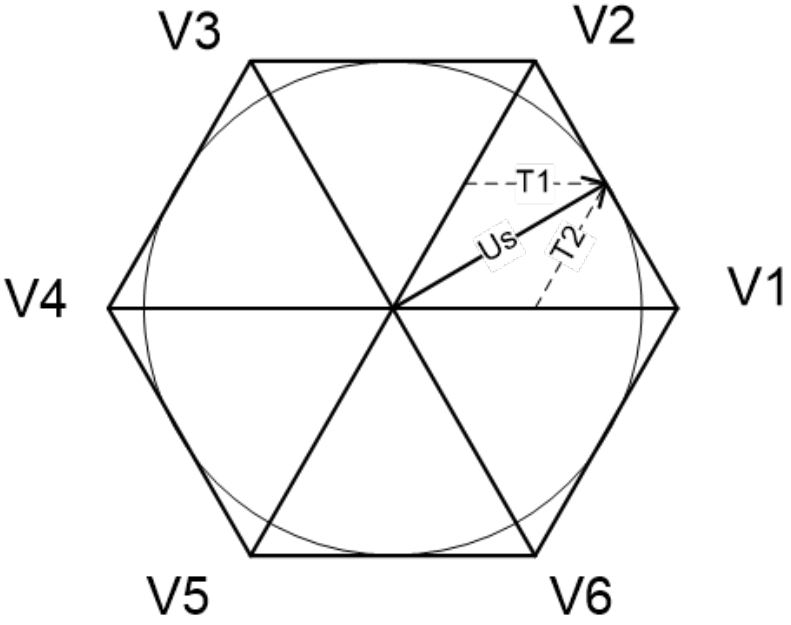
STM32 MC SDK Overmodulation (new in V5.Y)

Contents

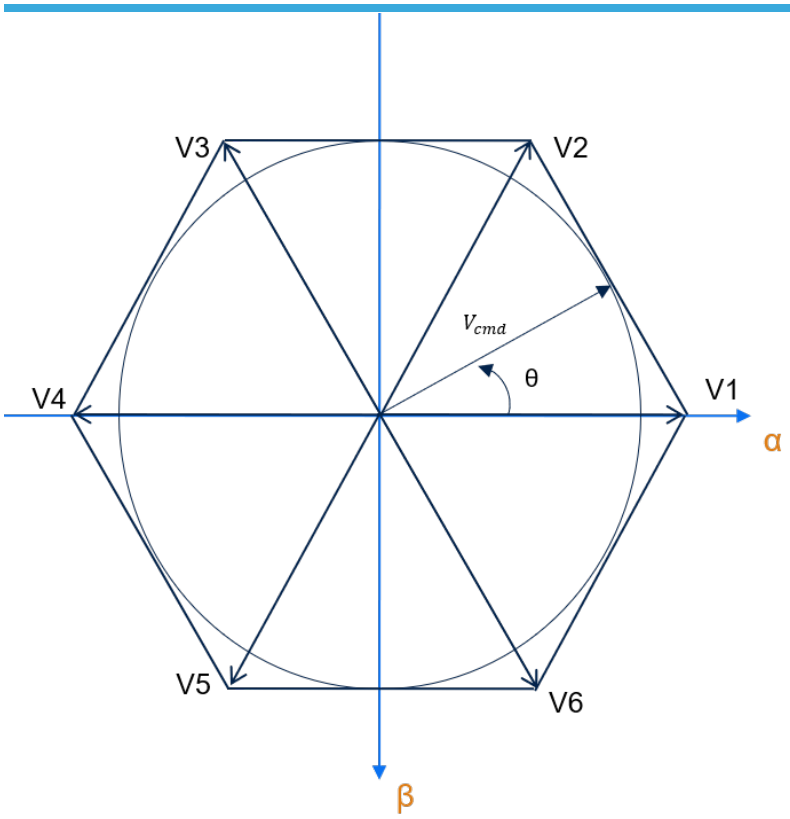
1 Principle of SVPWM



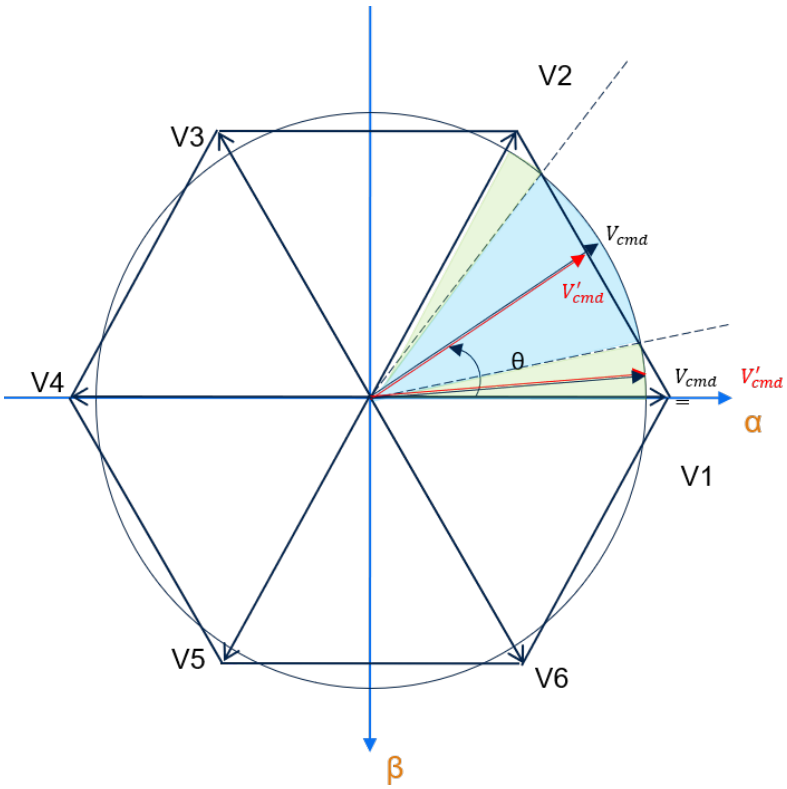
Space vector modulation index is limited to 3/2 but there is a way to extend this limit with the over-modulation. This technique is required when the modulation index, as the length of the reference space vector Us, exceeds the edges of the hexagon.

1.1 Linear mode

In the linear area, V'_{cmd} can keep both the amplitude and angle of V_{cmd} ,
then $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$ with $T'_1 = T_1$ and $T'_2 = T_2$.



1.2 OVM mode 1



There are two cases:

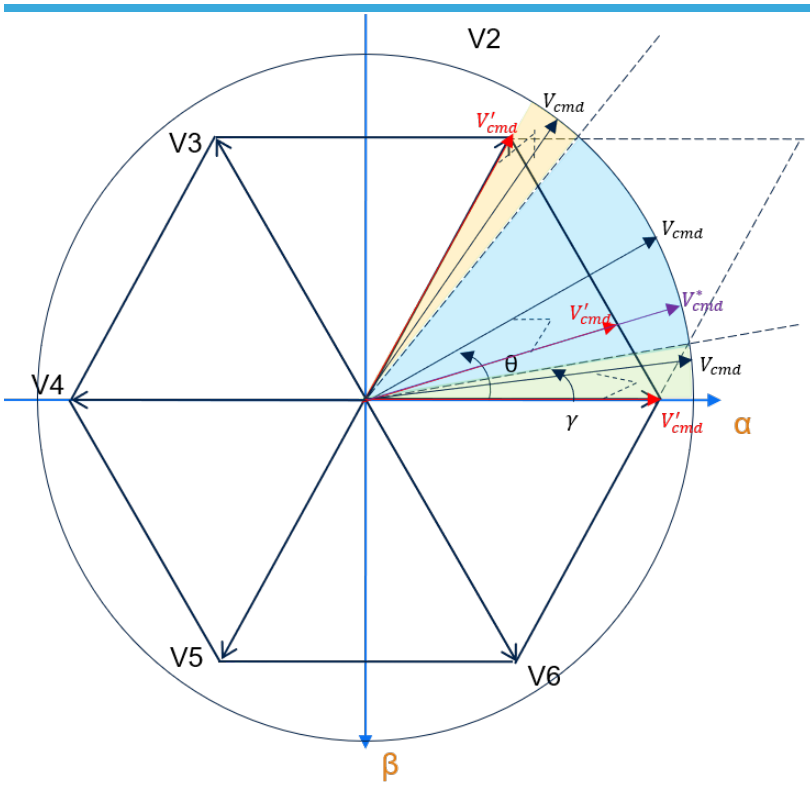
- In the green area: $T_1 + T_2 \ 1$.

V_{cmd} is unmodified and the timings remain unchanged $T'_1 = T_1$ and $T'_2 = T_2$. In that region V'_{cmd} follows the circle.

- In the blue area: $T_1 + T_2 > 1$.

Then In order to keep V'_{cmd} on the edge of the hexagon and keep the angle , $/ V'_{cmd} /$ is shrunk to make $T'_1 + T'_2 = 1$. $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$ with $T'_1 = T_1 / (T_1 + T_2)$ and $T'_2 = T_2 / (T_1 + T_2)$.
In that region V'_{cmd} follows the hexagon edge.

1.3 OVM mode 2



There are three cases:

- In the green area: T_1 1.0 .

We only use V1 to generate the V'_{cmd} .

Then $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$ with $T_1 = 1.0$ and $T_2 = 0$.

- In the yellow area: T_2 1.0 .

We only use V2 to generate the V'_{cmd} .

Then $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$ with $T_1 = 0$ and $T_2 = 1.0$.

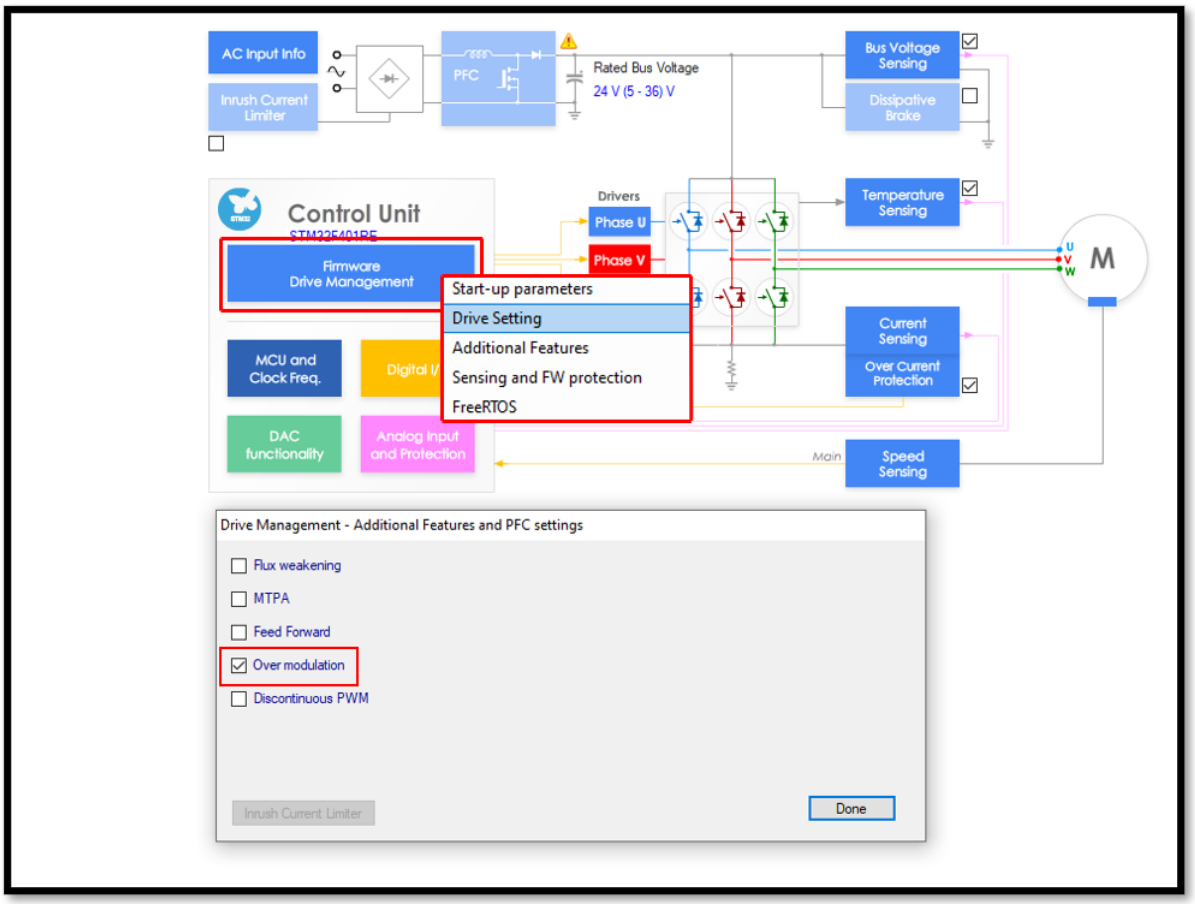
- In the blue area: $T_1 < 1.0$ && $T_2 < 1.0$.

Then $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$ with T'1 = (T1 / (T1 + T2) + 3 / .) . (/6) / (/6) and T'2 = 1.0 T'1 .

2 Over-modulation timings sum-up

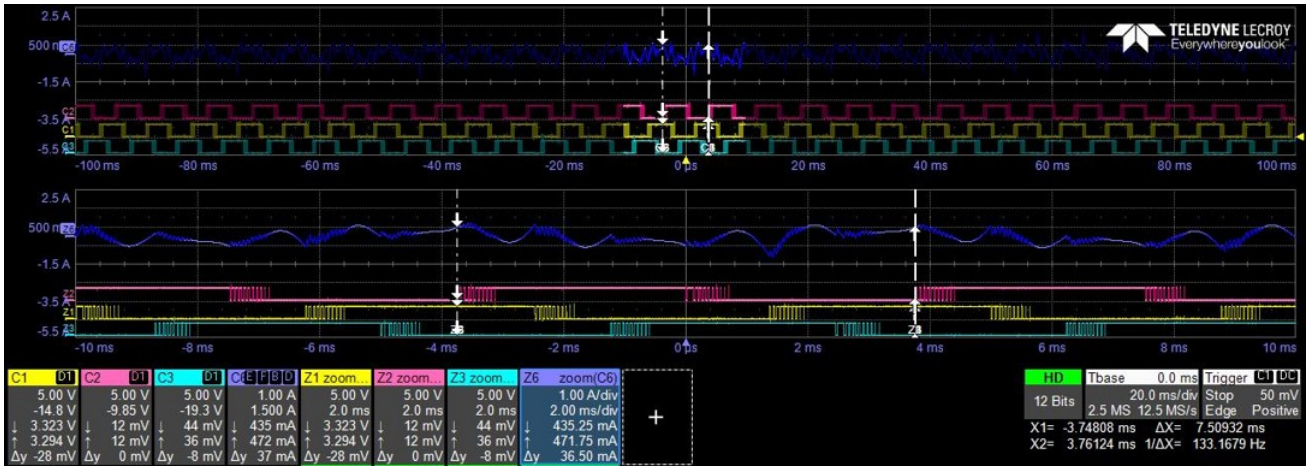
	Linear	OVM Mode 1	OVM Mode 2
T'_1	$T'_1 = T_1$	If $T_1 + T_2 > 1$ $T'_1 = \frac{T_1}{T_1+T_2}$ else $T'_1 = T_1$	If $T_1 \geq 1$ $T'_1 = 1$ else if $T_2 \geq 1$ $T'_1 = 0$ else $T'_1 = \left(\frac{T_1}{T_1+T_2} + \frac{3}{\pi}\gamma\right)\frac{\frac{\pi}{6}}{\frac{\pi}{6}-\gamma}$
T'_2	$T'_2 = T_2$	If $T_1 + T_2 > 1$ $T'_2 = 1 - T'_1$ else $T'_2 = T_2$	If $T_1 \geq 1$ $T'_2 = 0$ else if $T_2 \geq 1$ $T'_2 = 1$ else $T'_2 = 1 - T'_1$

3 Over-modulation activation in STM32 MC SDK V5.Y



4 Over-modulation example

Example: F4 three shunt with Shinano motor at 4000 rpm

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- In the middle of this snapshot: the blue curve shows the phase current
- Just bellow: the pink, yellow and green curves show the PWM channels
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The over-modulation increases the total harmonic distortion, but it allows the modulation index to exceed 3/2.