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Two New Controllers for Boost, Flyback, SEPIC and Inverting DC/DC Converters Accept Inputs up to 100V

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Introduction

Two new versatile DC/DC controller ICs, the LT®3757 and LT3758, are optimized for boost, flyback, SEPIC and inverting converter applications. The LT3757 operates over an input range of 2.9V to 40V, suitable for applications from single-cell lithium-ion battery portable electronics up to high voltage automotive and industrial power supplies. The LT3758 extends the input voltage to 100V, providing flexible, high performance operation in high voltage, high power telecommunications equipment. Both ICs exhibit low shutdown quiescent current of 1µA, making them an ideal fit for battery-operated systems.

Both integrate a high voltage, low dropout linear (LDO) regulator. Thanks to a novel FBX pin architecture, the LT3757 and LT3758 can be connected directly to a divider from either the positive output or the negative output to ground. They also pack many popular features such as soft-start, input undervoltage lockout, adjustable frequency and synchronization in a small 10-lead MSOP package or a 3mm × 3mm QFN package.

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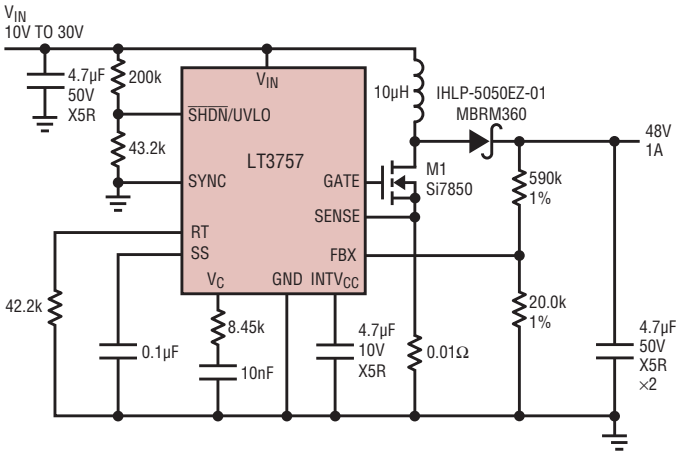

Figure 1. A 10V–30V input, 48V at 1A output boost converter

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Internal High Voltage LDO

In high voltage applications, the LT3757 and LT3758 eliminate the need for an external regulator or a slow-charge hysteretic start scheme through the integration of an onboard linear regulator, allowing simple start-up and biasing. This regulator generates $INTV_{CC}$, the local supply that runs the IC from the converter input V_{IN}. The internal LDO can operate the IC continuously, provided the input voltage and/or MOSFET gate charge currents are low enough to avoid excessive power dissipation in the part.

When the $INTV_{CC}$ pin is driven externally above its regulated voltage during operation—from the input, the output or a third winding—the internal LDO is automatically turned off, reducing the power dissipation in the IC. The LDO also provides internal current limit function to protect IC from excessive on-chip power dissipation. The current limit decreases as V_{IN} increases. If the current limit is exceeded, the $INTV_{CC}$ voltage falls and triggers the soft-start.

Sensing Output Voltage Made Easier

Unlike traditional controllers, which can only sense positive outputs, the LT3757 and LT3758 have a novel FBX pin architecture that simplifies the design of inverting and non-inverting converters. The LT3757 and LT3758 each contain two internal error amplifiers; one senses positive outputs and the other negative. When the converter starts switching and the output voltage starts ramping up or down, depending on the topologies, one of the error amplifiers seamlessly takes over the feedback control, while the other becomes inactive.

The FBX pin can be connected directly to a divider from either a positive output or a negative output. This direct connection saves space and expense by eliminating the traditional glue circuitry normally required to level-shift the feedback signal above ground in negative converters. The power supply designer simply decides the output polarity he needs, the topology he wants to use and the LT3757 or LT3758 does the rest.

Precision UVLO Voltage and Soft-Start

Input supply UVLO for sequencing or start-up over-current protection is easily achieved by driving the UVLO with a resistor divider from the V_{IN} supply. The divider output produces 1.25V at the UVLO pin when V_{IN} is at the desired UVLO rising threshold voltage. The UVLO pin has an adjustable input hysteresis, which allows the IC to resist a settable input supply droop before disabling the converter. During a UVLO event, the IC is disabled and V_{IN} quiescent current drops to 1µA or lower.

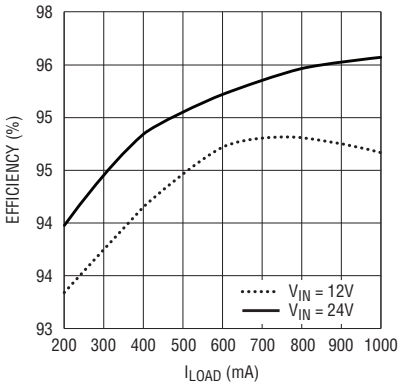

Figure 2. Efficiency of the converter in Figure 1

The SS pin provides access to the soft-start feature, which reduces the peak input current and prevents output voltage overshoot during start-up or recovery from a fault condition. The SS pin reduces the inrush current by not only lowering the current limit but also reducing the switching frequency. In this way soft-start allows the output capacitor to charge gradually towards its final value.

Adjustable/Synchronizable Switching Frequency

The operating frequency of the LT3757 and LT3758 can be programmed from 100kHz to 1MHz range with a single resistor from the R_T pin to ground, or synchronized to an external clock via the SYNC pin.

The adjustable operating frequency allows it to be set outside certain frequency bands to fit applications that are sensitive to spectral noise.

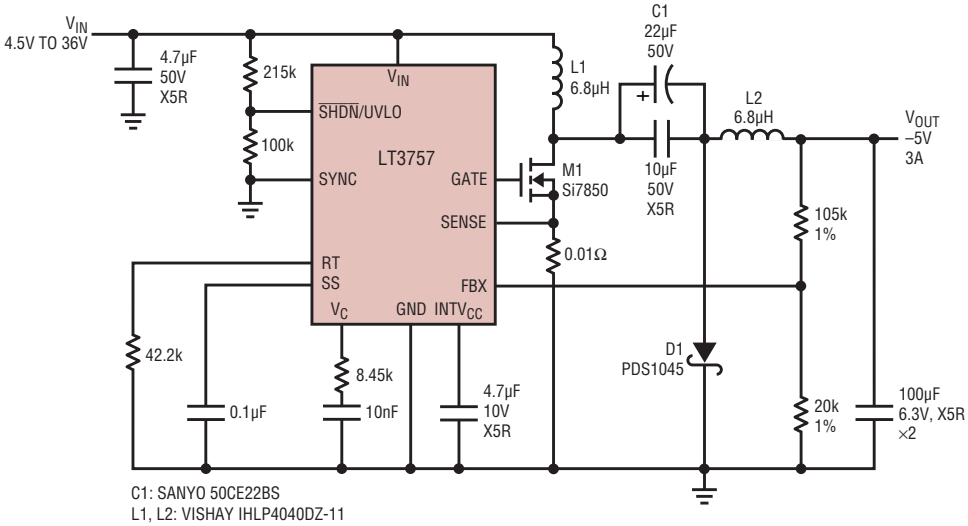

Figure 3. A 4.5V–36V to –5V at 3A inverting converter

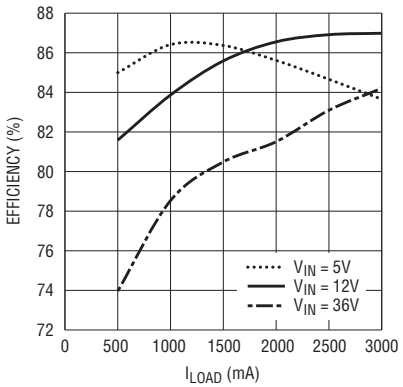

Figure 4. Efficiency of the converter in Figure 3

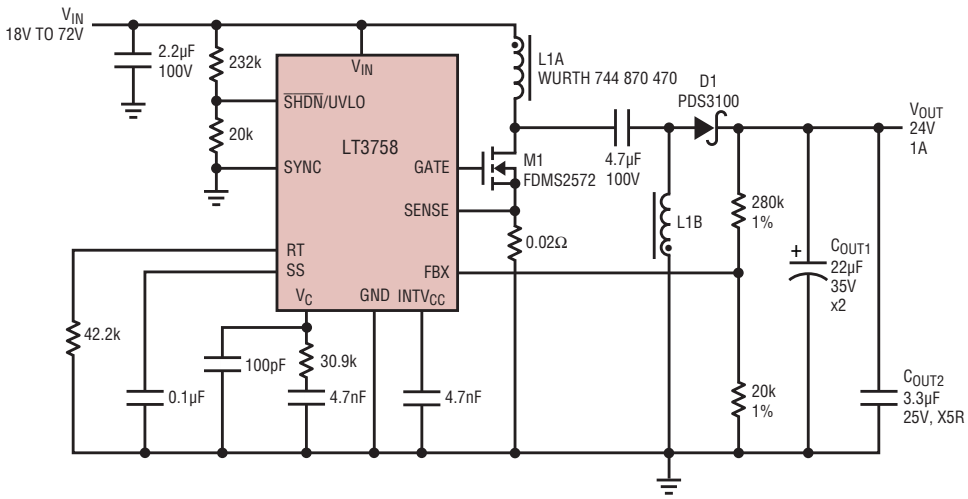

Figure 5. A 18V–72V input, 24V/1A output SEPIC converter

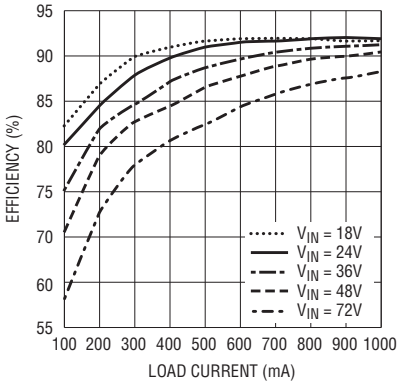

Figure 6. Efficiency of the converter in Figure 5

In space constrained applications, higher switching frequencies can be used to reduce the overall solution size and the output ripple. If power loss is a concern, switching at a lower frequency reduces switching losses, improving efficiency.

Current Mode Control

The LT3757 and LT3758 use a current mode control architecture to enable a higher supply bandwidth, thus improving response to line and load transients. Current mode control also requires fewer compensation components than voltage mode control architectures, making it much easier to compensate over all operating conditions.

A 10V–30V Input, 48V/1A Output Boost Converter

Figure 1 shows a 48V, 1A output converter that takes an input of 10V to 30V. The LT3757 is configured as a boost converter for this applications where the converter output voltage is higher than the input voltage. Figure 2 shows the efficiency for this converter.

A 4.5V–36V Input, –5V/3A Output Inverting Converter

Figure 3 shows the LT3757 in an inverting converter that operates from a 4.5V to 36V input and delivers 3A to a –5V load. The negative output can be either higher or lower in amplitude than the input. It has output short-circuit protection, which is further enhanced by the frequency foldback feature in the LT3757. The 300kHz operating frequency allows the use of small inductors. The ceramic capacitor used for the DC coupling capacitor provides low ESR and high RMS current capability. The output power can easily scaled by the choice of the components around the chip without modifying the basic design. Figure 4 shows the efficiency for this converter at different input voltages.

An 18V–72V Input, 24V/1A Output SEPIC Converter

A SEPIC converter is similar to the inverting converter in that it can step up or step down the input, but with a positive output. It also offers output disconnect and short-circuit protection. Figure 5 illustrates an 18V–72V input, 24/1A output SEPIC power supply using LT3758 as the controller. Figure 6 shows the efficiency for this converter at different input voltages.

An 18V–72V Input, –3.3V/2A Output Flyback Converter

Figure 7 shows the LT3758 in a non-isolated flyback converter with an 18V to 72V input voltage range and a –3.3V / 2A output. It provides robust output short-circuit protection thanks to the frequency foldback feature in the LT3758. The circuit can also be used for different negative voltages simply by changing the value of the resistor divider on the FBX pin.

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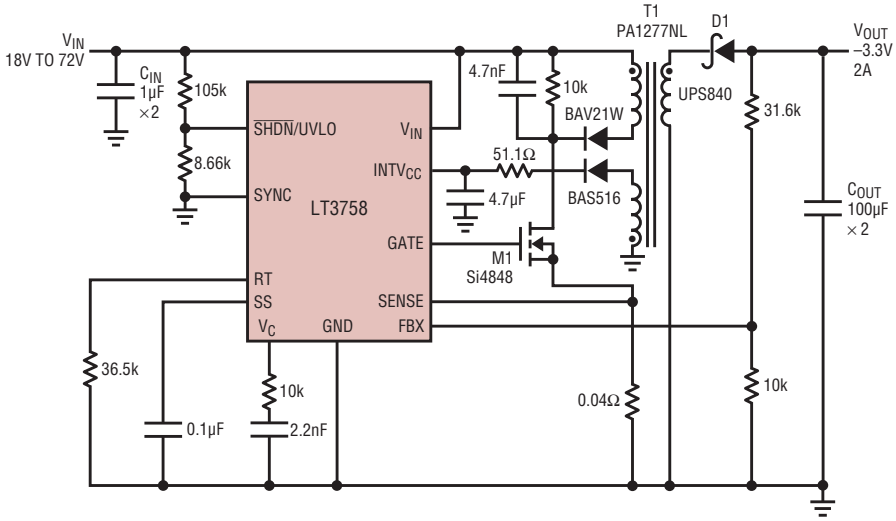

Figure 7. 18V–72V input, –3.3V/2A output flyback converter

margin to switch from tracking the TRACK/SS input voltage to regulating to the internal reference.

Figure 7 shows typical tracking waveforms of the application in Figure 6. V_{OUT} and the reference supply voltage, V_{MASTER}, are equal and track together during start-up until they reach 1.2V, at which point V_{OUT} regulates to 1.2V while V_{MASTER} continues ramping to 1.8V.

Conclusion

The LTC3878 and the LTC3879 support a V_{IN} range from 4V to 38V (40V abs max). The regulated output voltage is programmable from 90% V_{IN} down to 0.8V (for the LTC 3878) and 0.6V (for the LTC3879). The output regulation accuracy is ±1% over the full –40°C to 85°C temperature range. The operating frequency is resistor programmable and is compensated for variations in V_{IN}. Current limit is continuously programmable and is measured without a sense resistor by using the voltage drop across the external synchronous bottom MOSFET.

The valley current mode architecture is ideal for low duty factor operation and allows very low output voltages at reasonable current loop bandwidths. Compensation is easy to design and offers robust and stable operation even with low ESR ceramic output capacitors. The LTC3878 offers current limited start-up, while the LTC3879 has separate run and output voltage tracking pins. The LTC3878 is available in the GN16 package, and the LTC3879 is available in thermally enhanced MSE16 and QFN (3mm × 3mm) packages. Excellent performance and compact size make the LTC3878 and LTC3879 well suited to small, tightly constrained applications such as distributed power supplies, embedded computing and point of load applications.

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An 18V–72V Input, 5V/2A Output Isolated Flyback Converter

The basic design shown in Figure 7 can be modified to provide DC isolation between the input and output with the addition of a reference, such as the LT4430, on the secondary side of the transformer and an optocoupler to provide feedback from the isolated secondary to the LT3758. Figure 8 shows an 18V–72V input, 5V/2A output isolated flyback converter.

Conclusion

The LT3757 and LT3758 are versatile control ICs optimized for a wide variety of single-ended DC/DC converter topologies. Both offer a particularly wide input voltage range. These ICs produce space saving, cost efficient and high performance solutions in any of these topologies. The range of applications extends from single-cell, lithium-ion powered systems to automotive, industrial and telecommunications power supplies.

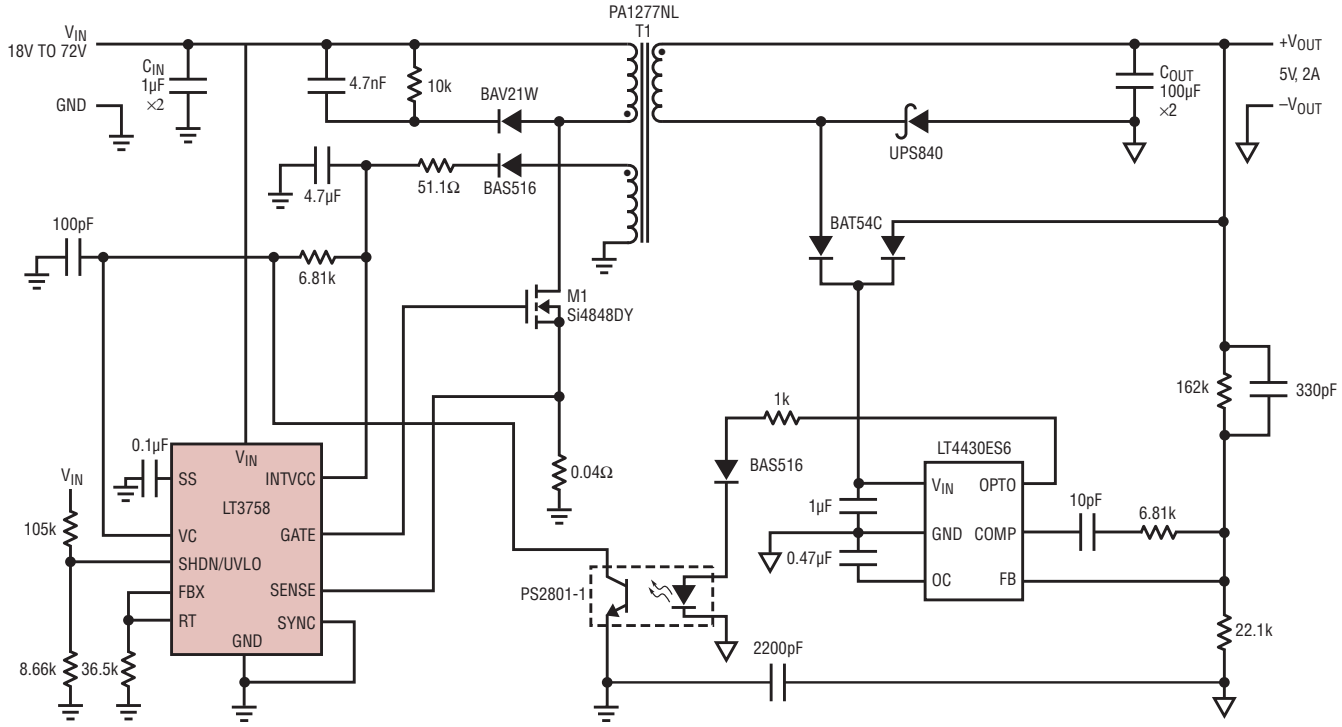

Figure 8. 18V–72V input, 5V/2A isolated flyback converter