Signal Training Bulletin

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

G-3 Ohmmeter

Approved November 1978

Definition: An instrument for measuring resistance in ohms.

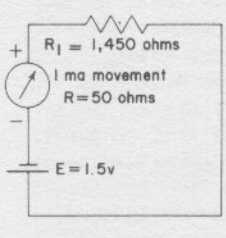
Symbol: None

Description: Basically, an ohmmeter consists of an internal battery, the meter movement, and a current-limiting resistance, as illustrated in Figure 1. When measuring resistance, the ohmmeter leads are connected across an external resistance to be measured, with power off in the circuit being tested, so that only the ohmmeter battery produces current for deflecting the meter movement. Since the amount of current through the meter depends on the external resistance, the scale can be calibrated in ohms. The amount of deflection on the ohms scale indicates directly the measured resistance.

Purpose and Application: An ohmmeter is used to measure any known or unknown resistance in an electrical circuit or circuit component.

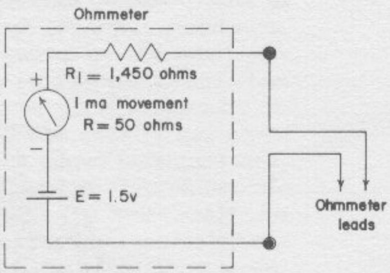
General Information: The ohmmeter needle deflects from left to right regardless of the polarity of the leads because the polarity of the internal battery determines the direction of current through the meter movement.

Figure 1(a) illustrates a series-ohmmeter circuit with 1500 ohms resistance and a 1.5 volt dry cell producing 1 ma, deflecting the moving coil full scale. When these components are enclosed in a case, as in Figure 1(b), the series circuit forms an ohmmeter. If the leads are shorted together or connected across a short circuit, 1 ma flows and the meter movement is deflected full scale to the right as in Figure 1(a). With the ohmmeter leads not touching each other, the current is zero and the ohmmeter indicates infinitely high resistance or an open circuit as in Figure 1(b). Therefore, the meter face can be marked zero ohms at the right for full scale deflection. Other values of resistance result in less than 1 ma through the meter movement. The corresponding deflection on the ohms scale indicates how much resistance is across the ohmmeter terminals, that is, how much this resistance is limiting current from full-scale deflection. This is the type of circuit found in most field test units such as the various types of multimeters.



(a)

Figure 1(a)



(b)

Figure 1(b)

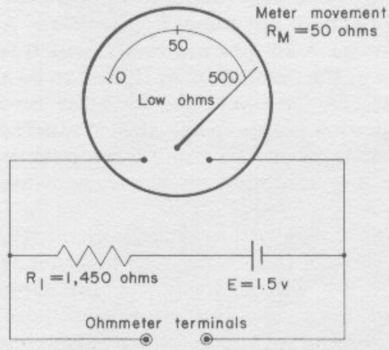


Figure 2

Figure 2 illustrates a shunt-ohmmeter circuit. The unknown resistance to be measured acts as the shunt across the meter movement. With test loads shorted across the ohmmeter terminal, there is no current in the meter as all the battery current goes through the shorted shunt path. Zero ohms corresponds to zero current in the meter; therefore, zero ohms is at the left end of the scale. This ohms scale reads left to right, like current and voltage scales, but opposite from a series ohmmeter. The internal resistance of 1450 ohms is the value needed for full scale deflection with an opening across the meter leads. It should be noted that the mistake of applying voltage to an ohmmeter will easily damage the meter movement in this circuit because the coil is directly across the terminals without any series resistance. The shunt circuit expands the low ohms value and is usually found in meters used in shops or laboratories when a precise knowledge of low resistance values are necessary.

Detail Operation: Multiple ohmmeter ranges on commercial multimeters provide for resistance measurements of less than 1 ohm up to many megohms, in several ranges. The range switch in Figure 3 shows the multiplying factors for the ohm scale. On the RX1 range, for low resistance measurements, read the ohms scale directly. In the example here, the pointer indicates 12 ohms. When the range switch is on RX100, multiplying the scale reading by 100; this reading may then be 12 x 100 or 1200 ohms. On the RX10,000 range, the pointer would indicate 120,000 ohms. Remember for the ohmmeter ranges, always multiply the scale reading by the RX factor.

Another valuable use of an ohmmeter is for checking continuity. A wire conductor that is continuous without a break has practically zero ohms of resistance. Therefore, the ohmmeter can be useful in testing for continuity. This test should be done on the lowest ohms range. There are many applications. A wire conductor can have an internal break, which is not visible because of the insulation, or there can be a bad connection at the terminal. Checking for zero ohms between any two points along the conductor tests continuity. A break in the conducting path is evident from a reading of infinite resistance, showing an open circuit.

As another application of checking continuity, suppose there is a cable of wires harnessed together as illustrated in Figure 4 where the individual wires cannot be seen, but it is desired to find the conductor that connects to terminal A. This is done by checking continuity for each conductor to point A. The wire that has zero ohms to A is the one connected to this terminal. Often the individual wires are color-coded but it may be necessary to check the continuity of each lead.

An additional technique that can be helpful is illustrated in Figure 5. Here it is desired to check the continuity of the two-wire line, but its ends are too far apart for the ohmmeter leads to reach. The two conductors are temporarily connected at one end, however, so that the continuity of both wires can be checked at the other end.

In summary, the ohmmeter is used to measure resistance of circuits or circuit components and is helpful in checking the continuity of any wire conductor. This check includes resistance-wire heating elements, like the wires in a toaster or the filament of an incandescent bulb. Their cold resistance is normally just a few ohms. Infinite resistance means that the wire element is open. Similarly, a good fuse has practically zero resistance; a burned-out fuse has infinite resistance, meaning it is open.

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 RX1000, a 9-volt battery is placed in the circuit which could cause damage to semi-conductors.

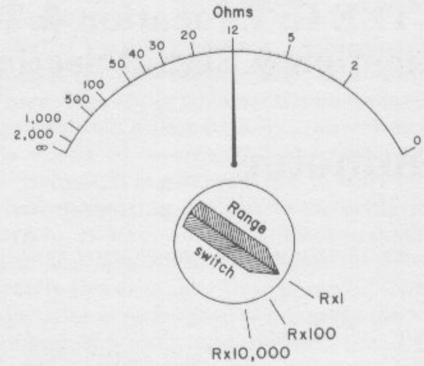


Figure 3

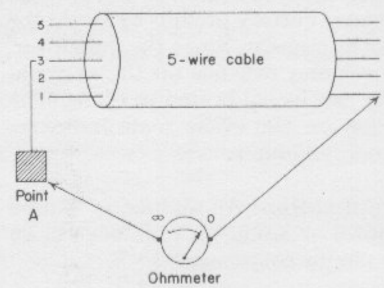


Figure 4

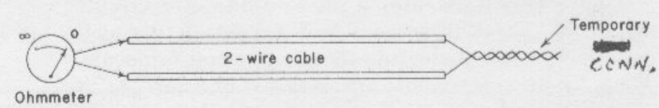


Figure 5