DEMONSTRATION CIRCUIT 1641A
QUICK START GUIDE
LTC3786 High Efficiency Synchronous Boost Converter

DESCRIPTION

Demonstration circuit DC1641 is DC/DC boost converter featuring the LTC3786 constant frequency current mode boost controller. The DC1641A operates over 5V to 24V input and provides over 5A at 6V input voltage and over 9A of output current at 10V input as shown in figure 3. The 350kHz constant frequency operation results in small and efficient circuit. The converter provides high output voltage accuracy (typically ±3%) over wide load range with no minimum load requirement. The demonstration circuit can be easily modified to generate different output voltages. Please consult LTC factory for details.

Table 1. Performance Summary

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Input Voltage</td>
<td>IOUT = 0A to 5A</td>
<td>5V</td>
</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>IOUT = 0A to 9A</td>
<td>24V</td>
</tr>
<tr>
<td>VOUT</td>
<td>VIN = 5V to 24V, IOUT = 0A to 5A</td>
<td>24V ±3%</td>
</tr>
<tr>
<td>Typical Output Ripple</td>
<td>VIN = 12V, IOUT = 3A</td>
<td>100mV P-P</td>
</tr>
<tr>
<td>Nominal Switching Frequency</td>
<td></td>
<td>350kHz</td>
</tr>
</tbody>
</table>

QUICK START PROCEDURE

Demonstration circuit DC1641 is easy to set up to evaluate the performance of the LTC3786. For proper measurement equipment setup refer to Figure 1 and follow the procedure below:

1. With power off, connect the input power supply to Vin and GND.
2. Check the Vcc Bias voltage-setting jumper JP3. Move it into Vin position if required.
3. Turn the input power source on and slowly increase the input voltage. Be careful not to exceed 24V.

NOTE: When measuring the input or output voltage ripple, care must be taken to minimize the length of oscilloscope probe ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the VIN or VOUT and GND terminals as shown in Figure 2.

4. Set the input voltage to 6V and check for the proper output voltage of 24V. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
5. Once the proper output voltage is established, adjust the load and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

Design files for this circuit board are available. Call the LTC factory.

LTC, LTM, LT, Burst Mode, OPTI-LOOP, Over-The-Top and PolyPhase are registered trademarks of Linear Technology Corporation. Adaptive Power, C-Load, DirectSense, Easy Drive, FilterCAD, Hot Swap, LinearView, µModule, Micropower SwitcherCAD, Multimode Dimming, No Latency, No Latency Delta-Sigma, No RSense, Operational Filter, PanelProtect, PowerPath, PowerSOT, SmartStart, SoftSpan, Stage Shedding, SwitcherCAD, ThinSOT, UltraFast and VLDO are trademarks of Linear Technology Corporation. Other product names may be trademarks of the companies that manufacture the products.
CHANGING THE OUTPUT VOLTAGE

To set the output voltage lower than 24V, change the bottom voltage divider resistors connected to LTC3786 FB pin (see the schematic on page 4). To get higher than 24V output voltage MOSFETs and capacitors with higher voltage ratings may be required. Please contact LTC factory for details.

Note that the output voltage will start following the input voltage when input voltage is greater than the voltage set by the voltage divider. In this mode (wire mode) the synchronous output rectifier MOSFET is turned continuously ON. The only losses in this mode are due to the current sense resistor, inductor and output MOSFET DC resistance.
CONVERTER EFFICIENCY AND OUTPUT CURRENT

The DC1641 output current capability depends on the input voltage and proper cooling. Typical performance of DC1641A is shown in Figure 3. As can be seen from Figure 3, the output current capability depends on the input voltage. Also, when input voltage is equal to, or higher than the output voltage setting (wire mode) the efficiency is very high (99%) since the converter is not really running and the output MOSFET is shorting Vin to Vout.

The LTC3786 controller can be biased from $V_{OUT}$ (move jumper JP3 to V_out position). The startup voltage in this case has to be higher than the $V_{GS}$ threshold of MOSFETs. Also, the output current capability at minimum $V_{IN}$ may be extended due to full bias of MOSFETs.

Keep in mind that the bias circuit power dissipation will be higher when LTC3786 is biased from $V_{OUT}$ because $V_{OUT}$ is higher than $V_{IN}$ (except in WIRE mode). If the power dissipation in LTC3786 is too high an external NPN-Zener pre-regulator can also be used.

![LTC3786 24V Output Efficiency, BURST Mode](image)

Figure 3. High efficiency of DC1641 allows the board to be used in thermally critical applications with outputs over 5A.

OUTPUT LOAD STEP RESPONSE

The load step response of DC1641A is very good even though relatively small amount of output capacitance is present at the output. If higher load steps need to be handled more output capacitance can be added in order to keep the voltage transients at the desired level. The load step transients are shown in Figure 4. Also, note that the load step response even from 0% load is excellent thanks to synchronous rectification.

![Figure 4. Fast transient response of DC1641 is achieved with a small amount of output capacitance.](image)

INPUT VOLTAGE RANGE AND OUTPUT CURRENT

The minimum operating input voltage can be extended down to 4V or lower. However, the $V_{GS}$ of MOSFETs and biasing must be considered.
SOFT START FUNCTION
The DC1641 features soft-start circuit that controls the inrush current and output voltage ramp at startup. The capacitor $C_{15}$ (Figure 6) controls the startup period. The startup waveforms are shown in figure 5. Please note the output voltage step at about $-7$ms mark. The step is resulting from synchronous MOSFET being turned on. When the synchronous MOSFET is turned on, the voltage drop across the synchronous MOSFET (body diode) is reduced from about 0.7V to $I_{out} \times R_{dson}$. While the synchronous MOSFET is in the off state (prior to $-7$ms mark) the synchronous MOSFET body diode is dissipating about $0.7V \times I_{out}$ or about 4.2W with 6A load. Please refer to the LTC3786 data sheet for details about proper handling of synchronous MOSFET in your application.

![Figure 5. The DC1641 ramps the output slowly at startup without generating an input current surge.](image-url)