

LM5017 Evaluation Board

Texas Instruments
Application Note 2200
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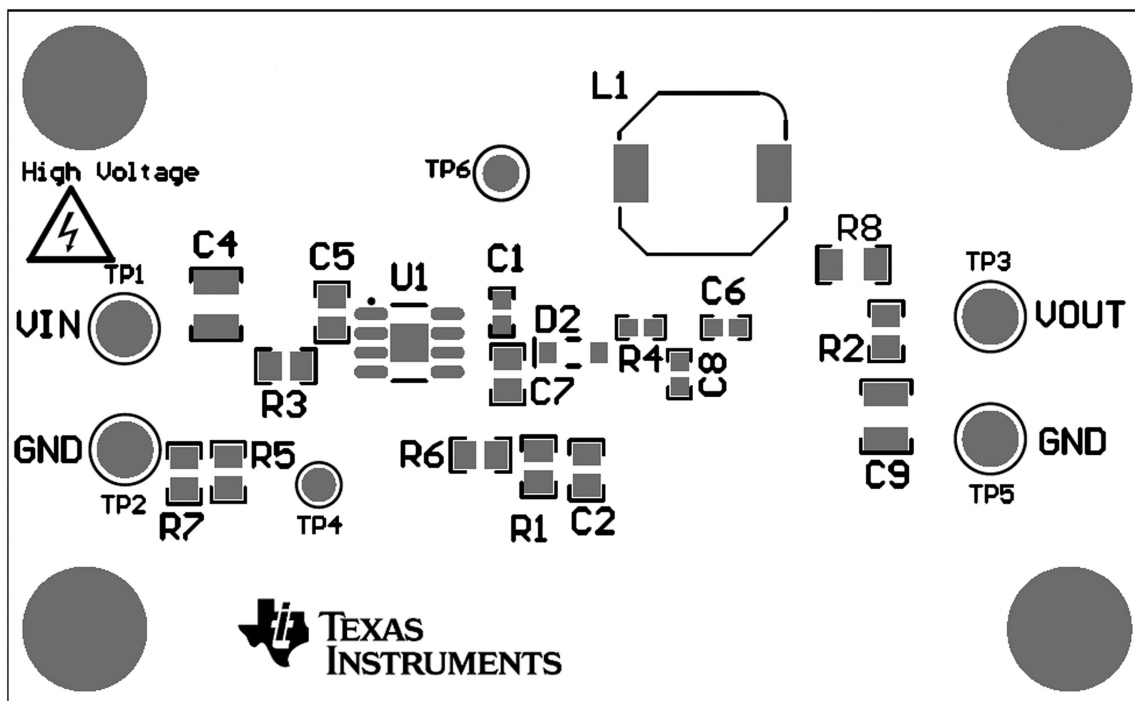
Introduction

The LM5017 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 10V output over an input range of 12.5V to 100V.

The board's specifications are:

- Input Range: 12.5V to 95V, transients up to 100V (absolute maximum)

- Output Voltage: 10V
- Output Current: 600 mA
- Nominal Switching Frequency ~ 200 kHz
- Measured Efficiency: 92.4% at 400mA and VIN = 24V
- Board size: 2.95 in. x 1.8 in.



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FIGURE 1. Evaluation Board (Top View)

Theory of Operation

Refer to the evaluation board schematic in [Figure 2](#). When the circuit is in regulation, the buck switch is turned on each cycle for a time determined by R3 and VIN according to the equation:

$$T_{ON} = \frac{10^{-10} \times R3}{V_{IN}}$$

The on-time of this evaluation board ranges from 5.56µs at VIN = 12V to 702ns at VIN = 95V. The on-time varies inversely with input voltage. At the end of each on-time the buck switch is off for at least 144ns. In normal operation, the off-time is much longer. During the off-time, the load current is supplied by the output capacitor (C9). When the output voltage falls sufficiently that the voltage at FB is below 1.225V, the regulation comparator initiates a new on-time period. For stable, fixed frequency operation, a minimum of 25mV of ripple is re-

quired at FB to switch the regulation comparator. Refer to the LM5017 data sheet for a more detailed block diagram, and a complete description of the various functional blocks.

UVLO

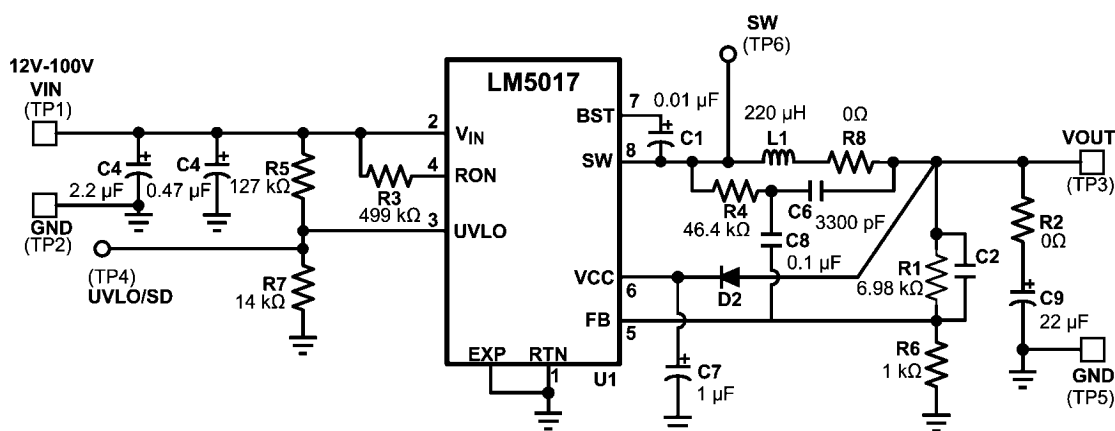
The UVLO resistors (R5, R7) are selected using the following two equations:

$$V_{IN(HYS)} = I_{HYS}R_5$$

and

$$V_{IN (UVLO, rising)} = 1.225V \times \left(\frac{R_5}{R_7} + 1 \right)$$

On this evaluation board R5=127kΩ and R7=14.0kΩ, resulting in UVLO rising threshold at VIN=12V and a hysteresis of 2.5V.



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FIGURE 2. Complete Evaluation Board Schematic for LM5017 Based Buck Converter

Board Connection and Start-up

The input connections are made to the TP1 (VIN) and TP2 (GND) terminals. The load is connected to the TP3 (VOUT) AND TP5 (GND) terminals. Ensure the wires are adequately sized for the intended load current. Before start-up a voltmeter should be connected to the input terminals, and to the 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 12V, at which time the output voltage should be 10V. If the output voltage is correct, then increase the input voltage as desired and proceed with evaluating the circuit. DO NOT EXCEED 100V AT VIN.

TABLE 1. Bill of Materials

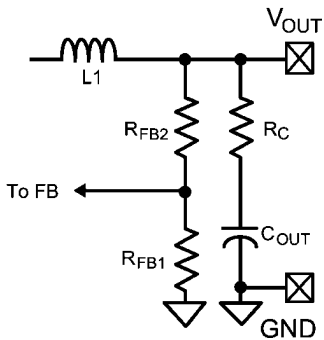
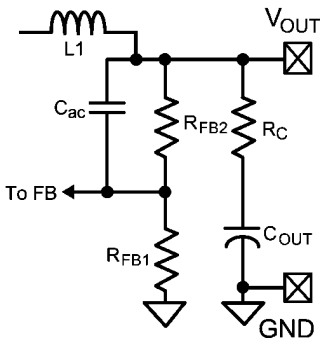
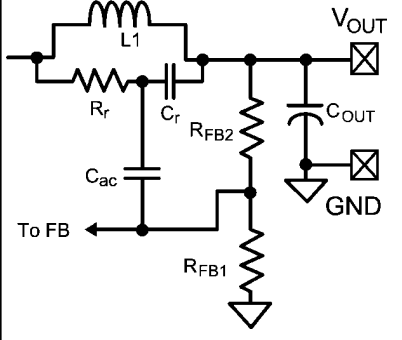
Item	Description	Mfg., Part Number	Package	Value
U1	Sync Switching Regulator	National Semiconductor, LM5017	PSOP-8	100V, 0.6A
L1	Inductor	Bourns, SRR1260–221k	12.5mm x 12.5mm	220uH, 1.38A
	Alternate Inductor	Coilcraft, MSS1246–224K	12.3mm x 12.3mm	220uH, 1.4A
D2	Diode	Central Semi, CMMSH1–40	SOD-123F	40V, 1A
	Alternate Diode	NXP, BAS40H, 115	SOD123F	40V, 120mA
C1	Ceramic Capacitor	Murata, GRM188R71C103KA01D	0603	0.01µF, 16V, X7R
C2				NA
C4	Ceramic Capacitor	Murata, GRM32ER72A225KA35L	1210	2.2uF, 100V, X7R
C5	Ceramic Capacitor	Murata, GRM21BR72A474KA73L	0805	0.47uF, 100V, X7R
C6	Ceramic Capacitor	TDK, C1608X7R1H332K	0603	3300pF, 50V, X7R
C7	Ceramic Capacitor	TDK, C2012X7R1C105K	0805	1uF, 16V, X7R
C8	Ceramic Capacitor	Murata, GRM188R71E104KA01D	0603	0.1uF, 25V, X7R
C9	Ceramic Capacitor	Murata, GRM32ER71E226KE15L	1210	22uF, 25V, X7R
R1	Resistor	Vishay–Dale, CRCW08056K98FKEA	0805	6.98k ohm, 1%
R2	Resistor	Panasonic, ERJ-6GEY0R00V	0805	0 ohm
R3	Resistor	Panasonic, ERJ-6ENF4993V	0805	499k ohm, 1%
R4	Resistor	Panasonic, ERJ-3EKF4642V	0603	46.4k ohm, 1%
R5	Resistor	Vishay-Dale, CRCW0805127KFKEA	0805	127k ohm, 1%
R6	Resistor	Vishay-Dale, CRCW08051K00FKEA	0805	1.0k ohm, 1%
R7	Resistor	Vishay-Dale, CRCW080514K0FKEA	0805	14.0k ohm, 1%
R8	Resistor	Yageo, RC1206JR-070RL	1206	0 ohm

Ripple Configuration

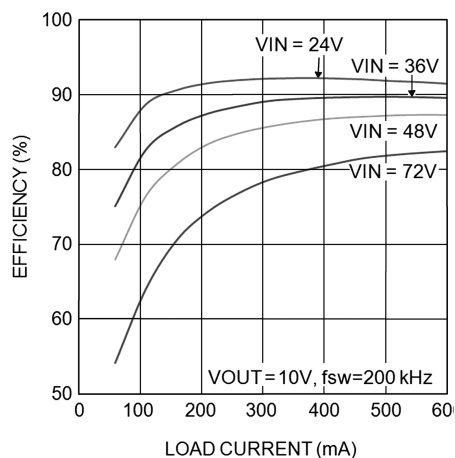
The LM5017 is a constant-on-time (COT) buck, and requires adequate ripple at feedback (FB) node. Three commonly used ripple generation methods are shown in [Table 2](#).

LM5017 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 2](#).

TABLE 2. Ripple Configuration

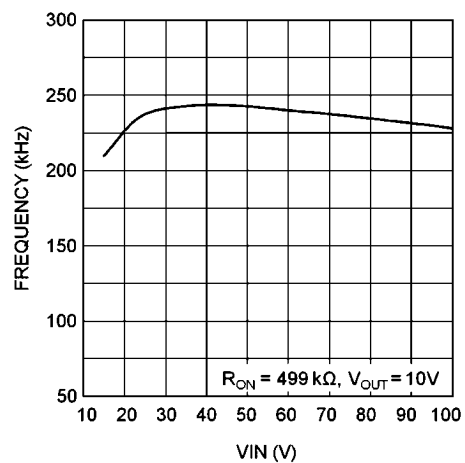
Type 1 Lowest Cost Configuration	Type 2 Reduced Ripple Configuration	Type 3 Minimum Ripple Configuration
		
R4, C6, C8 open. Select R2:	R4 open, C6=0Ω. Select R2 and C8:	R2=0Ω. Select R4, C6, and C8:
$R2 \geq \frac{40 \text{ mV}}{\Delta I_{L(\text{MIN})}} \times \frac{V_{\text{OUT}}}{V_{\text{REF}}}$	$C8 \geq \frac{5}{f_{\text{SW}} (R_1 \parallel R_6)}$ $R2 \geq \frac{40 \text{ mV}}{\Delta I_L}$	$C6 = 3300 \text{ pF}$ $C8 = 100 \text{ nF}$ $R4 \times C6 \leq \frac{(V_{\text{IN}(\text{MIN})} - V_{\text{OUT}}) T_{\text{ON}}}{40 \text{ mV}}$

Performance Curves



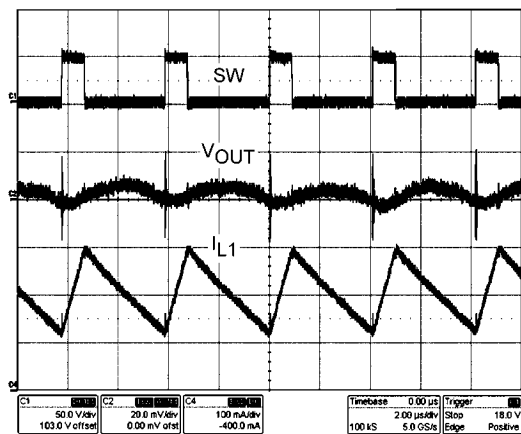
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FIGURE 3. Efficiency vs Load Current



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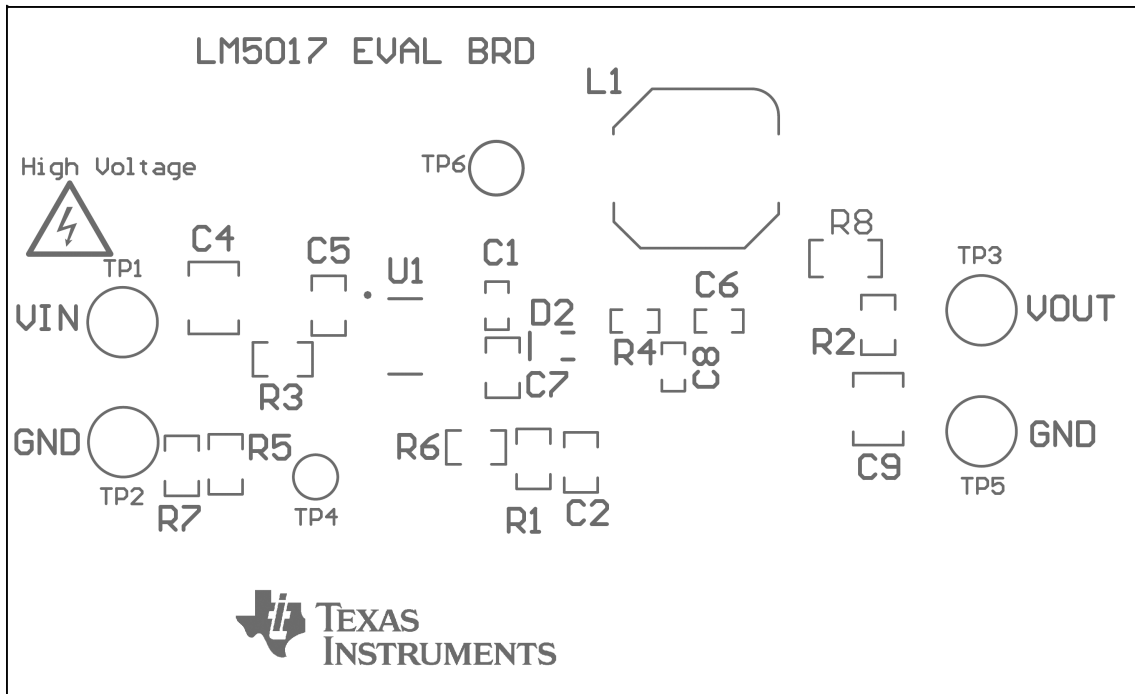
FIGURE 4. Frequency vs Input Voltage



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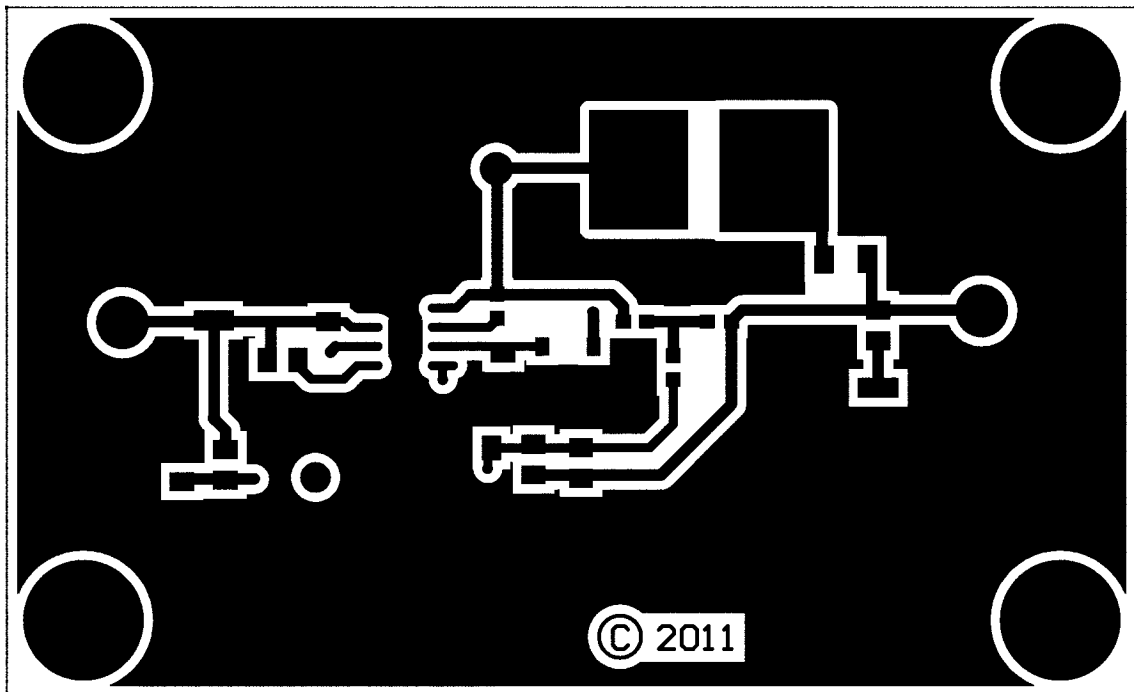
FIGURE 5. Typical Switching Waveform ($V_{IN}=48\text{ V}$, $I_{out}=200\text{ mA}$)

PC Board Layout



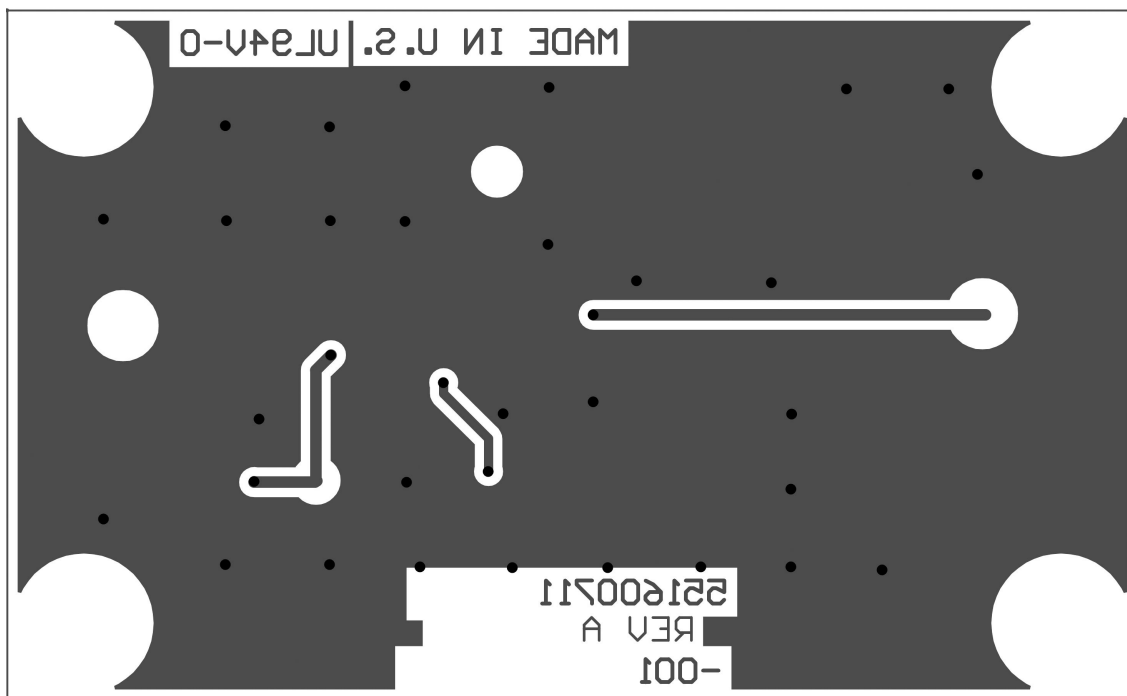
Board Silkscreen

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Board Top Layer

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Board Bottom Layer

Notes