

Calculations performed by the MCALC32 Motor Calculator program

The equations herein assume SI units

To do the motor calculations, you will need:

- spec_free_speed
- spec_stall_torque
- spec_free_amps
- spec_stall_amps

at some specified voltage "spec_volts" for the selected motor

Example:

for the CIM,

spec_volts = 12 volts

spec_free_speed = 5310 / 60 * 2pi rad/sec

spec_stall_torque = 343.4 * 0.00706155 Newton-meters

spec_free_amps = 2.7 amps

spec_stall_amps = 133 amps

Once you have the above specs for a motor, you can do motor calculations:

1) If you know the applied voltage "volts" and (speed or torque or amps or power_in or power_out) then do steps (1.1) and (1.2):

1.1) calculate free_speed, stall_torque, free_amps, and stall_amps at that voltage "volts" as follows:

free_speed = spec_free_speed * (volts/spec_volts)

free_amps = spec_free_amps * (volts/spec_volts)

stall_torque = spec_stall_torque * (volts/spec_volts)

stall_amps = spec_stall_amps * (volts/spec_volts)

ohms = spec_volts/spec_stall_amps

1.2) choose one of the following:

1.2a) if you know the motor torque:

$speed = free_speed * (1 - torque/stall_torque);$

$amps = free_amps + (torque/stall_torque)*(stall_amps-free_amps)$

$power_out = speed*torque;$

$power_in = volts*amps;$

$efficiency = 100.0*power_out/power_in$

1.2b) if you know the motor amps:

$torque = (amps-free_amps)/(stall_amps-free_amps)*stall_torque$

then do the calculations in (1.2a)

1.2c) if you know the motor speed:

$torque = stall_torque * (1 - speed/free_speed)$

then do the calculations in (1.2a)

1.2d) if you know the output power:

there are 2 solutions

$temp1 = free_speed*stall_torque$

$temp2 = sqrt(temp1*(temp1-4*power_out))$

solution 1:

$torque = (temp1+temp2)/(2*free_speed)$

do the calculation in (1.2a)

solution 2:

$torque = (temp1-temp2)/(2*free_speed)$

do the calculation in (1.2a)

1.2e) if you know the input power:

$$\text{amps} = \text{power_in}/\text{volts}$$

do the calculations in (1.2b)

1.2f) if you know the efficiency:

$$\text{temp1} = \text{stall_amps} * \text{volts} * \text{eff} / 100$$

$$\text{temp2} = \text{free_amps} * \text{volts} * \text{eff} / 100$$

$$\text{temp3} = \text{free_speed} * \text{stall_torque}$$

$$\text{temp4} = \sqrt{\text{temp1}^2 - 2 * \text{temp1} * (\text{temp2} + \text{temp3}) + \text{temp2}^2 - 2 * \text{temp2} * \text{temp3} + \text{temp3}^2}$$

solution 1:

$$\text{torque} = (-\text{temp1} + \text{temp2} + \text{temp3} - \text{temp4}) / (2 * \text{free_speed})$$

do the calculation in (1.2a)

solution 2:

$$\text{torque} = (-\text{temp1} + \text{temp2} + \text{temp3} + \text{temp4}) / (2 * \text{free_speed});$$

do the calculation in (1.2a)

2) If you know the speed and the torque do the following:

$$\text{volts} = \text{spec_volts} * (\text{torque} / \text{spec_stall_torque} + \text{speed} / \text{spec_free_speed})$$

do the calculations in (1.1)

do the calculations in (1.2a)