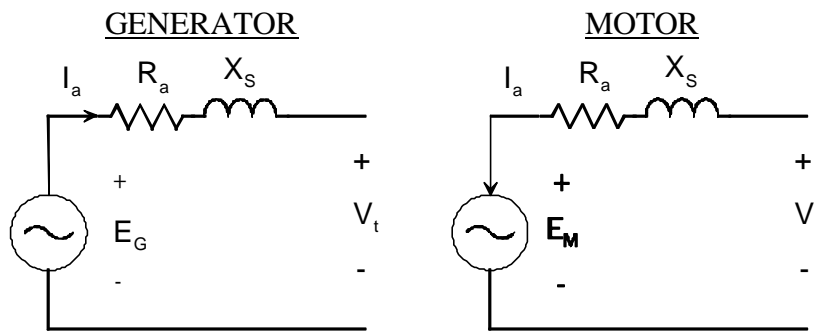


Synchronous Generator vs. Synchronous Motor:

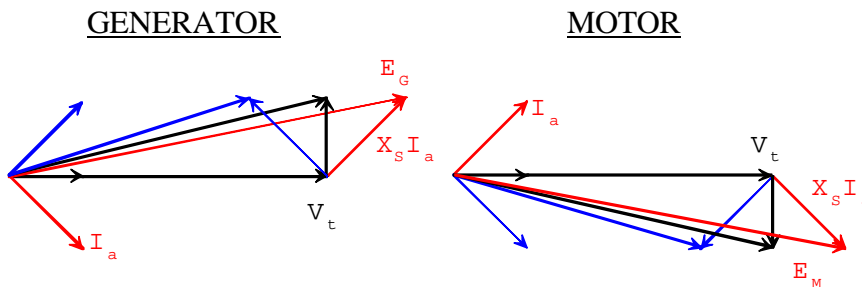
The main difference between the two is the sign conventions. Below are the diagrams for a generator on the left and a motor on the right. Each is connected to an infinite bus with voltage V_t (voltage and frequency of an infinite bus are fixed regardless of prime mover power and excitation of the machine.) Note that current references are opposite! Current reference is **out** of the plus terminal of the generator, but **into** the plus terminal of the motor. This leads to different diagrams for various DC excitations of the field as shown below. Note also that the over-excited machine (generator or motor) is "capacitive" and will supply vars to the infinite bus system. The opposite is true for the under-excited machine. In the vector diagrams the value of R_a was neglected. Can you repeat one of these vector diagrams with the armature resistance included?



Generator: $E_G = V_t + I_a (R_a + jX_a)$

Motor: $E_M = V_t - I_a (R_a + jX_a)$

Neglecting the armature resistance, the diagrams below show the phasor diagrams for voltages and currents for over-excited, under-excited and normally excited (unity power factor,) for these two machines.

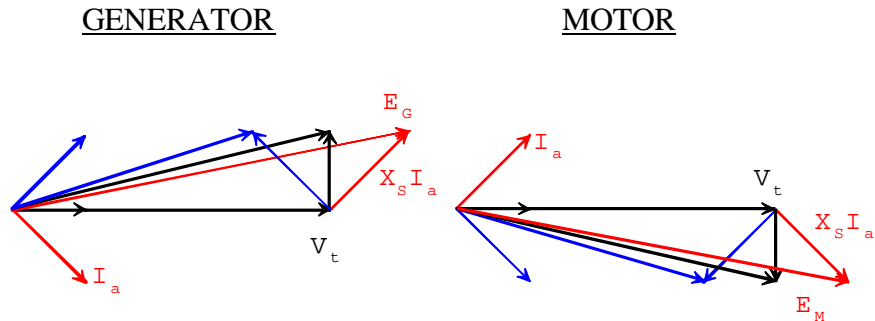


Note in each diagram there are three cases shown, each in a different color. In each case the equations above are satisfied with $R_a = 0$. Since we assume constant V and P , the locus of E is a horizontal line, and the locus of I_a is a vertical line as seen above. Black is for unity power factor (I_a and V_t are in phase.)

GENERATOR: Red is over-excited, supplies lagging current to the system (infinite bus,) thus the machine is drawing a capacitive current from the system. Like a capacitor it

supplies reactive power to the system. Blue is under-excited, supplies leading current, or drawing a lagging current. Like an inductor it draws reactive power from the system. Black is for unity power factor or normally excited generator. Note that E_G leads V_t in all cases which is typical generator operation.

MOTOR: Red is over-excited, motor is capacitive and supplies vars to the system. Blue is under-excited, lagging PF, motor is inductive and absorbs vars from the system. Black is normally excited (unity PF.) Note that in all cases E_M lags V_t which is typical motor operation.



In general: an over-excited synchronous machine (motor or generator) will supply vars to the system (like a capacitor) while the under-excited synchronous machine will absorb vars from the system (like an inductor.)