# Measuring Motor Efficiency

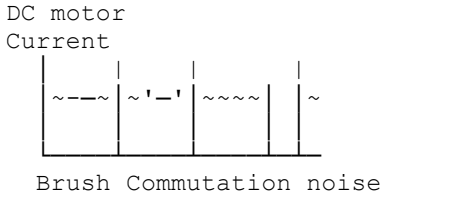
By G8MNY (New Feb 09)

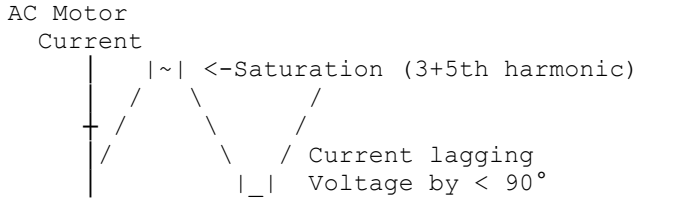
(8 Bit ASCII Graphics use code page 437 or 850)

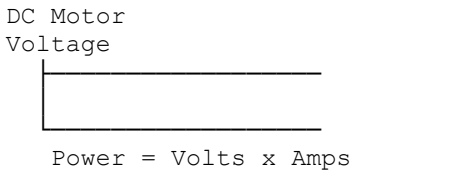
To determine the efficiency of an electric motor 2 things are needed, input & output powers.

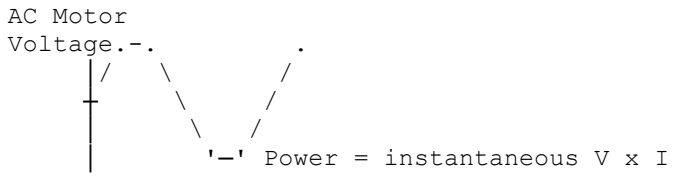
## INPUT POWER.

Two items to be measured & multiplied together, Voltage & Current.
With DC this is relatively easy, but pulse currents can mean "DC RMS" not an "average meter" is needed, but for an AC motor not so easy, as there is power factor as well as any pulse power (core saturation) to take into account.



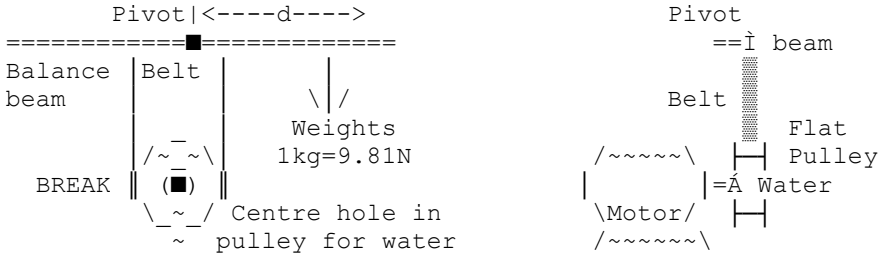




With modern true RMS meters & true AC power meter this can be can be accurately measured otherwise you are guessing!

## OUTPUT POWER

Using Si units you end up with everything in Watts. Again two items, Force (Newtons) over a Distance (m) for linear measurement, or Torque times RPM for a shaft power. The torque can be measured from 1st principles with a simple mechanical break.



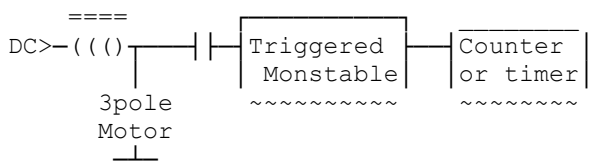




The 2 belt positions to the beam are at the pulley diameter apart, but with the central pivot slightly offset, this gives is self tensioning action as the weights are put on. The flat pulley has 2 side disk that insure the belt can't come off. For powers of over a few 10s of Watts water cooling is used inside the spinning pulley & allowed to boil off. The pivot's hight is set to keep the beam level.
With this set up the force (N) on the balance beam equals the torque & is set by the weights at the distance d (m) on the beam to pivot.

e.g. 0.1kg x 9.81 @ 1m = 0.981 Nm

The RPM can be done from the motor shaft with several types of pick up (e.g. on the pulley) or even on a small DC brush motor from the commutator noise.




Here the monstable is set to just wider than the commutator break time, so that counter sees cleaned up pulses of 6 per Rev due to the 3 breaks per brush. The inductor needed to see the current pulses across it, can often be just that of the connecting wires. So say with a simple 3 pole motor 120Hz on the counter equals 20 Rev/s & 1200RPM.

With say a torque of 0.981 Nm & 20 Rev/s = 19.62 Watts

Power Watts = Torque (Force x Distance) x Revs per second.

With AC synchronous motors the shaft RPM is a few Revs per second below the mains field speed, called slip. e.g. a 4 pole motor on 50Hz may be @ 1400RPM or 3.33 Rev/s slow seen strobing with a lamp.

EFFICIENCY
With everything in Watts it is straight forward to do calculations

$$\text{Efficiency \%} = \frac{\text{Output}}{\text{Input}} \times 100$$

The motor losses are of course mainly in heat, windage, bearings & noise/ vibration. Very good ones will be >80%, but some light weight motors (e.g. for carrying like hand tools) may be very poor @ 50%, & rely very heavily on fan cooling to allow that power rating. Faulty motors will show up below 20%.

For a series of results to find say the best efficiency, put all the results on a spread sheet & plot graphs etc.

Why Don't U send an interesting bul?

73 De John, G8MNY @ GB7CIP