DEMO 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.

The DC1641 has small circuit footprint. It is a high performance and cost effective solution for Telecom, Automotive and Power Over Ethernet applications.

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

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Table 1. Performance Summary

PARAMETER	CONDITION	VALUE
Minimum Input Voltage	I_{OUT} = 0A to 5A	5V
Maximum Input Voltage	I_{OUT} = 0A to 9A	24V
V_{OUT}	V_{IN} = 5V to 24V, I_{OUT} = 0A to 5A	24V ±3%
Typical Output Ripple V_{OUT}	V_{IN} = 12V, I_{OUT} = 3A	100mV_{P-P}
Nominal Switching Frequency		350kHz

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:

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.

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: Make sure that the input voltage Vin does not exceed 24V. If higher operating voltage is required, power components with higher voltage ratings should be used.
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.

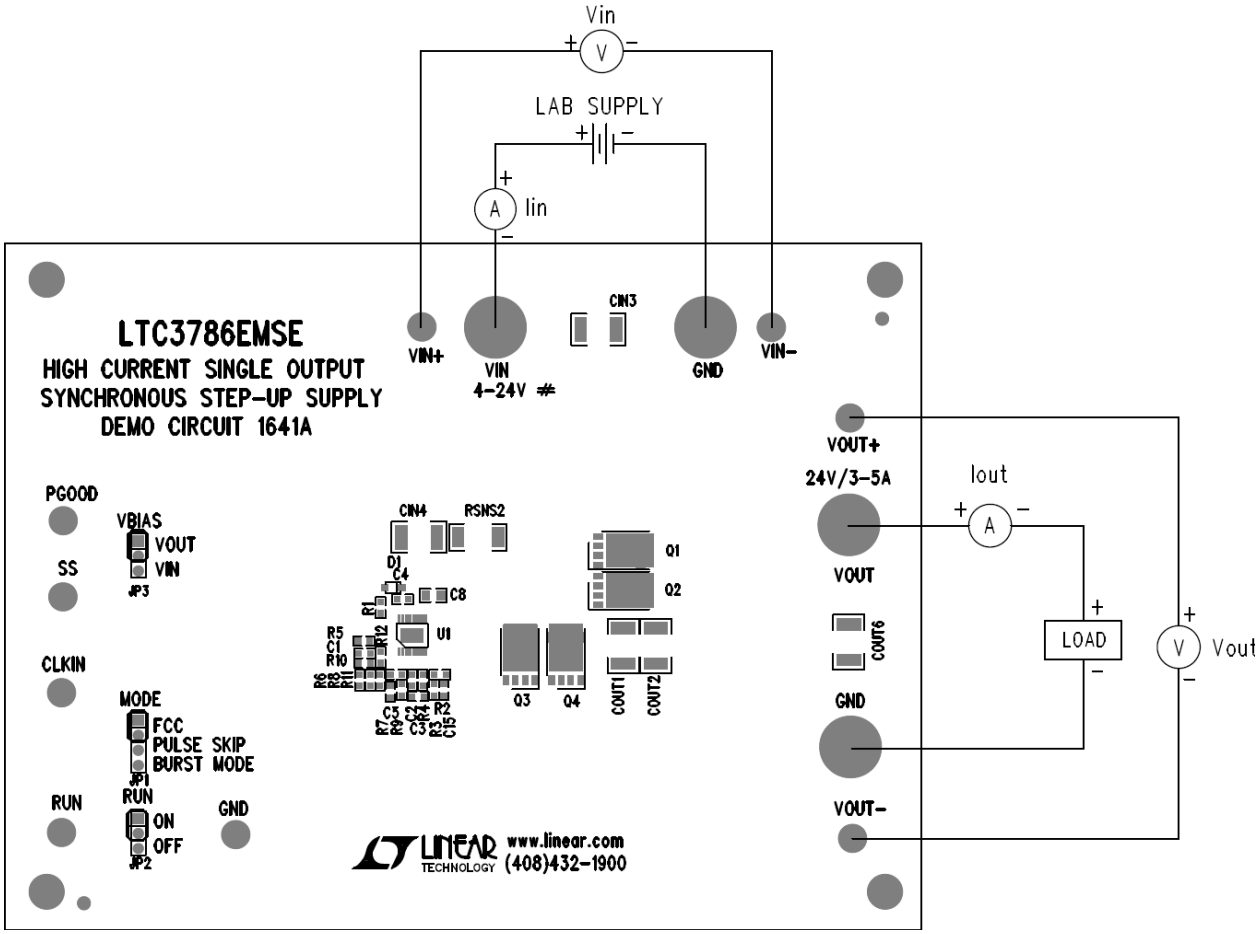


Figure 1. Proper Measurement Equipment Setup

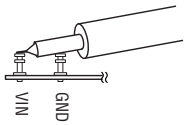


Figure 2. Measuring Input or Output Ripple

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.

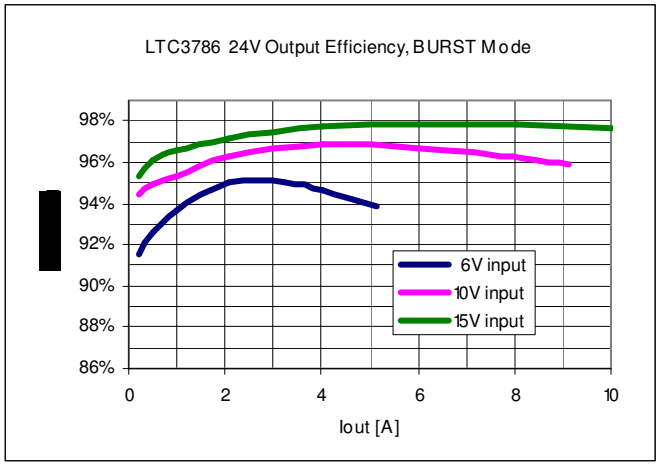


Figure 3. High efficiency of DC1641 allows the board to be used in thermally critical applications with outputs over 5A.

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.

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.

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.

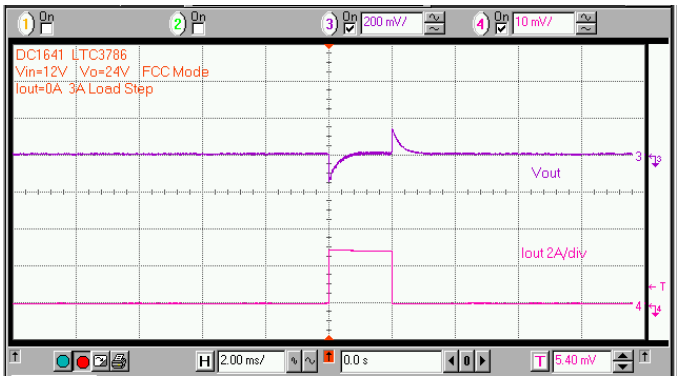


Figure 4. Fast transient response of DC1641 is achieved with a small amount of output capacitance.

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 –7ms 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 Iout*Rdson. While the synchronous MOSFET is in the off state (prior to –7ms mark) the synchronous MOSFET body diode is dissipating about 0.7V*Iout 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.

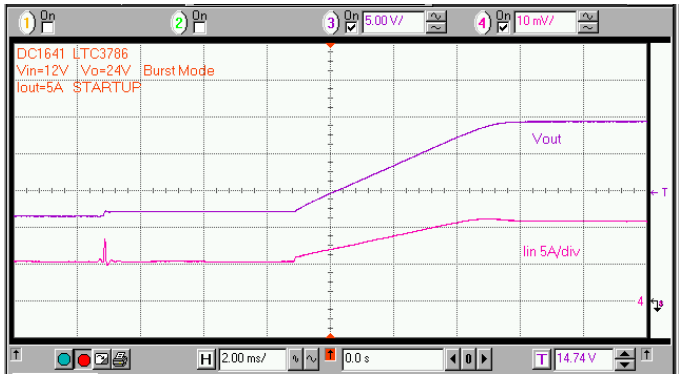
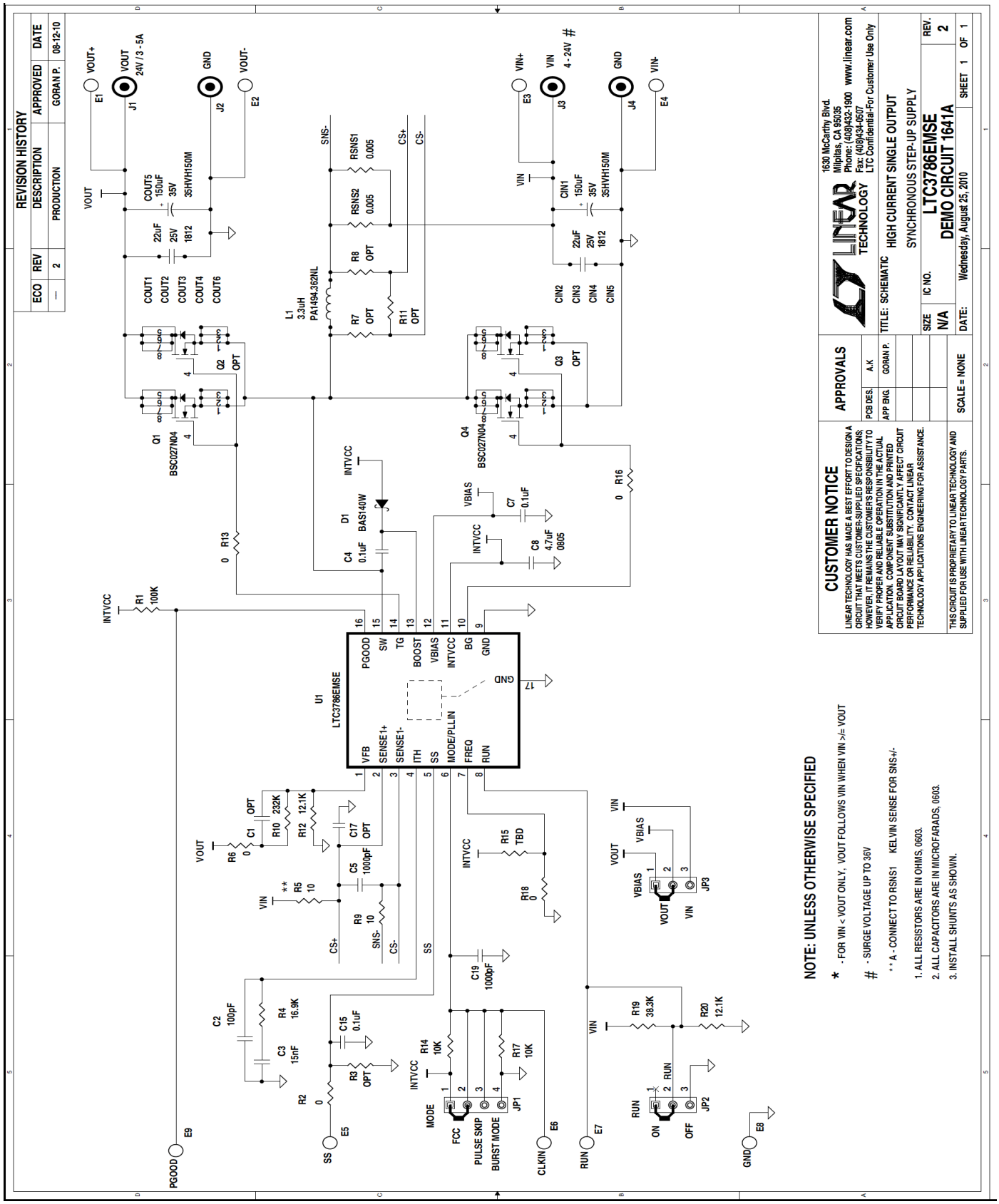


Figure 5. The DC1641 ramps the output slowly at startup without generating an input current surge.


REVISION HISTORY
ECO REV DESCRIPTION APPROVED DATE
— 2 PRODUCTION GORAN P. 08-12-10
CUSTOMER NOTICE
LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.
APPROVALS
PCB DES. A.K
APP ENG. GORAN P.
SCALE = NONE
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LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
HIGH CURRENT SINGLE OUTPUT
SYNCHRONOUS STEP-UP SUPPLY
SIZE IC NO.
N/A
LTC3786EMSE
DEMO CIRCUIT 1641A
REV. 2
DATE: Wednesday, August 25, 2010
SHEET 1 OF 1
NOTE: UNLESS OTHERWISE SPECIFIED
* - FOR VIN < VOUT ONLY. VOUT FOLLOWS VIN WHEN VIN >/= VOUT
# - SURGE VOLTAGE UP TO 36V
** A - CONNECT TO RSNS1 KELVIN SENSE FOR SNS+/-
1. ALL RESISTORS ARE IN OHMS, 0603.
2. ALL CAPACITORS ARE IN MICROFARADS, 0603.
3. INSTALL SHUNTS AS SHOWN.
U1
LTC3786EMSE
Q1 BSC027N04
Q2 OPT
Q3 OPT
Q4 BSC027N04
L1 3.3uH PA1494.362NL
D1 BAS140W
J1 VOUT 24V / 3 - 5A
J2 GND
J3 VIN 4 - 24V #
J4 GND
E1 VOUT+
E2 VOUT-
E3 VIN+
E4 VIN+
COUT5 150uF 35V 35HVH150M
CIN1 150uF 35V 35HVH150M
RSNS1 0.005
RSNS2 0.005
R1 100K
R2 0
R3 OPT
R4 16.9K
R5 10
R6 0
R7 OPT
R8 OPT
R9 10
R10 232K
R11 OPT
R12 12.1K
R13 0
R14 10K
R15 TBD
R16 0
R17 10K
R18 0
R19 38.3K
R20 12.1K
C1 OPT
C2 100pF
C3 15nF
C4 0.1uF
C5 1000pF
C7 0.1uF
C8 4.7uF 0805
C15 0.1uF
C17 OPT
C19 1000pF
JP1 MODE FCC PULSE SKIP BURST MODE
JP2 RUN ON OFF
JP3 VBIAS VOUT VIN
PGOOD
SS
CLKIN
RUN
GND