

AEVA NOVEMBER MEETING 2009

Meters for EVs

Meters for EVs

- **Voltmeter:** A voltmeter is the equivalent to a fuel gauge in a petrol car, it is an indication of how much charge is left in the battery.
- Units are Volts.
- It can be used to monitor the traction battery bank, the motor voltage, the accessories battery, etc.

Meters for EVs

- **Ammeter:** An ammeter is the equivalent to a fuel flow gauge in a petrol car.
- It shows the rate that the battery is being discharged.
- Units are Amps.
- It can be used to monitor how much power is being used under different rates of acceleration, the harder the accelerator is pressed, the more amps are drawn from the battery.

Meters for EVs

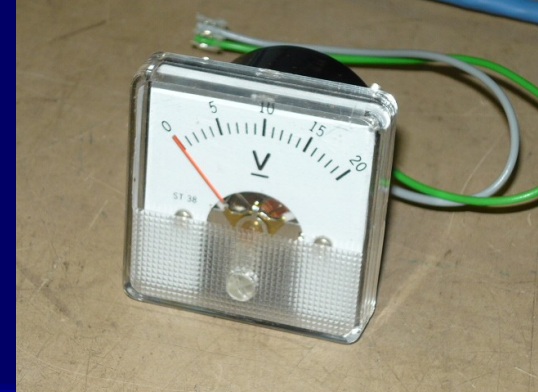
- **Temperature :** This is mainly used to measure the motor temperature to prevent overheating and subsequent damage.
- All of the above gauges can be bought off the shelf or can be modified to suit the parameters required for your application.

Meter Types



- **Digital:** These give a numerical readout so no scale needs to be read.
- Hard to read if the value is changing quickly.
- Sometimes hard to read in sunlight.
Can be subject to electrical spikes from motor circuit giving false readings.
- Can be modified to read any voltage or current range required.
- Needs 5V DC supply to power the electronics.

Meter Types



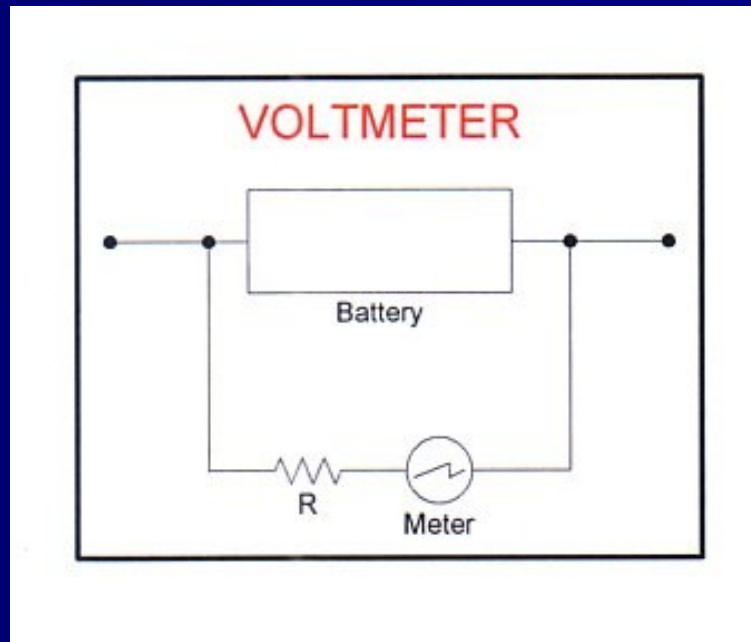
- **Analogue:** If the scale is coloured for important values of readings, it can be easy to read.
- Actual values can be harder to read while driving.
- Follows variations in readings better, easier to follow by the swing of the needle. There is some dampening effect so it will not follow really short major variations, but much better than a digital meter.
- Scale can be customised and colour matched to the vehicle trim.

Meter Types

- Easy to modify to read any voltage or current range required.
- Can be modified to become an expanded range voltmeter. E.g. Instead of measuring 0-12V it can be made to read 8-12V over the same scale size.
- My preference for meters is to buy a digital temperature gauge and modify analogue meters to measure voltage and current.

Modifying a voltmeter to change the range.

- The circuit shows how a voltmeter is connected to a circuit. The resistor R is internally connected to the meter



Modifying a voltmeter to change the range.

- An analogue meter reads full scale at a determined current. This is called the FSD (Full Scale Deflection) and remains constant no matter what the meter is calibrated for.
- To change the voltage range means having a resistor in series with the meter coil that allows FSD to occur at the voltage you want to measure.
- The resistor can be fitted inside the meter as per the original one fitted as standard.

Modifying a voltmeter to change the range.

- The scale below demonstrates test meter resistor values for different voltage ranges.

Scale	FSD	Resistor	Wattage
20V	1.98mA	20K	4mW
60V	1.98mA	60K	120mW
100V	1.98mA	100K	190mW
120V	1.98mA	120K	240mW

Modifying a voltmeter to change the range.

- Resistors can be trimmed by putting two in series or parallel to get exact readings.
- A variable resistor could be used but these can vary over time and so it is not advised to use them.
- The power that is dissipated in the resistor must be calculated and an appropriate wattage resistor used.
- If too small a wattage resistor is used it may overheat and could cause a fire.
- In reality a 0.25W resistor is usually adequate, but always check.

Formula used in calculations

- **Ohms Law:**

- $E = I \times R$ Volts = Amps X Ohms

- $R = E / I$ Ohms = Volts / Amps

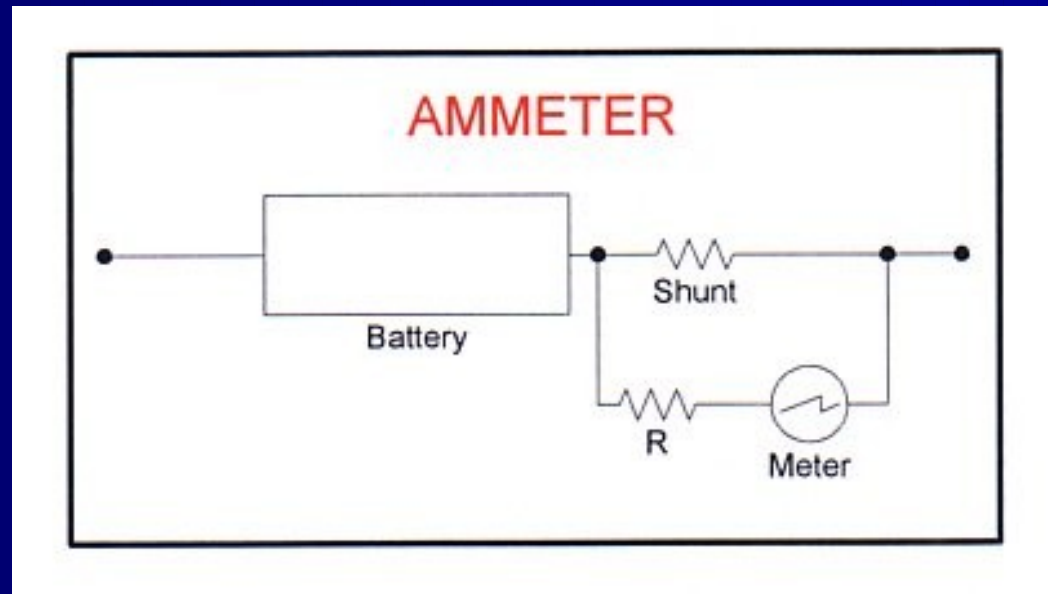
- $I = E / R$ Amps = Volts / Ohms

- **Wattage:**

- $P = E \times I$ Watts = Volts X Amps

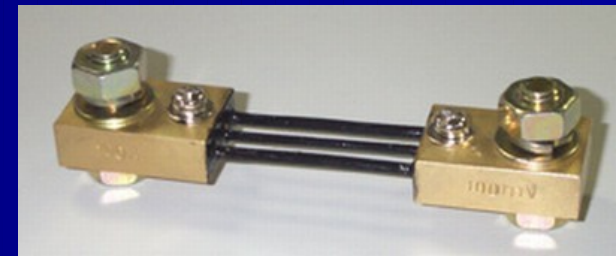
Modifying an ammeter to change the range.

- The circuit shows how an ammeter is connected to a circuit. The resistor R is internally connected to the meter



Modifying an ammeter to change the range.

- The meter is connected across a resistor in series with the load current (called a Shunt) and measures the voltage drop across the resistor.
- This is proportional to the current flowing through the shunt with the scale of the meter being calibrated in Amps.
- As with the voltmeter, a resistor is fitted in series with the meter coil to get FSD at the required maximum current.



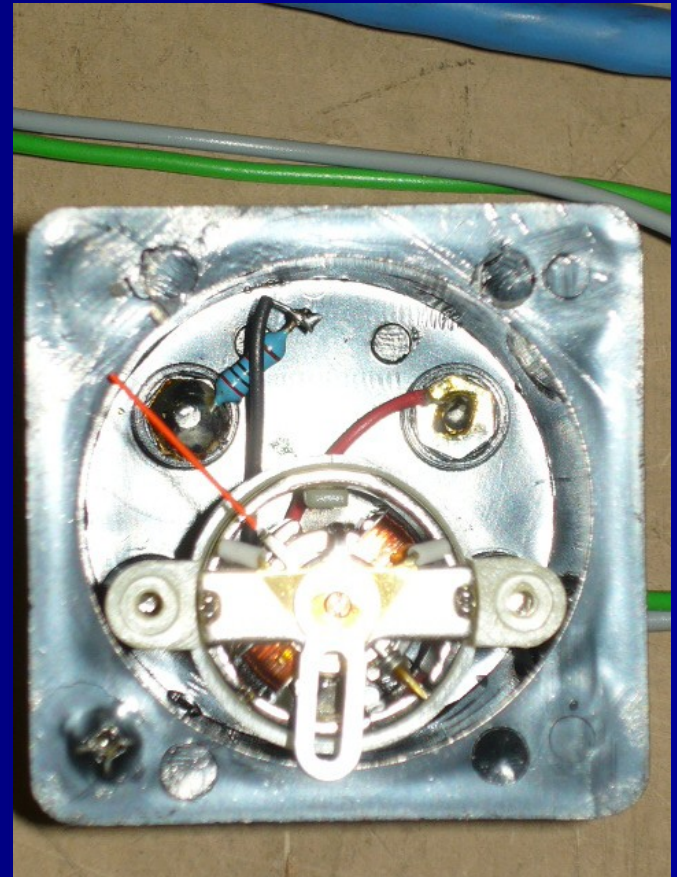
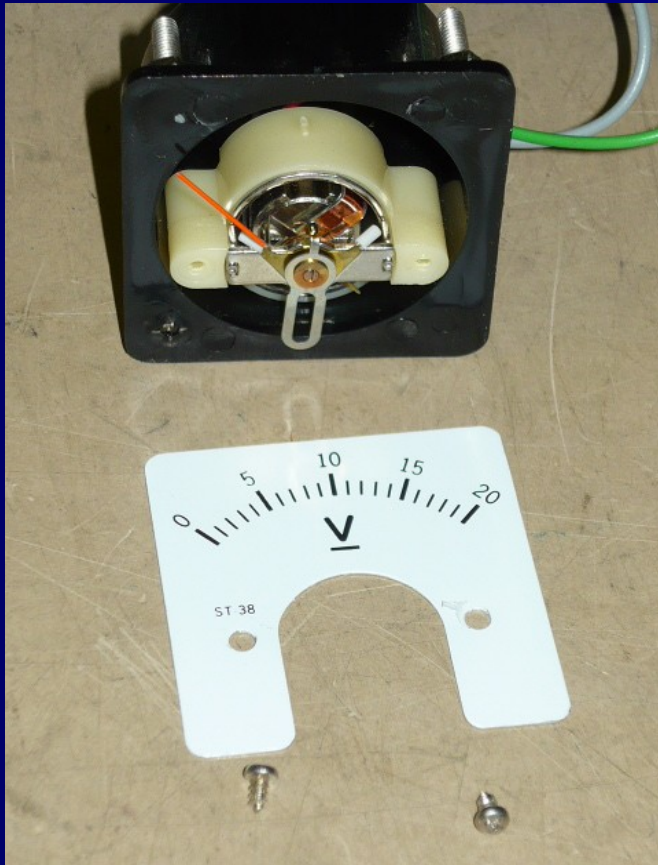
Modifying an ammeter to change the range.

- Instead of using a an extra resistor as a shunt, the actual cable (longest length) can be used with the ammeter measuring the voltage drop across the cable.
- In the motor circuit the high current can give quite a useful voltage drop to work with.
- In reality a clamp meter is used to measure the actual current while the voltage drop is measured so the resistor value can be calculated to give the required reading.

Disassembling a meter - 1



Disassembling a meter - 2



DEMONSTRATION

- Using the same meter to measure different voltages and also current