DESCRIPTION

Demonstration Circuit 725 is a 7A high efficiency, phase lockable constant frequency buck converter, incorporating the LTC3415 polyphase monolithic synchronous regulator. The DC725 has an input voltage range of 2.375V to 5.5V and an output voltage range from 0.6V to 5V. The reference voltage of 0.6V is +/-1% accurate, producing a more precise output voltage. The operating frequency range of the DC725 is either set by the LTC3415 internal oscillator to 1.5 MHz, set to 1 MHz or 2 MHz by forcing the PLLPF pin to ground or Vin, respectively, or synchronized to an external clock, with a range between 750 kHz and 2.25 MHz. The DC725 can deliver high power for a monolithic part – up to 7A of output current – due to the high current power switches (28 mΩ of on-state resistance) of the LTC3415. The LTC3415 also incorporates OPTI-LOOP compensation, so that the DC725 can be optimized with external components to provide fast transient response over a wide range of line and load conditions. However, the LTC3415 has internal compensation for those requiring a simple high power supply only. The LTC3415 can also do polyphase operation, which allows multiple DC725s to be used in parallel for higher current power supplies. Since the parallel LTC3415s can operate out-of-phase, the amount of input and output capacitance required will be minimal. The DC725 offers the three standard modes of operation: force continuous, pulse-skipping, and Burst-Mode™, for those circuits that operate during intervals of low output power. Extra features include tracking, for easy power supply sequencing, output margining, power good, and spread spectrum operation, which significantly reduces the peak switching noise emitted from the DC725. All these features make the DC725 perfectly suited for high current, high power applications, such as notebook or desktop computers.

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

TM - Burst Mode is a trademark of Linear Technology Corporation

Table 1.

Performance Summary (T_A = 25°C)

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage		2.375V
Maximum Input Voltage		5.5V
Output Voltage V_{OUT} Regulation	V_{IN} = 2.375V to 5.5V, I_{OUT} = 0A to 7A	1.2V ±3% (1.164V to 1.236V) 1.5V ±3% (1.455V to 1.545V) 1.8V ±3% (1.746V to 1.854V)
Typical Output Ripple V_{OUT}	V_{IN} = 5V, I_{OUT} = 7A (20 MHz BW)	<20mV_{P-P}
Operation Modes	Burst Mode - V_{IN} = 3.3V, V_{OUT} = 1.8V	<1.6A ±0.1A%
	Pulse-Skipping - V_{IN} = 3.3V, V_{OUT} = 1.8V	<1.5A ±0.1A%
	Forced Continuous	Any Output Current
Nominal Switching Frequency		1.5 MHz

QUICK START PROCEDURE

Demonstration Circuit 725 is easy to set up to evaluate the performance of the LTC3415. For proper measurement equipment configuration, set up the circuit according to the diagram in **Figure 1**. Before proceeding to test, make sure the jumper shunts are in the appropriate header according to the legend in **Figure 1**, except for one exception: insert jumper JP5 shunt into the off (upper) position, which connects the RUN pin to ground (GND), and thus, shuts down the circuit.

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the Vin or Vout and GND terminals. See **Figure 2** for proper scope probe technique.

1. With the DC725 set up according to the proper measurement and equipment in **Figure 1**, apply 3.3V at Vin (Do not hot-plug Vin or increase Vin over the rated maximum supply voltage of 5.5V, or the part may be damaged.). Measure Vout; it should read 0V. If desired, one can measure the shutdown supply current at this point. The supply current will be approximately 10 uA, or less, in shutdown.
2. Turn on the circuit by inserting the shunt in header JP5 into the ON (lower) position. The output voltage should be regulating. Measure Vout - it should measure 1.2V +/- 1.5% (1.182V to 1.218V).

3. Vary the input voltage from 2.375V to 5.5V and adjust the load current from 0 to 7A. Vout should read between 1.2V +/- 3% (1.164V to 1.236V).
4. Measure the output ripple voltage at any output current level; it usually will measure less than 20 mVAC.
5. Observe the voltage waveform at the switch node. Verify the switching frequency is between 1.3 MHz and 1.7 MHz (T = 0.769 us and 0.588 us), and that the switch node waveform is rectangular in shape.

Insert jumper JP5 shunt into the OFF position and move the 1.2V Vout shunt into any of the remaining output voltage options: 1.5V or 1.8V. Just as in the 1.2Vout test, the output voltage should read Vout +/- 1.5% tolerance under static line and load conditions, and another +/- 1.5% tolerance under dynamic line and load conditions (+/- 3% total).

The Burst-Mode™ or pulse-skipping operation modes of the LTC3415 can also be observed now by changing the position of the shunt in header JP7. 1 or 2 MHz operating frequencies can be activated by re-positioning the JP6 shunt. The tables below show the extra features, such as margining and spread spectrum.

When finished, turn off the circuit (connecting the RUN pin to ground) by inserting the shunt in header JP5 into the OFF (upper) position.

PARAMETER	CONDITIONS	VALUE
CLOCKOUT	PHMODE Pin Pulled to V_{IN} - V_{IN} = 3.3V, V_{OUT} = 1.8V	1.5 MHz
CLOCKIN	CLOCKIN Pin Connected to V_{IN} - V_{IN} = 3.3V, V_{OUT} = 1.8V	Spread Spectrum (See Photo)
	Synchronized to 2Vpk-to-pk, 2 MHZ signal injected into the PLLPF pin - V_{IN} = 3.3V, V_{OUT} = 1.8V	2 MHZ (Measured at SW & CLOCKOUT Pins)

PARAMETER	CONDITIONS	POSITION MGN	POSITION BSEL	VALUE
Margining	V_{IN} = 3.3V, V_{OUT} = 1.8V, I_{OUT} = 5A	MGN+	5%	1.89V ±4% (1.814V to 1.966V)
			10%	1.98V ±4% (1.900V to 2.060V)
			15%	2.07V ±4% (1.987V to 2.153V)
		MGN-	5%	1.71V ±4% (1.641V to 1.779V)
			10%	1.62V ±4% (1.555V to 1.685V)
			15%	1.53V ±4% (1.468V to 1.592V)

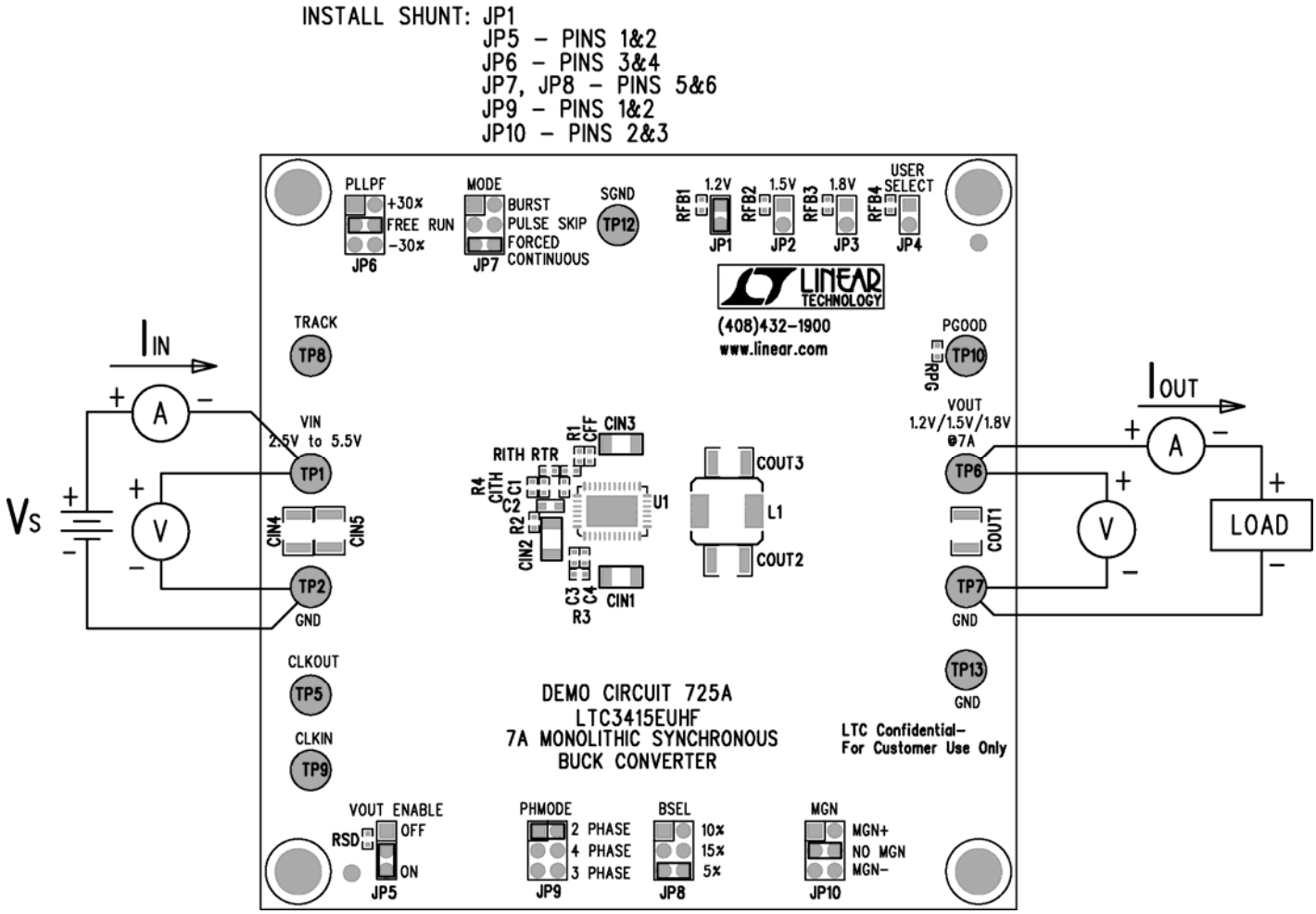


Figure 1. Proper Measurement Equipment Setup

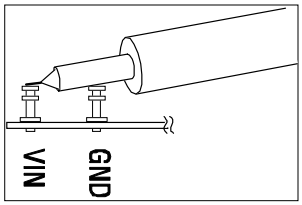


Figure 2. Measuring Input or Output Ripple

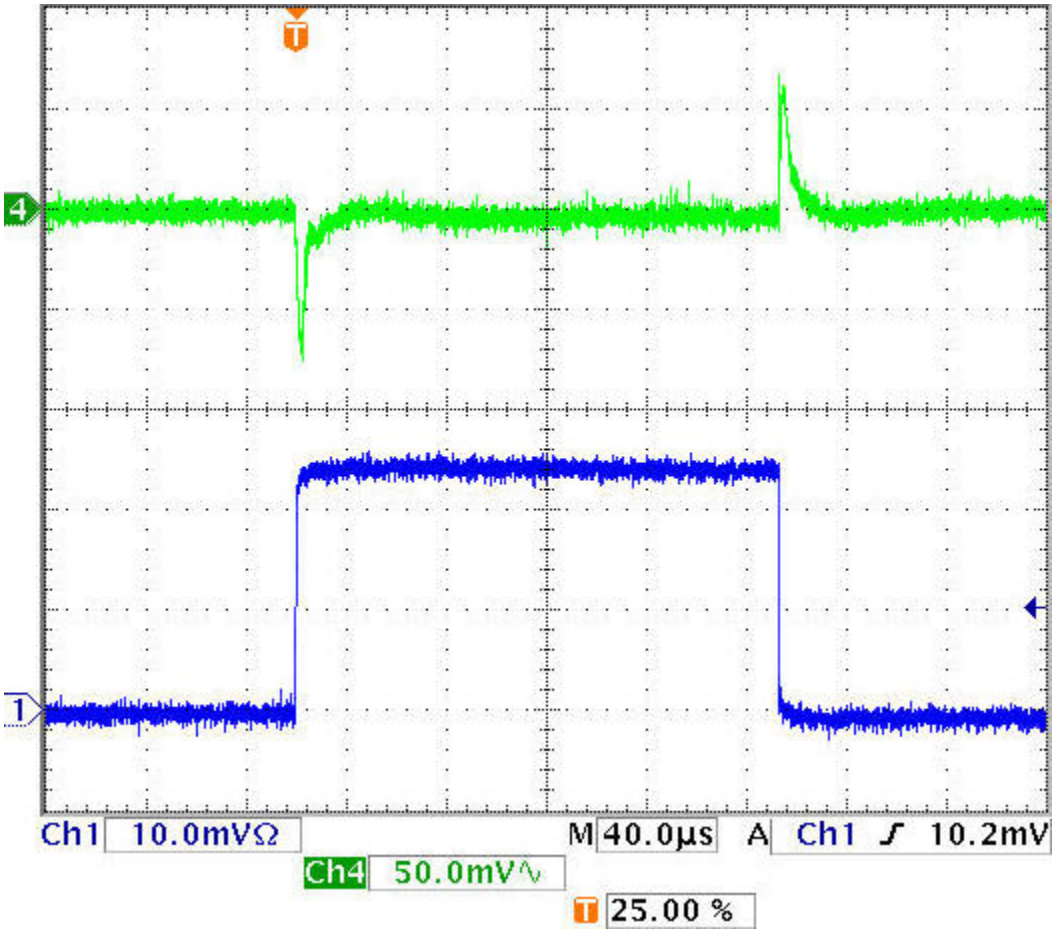


Figure 3. Load Step Response
V_{IN} = 3.3V, V_{OUT} = 1.8V & 5A Load Step
Trace 1: Output Voltage (100mV/div AC)
Trace 2: Output Current (2A/div)

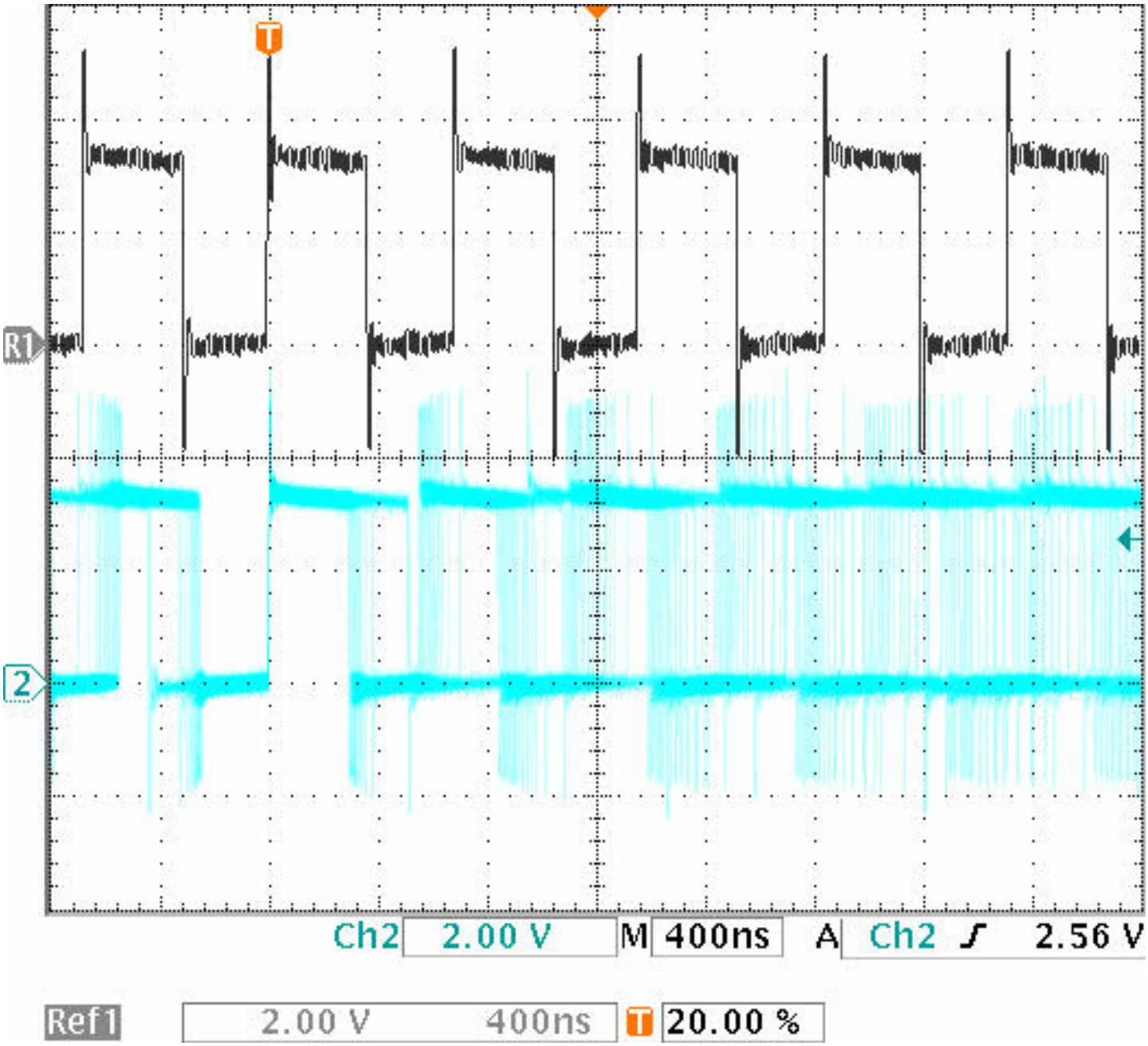
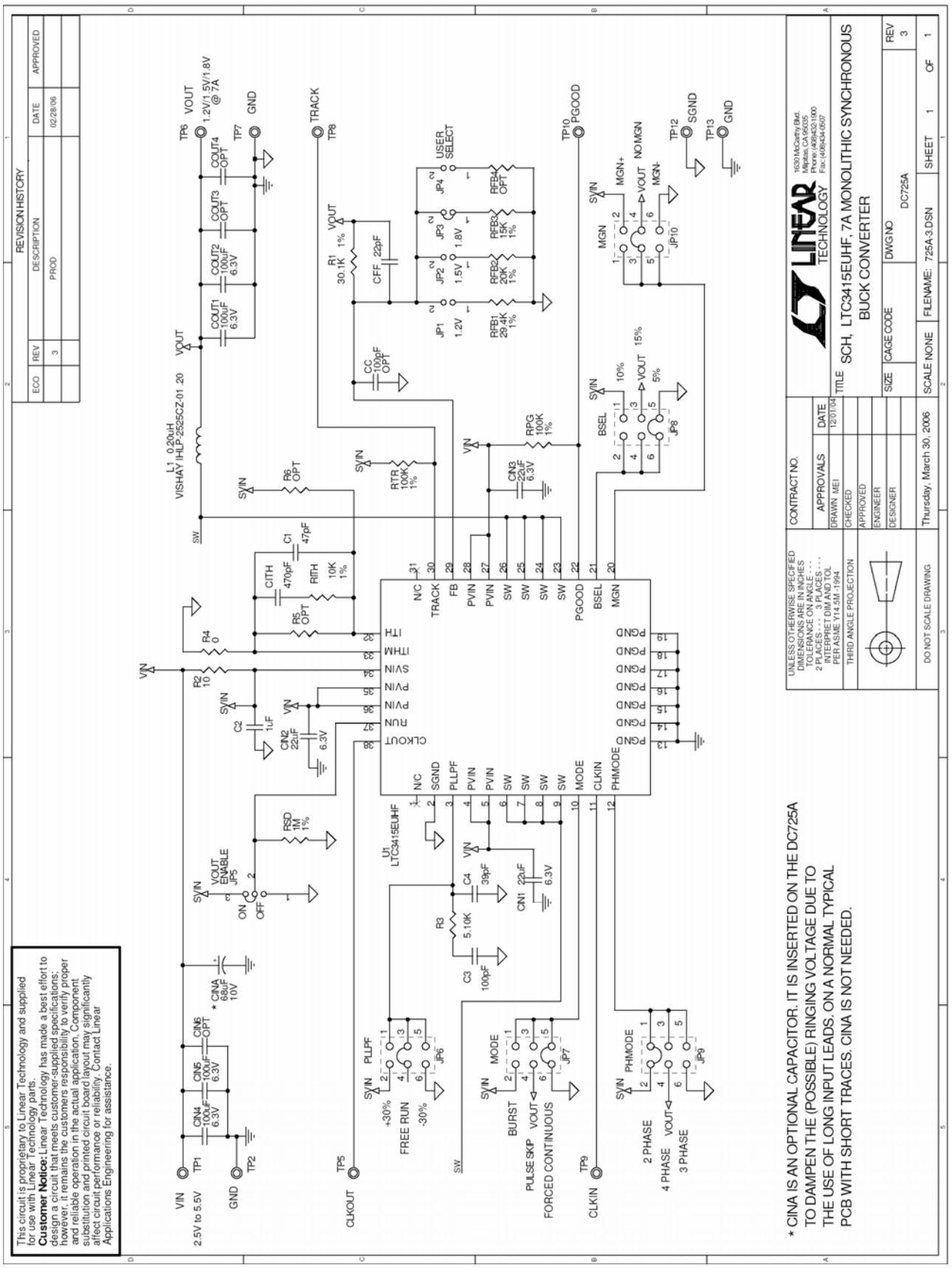


Figure 4. Normal Switching Operation vs. Spread Spectrum Operation

V_{IN} – 3.3V, V_{OUT} – 1.8V, I_{OUT} – 5A


REVISION HISTORY
ECO REV DESCRIPTION DATE APPROVED
3 PROD 02/28/06
This circuit is proprietary to Linear Technology and supplied for use with Linear Technology parts.
Customer Notice: Linear Technology has made a best effort to design a circuit that meets customer-supplied specifications; however, it remains the customers 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 Applications Engineering for assistance.
U1 LTC3415EUHF
L1 0.20uH VISHAY IHLP-2525CZ-01 20
VIN 2.5V to 5.5V
VOUT 1.2V/1.5V/1.8V @ 7A
GND
CLKOUT
CLKIN
SW
TRACK
PGOOD
SGND
* CINA 68uF 10V
CIN1 22uF 6.3V
CIN2 22uF 6.3V
CIN3 22uF 6.3V
CIN4 100uF 6.3V
CIN5 100uF 6.3V
CIN6 OPT
COUT1 100uF 6.3V
COUT2 100uF 6.3V
COUT3 OPT
COUT4 OPT
C1 47pF
C2 1uF
C3 100pF
C4 39pF
CC 100pF OPT
CFF 22pF
CITH 470pF
RITH 10K 1%
R1 30.1K 1%
R2 10
R3 5.10K
R4 0
R5 OPT
R6 OPT
RSD 1M 1%
RTR 100K 1%
RPG 100K 1%
RFB1 29.4K 1%
RFB2 20K 1%
RFB3 15K 1%
RFB4 OPT
VOUT ENABLE JP5
ON OFF
PLLPF JP6
+30% FREE RUN -30%
MODE JP7
BURST PULSE SKIP FORCED CONTINUOUS
PHMODE JP9
2 PHASE 4 PHASE 3 PHASE
JP1 1.2V
JP2 1.5V
JP3 1.8V
JP4 USER SELECT
BSEL JP8
10% 15% 5%
MGN JP10
MGN+ VOUT MGN- NO MGN
TP1 TP2 TP5 TP6 TP7 TP8 TP9 TP10 TP12 TP13
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON ANGLE - - - 2 PLACES - - - 3 PLACES - - - INTERPRET DIM AND TOL PER ASME Y14.5M -1994
THIRD ANGLE PROJECTION
CONTRACT NO.
APPROVALS DATE
DRAWN MEI 12/07/04
CHECKED
APPROVED
ENGINEER
DESIGNER
DO NOT SCALE DRAWING
LINEAR TECHNOLOGY
1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408)432-1900 Fax: (408)434-0507
TITLE SCH, LTC3415EUHF, 7A MONOLITHIC SYNCHRONOUS BUCK CONVERTER
SIZE CAGE CODE DWG NO DC725A REV 3
SCALE NONE FILENAME: 725A-3.DSN SHEET 1 OF 1
Thursday, March 30, 2006
* CINA IS AN OPTIONAL CAPACITOR. IT IS INSERTED ON THE DC725A TO DAMPEN THE (POSSIBLE) RINGING VOLTAGE DUE TO THE USE OF LONG INPUT LEADS. ON A NORMAL TYPICAL PCB WITH SHORT TRACES. CINA IS NOT NEEDED.