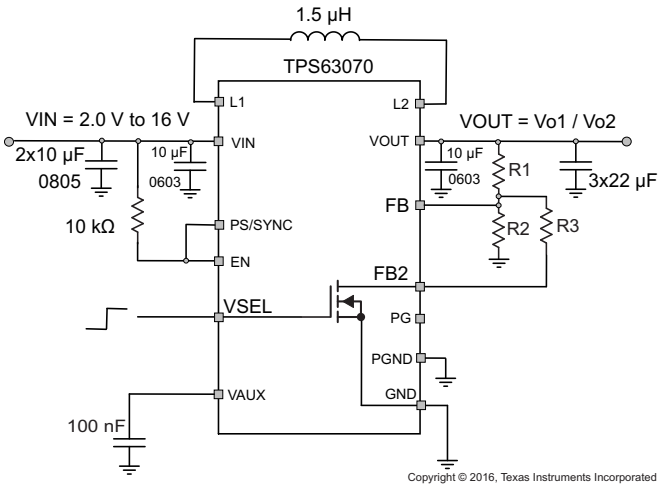
How to use VSEL function of TPS63070

Changing the output voltage of a DC/DC converter during operation can be a useful feature in battery operated applications to increase the battery lifetime. In applications that include processors, a lower system voltage reduces the leakage currents. In addition, it typically reduces the operating frequency as well. Both effects lower the power consumption and increase the battery lifetime.
Other examples include environment controllers for building automation where a higher operating voltage is needed to supply a particle sensor, or that is, in wireless network cameras where the forward voltage of a LED shortly increases to create a flash.

The TPS63070 dynamic voltage scaling feature uses the VSEL pin to change the output voltage during operation. Through an internal MOSFET an additional external resistor is pulled to GND (VSEL=high) or left floating (VSEL=low). If pulled to GND the resistor is connected in parallel to the bottom feedback resistor which then enables a higher output voltage.



The needed output voltages can be calculated with the following formulas:

$$\text{VSEL} = \text{Low}: \quad V_{O1} = V_{FB} \times \frac{R1 + R2}{R2} \tag{1}$$

$$\text{VSEL} = \text{High}: \quad V_{O2} = V_{FB} \times \frac{R1 + (R2 \,||\, R3)}{R2 \,||\, R3}$$

where:

$$R2 \,||\, R3 = \frac{R2 \times R3}{R2 + R3} \tag{2}$$

R3 can be calculated with this formula:

$$R3 = \frac{V_{FB}}{(V_{O2} - V_{O1})} \times R1, \text{ for } V_{O2} > V_{O1} \tag{3}$$

This excel calculator can be used: VSEL Calculator.

	A	B	C	D	E	F
1		Input field				
2		Calculated Output				
3						
4		Use Resistor E-series for Calculation output:		E48		
5						
6		Calculation for Single Output Voltage				
7		calculate ... depending on available input				
8		R2	Vo	R1		
9	R1	590.00 kΩ	590.00 kΩ	590.00 kΩ	Error:	2.50 kΩ
10	R2	100.00 kΩ	100.00 kΩ	100.00 kΩ	Error:	0.43 kΩ
11	Vo	5.50 V	5.52 V	5.50 V		
12						
13		Calculation for Dual Output Voltage				
14		calculate ... depending on available input				
15		R3	Vo1	Vo2		
16	R1	470.00 kΩ	590.00 kΩ	590.00 kΩ		
17	R2	150.00 kΩ	100.00 kΩ	100.00 kΩ		
18	R3	226.00 kΩ	221.00 kΩ	221.00 kΩ	Error:	0.27 kΩ
19	Vo1	3.30 V	3.61 V	5.50 V	VSEL=LOW	
20	Vo2	5.00 V	5.00 V	7.63 V	VSEL=HIGH	

Figure 1. VSEL calculator tool

TPS63070 dynamic voltage scaling feature can be used during operation. Figure 2 shows a dynamic output voltage change from 5 V to 3.3 V with a slow signal ramp on the VSEL pin. The VSEL pin has an inbuilt hysteresis of typically 30 mV preventing Vo oscillations.

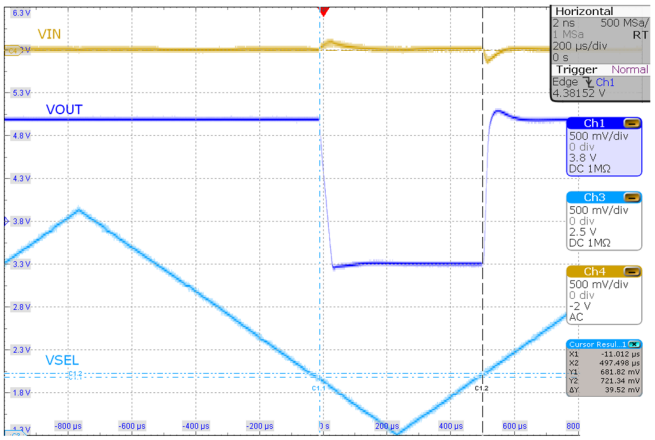


Figure 2. Triangular waveform on VSEL pin shows smooth output voltage change

The maximum switching frequency depends on the operating mode, output current, voltage step and output capacitor.

If the device operates in forced-PWM or PWM mode the maximum switching frequency is 10 kHz. Higher frequencies result in the output voltage not reaching the lower value. The discharge is dependent on the negative current limit and the output capacitance.

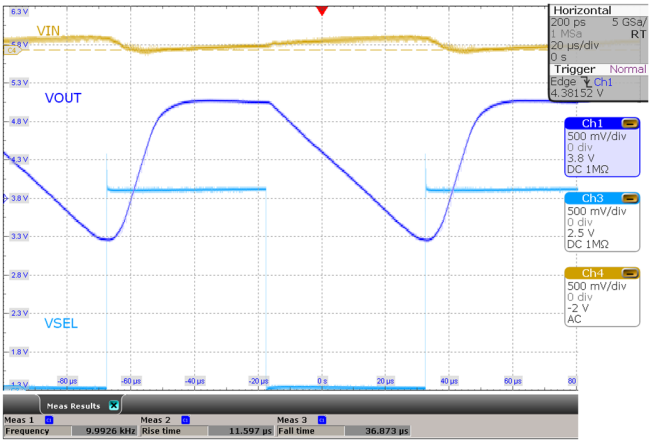


Figure 3. VSEL toggled with 10kHz, V_I = 5 V, V_O = 3.3 V or 5V, forced-PWM

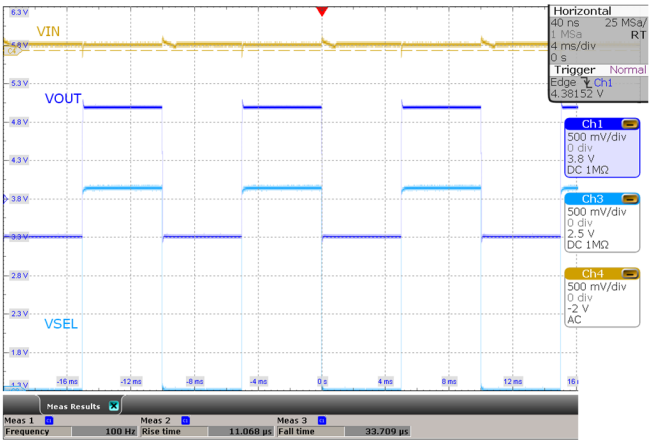


Figure 4. VSEL toggled with 100 Hz. V_I = 5 V, V_O = 3.3 V or 5 V, forced PWM

In power save mode (PSM) the output capacitor discharge is determined by the output current. Higher output current results in faster output voltage changes. Figure 5 and Figure 6 show two different output current both with 1 kHz switching frequency.

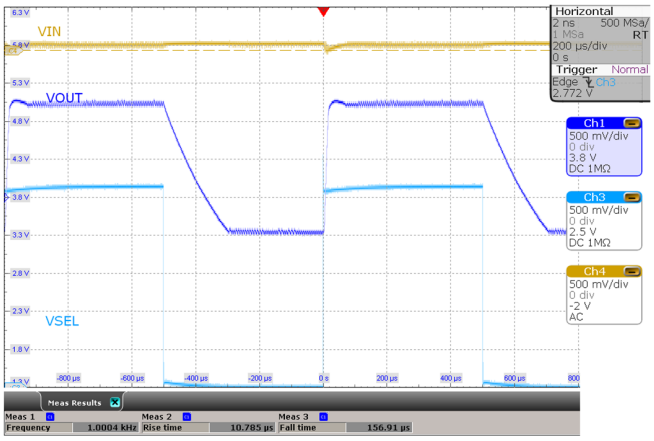


Figure 5. Power save mode. V_I= 5 V, V_O = 3.3 V or 5 V, I_O = 250 mA, PSM

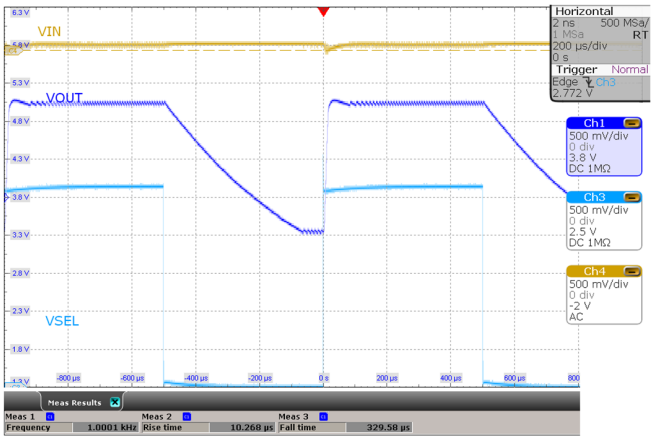


Figure 6. Power save mode. V_I= 5V, V_O= 3.3 V or 5 V, I_O= 125 mA, PSM

1 References

VSEL Calculator

TPS63070 Datasheet

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