High-Power LED Driver Using The TPS40200

ABSTRACT

The reference design in Figure 1 is capable of driving four 500-mA LEDs in series, using the TPS40200. The circuit diagram and a brief application note describe how to change the average output current and the number of LEDs in series. With minor component changes the output current can be reduced, or it may be increased in excess of 1 A to accommodate other types of LEDs.

1 TPS40200 Characteristics:

- Input Voltage Range 4.5 to 52 V
- Output Voltage (700 mV to 90% V_{in})
- 200 mA Internal P-FET Driver
- Voltage Feed-Forward Compensation
- Undervoltage Lockout
- Programmable Fixed Frequency (35–500 kHz) Operation
- Programmable Short Circuit Protection
- Hiccup Overcurrent Fault Recovery
- Programmable Closed Loop Soft Start
- 700 mV 1% Reference Voltage
- External Synchronization
- Small 8-Pin SOIC (D) Package

2 TPS40200 Reference Design

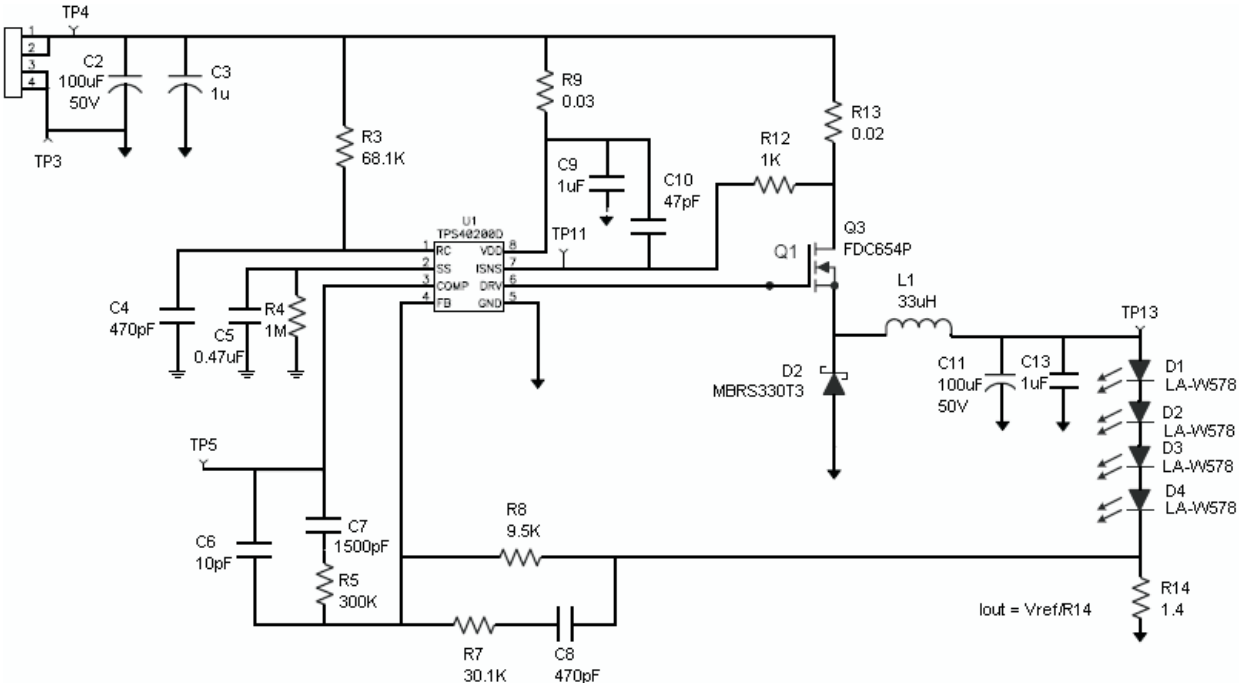

Figure 1. Reference Schematic

2.1 Bill of Materials

Table 1. TPS40200 BOM – 500mA LED Driver

COUNT	RefDes	Value	Description	Size	Part Number	Mfr
2	C2, C11	100µF	Capacitor, Aluminum, 100µF, 50V, 20%	8,3 mm × 8,3 mm	EEV-FK1J101P	Panasonic
3	C3, C9, C13	1µF	Capacitor, Ceramic, 1µF, 50V, X7R, 20%	603	Std	TDK
2	C4, C8	470pF	Capacitor, Ceramic, 470pF, 50V, X7R, 20%	603	Std	TDK
1	C5	0.470pF	Capacitor, Ceramic, 0.470pF, 50V, X7R, 20%	603	Std	TDK
1	C6	10µF	Capacitor, Ceramic, 10µF, 50V, X7R, 20%	603	Std	TDK
1	C7	1500pF	Capacitor, Ceramic, 1500pF, 50V, X7R, 20%	603	Std	TDK
1	D2	MBRS330T3	Dual_Schottky_Diode, 6A, 40V	Dpak	MBRD640CTT4	On Semi
2	J1, J2	ED1514	Terminal Block, 2pin, 6A, 3,5mm	0.27 × 0.25	ED1514	OST
1	L1	33µH	Inductor, SMT, 33µH, 3.2A, 0.047Ω	½ inch sq"	SLF12575T-330M3R2	TDK
1	Q2	FQPF13N06	MOSFET, N-ch, 60V, 2.8A -0.110Ω	TO220	FQPF13N06	Fairchild
1	U1	TPS40200D	IC, Low Cost Sync Buck Controller	SO-8	TPS40200D	TI
1	R3	68.1KΩ	Resistor, Chip, 68.1kΩ, 1/16W, 1%	0603	Std	Std
1	R4	1MΩ	Resistor, Chip, 1MΩ, 1/16W, 1%	0603	Std	Std
1	R5	300KΩ	Resistor, Chip, 300kΩ, 1/16W, 1%	0603	Std	Std
1	R7	30.1KΩ	Resistor, Chip, 30.1kΩ, 1/2W, 1%	2010	Std	Std
1	R8	9.5KΩ	Resistor, Chip, 9.5kΩ, 1/16W, 1%	0603	Std	Std
1	R9	0.03Ω	Resistor, Chip, 0.03Ω, 1/16W, 1%	0603	Std	Std
1	R12	1KΩ	Resistor, Chip, 1kΩ, 1/16W, 1%	0603	Std	Std
1	R13	0.02Ω	Resistor, Chip, 0.02-Ω, 1/16W, 1%	0603	Std	Std
1	R14	1.4Ω	Resistor, Chip, 1.4-Ω, 1W, 1%		Std	Std
6	TP1, TP3 TP4, TP5, TP8, TP9		Test Point, Red, 1m	0.038	5000 RED	Keystone

Table 1. TPS40200 BOM – 500mA LED Driver (continued)

COUNT	RefDes	Value	Description	Size	Part Number	Mfr
3	TP2, TP6, TP7		Test Point, Black, 1mm	0.038	5001 Black	Keystone

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 MFR's components.

3 Driving 500-mA LEDs With The TPS40200

The TPS40200 can be used to drive a wide range of LED types. With a maximum duty cycle of 90%, it can drive a series of LEDs up to 90% of the applied input voltage.

The voltage input range of the TPS40200 is from 4.5 V to 52 V. It can be readily determined how many LEDs can be driven in series by the following formula.

- Number of series LEDs = $(D \times V_{IN}) \div V_F$

Where:

V_{IN} = the input voltage applied to the TPS40200

D = the maximum duty cycle obtainable by the controller, with the TPS40200 this is 90%

V_F = the worst case maximum forward voltage drop of the particular LED, including the stackup of all affecting tolerances

Example:

Using a white LED (PN - LW W5SG) with a maximum forward voltage drop (V_F) of approximately 5 V, and driven at the maximum value of 500 mA with an input voltage of 24 V, the reference design could drive up to 4 of these LEDs without stress.

- Number of series LEDs = $(0.9 \times 24) \div 5 = 4$ LEDs

Setting the RMS drive current:

Since the internal reference (V_{REF}) of the TPS40200 is 700 mV, the current-sense resistor R14 is set by the following formula:

$I_{OUT} = V_{REF} \div R14$

Where:

I_{OUT} = LED RMS current

The reference circuit is designed to drive the white LED with 500 mA.

Solving the equation for R14 gives us 1.4 Ω.

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