

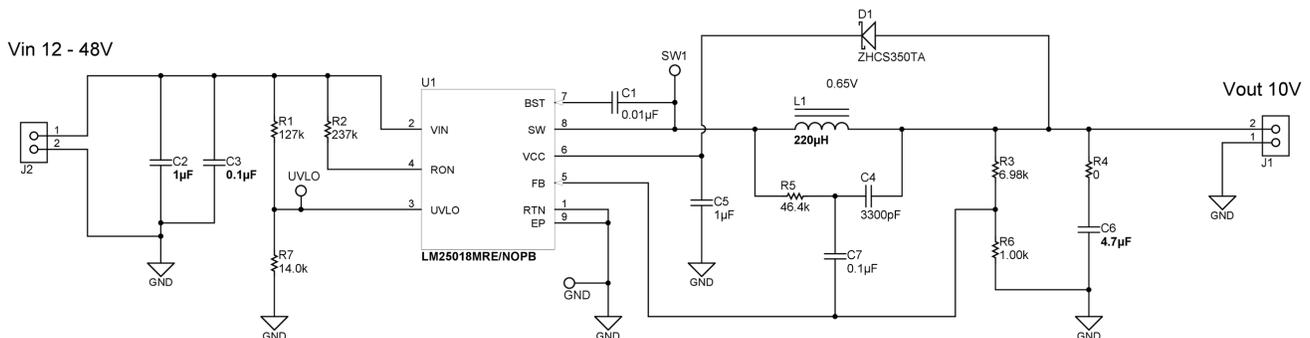
# LM25018 Evaluation Board

## 1 Introduction

The LM25018 evaluation board provides the design engineer with a fully functional buck regulator, employing the constant on-time (COT) operating principle. This evaluation board provides a 10 V output over an input range of 12.5 V to 48 V.

The board's specifications are:

- Input Range: 12.5 V to 48 V
- Output Voltage: 10 V
- Output Current: 300 mA
- Nominal Switching Frequency ~ 440 kHz
- Measured Efficiency: 91% at 200 mA and  $V_{IN} = 15$  V
- Board size: 2.3 inch x 1.4 inch



**Figure 1. Complete Evaluation Board Schematic for LM25018 Based Synchronous Buck Converter**

## 2 Theory of Operation

When the circuit is in regulation, the buck switch is turned on each cycle for a time determined by R3 and  $V_{IN}$  according to [Equation 1](#):

$$T_{ON} = \frac{10^{-10} \times R2}{V_{IN}} \quad (1)$$

The on-time of this evaluation board ranges from 2.17  $\mu$ s at  $V_{IN} = 12$  V to 477 ns at  $V_{IN} = 48$  V. The on-time varies inversely with input voltage. At the end of each on-time, the buck switch is off for at least 144 ns. In normal operation, the off-time is much longer. During the off-time, the load current is supplied by the output capacitor (C6). When the output voltage falls sufficiently that the voltage at FB is below 1.225 V, the regulation comparator initiates a new on-time period. For stable, fixed frequency operation, a minimum of 25 mV of ripple is required at FB to switch the regulation comparator. For a more detailed block diagram and a complete description of the various functional blocks, see the *LM25018 48V, 325mA Constant On-Time Synchronous Buck Regulator Data Sheet* ([SNVS953](#)).

## 3 UVLO

The UVLO resistors (R1, R7) are selected using [Equation 2](#):

$$V_{IN(HYS)} = I_{HYS}R_1 \quad (2)$$

and [Equation 3](#):

$$V_{IN(UVLO,rising)} = 1.225V \times \left( \frac{R_1}{R_7} + 1 \right) \quad (3)$$

On this evaluation board, R1 = 127 k $\Omega$  and R7 = 14.0 k $\Omega$ , resulting in UVLO rising threshold at  $V_{IN} = 12$  V and a hysteresis of 2.5 V.

## 4 Board Connection and Start-up

The input connections are made to J2. The load is connected to J1. Ensure the wires are adequately sized for the intended load current. Before start-up, a voltmeter should be connected to the input and output terminals. The load current should be monitored with an ammeter or a current probe. It is recommended that the input voltage be increased gradually to 12 V, at which time the output voltage should be 10 V. If the output voltage is correct, increase the input voltage as desired and proceed with evaluating the circuit. **DO NOT EXCEED 48 V AT  $V_{IN}$  (J2).**

## 5 Bill of Materials (BOM)

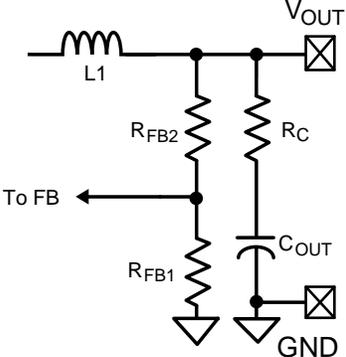
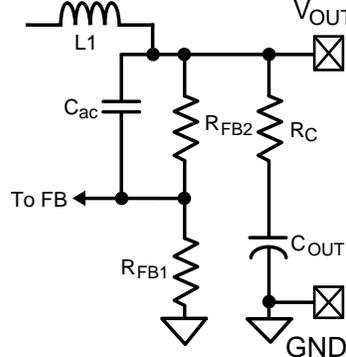
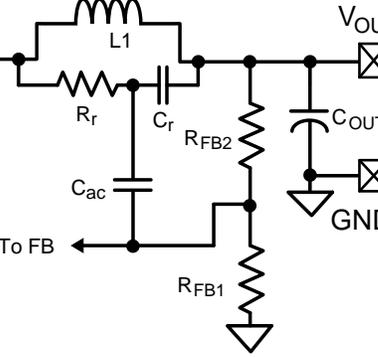
| Designator         | Value  | Description   | Package Reference | Part Number        | Manufacturer      |
|--------------------|--------|---|-------------------|--------------------|-------------------|
| C1                 | 0.01uF | CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0603               |                   | GRM188R71C103KA01D | MuRata            |
| C2                 | 1uF    | CAP, CERM, 1uF, 50V, +10%, X7R, 1206                    | 1206              | GRM31MR71H105KA88L | MuRata            |
| C3                 | 0.1uF  | CAP, CERM, 0.1uF, 50V, +5%, X7R, 0805                   | 0805              | C0805C104J5RACTU   | Kemet             |
| C4                 | 3300pF | CAP, CERM, 3300pF, 50V, +10%, X7R, 0603                 | 0603              | C0603C332K5RACTU   | Kemet             |
| C5                 | 1uF    | CAP, CERM, 1uF, 25V, +10%, X7R, 0603                    | 0603              | GRM188R71E105KA12D | MuRata            |
| C6                 | 4.7uF  | CAP, CERM, 4.7uF, 25V, +10%, X7R, 1206                  | 1206              | GRM31CR71E475KA88L | MuRata            |
| C7                 | 0.1uF  | CAP, CERM, 0.1uF, 100V, +10%, X7R, 0603                 | 0603              | GRM188R72A104KA35D | MuRata            |
| D1                 | 0.65V  | Diode, Schottky, 40V, 0.35A, SOD-523                    | SOD-523           | ZHCS350TA          | Diodes Inc.       |
| L1                 | 220uH  | INDUCTOR SHIELD PWR 220UH SMD                           | 7.60mm x 7.60mm   | DR74-221-R         | Cooper Bussman    |
| Alternate Inductor | 220uH  | INDUCTOR SHIELD PWR 220UH SMD                           | 7.3mm x 4.5mm     | 744777222          | Würth             |
| R1                 | 127k   | RES, 127k ohm, 1%, 0.1W, 0603                           | 0603              | CRCW0603127KFKEA   | Vishay-Dale       |
| R2                 | 237k   | RES, 237k ohm, 1%, 0.1W, 0603                           | 0603              | CRCW0603237KFKEA   | Vishay-Dale       |
| R3                 | 6.98k  | RES, 6.98k ohm, 1%, 0.1W, 0603                          | 0603              | CRCW06036K98FKEA   | Vishay-Dale       |
| R4                 | 0      | RES, 0 ohm, 5%, 0.125W, 0805                            | 0805              | CRCW08050000Z0EA   | Vishay-Dale       |
| R5                 | 46.4k  | RES, 46.4k ohm, 1%, 0.1W, 0603                          | 0603              | CRCW060346K4FKEA   | Vishay-Dale       |
| R6                 | 1.00k  | RES, 1.00k ohm, 1%, 0.1W, 0603                          | 0603              | CRCW06031K00FKEA   | Vishay-Dale       |
| R7                 | 14.0k  | RES, 14.0k ohm, 1%, 0.1W, 0603                          | 0603              | CRCW060314K0FKEA   | Vishay-Dale       |
| U1                 |        | 100V, 325mA Constant On-Time Synchronous Buck Regulator | SO-8 PowerPAD     | LM25018MRE/NOPB    | Texas instruments |

## 6 Ripple Configuration

The LM25018 is a COT buck and requires adequate ripple at feedback (FB) node. Three commonly used ripple generation methods are shown in [Table 1](#).

LM25018 evaluation board has been supplied with minimum ripple configuration (Type 3), but can be configured to Type 1 or Type 2 with modifications as suggested in [Table 1](#).

**Table 1. Ripple Configuration**

| Type 1<br>Lowest Cost Configuration  | Type 2<br>Reduced Ripple Configuration   | Type 3<br>Minimum Ripple Configuration  |
|--|--|---|
|   |   |    |
| <p>R5, C4, C7 open. Select R4:</p> $R4 \geq \frac{25 \text{ mV}}{\Delta I_{L(\text{MIN})}} \times \frac{V_{\text{OUT}}}{V_{\text{REF}}} \quad (4)$ | <p>R5 open, C4 = 0 Ω. Select R4 and C7:</p> $C7 \geq \frac{5}{f_{\text{SW}} (R_3 \parallel R_6)}$ $R4 \geq \frac{25 \text{ mV}}{\Delta I_L} \quad (5)$ | <p>R4 = 0 Ω. Select R5, C4, and C7:</p> <p>C4 = 3300 pF<br/> C7 = 100 nF<br/> <math>R5 \times C4 \leq \frac{(V_{\text{IN}(\text{MIN})} - V_{\text{OUT}}) T_{\text{ON}}}{25 \text{ mV}} \quad (6)</math></p> |

## 7 Performance Curves

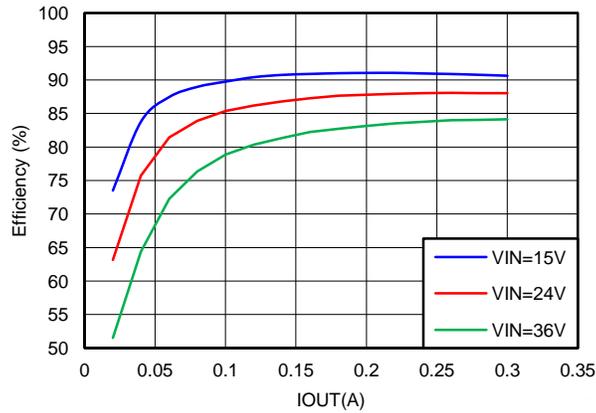


Figure 2. Efficiency vs Load Current

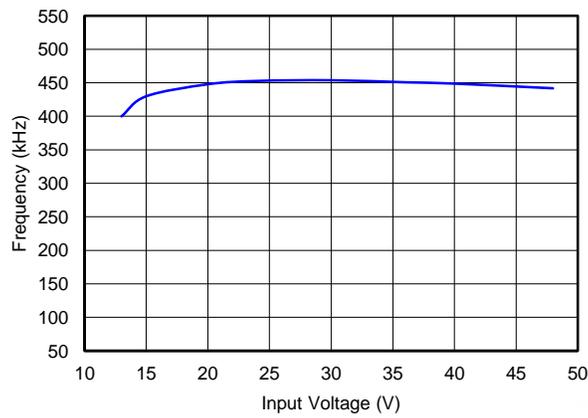


Figure 3. Frequency vs Input Voltage ( $I_{OUT} = 100\text{ mA}$ )

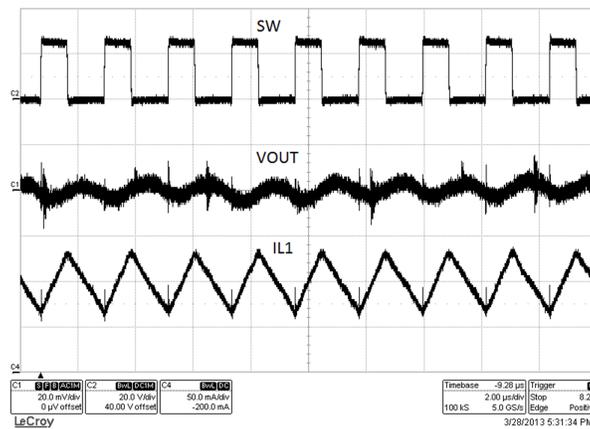


Figure 4. Typical Switching Waveform ( $V_{IN} = 24\text{ V}$ ,  $I_{out} = 100\text{ mA}$ )

## 8 PC Board Layout

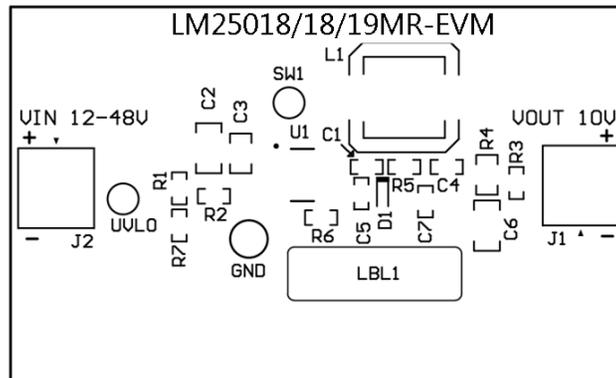


Figure 5. Top Silk

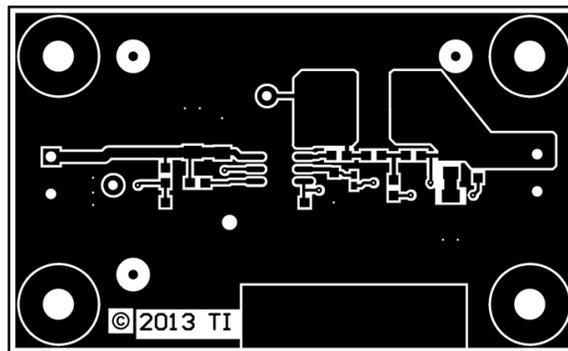


Figure 6. Top Copper

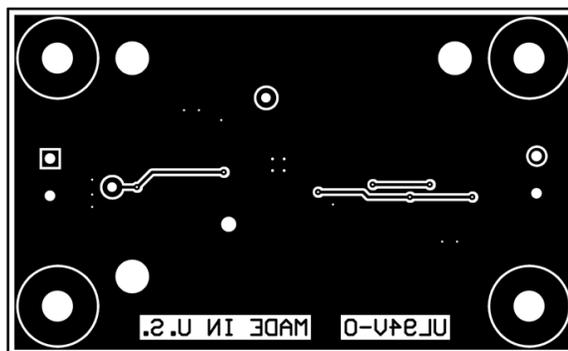


Figure 7. Bottom Copper

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |  |
|------------------------------|--|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>   |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>   |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |  |
|-------------------------------|--|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)