## DESCRIPTION

Demonstration circuit 519 is a 1.1MHz dual step-down DC/DC switching converter using the LT1940. The LT1940 features fast switching speed, two 1.6A internal power switches, and a wide input voltage range, making it a versatile and powerful IC that fits easily into space-constrained applications and removes the need for two separate dc/dc converters in dual output step-down applications. The constant 1.1MHz switching frequency allows for the use of tiny, surface mount external components. The current-mode control topology yields fast transient response and good loop stability, requiring a minimum number of external compensation components and allowing the use of ceramic input and output capacitors. The anti-phase switching and single-IC solution require the use of only a single input capacitor. The low resistance internal 2A power switches  $(0.21\Omega)$  maintain high efficiencies (as high as 90%) over a wide range of input voltages and loads. Its 30µA shutdown current (activated via the Run/SS pins) extends battery life. The wide VIN range of the LT1940 allows step-down configurations with up to 25V input.

The demonstration board has two circuits to demonstrate both the small space that the monolithic dual step-down converter can achieve with high currents and a single IC as well as the versatility and maximum power output of the IC. The circuit demonstrating smallest size generates 3.3V at up to 1A and 1.8V at up to 1A output from a 4.8V–14V input. The larger, more versatile circuit generates 5V at up to 1.4A and 3.3V at up to 1.4A output from a separate 6.8V to 25V input. The two circuits are completely isolated from each other and can be run simultaneously or independently. The versatile circuit has options for changing the boost diodes for highest efficiency under different output voltage conditions. The feedforward capacitors and noise-reduction capacitors on the Vc pins further increase the parts count on the versatile board, yet they improve the transient response and give the ability to optimize loop compensation under various conditions.

LT1940

This board is designed for applications that require two step-down supplies with up to 1.4A load current in a small board space with low cost and low parts count as well as simple circuit design. The high current, onboard, dual monolithic switches eliminate the need for external switches. The use of ceramic capacitors in this circuit not only demonstrates small size and low cost, but the advantage of current-mode control in step-down applications with a simple compensation network and a feedforward capacitor for more rugged stability and excellent transient response.

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

| PARAMETER                      | VALUE   |
|--------------------------------|---|
| V <sub>IN</sub>                | 4.8V to 14V   |
| VOUT1                          | 3.3V  |
| V <sub>OUT2</sub>              | 1.8V  |
| V <sub>OUT1</sub> Load Current | 1A(max)   |
| V <sub>OUT2</sub> Load Current | 1A(max)   |
| Efficiency                     | 80% at 1A load current (V <sub>OUT1</sub> and V <sub>OUT2</sub> ) |

Table 1. Typical Performance ( $T_A = 25^{\circ}C$ ) for Small Dual Step-Down Converter (VOUT1=3.3V and VOUT2=1.8V)

#### QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 519 1.1MHZ DUAL STEP-DOWN DC/DC CONVERTER

| Parameter          | Value                                    |
|--------------------|--|
| V <sub>IN</sub>    | 6.8V to 25V                              |
| VOUT1              | 5.0V                                     |
| VOUT2              | 3.3V                                     |
| VOUT1 Load Current | 1.4A(max)                                |
| VOUT2 Load Current | 1.4A(max)                                |
| Efficiency         | 84% at 1A load current (VOUT1 and VOUT2) |

Table 2. Typical Performance (T<sub>A</sub> = 25°C) for Customizable Dual Step-Down Converter (VOUT1=5.0V and VOUT2=3.3V)











Figure 3. Typical Efficiency of Demo Circuit 519 LT1940, Customizable Dual Step-Down VOUT1=5.0V, VOUT2=3.3V



Figure 4. Typical Efficiency of Demo Circuit 519 LT1940, Customizable Dual Step-Down VOUT1=5.0V, VOUT2=3.3V

## **QUICK START PROCEDURE**

Demonstration circuit 519 is easy to set up to evaluate the performance of the LT1940. Refer to Figure 5 for proper measurement equipment setup and follow the procedure below:

- 1. Connect the 4.8V–14V or 6.8V–25V input power supply to the VIN and GND terminals on the board corresponding to the small, top circuit or the larger, customizable, bottom circuit. Each circuit is powered separately from its own VIN and GND terminals.
- 2. After all connections are made, turn on input power and verify that the output voltage is either 3.3V and 1.8V (small, top circuit) or 5V and 3.3V (larger, bottom circuit) for the circuit to which the input supply is connected.
- 3. The Run/SS and Power Good functions are optional and their terminals can be left floating (disconnected) if their functions are not being used. Connecting a Run/SS terminal to the GND terminal will disable the corresponding output.



Figure 5. Proper Measurement Equipment Setup

#### **CUSTOMIZING THE BOARD**

The components used in the demonstration circuits are optimized for wide input voltage ranges. Nevertheless, the bandwidths can be increased for more specific input voltages, such as 12V±10% or 5V±10%, by changing the V<sub>C</sub> components, the noise filter caps, the feedforward caps, and the output capacitors. The adjustable feedback resistors allow the output voltages to be customized. The boost diodes D8 and D11 on the small circuit are the only boost diode options on that circuit for minimal space considerations. The anode of D8 is connected to Vout1 (3.3V). The anode of D11 is connected to Vin (4.8V to 14V) since Vout2 is 1.8V and is below 3.0V. The minimum boost voltage required for the internal power switch is 3.0V and that can usually be taken directly from a 3.3V output or greater. However, if the output voltage is below 3.3V, in order to maintain high efficiency, the boost diode should get its voltage from either the input (which is less efficient than a greater than 3.3V output) or another source such as the other output on the board (if it is greater than 3.3V). Since there is not space to make these changes in boost diode location on the small circuit, D8 and D11 should always be used (not customized) and Vout1 should always be 3.3V or greater and Vout 2 can be less than 3.3V. If Vout2 is 3.3V or greater, the small circuit, with D11 installed connecting to the input, will not be as efficient as it could be if D11 was instead connected to Vout2.

The larger, versatile circuit has pad placements built-in for customized output voltages of all acceptable levels. D1 and D3 are connected to Vout1 (5V) and Vout2 (3.3V) respectively since they are both 3.3V or greater and they provide enough boost to saturate the high-side NPN power switches. However, if either output voltage is customized to less than 3.3V, D1 can be removed and replaced by stuffing D2 with the same part. D3 can be removed and replaced by stuffing D4 with the same part. Both D2 and D4 connect the boost to Vin. Additionally, D5 provides a way to replace D3 with a boost diode that is connected to Vout1 in case Vout1 is 3.3V or greater and Vout2 is less than 3.3V.

Make sure that the boost capacitors (C27, C15, C1, C2) have voltage ratings greater than or equal to the output voltage for applications where the boost diode is connected to the output. However, the boost capacitor must have a voltage rating greater than the input voltage whenever the boost diode is connected to the input.









| ltem | Qty | Ref                       | Desc   | Part Number                 |
|------|-----|---------------------------|--|-----------------------------|
| 1    | 1   | CIN                       | CAP, X7R 4.7uF 25V 20% 1210                  | TDK C3225X7R1E475M          |
| 2    | 1   | CIN2                      | CAP, X5R 4.7uF 16V 10% 1206                  | TAIYO YUDEN EMK316BJ475KL   |
| 3    | 2   | Cff1,Cff2                 | CAP, NPO 62pF 25V 5% 0603                    | AVX 06033A620JAT            |
| 4    | 8   | C1,C2,C9,C12,C13,C15,C22, | CAP, X7R 0.1uF 16V 10% 0603                  | AVX 0603YC104KAT            |
|      |     | C27                       |  |                             |
| 5    | 2   | C4,C3                     | CAP, X5R 10uF 6.3V 20% 1206                  | TAIYO YUDEN JMK316BJ106ML-T |
| 6    | 2   | C5,C7                     | CAP, X7R 1000pF 50V 5% 0603                  | AVX 06035C102JAT2A          |
| 7    | 2   | C6,C8                     | CAP, NPO 100pF 50V 5% 0603                   | AVX 06035A101JAT            |
| 8    | 0   | C10,C11,C23,C24           | CAP, X7R 0.1uF 16V 10% 0603                  | AVX 0603YC104KAT OPTION     |
| 9    | 1   | C16                       | CAP, X5R 10uF 6.3V 10% 0805                  | TDK C2012X5R0J106M          |
| 10   | 1   | C17                       | CAP, X5R 22uF 6.3V 10% 1210                  | TDK C3225X5R0J226M          |
| 11   | 1   | C18                       | CAP, X7R 1000pF 50V 5% 0402                  | AVX 04025C102JAT            |
| 12   | 1   | C20                       | CAP, X7R 1500pF 50V 5% 0402                  | AVX 04025C152KAT            |
| 13   | 2   | C26,C25                   | CAP, X5R 0.1uF 10V 10% 0402                  | AVX 0402ZD104KAT            |
| 14   | 4   | D1,D3,D8,D11              | DIODE, CMDSH-3 SOD323                        | CENTRAL CMDSH-3             |
| 15   | 0   | D2,D4,D5                  | DO NOT STUFF                                 | OPTION                      |
| 16   | 2   | D6,D7                     | DIODE, B130 SCHOTTKY RECTIFIER 1A            | DIODES INC. B130            |
| 17   | 2   | D14,D13                   | DIODE, SCHOTTKY RECTIFIER 1A UPS120          | MICROSEMI UPS120            |
| 18   | 1   | L1                        | IND, 5.3uH                                   | SUMIDA CDRH5D28-5R3         |
| 19   | 1   | L2                        | IND, 4.1uH                                   | SUMIDA CDRH5D18-4R1NC       |
| 20   | 1   | L3                        | IND, 2.7uH                                   | COILCRAFT 1008PS-272M       |
| 21   | 1   | L4                        | IND, 1.8uH                                   | COILCRAFT 1008PS-182M       |
| 22   | 2   | R1,R3                     | RES, 24.9k OHMS 1% 1/16W 0603                | AAC CR16-2492FM             |
| 23   | 1   | R2                        | RES, 78.7k OHMS 1% 1/16W 0603                | AAC CR16-7872FM             |
| 24   | 1   | R4                        | RES, 41.2k OHMS 1% 1/16W 0603                | AAC CR16-4122FM             |
| 25   | 2   | R6,R5                     | RES, 22K OHMS 5% 1/16W 0603                  | AAC CR16-223JM              |
| 26   | 2   | R7,R8                     | RES, 100K OHMS 5% 1/16W 0603                 | AAC CR16-104JM              |
| 27   | 2   | R11,R9                    | RES, 24.9k OHMS 1% 1/16W 0402                | AAC CR05-2492FM             |
| 28   | 1   | R10                       | RES, 41.2k OHMS 1% 1/16W 0402                | AAC CR05-4122FM             |
| 29   | 1   | R12                       | RES, 12.4k OHMS 1% 1/16W 0402                | AAC CR05-1242FM             |
| 30   | 2   | R13,R14                   | RES, 22K OHMS 5% 1/16W 0402                  | AAC CR05-223JM              |
| 31   | 2   | R15,R16                   | RES, 100K OHMS 5% 1/16W 0402                 | AAC CR05-104JM              |
| 32   | 20  | TP1-TP20                  | TURRETS                                      | MILL-MAX-2501-2             |
| 33   | 2   | U1,U2                     | IC, LT1940EFE DUAL STEP-DOWN DC/DC CONVERTER | LINEAR TECH LT1940EFE       |

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