Sine-Triangle PWM

$$v_{Rn} = m\frac{V_{dc}}{2}\sin\omega_s t \rightarrow \text{Line to Neutral}$$

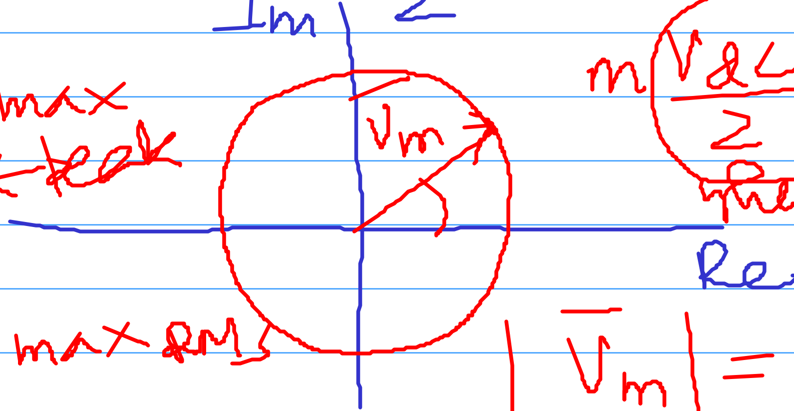
$$v_{Yn} = m\frac{V_{dc}}{2}\sin(\omega_s t - 120^\circ)$$

$$v_{Bn} = m\frac{V_{dc}}{2}\sin(\omega_s t + 120^\circ)$$

Line-Line$\Big|_{max}$

$= \sqrt{3}\frac{V_{dc}}{2}$ ← peak

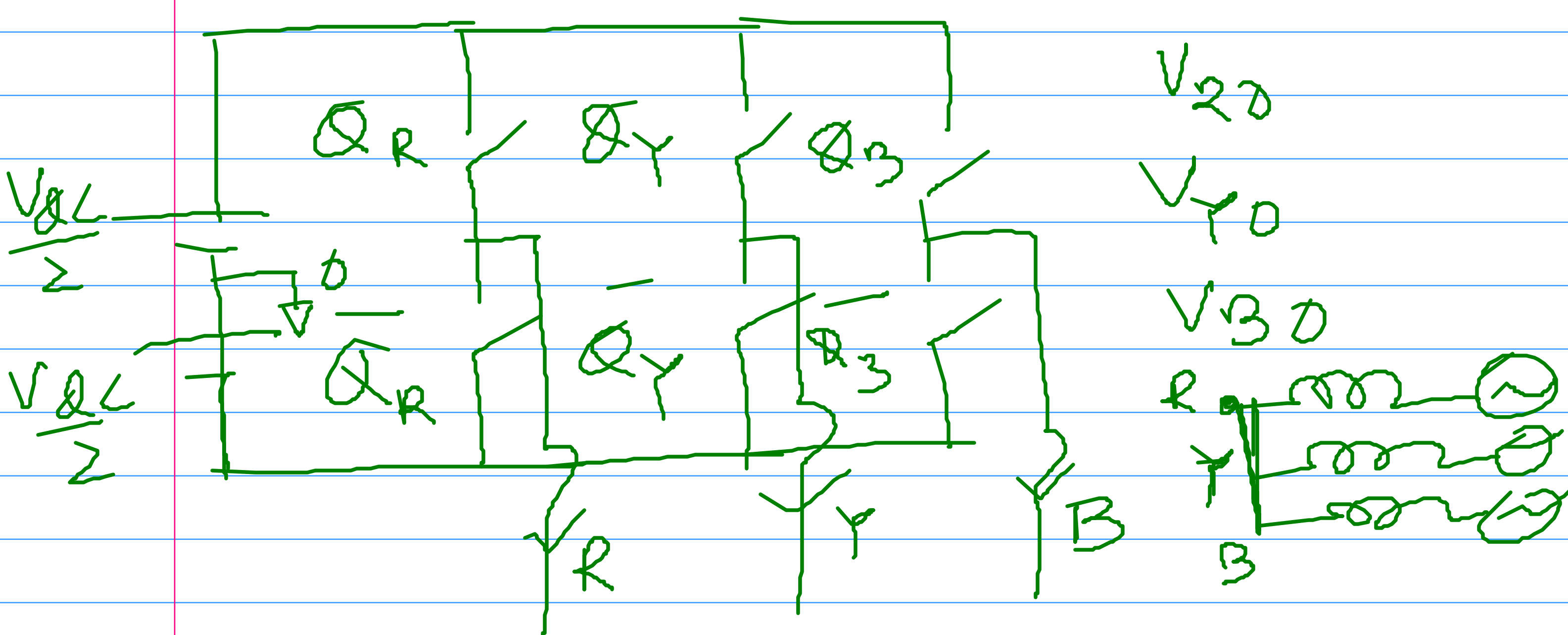
$\Rightarrow \frac{\sqrt{3}}{\sqrt{2}}\frac{V_{dc}}{2}\Big|_{max\ RMS}$



$m\frac{V_{dc}}{2}\times\frac{3}{2}$ when $m=1$

$$\left|\bar{V}_m\right|_{max} = \frac{3V_{dc}}{4}$$

$$\bar{V}_M = v_{Rn}(t) + v_{Yn}(t)\,e^{j2\pi/3} + v_{Bn}(t)\,e^{-j2\pi/3}$$

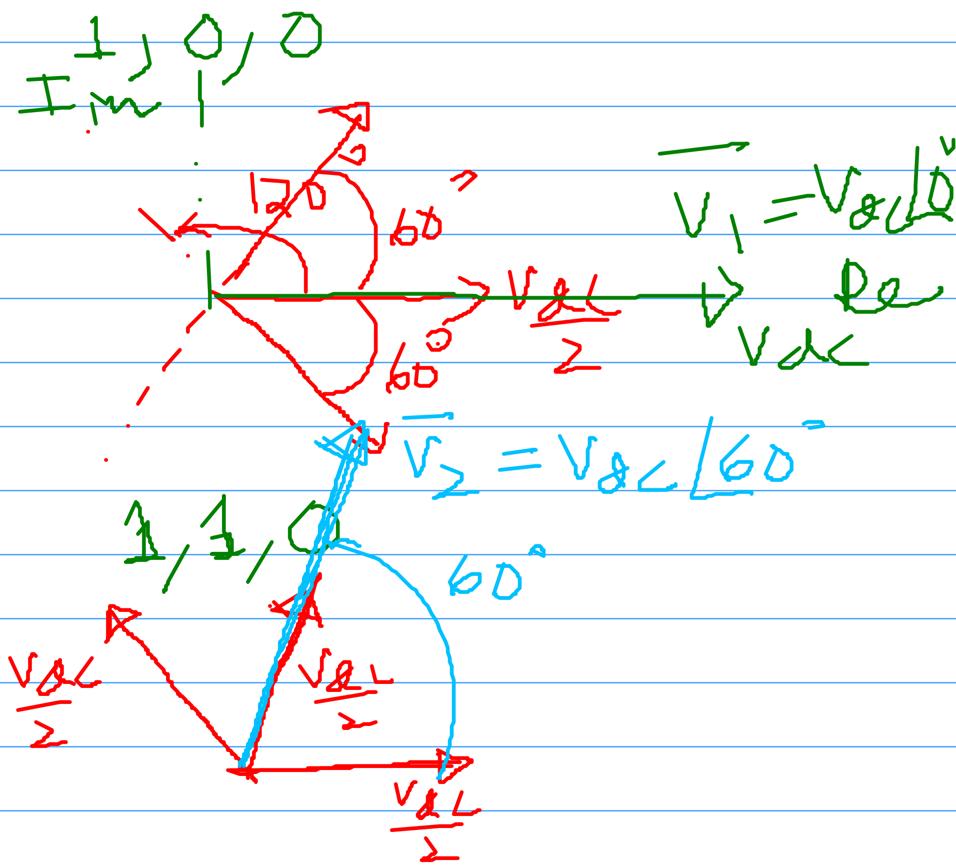


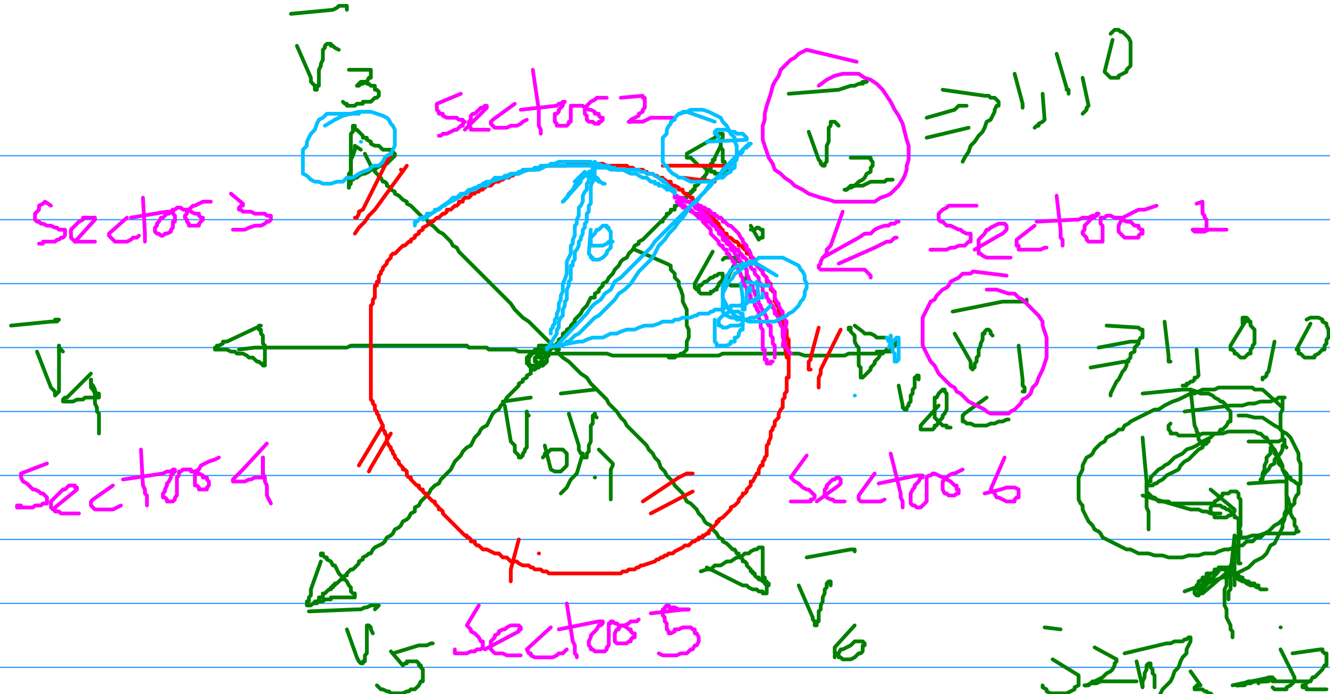
Basic Switching States of an Inverter

Q_R	Q_Y	Q_B	V_{RO}	V_{YO}	V_{BO}	
1	0	0	$+\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$\rightarrow \bar{V}_1$
1	0	1	$+\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	$\rightarrow$
1	1	0	$+\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$\rightarrow \bar{V}_2$
1	1	1	$+\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	+
0	0	0	$-\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	
0	0	1	$-\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	
0	1	0	$-\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	
0	1	1	$-\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	$-\frac{V_{dc}}{2}$	
			$-\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	$+\frac{V_{dc}}{2}$	

"1"
3
(0,1)
3
$2^3 = 8$

$$\bar{V}_1 = +\frac{V_{dc}}{2} - \frac{V_{dc}}{2} e^{j2\pi/3} - \frac{V_{dc}}{2} e^{-j2\pi/3}$$





$(0,0,0)\quad \bar{V}_0 = -\frac{V_{dc}}{2} - \frac{V_{dc}}{2}e^{j2\pi/3} - \frac{V_{dc}}{2}e^{-j2\pi/3}$

$= 0 \longrightarrow$ Null Vector

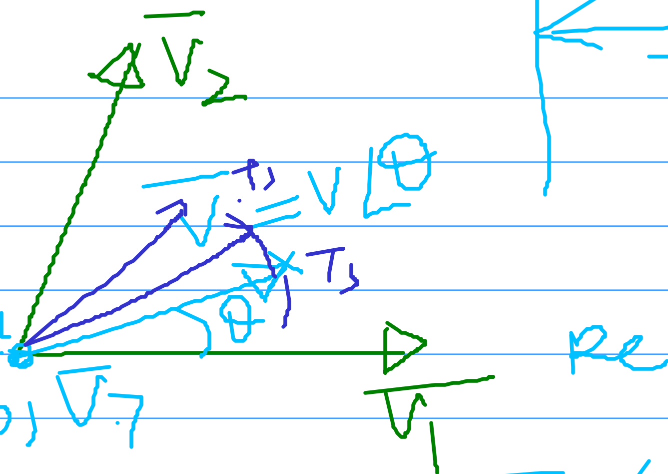
$(1,1,1)\quad \bar{V}_7 = \frac{V_{dc}}{2} + \frac{V_{dc}}{2}e^{j2\pi/3} + \frac{V_{dc}}{2}e^{-j2\pi/3}$

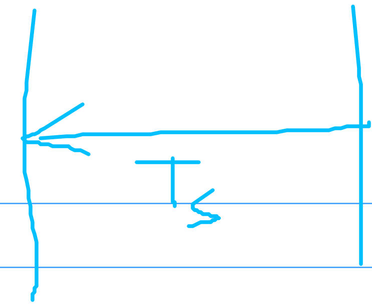
$= 0 \longrightarrow$ Null Vector

$\bar{V}_1, \bar{V}_2, \ldots, \bar{V}_6$ are called active voltage vector

$\bar{V}_0, \bar{V}_7$ are called null voltage vector

Sector 1





$T \rightarrow T_s, T_s, T_s \ldots$

$T_s, \ldots \ldots /$

$50Hz \rightarrow T = 20msec$

$10000Hz \rightarrow T_s = 100msec$

$$\underline{\bar V \times T_s} = \underline{\bar V_1 \times T_1} + \underline{\bar V_2 T_2} + \underline{\bar V_0 (T_s - T_1 - T_2)}$$

$\frac{10000}{50} = 200$ steps $\qquad 1/T_s$

$360° \Rightarrow 200$ steps

$\frac{360°}{200} \leftarrow$ Angle/step $= 1.8°$

V, θ are known

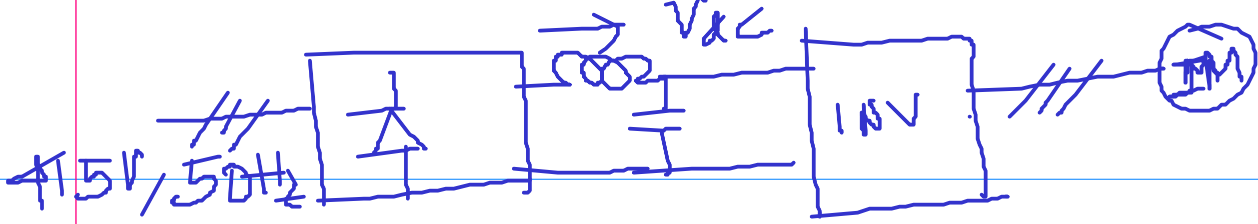
$$V\cos\theta \, T_s = V_{dc} T_1 + \frac{V_{dc}}{2} T_2$$

$$V\sin\theta \, T_s = V_{dc} \frac{\sqrt{3}}{2} T_2$$

$$\bar V_2 \leftarrow T_2 = \frac{V\sin\theta \, T_s}{V_{dc}\sqrt{3}/2}$$

$$\bar V_1 \leftarrow T_1 = \frac{V\cos\theta \, T_s}{V_{dc}} - \frac{\cancel{V_{dc}}}{2} \frac{V\sin\theta \, T_s}{V_{dc}\sqrt{3}/2} \times \frac{1}{\cancel{V_{dc}}}$$

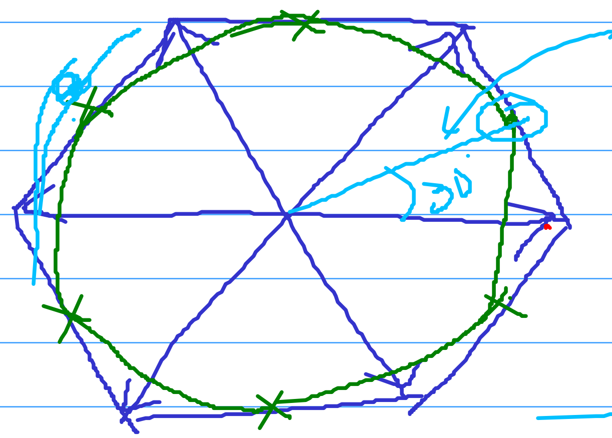
$$T_s - T_1 - T_2 \leftarrow \bar V_0, \bar V_7 \rightarrow \bar V_0 \, \bar V_7$$



$V_{in\,RMS}$

$V_{dc} = V_{in}(L-L)_{RMS} \times 1.35$ (CCM)

$= 560V$



$V_{dc}\frac{\sqrt{3}}{2}$ (peak)

Space Vector PWM

$\frac{V_{dc}}{2} \times \frac{3}{2} = \frac{3}{4} V_{dc}$

$\overline{V}_{sine\,SWM} = 315V$ sinest

$|\overline{V}_{SWM}|_{max} = 485V \rightarrow V_{LL\,RMS} = 395V$

$|\overline{V}_{ST}|_{max} = 420V \rightarrow \frac{2}{3} \times 420 \times \frac{\sqrt{3}}{\sqrt{2}}$ $V_{LL\,sine\,RMS}$

$= 343V$