Application Brief

Three Steps to Quickly Decide Your Boost Converter's Max Output Current

![Texas Instruments logo]

Wenhao Wu

Introduction

Boost converters are widely used for different markets, to provide higher output voltage from input supply like alkaline and Li-ion batteries. Most of boost converter do not directly specify maximum output current in data sheet. Engineers who misunderstand current capability specification from data sheet title can choose an improper small current converter for their system which actually demands heavier load. This application brief illustrates three steps to quickly know what is your boost converter's output current capability.

Additionally, this application provides two examples based on TPS61022 and TPS61099. The operating condition is given as the following:

- Input voltage V_{IN}: 1.8 V to 3.7 V;
- Output voltage V_{OUT}: 5 V;
- Operating temperature: 25ºC;
- Target output current for TPS61022: 2 A;
- Target output current for TPS61099: 100 mA.

Step 1: Know Your Device's Input Current Limit

The current specification in data sheet title represents device's typical input current limit. To make calculation, we need minimum value of input current limit. Minimum value is the worst current limit spec across variations. The higher this value is, the stronger current capability the device has.

For TPS61022, it has minimum valley current limit of 6.5 A as shown in Table 1.

Table 1. TPS61022 Current Limit Specification

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{LIM,SW}$	Valley current limit	V_{IN} = 3.6 V, V_{OUT} = 5 V,	6.5	8	10	A

For TPS61099, as shown in Table 2, it has minimum current limit of 0.8 A for $V_{OUT} \geq 2.5$ V.

**Table 2. TPS61099 Current Limit Specification**

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{LIM}	Current limit threshold	$V_{OUT} \geq 2.5$ V, boost operation	0.8	1	1.25	A
		$V_{OUT} < 2.5$ V, boost operation	0.5	0.75		A

### Step 2: Know Your Device's Efficiency Level at Interested Operating Condition

Efficiency data is needed to build relation between input current limit and output current. We need efficiency in the worst case to make sure device not enter current limit across operating conditions. The worst case for boost converter is at minimum input voltage, highest $V_{OUT} \times I_{OUT}$ and highest operating temperature.

Figure 1 shares TPS61022's efficiency data at V_{OUT}=5 V. We know the efficiency for V_{IN}=1.8 V and I_{OUT}=2 A is around 87%.
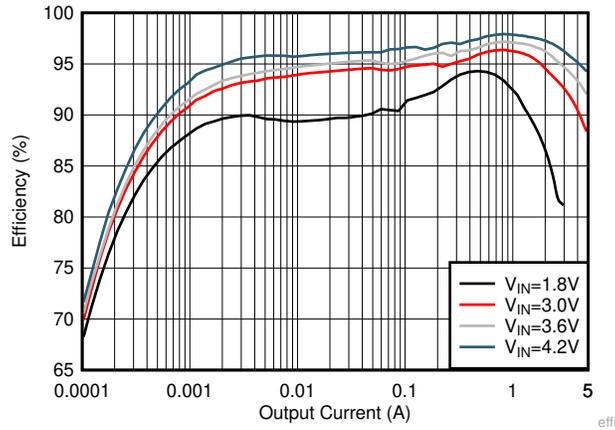
Figure 1. TPS61022 Load Efficiency with Different Input in Auto PFM

Figure 1 is TPS61099's efficiency data at V_{OUT}=5 V. It does not have efficiency at V_{IN}=1.8 V, so we use lower V_{IN}=1.5 V curve for approximation. At output current of 100 mA, the efficiency is about 88%.
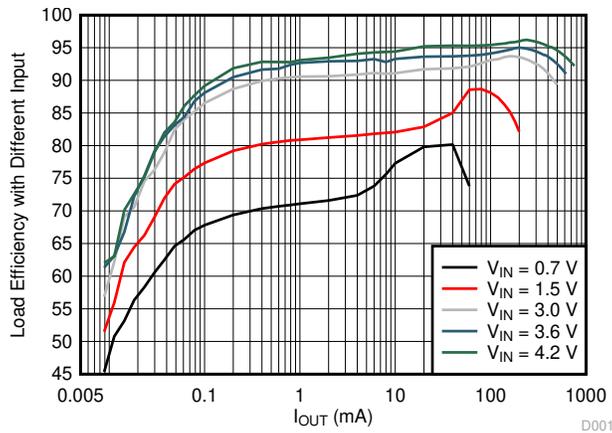
Figure 2. TPS61099 Load Efficiency with Different Inputs

Step 3: Know Your Boost Converter's Output Current Capability

Equation 1 illustrates maximum output current calculation.

$$I_{OUT, MAX} = \frac{V_{IN, MIN} \cdot \left(I_{IN, MIN} \pm 0.5 \cdot \Delta I_L \right) \cdot \eta}{V_{OUT}}$$

(1)

Inside equation, where:

$V_{IN,MIN}$ is minimum input voltage;

$I_{IN,MIN}$ is minimum input current limit in Step 1;

ΔI_L is inductor current ripple;

η is efficiency data in Step 2.

For device using valley current limit, half of inductor current ripple can be added in. On the other hand, device that uses peak current limit must minus half of inductor current to make calculation more accurate. Figure 3 shows how valley current limit and peak current limit is influencing average input current differently.
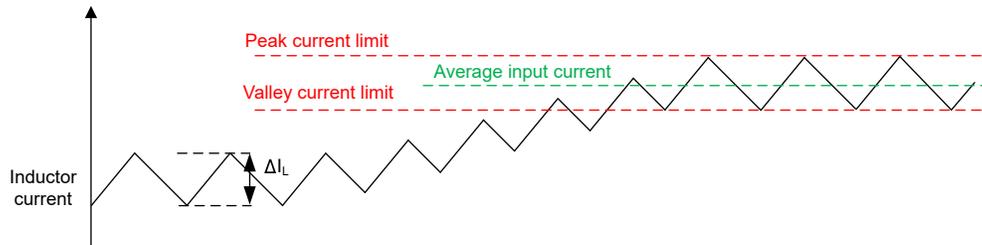
Figure 3. Influence of Peak and Valley Current Limit to Input Average Current

TPS61022 uses valley current limit. Maximum output current at operating condition is calculated as Equation 2 of 2.1238 A. The inductor ripple is given based on 2.2 uH inductance.

$$I_{OUT, MAX} = \frac{1.8V \cdot (6.5A + 0.5 \cdot 0.562A) \cdot 87\%}{5V} = 2.1238A \qquad (2)$$

TPS61099 uses peak current limit. As a result of hysteretic control, its inductor current ripple is constant. Refer to Table 3, inductor current ripple at V_{OUT}=5 V is 350 mA. Maximum output current is calculated in as 198 mA.

Table 3. TPS61099 Inductor Current Ripple Specification

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{LH}	Inductor current ripple	V_{OUT} = 5 V		350		mA
		V_{OUT} = 3.3 V		300		mA
		V_{OUT} = 1.8 V		250		mA

$$I_{OUT, MAX} = \frac{1.8V \cdot (0.8A - 0.5 \cdot 0.35A) \cdot 88\%}{5V} = 198mA \qquad (3)$$

Conclusion

Boost converters' data sheet does not directly specify their maximum output current. Engineers can calculate the result based on data sheet spec using three steps in this application brief. It is recommended to leave some margin over calculated maximum output current to prevent device from entering current limit, because of temperature rise and external components degradations.

Related Documentation

1. TPS61022 8-A Boost Converter with 0.5-V Ultra-low Input Voltage
2. TPS61099x Synchronous Boost Converter with Ultra-Low Quiescent Current

IMPORTANT NOTICE AND DISCLAIMER