

LM25019 Evaluation Board

1 Introduction

The LM25019 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: 100 mA
- Nominal Switching Frequency ~ 420 kHz
- Measured Efficiency: 90.2% at 100 mA and $V_{IN} = 15$ V
- Board size: 2.3 inch x 1.4 inch

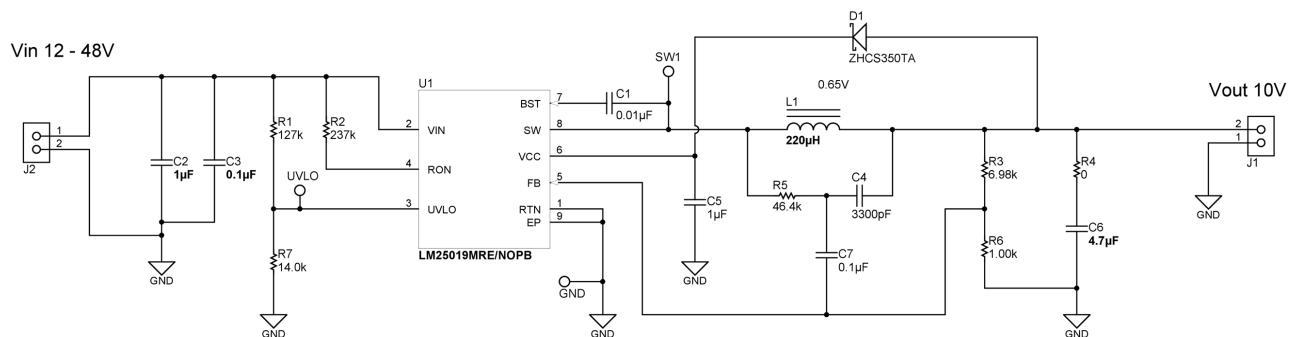


Figure 1. Complete Evaluation Board Schematic for LM25019 Based Synchronous Buck Converter

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 2.39 μ s at $V_{IN} = 12$ V to 493 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 *LM25019 48V, 100mA Constant On-Time Synchronous Buck Regulator Data Sheet* ([SNVS952](#)).

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 Ω and R7 = 14.0 k Ω , 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)

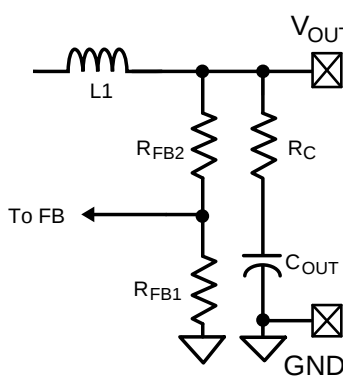
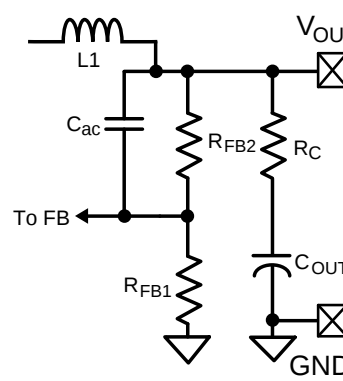
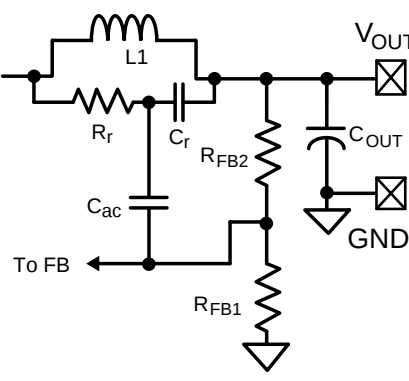
Designator	Value	Description	Package Reference	PartNumber	Manufacturer
C1	0.01uF	CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0603		GRM188R71C103KA01D	MuRata
C2	1uF	CAP, CERM, 1uF, 50V, +10/%, X7R, 1206	1206	GRM31MR71H105KA88L	MuRata
C3	0.1uF	CAP, CERM, 0.1uF, 50V, +5/%, X7R, 0805	0805	C0805C104J5RACTU	Kemet
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, Shielded Drum Core, Ferrite, 220uH, 0.52A, 1.05 ohm, SMD	DR73	DR73-221-R	Cooper Bussman
Alternate Inductor	220uH	Inductor, 220uH, 0.290A	5.8mm x 5.8mm	744053221	Würth
Alternative Inductor	220uH	Inductor, 220uH, 0.245A	5mm x 5mm	LPS5030-224	Coilcraft
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, 100mA Constant On-Time Synchronous Buck Regulator	SO-8 PowerPAD	LM25019MRE/NOPB	Texas Instruments

6 Ripple Configuration

The LM25019 is a COT buck and requires adequate ripple at feedback (FB) node. Three commonly used ripple generation methods are shown in [Table 1](#).

LM25019 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 Lowest Cost Configuration	Type 2 Reduced Ripple Configuration	Type 3 Minimum Ripple Configuration
		
R5, C4, C7 open. Select R4: $R4 \geq \frac{25 \text{ mV}}{\Delta I_{L(\text{MIN})}} \times \frac{V_{\text{OUT}}}{V_{\text{REF}}} \quad (4)$	R5 open, C4 = 0 Ω. Select R4 and C7: $C7 \geq \frac{5}{f_{\text{SW}} (R_3 \parallel R_6)}$ $R4 \geq \frac{25 \text{ mV}}{\Delta I_L} \quad (5)$	R4 = 0 Ω. Select R5, C4, and C7: C4 = 3300 pF C7 = 100 nF $R5 \times C4 \leq \frac{(V_{\text{IN(MIN)}} - V_{\text{OUT}}) T_{\text{ON}}}{25 \text{ mV}} \quad (6)$

7 Performance Curves

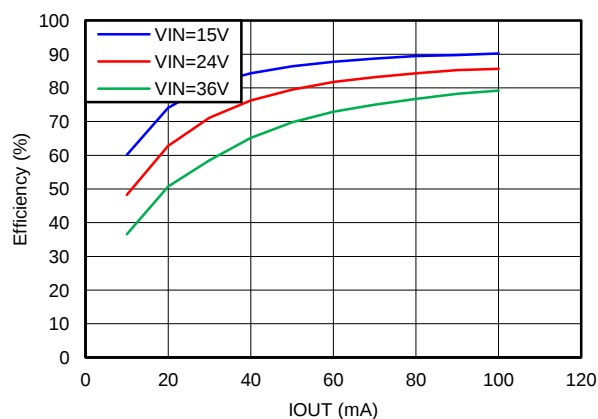


Figure 2. Efficiency vs Load Current

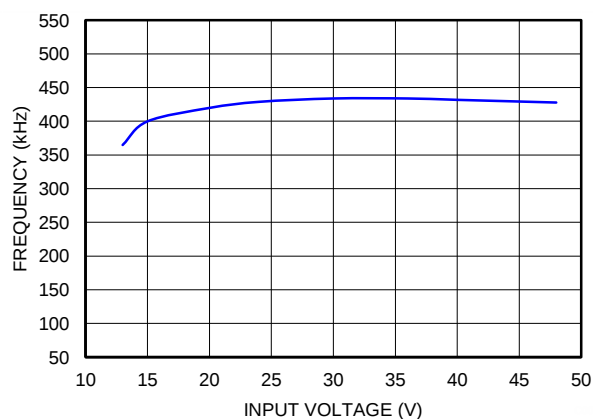


Figure 3. Frequency vs Input Voltage ($I_{OUT} = 100\text{ mA}$)

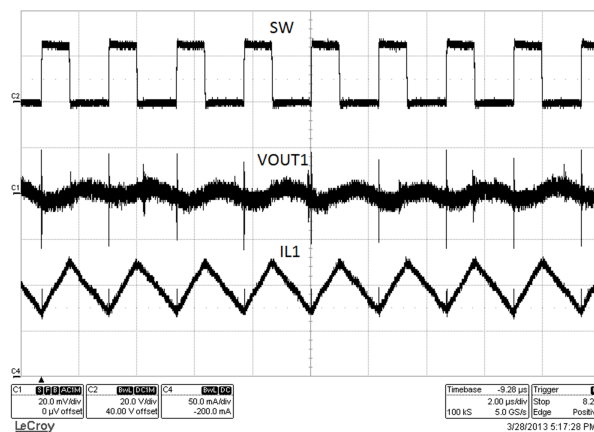


Figure 4. Typical Switching Waveform ($V_{IN} = 24\text{ V}$, $I_{out} = 100\text{ mA}$)

8 PC Board Layout

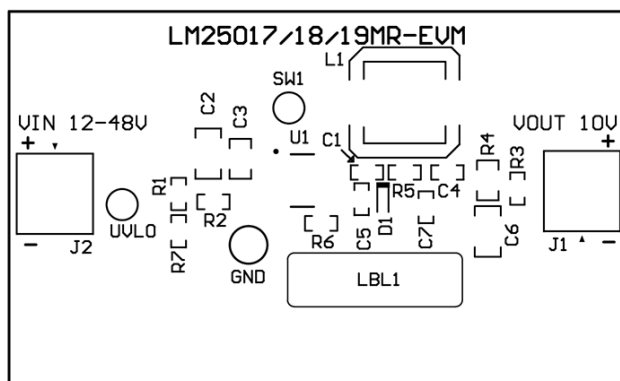


Figure 5. Top Silk

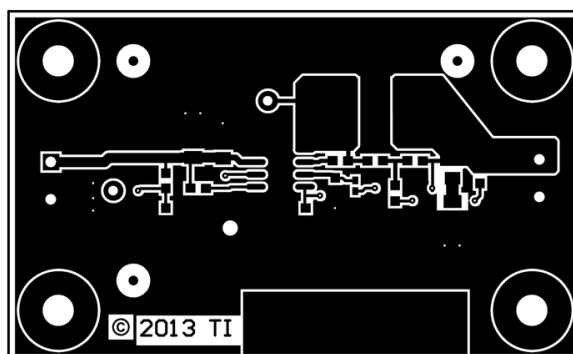


Figure 6. Top Copper

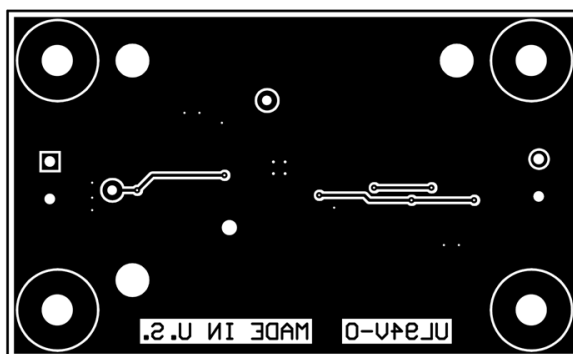


Figure 7. Bottom Copper

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- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
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