Application Note

Boost Converter with Average Input Current Limit is Simplifying Barcode Scanner Designs

TEXAS INSTRUMENTS

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ABSTRACT

This application note provides an overview of the integrated features of TPS61376 and how the features can help to simplify barcode scanner designs.

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1 Introduction

Several power sources have limited output current capability based on circuit characteristics or electrical standards. For instance, the maximum output current of Universal Serial Bus (USB) 2.0 port is 0.5 A. For Peripheral Component Interconnect Express (PCIe) card and USB Type-C® port the current is limited to 3 A. Also, Li-Ion or alkaline batteries have limited discharge current capability due to the internal resistance (ESR). When overloading these batteries, their capacity and the lifetime can be significantly reduced. A DC-DC converter with average input current limit function can help to avoid overloading such power sources.

Furthermore, switching power converters can typically generate inrush current when turning on. High inrush current can overload the power source. This process can trigger the UVLO and prevent the converter from a reliable startup. The conditions can be even worse while charging a large storage bulk output capacitor. There is also another function of input current limit, that is, control inrush current and provide controlled current to charge large capacitors.

TPS61376 with its integrated features can control and limit the input current during start up and steady state condition.

2 TPS61376 in Barcode Scanner Application

One typical application that requires the input average current limit function is barcode scanner. Barcode scanners are also known as barcode readers, which are input devices that converts barcode information into computer-acceptable information using the principle of photo-electricity, commonly used in libraries, hospitals, bookstores, supermarkets, logistics and other industries.

So how does the boost converter TPS61376 help in a more integrated barcode scanner design? Figure 2-1 shows a typical power tree of a barcode scanner. Barcode scanners usually have high power Flash LEDs for light transmission. The voltage depends on the number of LEDs in series and the LED current is relatively high, typically 2 to 3 A or even higher. The power supply for the barcode scanner is either USB or battery. For the limitation of maximum 500 mA current capability, the USB interface cannot provide such an instantaneous high current, so a buffer capacitor is usually incorporated into the system to provide instantaneous energy.

TPS61376 can be used to limit the input average current to protect the USB from crashing and boost the input voltage rail to a higher output voltage rail to charge the large output capacitors. The input average current limit is active during normal operation as well as during startup. This effectively limits the inrush current, and can also be used to reliably charge heavy loads, from a power source with limited current capability. The TPS61376 has programmable input average current limit range from 0.1A to 3A with an accuracy up to ±2.5%.
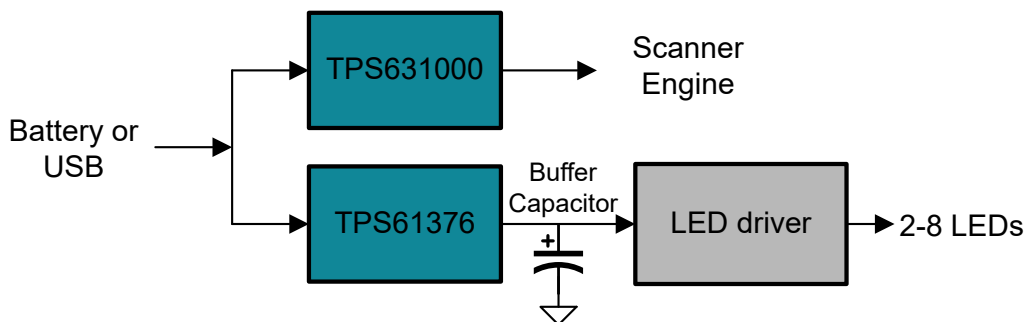

Figure 2-1. Barcode Scanner System Block Diagram

With all these features of input average current limit in TPS61376, a more integrated barcode scanner design can be achieved which can replace outdated designs that are using additional e-fuse or switch to implement input current limit.

3 TPS61376 Features

[Table 3-1](#) lists the parameters and features of the TPS6137.

Table 3-1. TPS61376 Parameters

Parameter	Value
Input Voltage range	2.9 - 23 V
Output Voltage range	4.5 - 25 V
Inductor peak current limit (typ)	4.5 A
Programmable average input current limit	0.1 - 3 A
Switching Frequency	1.2 MHz
RDSON	ISO FET 40 mΩ, Low Side FET 50 mΩ
Package	VQFN, 2.5 × 2.0 mm
Safety and robust operation features	True disconnection between input and output during shutdown
	Programmable average input current limit
	Output overvoltage protection
	Cycle-by-cycle overcurrent protection
	Thermal shutdown
	Precise EN/UVLO threshold

[Figure 3-1](#) shows a typical schematic of TPS6137.
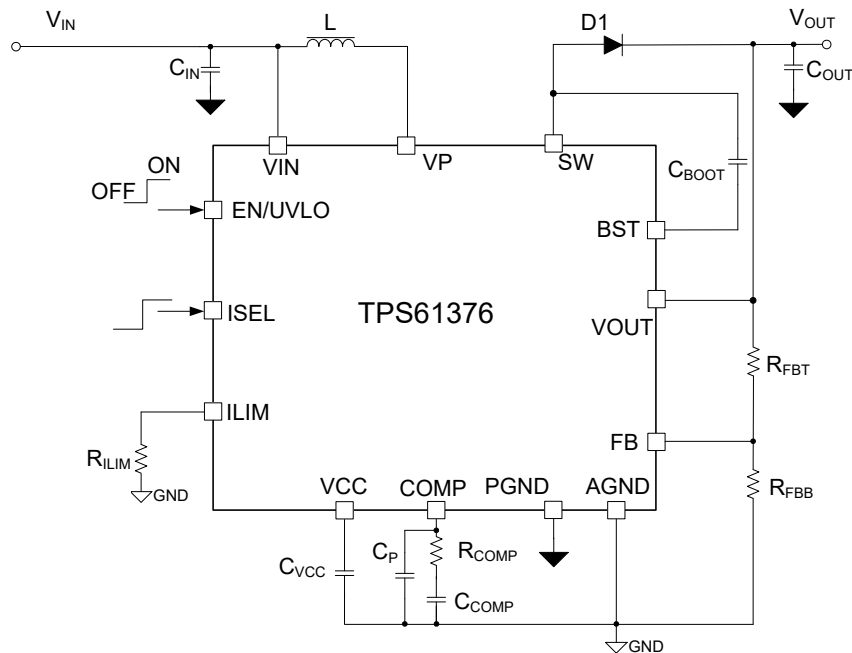
Figure 3-1. Typical TPS61376 Schematic

3.1 Inrush Current Control During Start-up

Figure 3-2 shows the startup waveform with an average input current limit set to 500 mA.

TPS61376 has the soft-start and input average current limit function to prevent high inrush current during startup. During start-up when Vin is higher than Vout, the ISO FET between VP and SW pin will limit the current across the inductor. This current will increase linearly as the Vin and Vout delta decreases. When Vout is higher than Vin, TPS61376 will regulate the input average current programmed through ILIM pin.
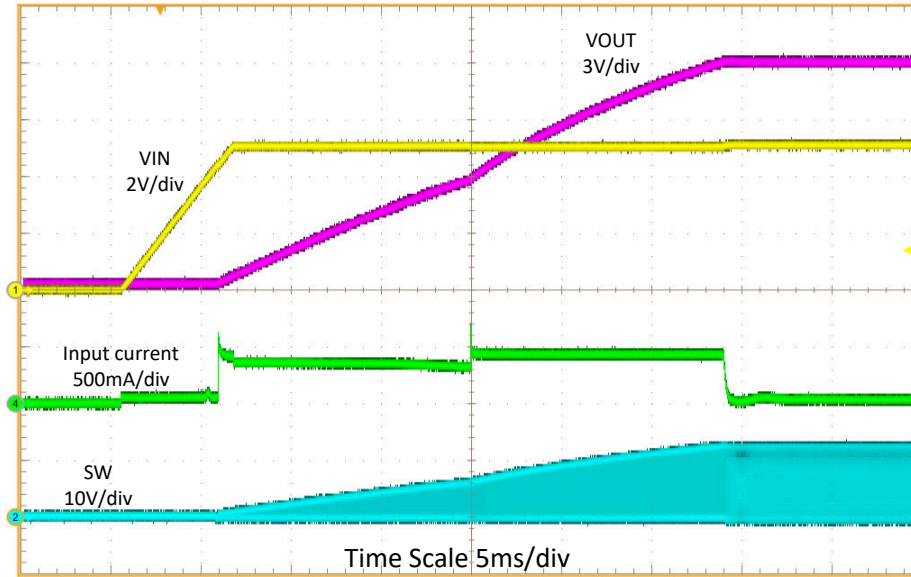
Figure 3-2. Start-up with 500 mA Avarage Input Current Limit

3.2 Input Average Current Limit During Load Transient

Figure 3-3 shows a load transient of 2 A for 1 ms waveform with an average input current limit set to 500 mA.

During the load transient, the voltage across the output capacitor drops rapidly. The power source is required to provide a large current to charge the capacitor to the target output voltage. The average input current limit function makes sure that the current is within the range allowed by the power source. Until the output capacitor voltage reaches the target output voltage, the charging phase ends.
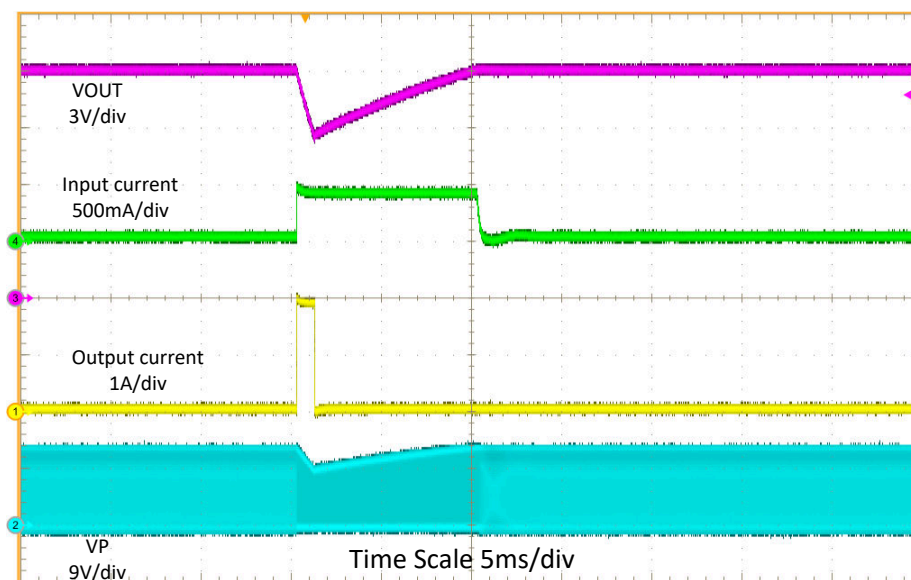

Figure 3-3. Load Transient with 500 mA Avarage Input Current Limit

3.3 True Load Disconnect During Shutdown

When the input voltage is below the UVLO threshold or the EN pin is pulled low, The TPS61376 is in shutdown mode and all the functions are disabled. The TPS61376 integrates a load disconnect function where the ISO FET between the VP and SW pin will completely cut off the path between input and output when the device is disabled, so the output voltage can remain at 0 V.

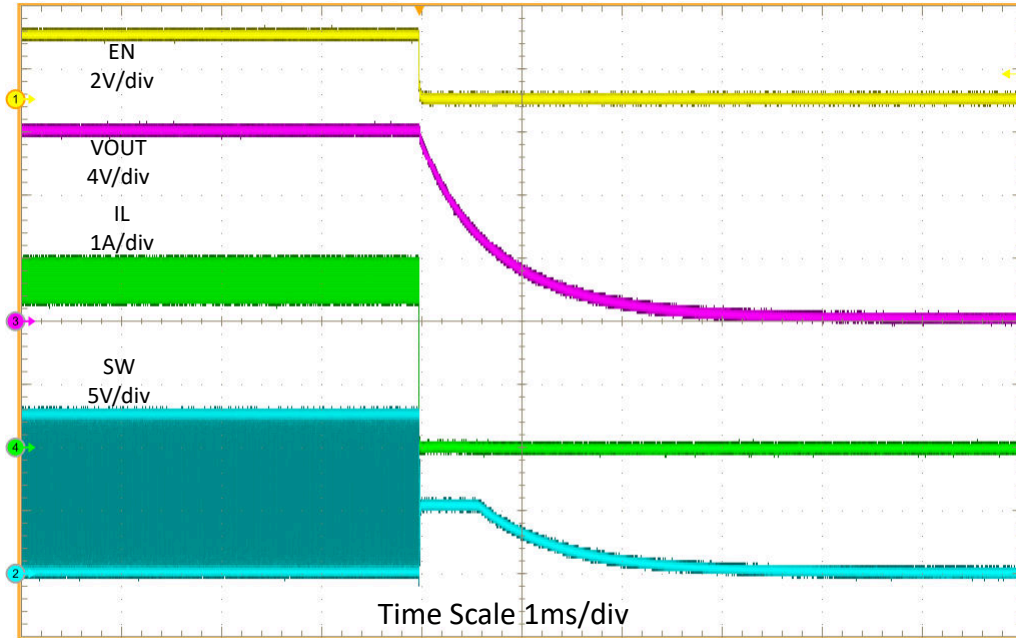Figure 3-4 shows the process of shutdown when the device gets disabled.

Figure 3-4. Device Shutdown

4 References

- Texas Instruments, *25-V, 4.5-A, Boost Converter with 2.5% Accuracy Input Average Current Limit and True Disconnection* data sheet.

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