MODEL 154

DIGITAL VOLTMETER

OPERATION MANUAL

KIKUSUI ELECTRONICS CORP.

- C O N T E N T S -

1. General Description

KIKUSUI ELECTRONICS' Model 154 Digital Voltmeter consists of continuous balance method Analogue-Digital converter, in which semiconductor and highly reliable electronic parts are employed, and is featured as described below.

* Small in size, light in weight and minimized power consumption, since semiconductor is used throughout the electronic circuit.
* Operation is facilitated, since the range can be turned manually and automatically just as polarity changing.
* Usable also by input floating, since the common terminal of input is floated from the case body.
* The holding switch enables to hold a measured value as long as desired.
* The protective circuit of input ensures safety, when over-voltage is ever impressed upon the input terminal.
* The indicating device has such a construction as can be inclined horizontally or two steps upwards and downwards respectively for ensuring easily visible angle always, even if this voltmeter is mounted at the top of a rack or on a desk.
* Convenient in use, since the full scale is extended by approx. 10% up to 10.999.

2. SPECIFICATION

Title	Digital Voltmeter
Model	154
Method	continuous balance
Measuring Range	0 ~ ±10.999V/0 ~ ±109.99V/0 ~ ±1099.9V
Range Change	Automatic and manual change
	Polarity Autmoatic change
Input Floating	Maximum DC 250V between the case and input common terminal
Accuracy	±(0.05% + 1 digit)
Balance Time	Approx. 2 seconds average
Input Resistance	10MΩ at the balancing time
Indicating Device	Inclining horizontally and two steps upwards and downwards respectively
Indicator	Indicator discharge tube
Ambient Temperature	5°C ~ 35°C
Power Consumption	Approx. 35VA (in measuring)
	Approx. 20VA (in balancing or holding)
External Dimensions	(the maximum)
	200(200) W x 150(168) H x 370(407) D mm
Weight	Approx. 9 Kg
Accessories	Input cable 1
	Instruction manual & test data 1 each

3. Operation

Model 154 Digital Voltmeter operates by 100V commercial power of 50 or 60 cycles. Fluctuation in power voltage by ±10% does not almost affect the accuracy, but in view of longer service life, it is preferable to be used within ±5%, if possible.

3.1 Explanation of Panel (Refer to Fig. 3-1)

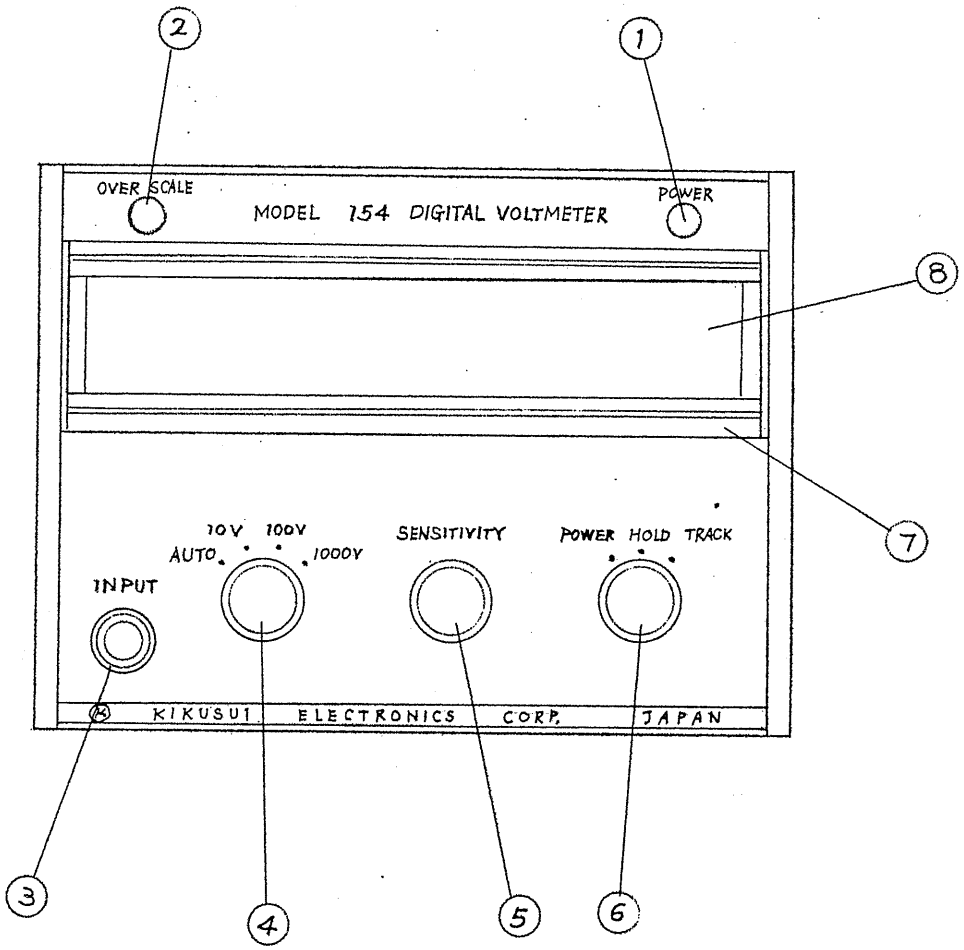

Fig. 3-1

①	POWER	Lamp which lights when power is turned on; which is connected to the primary side of a power transformer.
②	OVER SCALE	In each range, when a voltage higher than the full scale of the range having been set is given to the input terminal, the indicator shows full scale indication, and this lamp lights. When this lamp lights during manual operation, the range shall be switched to that one step higher.
③	INPUT	Input connector, and shall be connected with the input cable, an accessory to this voltmeter.
④	RANGE AUTO 10V 100V 1000V	When this knob is rotated counterclockwise to the extreme, i.e. the position of "AUTO", the range changing becomes automatic. Then, when this knob is rotated clockwise to 10V, 100V and 1000V, the range is turned to the full scale of ±10.999V, ±109.99V and ±1099.9V respectively.
⑤	SENSITIVITY	Knob for adjusting the sensitivity of the error amplifier, and sensitivity is increased when rotated clockwise.
⑥	POWER (OFF) HOLD TRACK	When this knob is rotated counterclockwise to the extreme, i.e. the position of "OFF", power if turned off, and

when set to the position of "HOLD" and "TRACK", power is turned on.
"HOLD" is to be used for holding measured value, and "TRACK" is for performing measurement.

⑦ Indicating Device Mechanism allowing to incline horizontally and two steps upwards and downwards respectively, so that a suitable angle shall be selected depending upon the setting location.

⑧ Indicator Discharge Tube
Polarity, digits and decimal point are indicated by this tube. In case of full scale, the digits become 10999, that is to say, the initial digit be "1" and the second digit "0". In case of less than 10000, the indicator tube of the initial digit is always turned off.

3.2 Preparation for Measurement

1) The accessory measuring cord shall be connected to INPUT connector.
2) The line cord shall be connected to a commercial outlet (100V 50 or 60 c/s).
3) The power shall be turned on by setting the knob ⑥ to "HOLD", thus the temperature in the constant temperature cabinet inside the voltmeter will become the

prescribed value after about 15 minutes, then. The preparation is completed with the above.

3.3 Operation

After completing the foregoing preparation for measurement, proceed to the measurement in the following order of operation.

1) The range switch shall be set to "AUTO" or to an adequately selected range when the voltage value to be measured can approximately be found beforehand.
2) The knob ⑥ shall be turned to "TRACK".
3) The toothed clip (black) of the input cable shall be connected to the low impedance side of the power to be measured and the toothed clip (red) to the high impedance side, respectively.
4) Adjust the knob ⑤ of "SENSITIVITY" so as to set to a position immediately before producing hunting.
5) In the event of holding the measured result, the knob ⑥ shall be turned to the position of "HOLD". When set to "HOLD", the measured result can be kept constant even if the voltage under test is changed.

4. Theory of Operation

Model 154 Digital Voltmeter consists of, as shown in Fig. 4-1, input circuit, chopper modulator, reference voltage supply circuit, error amplifier, demodulator, switch driving circuit, Kelvin Varley potentiometer, logic circuit, indicating device and power supply.

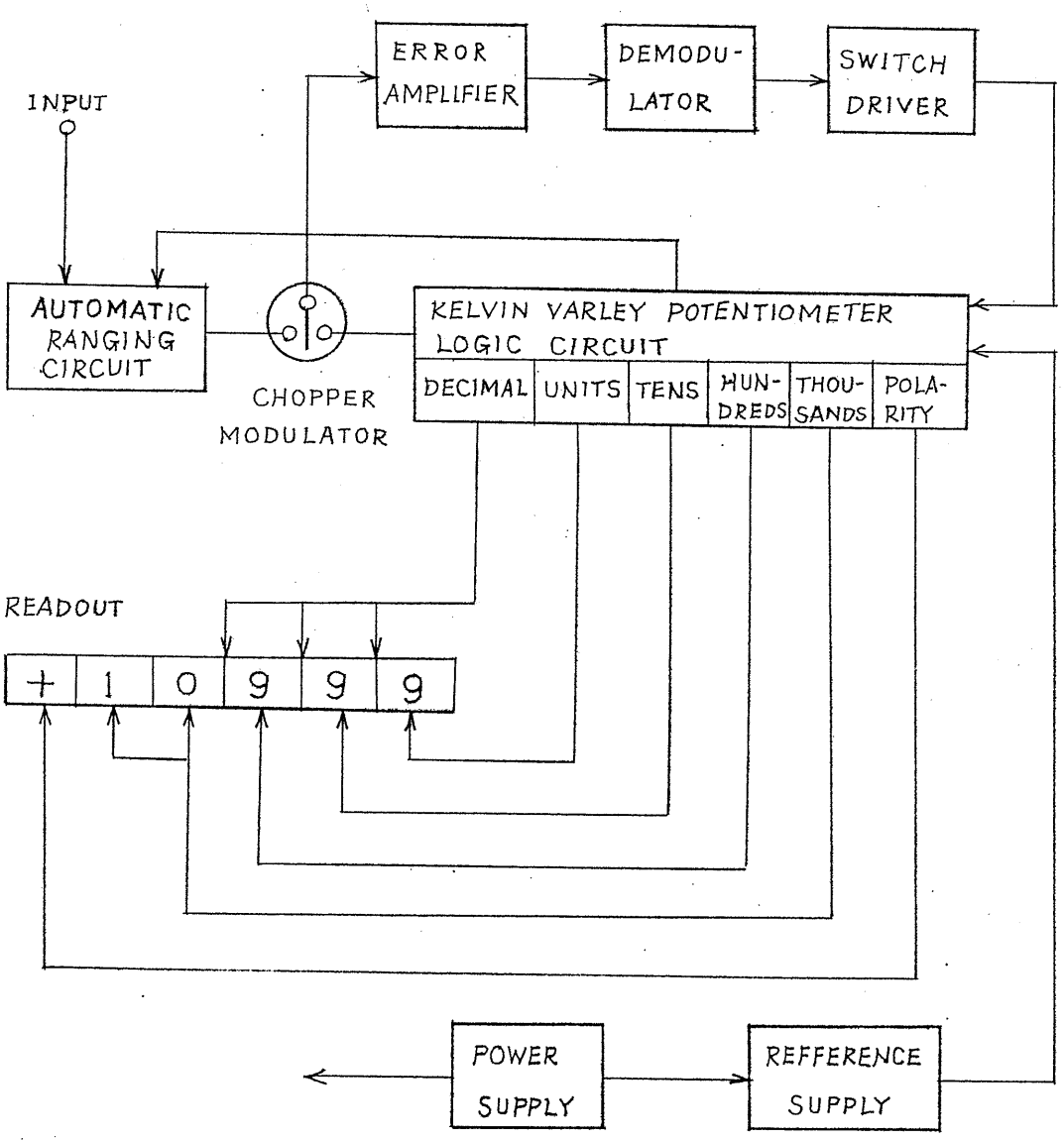

Fig. 4-1

If the above block diagram is explained here, the voltage for measurement given to the input terminal is compared, via the input circuit consisting of low-pass filter and voltage divider, with the internal reference voltage by means of mechanical chopper modulator, and the differential voltage is brought to the input of the amplifier. This voltage is sufficiently amplified there, and the polarity of the differential voltage is discriminated by the demodulator.

That is to say, if the result of discrimination is MEASURED VOLTAGE $>$ REFERENCE VOLTAGE, up-pulse is generated, and if MEASURED VOLTAGE $<$ REFERENCE VOLTAGE, down-pulse is generated, respectively. And the stepping switch of Kelvin Varley potentiometer is driven in the direction of reducing the error in correspondence to these up and down pulses.

The foregoing operation is carried on continuously, and when the measured voltage and reference voltage become equal, the measurement is completed. Accordingly, these operational procedure can be called one method of servomechanism.

5. Maintenance

5.1 Internal Inspection

The setscrews in the two places as shown in Fig. 5-1 shall be rotated counterclockwise with a coin, and the back panel can be taken off. Then , the panels on the both sides, top side and bottom side shall be pulled out slowly in the arrow-head direction. Now, internal inspection can be made.

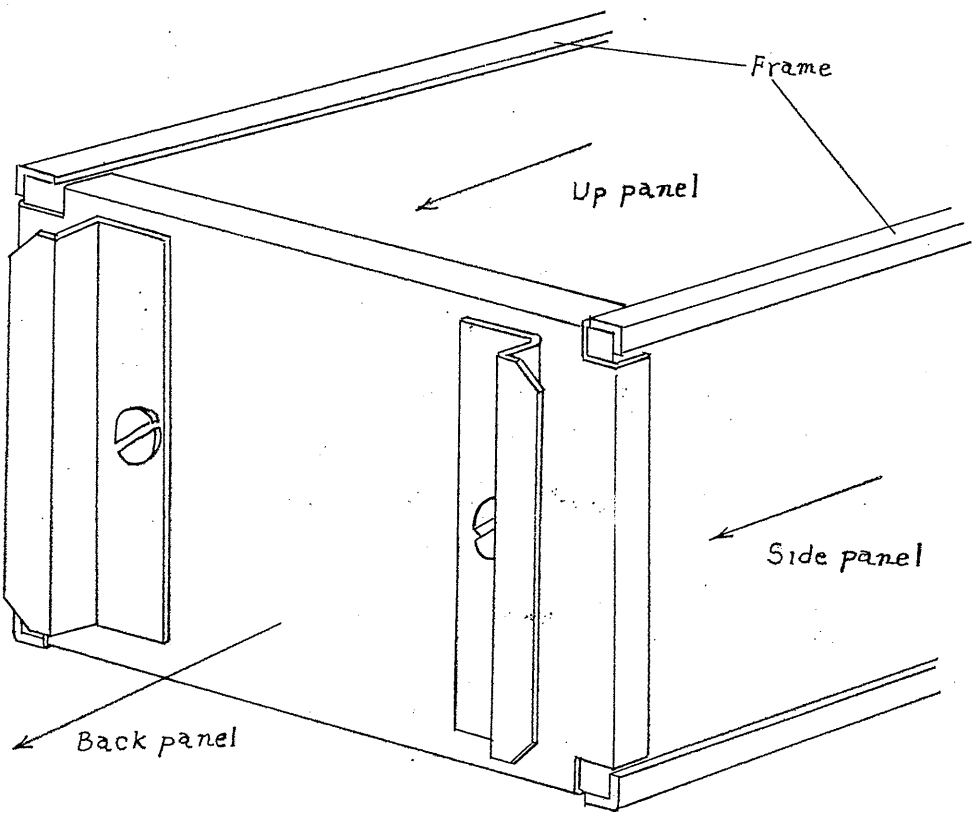

Fig. 5-1

Caution: When this voltmeter is inclined towards the front panel by gripping the handle in the state of the back panel having been taken off, the top panel slips out from the frame. Care shall be taken thereto.

5.2 Disposition

Fig. 5-2 and Fig. 5-3 show the disposition of the main component parts of this voltmeter.

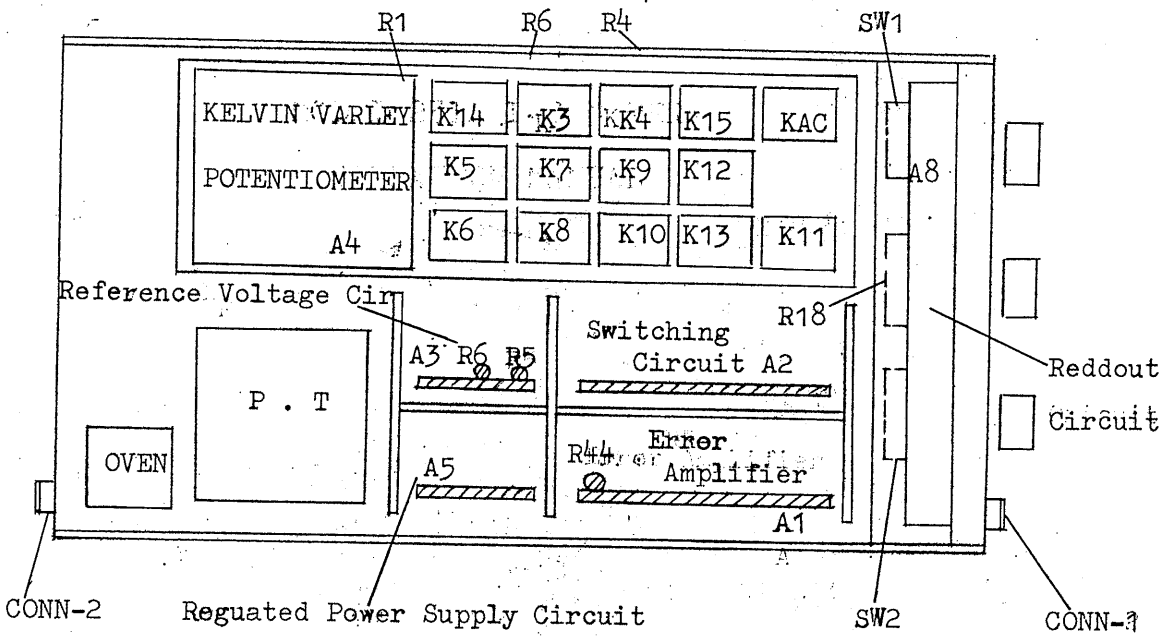

Fig 5-2 Top View

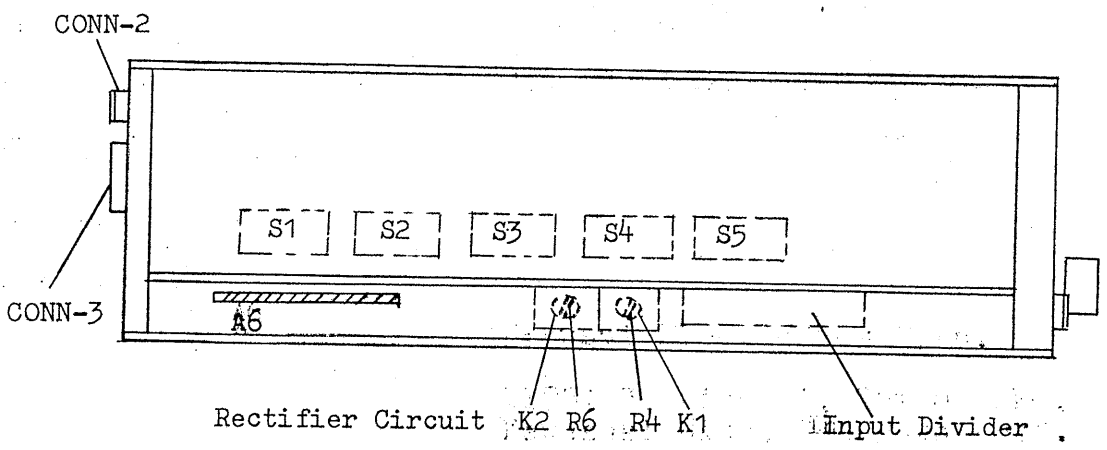

Fig 5-3

5.3 Calibration

In order to maintain the accuracy of Model 154 for a long time, it is recommended to check and calibrate the accuracy periodically (once every 6 to 12 months).

For calibration, use a DC standard voltage generator having an accuracy of 0.01% or better, or a combination of a constant-voltage power source (0 to 1000 V) with a stability of 10 ppm or better and a potentiometer.

From the viewpoint of calibration accuracy, conduct the calibration at about 20 to 25°C with minimum ambient temperature variations.

1. Energize Model 154 and allow approximately one hour or more for warmup.
2. Adjust R_5 of the reference power source (printed circuit board A_3) so that the current flowing in R_3 is 11 mA. (Refer to Fig. 5-2.)
3. Connect a digital voltmeter or differential voltmeter or differential voltmeter to connectors 10 and 8 of the reference power source board. Vary the commercial line voltage to the rated value ±10%, and adjust R_6 so that the voltage variation across connectors 10 and 8 is less than 0.01%.
4. Set the 10-V range on Model 154, apply 10.000 V to the input, and adjust R_1 of printed circuit board A_4 so that indication

is "10.000". (Refer to Fig. 5-2).

5. Set the 100-V range, make the input voltage 100.00 V, and adjust R_4 (lower portion of the chassis; shown in Fig. 5-3) so that indication is "100.00".

6. Set the 1000-V range, make the input voltage 1000.0 V, and adjust R_6 (located by R_4) so that indication is "1000.0".

It is only needed to calibrate the accuracy with positive (+) voltages, and calibration with negative (-) voltages is unnecessary.