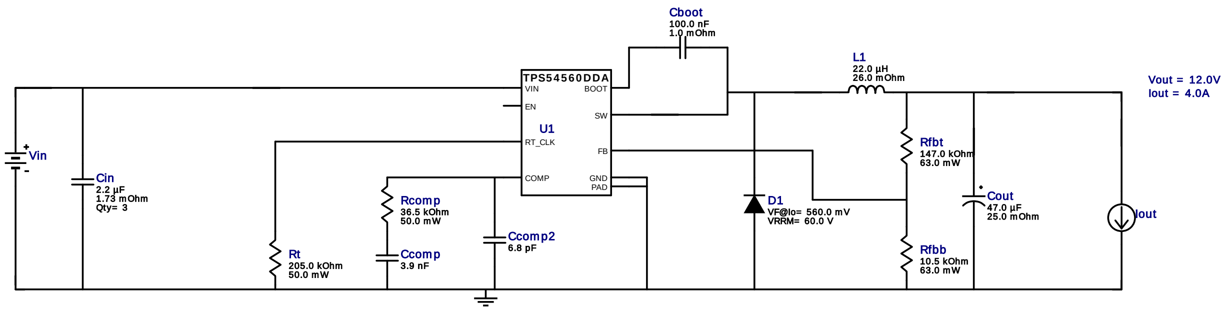
VinMin = 28.0V
VinMax = 48.0V
Vout = 12.0V
Iout = 4.0A

Device = TPS54560DDAR
Topology = Buck
Created = 2022-12-30 06:53:21.976
BOM Cost = $4.49
BOM Count = 14
Total Pd = 3.02W

WEBENCH ® Design Report

Design : 13 TPS54560DDAR
TPS54560DDAR 28V-48V to 12.00V @ 4A dodsfalla



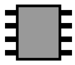
Design Alerts

Component Selection Information

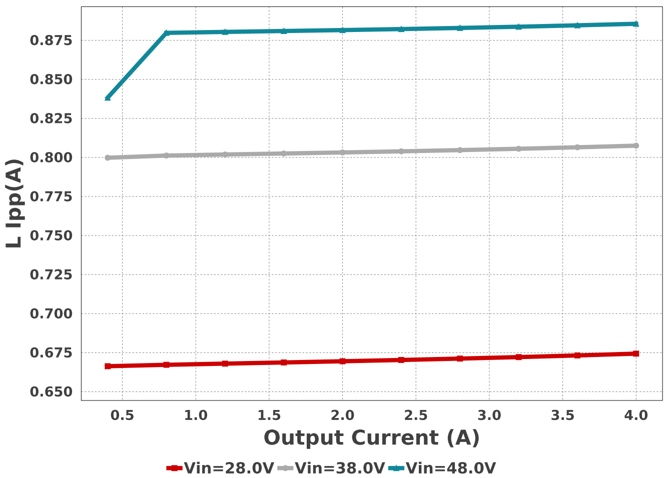
TI does not recommend using TPS54560 part in a new design. Please use TPS54560B which is an EXACT EQUIVALENT in functionality and parametrics to the compared device.

Electrical BOM

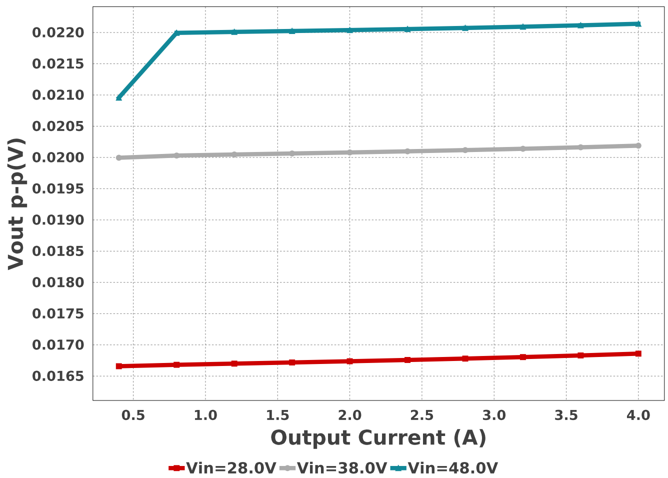
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Ccomp2	AVX	06031U6R8BAT2A Series= C0G/NP0	Cap= 6.8 pF VDC= 100.0 V IRMS= 0.0 A	1	$0.05	0603 5 mm^2
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	3	$0.21	1210_250 15 mm^2
Cout	Panasonic	16SVPG47M Series= SVPG	Cap= 47.0 uF ESR= 25.0 mOhm VDC= 16.0 V IRMS= 3.2 A	1	$0.52	CAPSMT_62_B45 53 mm^2
D1	Diodes Inc.	PDS760-13	VF@Io= 560.0 mV VRRM= 60.0 V	1	$0.36	PowerDI5 50 mm^2
L1	Coilcraft	MSS1210-223MEB	L= 22.0 µH 26.0 mOhm	1	$0.81	MSS1210 204 mm^2
Rcomp	Yageo	RC0201FR-0736K5L Series= ?	Res= 36.5 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbb	Vishay-Dale	CRCW040210K5FKED Series= CRCW..e3	Res= 10.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Vishay-Dale	CRCW0402147KFKED Series= CRCW..e3	Res= 147.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rt	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
U1	Texas Instruments	TPS54560DDAR	Switcher	1	$2.03	 DDA0008E_N 55 mm²

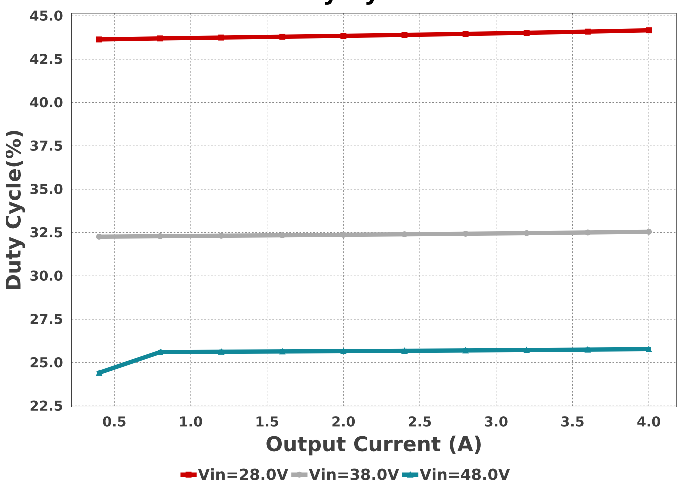
L Ipp



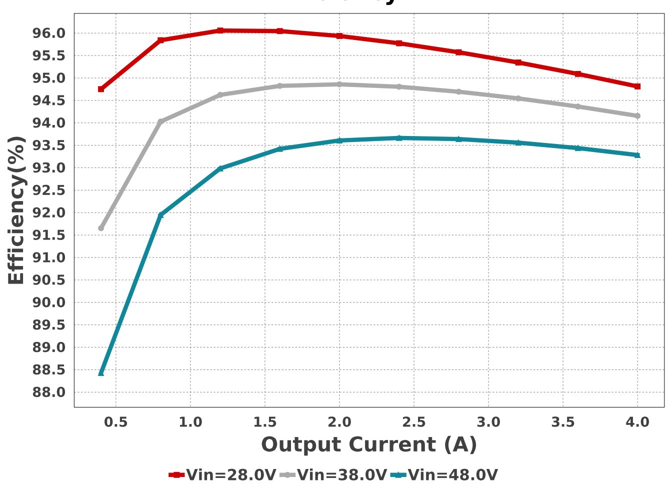
Vout p-p



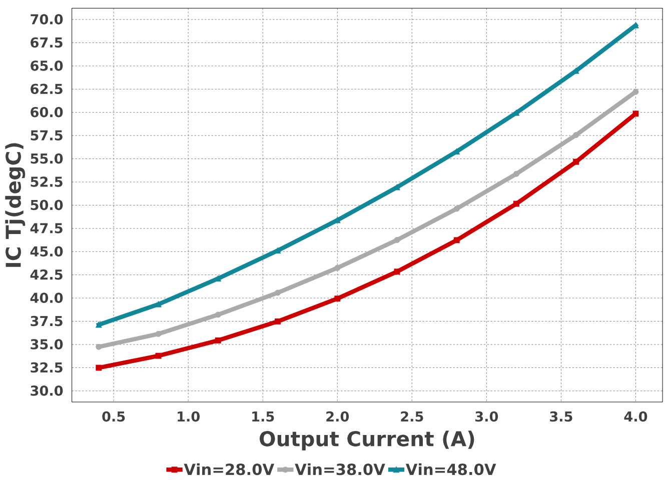
Duty Cycle



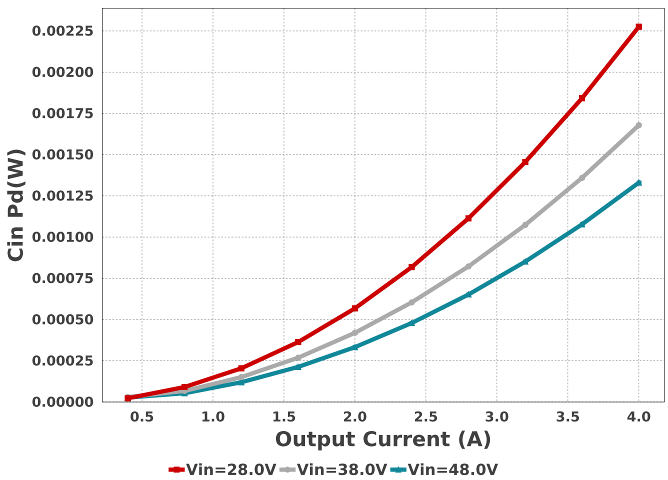
Efficiency

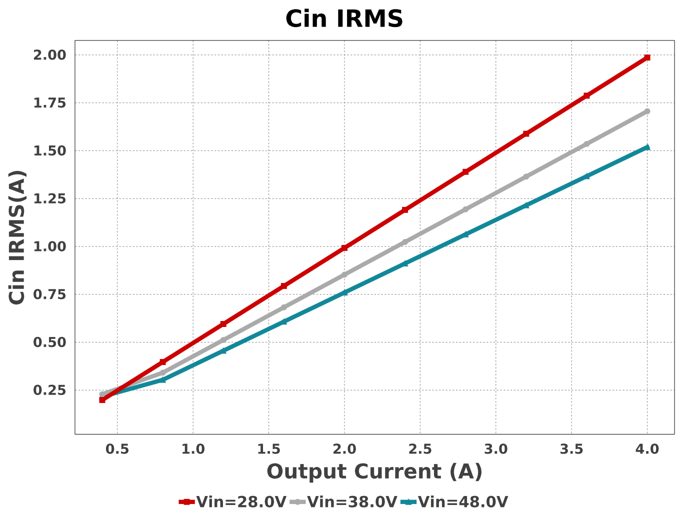


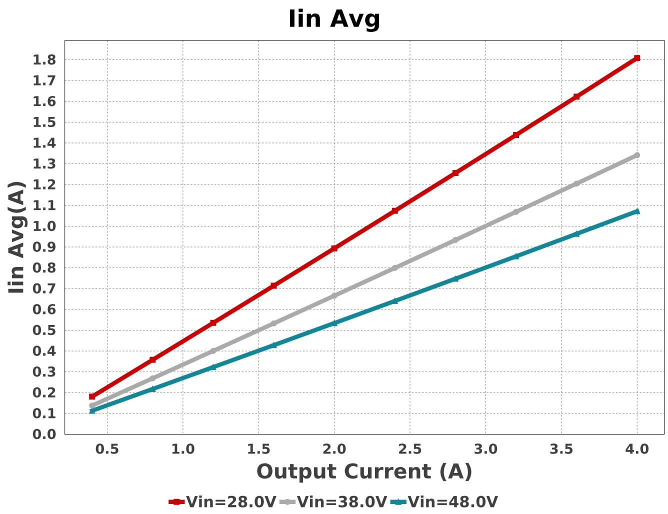
IC Tj

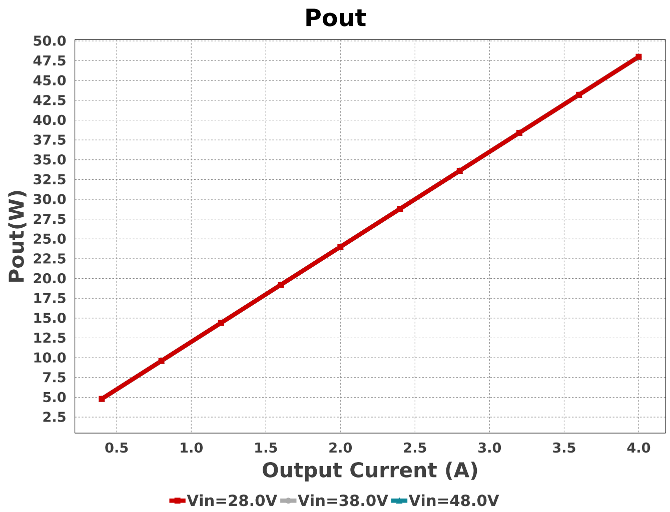


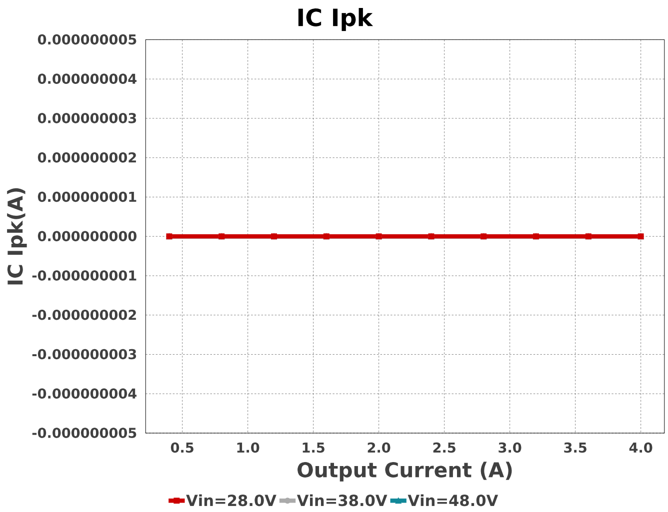
Cin Pd

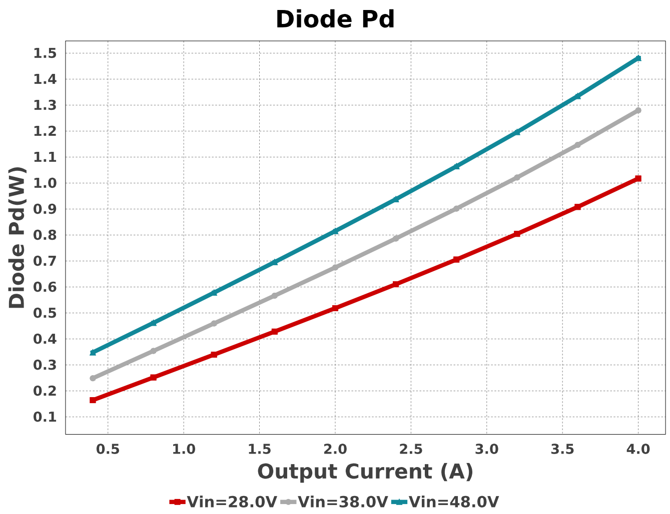


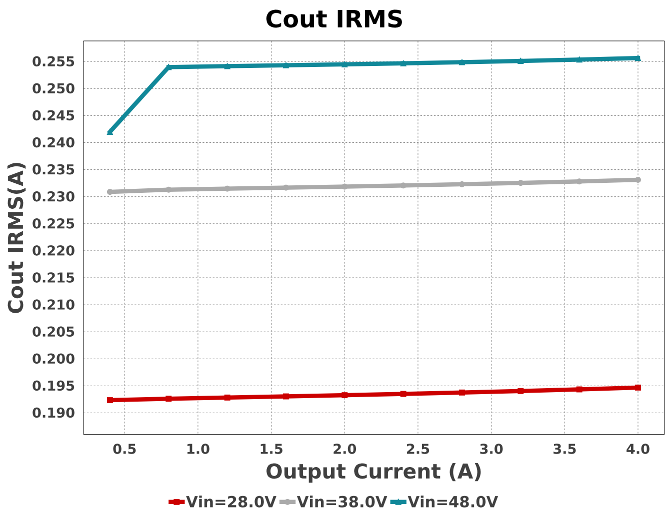

Cin IRMS
Cin IRMS(A)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V

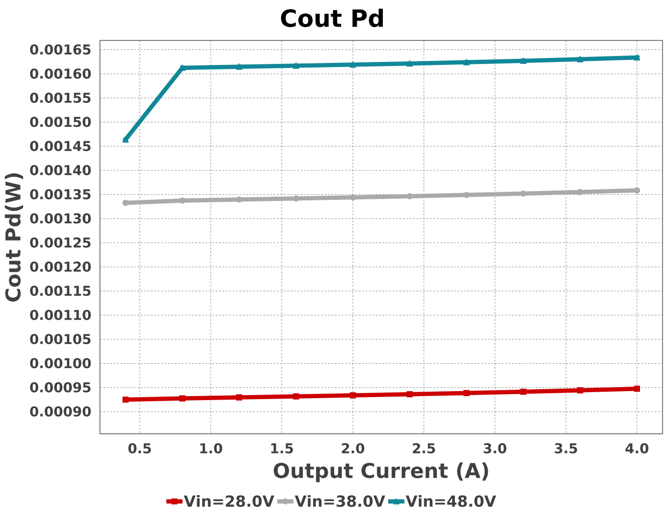

Iin Avg
Iin Avg(A)
1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V

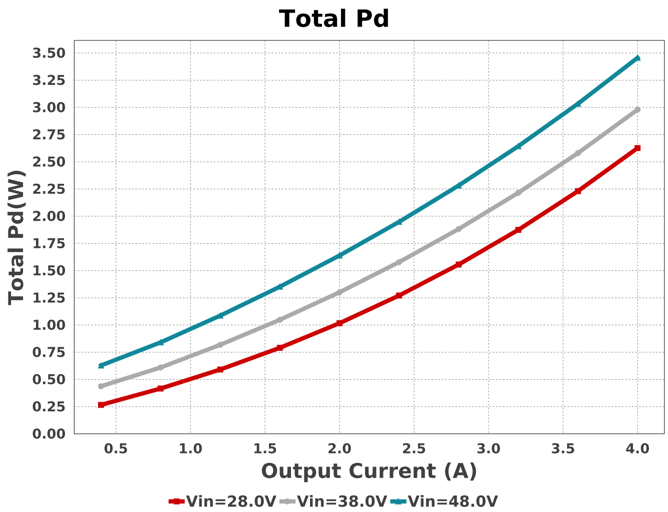

Pout
Pout(W)
50.0 47.5 45.0 42.5 40.0 37.5 35.0 32.5 30.0 27.5 25.0 22.5 20.0 17.5 15.0 12.5 10.0 7.5 5.0 2.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V

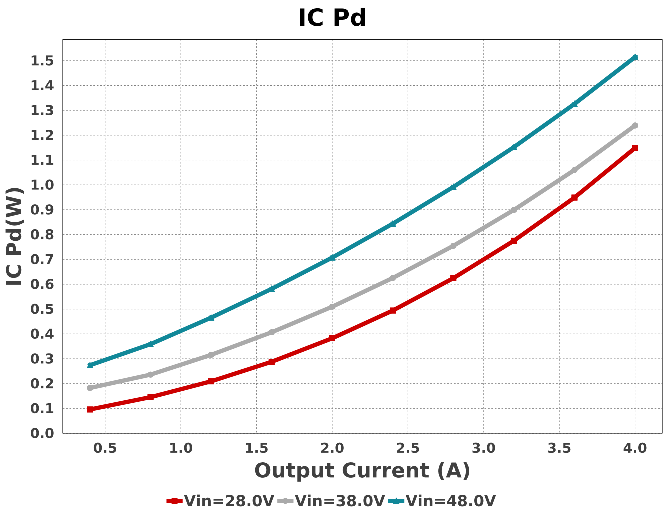

IC Ipk
IC Ipk(A)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V

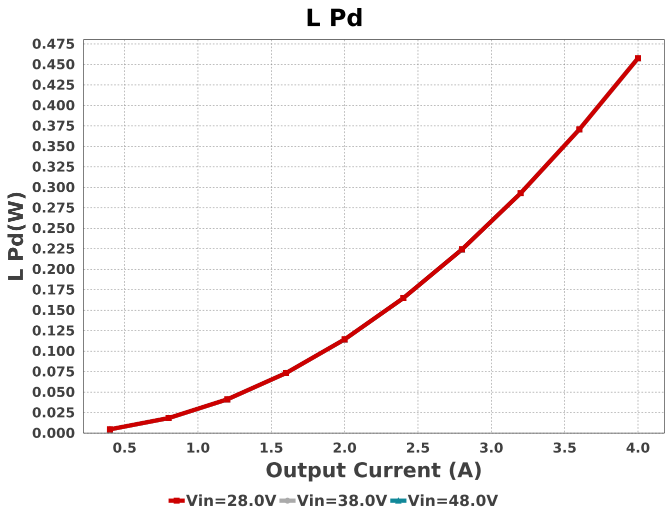

Diode Pd
Diode Pd(W)
1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V

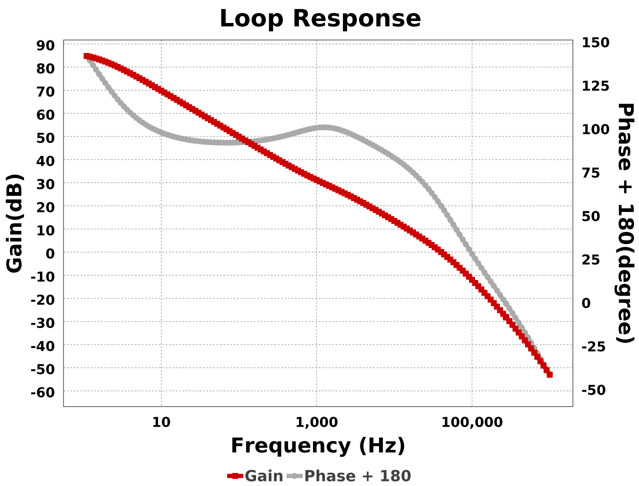

Cout IRMS
Cout IRMS(A)
0.255 0.250 0.245 0.240 0.235 0.230 0.225 0.220 0.215 0.210 0.205 0.200 0.195 0.190
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=28.0V Vin=38.0V Vin=48.0V











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	14		Total Design BOM count
2.	Total BOM	$4.493		Total BOM Cost
3.	Cin IRMS	1.684 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	1.636 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	235.888 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	1.391 mW	Capacitor	Output capacitor power dissipation
7.	Diode Pd	1.302 W	Diode	Diode power dissipation
8.	IC Ipk	0.0 A	IC	Peak switch current in IC
9.	IC Pd	1.26 W	IC	IC power dissipation
10.	IC Tj	62.749 degC	IC	IC junction temperature
11.	ICThetaJA Effective	26.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance

#	Name	Value	Category	Description
12.	Iin Avg	1.308 A	IC	Average input current
13.	L Ipp	817.138 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	457.6 mW	Inductor	Inductor power dissipation
15.	Cin Pd	1.636 mW	Power	Input capacitor power dissipation
16.	Cout Pd	1.391 mW	Power	Output capacitor power dissipation
17.	Diode Pd	1.302 W	Power	Diode power dissipation
18.	IC Pd	1.26 W	Power	IC power dissipation
19.	L Pd	457.6 mW	Power	Inductor power dissipation
20.	Total Pd	3.022 W	Power	Total Power Dissipation
21.	Cross Freq	38.562 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	31.713 %	System Information	Duty cycle
23.	Efficiency	94.077 %	System Information	Steady state efficiency
24.	FootPrint	431.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	476.3 kHz	System Information	Switching frequency
26.	Gain Marg	-29.482 dB	System Information	Bode Plot Gain Margin
27.	Iout	4.0 A	System Information	Iout operating point
28.	Low Freq Gain	84.489 dB	System Information	Gain at 1Hz
29.	Mode	CCM	System Information	Conduction Mode
30.	Phase Marg	53.211 deg	System Information	Bode Plot Phase Margin
31.	Pout	48.0 W	System Information	Total output power
32.	Vin	39.0 V	System Information	Vin operating point
33.	Vout	12.0 V	System Information	Operational Output Voltage
34.	Vout Actual	12.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	2.904 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	20.428 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	4.0	Maximum Output Current
VinMax	48.0	Maximum input voltage
VinMin	28.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	TPS54560	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

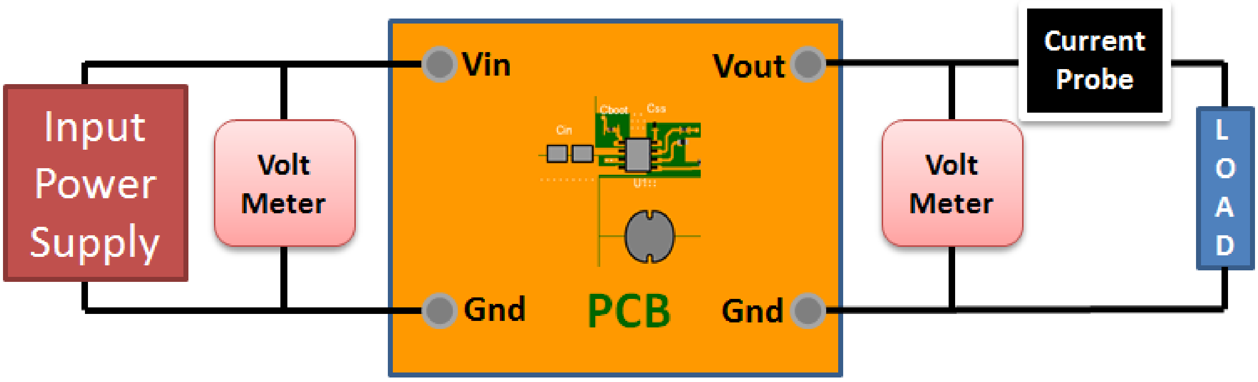
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 28.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. TI does not recommend using TPS54560 part in a new design. Please use TPS54560B which is an EXACT EQUIVALENT in functionality and parametrics to the compared device.

2. Master key : E4B9CFD1C57BC38D[v1]

3. **TPS54560** Product Folder : http://www.ti.com/product/TPS54560 : contains the data sheet and other resources.

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