Strange Voltmeter Readings

An thread from the AeroElectric-List

5 August 2012

New question - I have the Van's starter contactor (Part Number = ES 24021) and when I apply 12v to the battery connection, I get about 0.4v on the starter connection. Â This is before it is energized. When I apply the 12v to the 'S' terminal, I get the full 12v on the starter terminal.

Is it normal for some voltage to "leak" even when the device is "idle"? Â My battery contactors don't do this, and I don't have another starter contactor to test with.

Thanks,
Mickey

Theoretically there should be NO leakage through the starter contactor. But the insulation used in the contactor is not perfect. There could be some insignificant leakage. Digital voltmeters have a very high input impedance which allows them to measure insignificant voltage. Try shorting the output terminal to ground with your fingers of one hand while measuring the voltage. Or use an old analog voltmeter which will give more meaningful measurements in this situation. Or use a very small 12v test lamp, the type used for automotive instrument illumination.
I do not think there is enough leakage to worry about.

Joe

My thoughts exactly. This thread illustrates a measurement conundrum that has existed since day one in the study and diagnosis of electron flow. The ideal measurement technique should be transparent to quantities being explored.

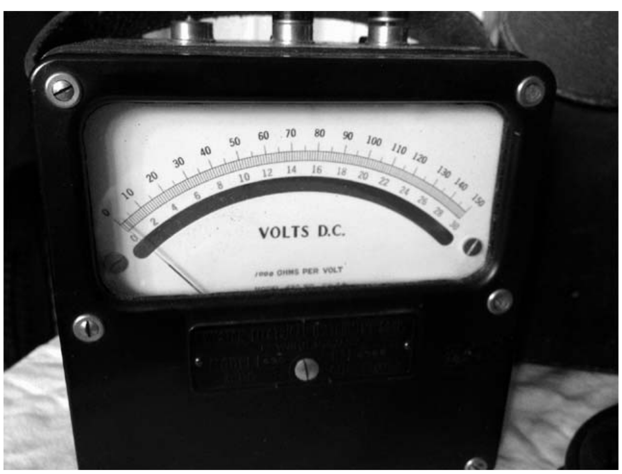

Figure 1.

Figure 1 illustrates a precision voltmeter (ammeters with resistors in series) circa 1950 which is an excellent demonstration of the best-we-knew-how-to-do at the time.

Note the label at the bottom of the scale-plate that says "1000 ohms per volt". This is one way of saying that this instrument has a basic sensitivity of 1 milliampere full scale. When taking a reading on the 150 volt scale the instrument presents a "load" to the circuit being measured of 1000 x 150 or 150,000 ohms. It will "draw" 1 milliampere of current from the measurement node at 150 volts. These instruments were a trade off between sensitivity, accuracy, linearity and calibration drift due to temperature and age. But an instrument like this is fitted with a 'mirrored scale'. The observer lines up the pointer with the reflection of the pointer so as to drive parallax error to zero. This instrument could be both read and relied upon for readings with certainty of 1% or better.

If you had measured the "output" from your open starter contactor with such a device, no doubt the reading would be zero . . . and commensurate with your expectations.

The day I got hired into Boeing (at $86/week) I went down to Interstate Electronics and bought a Triplett 630 multimeter. It was a 20,000 ohm/volt instrument (50 microamp movement) and exemplar technology for run-of-the-mill bench test instruments. It replaced a 1000 ohm/volt meter that somebody had given me some 5 years earlier. It was 20 times more sensitive than the earlier instrument and offered accuracies on the order of 2%. But no doubt the Triplett would also say that your contactor was working as expected.

The internal impedance of the meter is in parallel to the measured circuit. You want this impedance to have as little effect on the measurement as possible; the higher the impedance the better. But this discussion illustrates a situation where extraneous current flow

For most electrical measurements this effect is minimal, but for sensitive electronics of today the effect of the added resistance could be significant. This is just one of the disadvantages of an Analog meter. There are however a few useful applications for analog meters. For example, being able to see tempo and amplitude of excursions in displayed readings can be a useful diagnostic tool. So they aren't going away tomorrow.

Figure 2

Such devices were useless for many investigations into the function of vacuum tubes. The source impedance of many voltages of interest were so high that probing the node with this voltmeter

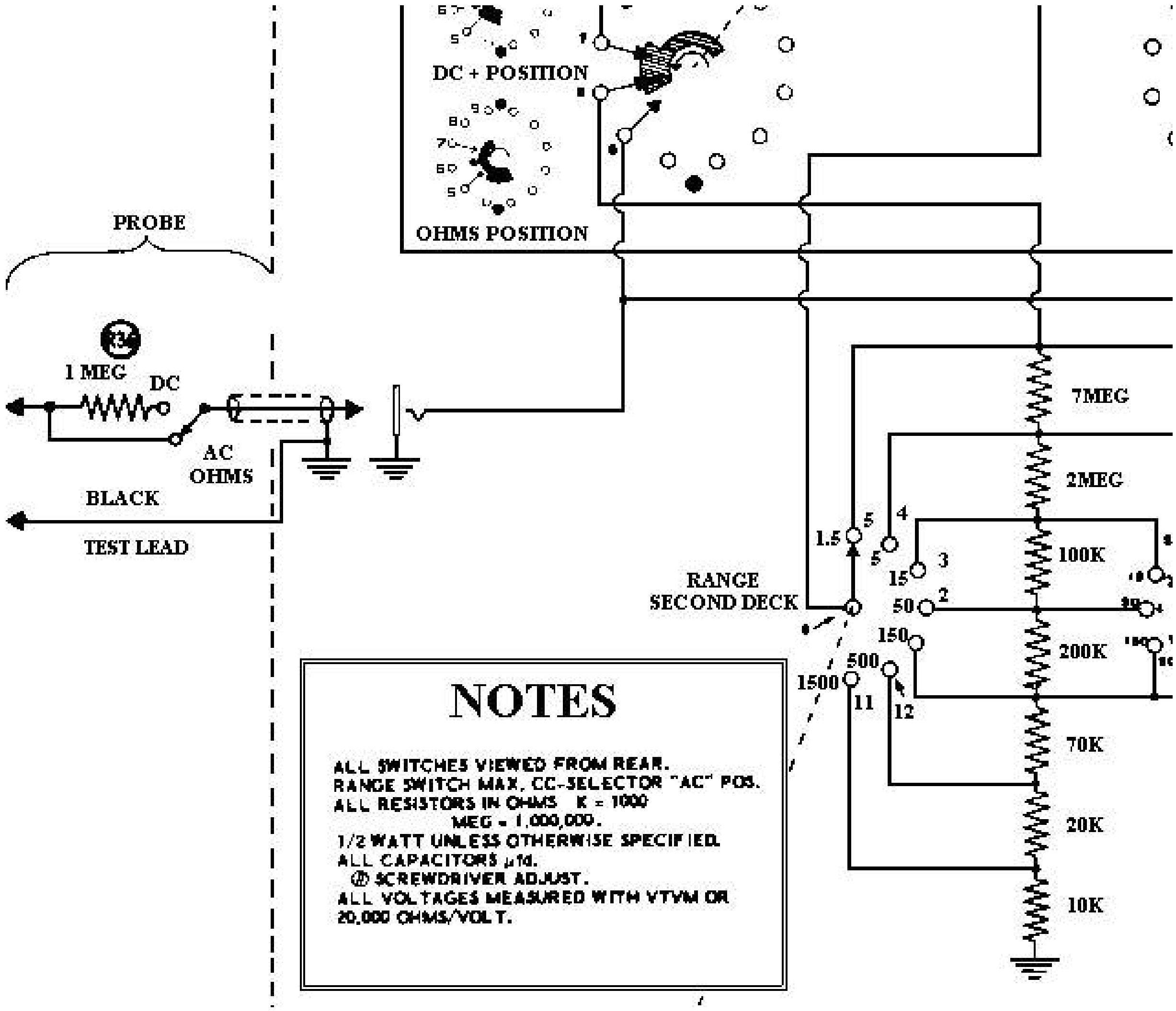

Figure 3

would also show zero volts . . . and the circuit under test would cease to function at all.

Probing through sensitive circuitry added new requirements for sensitivity and isolation. This was achieved with some form of amplification. A exemplar instrument is shown in Figure 2.

This Heathkit product has an input circuit illustrated in Figure 3.. Notice the voltage divider of resistors that total up to more than 9 megohms. Notice too a 1 meg resistor built into the probe. The input impedance for this instrument is over 10 megohms. Further, probing a node with a combination of DC volts of interest that also carries some signal (perhaps even high frequency RF) is only very slightly affected by the probe. This instrument is several hundred times mor sensitive than the precision bench meter cited earlier.

This instrument would have produced an similar anomalous contactor output reading for the de-energized condition.

Modern digital voltmeters have input impedances on the order of 20 megohms. Further, they do not offer isolation for probe capacity when measuring 'busy circuits'. I have crafted a x10 probe for my Fluke multimeter from an low capacity, oscilloscope probe to conduct the kinds of measurements I used to do with my Heathkit VTVM. Also, I have some load resistors I can stack onto the voltmeter's test lead jacks that deliberately degrade instrument sensitivity so that readings are not influenced by small leakages.

The point of this soliloquy is to remind us that not all observations provide good data . . . but all data can be filtered through a healthy level of skepticism supported by an understanding of the circuit under test along with the measuring device's limits.

Bob . . .