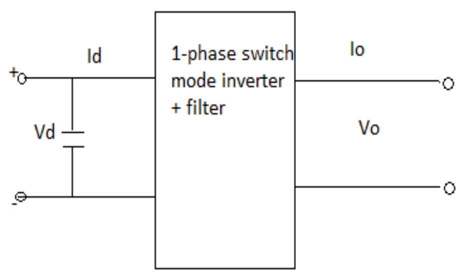
Pulse width modulated inverters

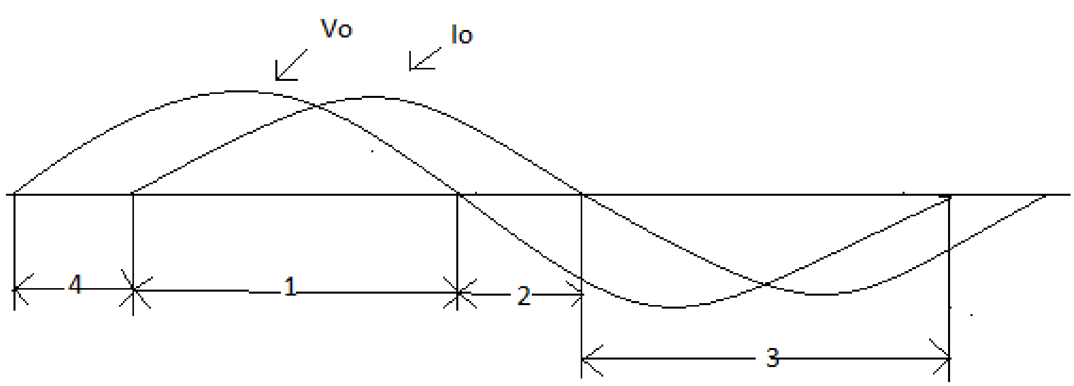
The input dc voltage is of constant magnitude . The diode rectifier is used to rectify the line voltage.The inverter control the magnitude and frequency of the ac output voltage.

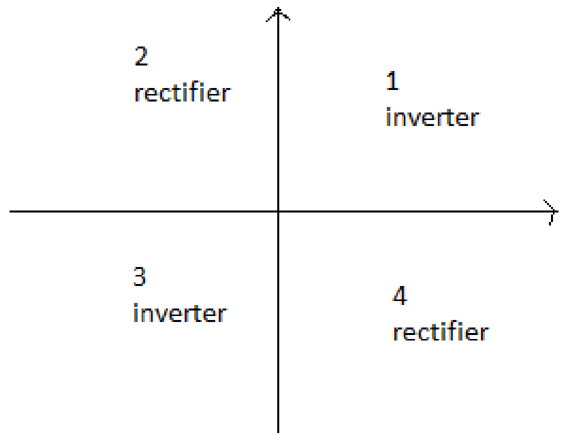
This is achieved by PWM technique of inverter switches and this is called PWM inverters.

The sinusoidal PWM technique is one of the PWM technique to shape the output voltage to as close as sinusoidal output.

Basic concepts of switch mode inverter







During interval 1 $v_0$and i_0 both are positive

During interval 3 v_0 and i_0 both are negative

Therefore during 1 and 3 the instantaneous power flow is from dc side to corresponding to inverter mode of operation.

In contrast during interval 2 and 4 v_0 and i_0 are of opposite sign i.e. power flows from ac side to dc side corresponding to rectifier mode of operation.

<u>Pulse width modulated switching scheme</u>

We require the inverter output to be sinusoidal with magnitude and frequency controllable.

In order to produce sinusoidal output voltage at desired frequency a sinusoidal control signal at desired frequency is compared with a triangular waveform as show.

The frequency of the triangular waveform established the inverter switching frequency.

The triangular waveform is called carrier waveform. The triangular waveform establishes switching frequency f_s , which establishes with which the inverter switches are applied.

The control signal has frequency f_s and is used to modulate the switch duty ratio.

f_1 is the desired fundamental frequency of the output voltage.

<u>The amplitude modulation ratio m_a is defined as</u>

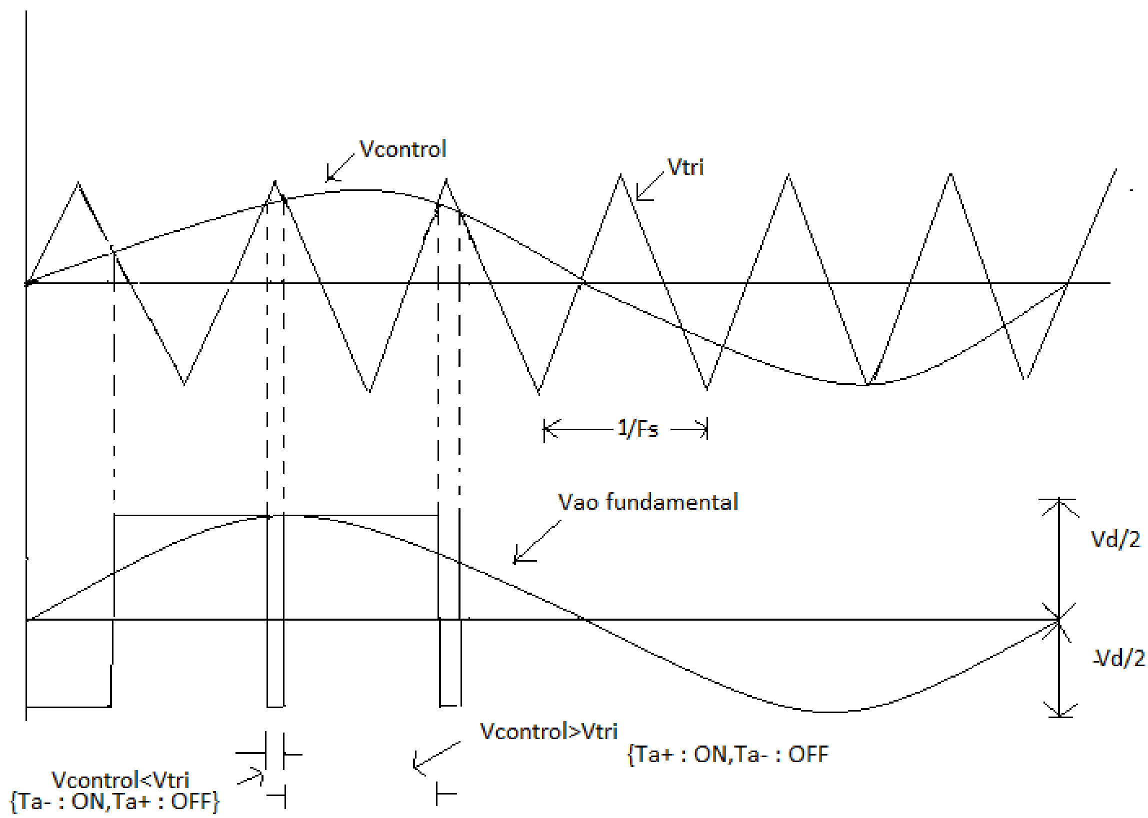
$m_a=\frac{V_{control}}{V_{tri}}$

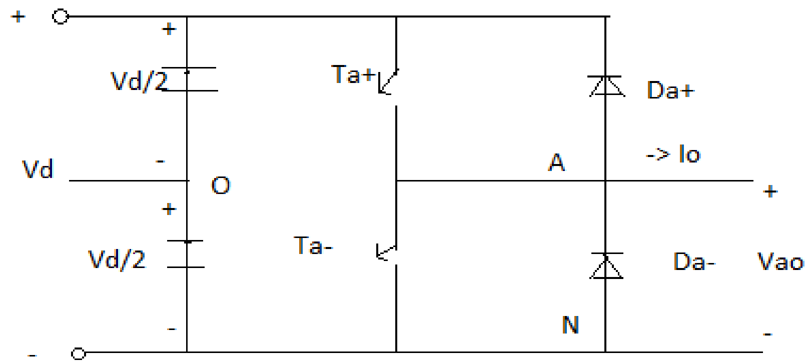
$V_{control}$ is the peak amplitude of control signal.

V_{tri} peak amplitude of triangular signal.

The frequency modulation ratio m_f

$$m_f = \frac{f_s}{f_1}$$





When $V_{control} > V_{tri}$ T_A^+ is ON $V_{AO} = \frac{1}{2}V_d$

$V_{control} < V_{tri}$ T_A^- is ON $V_{AO} = \frac{1}{2}V_d$

So the following inferences can be drawn

The peak amplitude of fundamental frequency is $m_a$times $\frac{1}{2}V_d$

$V_{AO}=m_a\frac{V_d}{2}$

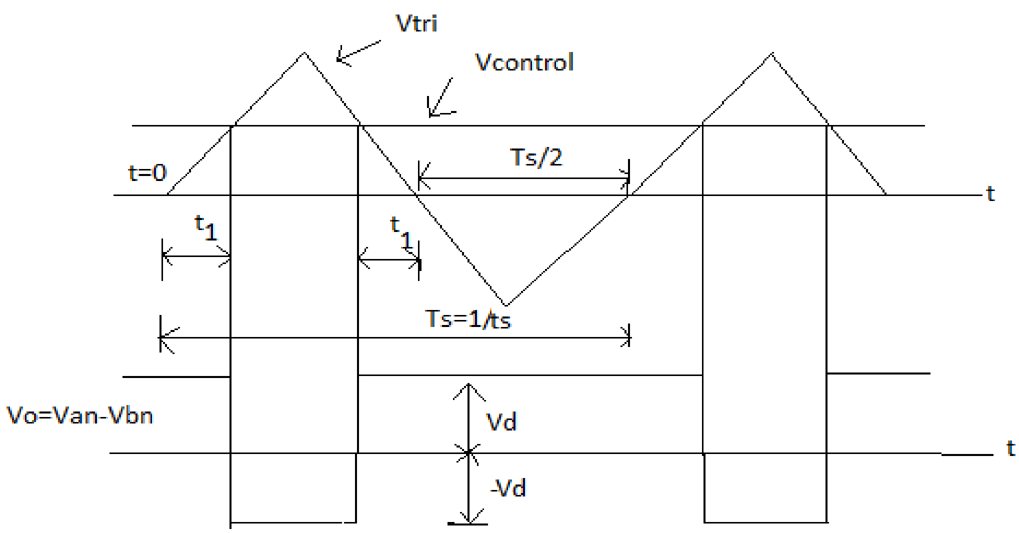
$V_{AO}=\frac{V_{control}}{\hat{V}_{tri}} * \frac{V_d}{2}$ $V_{control} \leq \hat{V}_{tri}$

<u>The foregoing arguments shown why $V_{control}$is chosen to be sinusoidal to provide sinusoidal output voltage with fewer harmonics</u>

Let the $V_{control}$ vary sinusoidal with frequency f_1,which is the desired frequency of the inverter output voltage.

Let $V_{control}=\hat{V}_{control}\sin\omega_1 t$

$\hat{V}_{control} \leq \hat{V}_{tri}$



$\frac{\hat{v}_{tri}}{t_1}=\frac{\hat{V}_{tri}}{T_s/4}$

At t=t_1 , $v_{tri}=v_{control}$

So $\frac{v_{control}}{t_1}=\frac{\hat{V}_{tri}}{T_s/4}$

$t_1=\frac{\hat{v}_{control}}{\hat{V}_{tri}}*\frac{T_S}{4}$

$T_{on}=2t_1+\frac{T_S}{2}$

$D_1=\frac{T_{on}}{T_s}=\frac{2t_1+\frac{T_S}{2}}{2}$

$=\frac{1}{2}+\frac{2t_1}{T_s}$

$D_1=\frac{1}{2}+\frac{1}{2}(\frac{\hat{v}_{control}}{\hat{V}_{tri}})$

Three phase inverter

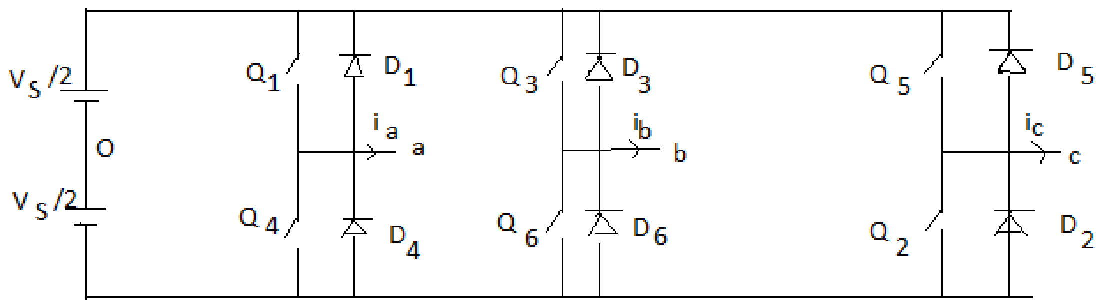
When three single-phase inverters are connected in parallel a three phase inverter is formed.

The gating signal has to be displaced by 120^0 with respect to each other so as achieve three phase balanced voltages.

A 3-phase output can be achieved from a configuration of six transistors and six diodes.

Two type of control signal can be applied to transistors, they are such as 180^0 or 120^0 conduction.

180-degree conduction



When Q_1 is switched on, terminal a is connected to the positive terminal of dc input voltage.

When Q_4 is switched on terminal a is brought to negative terminal of the dc source.

There are 6 modes of operation is a cycle and the duration of each mode is 60^0.

The conduction sequence of transistors is 123,234,345,456,561,612. The gating signals are shifted from each other by 60^0 to get 3-φ balanced voltages.

Switching states for the three phase voltage inverters