Sure, I know how to use my VoltMeter?

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- This is an overview session
- You don’t have to be a math whiz
- You do have to put your ‘thinking cap’ on
- It isn’t rocket science, but you’ll need logic
- You should come away with a better understanding of the tool
- “Google it!”
- Safety First

Two Wires, a rotary switch, and a display.

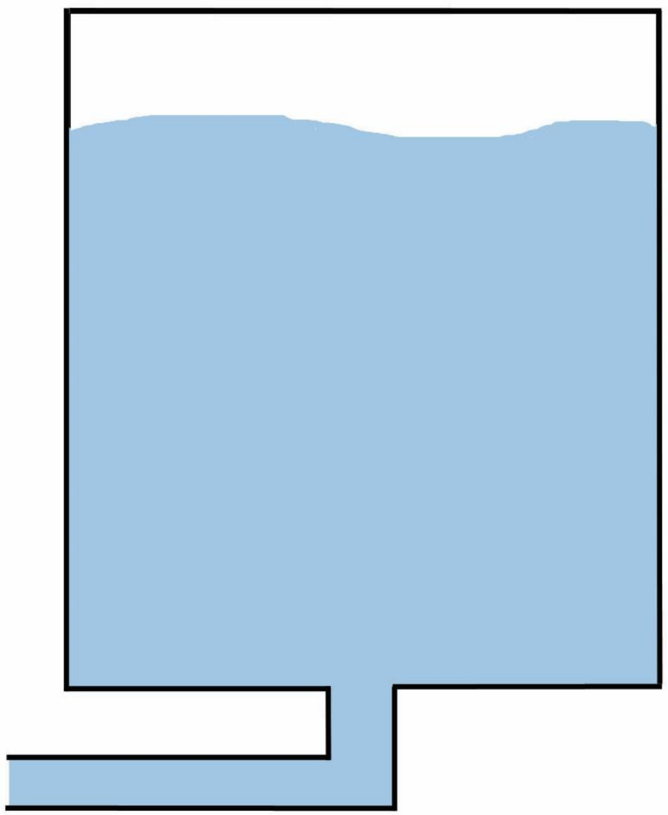
Looks simple enough…….

- Let’s start by asking what kind of “meter” are you using.
- Most of the handheld meters that we have become familiar with are actually Volt-Amp-Ohm meters. aka VOM.
- Which is better, Digital or Analog? It’s like a car – Ferrari or Ford - either will get you there. It’s also like a guitar – Electric or Acoustic – if you can’t play, it doesn’t matter.
- The basic meter measures:
- Voltage or amount of potential power.
- Current or the actual flow of power.
- Resistance or the regulator of power.
- Current is expressed as I, Voltage expressed as E, and Resistance as R.

The Plumbing Analogy

Voltage (E)

Voltage can be represented by the pressure in a water tank forcing water through the pipe.



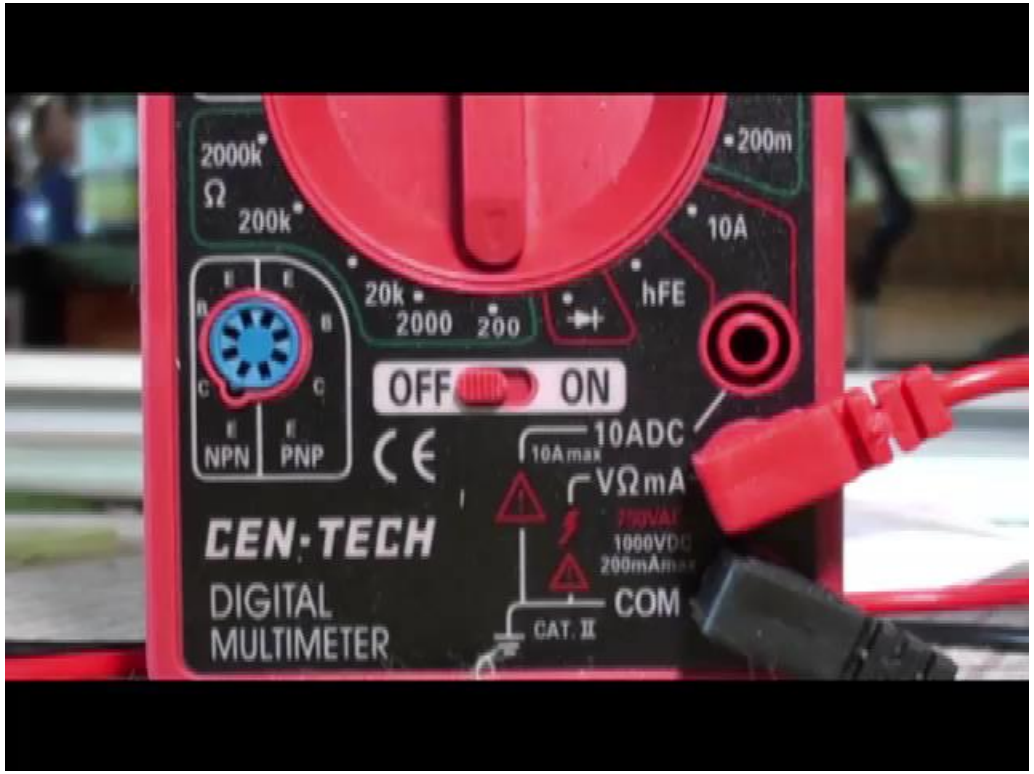
(R) Resistance

The amount of water flowing is directly effected by the diameter of the pipe. Smaller pipe (higher resistance) less flow.

Current (I)

The water flowing through the pipe represents the electrical current. The more pressure here, the more current you get.

- So let’s look at a little theory and even a little math.
- Ohm’s Law! I = E / R or E = I * R or R = E / I (Amps, Volts, & Ohms)
- Current is expressed as I, Voltage expressed as E, and Resistance as R.
- 1 volt / 1 ohm = 1 amp
- 12 volts /12 ohms = 1 amp
- 12volts / 1 ohm = 12 amps
- Measuring a voltage is simple, but ‘knowing’ what you’re doing is another story.
- If you are using the VOM in model railroading there are a few tricks to know.


2000k
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NPN
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10ADC
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VΩmA
1000VDC
200mA max
COM
CAT. II
CEN-TECH
DIGITAL
MULTIMETER

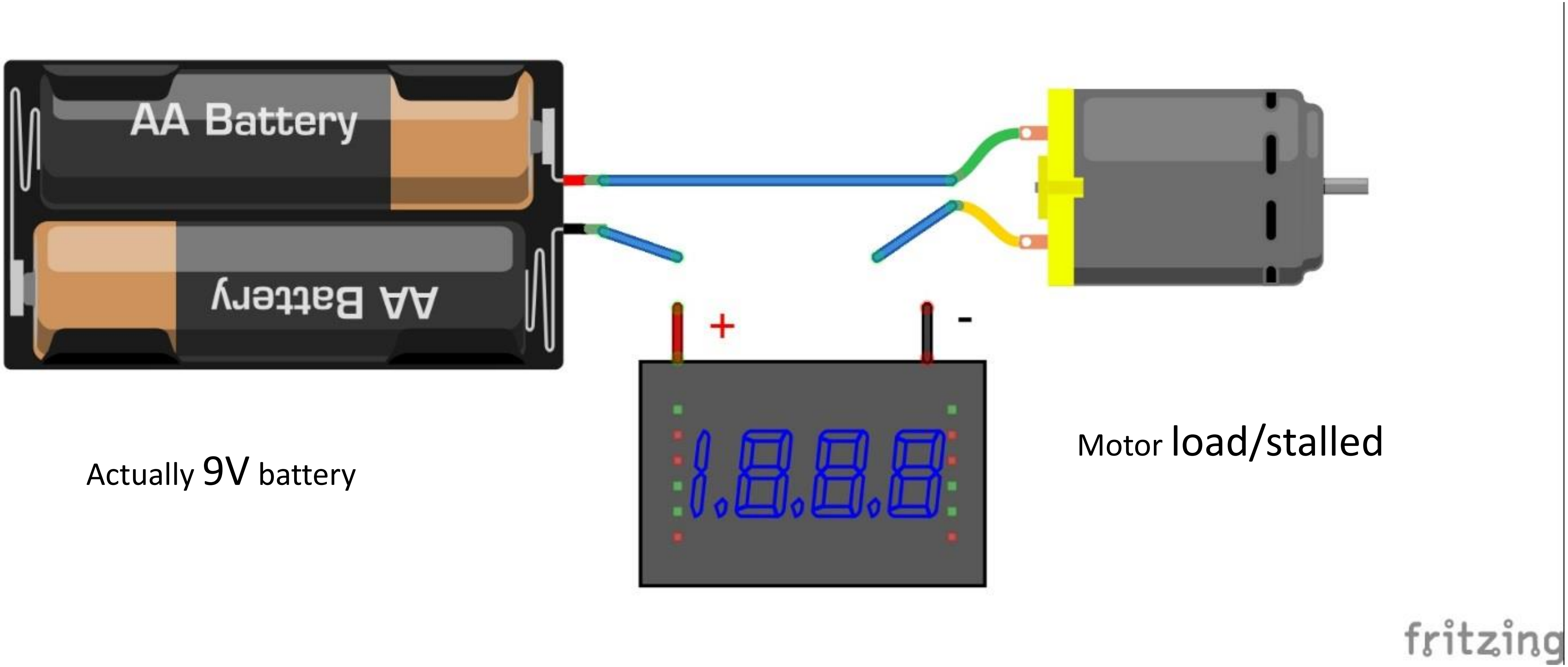
- All VOM's have a selector, and 'ranges'. After you decide what you want to measure, set the range 'higher' than the expected result, or you could damage the meter.
- Use caution where you stick your probes.
- Your VOM measures Voltage, (DC and AC) Direct Current, and Resistance.
- Observe the 'polarity' of your intended circuit. Unless it is AC.
- DC is used for the non-DCC locomotives. DCC on the other hand will require voltage and current measurements in AC.
- However, DCC meter readings will be inaccurate. Why? DCC is a pulsed signal well above the 60 HZ that a VOM is calibrated for. So you need to remember that it will always read much lower than the actual voltage and current.

- Where does that come into immediate play? If you are adding a decoder to that older locomotive, and you see that the decoder you are selecting has a 1 amp rating, will it work on your locomotive? If you are using track power from a DCC booster, you have NO WAY of knowing what current that motor is drawing! So what do you do? A smoke test?

- Of course not! You can get a fresh 9 Volt battery (measure the battery's voltage and write that down) . Then switch your VOM to read current (milliamps-Amps). The meter will be wired in 'series' with the battery and the motor. The motor will be running 'wide open'. Stop the wheels from turning and record the current being drawn. At this point you have 2 numbers to plug into Ohms law. Lets' use for example 9.2 Volts from that fresh battery, and a current of 770 milliamps. Will a 1 amp decoder 'fly' or 'fry'?

- Hmm, lets' see…. R = E / I …….R = 9.2 / .770….. R = 11.95 ohms. So knowing that the effective motor resistance is 11.95 ohms, we can calculate the current draw at 13-14 volts of DCC track voltage under 'stall' conditions.

- On the next screen.



Actually 9V battery

Motor load/stalled

Meter measuring current

However, !!!!

That 9 volt battery was NEVER designed to run a locomotive. As we draw a hefty current from it, the voltage drops fairly substantially. In fact in our example, the 9 volts drops to 5.5 volts under load conditions. This was measured back in the 'voltage reading' setup, and putting the stall loading back on the engine.

So you want to make sure you have a power supply capable of supplying a fairly constant voltage to your testing. That old DC power pack would probably be a wiser choice as your voltage source. (remember to measure the output voltage)

Let's take a look at the results…with our new (actual) numbers. R is still equal to E/I so that changes R to 5.5V / .85 A or 6.47 ohms.

- Back to the formula now I = E / R. We'll substitute 13.5 volts normal track voltage, and divide it by the resistance. 13.5 Volts / 6.47 Ohms = 2.08 Amps. The answer is 'fry'. The 2.08 Amps (2,080 milliamps) is over twice the rating of that 1 Amp decoder. Add a light or two, and it's a trip to the decoder locker.
- How can we make that assumption? Because of the 3 values, the resistance is not variable.

- Another way of using the VOM is to measure the motor's resistance. Put the meter into resistance mode and read across the motor terminals. Maybe you'll read nothing. Why? Maybe you found a dead spot on the armature and it is effectively an 'open' circuit. Just turn the motor a bit by hand and see if the motor resistance shows a reading.

- For a small DC motor, set your meter to the lowest range (typically 200 ohm range). You are reading the R directly without the influence of DC/DCC. An older 'open frame' motor will generally have a lower resistance than a newer 'can' motor. Lower resistance in our applications is usually a 'bad thing'. 30 to 50 ohms usually good.

- Now that we know that the meter has the ability to do more than measure Voltage and Current , we'll take on a 'short' on the layout. Always measure for a short with ALL POWER OFF.

- Before we hop into that challenge, let's understand that a DCC locomotive on a open rail WILL NOT show you any resistance on your meter. Why? The decoder isolates the motor circuit while there is no power to the track. So, with that bit of information, you know that a properly working and railed loco will NOT be the source of a short on the layout. A reading of less than 10 ohms will normally trip your booster.
- Here is something to remember, resistance in series is additive. RT = R1 + R2 +Rx
- Resistance in parallel is calculated: RT = 1/ (1/r + 1/r + 1/r)

- Possible causes like crossed feeders, a 'non-DCC' switch, a piece of wire, or a chunk of metal laying across a section of track would cause a 'short'. Before you go on a painful wild goose chase looking for a layout short, think about using the tool between your ears. Disconnect the power booster or power pack. If you have power blocks installed, isolate as many as you can. Troubleshoot the smallest piece of the layout pie that you can. Although DCC seemingly eliminates the need for using 'blocks' in the design of a layout, that is an easy trap to fall into. It makes what should be easy fault finding nearly impossible.

- In the planning stage of your layout, make sure you have logical separation points to allow for problem isolation.
- Thinking cap time…the ohmmeter can test for a ‘short’. We can use that function to test for ‘continuity’. Name a few instances where we WANT a short , an open?
- Locating dead spots on the layout, testing switches, testing fuses, light bulbs, LEDs, diodes, and other components. Isolating track sections, blocks, components.
- Testing expected results vs actual results. (knowledge).
- <REMEMBER TO CHECK YOUR METERING MODE ALWAYS>

POP QUIZ

1. To check a 9 volt battery, how do you set your meter?
   a. Select AC Volts, place probes on battery terminals
   b. Select DC Volts, Choose a range higher than 9 volts, place probes on battery terminals
   c. Select DC Volts, Choose a range lower than 9 volts, place probes on battery terminals
   d. Select Resistance, Choose the highest range, place probes on battery terminals

2. To check track voltage on a DC layout, how do you set your meter?
   a. Select DC Volts, Choose the highest range and place probes across a set of rails.
   b. Select DC Volts, Choose the lowest range and place probes across a set of rails.
   c. Select Resistance, Choose the highest range, place probes across a set of rails.
   d. Select AC Volts, Choose the range a little higher than expected, place probes across a set of rails.

3. To check for an open connection, how do you set your meter?
   a. Select DC Volts, Choose the range a little higher than expected, measure across the open.
   b. Select AC Volts, Choose the range a little lower than expected, measure across the short.
   c. It’s impossible to measure an open.
   d. Select Resistance, Choose the highest range, measure across the circuit.

Prize Question

You have a string of 12 volt lights that you want to include on your layout. Each bulb's draw is rated at .5 amps. There are 16 bulbs connected in parallel and 4 are connected in series . Tell me what information you can expect to gather from using your meter. How much power will be required to light the lights?

Power (Watts) = I * E   if this helps your answer.

RT = R1 + R2 + Rx

RT = 1/ (1/r + 1/r + 1/r)

Thank You for your time.

Thank You for not throwing overripe vegetables.

My email address is jim@icmgt.com