

LM34919C-Q1 Evaluation Board User's Guide

User's Guide



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1	INTRODUCTION	5
2	THEORY OF OPERATION	5
3	BOARD LAYOUT AND PROBING	6
4	BOARD CONNECTION/START-UP	6
5	OUTPUT RIPPLE CONTROL	6
6	MONITOR THE INDUCTOR CURRENT	8
7	MINIMUM LOAD CURRENT	8
8	CIRCUIT PERFORMANCE	9
9	TYPICAL WAVEFORMS	11
10	PC BOARD LAYOUT	13

List of Figures

1	Evaluation Board - Top Side	5
2	Lowest Cost Configuration.....	6
3	Intermediate Ripple Configuration	7
4	Minimum Output Ripple Configuration	8
5	Complete Evaluation Board Schematic	8
6	Efficiency vs Load Current.....	9
7	Efficiency vs Input Voltage.....	9
8	Switching Frequency vs. Input Voltage	10
9	Load Derating Curve	10
10	Continuous Conduction Mode	11
11	Discontinuous Conduction Mode	11
12	Enable, Output Voltage, and PGD at Startup.....	12
13	Board Silkscreen.....	13
14	Board Top Layer.....	13
15	Board Bottom Layer (Viewed from Top).....	14

List of Tables

1	Bill of Materials	8
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LM34919C-Q1 Evaluation Board

The LM34919CQSDEVM 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 3.3 V output over an input range of 4.5 V to 24 V. The circuit delivers load current to 600 mA, with current limit set at a nominal 640 mA (valley current limit). The board is populated with all components except R7, C6, and C7. These components provide options for managing the output ripple as described later in this document.

1 INTRODUCTION

The LM34919CQSDEVM 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 3.3 V output over an input range of 4.5 V to 24 V. The circuit delivers load currents to 600 mA, with valley current limit set at 640 mA. The board is populated with all components except R7, C6 and C7. These components provide options for managing the output ripple as described later in this document.

The board's specification are:

- Input Voltage: 4.5 V to 24 V
- Output Voltage: 3.3 V
- Maximum load current: 600 mA
- Minimum load current: 0 A
- Current Limit: 768 mA to 812 mA
- Measured Efficiency: 87% ($V_{IN} = 6\text{ V}$, $I_{OUT} = 300\text{ mA}$)
- Nominal Switching Frequency: 1.5 MHz
- Size: 1.4 inches x 2.3 inches

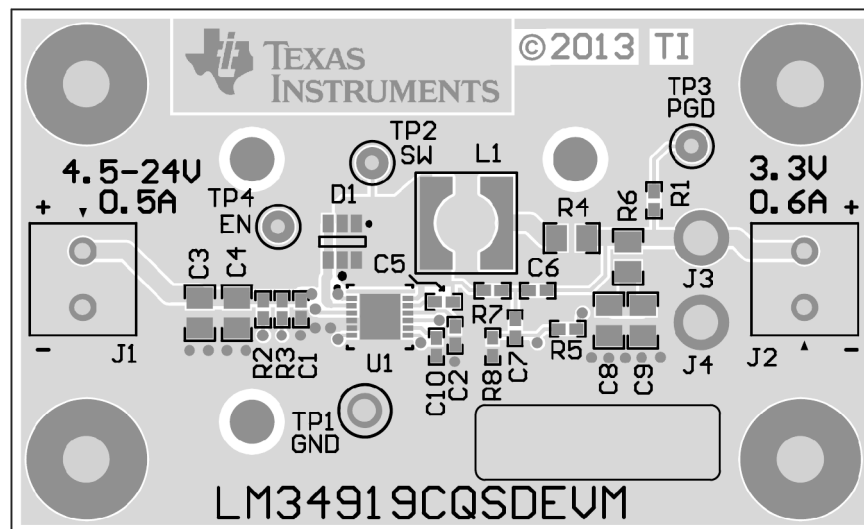


Figure 1. Evaluation Board - Top Side

2 THEORY OF OPERATION

Refer to the evaluation board topside view in [Figure 1](#). At nominal input voltage, $V_{IN} = 12\text{ V}$, the switching frequency can be determined by R_2 (R_{ON} resistor) and output voltage V_O , according to [Equation 1](#):

$$F_{SW} = \frac{V_{OUT}}{35.5 \times 10^{-12} \times R_2} \text{ Hz} \quad (1)$$

In LM34919C, like other constant on-time regulators, the on-time varies inversely with V_{IN} to maintain a nearly constant switching frequency. For stable, fixed frequency operation, a minimum of 25 mV of ripple is required at FB to switch the regulation comparator. The average load current limit threshold is $\approx 768\text{ mA}$ at $V_{IN} = 4.5\text{ V}$, and $\approx 812\text{ mA}$ at $V_{IN} = 24\text{ V}$. The variation is due to the change in ripple current amplitude as V_{IN} varies. Refer to the LM34919C data sheet for a more detailed block diagram, and a complete description of the various functional blocks.

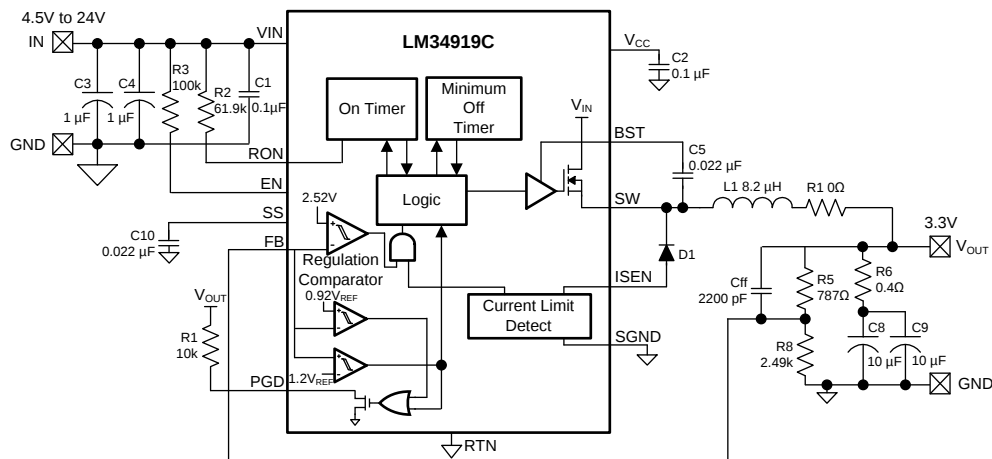


Figure 3. Intermediate Ripple Configuration

Since the output ripple is passed by Cff to the FB pin with little or no attenuation, R6 can be reduced so the minimum ripple at V_{OUT} is ≈25 mVp-p. The minimum value for Cff is calculated from:

$$C_{ff} \geq \frac{t_{ON(max)} \times 3}{(R5/R8)} \quad (2)$$

where t_{ON(max)} is the maximum on-time (at minimum V_{IN}), and R5//R8 is the parallel equivalent of the feedback resistors. See Figure 3.

Option C) Minimum Ripple Configuration: To obtain minimum ripple at V_{OUT}, R6 is set to 0Ω, and R7, C6, and C7 are added to generate the required ripple for the FB pin. In this configuration, the output ripple is determined primarily by the ESR of the output capacitance and the inductor's ripple current.

The ripple voltage required by the FB pin is generated by R7, C6, and C7 since the SW pin switches from –1 V to V_{IN}, and the right end of C6 is a virtual ground. The values for R7 and C6 are chosen to generate a 50-100 mVp-p triangle waveform at their junction. That triangle wave is then coupled to the FB pin through C7. The following procedure is used to calculate values for R7, C6 and C7:

- 1) Calculate the voltage V_A:

$$V_A = V_{OUT} - (V_{SW} \times (1 - (V_{OUT}/V_{IN}))) \quad (3)$$

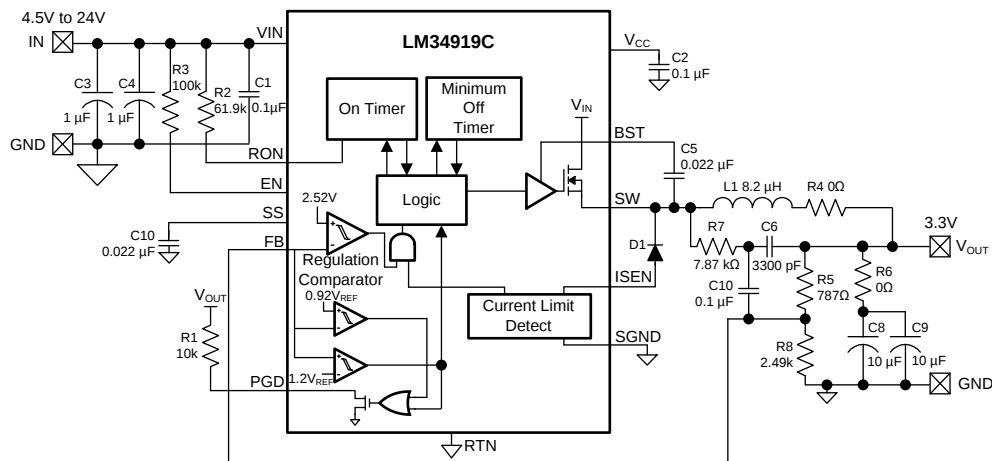
where V_{SW} is the absolute value of the voltage at the SW pin during the off-time (typically 1 V), and V_{IN} is the minimum input voltage. For this circuit, V_A calculates to 3.03 V. This is the approximate DC voltage at the R7/C6 junction, and is used in the next equation.

- 2) Calculate the R7 x C6 product:

$$R7 \times C6 = \frac{(V_{IN} - V_A) \times t_{ON}}{\Delta V} \quad (4)$$

where t_{ON} is the maximum on-time, V_{IN} is the minimum input voltage, and ΔV is the desired ripple amplitude at the R7/C6 junction, 50 mVp-p for this example.

R7 and C6 are then chosen from standard value components to satisfy the above product. Typically C6 is 3000 to 5000 pF, and R7 chosen close to 10 kΩ. C7 is chosen large compared to C6, typically 0.1 μF. See Figure 4.

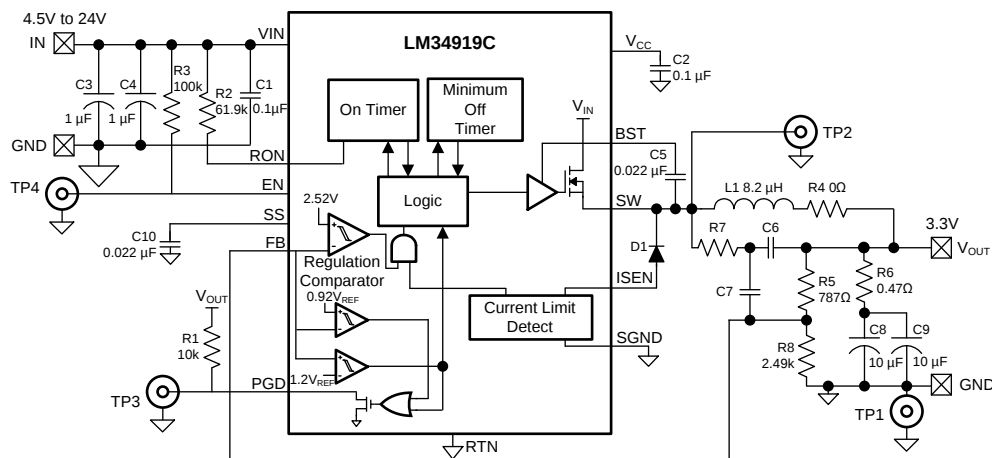

Figure 4. Minimum Output Ripple Configuration

6 MONITOR THE INDUCTOR CURRENT

The inductor's current can be monitored or viewed on a scope with a current probe. Remove R4, and install an appropriate current loop across the two large pads where R4 was located. In this way the inductor's ripple current and peak current can be accurately determined.

7 MINIMUM LOAD CURRENT

The LM34919C requires a minimum load current of ≈ 1 mA to ensure the boost capacitor (C5) is recharged sufficiently during each off-time. In this evaluation board, the minimum load current is provided by the feedback resistors allowing the board's minimum load current at V_{OUT} to be specified at zero.

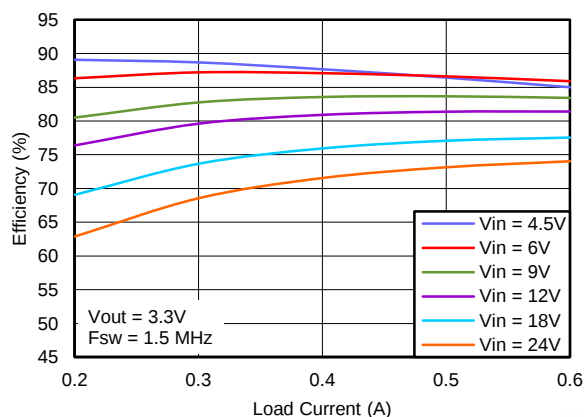
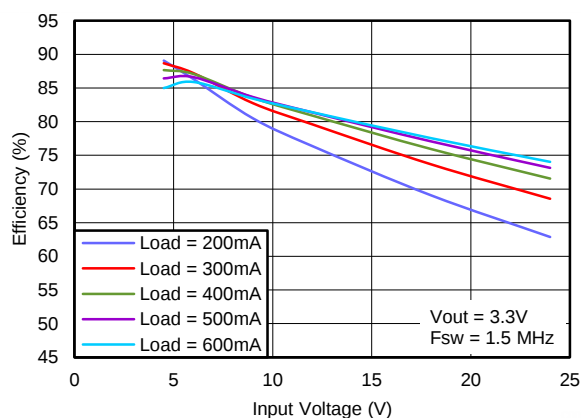

Figure 5. Complete Evaluation Board Schematic
Table 1. Bill of Materials

ITEM	DESCRIPTION	MFG. PART NUMBER	PACKAGE	VALUE
C1,C2	Ceramic Capacitor	TDK C1005X7R1H104K050BB	0402	0.1 μ F,50 V
C3,C4	Ceramic Capacitor	Murata GRM21BR71H105KA12L	0805	1 μ F,50 V
C5,C10	Ceramic Capacitor	Murata GRM155R71H223KA12D	0402	0.022 μ F,50 V
C6	Ceramic Capacitor	Unpopulated	0402	
C7	Ceramic Capacitor	Unpopulated	0402	

Table 1. Bill of Materials (continued)

ITEM	DESCRIPTION	MFG. PART NUMBER	PACKAGE	VALUE
C8,C9	Ceramic Capacitor	Murata GRM21BR71A106KE51L	0805	10 μ F, 10 V
D1	Schottky Diode	Zetex ZLLS2000TA	SOT-23-6	40 V, 2.2 A
L1	Power Inductor	Würth Elektronik 744053008	5.8mm x 5.8mm	8.2 μ H, 2.1 A
R1	Resistor	Vishay-Dale CRCW040210K0FKED	0402	10 k Ω
R2	Resistor	Vishay-Dale CRCW040261K9FKED	0402	61.9 k Ω
R3	Resistor	Vishay-Dale CRCW0402100KFKED	0402	100 k Ω
R4	Resistor	Vishay-Dale CRCW08050000Z0EA	0805	0 Ω Jumper
R5	Resistor	Vishay-Dale CRCW0402787RFKED	0402	787 Ω
R6	Resistor	Vishay-Dale RCWE0805R470FKEA	0805	0.47 Ω
R7	Resistor	Unpopulated	0402	
R8	Resistor	Vishay-Dale CRCW04022K49FKED	0402	2.49 k Ω
U1	Switching Regulator	Texas Instruments LM34919CQSD	12 Pin WSON	

8 CIRCUIT PERFORMANCE


Figure 6. Efficiency vs Load Current

Figure 7. Efficiency vs Input Voltage

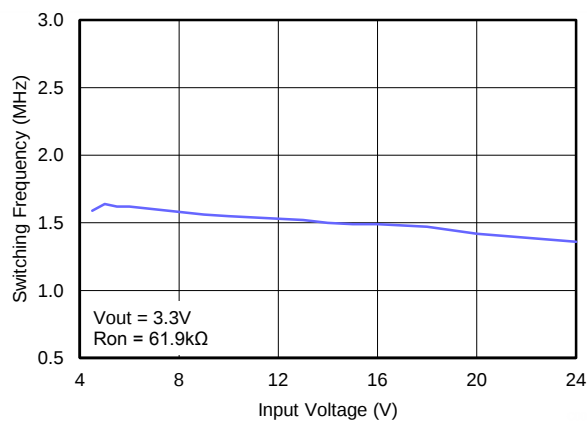


Figure 8. Switching Frequency vs. Input Voltage

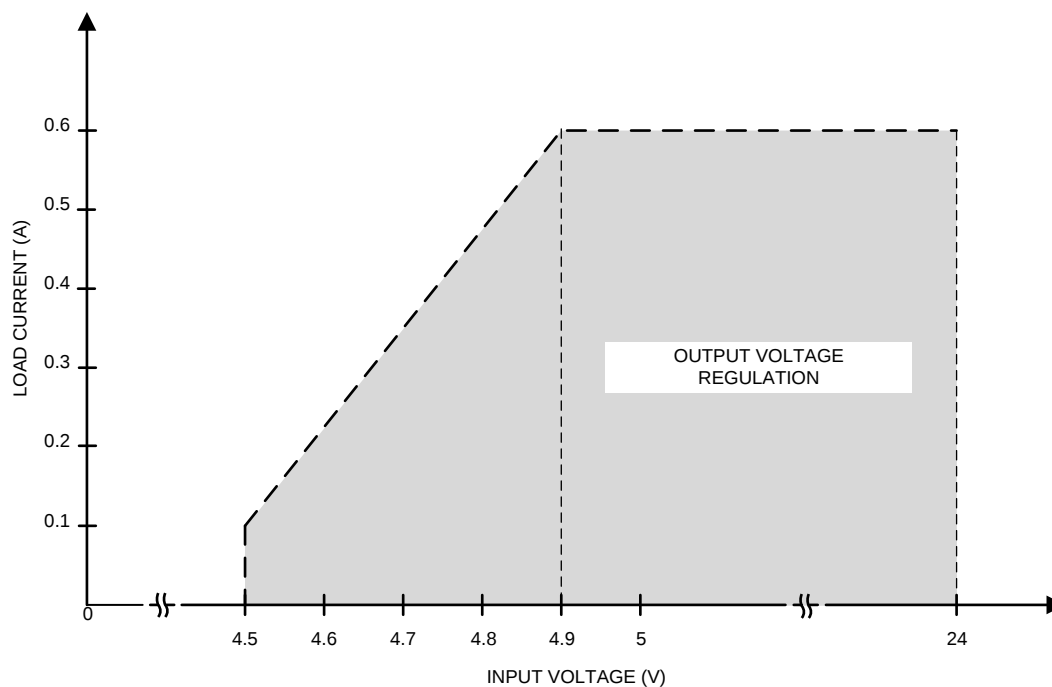
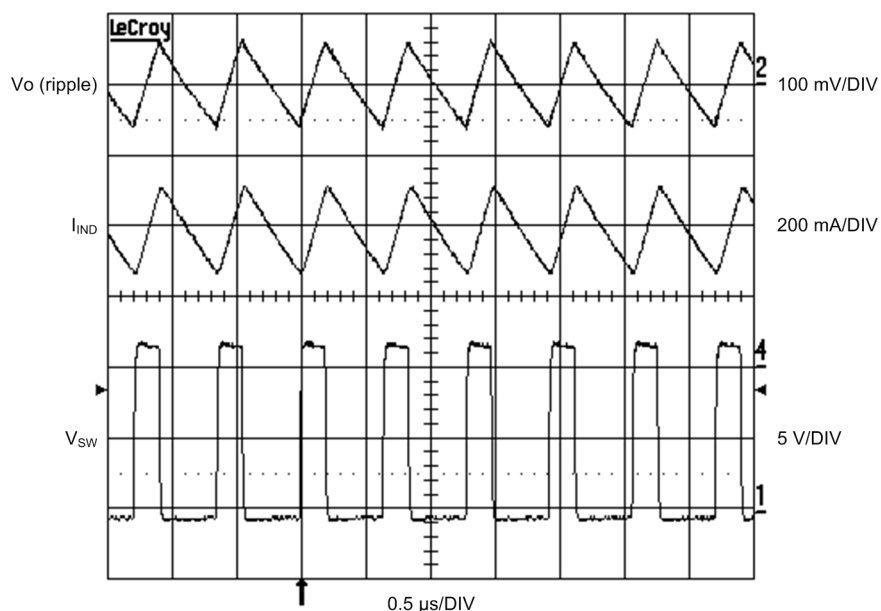


Figure 9. Load Derating Curve

9 TYPICAL WAVEFORMS



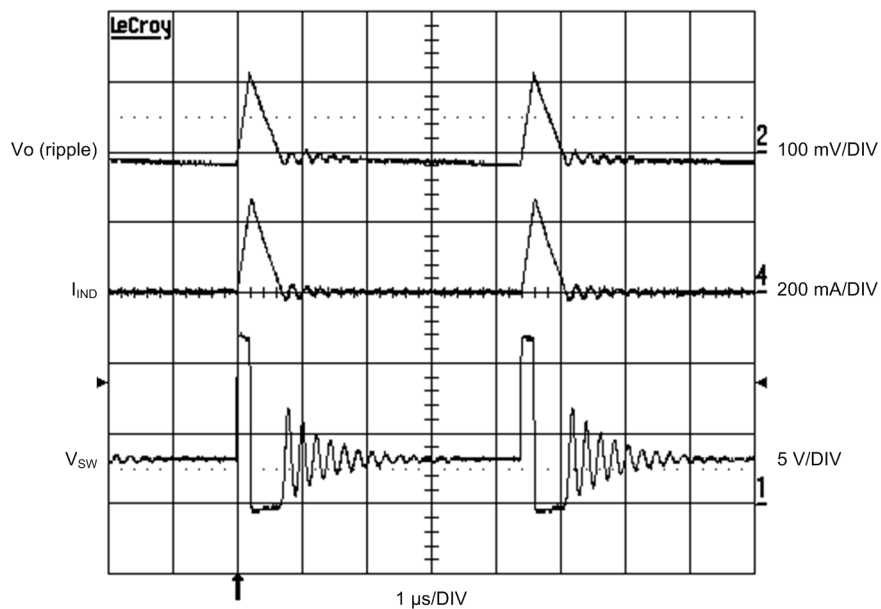
Trace 2 = V_{OUT} ripple (ac coupled)

Trace 4 = inductor Current

Trace 1 = SW Pin

$V_{in} = 12\text{ V}$, $I_{OUT} = 400\text{ mA}$

Figure 10. Continuous Conduction Mode



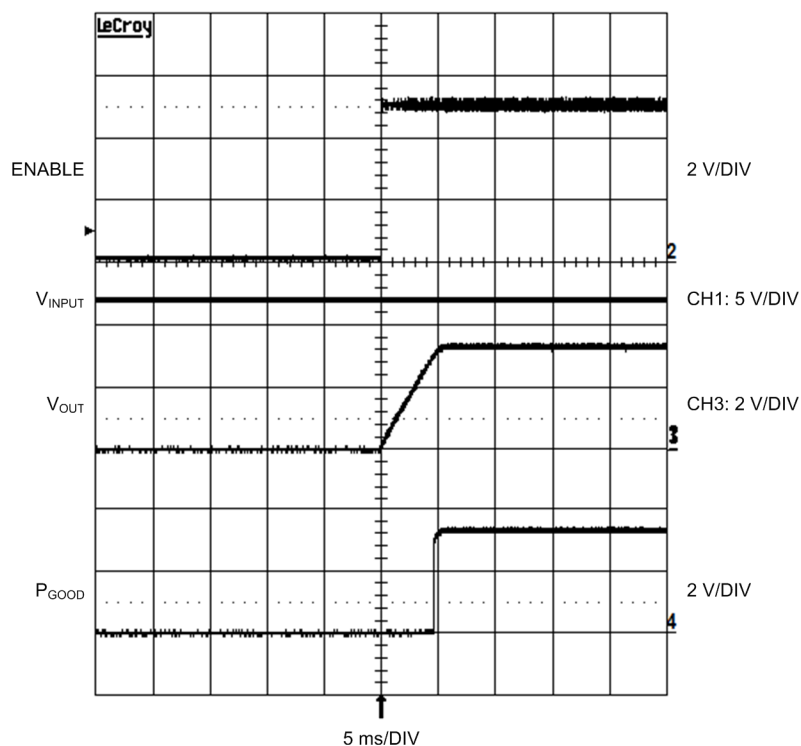
Trace 2 = V_{OUT} ripple (ac coupled)

Trace 4 = inductor Current

Trace 1 = SW Pin

$V_{in} = 12\text{ V}$, $I_{OUT} = 20\text{ mA}$

Figure 11. Discontinuous Conduction Mode



Trace 3 = V_{OUT}
Trace 2 = EN
Trace 4 = Power Good
Trace 1 = $V_{IN} = 12\text{ V}$
 $I_{OUT} = 300\text{ mA}$

Figure 12. Enable, Output Voltage, and PGD at Startup

10 PC BOARD LAYOUT

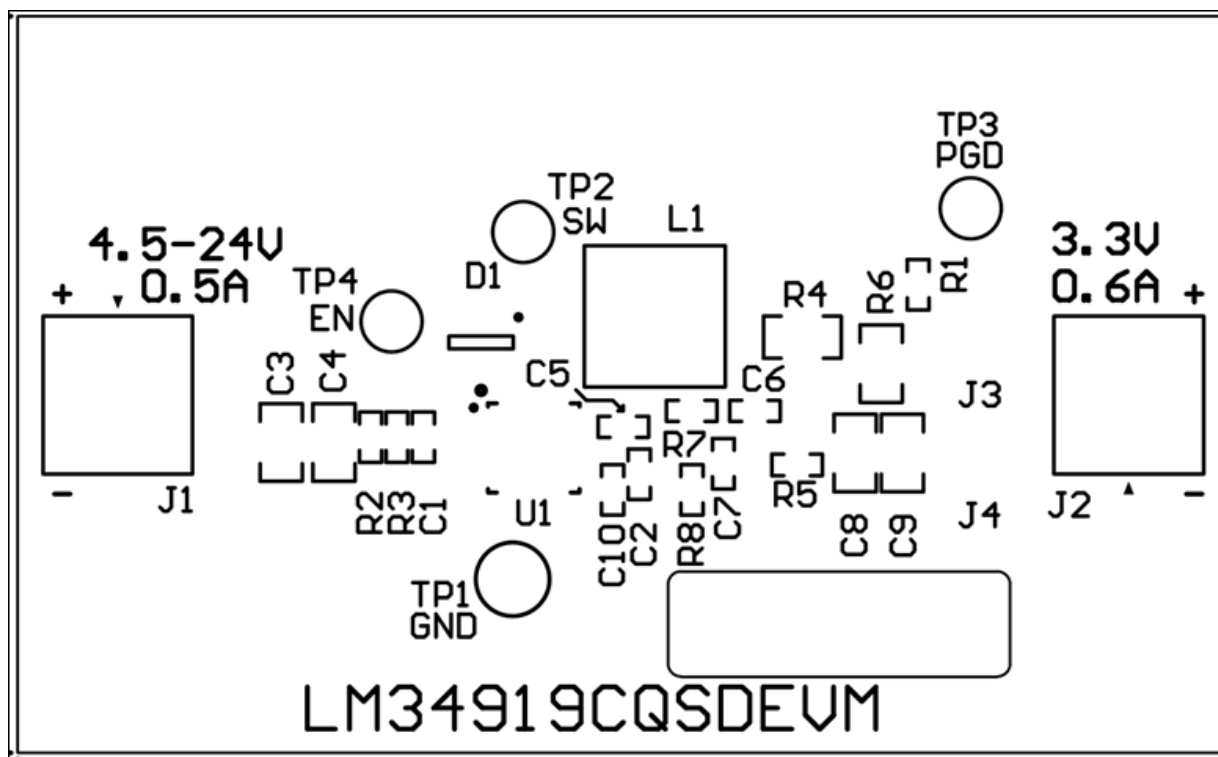


Figure 13. Board Silkscreen

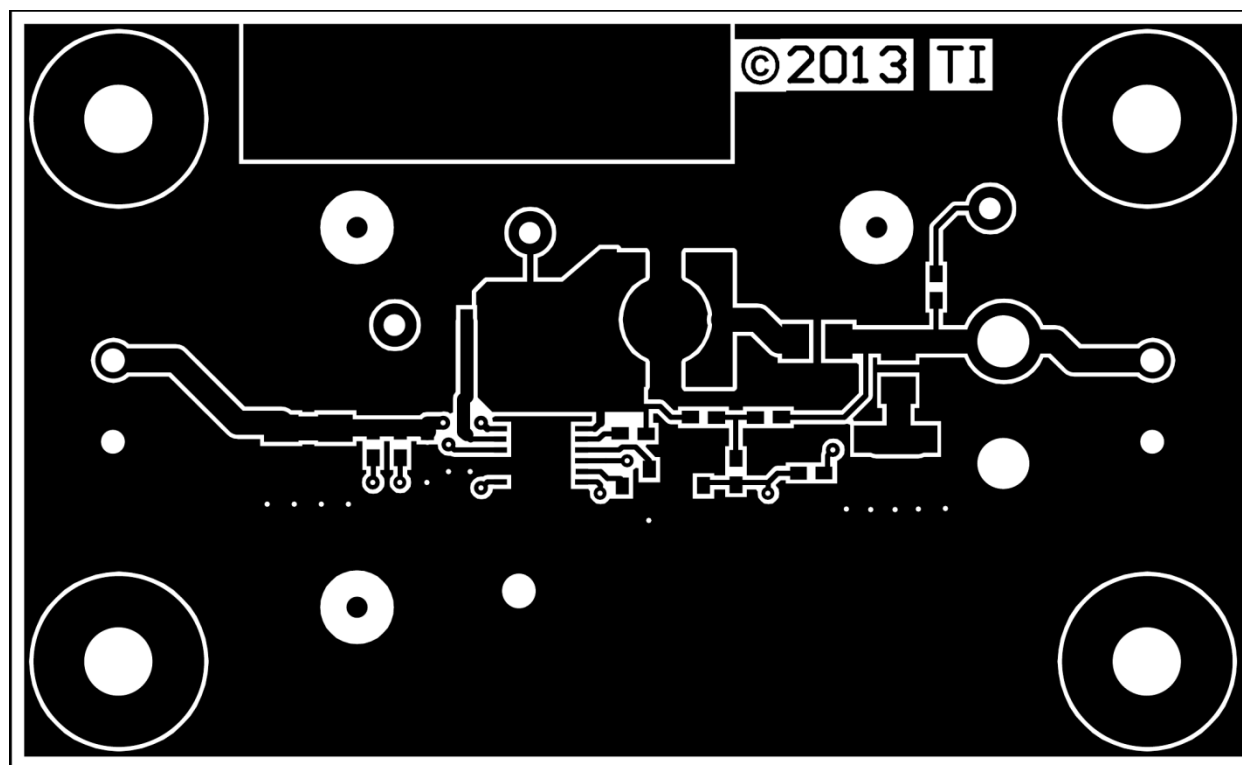


Figure 14. Board Top Layer

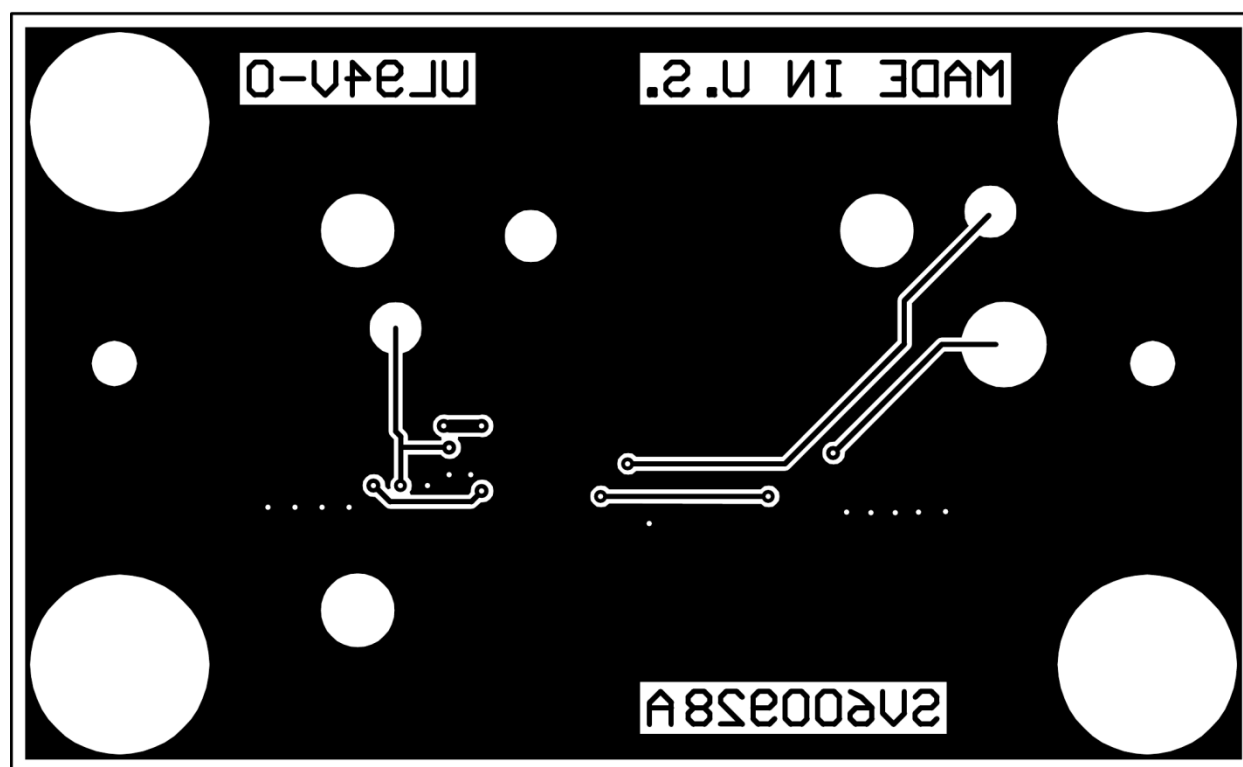


Figure 15. Board Bottom Layer (Viewed from Top)

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This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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- Reorient or relocate the receiving antenna.
- 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.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

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This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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