Newcomers and Elmers Net: Analog and Digital Meters 01-10-16
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A few words about multi-meters are in order because there are more meters out there than one can count, many almost at give-away prices at some of the local "box" stores and freight companies.
-- Some of the most basic meters are those which usually run about $5-10 (U.S.), and these will work to measure things like resistance and check battery voltage.
-- If this is all one needs from a meter they are fine.
-- If we intend to use the meter for more serious measurements then the issue of accuracy comes into play, as well as safety. Phil, KE6IMR also mentioned he has seen RFI affect cheaper meters which may not be shielded very well – a good point to consider!

Analog v. Digital Meters
For years all we had were analog meters, now almost all meters you see are digital
-- analog meters work off of a magnetic field created by the electrical current being measured; I won't get into specifics, but when they are will made they are very accurate
-- they are a bit more susceptible to damage, but hopefully you are careful with any equipment you use, so that should not be a factor
-- digital meters are more accurate in terms of being able to read smaller fractions of power, as most digital meters go to at least three places behind the decimal point
-- analog meters require you to change voltage or current levels based on the amount of current or power expected, usually by factors of 10
-- in some ways this makes you operate the meter more carefully as you do not want to be blowing up the meter by measuring 3 volts into the 10mV setting
-- another advantage to an analog meter is the ability to see the needle movement, particularly if there is a bit of wavering going on in the reading
-- it is easier to follow the needle than to try and read an ever shifting digital meter's numbers

Some of the advantages to digital meters are storing the highest reading (a nice feature if you are comparing several readings
-- also many digital meters come with an auto ranging function, a must-have feature for me
-- this is where the meter will automatically adjust itself to the correct measurement scale based on the amount of current or power it senses – you do not have to set it beforehand like you do with an analog meter
-- keep in mind though that not all digital multi-meters are auto-ranging;

some of the cheaper meters must be set based on the expected scale just like the analog meters
-- true RMS readings as mentioned before; if you are going to measure AC current then you will want this option for accuracy
-- you want a meter (analog or digital) which can read millivolts as well as Volts – some meters designed for electricians do not read down to the millivolt level
-- for the types of things we are likely to use a meter for, millivolts is an important scale
-- in the resistance department you want to have ranges from 100-200 ohms to 40 Mohms
-- 10Meg ohm input impedance – many less expensive models only have one or two meg-ohm impedance, and this can alter the current or voltage reading you are taking
-- for current, ranges from micro amps to milliamps to amps is the best range, at least up to 10 A or greater
-- the micro amps range is very useful for modern surface mount electronics
-- make sure the 10A input is fused – very important for safety!!

Price Ranges
-- The mid-range meters do seem to offer more features and better accuracy, and this is true to a point.
-- Two features are typically lacking from meters in the $50 range.
-- The first is true RMS readings.
-- Some meters will advertise RMS averaging (sometimes referred to as AC average rectified measurement), meaning they are using some calculations to get an approximation of the RMS value, rather than measuring each cycle.
-- This presumes the signal is a true sine wave and that they are measuring the average value for the rectified sine or the peak value.
-- They then apply a conversion factor to find the presumed RMS value.
-- This may be fine in some applications, but many circuits require knowing exact measurements as they affect power output and cycle duties.
-- Averaging often shows lower voltage numbers and true RMS.

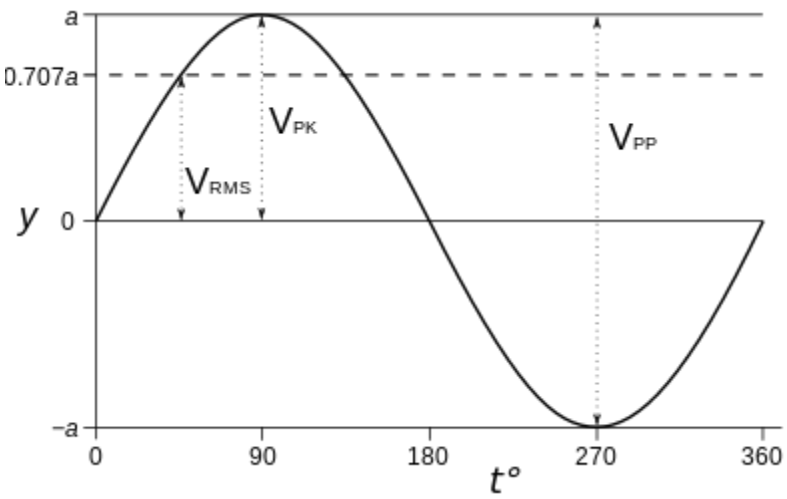

Figure 1 Graph of a sine wave's voltage vs. time (in degrees), showing RMS, peak(PK), and peak-to-peak(PP) voltages

RMS is obtained by taking the mean of the squares of the instantaneous values during a cycle such as found with alternating electrical current. It is equal to the value of the direct current that would produce the same power dissipation in a resistive load.

This is a result of Joule's first law, which states that the power in resistive load is proportional to the square of the current (and, as a consequence of Ohm's law, also to the square of the voltage).

-- The second feature often not found in less expensive meters is a separate jack for volts and amps.
-- Many meters have only three jacks, which usually means voltage and current measurements can easily be switched, possibly causing real damage to the meter, or worse, to the operator.

Volts, Ohms, and milliamps on the same jack (Left)

Separate jacks for A/mA and Volts; also Amps are fuse-protected (Right)

With these additional features as well as some other ones like peak hold, Relative (Δ), and manual/auto ranging capability, the price will go up to around $80-100.
-- You will have to decide for yourself if the features are worth the investment or not.
-- But do not throw away the old meter if you do upgrade, as there are times when it is nice to have two meters, one for volts and one for current.

Additional Meters

There are several other meters which might be of interest in a shop. One such meter is a variation on the type just discussed, called a clamping meter.

-- These meters allow the user to measure current through a wire without having to open the wire for contact. Instead the magnetic field is read and then converted into electrical current measurements.

This type of meter is not only safer, it also cuts down on repair time since bared or cut wires do not need to be repaired.

-- This is another area where less expensive meters will offer a non-conductive option, but unless it uses an optional add-on (which can be as much as a new meter itself), one is better off buying a dedicated clamping meter for increased accuracy and safety.

-- These meters can also be purchased with True RMS readings, and can function as a basic meter for volts and resistance as well.

Another meter which will find use in the shop is an L/C meter for measuring spare/replacement parts, or ones removed while troubleshooting a misbehaving circuit. The ability to accurately check inductors and capacitors is very useful for radio and antenna work.

-- keep in mind if you are working with older equipment, particularly tube-era equipment, you are dealing with much higher voltages than with modern equipment

-- transistors, capacitors, and resisters in modern equipment often deal with millivolts to a few volts; an old tube-era capacitor might be expected to work at 600V

-- most modern test equipment cannot operate that high

-- fortunately there are many old pieces of test equipment still running around, and with a little restorative work can operate just fine

Do I Need An Expensive Meter?

Well, of course it depends on what your definition of expensive is, but I will assume expensive is anything much over $100, whereas mid-range meters around $50-80, and inexpensive meters around $5-25

-- If you only plan on taking an occasional reading of a battery, check resistance in a circuit to see if it is resistive or open, or measuring the occasional coax for a break, then an inexpensive meter will do fine

-- if you plan on learning a bit of electronics and circuit design or repair, you will probably want one in the mid-price range for the features and accuracy
-- you probably do not need to spend anything over $75-100 maximum for a meter, unless there is some specific reason your work would require it, and that means you probably already know more about these than I do!
$50-$80 should get you all the meter you will need
-- one recommendation is if you are going to be measuring high voltages I would recommend getting silicon coated leads for the meter as a safety factor
-- many inexpensive meters come with fairly light gauge cables, and like antennas, the cables need to be rated for what you plan to measure
-- look for CAT III ratings of 600V and at least 400mA and 10A fused lines for current
-- a lot of cheaper meters are only CAT II rated to 600V, and the newer standards are safer.
-- if you happen to get one with a temperature probe that is a nice extra, and any capacitor/transistor checking capability is a bonus as well
- lights on the meters can be nice if you have to work in dark spaces