Signal Training Bulletin

COMMITTEE G: Education & Training
Communication & Signal Section, AAR

G-4 Multimeter

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Definition:
(a) Meter: A measuring instrument which indicates or records the value of the quantity under observation.
(b) Multimeter: A multi-range instrument combining an ammeter, voltmeter and ohmmeter in a single case.

Symbol: None

Description: The two main types are the volt-ohm-milliammeter (VOM) as shown in Figure 1 and the vacuum-tube-voltmeter (VTVM) as shown in Figure 2. The features compactness, simplicity and portability. The VTVM requires either an external or internal power source for operation. Usually the VTVM has no provision for current measurements.

Purpose and Application: Multimeters are portable test instruments for testing electrical circuits and their various components in the shop and remote field locations.

General Information: With a VOM, the same two leads are used for all measurements. On dc volts, the sensitivity with a 50 micro-amp meter is 20,000 ohms per volt. Its input resistance depends on the voltage range increasing with higher ranges. For ac voltage, the input is rectified to provide direct current for the meter. The sensitivity for ac voltage ranges is usually less than for dc voltage. Direct current can be measured by the VOM, with ranges from milliamperes to amperes. Usually there is no provision for measuring alternating current. On ohms operation, the highest range is generally RX 10,000 with a 50 micro-amp meter, allowing measurements up to 2000 x 10000 or 20 megohms. It is important to zero the ohms adjustment each time the ohms range is changed.

The VTVM needs a power supply because the meter movement is in a bridge circuit with an amplifier. However, some transistorized units are battery operated. The input resistance of 11 megohms or more on dc volts is the same for all ranges because the VTVM has a constant-resistance voltage divider in the input circuit. Too high an input resistance, however, results in stray pickup by the test leads, which makes the voltmeter read erratic values when not connected across a closed circuit, especially on the ac voltage ranges. VTVM usually has ohms ranges up to R X 1M, which allows resistance measurements as high as 1000 megohms. The ohms scale reads from left to right, like the volts scale. An internal battery is needed for the ohms ranges but the VTVM must be turned on because the ohms operation uses the voltmeter amplifier.

Figure 1

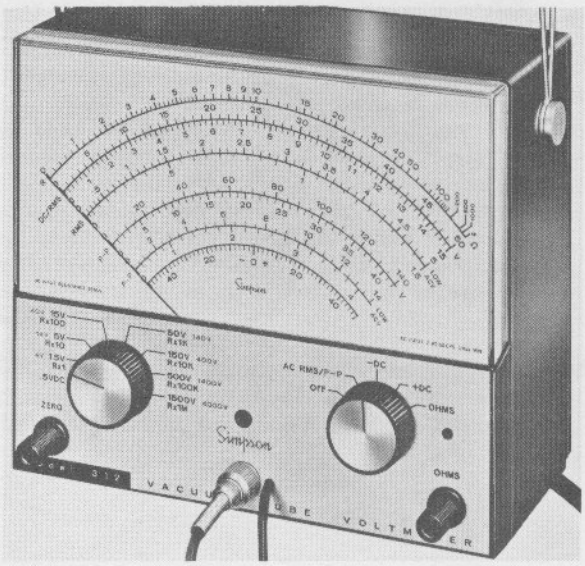

Figure 2

Detailed Operation: The test leads for the VTVM in Figure 2 are used as follows: The black common lead is connected to chassis ground or common reference point for all measurements. The probe is

used with the switch on "DC" for dc volts. Inside is a 1 megohm series resistor to isolate the probe from the capacitance of the shielded cable. The shield reduces stray pickup. For both ohms and ac volts measurements, as determined by the selector switch, the probe switch shorts out the internal resistor.

The two adjustments on the front panel of the VTVM are adjusted as follows:

(1). Allow a few minutes for the meter to warm up in accordance with the manufacturer's recommendation before making an adjustment. Then set the ZERO ADJUST control to line up the pointer at zero, with the selector switch on dc volts. This adjustment calibrates the instrument as a dc voltmeter.

(2). Next, turn the selector switch to the ohms position and vary the OHMS ADJUST control to line up the pointer with the extreme right line in the ohms scale. The test leads must be open, not shorted for this ohms adjustment, which is opposite from a VOM.

When the ZERO ADJUST and OHMS ADJUST controls have been set, they usually need not be changed for different ranges for VTVM. The selector switch has + and − positions for dc volts so that the meter leads do not have to be reversed for reading opposite polarities. In fact, for many measurements, the black lead must be on chassis ground for correct readings.

Table 1 summarizes the main points to remember when a voltmeter, ohmmeter, or milliameter is used. These rules apply whether the meter is a single unit or one function either on a multimeter or on a VTVM. To avoid excessive current through the meter movement, it is good practice to start on a high range when measuring an unknown value of voltage or current. It is very important not to make the mistake of connecting a current meter in parallel, because usually this mistake ruins the meter. The mistake of a voltmeter in series does not damage the meter, but the reading is wrong, and the additional resistance of meter in the circuit may cause adverse effects on relays in the circuit. If the ohmmeter is connected to a circuit where power is on, the meter can be damaged, especially with a shunt-ohmmeter circuit.

It should be noted that semi-conductors may be damaged by improper connection with an ohmmeter. Whenever the range switch is set to a position greater than RX 1000, a 9 volt battery is placed in the circuit which could cause damage to semi-conductors.

Voltmeter	Milliammeter or Ammeter	Ohmmeter
Power on in circuit	Power on in circuit	Power off in circuit; has internal battery
Connect in parallel	Connect in series	Connect in parallel
Very high internal resistance	Very low internal resistance	Internal resistance varied for ohms adjustment
Has internal series multipliers for extended ranges	Has internal shunts for extended ranges	Range extended by higher battery voltage or by meter shunts

Table 1: Direct current meters.

Notes