EE3014 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

UNIT IV-POWERCONVERTERS FOR WIND SYSTEMS

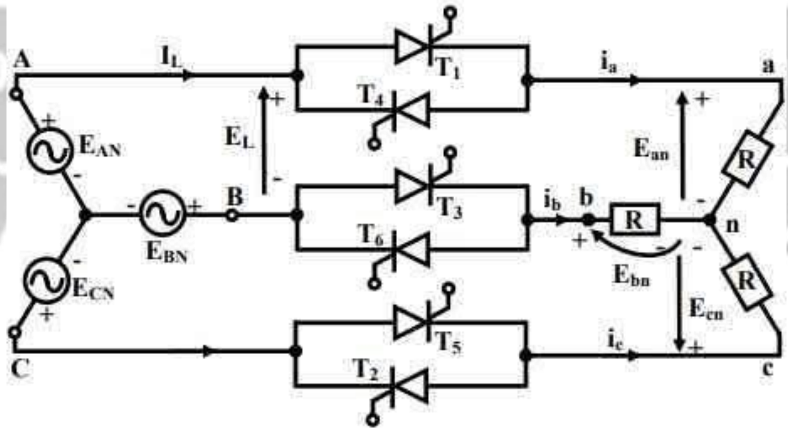
4.1-STAND POWER CONVERTERS: THREE-PHASE AC VOLTAGE CONTROLLERS.

THREE-PHASE AC VOLTAGE REGULATORS

There are many types of circuits used for the three-phase ac regulators (ac to ac voltage converters), unlike single-phase ones. The three-phase loads (balanced) are connected in star or delta. Two thyristors connected back to back, or a triac, is used for each phase in most of the circuits as described. Two circuits are first taken up, both with balanced resistive (R) load

Three-phase, star connected AC Regulator with Balanced Resistive Load

The circuit of a three-phase, three-wire AC regulator (termed as ac to ac voltage converter) with balanced resistive (star-connected) load is shown in Figure. It may be noted that the resistance connected in all three phases are equal. Two thyristors connected back to back are used per phase, thus needing a total of six thyristors. The current flow is bidirectional, with the current in one direction in the positive half, and then, in other (opposite) direction in the negative half. So, two thyristors connected back to back are needed in each phase. The turning off of a thyristor occurs, if its current falls to zero. To turn the thyristor on, the anode voltage must be higher that the cathode voltage, and also, a triggering signal must be applied at its gate.



Three-phase, three-wire star connected AC voltage regulator

The expression of the RMS value of output voltage is obtained by per phase for balanced star-connected resistive load which depends on range of firing angle. If is the RMS value of the input voltage per phase, and assuming the voltage, as the reference, the instantaneous input voltages per phase are,

$e_{AN} = \sqrt{2}E_s sin\omega t$

$e_{BN} = \sqrt{2}E_s \sin(\omega t - 120^0)$

$e_{CN} = \sqrt{2}E_s sin(\omega t + 120^0)$

Then, the instantaneous input line voltages are,

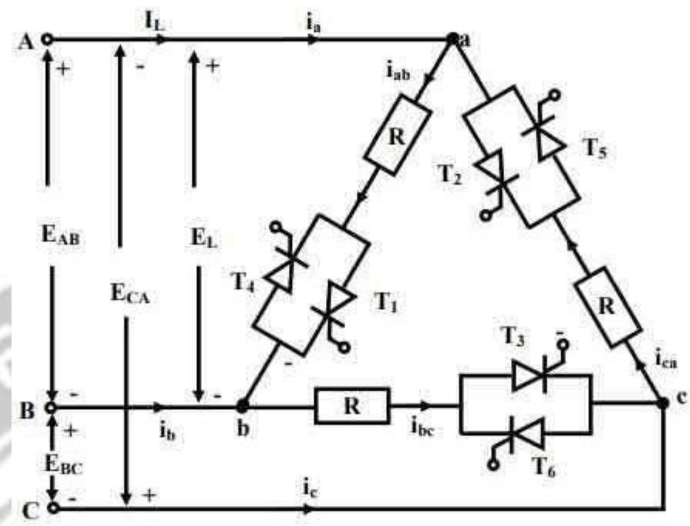
$e_{AB} = \sqrt{6}E_s sin(\omega t + 30^0)$

$e_{BC} = \sqrt{6}E_s \sin(\omega t - 90^0)$

$e_{CA} = \sqrt{6}E_s sin(\omega t + 150^0)$

Three-phase Delta-connected AC Regulator with Balanced Resistive Load

The circuit of a three-phase, delta-connected ac regulator (termed as ac to ac voltage converter) with balanced resistive load is shown in Figure. It may be noted that the resistance connected in all three phases are equal. Two thyristors connected back to back are used per phase, thus needing a total of six thyristors. As stated earlier, the numbering scheme may be noted. It may be observed that one phase of the balanced circuit is similar to that used for single phase ac regulator. Since the phase current in a balanced three-phase system is only (1/√3) of the line current, the current rating of the thyristors would be lower than that if the thyristors are placed in the line.



Assuming the line voltage as the reference, the instantaneous input line voltages are,

$e_{AB} = \sqrt{2}E_s sin\omega t$

$e_{BC} = \sqrt{2}E_s \sin\,(\omega t - 120^0)$

$e_{CA} = \sqrt{2}E_s sin\,(\omega t + 120^0)$