

## **TPS65560EVM-165**

This user's guide describes the characteristics, operation, and use of the TPS65560EVM-165 Evaluation Module (EVM). This EVM demonstrates the Texas Instruments TPS65560 Integrated Photo Flash Chargers with IGBT Drivers. This user's guide includes setup instructions, a schematic diagram, a bill of materials, and printed-circuit board layout drawings for the evaluation module.

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## **1 Introduction**

The TPS65560 is a highly integrated flyback converter used to charge photo flash capacitors. The Texas Instruments TPS65560EVM-165 evaluation module (EVM) helps designers evaluate the operation and performance of this device.

The EVM contains one fully functional photo flash charger capable of charging a photo flash capacitor to 320 volts from a battery with voltage between 1.6 and 12 volts. The EVM also provides a flash lamp and trigger circuit to help the designer evaluate the charging characteristics. The onboard lamp circuit can be disabled so that the EVM can be connected to a user-supplied lamp and trigger circuit.

## 2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TPS65560EVM-165.

### **WARNING**

The TPS65560EVM-165 produces high voltage and is designed to charge the bulk flash capacitor to more than 320 volts. This capacitor can maintain this voltage for a long time, even after the input power has been removed from the board. Do not touch any exposed metal on the TPS65560EVM-165 without first discharging the bulk flash capacitor.

### 2.1 Input / Output Connector Descriptions

#### 2.1.1 J1 – Vbatt

This is the positive battery voltage input connection to the converter. This voltage should be between 1.6 and 12 volts dc.

#### 2.1.2 J2 – GND

This is the return connection for the battery voltage to the converter.

#### 2.1.3 J3 – V<sub>CC</sub>

This is the positive digital voltage supply. This voltage should be between 2.7 and 4 volts dc.

#### 2.1.4 J4 – GND

This is the return connection for the digital voltage supply.

#### 2.1.5 J5 – REMOTE CONTROL

This connector is used to interface the EVM to a personal computer as an optional method of controlling the EVM. All necessary control inputs and outputs for the converter are present on this connector. The flash and charge signals are inverted before connecting to the TPS65560 on the EVM board. The pinout for the connector is shown [Table 1](#).

**Table 1. J5 Pinout**

Pin No.	Signal	Function
1, 3, 5, 7, 9	GND	Signal ground
2	Charge Complete	Output: An active low indicates the flash capacitor is charged
4	Charge	Input: A positive edge initiates the charging of the flash capacitor
6	Flash	Input: A logic-high signal initiates a lamp flash
8	I_PEAK	Input: Used to provide the peak current set point of the charger
10	V <sub>CC</sub>	This pin is connected to the V <sub>CC</sub> plane of the EVM board

### 2.1.6 J6 –User Lamp module HV connections

This connector is used to connect the EVM module to a user-supplied lamp and trigger circuit. Pin 1 of this connector is the trigger signal. Pin 2 of this connector is the high-voltage side of the photo flash capacitor. See the EVM schematic for more information

### 2.1.7 J7 –User Lamp module HV Return connections

This connector is used to connect the EVM module to a user-supplied lamp and trigger circuit. Both pins of this connector are connected to the negative side of the photo flash capacitor and provide the return path for the flash currents.

### 2.1.8 JP1 & JP2 – EVM Lamp disconnect

These jumpers are used to disconnect the lamp and trigger circuit of the EVM so that a user-supplied lamp and trigger can be evaluated. The lamp and trigger are disconnected when both jumpers JP1 and JP2 are removed.

### 2.1.9 JP3 –I\_PEAK

This connector is used to externally set the charge current. Pin 2 of this connector is tied directly to the I\_PEAK pin of the TPS65560. Connecting a jumper from pin 2 (I\_PEAK) to pin 1 (V<sub>CC</sub>) configures the TPS65560 to charge the flash capacitor using the maximum peak current. Connecting a jumper from pin 2 (I\_PEAK) to pin 3 (GND) configures the TPS65560 to charge the flash capacitor using the minimum peak current. Other peak current levels can be programmed by installing resistors in positions R6 and R7 on the EVM board. R6 and R7 can be used to form a voltage divider between V<sub>CC</sub> and GND to set the voltage on the I-Peak pin of the TPS65560.

## 2.2 Setup and Operation With Onboard Lamp and Trigger Circuit

1. Discharge the photo flash capacitor by shorting C5 with a 15-kΩ resistor for over 20 seconds. Use a multimeter to measure the voltage on C5 and verify that the voltage is close to zero before continuing or touching any connectors or components.
2. If needed, install jumpers across JP1 and JP2 to connect the onboard lamp and trigger circuit to the control circuitry.
3. Connect the positive lead of an input power supply J3. This voltage should be between 2.7 and 4 volts dc to supply V<sub>CC</sub> to the TPS65560.
4. Connect the negative lead of an input power supply to J4.
5. Connect the positive lead of a battery or power supply to J1. This voltage can be between 1.6 and 12 volts.
6. Connect the negative of the battery or power supply to J2.
7. Turn on the V<sub>CC</sub> input supply.
8. Turn on the battery voltage supply.
9. Push and hold the *Charge* button to start charging the flash capacitor.
10. Release the *Charge* button when the green *Charge Complete* LED (D2) illuminates.
11. Push the *Flash* switch to flash lamp.
12. Repeat steps 9 through 11 as needed.

### **2.3 Setup and Operation With User-Supplied Lamp and Trigger Circuit Operation**

1. Discharge the photo flash capacitor by shorting C5 with a 15-k $\Omega$  resistor for over 20 seconds. Use a multimeter to measure the voltage on C5 and verify the voltage is close to zero before continuing or touching any connectors or components.
2. Remove jumpers across JP1 and JP2 to disconnect the onboard lamp and trigger circuit from the control circuitry. The TPS65560 EVM should only be used to flash a single flash tube.
3. Connect the high-voltage portion of the user supplied lamp circuit to pin 2 of J6.
4. Connect the trigger portion of the user-supplied lamp to pin 1 of J6. See the EVM schematic to verify the circuit hook up.
5. Connect the ground portion of the user lamp circuit to pin 1 of J7.
6. Connect the positive lead of an input power supply J3. This voltage should be between 2.7 and 4 volts dc to supply  $V_{CC}$  to the TPS65560.
7. Connect the negative lead of an input power supply to J4.
8. Connect the positive lead of a battery or power supply to J1. This voltage can be between 1.6 and 12 volts.
9. Connect the negative of the battery or power supply to J2.
10. Turn on the  $V_{CC}$  input supply.
11. Turn on the battery voltage supply.
12. Push and hold the *Charge* switch to start charging the flash capacitor.
13. Release *Charge* switch when the green *Charge Complete* LED (D2) illuminates.
14. Push the *Flash* switch to flash lamp.

Repeat steps 12 through 14 as necessary.

### 3 Board Layout

This section provides the TPS65560EVM-165 board layout and illustrations.

#### 3.1 Layout

Board layout is critical for all high-frequency switch mode power supplies. [Figure 1](#) through [Figure 4](#) show the board layout for the TPS65560EVM-165 PCB. The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance. Careful attention has been given to the routing of high-frequency current loops and a single-point grounding scheme is used for all high-current and high-voltage traces. See the data sheet for specific layout guidelines.

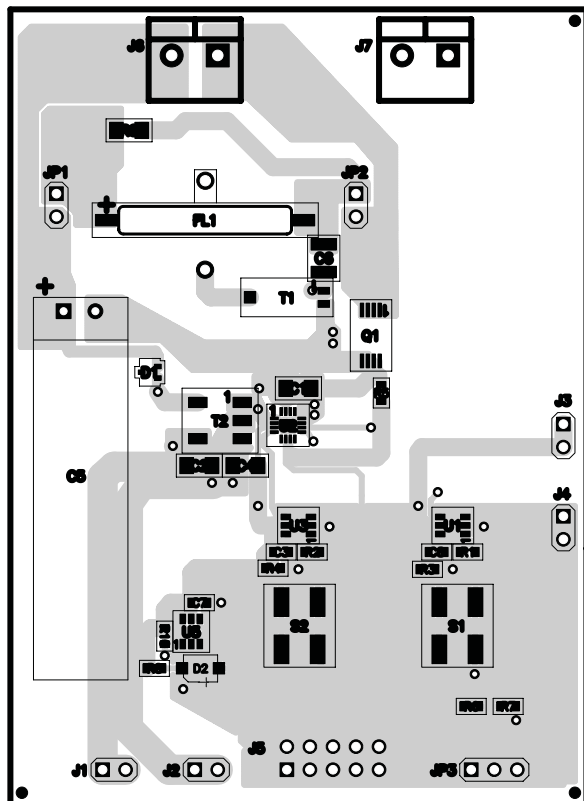


Figure 1. Top Assembly Layer

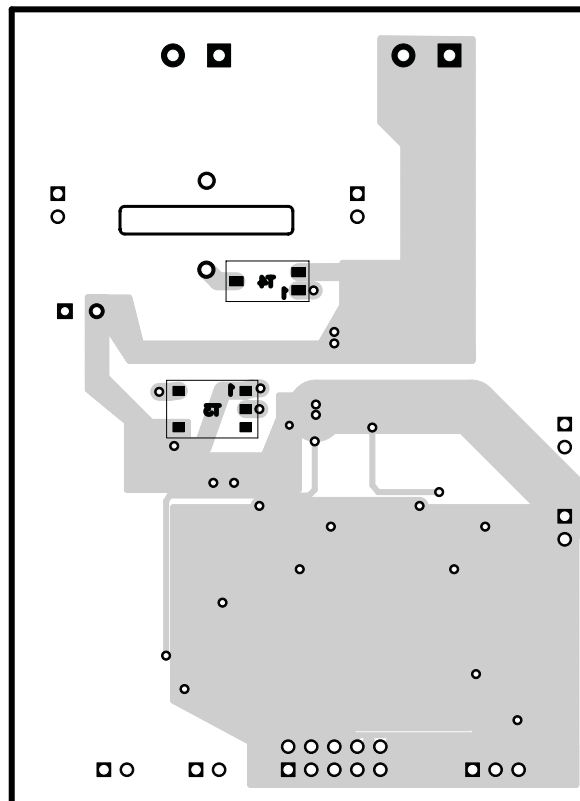


Figure 2. Bottom Assembly Layer

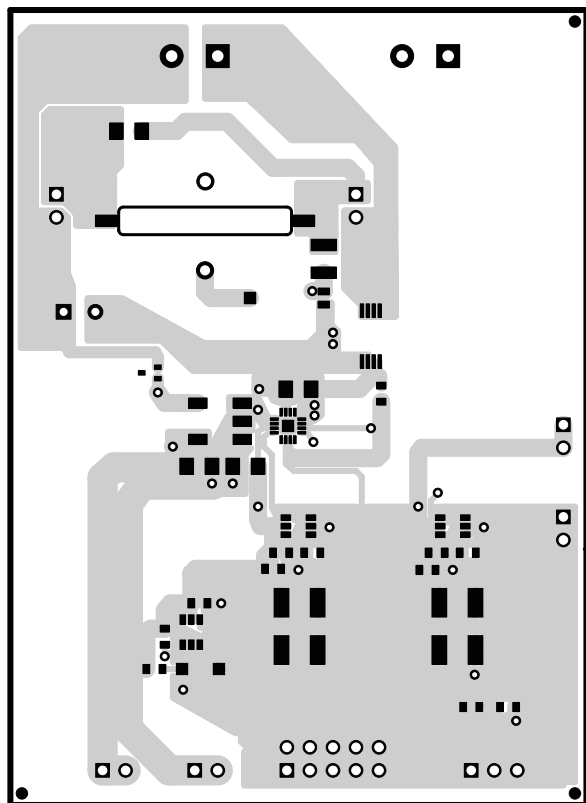


Figure 3. Top Layer Routing

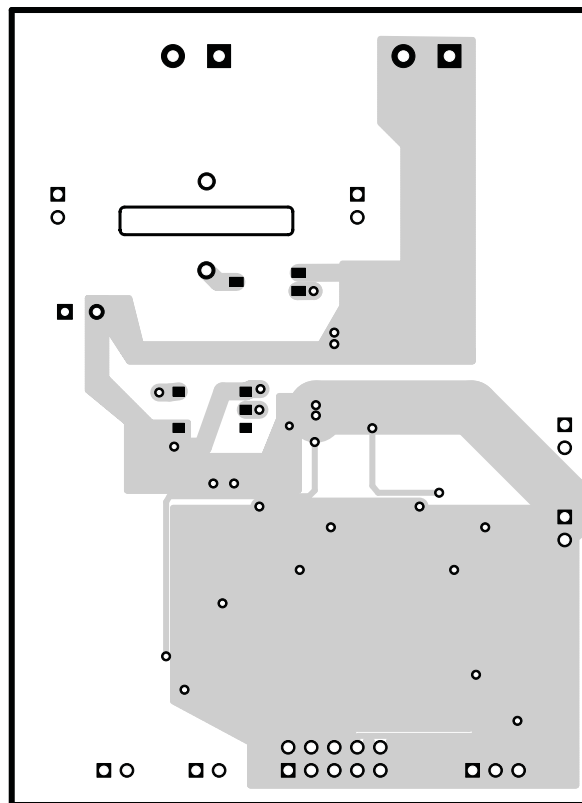
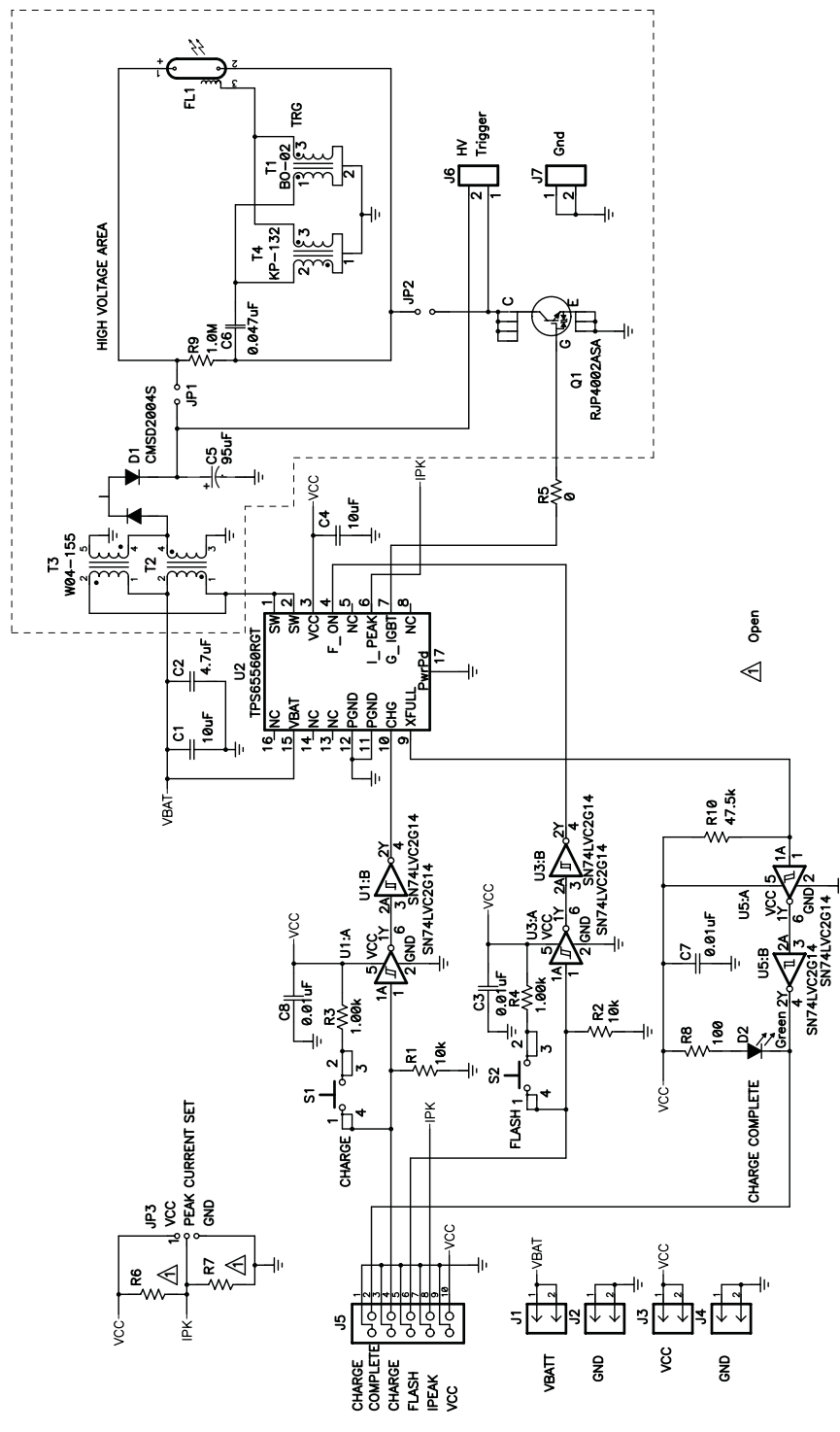


Figure 4. Bottom Layer Routing

## 4 Schematic and Bill of Materials

This section provides the TPS65560EVM-165 schematic and bill of materials.

### 4.1 Schematic



## 4.2 Bill of Materials

**Table 2. TPS65560EVM-165 Bill of Materials**

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C1, C4	10 $\mu$ F	Capacitor, Ceramic, 16V, X7R, 10%	1206	C3216X7R1C106KT	TDK
1	C2	4.7 $\mu$ F	Capacitor, Ceramic, 25V, X7R, 10%	1206	C3216X7R1E475K	TDK
3	C3, C7, C8	0.01 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	C1608X7R1H103KT	TDK
1	C5	95 $\mu$ F	Capacitor, Aluminum, 330VDC, 20%	9.5 x 37 mm	330FW95V9537	Rubycon
1	C6	0.047 $\mu$ F	Capacitor, Ceramic, 630V, X7R, 10%	1210	C3225X7R2J473K	TDK
1	D1		Diode, Dual Switching, 300V, 275mA, 225mA	SOT-323	CMSD2004S	Central Semiconductor
1	D2		Diode, LED, Green, Gullwing, GW Type, 20mA, 7.5 mcd typ.	0.120 x 0.087	LN1361CTR	Panasonic
1	FL1		Flash Tube, 320v Max	0.071 x 0.807 inch	FFT-N-I018001850-1	Nam Kwong Electric <a href="http://www.namkwong.com.hk">www.namkwong.com.hk</a>
4	J1 - J4		Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
1	J5		Header, 2x5-pin, 100mil spacing (36-pin strip)	0.100 x 5 X 2	PTC36DAAN	Sullins
2	J6, J7		Terminal Block, 2 pin, 15A, 5.1mm	0.40 x 0.35	ED1609	OST
2	JP1, JP2		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
1	JP3		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 x 3	PTC36SAAN	Sullins
1	Q1		Trans, N-Ch IGBT, Vgem 6, Vces 400, Icm 150	TSSOP-8	RJP4002ASA	Renesas
2	R1, R2	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R10	47.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R3, R4	1.00k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	0	Resistor, Chip, 1/16W, 5%	0603	Std	Std
2	R6, R7	Open	Resistor, Chip, 1/16W, 1%	0603		
1	R8	100	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R9	1.0M	Resistor, Chip, 1/4W, 5%, 400V	1206	ERJ8GEYJ105V	Panasonic
2	S1, S2		Switch, SPST, PB Momentary, Sealed Washable	0.245 X 0.251	KT11P2JM	C & K
0	T1		Transformer, Trigger	0.330 X 0.137 inch	BO-02	Tokyo Coil
0	T2		Transformer,	0.303 x 0.252 inch	TTRN-038S_Type	Tokyo Coil
1	T3		XFMR, Flyback	0.220 X 0.335 inch	W04-155	Kijima-Musen <a href="mailto:t_ishino@kijima-m.co.jp">t_ishino@kijima-m.co.jp</a>
1	T4		XFMR, Trigger	0.146 X 0.303 inch	KP-132	Kijima-Musen
3	U1, U3, U5		IC, Dual Schmitt-Trigger Inverter	SOT23-6	SN74LVC2G14DBV	TI
1	U2		IC, Integrated Photo Flash charger and IGBT Driver	QFN16	TPS65560RGT	TI
1	–		PCB, 3.45 In x 2.5 In x 0.062 In		HPA165	Any
3	–		Shunt, 100-mil, Black	0.100	929950-00	3M
4	–		Bumpon, Transparent	0.44 x 0.2	SJ5303	3M
1			26 AWG Buss Wire (approximately 1.5 inches)			

Notes: 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 unclean flux is not acceptable.  
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.  
4. Reference designators marked with an asterisk ("\*\*") cannot be substituted.  
All other components can be substituted with equivalent MFG's components.

## 5 Related Documentation From Texas Instruments

TPS65560 data.sheet ([SLVS608](#))

### 5.1 If You Need Assistance

Contact your local TI sales representative.



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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 1.6 V to 12 V (V<sub>batt</sub>), 2.7 V to 4 V (V<sub>cc</sub>) and the output voltage range of 0 V to 320 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 50°C. The EVM is designed to operate properly with certain components above 50°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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