## 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$^{TM}$, 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)<br>1.5V ±3% (1.455V to 1.545V)<br>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) |

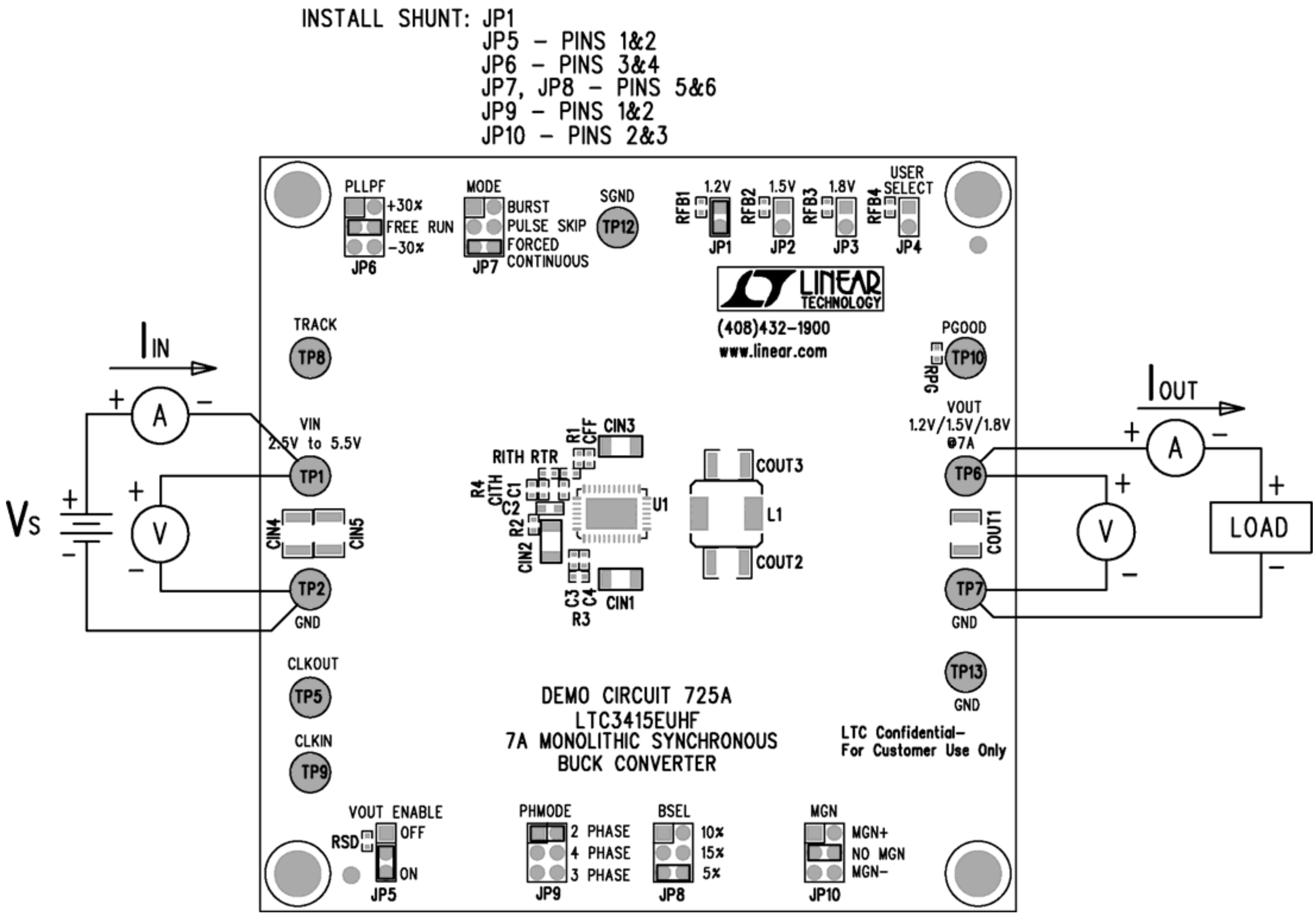



**Figure 1. Proper Measurement Equipment Setup**

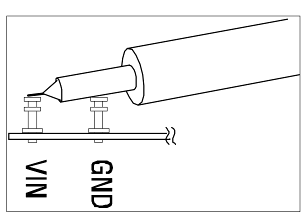



**Figure 2. Measuring Input or Output Ripple**

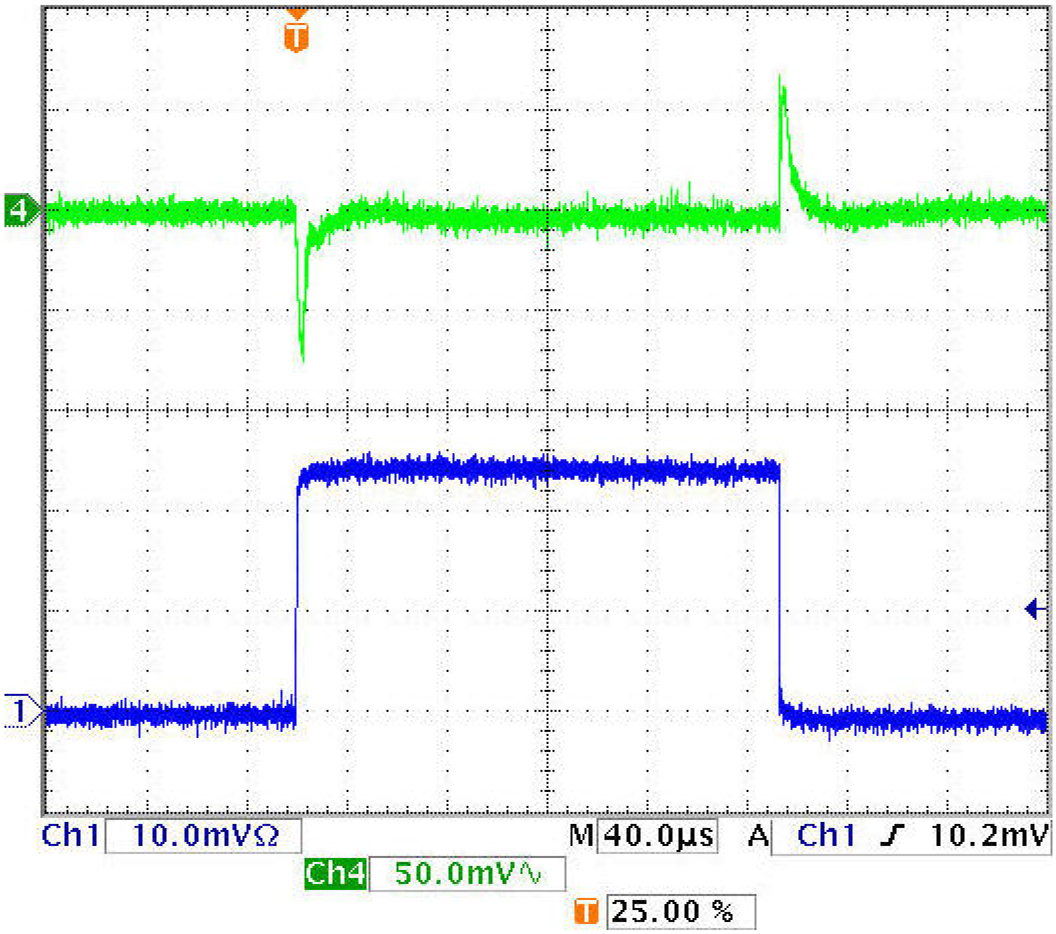



**Figure 3. Load Step Response**
**$V_{IN}$ = 3.3V, $V_{OUT}$ = 1.8V & 5A Load Step**
**Trace 1: Output Voltage (100mV/div AC)**
**Trace 2: Output Current (2A/div)**

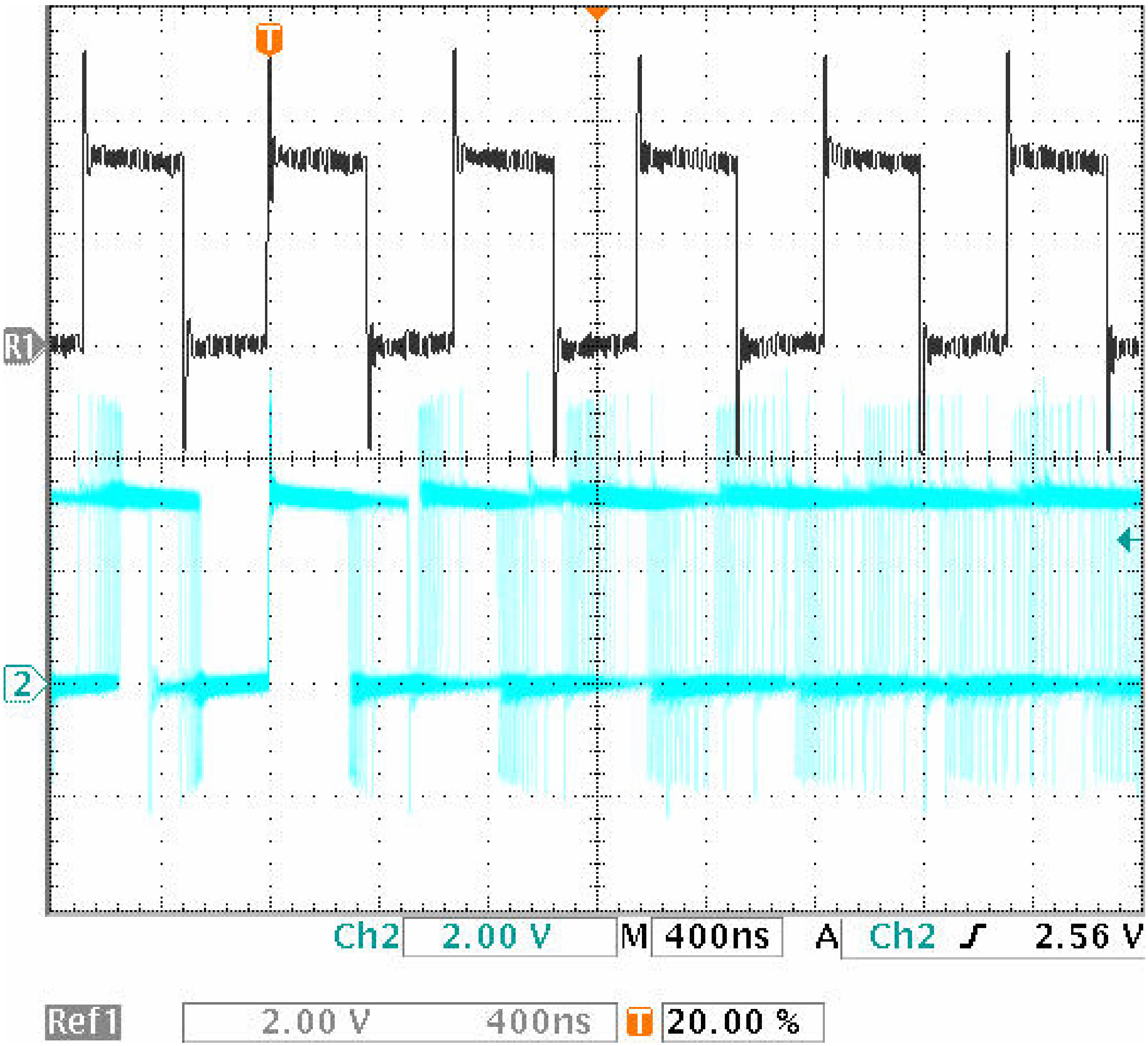
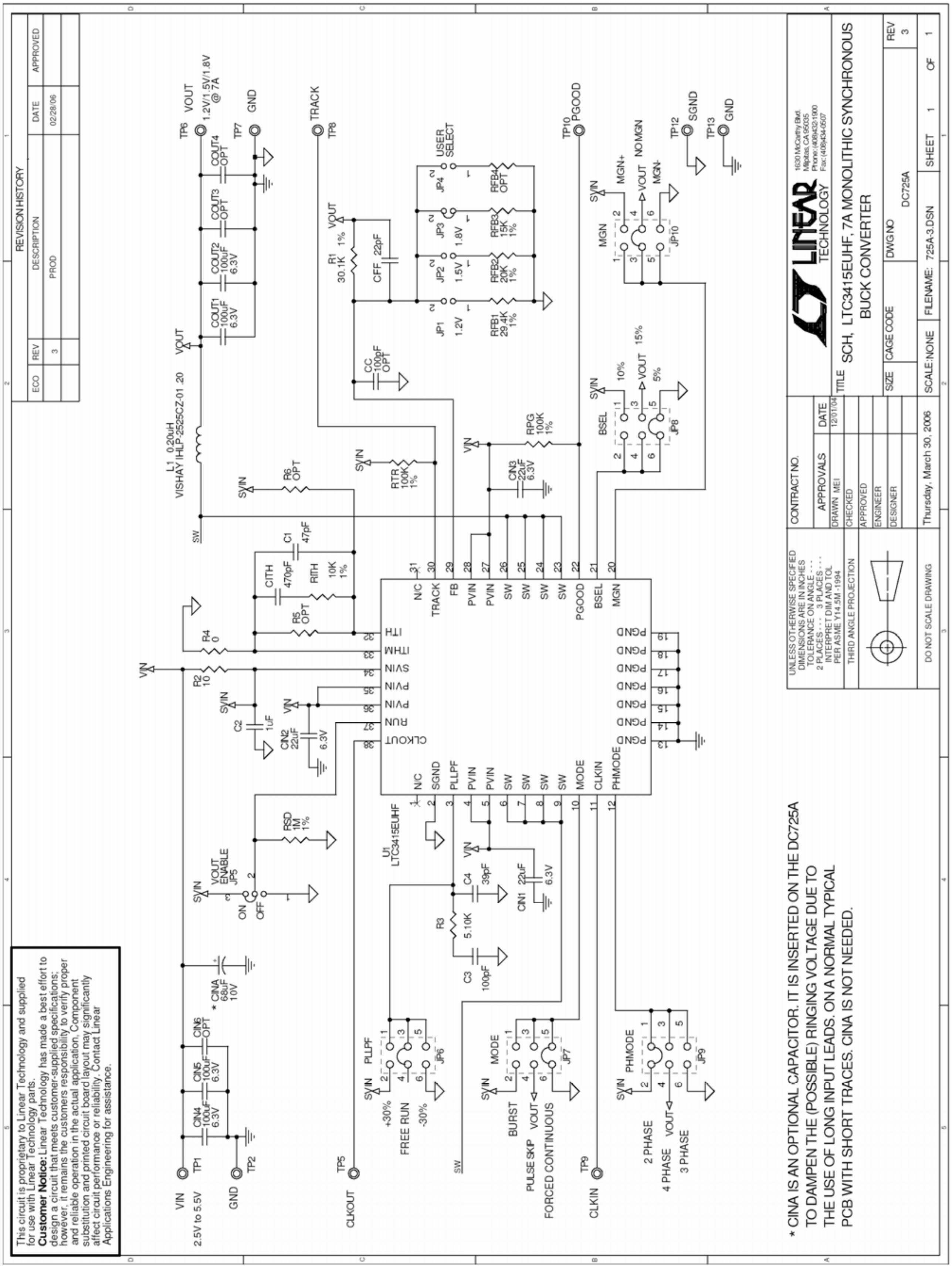



**Figure 4. Normal Switching Operation vs. Spread Spectrum Operation**

**$V_{IN}$ – 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.
VIN
2.5V to 5.5V
GND
CLKOUT
CLKIN
VOUT
1.2V/1.5V/1.8V
@ 7A
TRACK
PGOOD
SGND
U1
LTC3415EUHF
L1 0.20uH
VISHAY IHLP-2525CZ-01 .20
* 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.
LINEAR TECHNOLOGY
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
TITLE
SCH, LTC3415EUHF, 7A MONOLITHIC SYNCHRONOUS BUCK CONVERTER
DWG NO
DC725A
REV
3
FILENAME: 725A-3.DSN
SHEET 1 OF 1
Thursday, March 30, 2006
DO NOT SCALE DRAWING