

## **TPS61170EVM-316**

This user's guide describes the characteristics, operation, and use of the TPS61170EVM-316 evaluation module (EVM). This EVM contains the Texas Instruments TPS61170 high-efficiency boost converter that is configured in a SEPIC topology to provide a regulated 12-V output voltage from an input voltage ranging from 9 V to 15 V. The user's guide includes a schematic diagram, bill of materials and test data.

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## **1 Introduction**

This section contains background information for the TPS61170EVM-316 evaluation module.

### **1.1 Background**

This TPS61170EVM-316 converts 9-V to 15-V input voltages to a 12-V output. The goal of the EVM is to facilitate evaluation of the TPS61170 power supply solution. The EVM uses the TPS61170 adjustable output boost converter, external Schottky diode, input, output and flying capacitors, coupled inductor and the appropriate feedback and compensation components to provide 12 V.

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## 1.2 Performance Specification Summary

Table 1 provides a summary of the TPS61170EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

**Table 1.**

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IN}$		9		15	V
$V_{OUT}$	$V_{IN} = 9\text{ V}, I_{OUT} < 325\text{ mA}$	11.7	12	12.5	V
	$V_{IN} = 15\text{ V}, I_{OUT} < 420\text{ mA}$				

## 1.3 Modifications

Because the primary goal of the EVM is to demonstrate the small size of the TPS61170 power supply solution, capacitors and inductors with small footprints were chosen. These capacitors and inductors were carefully selected to maximize efficiency and minimize ripple while minimizing overall solution size. Changing components could improve or degrade EVM performance.

The TPS61170 integrated circuit (IC) has a maximum input voltage of 18 V and can boost its input voltage up to 37 V. Changes to this EVM's operating input and output voltage range likely requires changing one or more of the following components: Schottky diode, input or output capacitors, inductor, feedback resistors, or error amplifier compensation components. See the data sheet and/or design tools for assistance in selecting these components for the user's application.

## 2 Setup and Test Results

This section describes how to properly connect, set up, and use the TPS61170EVM.

### 2.1 *Input/Output Connections*

The connection points are described in the following paragraphs.

#### 2.1.1 J1-VIN

This header is the positive connection to the input power supply. Twist the leads to the input supply, and keep them as short as possible.

#### 2.1.2 J2-GND

This header is the return connection to the input power supply.

#### 2.1.3 J3-VOUT

This header is the positive output for the device.

#### 2.1.4 J4-GND

This header is the return connection for the load.

#### 2.1.5 J5-USB-TO-GPIO Connector

This connector is for the 10-pin ribbon cable that connects the EVM to the USB-TO-GPIO interface box. It is only used when the software is used to perform dimming.

#### 2.1.6 JP1-ON/CTRL

Installing this jumper ties the CTRL pin to  $V_{IN}$ , thereby turning on the device. Removing the jumper allows the internal pulldown resistor to pull CTRL to ground, thereby disabling the device.

## 2.2 *Hardware Requirements*

This EVM requires an external power supply capable of providing 9 V to 15 V at 1.5 A.

To change the default feedback (FB) value from 1.229 V, which dynamically changes the regulated output voltage, the user can apply either a pulse width modulation (PWM) or digital control signal to the CTRL pin. Both signals change the feedback voltage at the IC's FB pin. A function generator capable of driving the CTRL pin with 1.2-V to 15-V amplitude and a 5-kHz to 100-kHz PWM signal is required for PWM-controlled modulation of the FB voltage. The user also can change the FB voltage using a digital control signal. The EVM kit includes a personal computer (PC) software compact disk (CD) and USB-TO-GPIO interface box which, when installed on a PC and connected to the EVM, allows the user to communicate with the EVM via a GUI interface. The minimum PC requirements are:

- Windows™ 2000 or Windows™ XP operating system
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

### 2.3 Hardware Setup

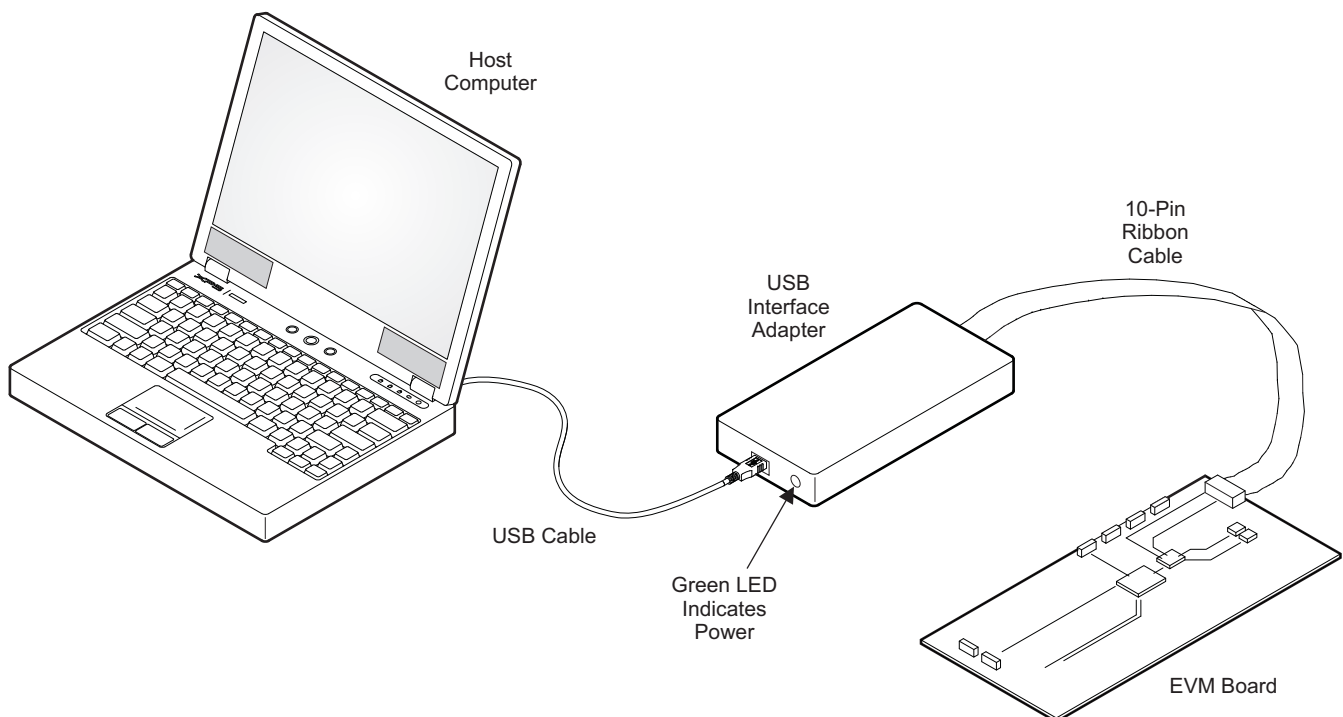
After connecting the power supply between J1 and J2, turning on the power supply, and installing JP1, the EVM will regulate the output voltage to the value per [Table 1](#). Additional input capacitance may be required in order to mitigate the inductive voltage droop that may occur during a load transient event.

In order to change the output voltage via a PWM signal, remove the jumper on JP1 and the 10-pin ribbon cable from J5, if installed, and perform the following steps in any sequence:

- Connect the power supply between J1 and J2 and turn on the power supply.
- Connect the appropriately configured function generator to the CTRL side of JP1.
- Adjust the duty cycle of the 5kHz-100kHz PWM signal from the function generator to produce the desired feedback voltage. The PWM signal's duty cycle is directly proportional to the regulated output voltage, i.e.,  $V_{FB} = D_{CTRL} \times 1.229V$ .

In order to change the output voltage by sending the digital control signal via a PC running the TPS6116x Controller software and USB-TO-GPIO interface box, remove the jumper or the function generator on JP1, and perform the following steps in any sequence:

- Connect one end of the USB-TO-GPIO box to the PC using the USB cable and the other end to J5 of the TPS61161EVM using the supplied 10-pin ribbon cable per [Figure 1](#). The connectors on the ribbon cable are keyed to prevent incorrect installation,
- Connect the power supply between J1 and J2, and turn on the power supply.
- Run the software as explained in the next section.



**Figure 1. USB Interface Adapter Quick Connection Diagram**

### 2.4 Software Installation and Operation

If installing from a CD, insert the CD and run Setup.exe; follow all the prompts to install the software.

If installing from the TI Web site, go to the

URL, <http://focus.ti.com/en/download/aap/DesignEnv/TPS6116xEVM-SW/publish.htm>.

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**Note:** This installation page is best viewed with Microsoft™ Internet Explorer browser (It may not work correctly with other browsers).

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Click on the install button; the PC gives a security warning and asks if the user wants to install this application. Select Install to proceed. If a pre-release or Beta version is currently installed on the PC, the user must uninstall this version of the software before installing the final version from either the CD or the TI Web site.

With both types of installation, the software attempts to install the Microsoft Dot Net Framework 2.0 (if it is not already installed) This framework is required for the software to run.

Immediately following installation, the software automatically runs.

To run the software after installation, go to

Start → all programs → Texas Instruments, Inc. → TPS6116x Controller EVM Software.

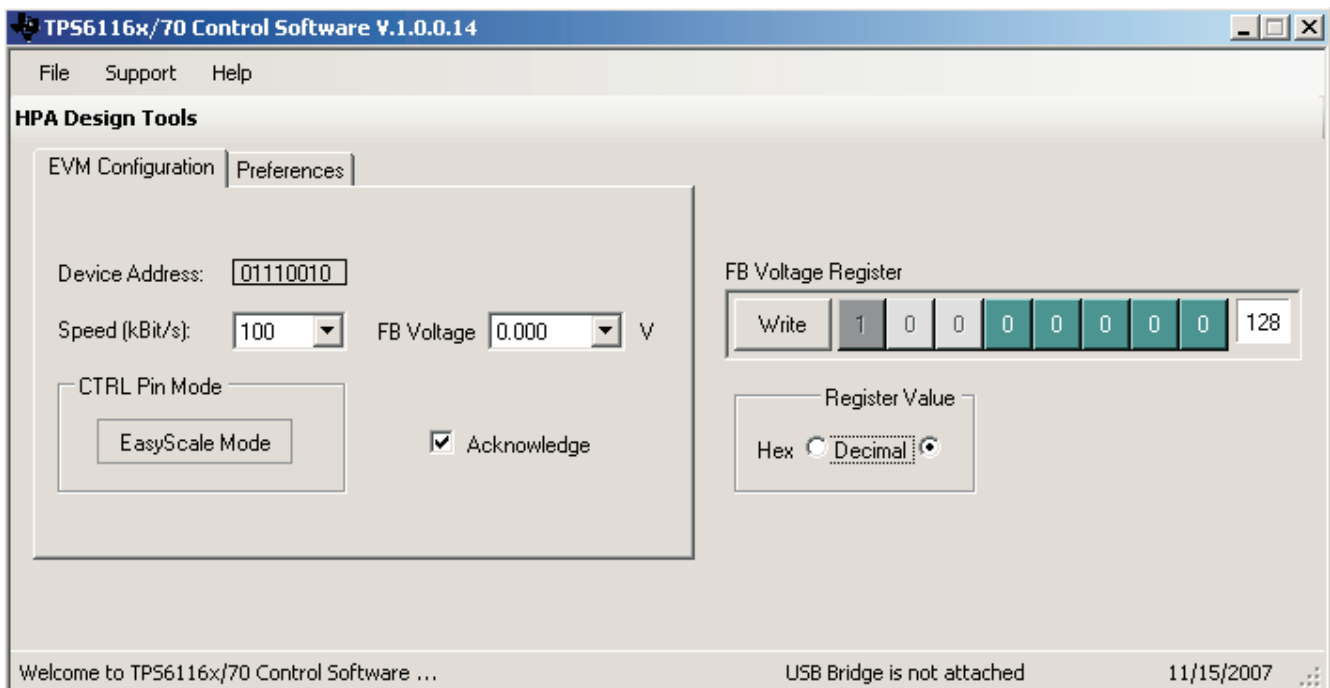
At start-up, the software first checks the firmware version of the USB-TO-GPIO adapter box. If an incorrect firmware version is installed, the software automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update, and downloads and installs the software. Note that after the firmware is updated, the user must disconnect and then reconnect the USB cable between the adapter and PC, as instructed during the install process. The host PC software also automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update and downloads and installs it.

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**Note:** VeriSign™ Code Signing is used to prevent any malicious code from changing this application. If at any time in the future the binaries are modified, the code will no longer attempt to run.

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The TPS61170 IC has a 5-bit register that stores the feedback voltage to which the error amplifier regulates the FB pin. Using the EasyScale™ protocol, the user can program a separate digital IC to generate a signal that changes this register to one of 32 discrete settings, thereby changing the FB voltage and subsequent regulated output voltage. The software provides a GUI interface which allows the user to change the bits directly or by a drop-down box. After changing the bits, the Write button must be pressed. See a screen shot of the software in [Figure 2](#) In order to exit EasyScale™ mode, the IC needs to be shutdown by pulling the CTRL low for 2.5ms and restarted.



**Figure 2. Screen Capture of TPS6116x/70 Controller Software GUI Interface**

## 2.5 Test Results

Figure 3 shows the test results using this EVM.

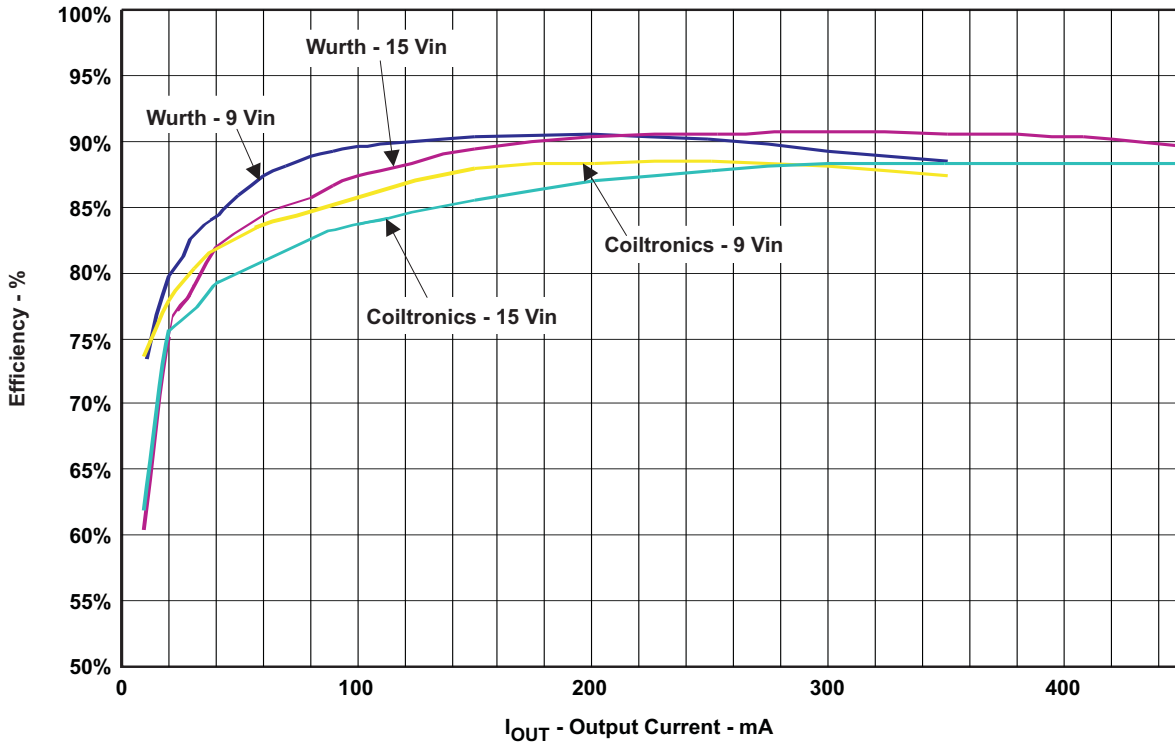


Figure 3. Efficiency with Coiltronics DRQ73-220 and Würth 744877220

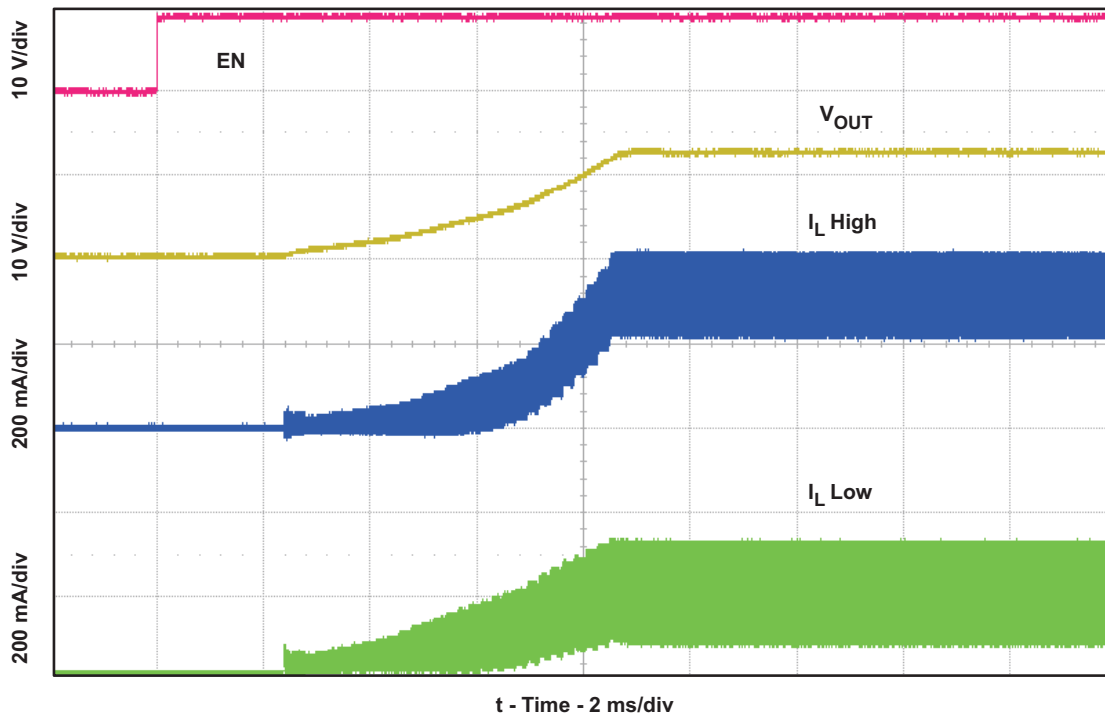


Figure 4. Start-Up With  $V_{IN} = 9\text{ V}$  and  $I_{OUT} = 200\text{ mA}$

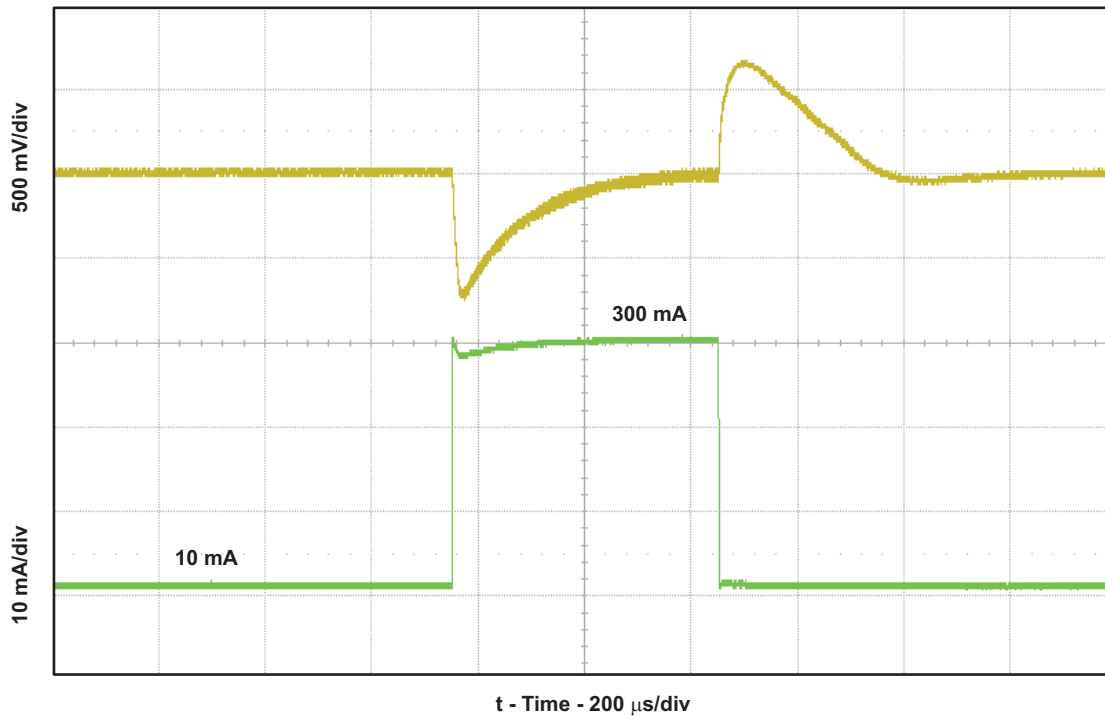


Figure 5. Load Transient Response From 10 mA to 300 mA With  $V_{IN} = 9$  V

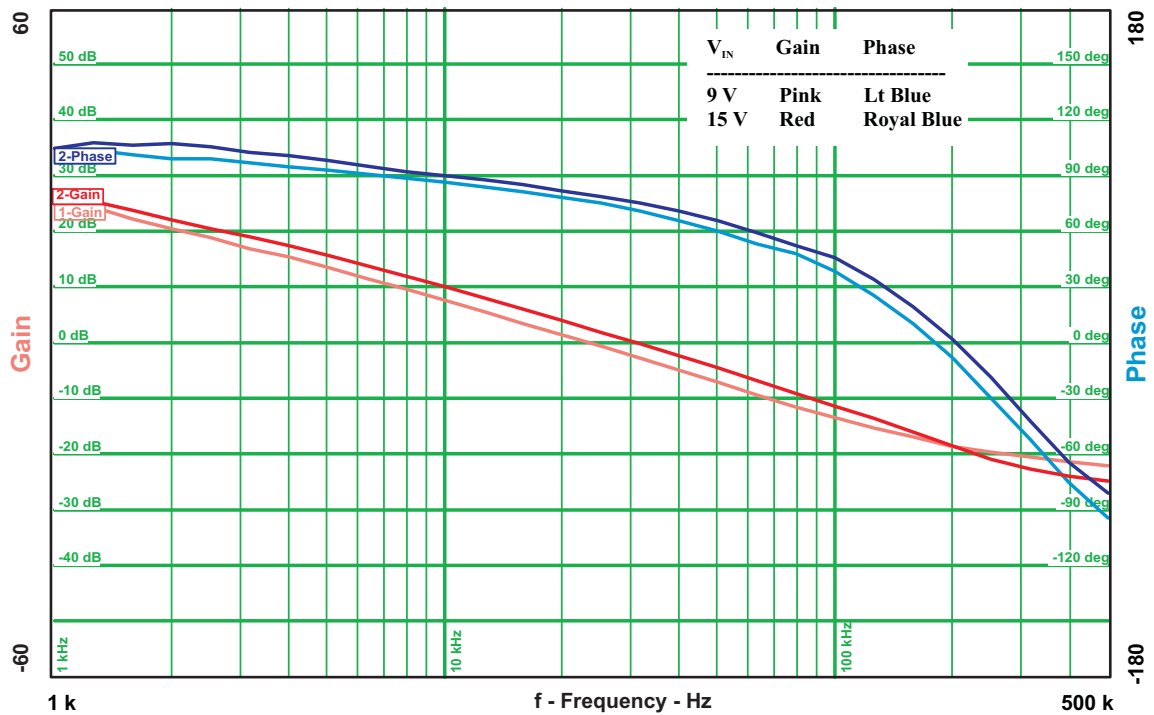
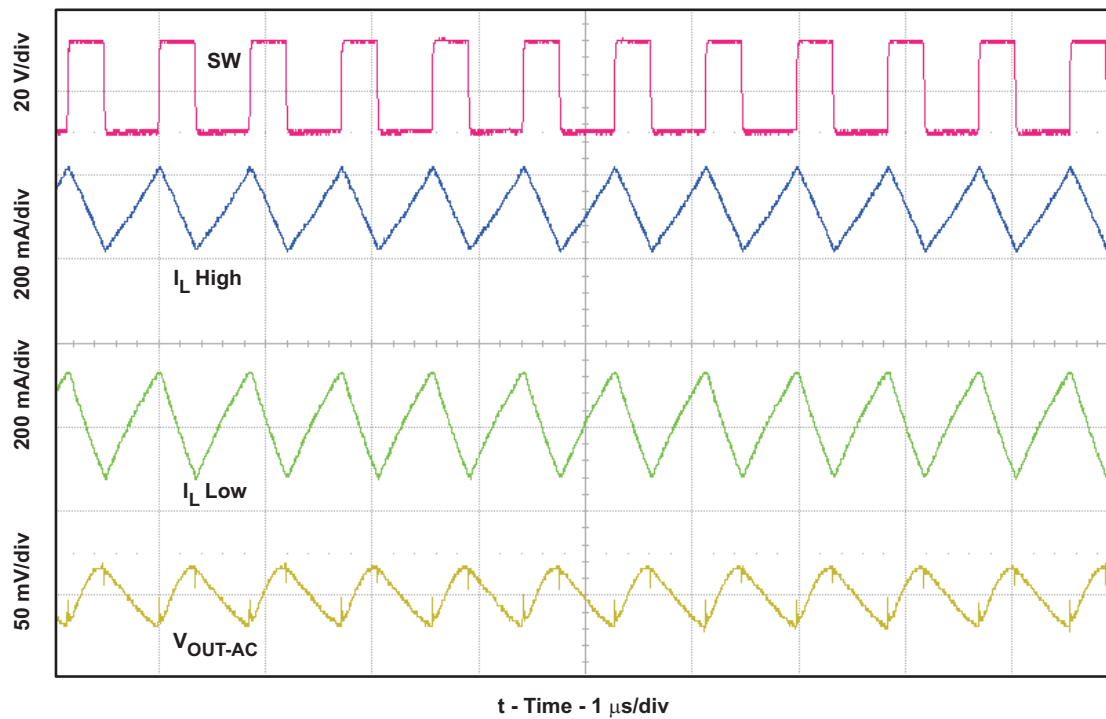


Figure 6. Loop Gain With  $I_{OUT} = 225$  mA and  $V_{IN} = 9$  V and 15 V



**Figure 7. PWM Operation at 200 mA With  $V_{IN} = 9$  V**

### 3 Board Layout

This section provides the TPS61170EVM board layout and illustrations.

#### 3.1 Layout

Board layout is critical for all switch-mode power supplies. [Figure 8](#), [Figure 9](#), and [Figure 10](#) show the board layout for the HPA316 printed-circuit board. The switching nodes with high-frequency noise are isolated from the noise-sensitive feedback circuitry. Careful attention has been given to the routing of high-frequency current loops. See the data sheet for further layout guidelines.



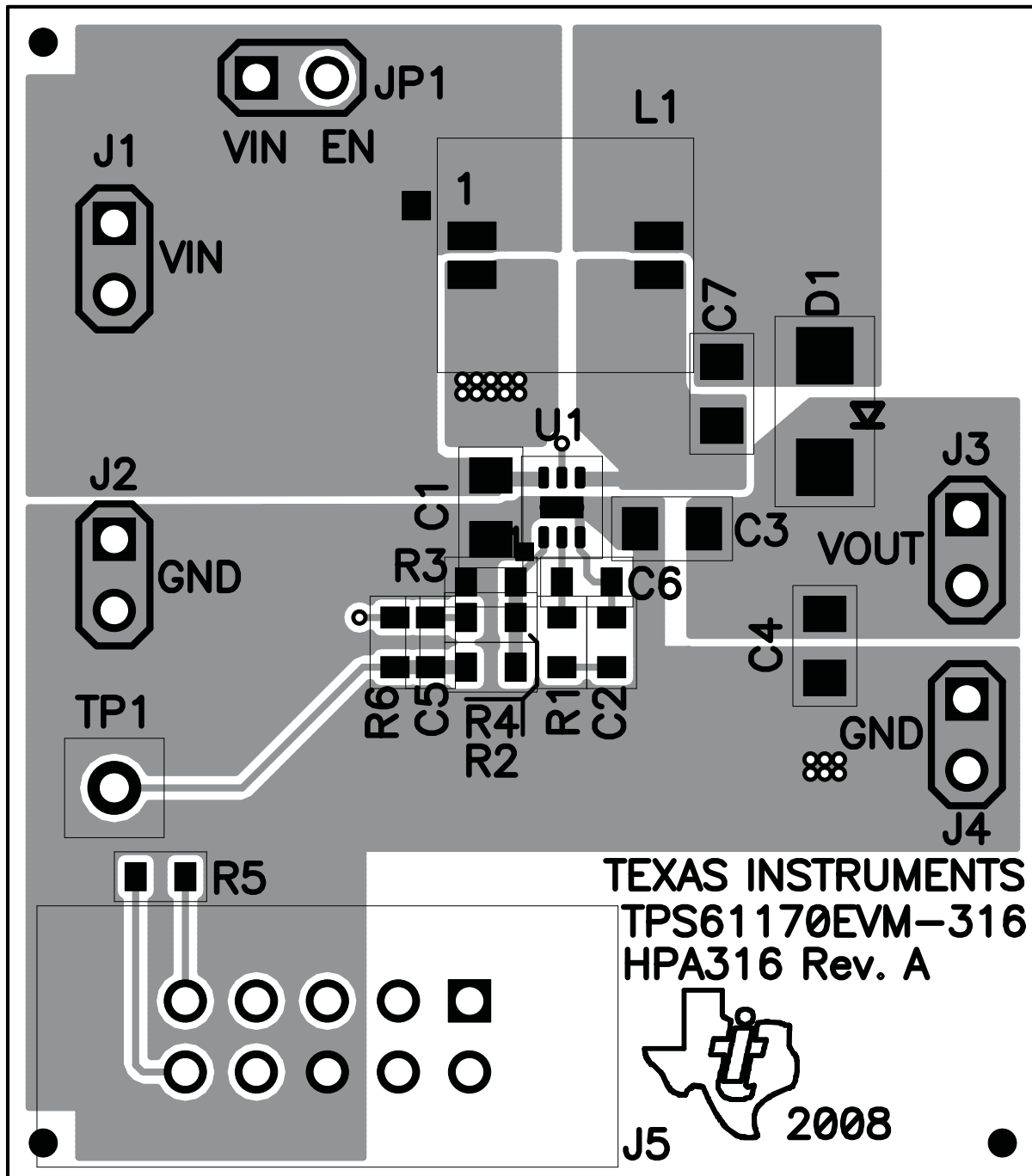


Figure 8. Top-Assembly Layer

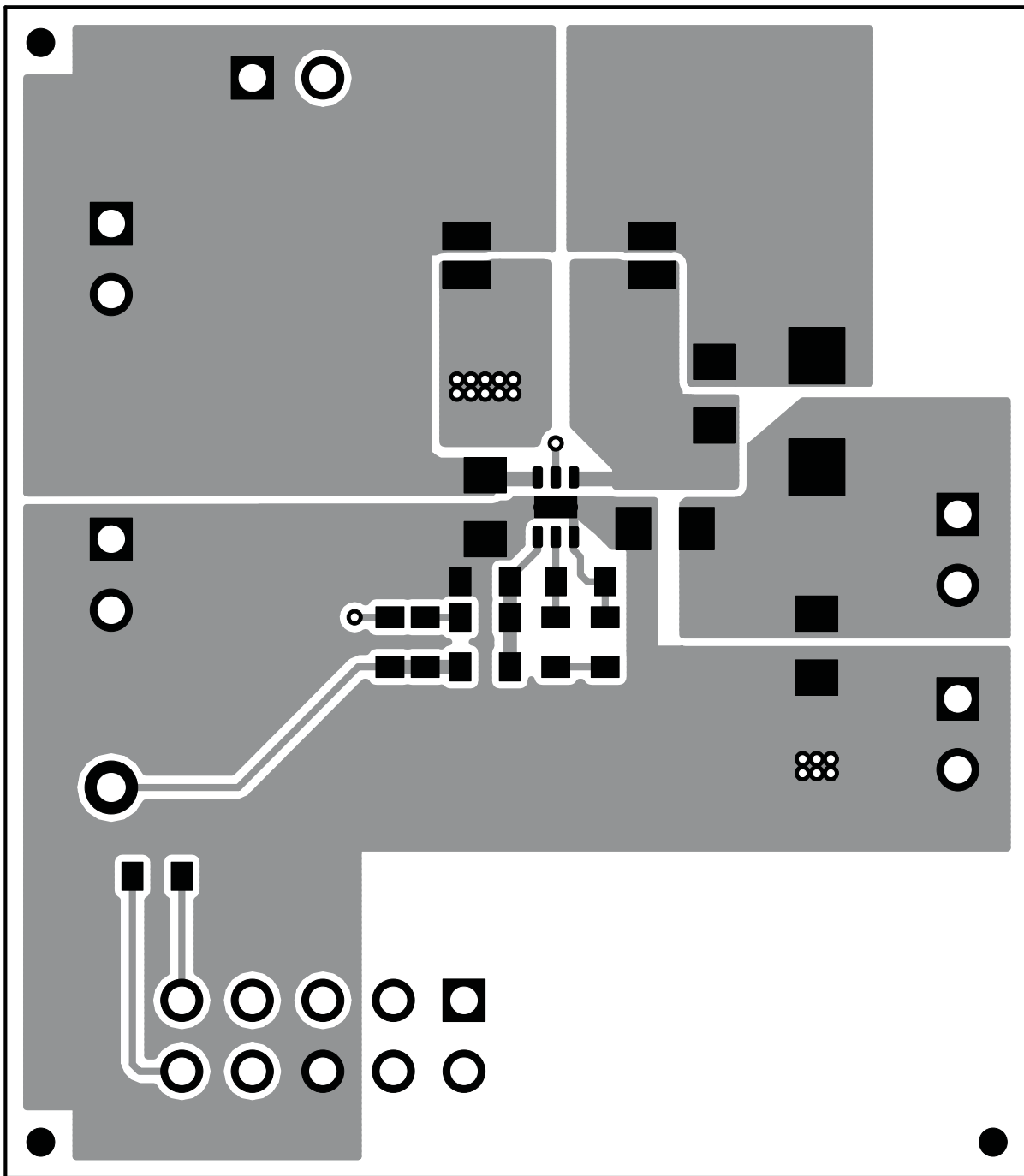


Figure 9. Top-Side Layer

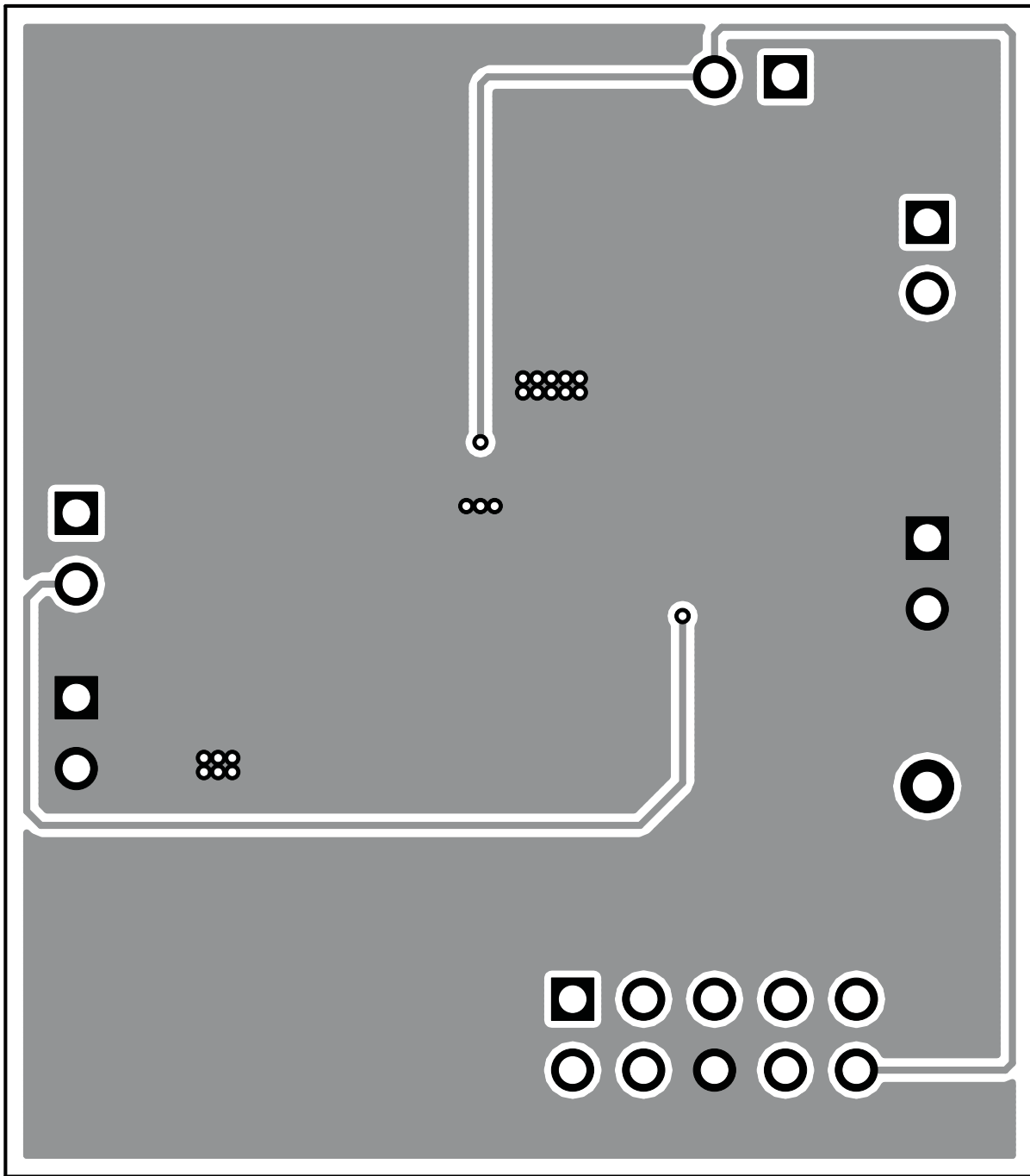


Figure 10. Bottom-Side Layer

## 4 Bill of Materials and Schematic

This section provides the TPS61170EVM-316 bill of materials and schematic.

### 4.1 Bill of Materials

**Table 2. HPA316A Bill of Materials<sup>(1)(2)(3)</sup>**

COUNT	RefDes <sup>(4)</sup>	Value	Description	Size	Part Number	MFR
1	C1	4.7uF	Capacitor, Ceramic, 25V, X5R, 10%	0805	TMK212BJ475KG-T	Taiyo Yuden
1	C2	0.022uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	Std	muRata
2	C3, C4	2.2uF	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
0	C5, C6	Open	Capacitor, Ceramic	0603		
1	C7	1.0uF	Capacitor, Ceramic, 50V, X5R, 10%	0805	Std	Taiyo Yuden
1	D1	MBRA140T3	Diode, Schottky, 1-A, 40-V	SMA	MBRA140T3	Motorola
4	J1, J2, J3, J4	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
1	J5	2510-6002UB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	2510-6002UB	3M
1	JP1	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
1	L1	22uH	Inductor, SMT, 1.6A, 0.11milliohm	0.300 x 0.300	DRQ73-220	Coiltronics
1	R1	4.99k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	280k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R3	31.6k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R4	Open	Resistor, Chip, 1/16W, 1%	0603		
1	R5	1.82k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	TP1	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
1	U1	TPS61170DRV	IC, 1.2 MHz/1A PWM	SON-6	TPS61170DRV	TI
1	--	--	PCB, 1.65 In x 1.45 In x 0.062 In		HPA316	Any
1	--	--	Shunt, 100 mil, Black	0.100	929950-00	3M

- (1) These assemblies are ESD sensitive, ESD precautions shall be observed.
- (2) These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
- (3) These assemblies must comply with workmanship standards IPC-A-610 Class 2.
- (4) Ref designators marked with an asterisk (\*\*\*) cannot be substituted. All other components can be substituted with equivalent MFG's components.

4.2 Schematic

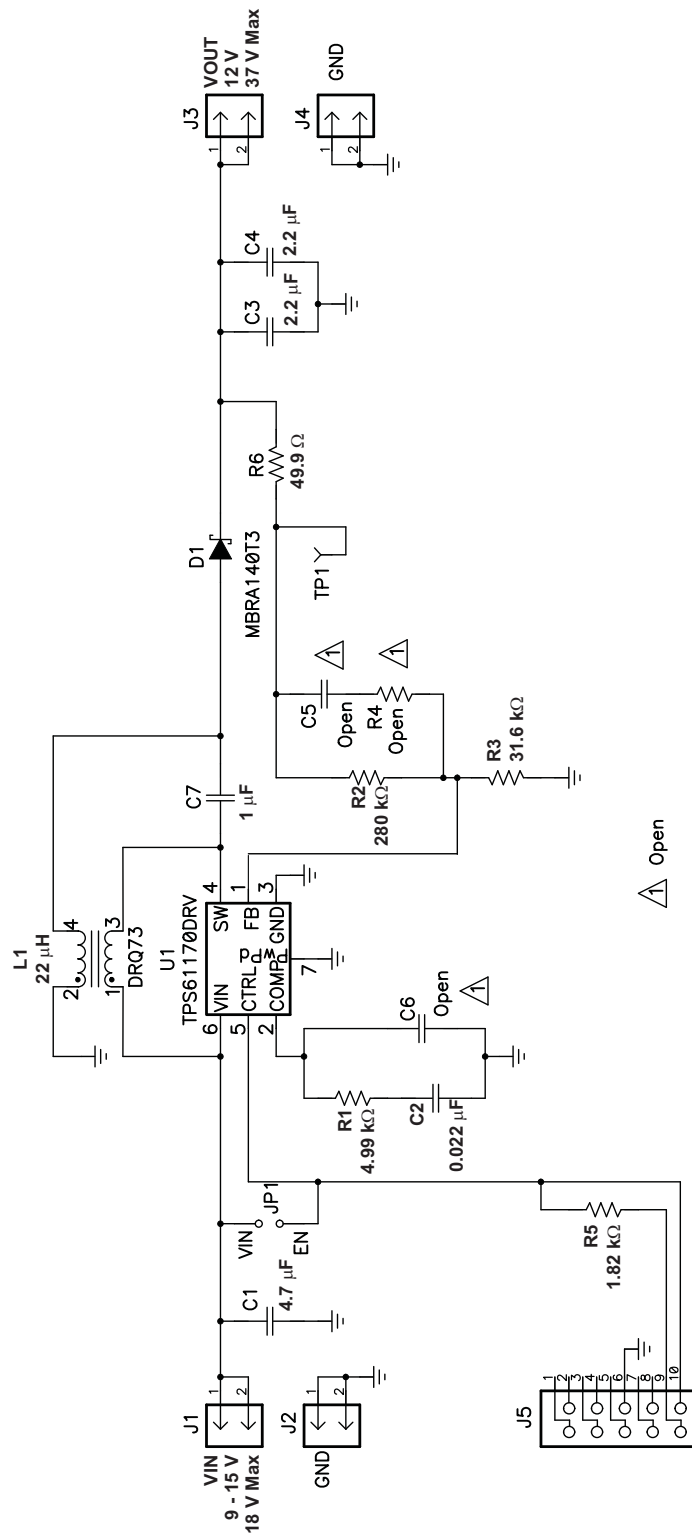


Figure 11. TPS61170EVM-316 Schematic

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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 3 V to 18 V and the output voltage range of up to 39 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 125° C. The EVM is designed to operate properly with certain components above 85° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

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