

COMPARISON OF DIGITAL MULTIMETERS' PERFORMANCE

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DT380D



FLUKE 287



VAR TECH MP9A

Abstract: We compare various multimeters available in our lab against Fluke 287. Fluke 287 is a high-end multimeter and its calibration certificate is valid at the time of this activity. DC voltage, DC current and resistance values are measured using all the multimeters and deviation from Fluke 287 is reported. Based on this exercise and the specification of the multimeters, we come up with the usage guidelines. A brief introduction on the techniques to measure DC voltage, DC current and resistance values, by the multimeters, are also presented.

Introduction To Digital Multimeter (DMM)

A Digital Multimeter is also known as a multi-tester which is an electronic measuring instrument that combines several measurement functions in one unit. Basically all the multimeters in market contains current, voltage, Resistance mode for measurement but some multimeter has additional like capacitance, diode, transistor modes for measurements. DMM are basically voltage to display device.

Working Principle Principle Of Digital Multimeter In Voltage Mode

The working of Digital Multimeter can be explained with the help of resistive circuit which has two resistor (R_1 and R_2), as shown in Fig 1, connected in series to the power supply with some voltage (V)

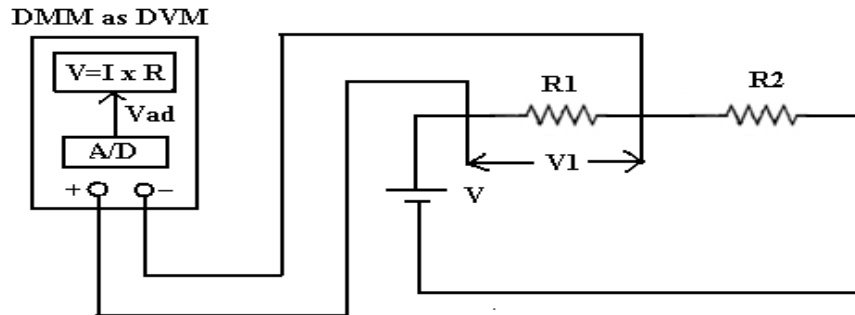


Fig 1 : CIRCUIT DIAGRAM OF MULTIMETER IN VOLTAGE MODE

For voltage measurement the DVM should have infinite or very large input resistance. In figure1, the multimeter senses the voltage drop produced across the resistor R_1 and provides this input to the internal A/D converter IC. This IC converts the analog input into digital output–The digital voltage is finally displayed with the help of a controller.

Working Principle Of Digital Multimeter In Current Mode

The working of Digital Multimeter can be explained with the help of resistive circuit which has two resistor (R_1 and R_2) connected in series to the power supply with some voltage (V). Figure 2 shows the circuit arrangement of multimeter in current mode. Note the difference in usage of DMM in voltage and current mode.

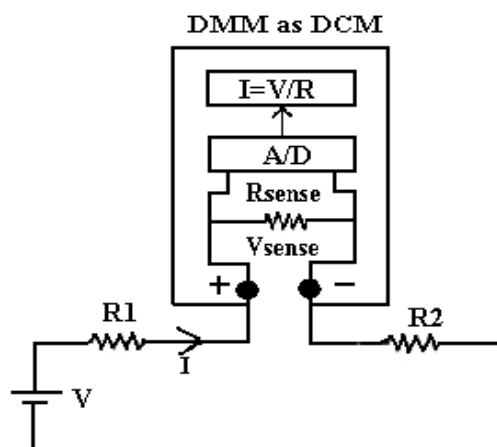


Fig 2 CIRCUIT DIAGRAM OF MULTIMETER IN CURRENT MODE

For measurement of current we should keep in mind that the internal impedance of multimeter should be ideally zero. However, small internal resistance (current sense resistor) is present in the multimeters. The current to be measured passes through current sense resistor and causes corresponding voltage drop across

it. This analog voltage is converted into digital by internal A/D converter and finally current value ($I=V/R_{sense}$) is displayed.

Working Principle Principle Of Digital Multimeter In Resistor Mode

The working of Digital Multimeter can be explained with the help of resistive circuit which has a resistor R_1 connected to multimeter. Figure 3 shows the circuit arrangement of multimeter in Resistance mode

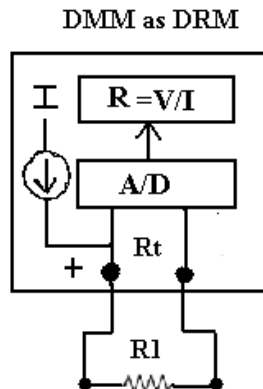


Fig 3: CIRCUIT DIAGRAM OF MULTIMETER IN RESISTANCE MODE

Multimeter uses internal constant current source to create voltage drop across the resistor under measurement (as R_1 in Fig 3). Voltage drop across the resistor is measured and converted to digital value by using A/D converter internally. Multimeter uses this digitalised voltage across the resistor and the known value of current to calculate the resistor value. Typically, the voltage drop created across the test resistor by the multimeter current source is in few hundred millivolts range. *For higher value of resistance smaller value of current is used and vice versa.*

For more information please read the following link

<http://www.electronickits.com/kit/complete/meas/m-2666k.pdf>

http://books.google.co.in/books/about/Basic_Communication_And_Information_Engi.html?id=43v70cYbyKkC&redir_esc=y

Calibration / Benchmarking Of Multimeters

We benchmark various multimeters available in our lab against Fluke 287. Fluke 287 is a high-end multimeter and its calibration certificate is valid at the time of this activity. DC voltage, DC current and resistance values are measured using all the multimeters and deviation from Fluke 287 is reported. Based on this exercise and the specification of the multimeters, we come up with the usage guidelines.

Benchmarking Procedure:-

1. To do bechmarking of Test multimeters (DT830d, MP9A, HP3457A) Fluke 287 is taken as Standard and dt830d, Mp9A and HP3457A multimeters are taken as test instrument.
 - 1.1 The reason for taking Fluke 287 multimeter as standard because of the following reasons.
 - 1.1. a. Fluke 287 has a valid calibration certificate.
 - 1.1. b. Fluke 287 Specification is as follows.

FUNCTION	RANGE	ACCURACY
DC voltage	50mV	0.05%
	500mV to 50V	0.025%
DC current	500 μ A to 5000 μ A	0.075%
	50mA	0.05%
	400mA	0.15%
	5A	0.3%
Resistance	50 Ω	0.15%
	500 Ω to 500K Ω	0.05%
	5M Ω	0.15%

2. For DC voltages benchmarking the multimeters are connected to power supply. Five 100 Ω resistor are connected in parallel.i.e, 20 Ω . By changing the voltage in power supply note down the corresponding value of multimeter. When power supply reached 20V, then by changing load the voltage was measured.

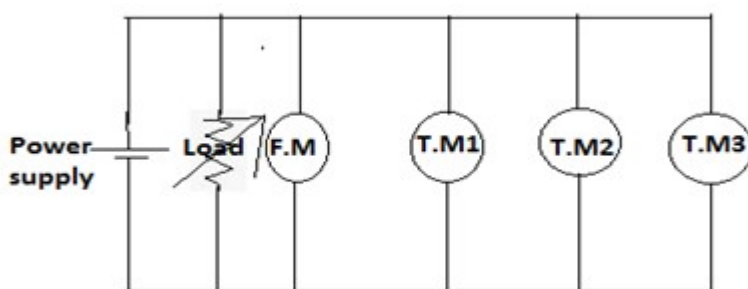
3. For DC current benchmarking the multimeter are connected to power supply in series with 2.2 Ω / 10 W resistors. By varying the power supply the current was set in the fluke multimeter and the test multimeter readings were noted down.

4. For DC resistance benchmarking different values of POT was taken (100 Ω , 10K and 1M Ω) by varying the pot the resistance was set in the fluke multimeter and the readings of test multimeter was noted down.

5. The benchmarking range for voltage is from 10mV to 25V.

7. The benchmarking range for Resistance is from 1 Ω to 1M Ω .

Dc Voltage Benchmarking:-



Circuit 1: Voltage calibration of multimeter

F.M-Fluke 287 DMM

T.M-Test multimeter

Load-20 Ω

Please Note: The calibration range for voltage is from 10mV to 25V.

DT830D Multimeter



HP3457A multimeter



MP9A multimeter



Pic: 1.1: Voltage benchmarking of DT830d MM

Pic: 1.2: Voltage benchmarking of HP357A MM

Pic: 1.3: Voltage benchmarking of MP9A MM

Percentage error calculation

Percentage error= (Fluke multimeter value-test multimeter Value)/ (Fluke multimeter Value)*100

Table : 1

Range	DT830D-S0303 %Error	DT830D-S0311 %Error	DT830D-S0323 %Error	MP9A-S0305 %Error	MP9A-S0314 %Error	MP9A-S0315 %Error	HP 3457A %Error
200mV	-3.12%	-2.51%	-2.20%	0.58%	0.5%	0.58%	-0.00005%
2V	-3.33%	-2.13%	-2.00%	0.76%	0.77%	0.40%	0.0030%
20V	-3.06%	-2.38%	-2.14%	1.05%	0.84%	0.55%	0.0002%
200V	-3.34%	-2.13%	-2.00%	1.26%	1.26%	0.82%	0.0002%

Example:

Test multimeter (DT830D-0303) voltage: 100.6mV

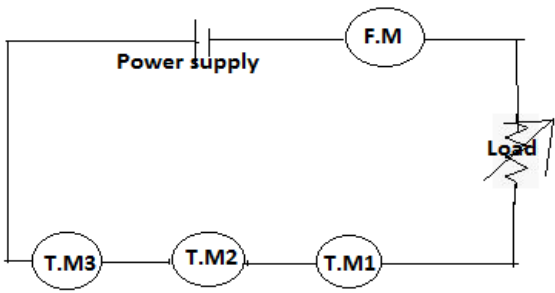
Percentage error:-3.12%

Accurate value=Test multimeter value% Error -3.12/100(test multimeter value)*

=100.6mV-0.0312(100.6mV)*

=97.46mV

Dc Current Benchmarking:-



Circuit 2: Current benchmarking of multimeter multimeter

Pic: 2. current benchmarking of MP9A

F.M-Fluke multimeter

T.M-Test multimeter

Load-20Ω

Please Note: The benchmarking range for current is from 0.5mA to 1A

Table: 2

Range	DT830D-S0311 %Error	DT830D-S0323 %Error	MP9A-S0305 %Error	MP9A-S0314 %Error	MP9A-S0315 %Error
2000μA	10.20%	10.50%	-0.884%	-0.885%	-0.884%
20mA	-2.02%	-5.83%	-0.968%	-0.957%	0.976%
200mA	-1.89%	-1.53%	-0.913%	-0.877%	0.879%
10A	0.01%	0.01%	0.620%	-0.344%	-0.372%

Example:

Test multimeter (DT830D-0311) current: 25.4mA

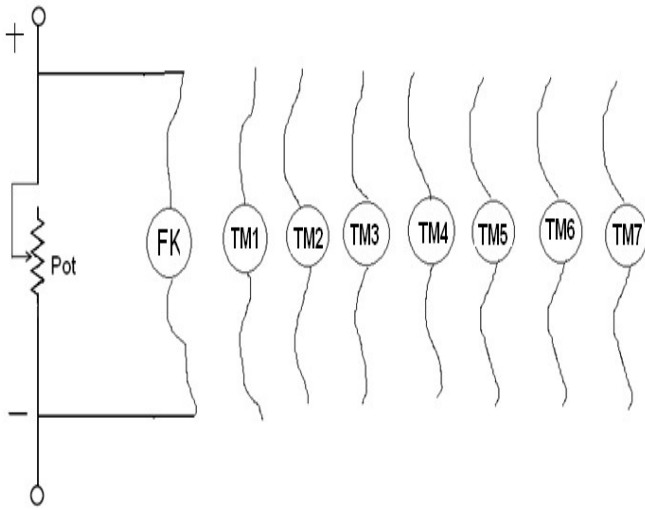
Percentage error:-1.89%

Accurate value=Test multimeter value-1.89/100(test multimeter value)*

=25.4mA-0.0189(25.4mA)*

=24.91mA

RESISTANCE BENCHMARKING:-



Circuit 3: Resistance benchmarking of multimeter Pic:3 Resistance benchmarking for all test multimeter
 FK=Fluke 287(Std. Meter), TM1=Var 0305, TM2=Var 0314, TM3=Var 0315,
 TM4=DT0303, TM5=DT0311, TM6=DT0323, TM7= HP 3457A.

Table: 3

Range	MP9A (S0305) %Error	MP9A (S0314) %Error	MP9A (S0315) %Error	DT 830D (S0303) %Error	DT 830D (S0311) %Error	DT 830D (S0323) %Error	HP 3457A %Error
200 Ω	-0.078%	-0.041%	-0.042%	-0.189%	-0.184%	-0.190%	0.020%
2K	0.005%	0.004%	0.003%	0.000%	-0.003%	-0.003%	0.000%
20K	0.006%	0.006%	0.004%	-0.001%	0.001%	-0.001%	0.000%
200K	0.005%	0.006%	0.004%	0.001%	-0.002%	-0.002%	0.000%
2M	0.007%	0.005%	0.006%	0.000%	0.002%	0.001%	0.000%

Example:

Test multimeter (VarS0305) Resistance: 10.3 Ω

Percentage error:-0.078%

Accurate value=Test multimeter value-0.078/100(test multimeter value)*

=10.3 Ω -0.078(10.3 Ω) =9.4966 Ω*

Please Note: The benchmarking range for resistance is from 1 Ω to 1M Ω.

CONCLUSION:-

Table: 4

<i>MULTIMETER</i>	<i>RATING SUMMARY</i>			<i>SUGGESTED APPLICATION</i>
	<i>V</i>	<i>I</i>	<i>R</i>	
<i>Fluke 287, Fluke 116</i>	<i>3</i>	<i>3</i>	<i>3</i>	<i>For applications where the precision is important</i>
<i>HP 3457A</i>	<i>3</i>	<i>-</i>	<i>3</i>	<i>For very high precision analog measurement; for small absolute value and small variation (voltage in mV and resistance <10 Ω)</i>
<i>VAR MP9A</i>	<i>2</i>	<i>2</i>	<i>2</i>	<i>For analog and digital circuits and systems where high precision is not important</i>
<i>DT 830D</i>	<i>1</i>	<i>0</i>	<i>1</i>	<i>Recommended only for digital circuits and systems</i>

Please Note:

Above mentioned rating is based on their calibration results and the rating number refers to the following list

Serial No. **3** refers to Highly accurate readings.

Serial No. **2** refers to Accurate readings.

Serial No. **1** refers to Acceptable readings.

Serial No. **0** refers to Not recommended