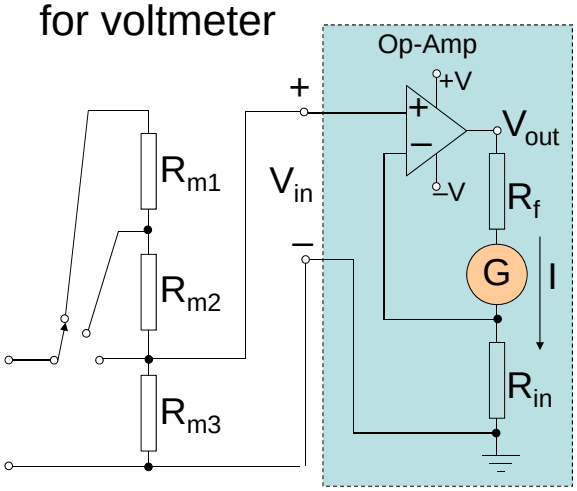
Multimeter

EIE 240 Electrical and Electronic Measurement
Class 7, January 26, 2012

Electronic Instrument

Disadvantage of moving coil meter

- Low input impedance ⇒ High loading error for voltmeter



DC Non-Inverting Amplifier

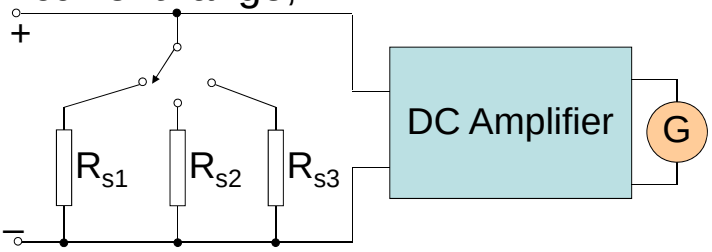
Higher input impedance (≈ 10 MΩ),
$V_{in} = I\ R_{in}$

$V_{out} = I\ (R_f+R_g+R_{in})$

Gain,
$A_v = (R_f+R_g+R_{in})/R_{in}$
$= 1 + (R_f+R_g)/R_{in}$

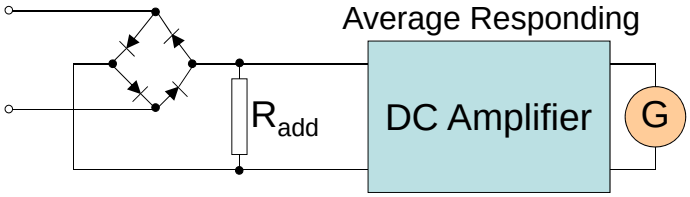
Electronic Instrument (Cont'd)

For low current range,



More disadvantage of moving coil meter

- Low sensitivity when used with a rectifier



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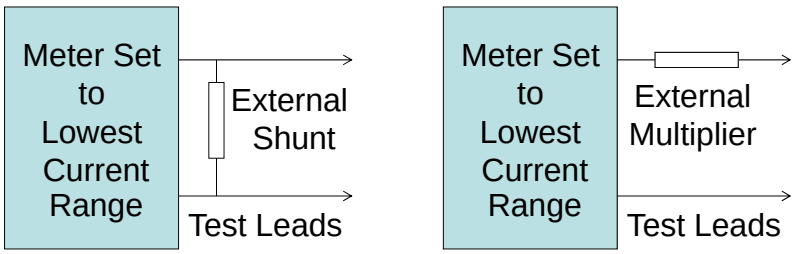
Extending of the Ranges

- The range of an ammeter or voltmeter can be extended to measure high current/voltage values by using external shunt or multiplier connected to the basic movement that is set to the lowest current range (minimum internal additional resistors → finest scale).
- Note that the range of the basic meter cannot be lowered, e.g. for 100 μA with 100 scale division → the pointer deflects by only one division of 1 μA



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Requirements of Shunt Materials

- Soldering of joint should not cause a voltage drop (minimum thermo dielectric voltage drop).
- Resistance of different sizes and values must be soldered with minimum change in value (solderability).

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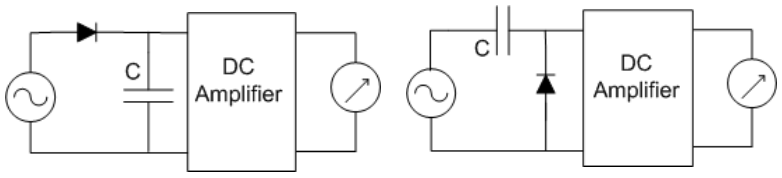
Peak Responding AC Voltmeter

- The difference to mean responding meters is the use of storage capacitors with the half-wave rectifying diode. The capacitor charges to peak value of the applied voltage, $V_c = Q/C$ and the meter then response to it.
- The capacitor discharges very slowly through the high input impedance of DC amplifier, so that a negligible small amount of current supplied by the circuit under test.
- The scale is then calibrated in RMS values.



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PMMC Analog Multimeter

Combination of

- Appropriate shunts for direct current ranges,
  50 μA - 10 A
- Multipliers for direct voltage ranges,
  100 mV - 3000 V
- Rectifier for alternating currents designed for sine wave, 10 mA - 10 A and 3 V - 3000 V (RMS)
- Ohmmeter with 1.5 V, 3 V, 9 V battery,
  2 kΩ - 20 MΩ
- Accuracy,
  about ±1%FSD (DC), ±2%FSD (AC),
  ±3% Mid-Scale Ω

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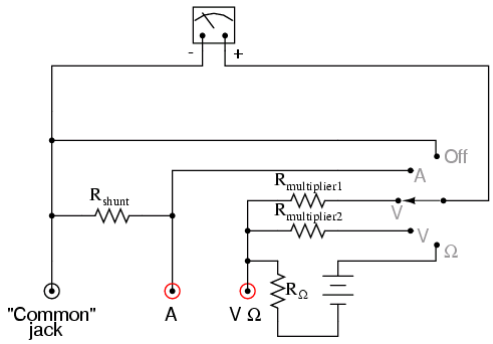
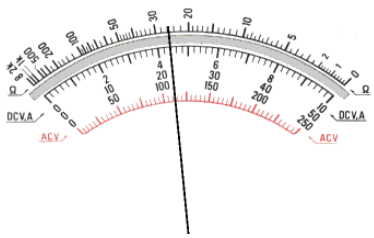
PMMC Analog Multimeter (Cont'd)

- With all three fundamental functions available, DCA, ACV/ACV and Ω, this multimeter may also be known as a volt-ohm-milliammeter (VOM).
- Multimeters may also have other functions, such as diode and continuity tests.





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e.g. Sanwa YX-360TRF Multitester

Analog Display

Battery
AA 1.5V×2

Setting
Selector

Test Lead +

Test Lead –COM

- Note that your multimeter should come with some basic instructions. Read and understand the user manual before operating the meter. 9

Parallax Error

- Because the pointer of the meter is usually a small distance above the scale of the meter, parallax error can occur when the operator attempts to read the scale line that lines up with the pointer.
- To counter this, some meters include a mirror along the markings of the principal scale. It is improved by reading the scale so that the pointer and the reflection of the pointer are aligned.

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DC Ammeter Precautions

- Never connect an ammeter across a source of EMF (electromotive force) because its low resistance would draw a high current and destroy the movement. Fuse is needed.
- Observe the correct polarity. Reverse current causes the meter to deflect against the mechanic stopper, which may damage the pointer movement.
- If the polarity is not known, insert the test leads momentarily. If the pointer goes down scale, remove immediately and reverse the polarity.

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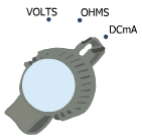
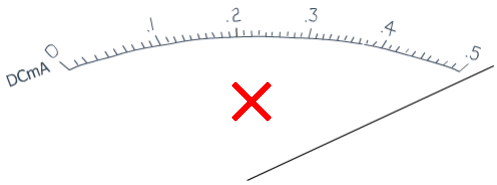
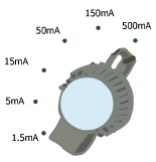
DC Ammeter Usage

- Set a function selector to the “DCmA” position.



- Set the range to the maximum current, i.e. 500 mA, to avoid pegging the meter or the pointer goes beyond the right of the scale.





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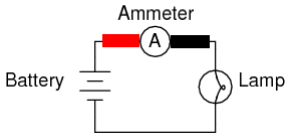
DC Ammeter Usage (Cont'd)

- Turn off the circuit power.
- Open the circuit and reconnect it by placing the ammeter in series between the two points the circuit broken.
- The red lead (+) should be placed on the side current enters the meter and the black lead (–) is for the current exits the meter.



- Turn the power on and re-energize the circuit.

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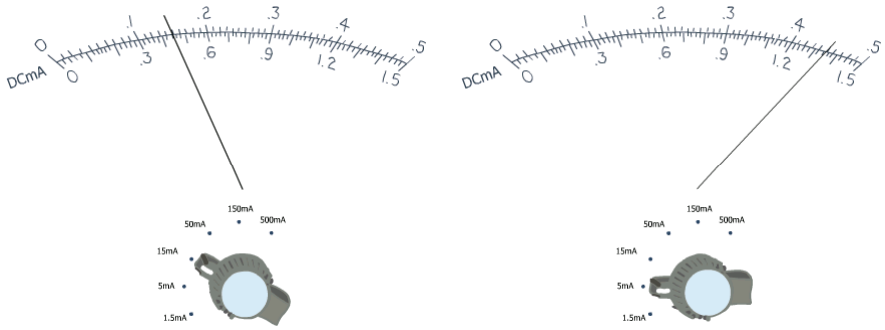
DC Ammeter Usage (Cont'd)

- Adjust the range so that the pointer is as close to the farthest position to the right, i.e. 0.5 mA range should be selected.



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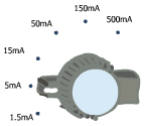
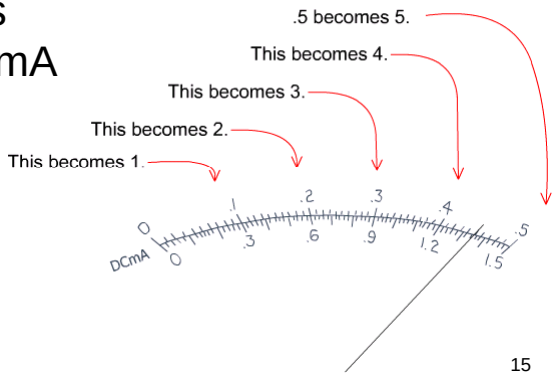
DC Ammeter Usage (Cont'd)

- Read the linear scale with the range you selected, e.g. the maximum value is 5 mA.
- Multiply the reading on 0.5 mA range by 10 and the answer is $0.450 \times 10 = 4.50$ mA
- Tolerance $\pm$e%FSD (DC)





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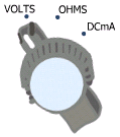
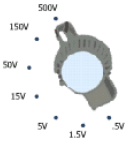
DC Voltmeter Usage

- Set a function selector to the "Volts" position.



- Set the range to the maximum voltage, i.e. 500 V, to avoid the condition the pointer goes beyond the right of the scale.



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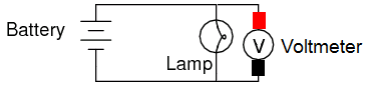
DC Voltmeter Usage (Cont'd)

- Turn off the circuit power.
- Connect the voltmeter in parallel to two terminals of the component we want to measure the voltage dropped across it.
- The red lead (+) should be placed on the side current enters the meter and the black lead (–) is for the current exits the meter.



- Turn the power on and re-energize the circuit.

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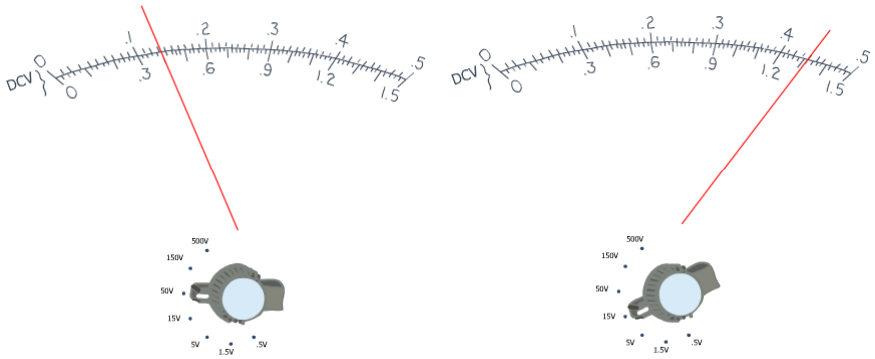
DC Voltmeter Usage (Cont'd)

- Adjust the range so that the pointer is as close to the farthest position to the right, i.e. 15 V range should be selected.



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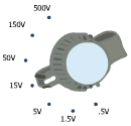
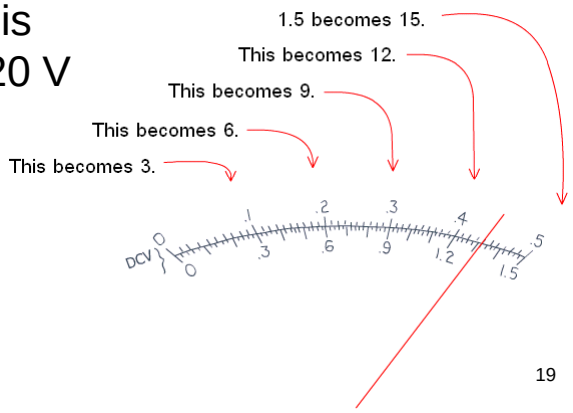
DC Voltmeter Usage (Cont'd)

- Read the linear scale with the range you selected, e.g. the maximum value is 15 V.
- Multiply the reading on 1.5 V range by 10 and the answer is $1.320 \times 10 = 13.20$ V
- Tolerance ±e%FSD (DC)





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AC Voltmeter Usage

- Connect the meter across the circuit as same as DC voltmeter usage but it does not require correct application of the polarity .
- If the voltage range is unknown get the estimate value by setting the knob at the highest range at 1000 V, then lower the range until you could read it conveniently.
- The reading is in RMS value.

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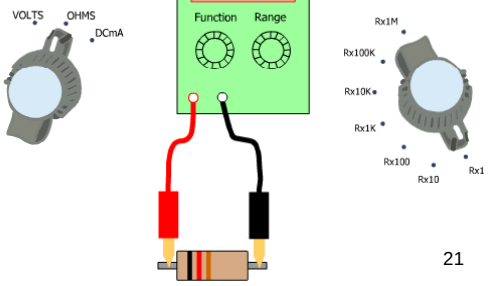
Ohmmeter Usage

- Set a function selector to the “Ohms” position.
- Set the range to the smallest multiplier, i.e. R×1.
- Connect the ohmmeter to the component being measured.



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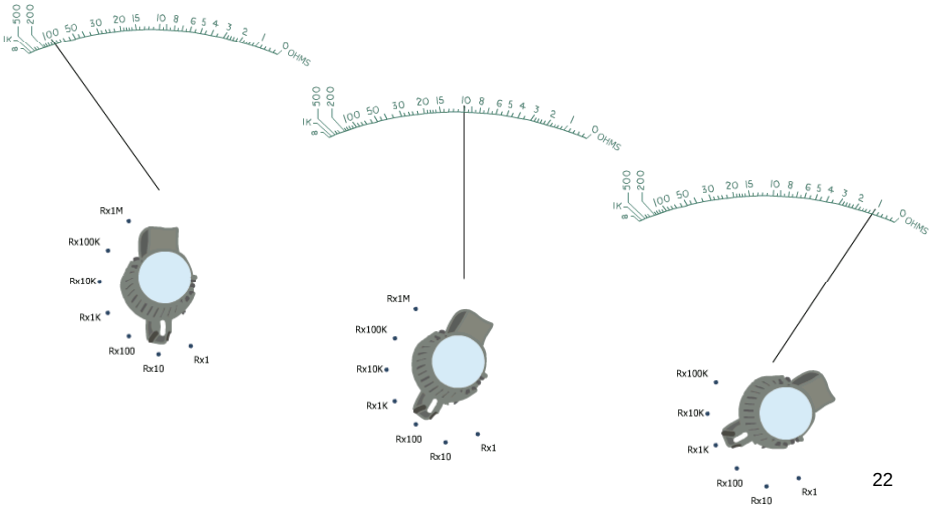
Ohmmeter Usage (Cont’d)

- Adjust the range so that the pointer is as close to the mid scale as possible, i.e. R×100.



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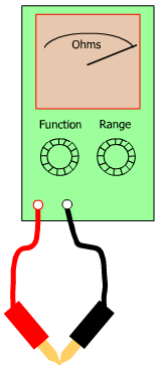
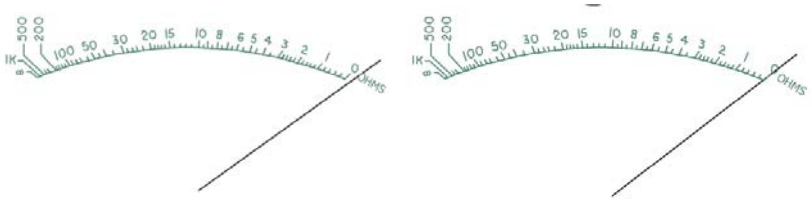
Ohmmeter Usage (Cont'd)

- Remove the component and touch the test leads together. If the pointer is not at the zero line, turn 0-Ω adjust knob so that it becomes properly aligned.





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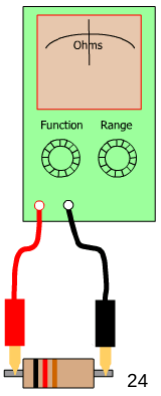
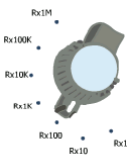
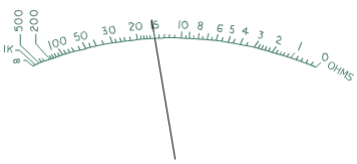
Ohmmeter Usage (Cont'd)

- The meter is now calibrated and ready to make an accurate measurement. Note that each time the different range is selected, the calibration needs to be repeated.
- e.g. multiply the reading by 100 and the answer is 15.00×100 Ω or 1.500 k Ω
- Tolerance ±e% Mid-Scale







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