TPS61059EVM-141

This user's guide describes the characteristics, operation, and use of the TPS6105xEVM-141 evaluation module (EVM). This EVM demonstrates the Texas Instruments TPS6105x synchronous boost converter with down mode used to power high-current, white-light LEDs for photo flash applications. This user's guide includes setup instructions, a schematic diagram, a bill of materials (BOM), and PCB layout drawings for the evaluation module.

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1 Introduction

The Texas Instruments TPS6105xEVM-141 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS61058 or TPS61059 high-current boost converters for white-light photo flash applications. The TPS6105x has an externally programmed LED current so that the LED can be used as a flash for still photography and as a torch, or movie light, for digital movies.

The EVM has one white-flash LED, the TPS6105x converter, and a timing circuit used to make the EVM a stand-alone flash module.

If desired, other LEDs or LED current settings can be tested on the EVM by changing the feedback resistors on the EVM. See the TPS6105x data sheet for information on calculating new resistor values.

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TPS6105xEVM-141.

2.1 Input / Output Connector Descriptions

2.1.1 J1 –VIN

This is the positive input voltage connection to the converter. The EVM can be powered from any voltage between 2.7 V and 5.5 V. The leads to the input supply should be twisted and kept as short as possible to minimize EMI transmission and input voltage droop.

2.1.2 J2 –GND

This is the input return connection for the input power supply.

2.1.3 J3 –External Measurement or Control Connector

This connector is used to monitor the flash and enable inputs of the TPS6105x. An external controller can also be connected to this connector to operate the EVM flash function. R11 and R12 should be removed and left open if an external controller is used to control the EVM. The pin functions of J3 when using an external controller are shown in Table 1.

Pin 1 – EN: Output of timing circuit. Drives EN pin of the TPS6105x.

Pin 2 – FLASH: Output of timing circuit. Drives $\overline{\text{FLASH}}$ signal of TPS6105x. A low on this pin produces a high-current flash.

Pin 3 – FLASH OFF: Input to timing circuit. A high on this pin immediately forces the TPS6105x to stop a high-current flash. This pin can be used to interrupt or mask off a high-current flash. The state of this pin does not effect the timing of the timing circuit.

Pin 4 – GND

Table 1. J3 Pin Functions

EN(1)	FLASH OFF(1)	FLASH(1)	FUNCTION
L	X	X	OFF
H	L	H	MOVIE LIGHT
H	L	L	FLASH
H	H	H	MOVIE LIGHT
H	H	L	MOVIE LIGHT

(1) X = don't care; L = 0 V; H = 1.8 V

2.1.4 JP1 –Torch Enable

JP1 is used to enable torch mode. Placing a shorting bar across pins 1 and 2 of JP1 turns the torch mode on. In torch mode, the LED is constantly illuminated with an LED current of approximately 200 mA. If the *FLASH* button is pushed, the LED flashes at the *flash* current limit of 700 mA and then returns to torch mode after the flash time. If JP1 is left open, the LED is off. If the *FLASH* button is pushed with JP1 open, then the LED flashes and returns to the off state after the flash time.

2.2 Setup

2.2.1 EVM Factory Configuration

The EVM is configured to provide the following nominal operating conditions:

- Movie light current: 200 mA
- Flash current: 700 mA
- Precharge current: 42 mA
- Length of flash: 320 ms
- Time between flashes: 3.2 s

2.2.2 Changing Flash Timing

The length of flash and time between flashes can be changed by changing capacitors C15 and C9. Capacitor C15 sets the length of the flash, and capacitor C9 sets the time between flashes. The time of each period can be calculated, in seconds, using Equation 1 where C(nF) is the value of the corresponding timing capacitor in nanoFarads.

$$t_{sec} = \frac{C_{(nF)}}{175} + 0.0005 \quad (1)$$

For example, the EVM has a 0.056-µF capacitor installed for C15 which determines the length of the flash. Using Equation 1, a 0.056-µF capacitor provides a 320-ms flash.

Care must be taken when changing the timing so that the maximum power rating of the LED (D1) or sense resistor (R7) are not exceeded. The average power of these components can be calculated using the duty cycle of the flash circuit. The flash duty cycle is the time the LED is in flash mode divided by the sum of the flash mode and time between flashes. The duty cycle can be calculated using Equation 2 with the value of the timing capacitors C15 and C9.

$$\text{Duty Cycle} = \frac{C_{15(nF)} + 0.0875}{C_{15(nF)} + C_{9(nF)} + 0.175} \quad (2)$$

The average power dissipated in the sense resistor R7 is calculated using Equation 3. In Equation 3, I_{flash} is the flash current level, and $I_{noflash}$ is the current when not flashing which is zero or the torch current value depending on the setting of JP1.

$$\text{AvgPower } R_7 = I^2 \text{ flash } R_7 D + I^2 \text{ noflash} R_7 (1 - D) \quad (3)$$

The average power dissipated in the LED is calculated using Equation 4. In Equation 4, V_{FLED} is the forward voltage of the LED, I_{flash} is the flash current level, and $I_{noflash}$ is the current when not flashing which is zero or the torch current value depending on the setting of JP1.

$$\text{AvgPowerLED} = I_{flash} V_{FLED} D + I_{noflash} V_{FLED} (1 - D) \quad (4)$$

2.2.3 Using External Control

The EVM has provisions to disable the onboard timing circuit and use an external controller. An external controller can be connected to connector J3 to drive the enable and flash inputs of the TPS6105x. Resistors R11 and R12 should be removed and left open on the EVM to avoid signal contention between the onboard timing circuit and the external controller.

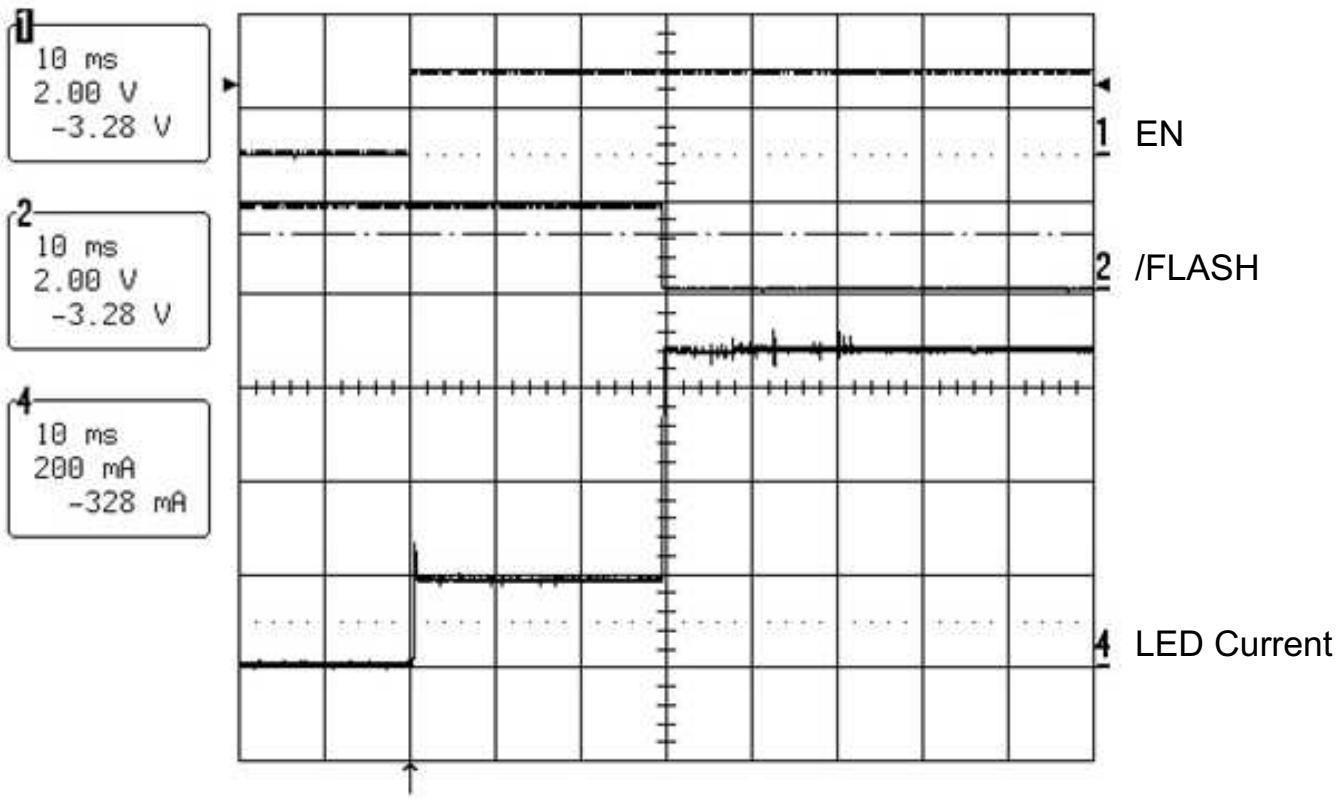
2.2.4 Operation

1. Configure JP1 to enable or disable torch mode as desired.
2. Connect the input voltage return to J2.
3. Connect the positive input voltage to J1.
4. Turn on input voltage. If JP1 is shorted, then the LED turns on in torch mode. If JP1 is open, the LED remains off.
5. Push the *FLASH* button to flash the LED.
6. The LED flashes for approximately 320 ms.
7. If JP1 is shorted, then the LED returns to torch mode. If JP1 is open, the LED turns off.

The EVM board has a built-in timing circuit to generate the necessary signals for torch and flash modes. The timing circuit sets the length of the flash. After a flash, the timing circuit disables the flash function for approximately 3.2 s. Pressing the flash button during this 3-s period has no effect. This keeps the average power dissipation of the LED below the maximum power limitation of the LED.

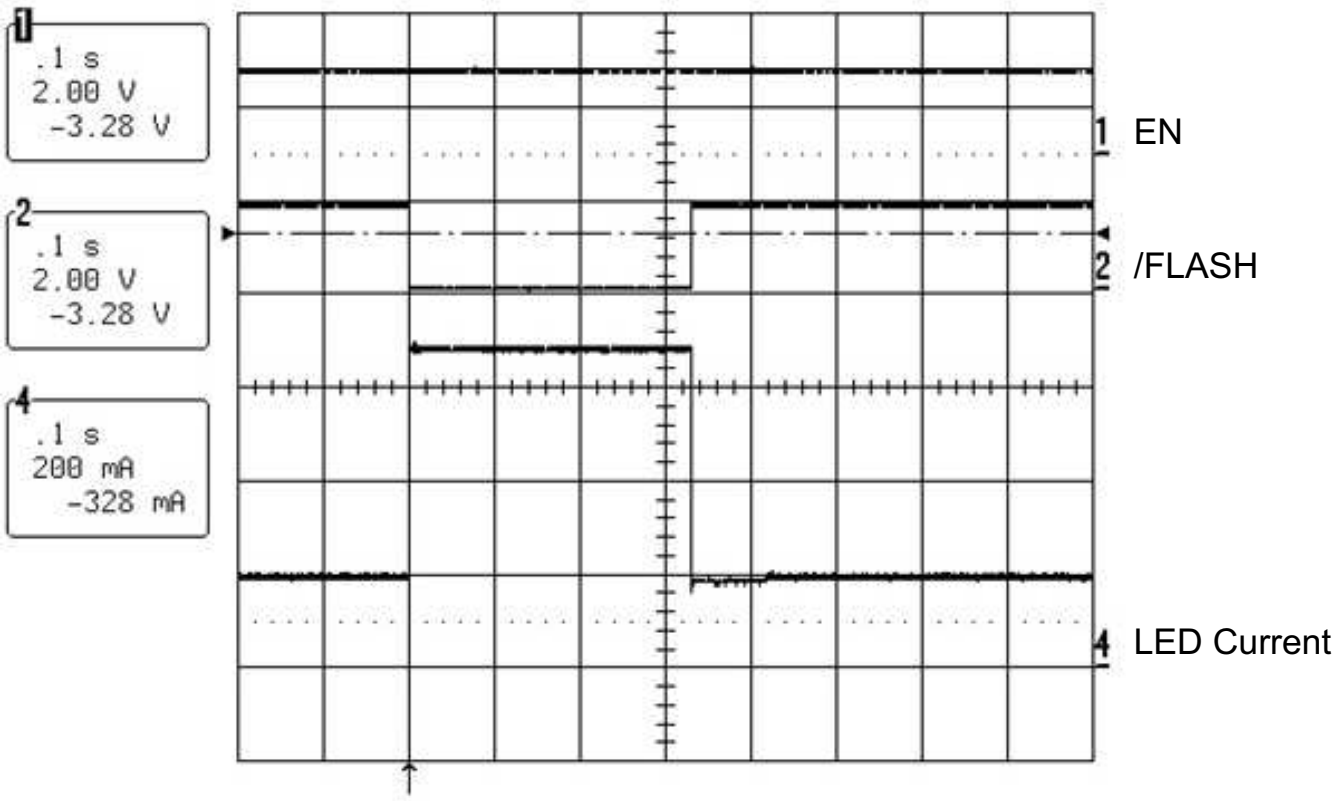
The *FLASH OFF* input on J3 can be used to force the LED flash off during a flash sequence. This is intended to turn the flash off in camera phones while the power amplifier is transmitting. A logic 1 on pin 3 of J3 extinguishes the flash as long as the input is high. This does not reset the timing of the timing circuit.

2.2.5 Test Results



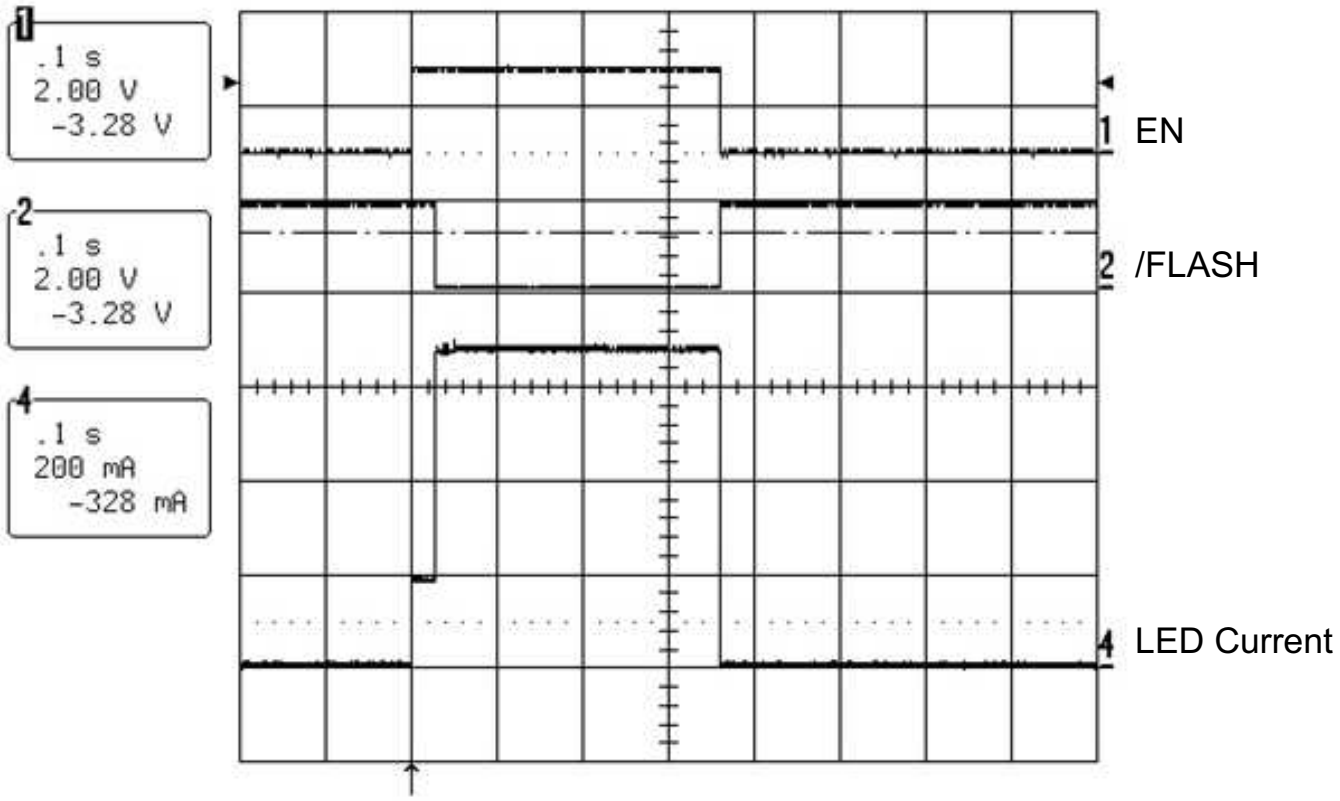
NOTE: CH1 = Enable Signal – pin 1 of J3; CH2 = $\overline{\text{Flash}}$ Signal – Pin 2 of J3; CH4 = LED Current

Figure 1. Timing From LED Off to 700-mA Flash



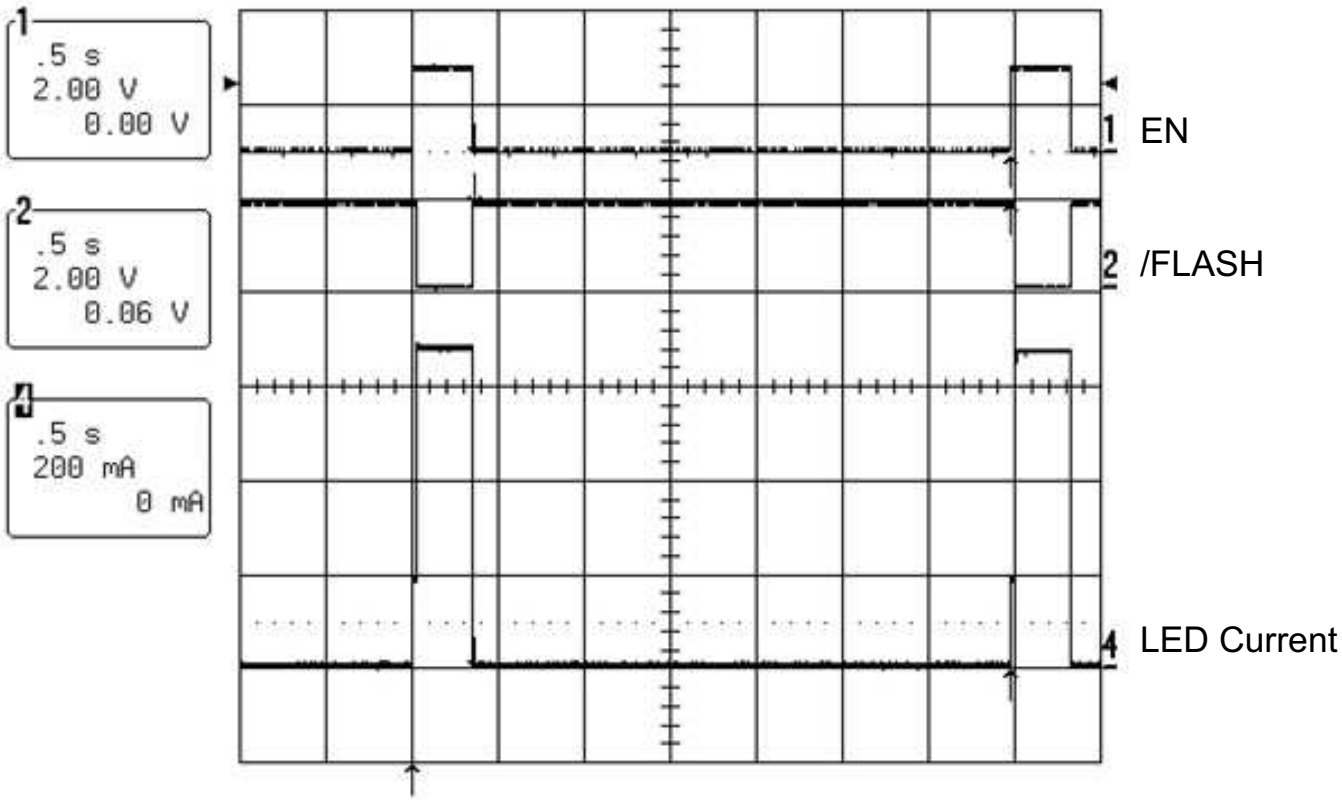
NOTE: CH1 = Enable Signal – pin 1 of J3; CH2 = $\overline{\text{Flash}}$ Signal – Pin 2 of J3; CH4 = LED Current

Figure 2. Timing From 200-mA Movie Light to 700-mA Flash



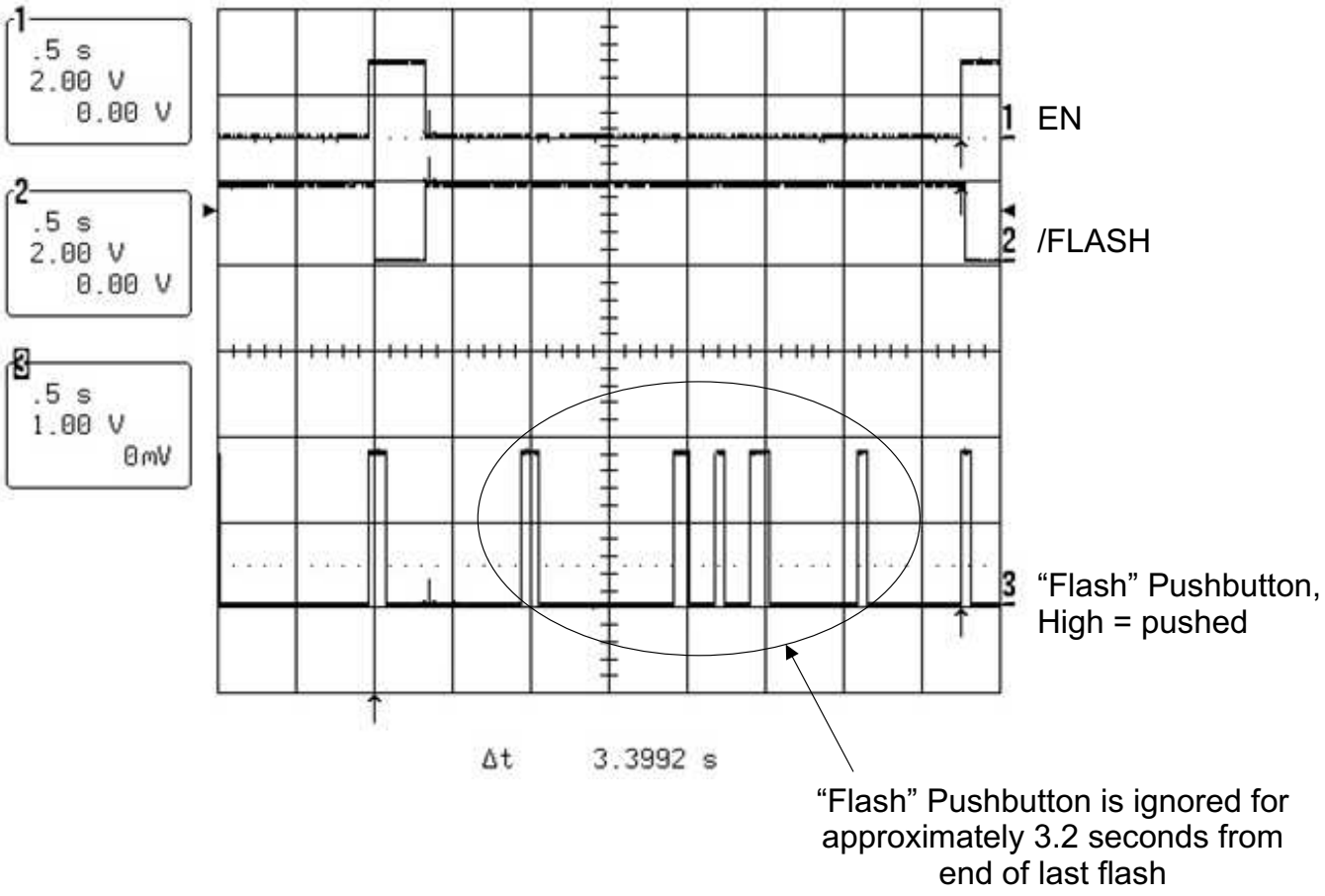
NOTE: CH1 = Enable Signal – pin 1 of J3; CH2 = $\overline{\text{Flash}}$ Signal – Pin 2 of J3; CH4 = LED Current

Figure 3. Timing From LED Off to 700-mA Flash



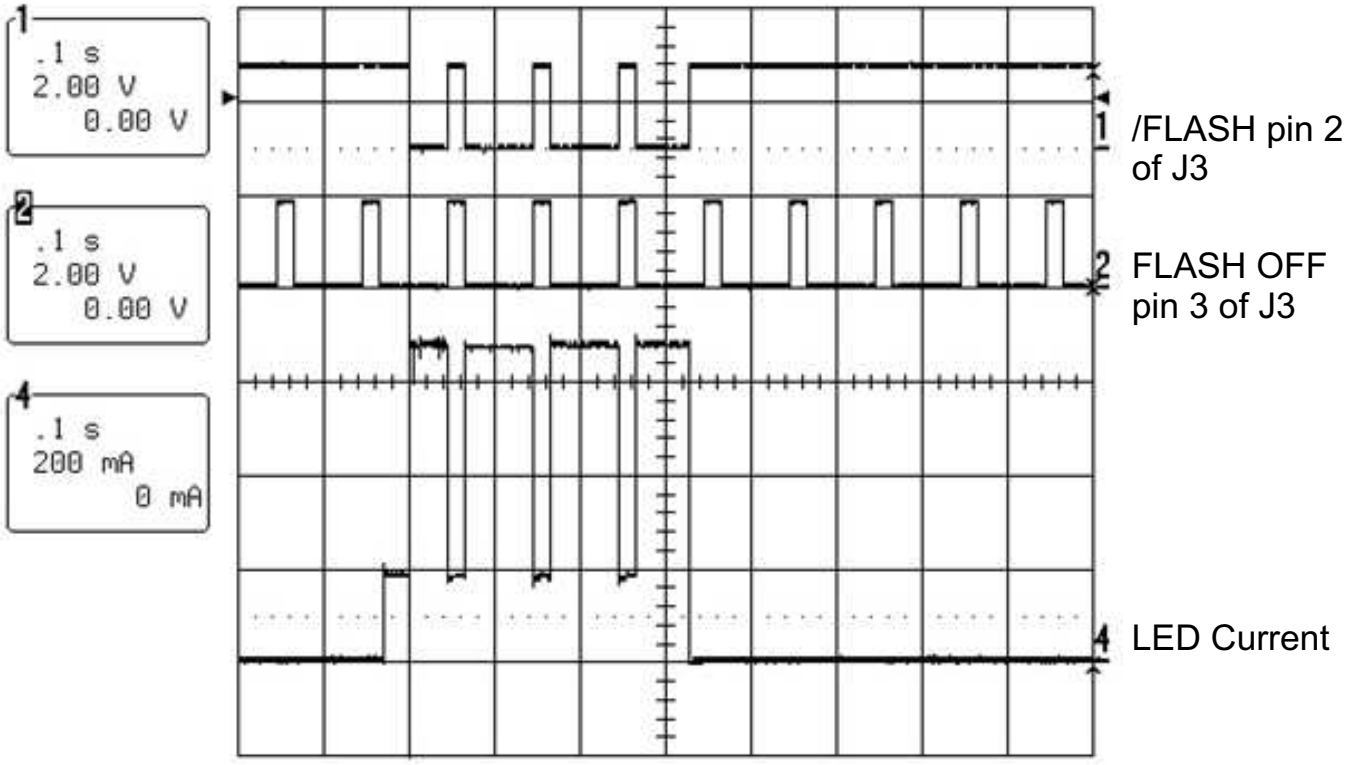
NOTE: CH1 = Enable Signal – pin 1 of J3; CH2 = $\overline{\text{Flash}}$ Signal – Pin 2 of J3; CH4 = LED Current

Figure 4. Timing Between Flashes



NOTE: CH1 = Enable Signal – pin 1 of J3; CH2 = $\overline{\text{Flash}}$ Signal – pin 2 of J3; CH3 = Pushbutton Signal pin A1 of U4

Figure 5. Timing Between Flashes Using Pushbutton



NOTE: CH1 = $\overline{\text{FLASH}}$– pin 2 of J3; CH2 = FLASH OFF – Pin 3 of J3; LED Current

Figure 6. LED Flash Interrupted With FLASH OFF Input

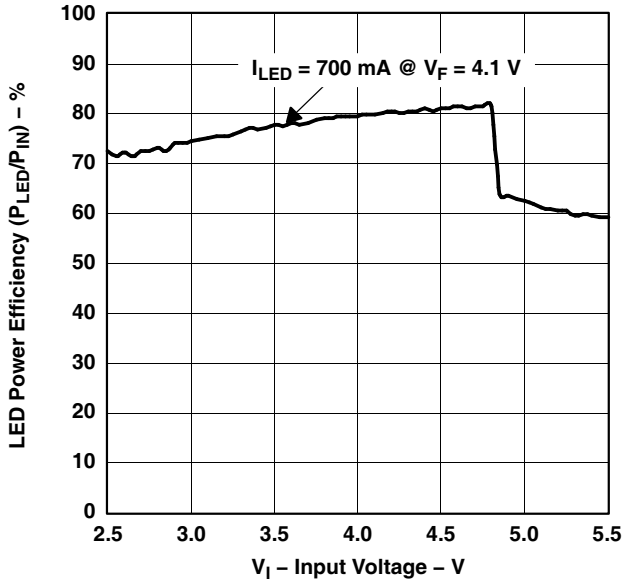


Figure 7. Efficiency

3 Board Layout

This section provides the TPS6105xEVM-141 board layout and illustrations.

3.1 Layout

Figure 8, Figure 9, and Figure 10 show the board layout for the TPS6105xEVM-141 printed-circuit board.

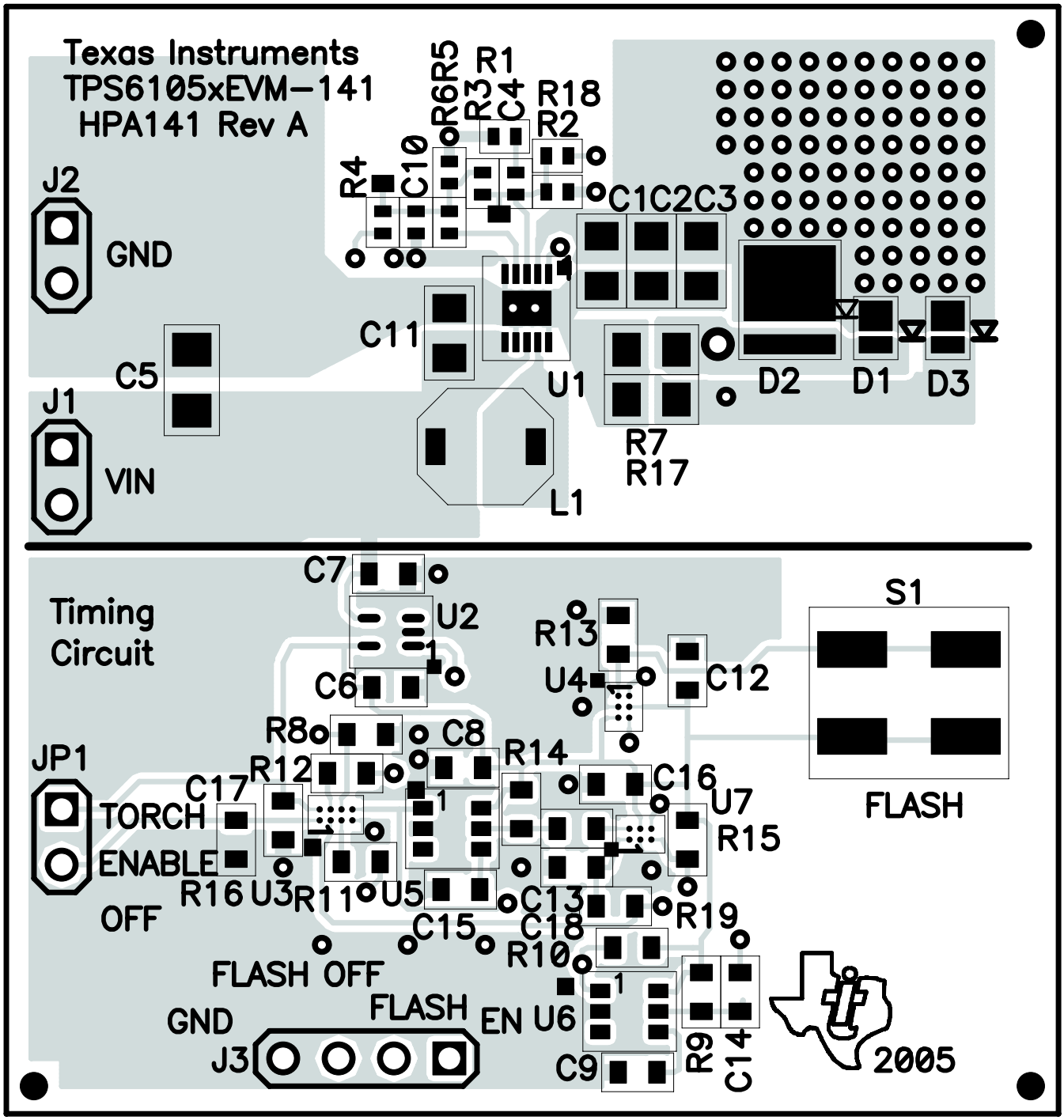


Figure 8. Assembly Layer

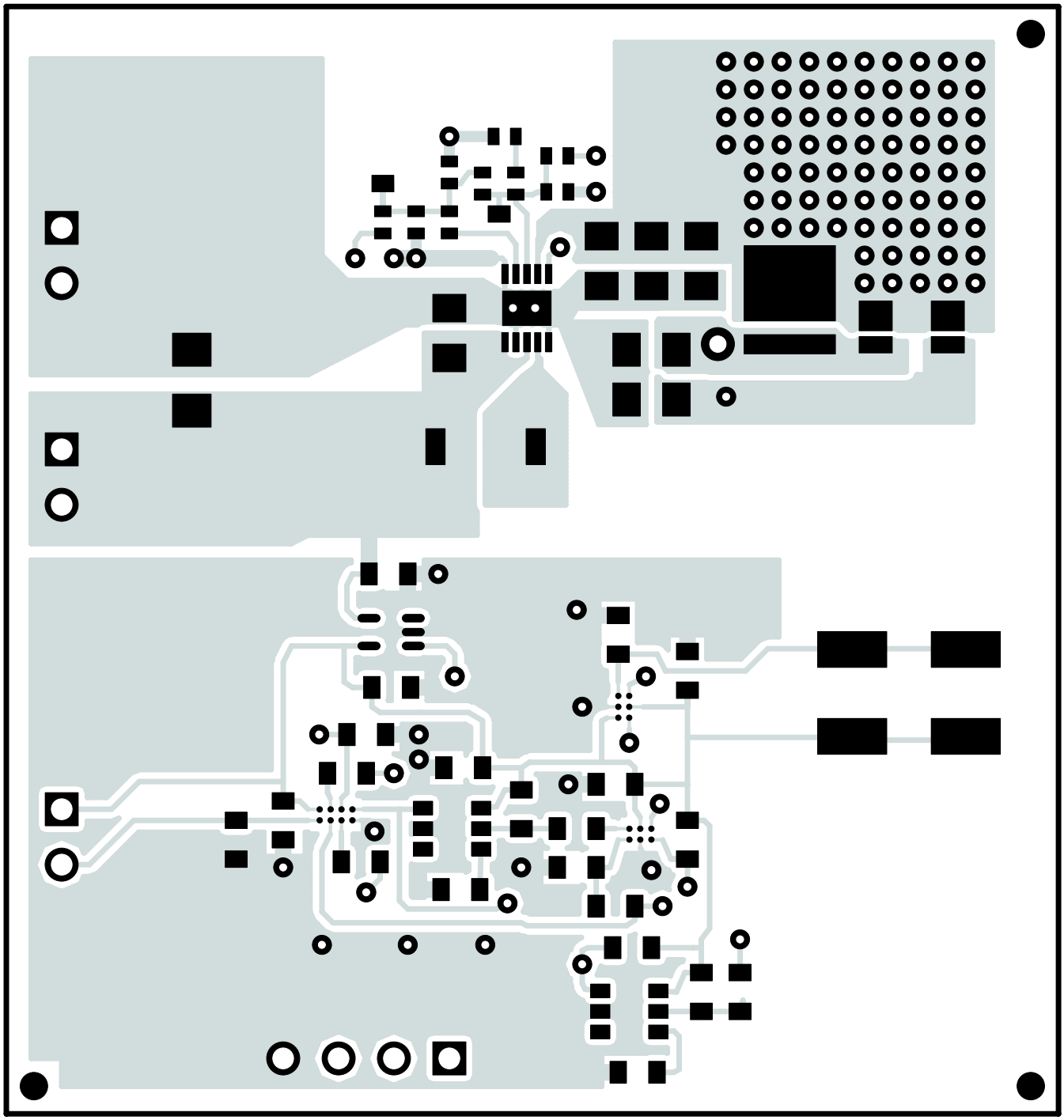


Figure 9. Top Layer Routing

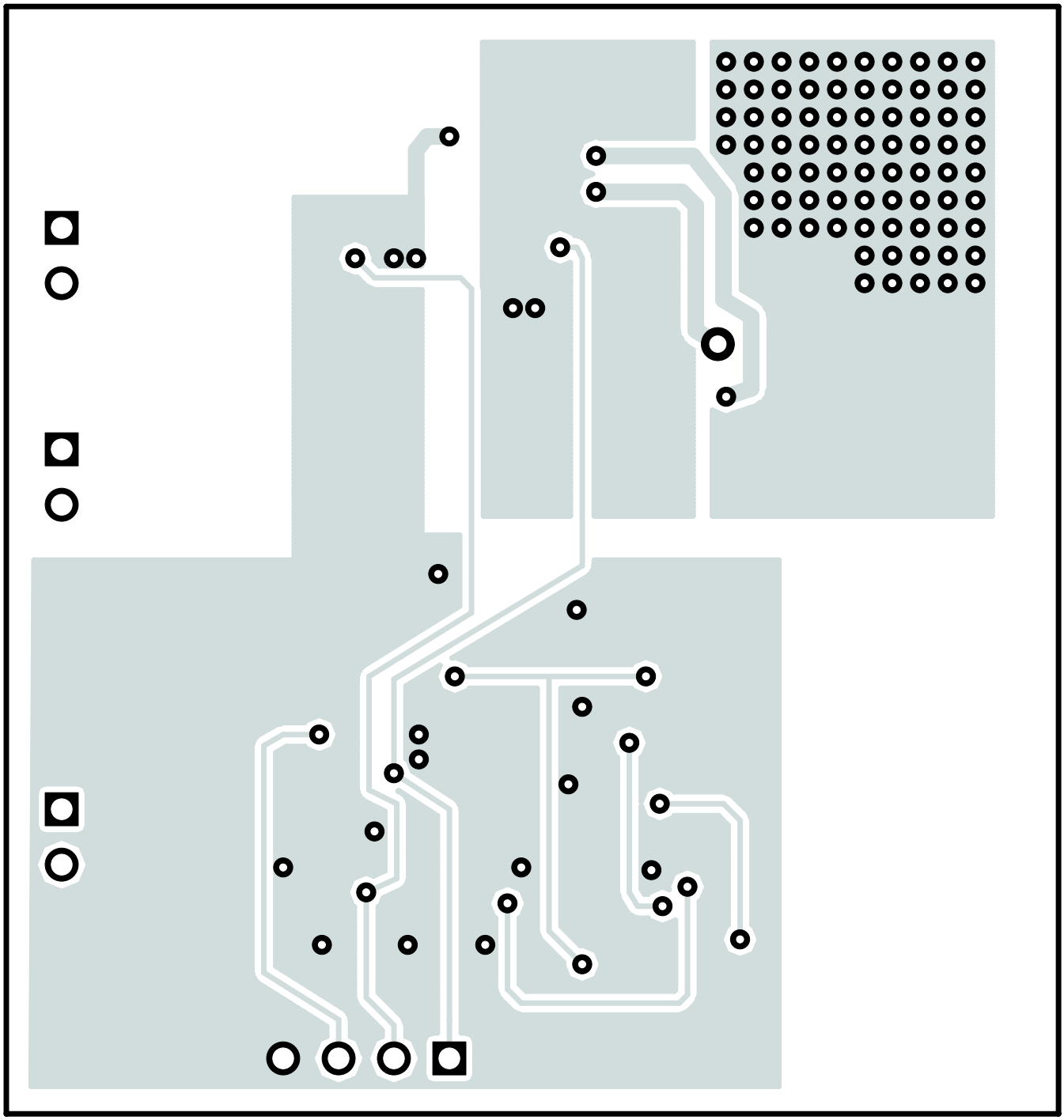


Figure 10. Bottom Layer Routing

4 Schematic and Bill of Materials

This section provides the TPS6105xEVM-141 schematic and bill of materials.

4.1 Schematic

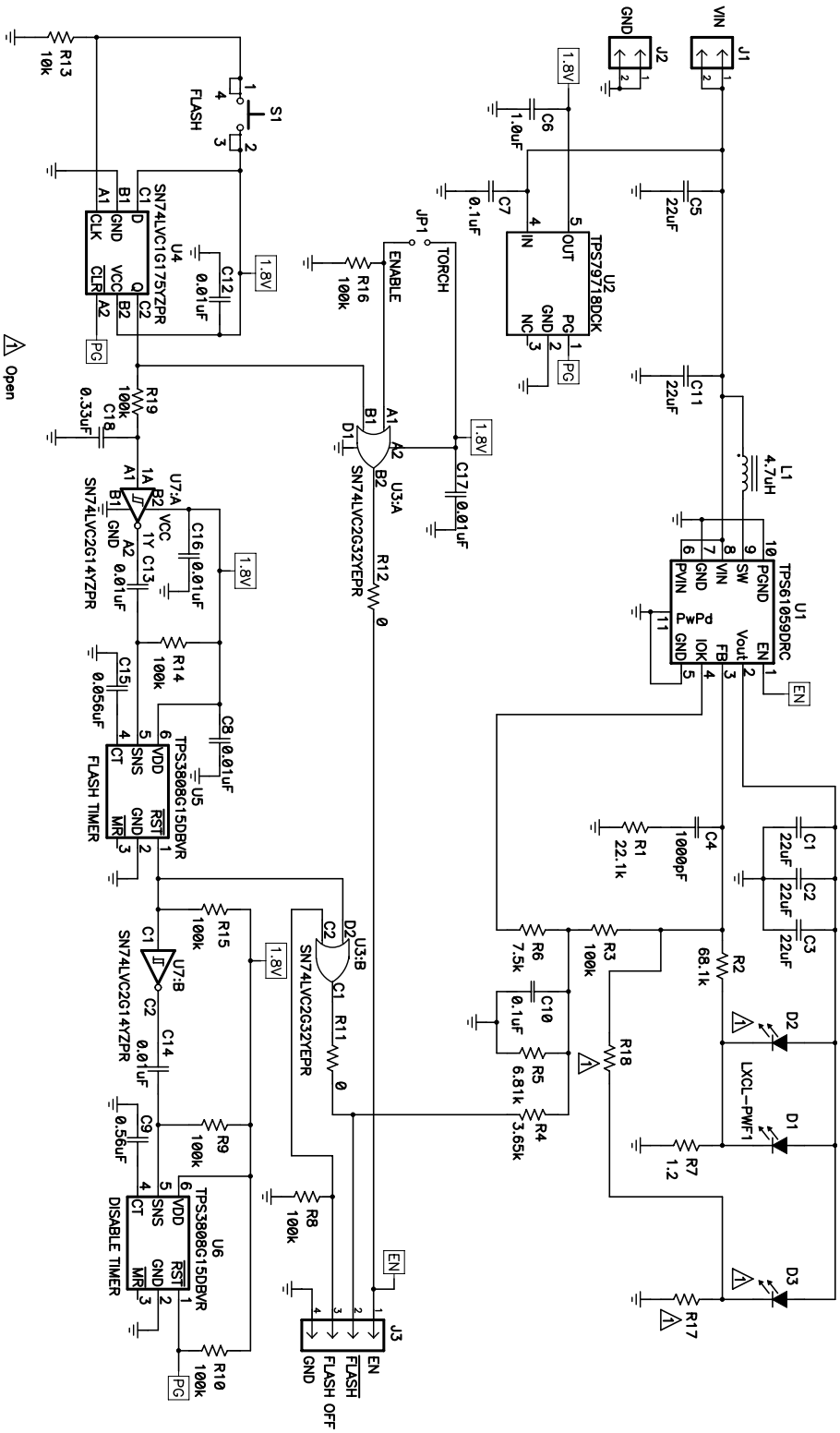


Figure 11. TPS6105xEVM-141 Schematic

4.2 Bill of Materials

Table 2. HPA141A Bill of Materials

COUNT	Ref Des	Value	Description	Size	Part Number	MFR
4	C1, C2, C3, C11	22 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	C2012X5R0J226MTJ	TDK
1	C10	0.1 µF	Capacitor, Ceramic, 25V, X5R, 10%	0402	C1005X5R1E104K	TDK
1	C15	0.056 µF	Capacitor, Ceramic, 16V, X7R, 10%	0603	GRM188R71C563KC01	Murata
1	C18	0.33 µF	Capacitor, Ceramic, 10V, X5R, 10%	0603	C1608X5R1A334KB	TDK
1	C4	1000 pF	Capacitor, Ceramic, 25V, C0G, 5%	0402	C1005C0G1E102K	TDK
1	C5	22 µF	Capacitor, Ceramic, 10V, X5R, 10%	1206	C3216X5R1A226K	TDK
1	C6	1.0 µF	Capacitor, Ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK
1	C7	0.1 µF	Capacitor, Ceramic, 50V, X7R, 15%	0603	C1608X7R1H104K	TDK
6	C8, C12, C13, C14, C16, C17	0.01 µF	Capacitor, Ceramic, 25V, C0G, 5%	0603	C1608C0G1E103K	TDK
1	C9	0.56 µF	Capacitor, Ceramic, 10V, X5R, 10%	0603	C0603C564K8PACTU	Kemet
1	D1		Diode, Flash, 1amp, Vfwd 3.9V	0.065 × 0.080	LXCL-PWF1	Lumileds Lighting
0	D2	Open	Diode, LED	1210		
0	D3	Open	Diode, Flash, 1amp, Vfwd 3.9V	0.065 × 0.080		
2	J1, J2		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 × 2	PTC36SAAN	Sullins
1	J3		Header, 4 pin, 100mil spacing, (36-pin strip)	0.100 × 4	PTC36SAAN	Sullins
1	JP1		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 × 2	PTC36SAAN	Sullins
1	L1	4.7 µH	Inductor, SMT, 1.1A, 120 mΩ	0.177 × 0.185	VLF5014AT-4R7M1R1	TDK
1	R1	22.1k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
2	R11, R12	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R13	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R17	Open	Resistor, Chip, 1/10W, 1%	0805		
0	R18	Open	Resistor, Chip, 1/16W, 1%	0402		
1	R2	68.1k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R3	100k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R4	3.65k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R5	6.81k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R6	7.5k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R7	1.2	Resistor, Chip, 1/10W, 1%	0805	Std	Std
7	R8, R9, R10, R14, R15, R16, R19	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	S1		Switch, SPST, PB Momentary, Sealed Washable	0.245 × 0.251	KT11P2JM	C & K
1	U1		IC, Synchronous Boost Converter With Down Mode High Power White LED Driver	SON-10	TPS61059DRC	TI
1	U2		IC, Regulator, LDO, Micropower, 1.1µA at 10mA. Vin 0.30–5.5V	SOP-5 (DCK)	TPS79718DCK	TI
1	U3		IC, Dual 2-Input Positive-OR Gates	WCSP-8	SN74LVC2G32YEPR	TI
1	U4		IC, Single D-Type Flip-Flop With Asynchronous Clear	WCSP-6	SN74LVC1G175YZPR	TI
2	U5, U6		IC, Low Quiescent Current, Programmable 1.5V, Delay Time: 1.25ms to 10s	SOT23-6	TPS3808G15DBVR	TI
1	U7		IC, Dual Schmitt-Trigger Inverter	WCSP-6	SN74LVC2G14YZPR	TI
1	—		PCB, 2 In x 1.9 In x 0.062 In		HPA141	Any
1	—		Shunt, 100-mil, Black	0.100	929950-00	3M

5 Related Documentation From Texas Instruments

TPS61058/9 data sheet (SLVS572)

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This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 2.7 V to 5.5 V and the output voltage range of 2.5 V to 5.5 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.

EVM WARNINGS AND RESTRICTIONS (continued)

During normal operation, some circuit components may have case temperatures greater than 55°C. The EVM is designed to operate properly with certain components above 60°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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