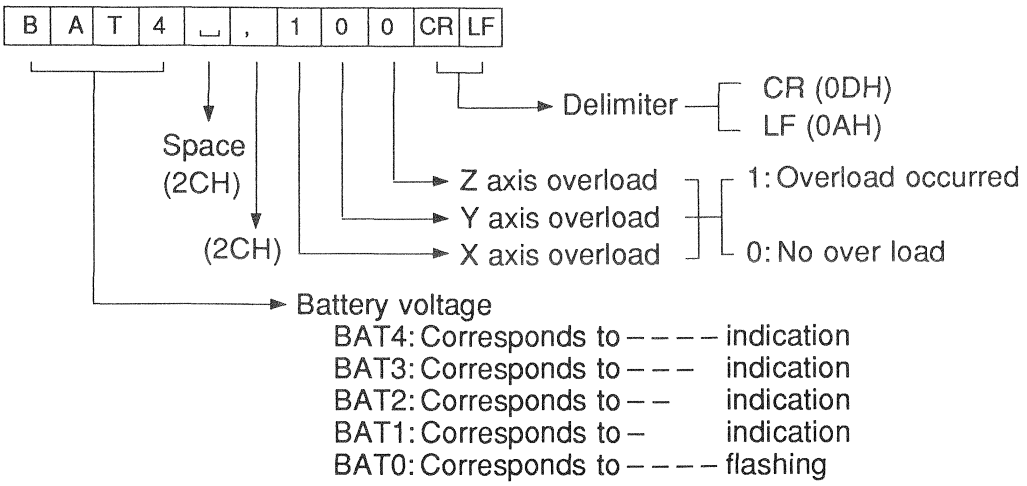
/AZ3<CR><LF> sets the Z axis level range to 60 dB.

• Data format (VM-51 to computer, ASCII codes)

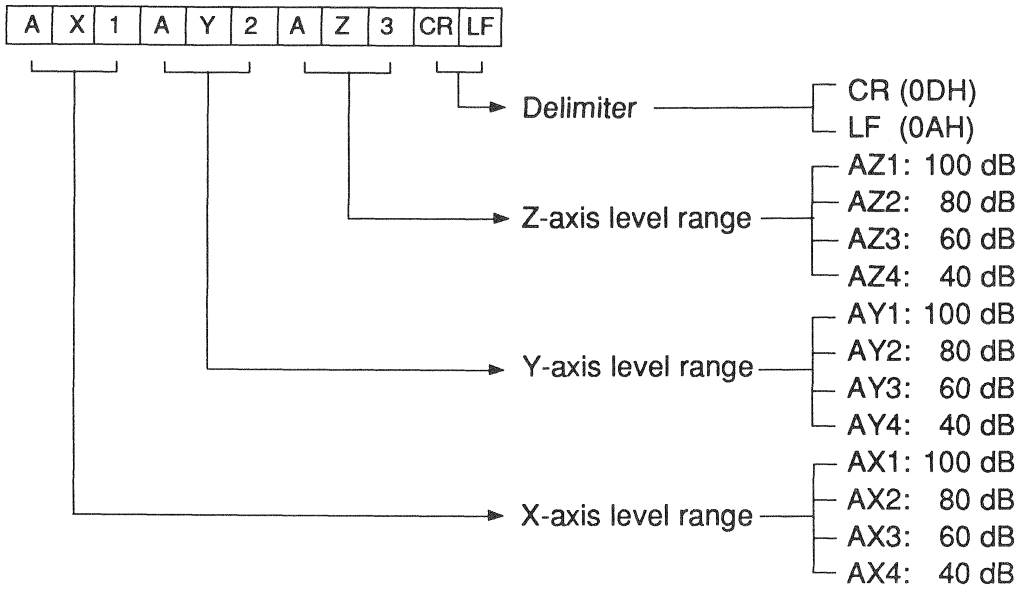
a) Measurement value



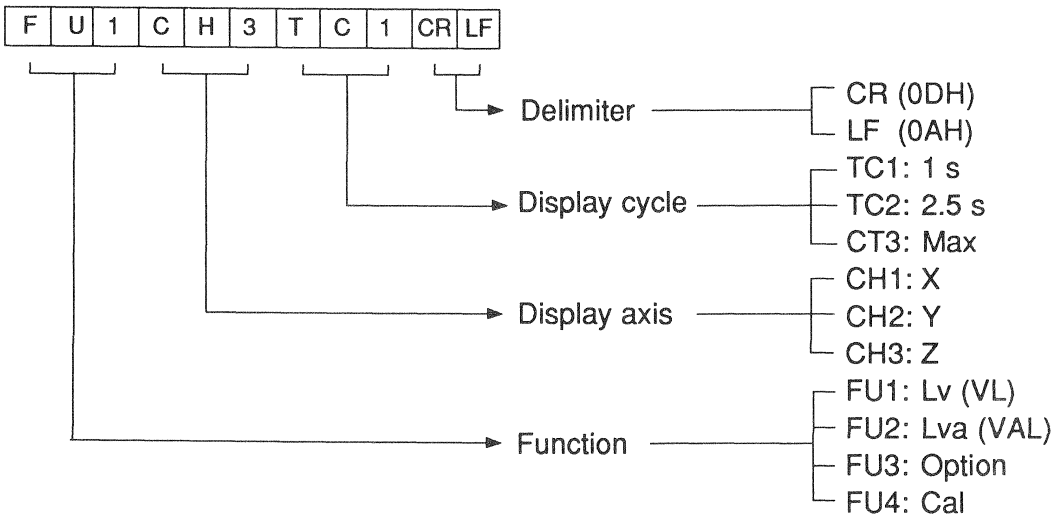
b) Status A



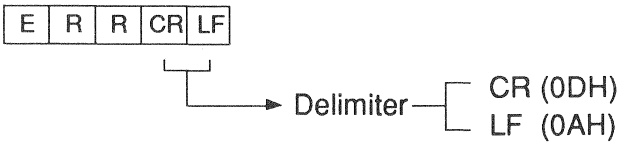
c) Status B



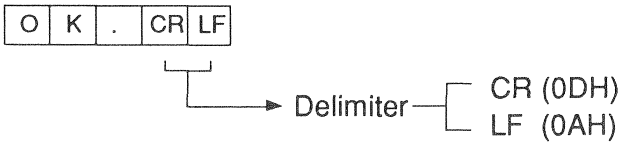
d) Status C



- Response (ASCII codes)
  a) In case of command error



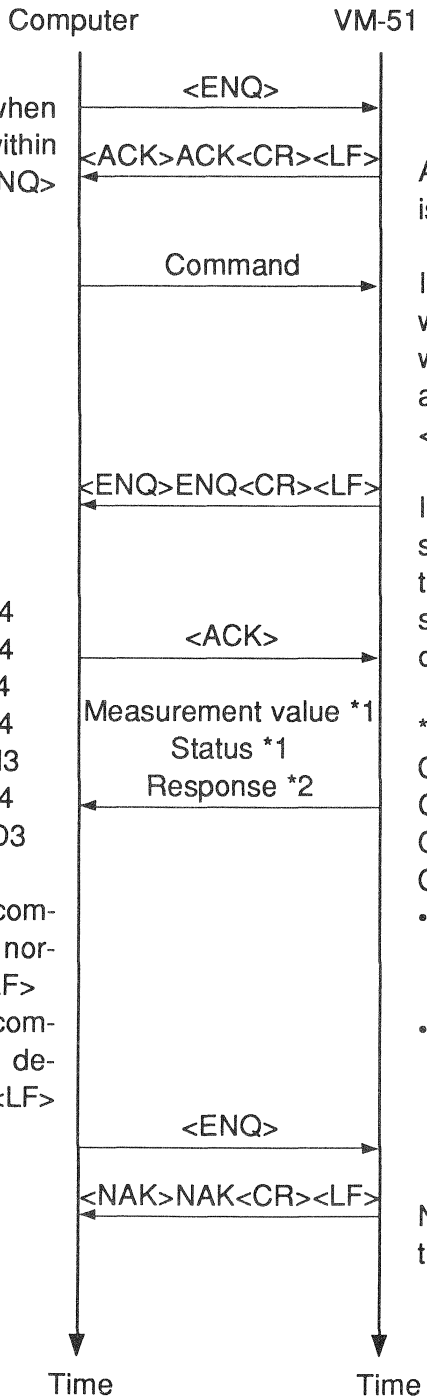
  b) Command was received normally.



Transfer Protocol

• Normal-protocol mode (command other than MD4)

<ENQ>: 05H
<ACK>: 06H
<NAK>: 15H



Time-out occurs when ACK is not returned within 2 seconds after <ENQ> was sent.

ACK indicates that the VM-51 is ready to receive commands.

If no command is received within 2 seconds after ACK was returned, time-out occurs and the VM-51 reverts to the <ENQ> standby condition.

If ACK is not returned within 2 seconds after ENQ was sent, time-out occurs and the subsequent steps are not carried out.

*2
Command AX1 - AX4
Command AY1 - AY4
Command AZ1 - AZ4
Command FU1 - FU4
Command CH1 - CH3
Command TC1 - TC4
Command MD1 - MD3

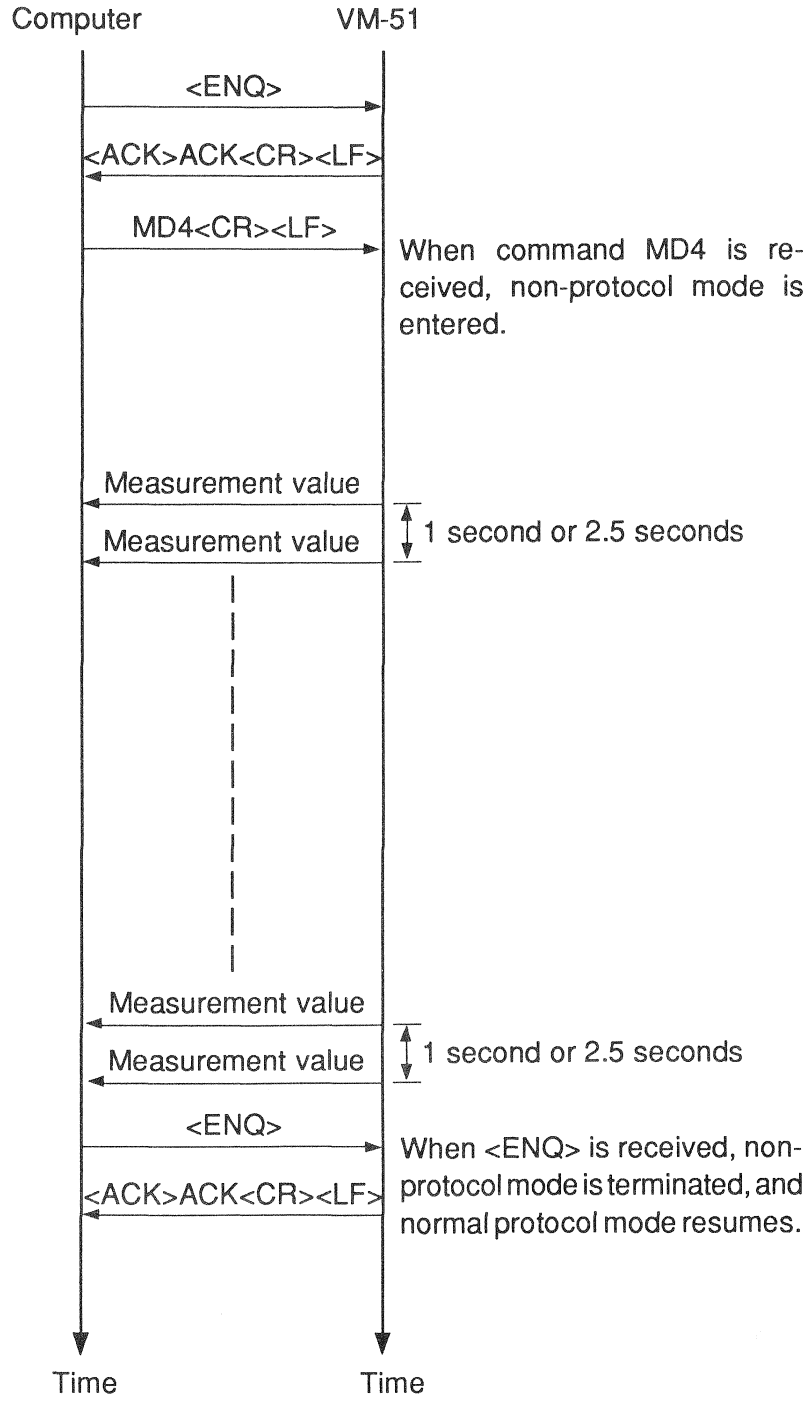
- Response when command is received normally: OK.<CR><LF>
- Response when command error was detected: ERR<CR><LF>

*1
Command RD1
Command RD2
Command RD3
Command RD4

- When command is received normally, measurement data or status data are sent.
- Response when command error was detected: ERR<CR><LF>

NAK is sent when string other than ENQ is received.

- Non-protocol mode (command MD4 was received)
  In the non-protocol mode, measurement data are sent at 1-second or 2.5-second intervals.



Sample Program

```
1000 '*****************************************
1010 '*                                       *
1020 '*      VM-51RS.BAS                      *
1030 '*                                       *
1040 '*      VM-51 RS-232-C SAMPLE PROGRAM    *
1050 '*                                       *
1060 '*      10th Jan. 1989  S.Miyazaki       *
1070 '*                                       *
1080 '*      BASIC                            *
1090 '*                                       *
1100 '*****************************************
1110 '
1120 '
1130 '**************************
1140 '*                        *
1150 '*   M A I N              *
1160 '*                        *
1170 '**************************
1180 '
1190 '***** W A I T  3 0 S E C  *****
1200 'GOSUB *WAIT30SEC
1210 '
1220 '***** I N I T I A L I Z E  R S - 2 3 2 - C  *****
1230 OPEN "COM:N83NN" AS #1
1240 CLOSE
1250 '
1260 OPEN "COM:N83NN" AS #1
1270 '
1280 '***** V M - 5 1  R E M O T E  C O N T O R O L  *****
1290 '
1300 COMMAND$="/MD2"     :'*** REMOTE MODE ***
1310 GOSUB *PROTOCOL
1320 '
1330 COMMAND$="/MD3"     :'*** DEFAULT SETTING ***
1340 GOSUB *PROTOCOL
1350 '
1360 COMMAND$="/AX2"     :'*** ATT-X = 80 dB ***
1370 GOSUB *PROTOCOL
1380 '
1390 COMMAND$="/AY3"     :'*** ATT-Y = 60 dB ***
1400 GOSUB *PROTOCOL
1410 '
1420 COMMAND$="/AZ4"     :'*** ATT-Z = 40 dB ***
1430 GOSUB *PROTOCOL
1440 '
1450 COMMAND$="/FU1"     :'*** FUNCTION = Lv ***
1460 GOSUB *PROTOCOL
1470 '
1480 COMMAND$="/CH3"     :'*** XYZ = Z ***
1490 GOSUB *PROTOCOL
1500 '
1510 COMMAND$="/TC1"     :'*** DISPLAY = 1 sec ***
1520 GOSUB *PROTOCOL
1530 '
1540 COMMAND$="/MD4"     :'*** MODE 4 ***
1550 GOSUB *PROTOCOL
1560 '
```

```
1570 GOSUB *READ50DATA   :'*** READ 50 DATA ***
1580 '
1590 GOSUB *MD4END
1600 '
1610 COMMAND$="/MD1"     :'*** LOCAL MODE ***
1620 GOSUB *PROTOCOL
1630 '
1640 '
1650 '***** C L O S E   R S - 2 3 2 - C  *****
1660 CLOSE
1670 '
1680 '***** R U N   A G A I N  *****
1690 GOSUB *SECWAIT
1700 PRINT
1710 PRINT
1720 GOTO 1220
1730 '
1740 '***** E N D  *****
1750 *OWARI
1760 COM OFF
1770 STOP
1780 END
1790 '
1800 '
1810 '**********************************
1820 '*                                *
1830 '*   S U B - R O U T I N E S      *
1840 '*                                *
1850 '**********************************
1860 '
1870 '
1880   '***** W A I T   3 0   S E C  *****
1890   *WAIT30SEC
1900     COUNT=0
1910     TT1$=TIME$
1920     TT2$=TIME$
1930     IF TT1$=TT2$ THEN 1920
1940     COUNT=COUNT+1
1950     PRINT "COUNT = ";COUNT
1960     IF COUNT < 30 THEN 1910
1970     PRINT
1980   RETURN
1990   '
2000   '
2010   '***** R E A D   5 0   D A T A  *****
2020   *READ50DATA
2030     FOR NN=1 TO 50
2040      LINE INPUT #1,DT$
2050      LOV$=RIGHT$(DT$,2)
2060      IF LOV$="OV" THEN LV$="Over"
2070      IF LOV$="Lo" THEN LV$="Lo   " ELSE LV$="   "
2080      MES$=LEFT$(DT$,5)
2090      PRINT " No ";NN," Lv-Z = ";MES$;" [dB] ";LV$
2100     NEXT NN
2110   RETURN
2120   '
2130   '
2140   '***** P R O T O C O L  *****
2150   *PROTOCOL
2160   '
```

```
2170      GOSUB *SEND.ENQ
2180      '
2190      INTFLAG=0
2200      ON COM GOSUB *RECEIVE.ACK
2210       COM ON
2220       GOSUB *T.CHECK
2230      COM OFF
2240      '
2250      GOSUB *TIMEWAIT
2260      '
2270      GOSUB *SEND.COMMAND
2280      '
2290      INTFLAG=0
2300      ON COM GOSUB *RECEIVE.ENQ
2310       COM ON
2320       GOSUB *T.CHECK
2330      COM OFF
2340      '
2350      GOSUB *TIMEWAIT
2360      '
2370      GOSUB *SEND.ACK
2380      '
2390      INTFLAG=0
2400      ON COM GOSUB *RECEIVE.RESPONSE
2410       COM ON
2420       GOSUB *T.CHECK
2430      COM OFF
2440      '
2450      GOSUB *TIMEWAIT
2460      PRINT
2470      '
2480    RETURN
2490  '
2500  '
2510    '***** M O D E  4  E N D  *****
2520    *MD4END
2530      PRINT
2540      PRINT
2550      GOSUB *SEND.ENQ
2560      ANS$=INPUT$(1,#1)
2570      IF ANS$=CHR$(6) THEN 2600
2580       GOSUB *TIMEWAIT
2590       GOTO 2550
2600      LINE INPUT #1,AA$
2610      IF AA$="ACK" THEN  2640
2620       GOSUB *TIMEWAIT
2630       GOTO 2550
2640      PRINT " <ACK>    PC <-- VM-51 "
2650      PRINT
2660      GOSUB *SECWAIT
2670      CLOSE
2680      OPEN "COM:N83NN" AS #1
2690      GOSUB *SECWAIT
2700      PRINT "=== END OF MODE-4 ==="
2710      PRINT
2720    RETURN
2730  '
2740  '
2750  '
2760  '
```

```
2770        '*** S E N D   <ENQ>  ***
2780        *SEND.ENQ
2790        PRINT #1,CHR$(5);
2800        PRINT " <ENQ>    PC --> VM-51 "
2810        RETURN
2820        '
2830        '
2835        '*** R E C E I V E   <ACK>  ***
2840        *RECEIVE.ACK
2850        IF INTFLAG=1 THEN RETURN
2860        INTFLAG=1
2870        A$=INPUT$(6,#1)
2880        IF A$=CHR$(6)+"ACK"+CHR$(13)+CHR$(10) THEN 2940
2890        IF A$=CHR$(21)+"NAK"+CHR$(13)+CHR$(10) THEN 2920
2900         PRINT "***** RECEIVE ERROR *****";A$
2910         RETURN *OWARI
2920        PRINT " <NAK>    PC <-- VM-51 "
2930        RETURN *OWARI
2940        PRINT " <ACK>    PC <-- VM-51 "
2950        COM OFF
2960        RETURN
2970        '
2980
2985        '*** S E N D   C O M M A N D  ***
2990        *SEND.COMMAND
3000        PRINT #1,COMMAND$
3010        PRINT " ";COMMAND$;"     PC --> VM-51 "
3020        RETURN
3030        '
3040        '
3045        '*** R E C E I V E   <ENQ>  ***
3050        *RECEIVE.ENQ
3060        IF INTFLAG=1 THEN RETURN
3070        INTFLAG=1
3080        C$=INPUT$(6,#1)
3090        IF C$=CHR$(5)+"ENQ"+CHR$(13)+CHR$(10) THEN 3120
3100        PRINT "*** RECEIVE ERROR ***";C$
3110         RETURN *OWARI
3120        PRINT " <ENQ>    PC <-- VM-51 "
3130        COM OFF
3140        RETURN
3150        '
3160        '
3165        '*** S E N D   <ACK>  ***
3170        *SEND.ACK
3180        PRINT #1,CHR$(6);
3190        PRINT " <ACK>    PC --> VM-51"
3200        RETURN
3210        '
3220        '
3225        '*** R E C E I V E   R E S P O N S E  ***
3230        *RECEIVE.RESPONSE
3240        IF INTFLAG=1 THEN RETURN
3250        INTFLAG=1
3260        E$=INPUT$(5,#1)
3270        IF E$="OK."+CHR$(13)+CHR$(10) THEN 3330
3280        IF E$="ERR"+CHR$(13)+CHR$(10) THEN 3310
3290         PRINT "*** RECEIVE ERROR ***";E$
3300         RETURN *OWARI
3310        PRINT " <ERR>    PC <-- VM-51"
```

```
3320        RETURN
3330        PRINT " <OK.>    PC <-- VM-51"
3340        COM OFF:RETURN
3350        '
3360        '
3365        '***  C H E C K   T I M E O U T  ***
3370        *T.CHECK
3380        COUNT=0
3390        TA$=TIME$
3400        TB$=TIME$
3410        IF INTFLAG=1 THEN RETURN
3420        IF TA$=TB$ THEN 3400
3430        COUNT=COUNT+1
3440        IF COUNT<=3 THEN 3390
3450        PRINT "*** TIME OUT ***"
3460        RETURN *OWARI
3470        '
3480        '
3485        '*** W A I T  ***
3490        *SECWAIT
3500        PRINT "----- WAIT -----"
3510        SCOUNT=0
3520        ST1$=TIME$
3530        ST2$=TIME$
3540        IF ST1$=ST2$ THEN 3530
3550        SCOUNT=SCOUNT+1
3560        IF SCOUNT<3 THEN 3520
3570        RETURN
3580        '
3590        '
3595        '*** W A I T (0.5 sec) ***
3600        *TIMEWAIT
3610        FOR NW= 1 TO 500
3620         ZZ=LOG(NW)
3630        NEXT NW
3640        RETURN
3650 '
3660 '
```

SPECIFICATIONS

Vibration pickup	
Model	Accelerometer PV-83A
Type	Shear-type piezoelectric 3-axis acceleration pickup, fully moisture-proof construction (JIS C 0920) with integrated preamplifier
Sensitivity	60 mV/m/s^2 ±3% (31.5 Hz)
Frequency range	1 to 90 Hz (±1 dB)
Maximum measurement acceleration	3 G
Transverse sensitivity	–20 dB or less
Noise level	25 dB or less
Dimensions	84 (dia.) x 61 mm
Weight	Approx. 750 g
Frequency characteristics	1 to 90 Hz, frequency weighting according to JIS C 1510-1976
Vibration level	X axis: horizontal vibration characteristics Y axis: horizontal vibration characteristics Z axis: vertical vibration characteristics
Vibration acceleration level	Flat characteristics in X, Y, Z axes
Measurement range	30 to 60 dB, 50 to 80 dB, 70 to 100 dB, 90 to 120 dB (0 dB = 10^{-5} m/s^2, JIS), separately selectable for X, Y, Z axes
Rectification characteristics	True rms
Analog meter	Effective display range 30 dB (linear decibel scale)

Digital display	3-1/2-digit LCD, 0.1-dB steps
Display value	Momentary or maximum value, updated every 1 or 2.5 seconds
Dynamic characteristics	$-1.0\ ^{+0.5}_{-1.0}$ dB for 31.5 Hz intermittent sine wave input with 1-second intervals
Overload indication	"Over" appears and separate LEDs for X, Y, Z axis light up at +15 dB over full-scale point or when internal amplifier saturates
Calibration	Electrical calibration with built-in oscillator (31.5 Hz, sine wave), separate calibration for X, Y, Z axes
Inputs	
Pickup connector	PRC03-23A10-7F
External input	1 BNC connector Input impedance 10 kΩ (unbalanced) With input level control
Outputs	
AC outputs	3 BNC connectors for X, Y, Z axes Load impedance 10 kΩ or more Output voltage 1 Vrms at meter full-scale point
DC output (log-converted)	Through I/O connector Load impedance 10 kΩ or more Dynamic range 60 dB or more Output voltage 2.5 V at meter full-scale point (0.5 V/10 dB)
Ambient conditions for operation	
Accelerometer	0 to 40°C, less than 100% RH
Main unit	0 to 40°C, less than 90% RH

Power requirements	
Power consumption	6 V, 100 mA (without backlight)
Batteries	IEC R14 x 4
Battery life	Max. 20 hours (continuous use, with manganese batteries, at 20°C)
Dimensions	11.4 (W) x 20.0 (H) x 7.0 (D) cm
Weight	Approx. 950 g (including batteries)

Supplied Accessories

Accelerometer PV-83A	1
EC-02 cable (3 m)	1
Carrying case	1
Miniature screwdriver	1
IEC R14 battery	4
Instruction manual	1

No. 14951 03-08