



## STM32 MC SDK Overmodulation (new in V5.Y)

---

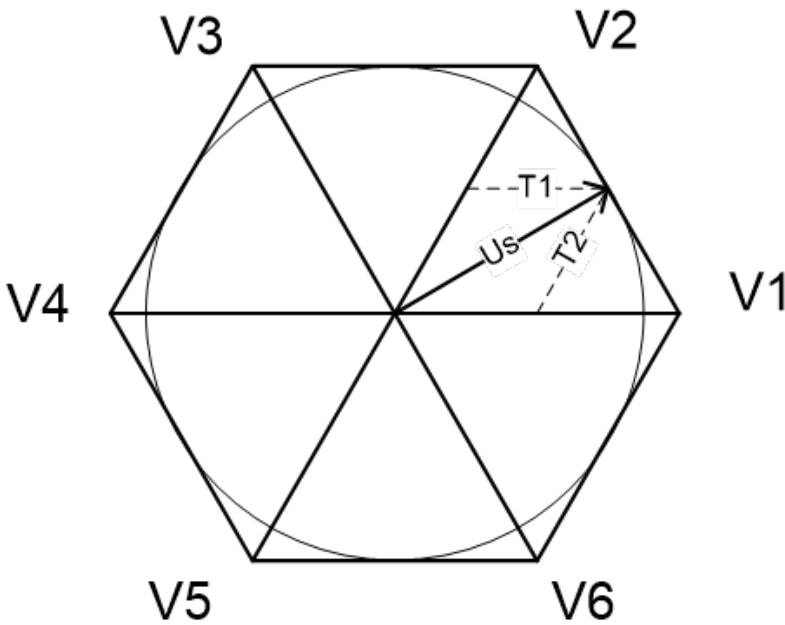
### STM32 MC SDK Overmodulation (new in V5.Y)



## Contents

1 Principle of SVPWM .....	2
1.1 Linear mode .....	2
1.2 OVM mode 1 .....	3
1.3 OVM mode 2 .....	3
2 Over-modulation timings sum-up .....	4
3 Over-modulation activation in STM32 MC SDK V5.Y .....	5
4 Over-modulation example .....	5

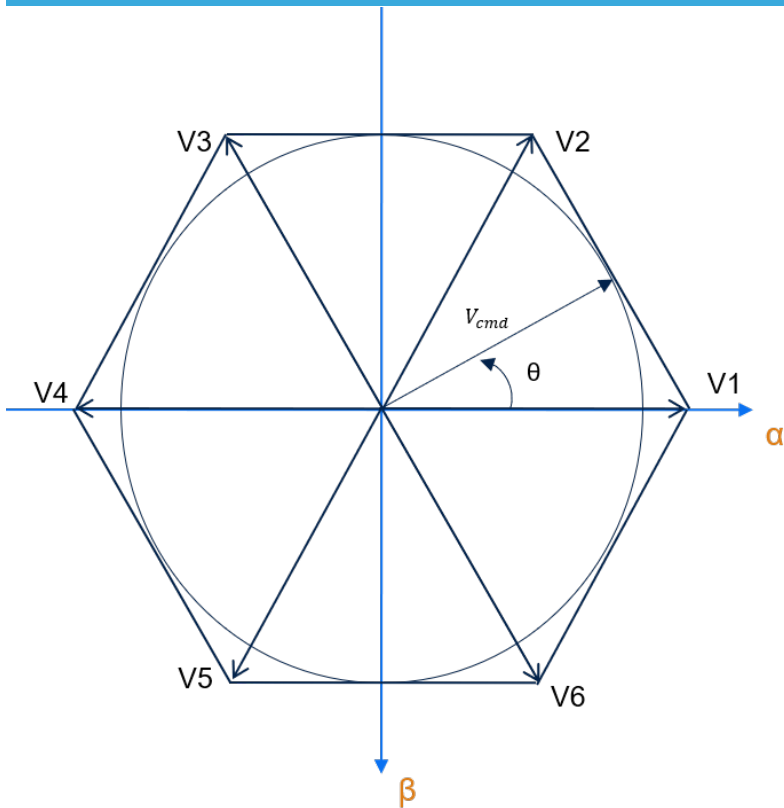
## 1 Principle of SVPWM



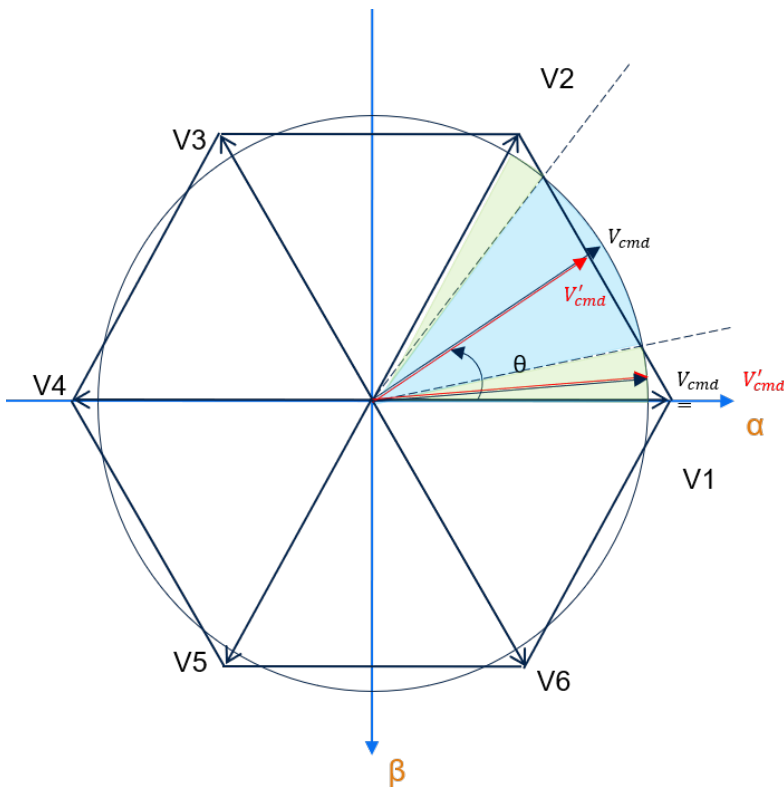
Space vector modulation index is limited to 3/2 but there is a way to extend this limit with the over-modulation. This technique is required when the modulation index, as the length of the reference space vector  $U_s$ , exceeds the edges of the hexagon.

### 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:

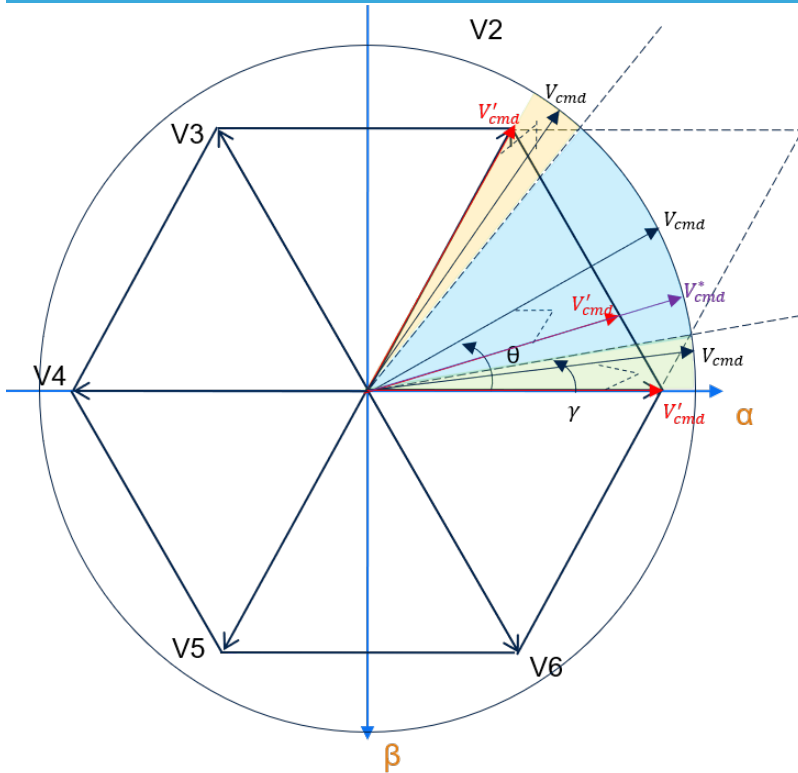
- In the green area:  $T_1 + T_2 < 1$ .

$V_{cmd}$  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:  $T_1 \geq 1.0$ .

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:  $T_2 \geq 1.0$ .

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:  $T_1 < 1.0$  &  $T_2 < 1.0$ .

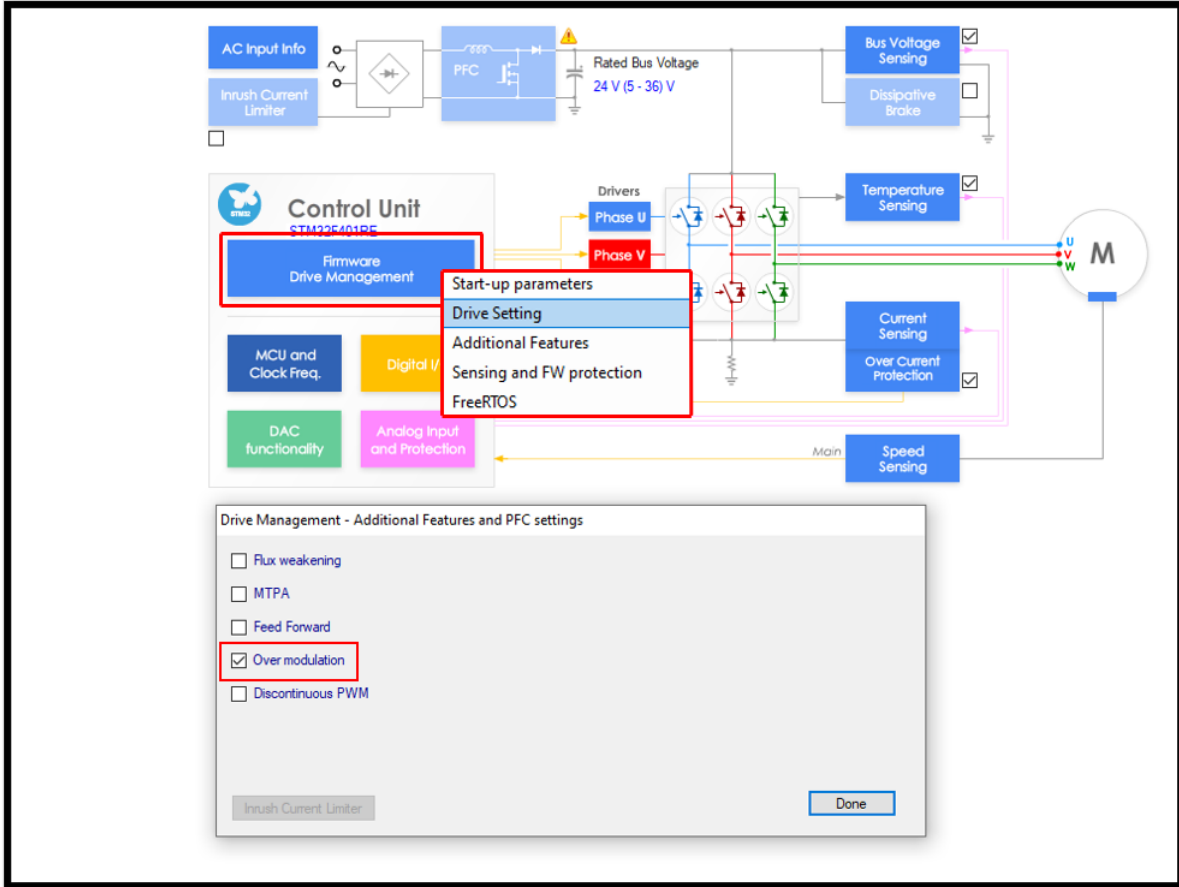
Then  $V'_{cmd} = T'_1 * V_1 + T'_2 * V_2$  with  $T'_1 = (T_1 / (T_1 + T_2 + 3 / \pi)) * (\pi / 6) / (\pi / 6 - \gamma)$  and  $T'_2 = 1.0 - T'_1$ .

## 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 $T'_1 = \left( \frac{T_1}{T_1 + T_2} + \frac{3}{\pi} \gamma \right) \frac{\pi/6}{\pi/6 - \gamma}$		
$T'_2$	$T'_2 = T_2$	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



- In the middle of this snapshot: the blue curve shows the phase current
- Just below: the pink, yellow and green curves show the PWM channels



---

The over-modulation increases the total harmonic distortion, but it allows the modulation index to exceed  $3/2$ .