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## ***Multiple Lamp Units Using the TPS68000***

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*PMP Portable Power*

### **ABSTRACT**

The TPS68000 device provides a power supply controller solution for CCFL backlight applications in a large variety of applications. The following reference designs depict both the TPS68000EVM-161 and the TPS68000EVM-166.

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### **1 Features**

- 8-V to 30-V Input Voltage Range
- Full Bridge Topology With Integrated Gate Drives for 4 NMOS Switches
- Synchronizable Constant Frequency Operation
- Programmable Phase Delays of Operating Frequency for Master-Slave Operation
- Lamp Voltage and Lamp Current Regulation
- Analog and Burst Dimming
- Configurable Distributed Burst Dimming in Multiple Controller Applications
- Programmable Voltage Regulation Timeout for Startup and Fault Conditions
- Open-Lamp and Short-Circuit Protection
- Internal Over-Temperature Protection
- Undervoltage Lockout
- 30-pin TSSOP Package

### **2 TPS68000EVM-161 Schematic and Bill of Materials**

The schematic and bill of materials (BOM) for the TPS68000EVM-161 evaluation module follow. The TPS68000-161 is a single-lamp unit. The schematic ([Figure 1](#)) has two sections - the upper unit is a small circuit layout and the lower unit is a full-feature design.

Additionally, one reference design ([Figure 2](#)) implements a dual-lamp circuit on the single-lamp EVM.



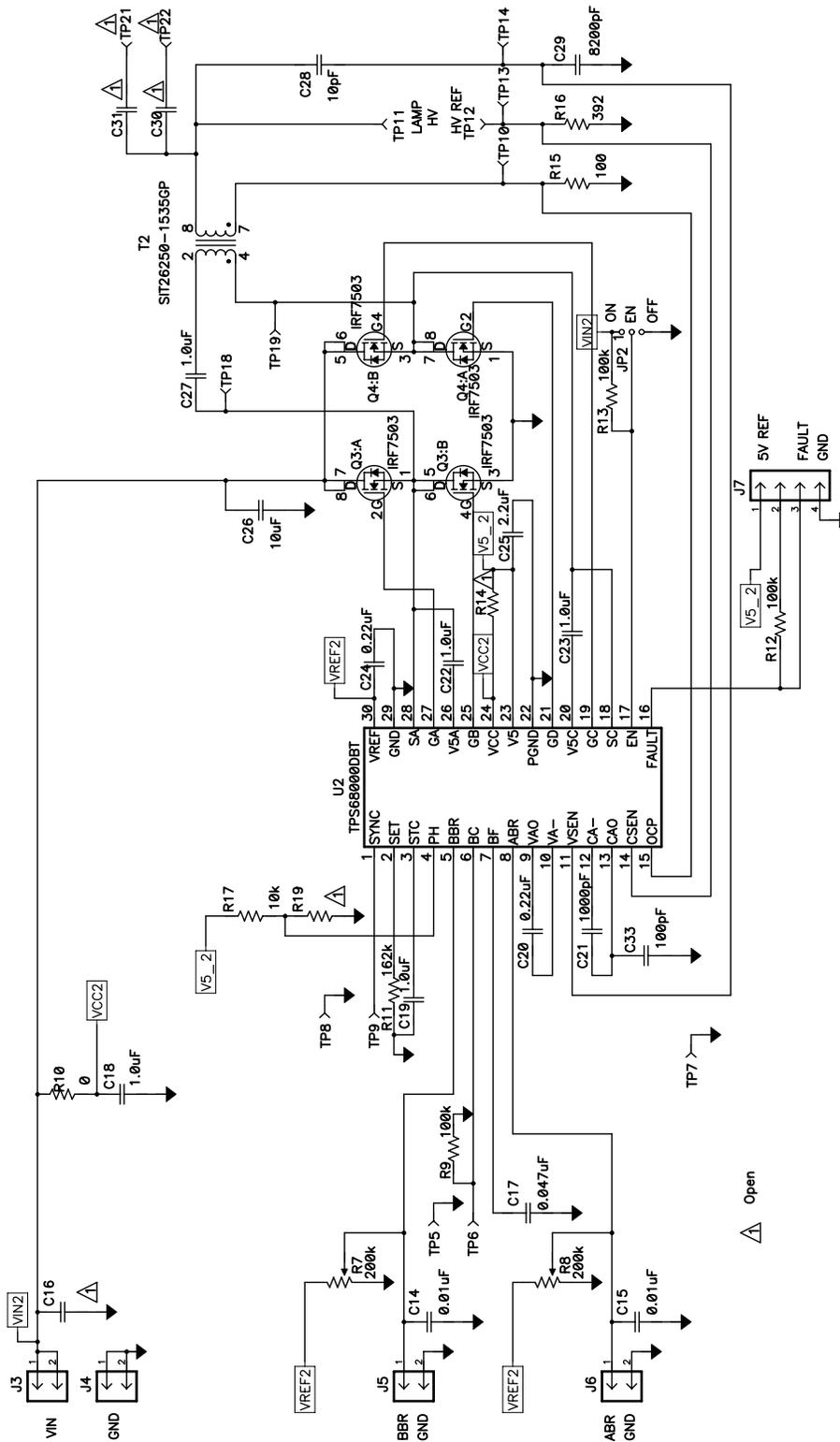


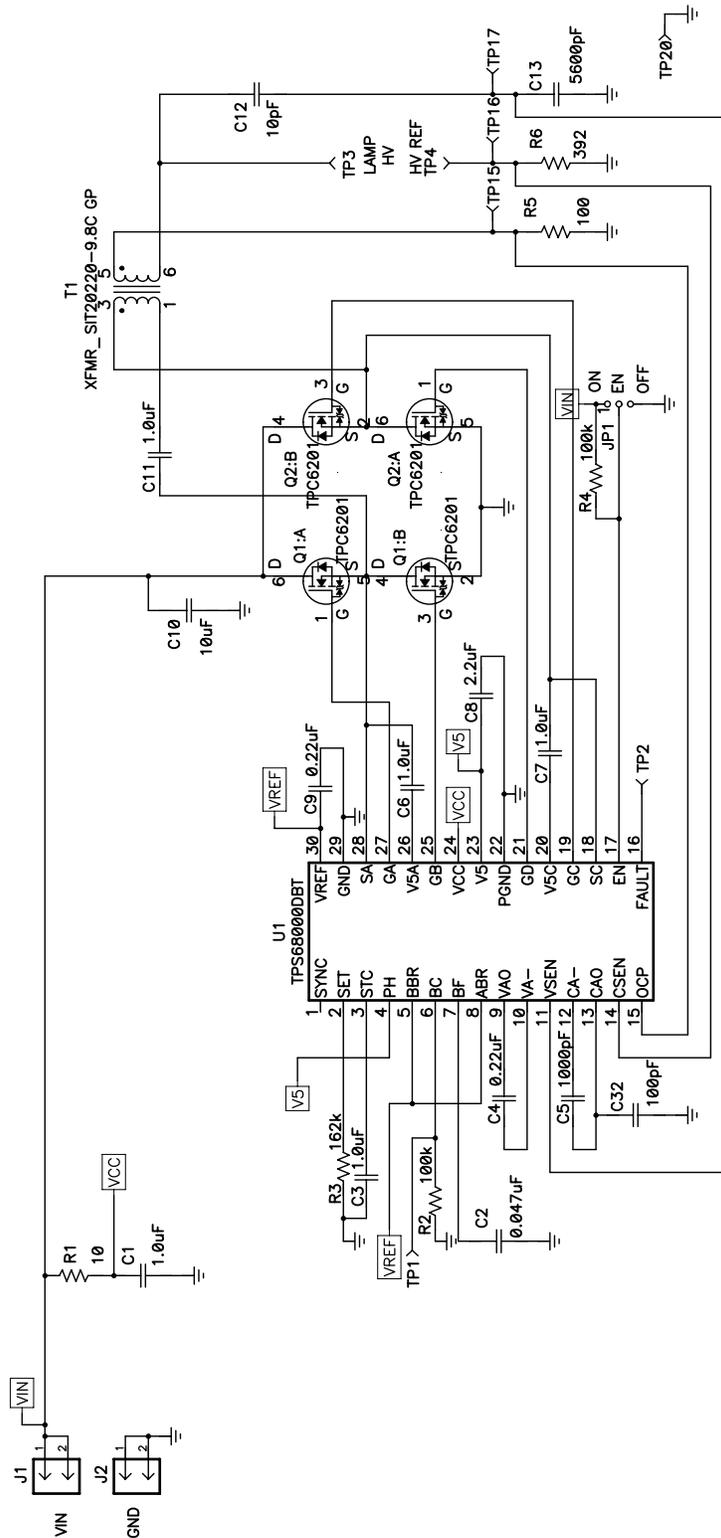
Figure 2. Single-Lamp Unit EVM (Schematic 2 of 2)

**2.2 TPS68000EVM-161 Bill of Materials**

Count	RefDes	Value	Description	Size	Part Number	MFR
4	C1, C3, C18, C19	1.0μF	Capacitor, ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK
2	C10, C26	10μF	Capacitor, ceramic, 25V, X5R, 10%	1206	C3216X5R1E106K	TDK
2	C11, C27	1.0μF	Capacitor, ceramic, 50V, X7R, 10%	1206	C3216X7R1H105K	TDK
2	C12, C28	10pF	Capacitor, 3kV, C0G, ±1pF	0.110 × 0.110	C4520C0G3F100F	TDK
1	C13	5600pF	Capacitor, ceramic, 50V, X7R, 10%	0603	GRM188R71H562KA01	Murata
2	C14, C15	0.01μF	Capacitor, ceramic, 25V, X5R, 10%	0603	C1608X5R1E103KB	TDK
0	C16	Open	Capacitor, ceramic, vV	1206		
2	C2, C17	0.047μF	Capacitor, ceramic, 50V, X7R, 10%	0603	C1608X7R1H473KB	TDK
1	C29	8200pF	Capacitor, ceramic, 50V, X7R, 10%	0603	GRM188R71H822KA01	Murata
0	C30, C31	Open	Capacitor	0.110 × 0.110		
2	C32, C33	100pF	Capacitor, ceramic, 50V, C0G, 5%	0603	C1608C0G1H101JB	TDK
4	C4, C9, C20, C24	0.22μF	Capacitor, ceramic, 16V, X5R, 10%	0603	C1608X5R1C224KB	TDK
2	C5, C21	1000pF	Capacitor, ceramic, 50V, X5R, 10%	0603	C1608X5R1H102KB	TDK
4	C6, C7, C22, C23	1.0μF	Capacitor, ceramic, 25V, X7R, 10%	0805	C2012X7R1E105K	TDK
2	C8, C25	2.2μF	Capacitor, ceramic, 25V, X5R, 10%	0805	C2012X5R1E225K	TDK
6	J1–J6		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 × 2	PTC36SAAN	Sullins
1	J7		Header, 4 pin, 100mil spacing, (36-pin strip)	0.100 × 4	PTC36SAAN	Sullins
2	JP1, JP2		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 × 3	PTC36SAAN	Sullins
2	Q1, Q2		MOSFET, N-Ch 30V, 2.5A	2-3T1B	TPC6201	Toshiba
2	Q3, Q4		XSTR, MOSFET, N-Chan, 30V, 2.4 A, Rds 0.135Ω	TSSOP8-MICRO8	IRF7503	IR
1	R1	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R10	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R14, R19	Open	Resistor, Chip, 1/16W, 1%	0603		
1	R17	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
5	R2, R4, R9, R12, R13	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R3, R11	162k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R5, R15	100	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R6, R16	392	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R7, R8	200k	Potentiometer, 1.4 cermet	12-Turn	3266W-1-204	Bourns
1	T1		Transformer, inverter LDC backlight	0.400 × 1.260	SIT20220-9.8C GP	Taipei Multipower
1	T2		Transformer, EFDL15 Inverter	0.525 × 0.420	SIT26250-1535 GP	Taipei Multipower
12	TP1, TP2, TP6, TP9, TP10, TP13–TP19		Test point, red, thru hole color keyed	0.100 × 0.100	5000	Keystone
0	TP21, TP22		Test point	0.125 × 0.125		
2	TP3, TP11		Test point, red, thru hole compact style	0.125 × 0.125	5005	Keystone
2	TP4, TP12		Test point, black, thru hole compact style	0.125 × 0.125	5006	Keystone
4	TP5, TP7, TP8, TP20		Test point, black, thru hole color keyed	0.100 × 0.100	5001	Keystone
2	U1, U2		IC, High Efficient Phase Shift Full Bridge CCFL Controller	TSSOP-30	TPS68000DBT	TI
1	—		PCB, 4.85 In x 3.4 In x 0.062 In		HPA161	Any
2	—		Shunt, 100mil, Black	0.100	929950-00	3M
4	—		Bumpon, Transparent	0.44 × 0.2	SJ5303	3M

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 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.

### 2.3 Single-Lamp Design Based on TPS68000EVM-161 –Schematic

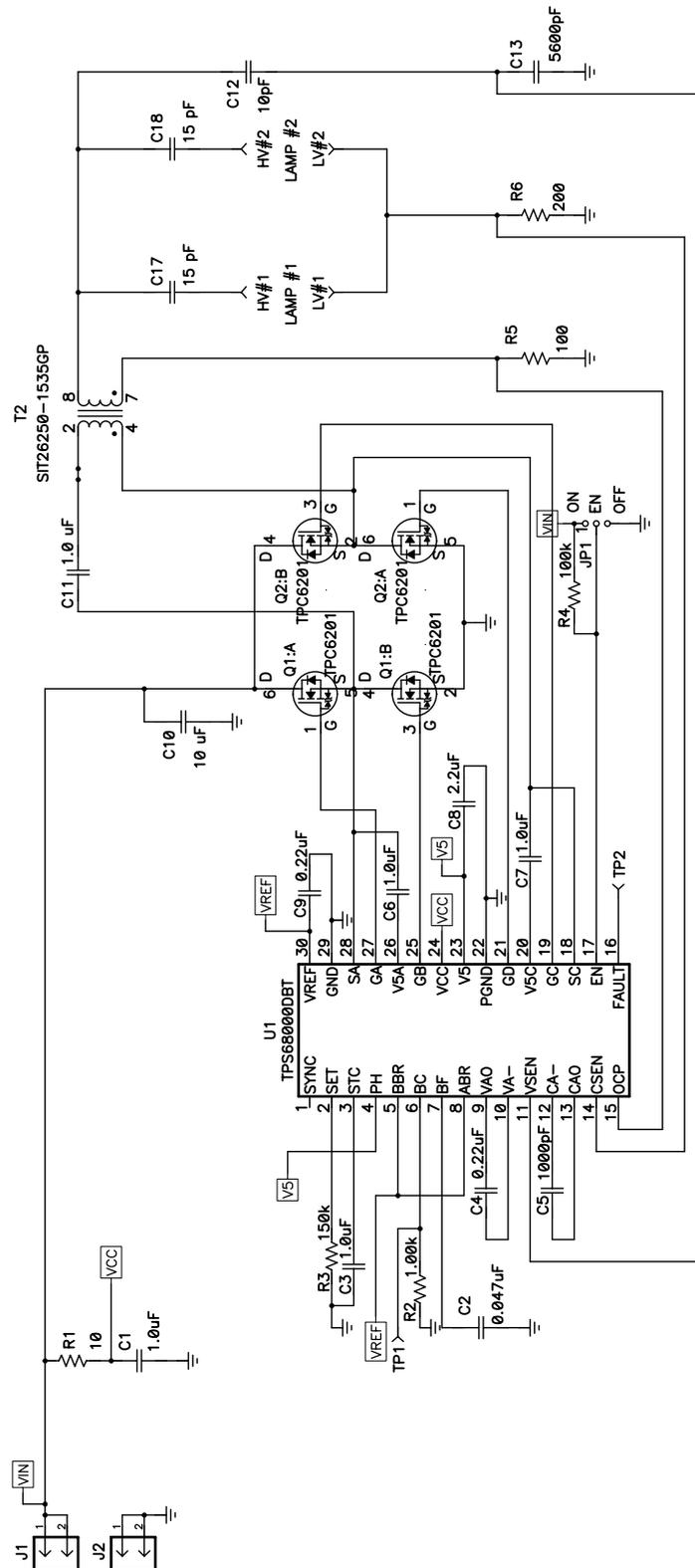


### 2.4 Single-Lamp Design Based on TPS68000EVM-161 –Bill of Materials

**TPS68000EVM-161 Schematic and Bill of Materials**

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C1, C3	1.0 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK
1	C10	10 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	1206	C3216X5R1E106K	TDK
1	C11	1.0 $\mu$ F	Capacitor, ceramic, 50V, X7R, 10%	1206	C3216X7R1H105K	TDK
1	C12	10pF	Capacitor, 3kV, C0G, $\pm$ 1pF	0.110 $\times$ 0.110	C4520C0G3F100F	TDK
1	C13	5600pF	Capacitor, ceramic, 50V, X7R, 10%	0603	GRM188R71H562KA01	Murata
1	C2	0.047 $\mu$ F	Capacitor, ceramic, 50V, X7R, 10%	0603	C1608X7R1H473KB	TDK
1	C32	100pF	Capacitor, ceramic, 50V, C0G, 5%	0603	C1608C0G1H101JB	TDK
2	C4, C9	0.22 $\mu$ F	Capacitor, ceramic, 16V, X5R, 10%	0603	C1608X5R1C224KB	TDK
1	C5	1000pF	Capacitor, Ceramic, 50V, X5R, 10%	0603	C1608X5R1H102KB	TDK
2	C6, C7	1.0 $\mu$ F	Capacitor, ceramic, 25V, X7R, 10%	0805	C2012X7R1E105K	TDK
1	C8	2.2 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	0805	C2012X5R1E225K	TDK
2	J1, J2		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 $\times$ 2	PTC36SAAN	Sullins
1	JP1		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 $\times$ 3	PTC36SAAN	Sullins
2	Q1, Q2		MOSFET, N-Ch 30V, 2.5A	2-3T1B	TPC6201	Toshiba
1	R1	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R2, R4	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R3	162k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	100	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	392	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	T1		Transformer, inverter LDC backlight	0.400 $\times$ 1.260	SIT20220-9.8C GP	Taipei Multipower
12	TP1, TP2, TP15–TP17		Test point, red, thru hole color keyed	0.100 $\times$ 0.100	5000	Keystone
1	TP20		Test point, black, thru hole color keyed	0.100 $\times$ 0.100	5001	Keystone
1	TP3		Test point, red, thru hole compact style	0.125 $\times$ 0.125	5005	Keystone
1	TP4		Test point, black, thru hole compact style	0.125 $\times$ 0.125	5006	Keystone
1	U1		IC, High Efficient Phase Shift Full Bridge CCFL Controller	TSSOP-30	TPS68000DBT	TI

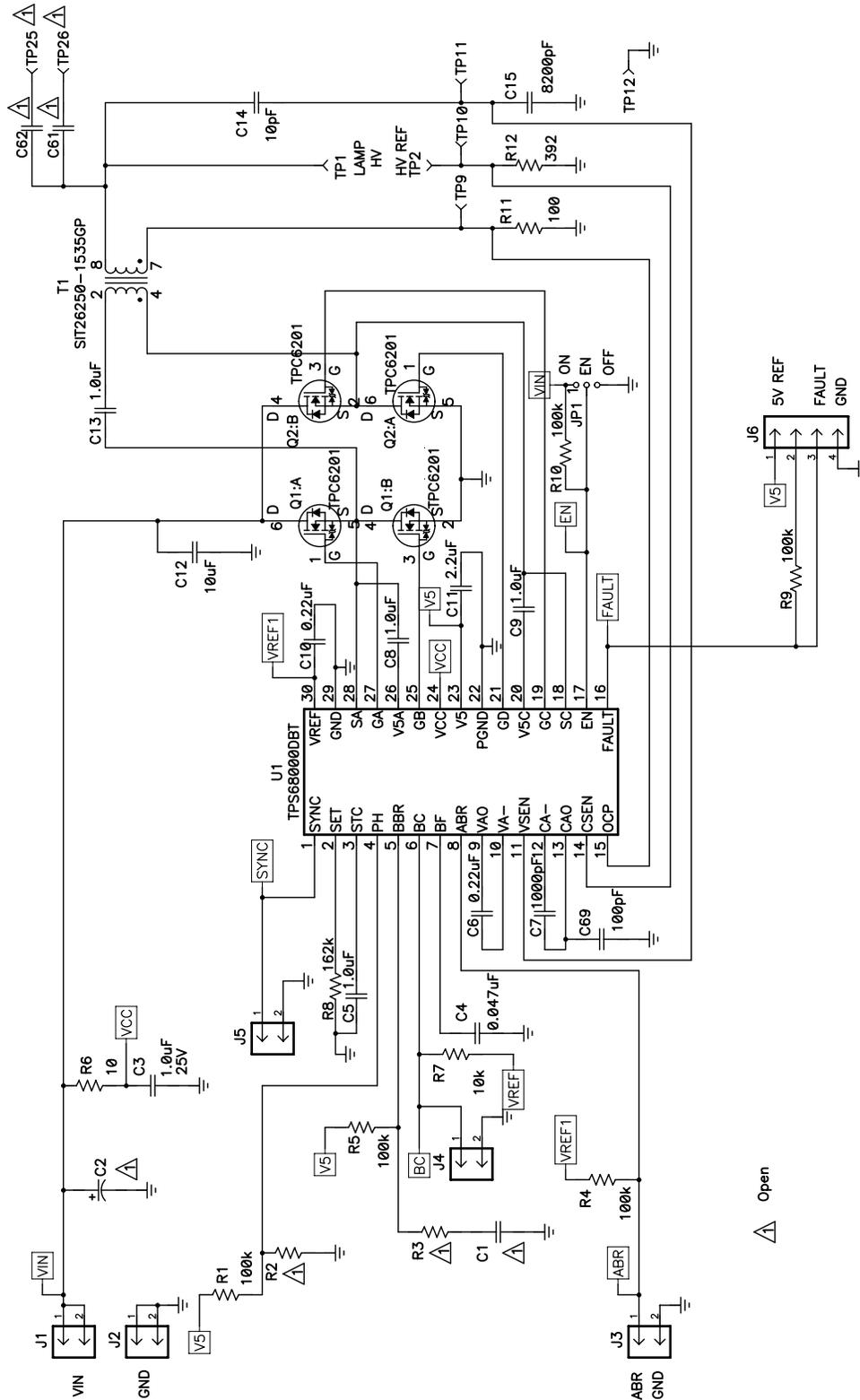
## 2.5 Dual -Lamp Circuit Based Single-Lamp EVM TPS68000-161 – Schematic



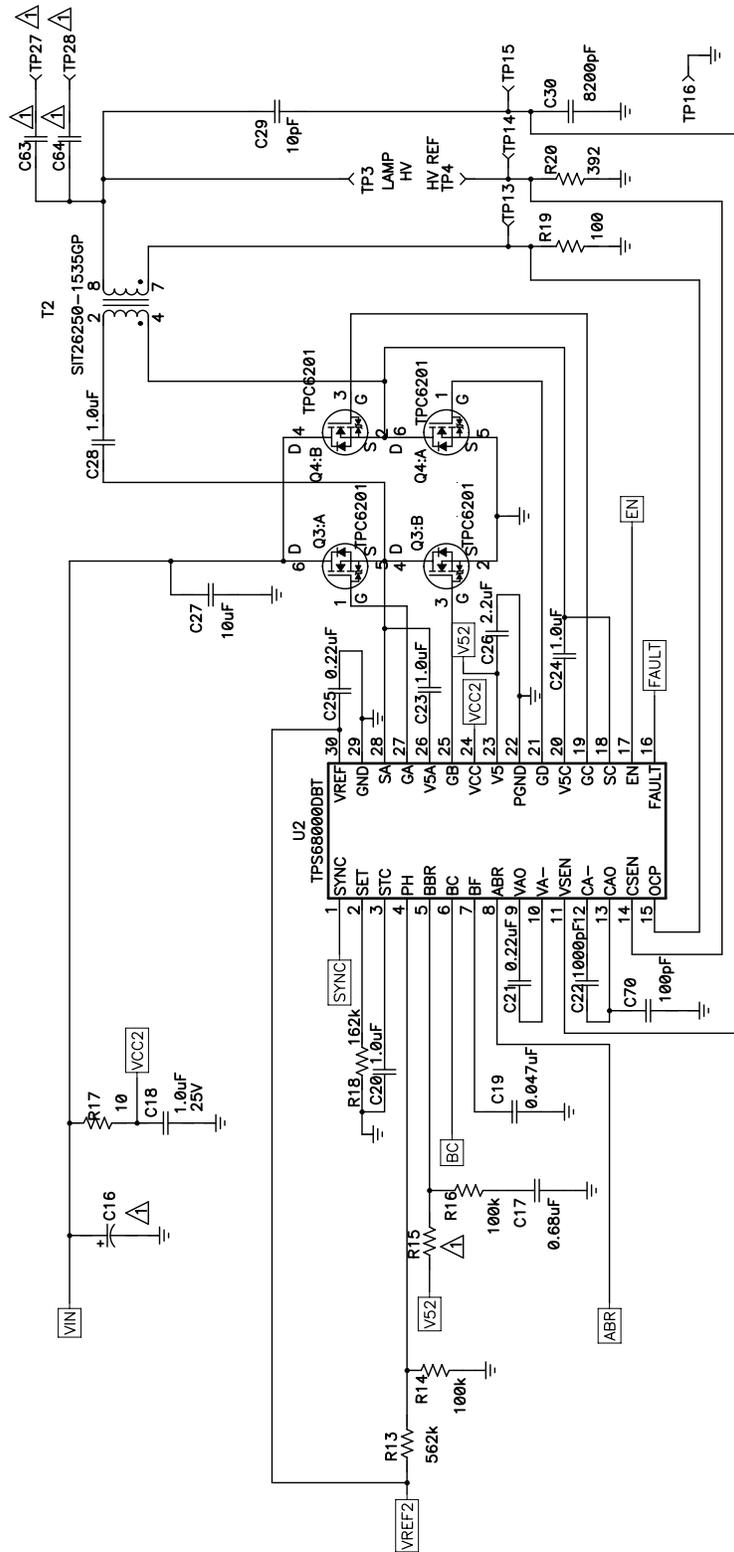
## **2.6 TPS68000EVM-166 Schematic and Bill of Materials**

This section presents the schematic and bill of materials (BOM) for the TPS68000EVM-166 evaluation module. The TPS68000-166 is a four-controller unit, in which the master unit controls three slave units that are used to demonstrate dimming.

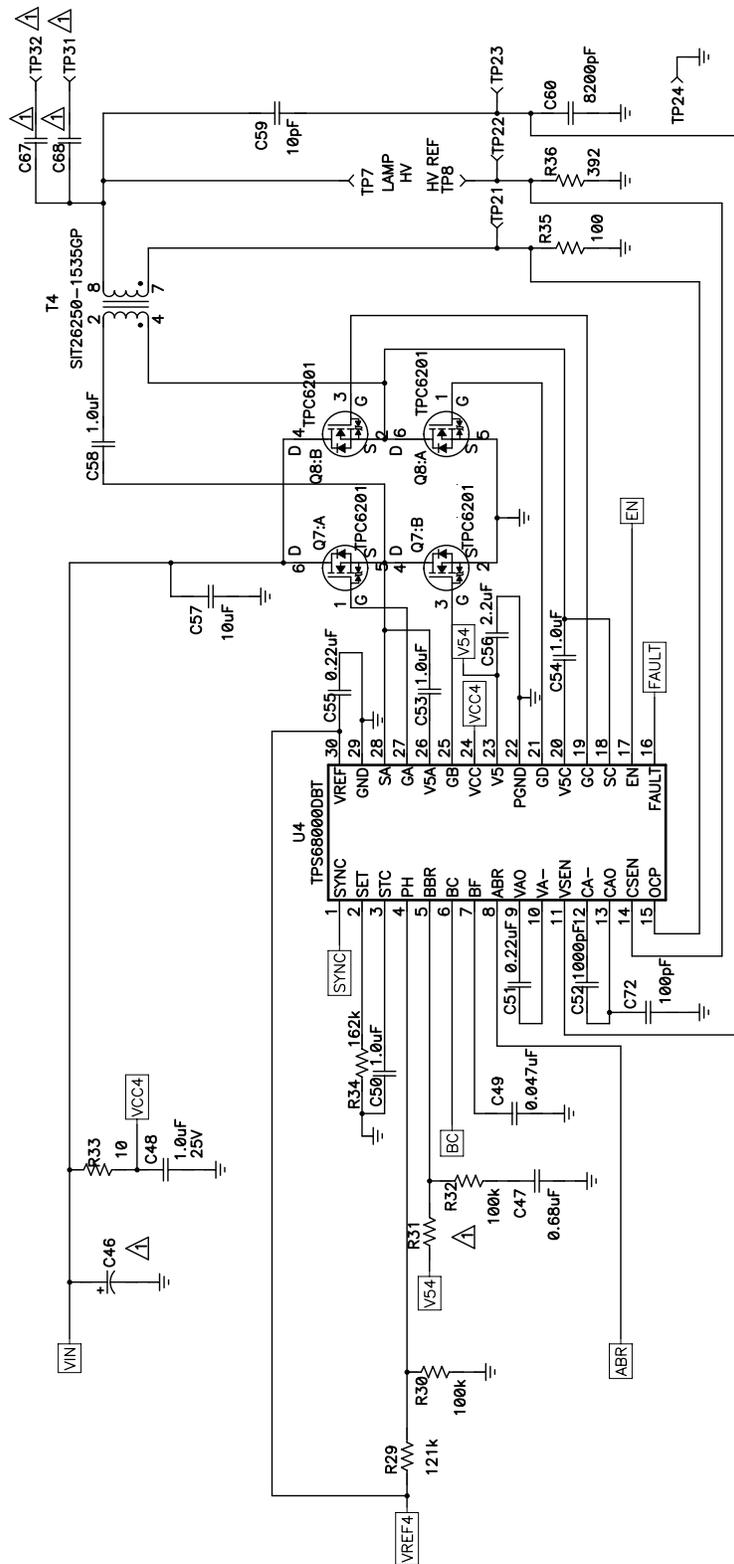
2.6.1 TPS68000EVM-166 Schematic (4 Designs)



TPS68000EVM-161 Schematic and Bill of Materials







### 2.6.2 TPS68000EVM-166 Bill of Materials (4 Designs)

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	Open	Capacitor, ceramic	0603		
4	C11, C26, C41, C56	2.2 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	0805	C2012X5R1E225K	TDK
4	C12, C27, C42, C57	10 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	1206	C3216X5R1E106K	TDK
4	C13, C28, C43, C58	1.0 $\mu$ F	Capacitor, ceramic, 50V, X7R, 10%	1206	C3216X7R1H105K	TDK
4	C14, C29, C44, C59	10pF	Capacitor, 3kV, C0G, $\pm$ 1pF	0.110 $\times$ 0.110	C4520C0G3F100F	TDK
4	C15, C30, C45, C60	8200pF	Capacitor, ceramic, 50V, X7R, 10%	0603	GRM188R71H822KA01	Murata
3	C17, C33, C47	0.68 $\mu$ F	Capacitor, ceramic, 10V, X5R, 10%	0603	C1608X5R1A684KC	TDK
0	C2, C16, C31, C46	Open	Capacitor, Tantalum	7361		
8	C3, C5, C18, C20, C32, C35, C48, C50	1.0 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK
4	C4, C19, C34, C49	0.047 $\mu$ F	Capacitor, ceramic, 50V, X5R, 10%	0603	C1608X5R1H473KB	TDK
8	C4, C10, C21, C25, C36, C40, C51, C55	0.22 $\mu$ F	Capacitor, ceramic, 25V, X5R, 10%	0603	C1608X7R1E223KB	TDK
0	C61–C68	Open	Capacitor	0.110 $\times$ 0.110		
4	C69–C72	100pF	Capacitor, ceramic, 50V, C0G, 5%	0603	C1608C0G1H101JB	TDK
4	C7, C22, C37, C52	1000pF	Capacitor, Ceramic, 50V, X5R, 10%	0603	C1608X5R1H102KB	TDK
8	C8, C9, C23, C24, C38, C39, C53, C54	1.0 $\mu$ F	Capacitor, ceramic, 25V, X7R, 10%	0805	C2012X7R1E105K	TDK
5	J1–J5		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 $\times$ 2	PTC36SAAN	Sullins
1	J6		Header, 4 pin, 100mil spacing, (36-pin strip)	0.100 $\times$ 4	PTC36SAAN	Sullins
1	JP1		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 $\times$ 3	PTC36SAAN	Sullins
8	Q1–A8		MOSFET, N-Ch 30V, 2.5A	2-3T1B	TPC6201	Toshiba
11	R1, R4, R5, R9, R10, R14, R16, R22, R25, R30, R32	100k	Resistor, chip, 1.16W, 1%	0.603	Std	Std
4	R11, R19, R27, R35	100	Resistor, chip, 1.16W, 1%	0.603	Std	Std
4	R12, R20, R28, R36	392	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R13	562k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R2, R3, R15, R24, R31	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R21	232k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R29	121k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R6, R17, R23, R33	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R7	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R8, R18, R26, R34	162k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	T1–T4		Transformer, EFDL15 Inverter	0.525 $\times$ 0.420	Std	Std
4	TP1, TP3, TP5, TP7		Test point, red, thru hole compact style	0.125 $\times$ 0.125	5005	Keystone
4	TP12, TP16, TP20, TP24		Test point, black, thru hole color keyed	0.100 $\times$ 0.100	5001	Keystone
4	TP2, TP4, TP6, TP8		Test point, black, thru hole compact style	0.125 $\times$ 0.125	5006	Keystone
0	TP25–TP32		Test point	0.125 $\times$ 0.125		
12	TP9–TP11, TP13–TP15, TP17–TP19, TP21–TP23		Test point, red, thru hole color keyed	0.100 $\times$ 0.100	5000	Keystone
4	U1–U4		IC, High Efficient Phase Shift Full Bridge CCFL Controller	TSSOP-30	TPS6800DBT	TI

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 TPS68000EVM-161 Schematic and Bill of Materials
 

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Count	RefDes	Value	Description	Size	Part Number	MFR
1	—		PCB, 5.55 In x 4.5 In x 0.062 In		HPA166	Any
1	—		Shunt, 100mil, Black	0.100	929950-00	3M
4	—		Bumpon, Transparent	0.44 x 0.2	SJ5303	3M
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 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.						

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Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
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Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
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Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265

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