

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 524

## POSITIVE INPUT TO NEGATIVE OUTPUT DC/DC CONVERTER

LTC3704

### DESCRIPTION

Demonstration circuit 524 is a positive input to negative output converter featuring the LTC3704 switching controller. The DC524 converts a 5V–15V input to a –5.2V output and provides up to 2.5A of output current from 5V input. The converter operates at 300kHz with a high efficiency of 89%. The DC524 is set to operate in No  $R_{SENSE}$ ™ mode with input voltages up to 15V. However, DC524 can be modified for higher input voltages with an optional current sense resistor. The circuit features optional soft-start circuitry that can be enabled or disabled with a single jumper. Also, DC524 has a jumper to program either continuous or Burst Mode™ operation. The DC524 can be synchronized to an external clock of up to

400kHz. Please refer to LTC3704 data sheet for design details and applications information.

The DC524 can produce up to 3A from a 5V input source, 4A from 10V source and 5A from 15V source. The actual current capability also depends on the operating temperature and available airflow. As MOSFET Q1 gets hot, its  $R_{DS(ON)}$  increases and the available output current decreases.

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

Burst Mode is a registered trademark and No  $R_{SENSE}$  is a trademark of Linear Technology Corporation

**Table 1. Performance Summary**

| PARAMETER                       | CONDITION                                     | VALUE                                   |
|---------------------------------|-----------------------------------------------|-----------------------------------------|
| Minimum Input Voltage           |                                               | 4.5V                                    |
| Maximum Input Voltage           | No $R_{SENSE}$ mode                           | 18V (or higher with some modifications) |
| $V_{OUT}$                       | $V_{IN} = 5V$ to 15V, $I_{OUT1} = 0A$ to 2.5A | –5.2V $\pm 3\%$                         |
| Typical Output Ripple $V_{OUT}$ | $V_{IN} = 5V$ to 15V, $I_{OUT1} = 0A$ to 2.5  | 50mV <sub>P-P</sub>                     |
| Nominal Switching Frequency     |                                               | 300kHz                                  |

### QUICK START PROCEDURE

Demonstration circuit 524 is easy to set up to evaluate the performance of the LTC3704. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

**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  $V_{IN}$  or  $V_{OUT}$  and GND terminals. See Figure 2 for proper scope probe technique.

1. Place jumper JP1 in the ENABLE position.
2. With power off, connect the input power supply to  $V_{IN}$  and GND. Make sure that the input power supply has

sufficient current rating at minimum input voltage for the required output load.

3. Turn on the power at the input.

**NOTE:** Make sure that the input voltage does not exceed 15V.

4. Check for the proper output voltage:  $V_{out} = -5.2V$

**NOTE:** 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 within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

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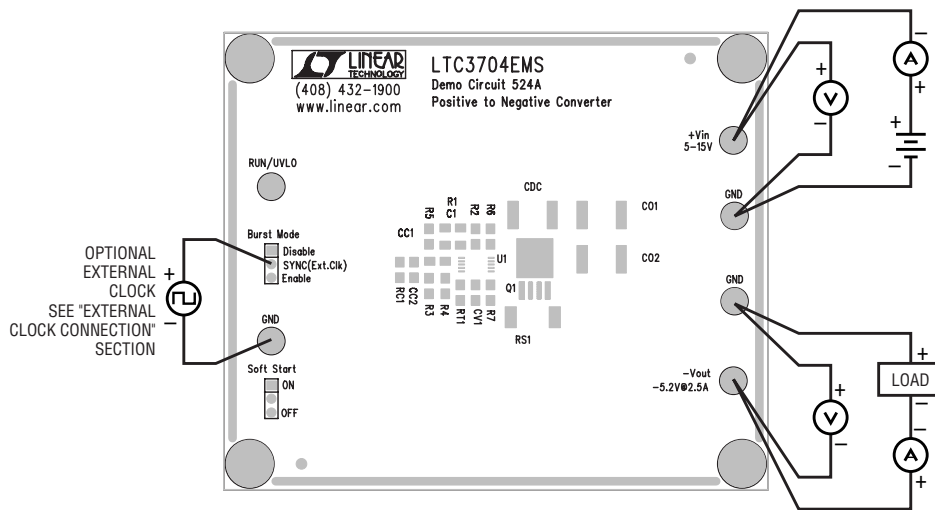


Figure 1. Proper Measurement Equipment Setup

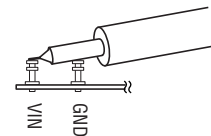


Figure 2. Scope Probe Placement for Measuring Input or Output Ripple

### CONNECTING AN EXTERNAL CLOCK

1. Turn the input power source Off.
2. Remove the Burst Mode jumper.
3. Set the clock source pulse amplitude to 5V and set the frequency between 330 kHz and 400kHz.
4. Turn the clock source off.
5. Connect the clock source (pulse generator with TTL output) to the middle pin of Burst Mode jumper.
6. Apply input power and observe the switching frequency of 300kHz.
7. Turn the clock source on and observe the switching frequency go up to the switching frequency of the external clock.

### USING AN OPTIONAL CURRENT SENSE RESISTOR

1. Refer to LTC3704 data sheet to determine the proper resistor value.
2. Replace current sense resistor Rs1 with the correct value.

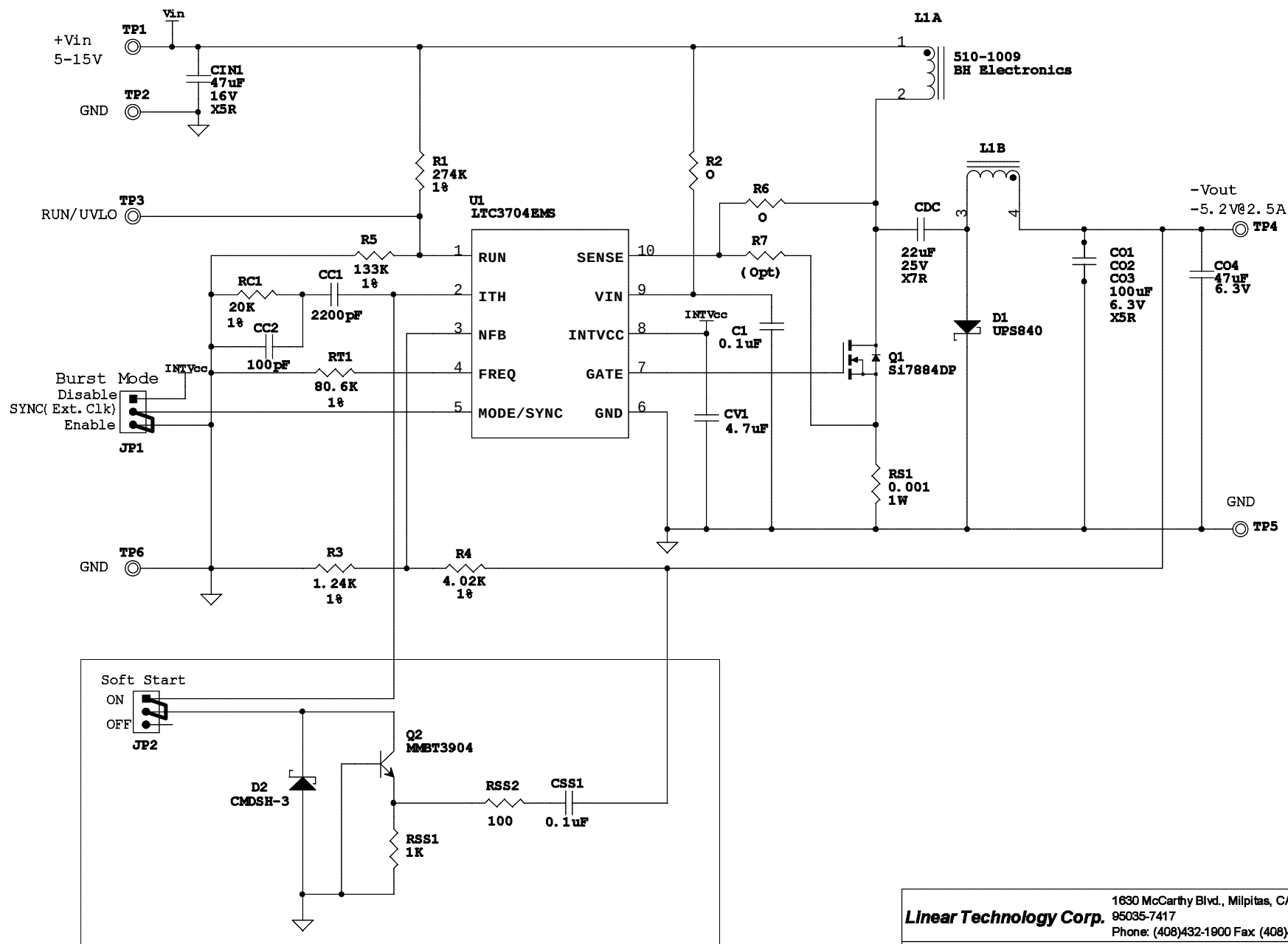
3. Remove resistor R6.

4. Install 0 $\Omega$  resistor R7.

### MONITORING THE MOSFET CURRENT

Monitor the MOSFET current through the Rs1 resistor.

1. Connect a 50 $\Omega$  coaxial cable across Rs1 with the shield connected to the ground connection of Rs1.
2. Use a 50 $\Omega$  surface mount resistor to connect the center conductor of the coaxial cable to the Rs1 terminal which is connected to the source of MOSFET Q1.
3. Set the scope input to 50 $\Omega$  and connect the coaxial cable to the scope.
4. Set the scope to 5mV/division or less. The current scale with 1m $\Omega$  Rs1 and 5mV/div is 10A/div (50 $\Omega$  resistor at the input of coaxial cable forms 2:1 divider with 50 $\Omega$  input impedance of scope).



|                                                                                                                           |                                                   |                        |
|---------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------------|
| <b>Linear Technology Corp.</b> 1630 McCarthy Blvd., Milpitas, CA<br>95035-7417<br>Phone: (408)432-1900 Fax: (408)434-0507 |                                                   |                        |
| <b>Title</b> LTC3704EMS ( Positive to Negative Converter)                                                                 |                                                   |                        |
| <b>Size</b>                                                                                                               | <b>Document Number</b><br><b>Demo Circuit 524</b> | <b>Rev</b><br><b>A</b> |
| <b>Date</b> Thursday, December 19, 2002 <b>Sheet</b> 1 <b>of</b> 1                                                        |                                                   |                        |

6/17/2005

| Item | Qty | Reference   | Part Description                | Manufacture / Part #            |
|------|-----|-------------|---------------------------------|---------------------------------|
|      |     |             |                                 |                                 |
| 1    | 1   | CC1         | CAP., X7R 2200pF 50V 10%        | AVX 08055C222KAT1A              |
| 2    | 1   | CC2         | CAP., NP0, 100PF, 50V, 10%      | AVX 08055A101KAT1A              |
| 3    | 1   | CDC         | CAP., X7R 22uF 25V 20%          | TDK C5750X7R1E226M              |
| 4    | 1   | CIN1        | CAP., X5R 47uF 16V 20%          | TDK C5750X5R1C476MT             |
| 5    | 3   | C01,C02,C03 | CAP., X5R 100uF 6.3V 20%        | Taiyo Yuden JMK432BJ107MU       |
| 6    | 1   | C04         | CAP., X5R 47uF 6.3V 20%         | TDK C4532X5R0J476M              |
| 7    | 1   | CSS1        | CAP., X7R, 0.1uF, 16V, 10%      | AVX 0805YC104KAT2A              |
| 8    | 1   | CV1         | CAP., Y5V 4.7uF 10V 80%         | AVX 0805ZG475ZAT1A              |
| 9    | 1   | C1          | CAP., X7R 0.1uF 25V 10%         | AVX 08053C104KAT2A              |
| 10   | 1   | D1          | Schottky Rect., 40V/8Amp        | Microsemi UPS840                |
| 11   | 1   | D2          | Schottky Diode, Super-Mini      | Central Semi. Corp. CMDSH-3-LTC |
| 12   | 2   | JP1,JP2     | Headers, 3 Pins 2mm Ctrs.       | CommConn Con Inc. 2802S-03G2    |
| 13   | 2   | XJP1,XJP2   | Shunt, 2 Pins 2mm Ctrs.         | CommConn Con Inc. CCIJ2MM-138G  |
| 14   | 1   | L1          | Dual Inductor, QTR-Pak          | BH Electronics 510-1009         |
| 15   | 1   | Q1          | Mosfet N-Chan., PowerPAK SO-8   | Vishay Siliconix Si7884DP       |
| 16   | 1   | Q2          | XSTR, NPN Small Sig.            | Diodes Inc. MMBT3904-7          |
| 17   | 1   | RC1         | RES., Chip 20K 0.1W 1%          | AAC CR10-2002FM                 |
| 18   | 1   | RSS1        | RES., Chip 1K 0.1W 5%           | AAC CR10-102JM                  |
| 19   | 1   | RSS2        | RES., Chip 100 Ohms 0.1W 5%     | AAC CR10-101JM                  |
| 20   | 1   | RS1         | RES., Chip 0.001 1W 5%          | Panasonic ERJM1WTJ1M0U          |
| 21   | 1   | RT1         | RES., Chip 80.6K 0.1W 1%        | AAC CR10-8062FM                 |
| 22   | 1   | R1          | RES., Chip 274K 0.1W 1%         | AAC CR10-2743FM                 |
| 23   | 2   | R6,R2       | Jumper, Chip 0 0.1W 5%          | AAC CJ10-000M                   |
| 24   | 1   | R3          | RES., CHIP, 1.24K, 0.1W, 1%     | AAC CR10-1241FM                 |
| 25   | 1   | R4          | RES., CHIP, 4.02K, 0.1W, 1%     | AAC CR10-4021FM                 |
| 26   | 1   | R5          | RES., Chip 133K 0.1W 1%         | AAC CR10-1333FM                 |
| 27   | 0   | R7 (OPT)    | Jumper, Chip 0 0.1W 5%          | AAC CJ10-000M                   |
| 28   | 6   | TP1-TP6     | Turret, Testpoint               | Mill Max 2501-2                 |
| 29   | 1   | U1          | I.C., NoRsense DC/DC Controller | Linear Tech. Corp. LTC3704EMS   |
| 30   | 4   |             | SCREW, #4-40, 1/4"              | ANY                             |
| 31   | 4   |             | STANDOFF, #4-40 1/2"            | MICRO PLASTICS 14HTSP003        |
| 32   | 1   |             | PRINTED CIRCUIT BOARD           | DEMO CIRCUIT 524A               |
| 33   | 2   |             | STENCIL                         | STENCIL 524A                    |