KENWOOD

AUTO RANGE VOLTMETER

VT-173

INSTRUCTION MANUAL

KENWOOD CORPORATION

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CONTENTS

1. GENERAL

The KENWOOD Electronic Voltmeter VT-173 is an absolute-mean value indication type automatic electronic voltmeter which can measure AC voltage ranging from 10Hz to 1MHz on the root-mean-square value scale.
It has a wide full scale ranges covering from 1mV to 300V and selects the optimum measurement range automatically in accordance with input level.
The measurement range can be fixed manually. For on-production-line use, a remote control unit (option) is available.

2. FEATURES

a. Dual power differential input amplifiers used in the entire circuit provide a high reliability and good characteristic of restoration from possible saturation due to excessive inputs.
b. A large-sized Taut-band meter has a high sensitivity and reliability.
c. The number of adjusting trimmers are minimized with the use of the amplifiers which are precisely calculated in the open loop gains and are negative-biased through metal-film resistors as accurate as 1%. The amplifier characteristics, therefore, are free from any secular change.
d. The input resistance is as high as 10MΩ in all ranges and its parallel capacitance is 45pF or lower.
e. The meter scales are graduated in the root-mean-square values for sinusolidal waves. Also, the meter has a dB and dBm scales convenient for measuring relative values.
f. The output terminal allows your VT-173 to use as a high-gain, wide-band amplifier.

g. An electronic circuit automatically selects the range most suitable for measuring input voltage.
   A desired range can also be selected manually.
h. AC and DC outputs are available for monitoring.

3. SPECIFICATIONS

[Meter Section]

Measurable voltages :	1mV–300mV in 12ranges: 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, and 300V full scales.
dB :	−80～+50dB (0dB=1V)
dBm :	−80～+52dBm (0dBm=1mW, 600Ω)
Error :	Within ± 3% of full scale at 1kHz.
Frequency response :	± 10% at 10Hz–1MHz, ± 3% at 20Hz–200kHz and ± 2% at 50Hz–100kHz as referenced to 1kHz response.
Input impedance :	10MΩ ± 5%, with less than 45pF parallel capacitance.
Durable input voltage :	500V (DC+ACpeak) 1V to 300V range 100V (DC+ACpeak) 1mV to 300mV range
Stability :	Within ± 0.5% of full scale for ± 10% line voltage fluctuation.
Residual voltage :	Less than 20μV with input shorted on 1mV range

[AC output Amplifier Section]

Output voltage :	1Vrms ±20%
Output resistance :	600Ω ±20%
Frequency response :	Within ±3dB at 10Hz−500kHz.
Distortion :	Less than 1% at full scale.(Rated by signal-noise ratio in 1mV range.)
Signal-to-noise ratio :	Over 40dB at full scale.

[DC Output Amplifier Section]

Output voltage :	1V±20% +offset voltage at fullscale
Offset voltage :	±100mV
Output resistance :	600Ω ±20%
Ripple :	Less than 10mVrms
Frequency response :	Within ±3dB at 10Hz to 1MHz

[Environmental]

Temperature coefficient :	±0.08%/℃.
Within specifications tenperature :	10～40℃
Full operating temperature :	0～50℃
Relative humidity :	Less than 80%

[Power Supply Section]

Line voltage :	100, 120, 220V AC ± 10%, 216−250V AC , 50/60Hz
Power consumption :	Approx, 5W.
[Dimensions]	128(130) W×190(215) H×238(270) Dmm. Valuen in ( ) include protrusions.
[Net weight]	3.2kg

[Accessories]

Power cable :	1pc.
Input cable :	CA-41, 1pc.
Replacement fuse :	0.3A 2pcs. 0.5A 2pcs.
Instruction manual :	1copy.

4. FUNCTIONAL CONTROLS

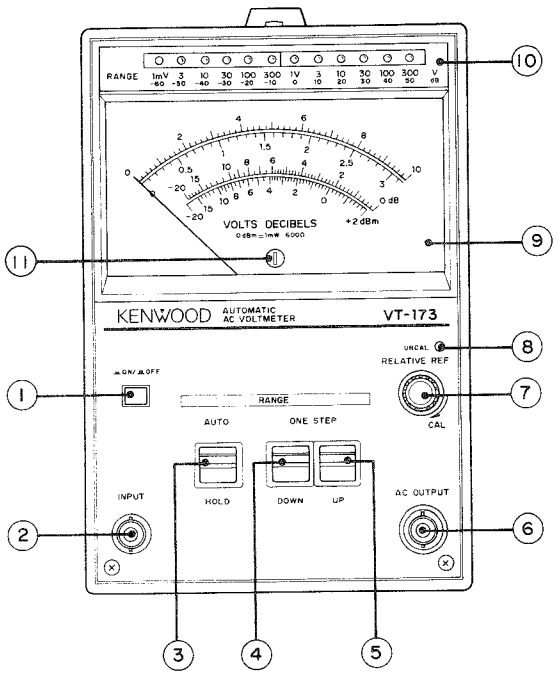

Figure 1 – Front Panel View.

Front Panel (see Figure 1)

REFERENCE No.	IDENTIFICATION	DESCRIPTION
①	ON /OFF	ON/OFF switch
②	INPUT	Input connector
③	AUTO/HOLD	Mode selector switch
④	DOWN	Range DOWN switch
⑤	UP	Range UP switch
⑥	AC OUTPUT	AC output terminalctor
⑦	RELATIVE REF	RELATIVE REF controller
⑧	UNCAL	Uncaliblation indicator
⑨	VOLTES/DECIBELS	Meter
⑩	RANGE	RANGE indicator lamp
⑪		METER zero-adjust trimmer

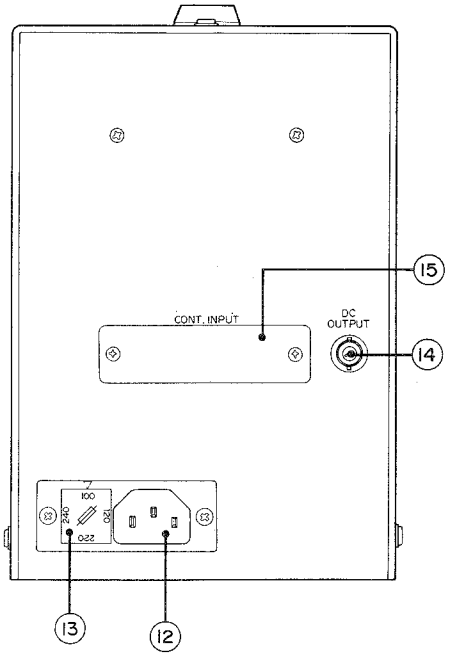

Figure 2 – Rear Panel View.

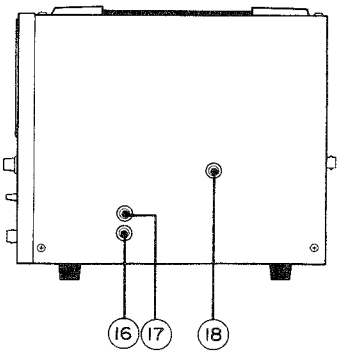

Figure 3

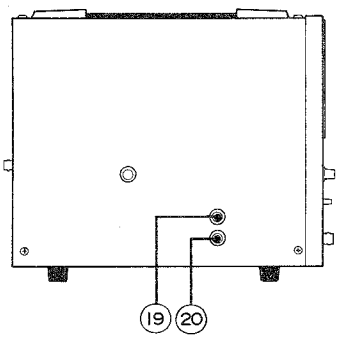

Figure 4

Rear Panel (see Figure 2)

REFER-ENCE No.	IDENTIFICATION	DESCRIPTION
⑫		Power connector
⑬		Line voltage selector and fuse holder
⑭	DC OUTPUT	DC output terminal
⑮	CONT. INPUT	Remote control connector (option) blind plate

Preset Controles on Side Panel (see Figure 3 and 4)

REFER-ENCE No.	IDENTIFICATION	DESCRIPTION
⑯	TC 101	First Attenuator preset trimmer capacitor
⑰	VR 101	First Attenuator preset variable resistor
⑱	VR 102	Meter fullscale preset variable resistor
⑲	VR 201	Range up level preset variable resistor
⑳	VR 202	Range down level preset variable resistor

5. OPERATION

The VT-173 has three range setting modes ; Auto, Hold and Remote (option). With these modes, the VT-173 provides a wide applications.

[How to Use Auto Mode]

(1) By pressing the ON/OFF switch ①, the RANGE indicator lamps ⑩ go on sequentially from 300V range indicator. The 1mV indicator goes on finally.

(2) When signal is input to the INPUT connector ②, the VT-173 automatically selects the measurement range where the meter pointer indicates a value from 27% to 102% of the full scale (standard value).

(3) If the level of the input signal corresponds to a value from 85% to 102% of the full scale (standard value), a 1 level higher range may be selected to indicate the voltage within 27% to 32% (standard value). In such a case, the sensitivity can be increased by 1 range with the DOWN switch ④ to indicate the voltage within 85% to 102% (standard value).

Note: The "full scale" denotes the division 10 on the scale

(4) To fix the range, set the MODE selector switch ③ to HOLD position. The range immediately before setting the selector switch is held hereafter.

[How to Use Hold Mode]

(1) Press the ON/OFF switch ① to fix indication of the RANGE lamps ⑩ to 300V.
(2) Supply signal to the INPUT connector②.
(3) While observing the swing of the meter pointer, select a desired range with the DOWN switch④.
(4) The selected range is changed into the 1 level higher range by pressing the UP switch ⑤ or the 1 level lower range by pressing the DOWN switch④.

[Scale (See Fig. 5)]

(1) Voltage Scale

The meter has double-graduated black scales: the scale Ⓐ graduated from 0 to 10 and the scale Ⓑ graduated from 0 to 3. In the 1V range, division 10 on the 0~10 scale Ⓐ indicates 1V. In the 300mV range, division 3 on the 0~3 scale Ⓑ indicates 300mV. Scales correspond to voltages likewise in other range.

(2) dB Scale

The dB scale, marked with dBV in general, indicates 1V as 0dB. The 0~10 scale Ⓐ has voltage-ratio-based divisions and division 10 on it corresponds to 0dB .

If the meter reads −6dB in measurement using the 20dB (10V) range, the measured value is 20dB−6dB = 14dB. This correspondence also applies to other ranges.

(3) dBm Scale

In general, voltmeters have a reference level division of 0dBm equal to 0.775V (1mV power) induced across a 600Ω resistance load. Therefore, the red dBm scale is available to measure a power level referenced to 0 dBm, with the impedance of the given power circuit being 600Ω pure resistance. Where measured across specific resistance loads, for example, 10kΩ, other than the 600Ω load, the levels are sometimes expressed in dBs.

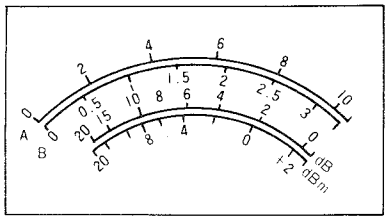

Figure 5 – Meter Scale Graduations.

[How to Use Relative Reference Control]

The RELATIVE REF control is kept at "CAL" in general cases of reading calibrated, absolute values on the Meter. To measure relative levels such as frequency responses, turn the control for uncalibration state (UNCAL) until the reference level is set to a desired value, for example, 0dBm. This allows reading the relative levels.

[How to Use Remote Control]

The RT-61 option, one of the features of the VT-173, provides the VT-173 with remote control capability. To attach the RT-61, remove the blind plate from the rear panel of the VT-173, install the connector supplied with the RT-61, then plug the RT-61 into the connector on the PCB (voltmeter unit).

Then, set the MODE selector switch on the remote control box to REMOTE position. By this, the measurement ranges of the VT-173 can be remote-controlled with the RANGE selector on the remote control box. By setting the MODE selector on the remote control box to PANEL, the VT-173 can be operated on the panel.

For details, see the Instruction Manual of the RT-61.

Note: To use the VT-173 in the Remote mode, be sure to set the MODE selector on the panel to AUTO position.

[How to Use AC OUTPUT and DC OUTPUT Connectors]

The AC OUTPUT connector outputs 1Vrms AC voltage when the meter reads the full scale, regardless of the measurement range.

Output impedance is 600Ω.

Likewise, the DC OUTPUT connector outputs approx. 1V DC voltage when the meter reads the full scale, regardless of the measurement range.

Output impedance is 600Ω.

6. APPLICATIONS

The basic use of your VT-173 is to measure sinusoidal wave voltages as an AC voltmeter. In addition, it provides a wide variety of applications as described below.

(1) Amplifier Gain Measurement

Your VT-173 is capable of measuring an amplifier gain, which is a signal magnification from point A to B in Figure6 with a signal generator connected to the amplifier input. If the measured signal levels at points A and B are a and b dB, respectively, then the gain is (b−a) dB.

Also, the method is applicable to negative-feedback amplifiers; that is, it is available for measuring an open loop gain of each amplifier circuit with the negative-feedback signal leaves applied.

Further, the method can be used for measuring the frequency responses of given circuits by changing the signal generator frequency.

As an example, let us calculate the open loop gain (from point A to B) of the negative-feedback amplifier shown in Figure7. Assume that the measured level at point A be+1.5dB in the −60dB range and that of point B −4dB in the +10dB range. The gain from point A to B is

(+10dB−4dB)−(−60dB+1.5dB)=64.5dB.

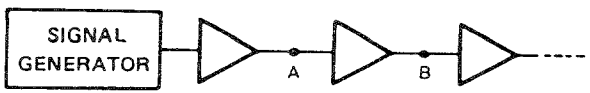

Figure 6 − Amplifier Gain Measurement.

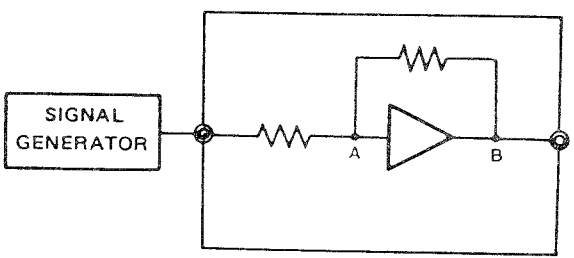

Figure 7− Negatve Feedback Amplifier Gain Measurement.

(2) Root-Mean-Square and Peak Value Calculations

Your VT-173, an voltmeter of absolute-mean value indication type, reads root-mean-square values of sinusoidal wave inputs. Also, it deflects the pointer in proportion to the absolute-mean value of a given input wave.

If the form factor (=root-mean-square value/absolute mean value) of the input wave and the crest (=peak value/root-mean-square value) are known, then the root-mean-square value and peak value can be calculated as follows.

Be sure to use the HOLD (manual) mode to measure non-sinusoidal wave voltage.

a. Assume that the meter reads x.

- Absolute mean value= $\frac{2\sqrt{2}}{\pi}x \fallingdotseq 0.9x$.
- Root-mean-square value=(Absolute mean value) ×(form factor).
- Peak value=(Root-mean-square value)×(crest).

b. For rectangular waves, their form factor is unity (1) and the crest unit (1).

- Absolute mean value= $\frac{2\sqrt{2}}{\pi}x \fallingdotseq 0.9x$.
- Peak value=0.9x.

c. For sawtooth waves, their form factor is $2/\sqrt{3}$ and the crest $\sqrt{3}$.

- Absolute mean value = $\frac{2\sqrt{2}}{\pi}x \fallingdotseq 0.9x$.
- Root-mean-square value= $\frac{2\sqrt{2}}{\pi} \times \frac{2}{\sqrt{3}}x = \frac{4\sqrt{2}}{\pi\sqrt{3}}x \fallingdotseq 1.04x$.
- Peak value= $\frac{4\sqrt{2}}{\pi\sqrt{3}} \times \sqrt{3}x = \frac{4\sqrt{2}}{\pi}x \fallingdotseq 1.8x$.

7. MAINTENANCE

(1) Removing the casing (see Figure 8)

1. Remove the six screws holding the casing on the both sides and top using a Phillips screw driver.
2. Widen the bottom of the 7-shaped casing a little and pull it up for removal.

(2) Mounting the casing (see Figure 9)

1. Widen the bottom of the casing a little when covering it over the main body.
2. Fit the casing PC board retianer to the PC board retainer.
3. Alternately tighten the six screws for uniform torque.

(3) Replacing the fuse (see Figure 10)

REPLACING FUSE

When a fuse goes out, the device is no longer operable. If gone out, check for a trouble cause, remedy it, remove the cap of the fuse holder on the rear panel using a minus screw driver and take it out and replace the fuse with a new one.

When replacing fuse, be sure to check the capacity of a new fuse for a specified value as follows:

AC 100V, 120 : 0.2A

AC 220V, 240V : 0.1A

(4) CHANGING THE SUPPLY VOLTAGE

Remove the fuse holder on the rear side device set, using a minus surew driver, adjust your preferred voltage indication with ▼ mark and plug the holder in. For changing 100V or 120V to 220V or 240V, change the fuse of 0.2A to that of 0.1A.

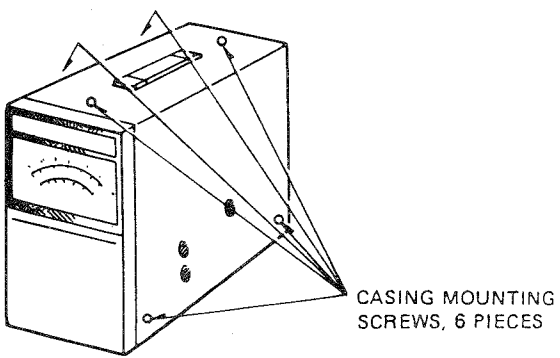

Figure 8 – Casing Removal.

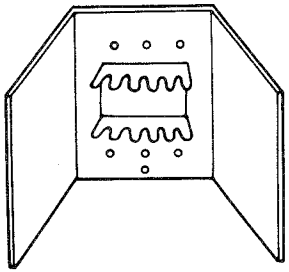

Figure 9 - PC Board Retainer.

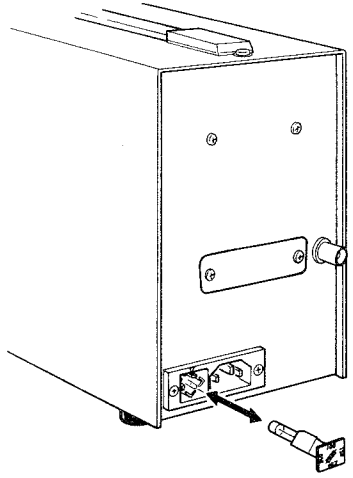

Figure 10 - Replacing the fuse.

8. ALIGNMENT

The VT-173 is factory-adjusted precisely. However, it can be adjusted through the adjust holes on the side while being housed in the casing if necessary. For re-adjustment, check the supply voltage first, then follow the instructions below using a precisely-calibrated measuring instrument.

1. Prior to turning on power, adjust the meter pointer indicates exactly zero with the ZERO ADJUST screw ⑪ of the meter.
2. Turn on the power of the VT-173, then set the MODE selector switch ③ to HOLD position. Rotate the RELATIVE RFF control ⑦ clockwise to activate it.
3. Connect the voltmeter calibrator output (1kHz or 400Hz) to the INPUT connector ②.
4. Set the calibrator output voltage to 300mV to set the range of the VT-173 to 300mV. Control VR102 ⑱ so that the meter reads the full scale.
5. Then, set the calibrator output voltage to 3V to set the range of the VT-173 to 3V. Control VR101 ⑰ so that the meter reads the full scale.
6. Disconnect the calibrator. Connect a wide-band signal generator to the INPUT connector ②.

7. Adjust the frequency and output voltage of the signal generator to 50kHz and 3V respectively to set the range of the VT-173 to 3V. Control TC101 ⑯ so that the meter reads the full scale.
8. Repeat steps from 5 to 7.
9. Fully rotate VR201 ⑲ clockwise and VR202 ⑳ counterclockwise.
10. Set the frequency and output voltage of the signal generator to 1kHZ and approx. 120mV respectively. Set the MODE selector switch ③ of the VT-173 to AUTO position.
11. Adjust the measurement range of the VT-173 to 100mV with the DOWN switch ④ and UP switch ⑤.
12. Control the RELATIVE REF ⑦ so that the meter reads 102mV.
13. Rotate VR201 ⑲ counterclockwise slowly untill the measurement range is changed into 300mV.
14. Control the RELATIVE REF ⑦ so that the meter reads approx. 80mV, then set the measurement range to 100mV with the DOWN switch ④.
15. Rotate the RELATIVE REF ⑦ clockwise slowly and check that the measurement range is automatically changed into 300mV range when the meter reads 102mV.
16. Control the RELATIVE REF ⑦ so that the meter reads 75mV in the 300mV range.
17. Rotate VR202 ⑳ slowly until the measurement range is changed into 100mV range.
18. Rotate the RELATIVE REF ⑦ clockwise slowly until the measurement range is automatically changed into 300mV range. Then, rotate it counterclockwise slowly and check that the measurement range is automatically changed into 100mV range when the meter reads 75mV.

9. CAUTIONS FOR USE

1. Your VT-173 will work just when the POWER switch is pressed in. For accurate measurements, wait around five minutes for warm-up.
2. Avoid placing your VT-173 where magnetic field and electric field are too strong.
3. The input cable other than the supplied one should be low-capacitance shielded cord, or coaxial cable.
4. Do not leave your VT-173 at any of high temperature and humidity places for a long period of time.
5. The maximum allowable continuous input voltage of the VT-173 is 100V (DC + AC peak) when the measurement range is set to 1mV~300mV. Thus, use great care.
6. Beware of line noises or other low-level noises since the VT-173 is a highly sensitive voltmeter. Great care should be used when a long cable or an instrument of poor isolation is connected to the MONITOR OUT connector.
7. Be sure to use the HOLD (manual) mode to measure non-sinusoidal wave voltage.
8. The ON/OFF switch of thit is designed to act on the secondary side of the power transformer. The primary side of the transformer remains energized even if the ON/OFF switch is set to OFF.Therefore, if the unit is to be unused for a long time, the power cord should be unplugged from the receptacle outlet.

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