BTEE3011-Power Electronics

Cycloconverters

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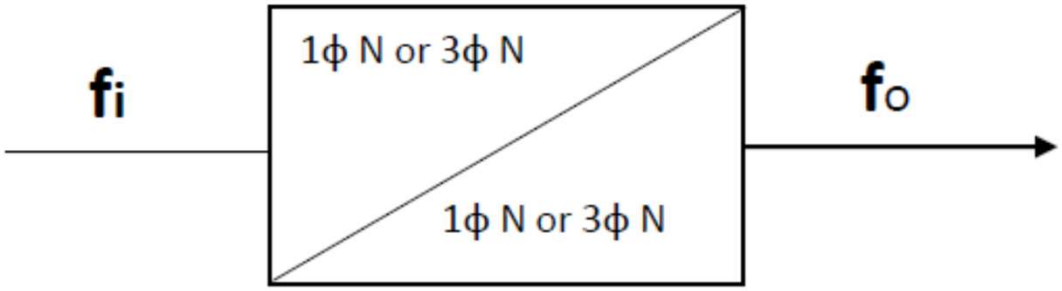
- ✓Three-phase to three-phase cycloconverter

Cycloconverter

A cycloconverter is a direct-frequency changer that converts ac power at one frequency to ac power at another frequency by ac-ac conversion.

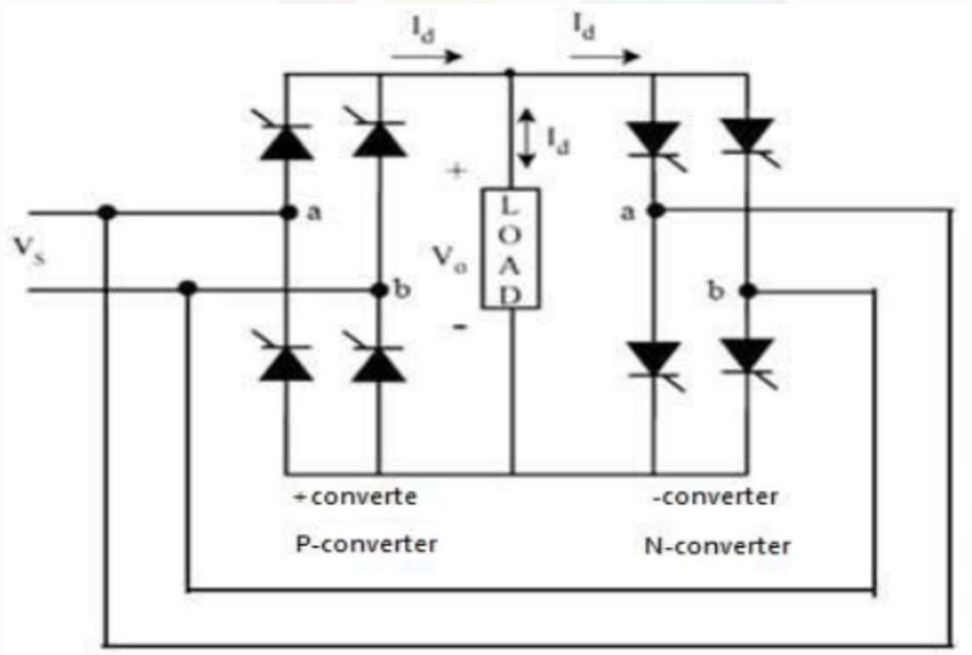
Cycloconverters are used in high power applications driving synchronous and induction motor. They are usually phase controlled and they use thyristors due to their ease of natural (phase) commutation.



Cycloconverter Fig.1

Single phase cycloconverter

This converter consists of back to ack connection of two full-wave bridge rectifier circuits.



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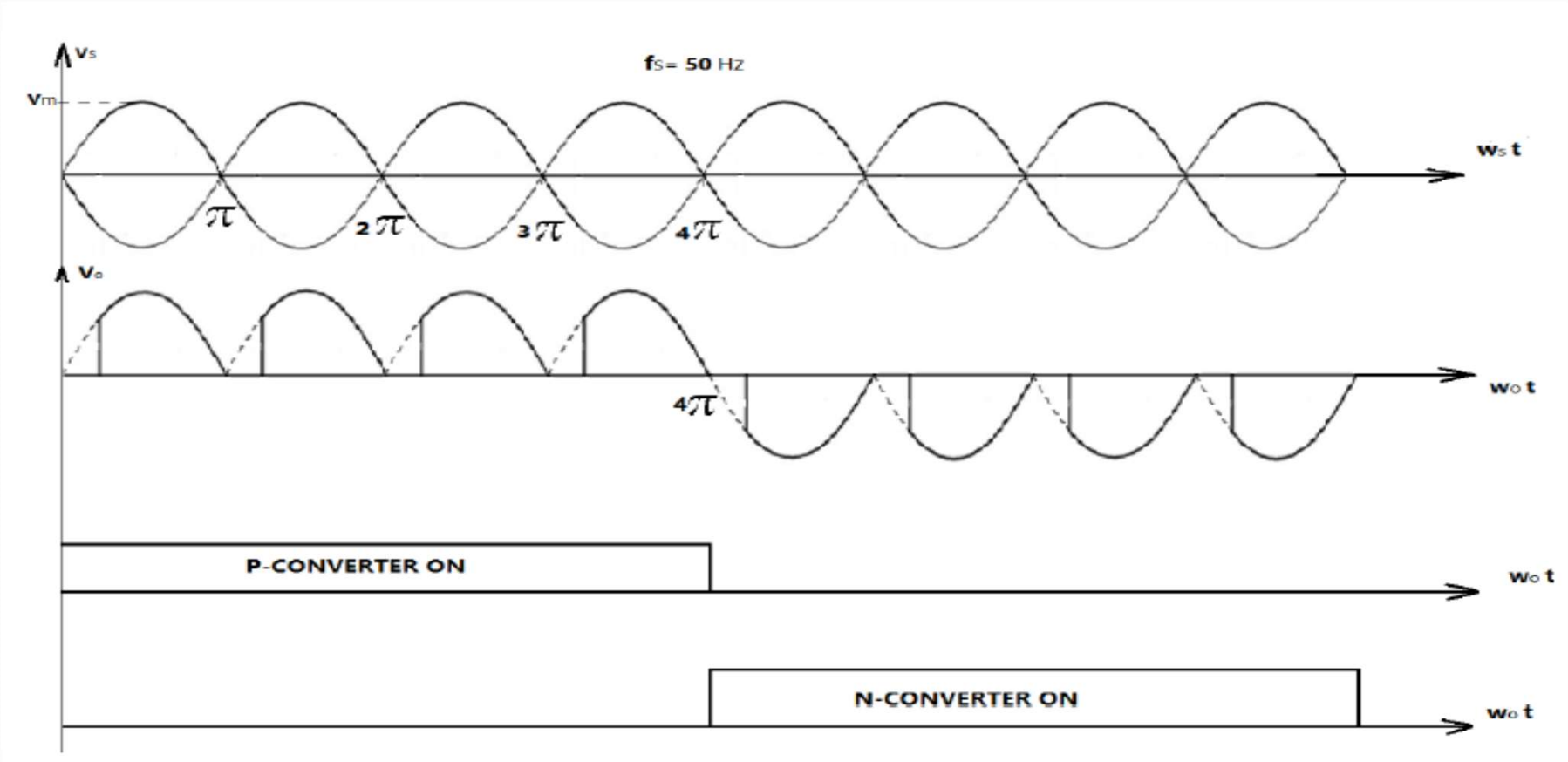

Vs
fs= 50 Hz
Vm
ws t
π
2π
3π
4π
Vo
4π
wo t
P-CONVERTER ON
wo t
N-CONVERTER ON
wo t

Contd.....

If input voltage is

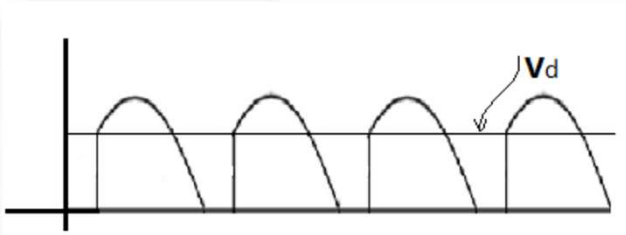
$v_s = V_m \sin w_s t$

The r.m.s output voltage can be found from:

$$V_o = \left\{\frac{8}{8\pi}\int_{\alpha p}^{\pi}\left(\sqrt{2}\,V_s \sin w_s t\right)^2 dwt\right\}^{\frac{1}{2}}$$

$$= \left\{\frac{16{V_s}^2}{16\pi}\int_{\alpha p}^{\pi}(1-\cos 2w_s t)\, dwt\right\}^{\frac{1}{2}}$$

$$= V_s\left[\frac{1}{\pi}\left(\pi - \alpha p + \frac{\sin 2\alpha p}{2}\right)\right]^{\frac{1}{2}}$$



The average output voltage of p-converter alone is given by

$$V_{d1} = \frac{2V_m}{\pi}\cos\alpha$$

Three-phase to single-phase cycloconverter

When p-converter operating alone, positive voltage (k) appears across the load, and when N-converter operating alone, negative voltage (L) appears across the load.

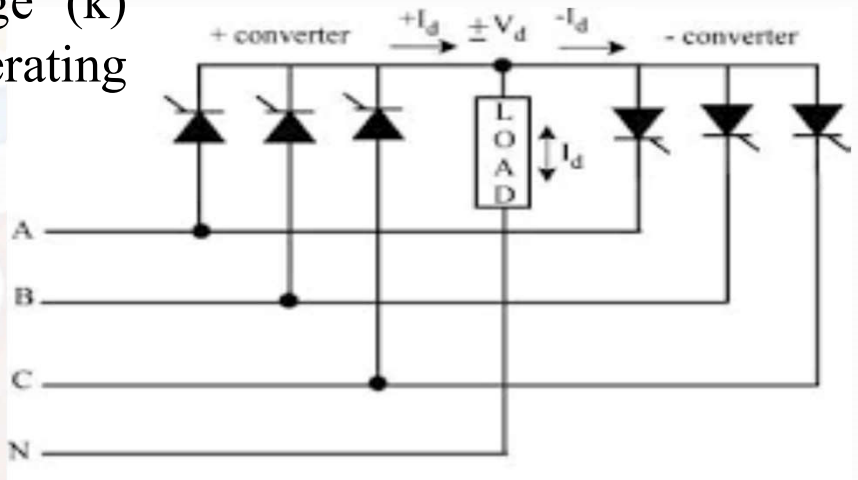
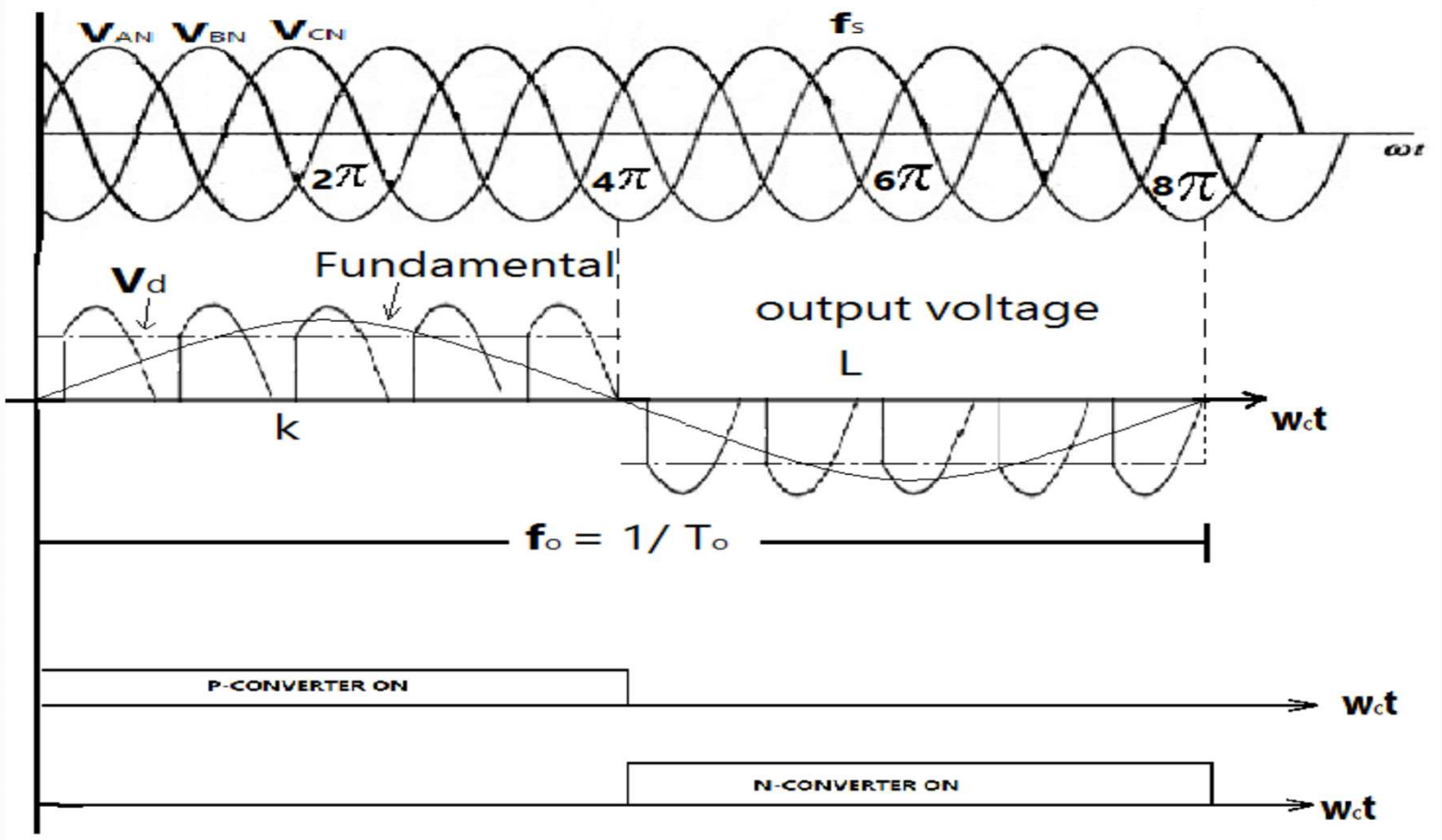


Fig. 4 3ϕ-1ϕ half-wave cycloconverter

Three-phase to single-phase cycloconverter



Contd.....

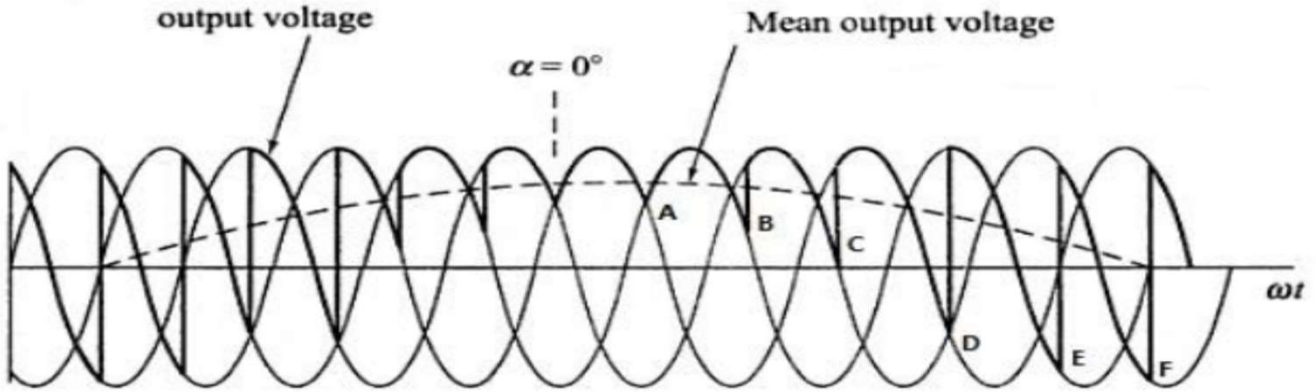
- For $\alpha \neq 0$

  For the positive group converter:

  At point "A" , $\alpha = 0$ $\quad V_d = \frac{3\sqrt{3}}{2\pi} V_m = V_{do}$.

  At point "B" , $\alpha > 0$ $\quad V_d = V_{do} \cos \alpha$

  At point "F" , $\alpha = \frac{\pi}{2}$ $\quad V_d = 0$



Positive group converter operating
Negative group converter is idling

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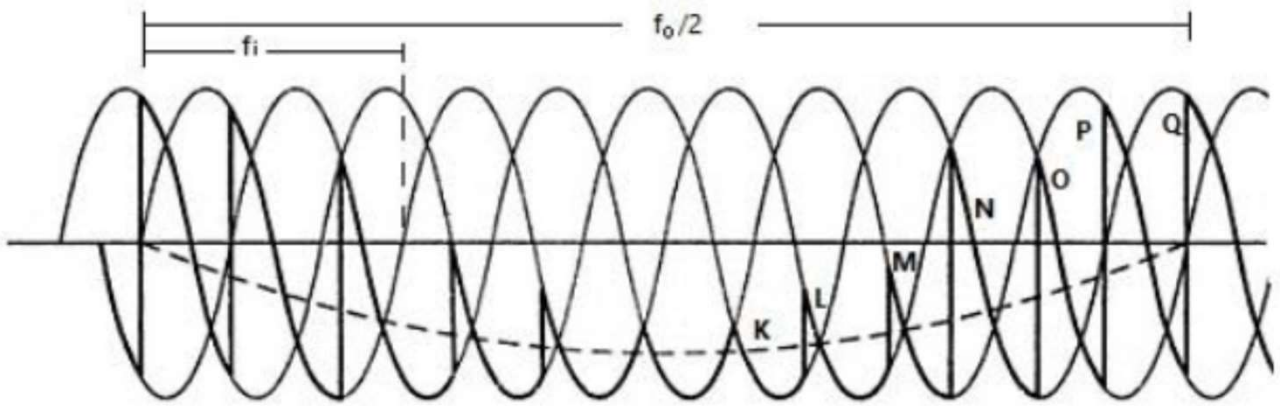


Negative group converter operating

Positive group converter is idling

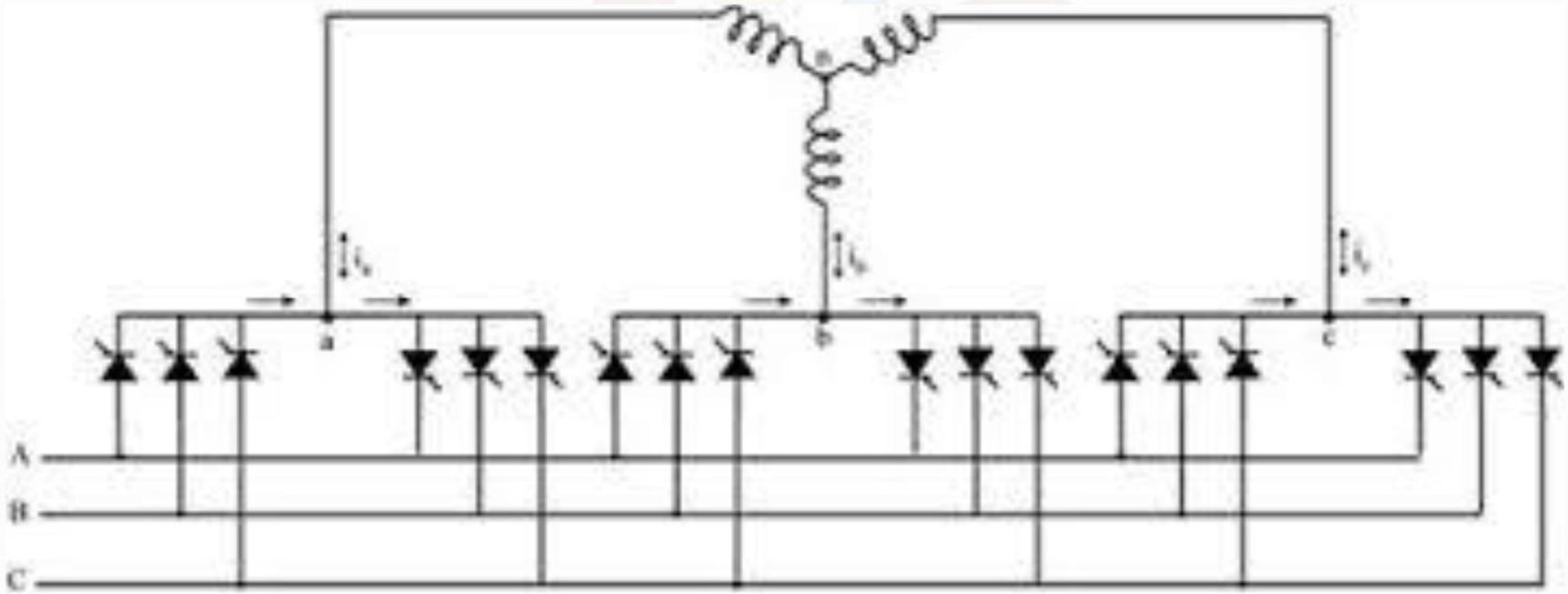
At point "K" "L" "M" "N" "O" "P" and "Q"

$\alpha > 90°$, V_d is negative [inverting mode]

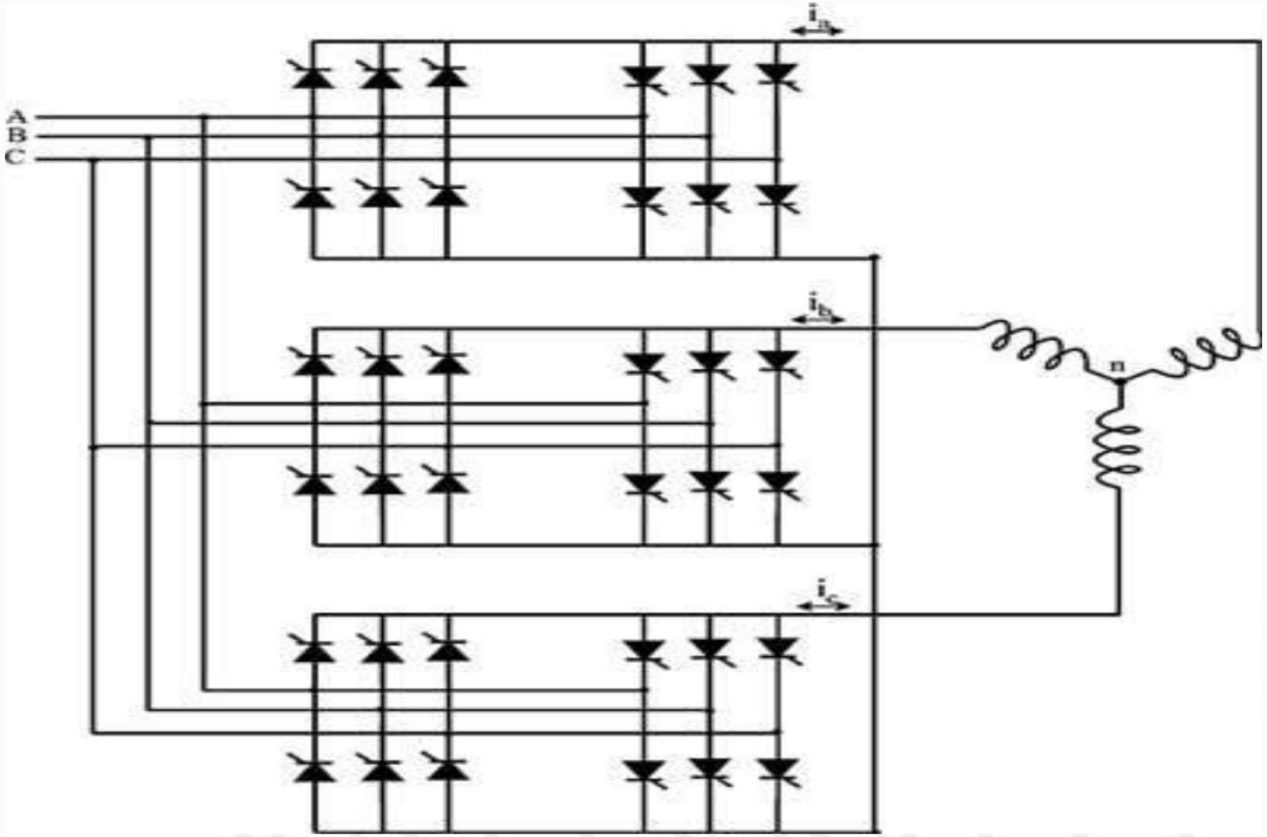
Change over from positive group converter to negative group converter should be done at points "F" and "Q" where the output of the two converter are zero to avoid short circuit. Then the condition $\alpha p + \alpha_N = \pi$ that should be met.

Three-phase to three-phase cycloconverter

If the output of 3-phase to single-phase converters of the same kind are connected in Y or Δ and if the output voltages are $\frac{2\pi}{3}$ radians phase shifted from each other, the resulting converter is a three-phase to three-phase cycloconverter as shown in Fig.5



Three-phase to three-phase cycloconverter



Reference

Contents are referred from Open Source

Books:

1. Power electronics by PS Bhimbhar