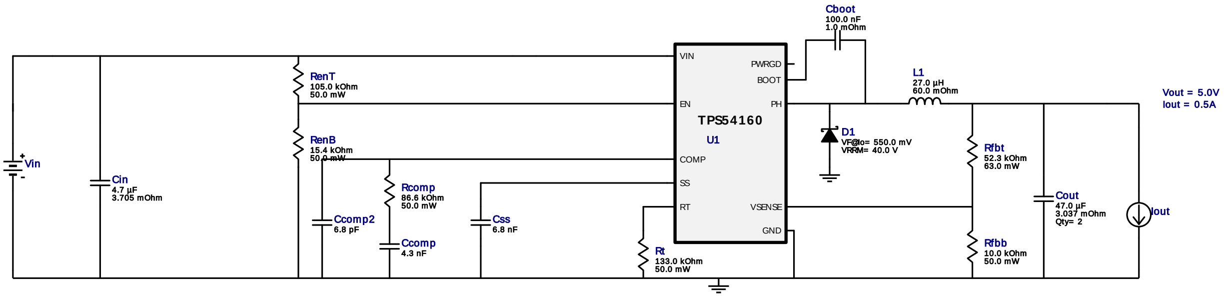
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 10.8V
VinMax = 13.2V
Vout = 5.0V
Iout = 0.5A

Device = TPS54160DGQR
Topology = Buck
Created = 2020-08-29 07:55:36.560
BOM Cost = $2.76
BOM Count = 16
Total Pd = 0.35W

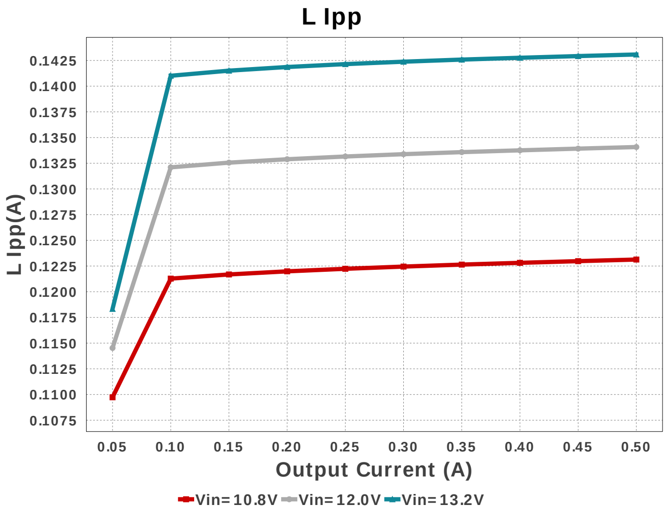
Design : 5 TPS54160DGQR
TPS54160DGQR 10.8V-13.2V to 5.00V @ 0.5A

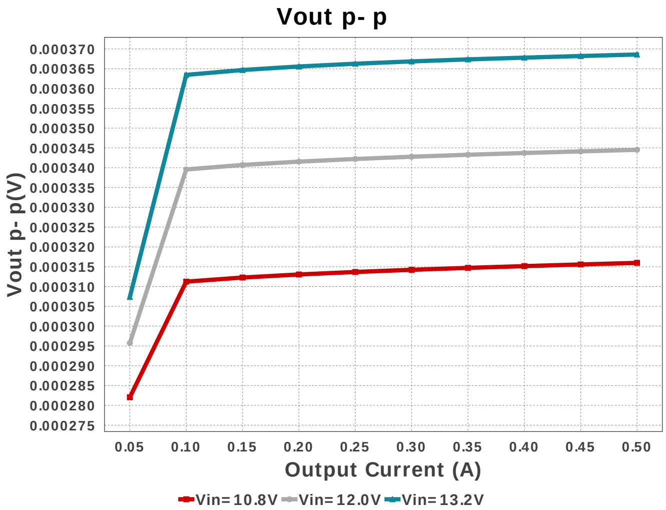


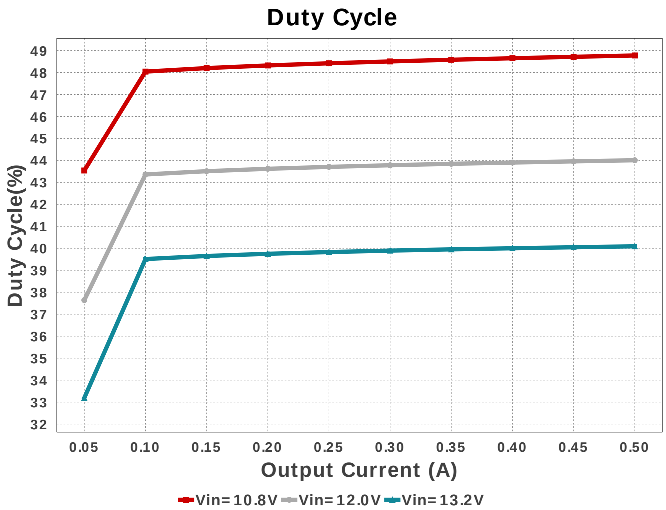
Electrical BOM

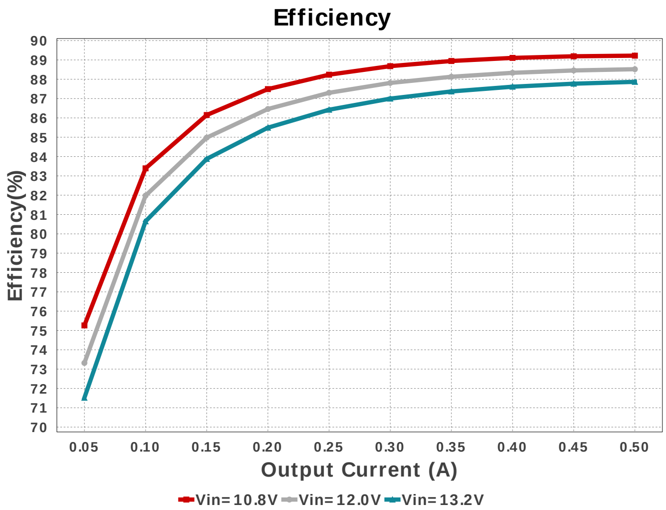
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	Kemet	C0603C432J5GAC7867 Series= C0G/NP0	Cap= 4.3 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	0603 5 mm²
Ccomp2	AVX	06031U6R8BAT2A Series= C0G/NP0	Cap= 6.8 pF VDC= 100.0 V IRMS= 0.0 A	1	$0.07	0603 5 mm²
Cin	MuRata	GRM31CR71E475KA88L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 25.0 V IRMS= 2.8649 A	1	$0.08	1206_190 11 mm²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	2	$0.38	1210_280 15 mm²
Css	TDK	C2012C0G1H682J060AA Series= C0G/NP0	Cap= 6.8 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
D1	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	SOD-123F 12 mm²
L1	Bourns	SDR1307-270ML	L= 27.0 µH 60.0 mOhm	1	$0.42	SDR1307 226 mm²
Rcomp	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
RenB	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
RenT	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbt	Vishay-Dale	CRCW040252K3FKED Series= CRCW..e3	Res= 52.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Yageo	RC0201FR-07133KL Series= ?	Res= 133.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	TPS54160DGQR	Switcher	1	$1.19	S-PDSO-G10 24 mm^2

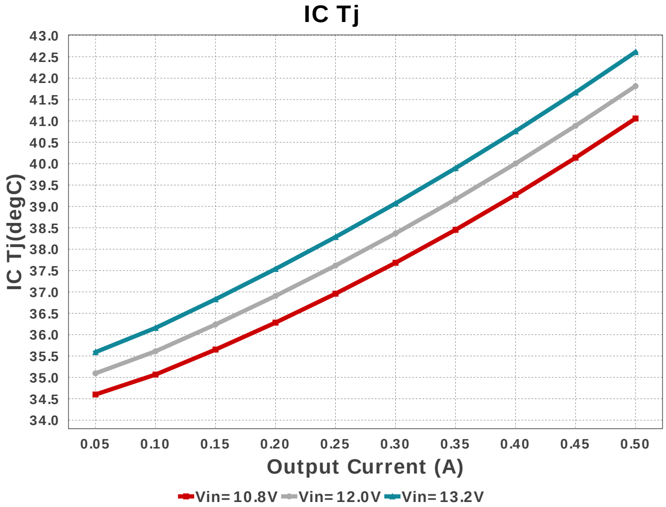




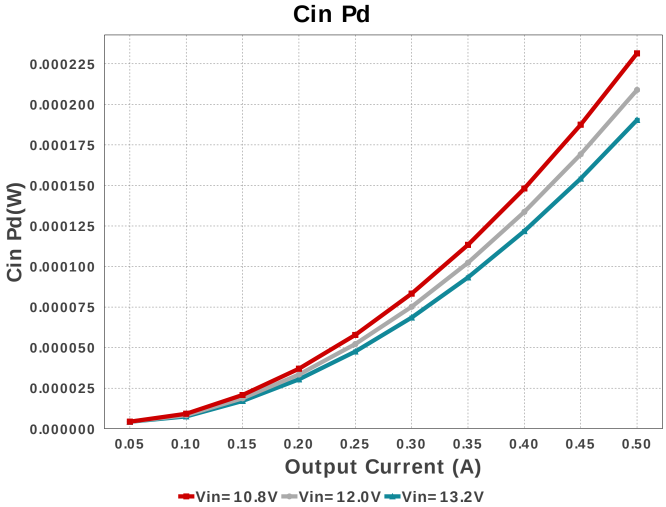




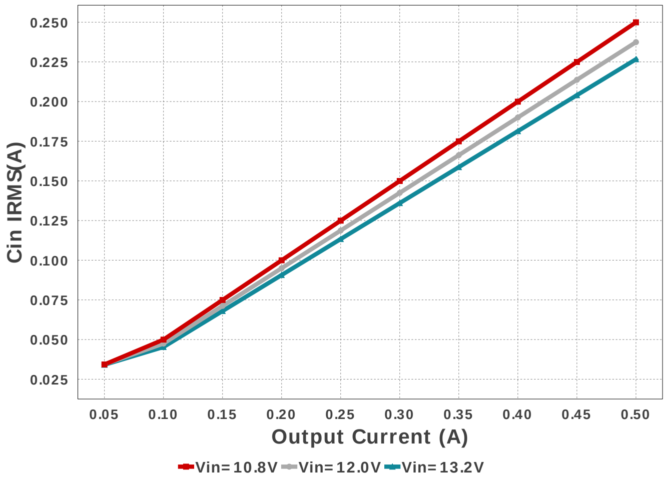
IC Tj



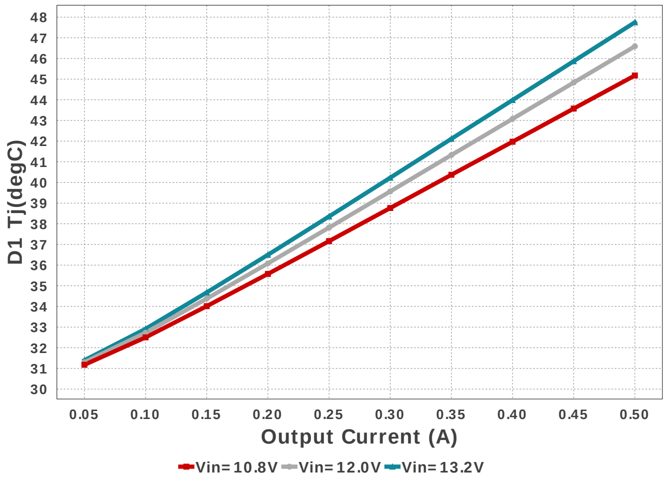
Cin Pd



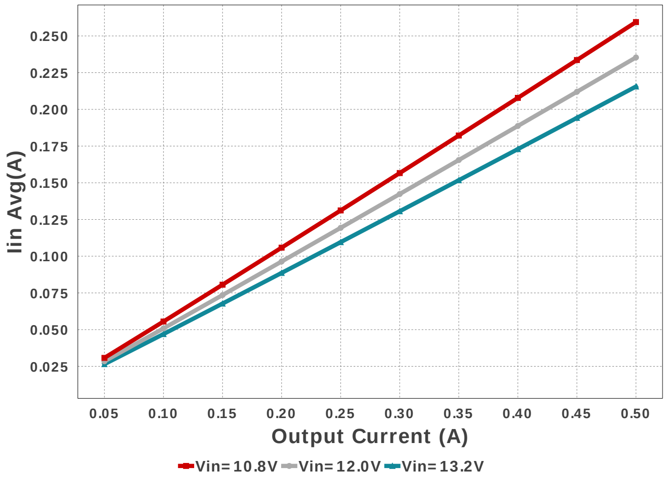
Cin IRMS



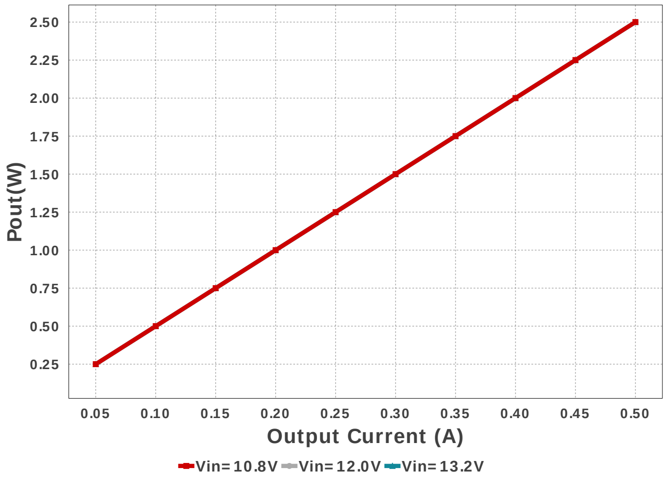
D1 Tj

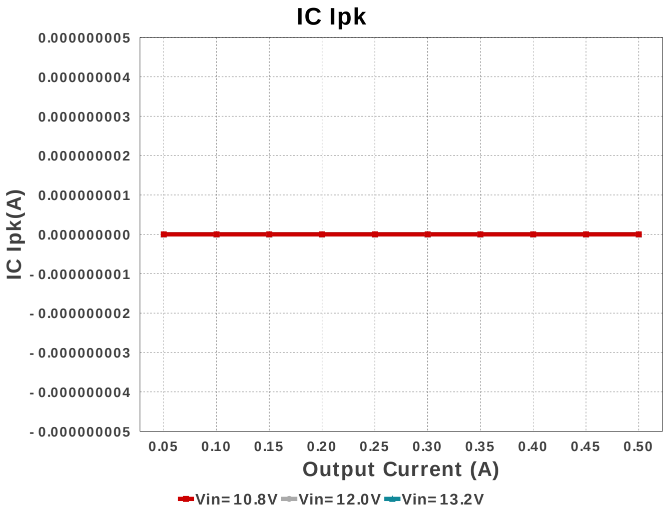


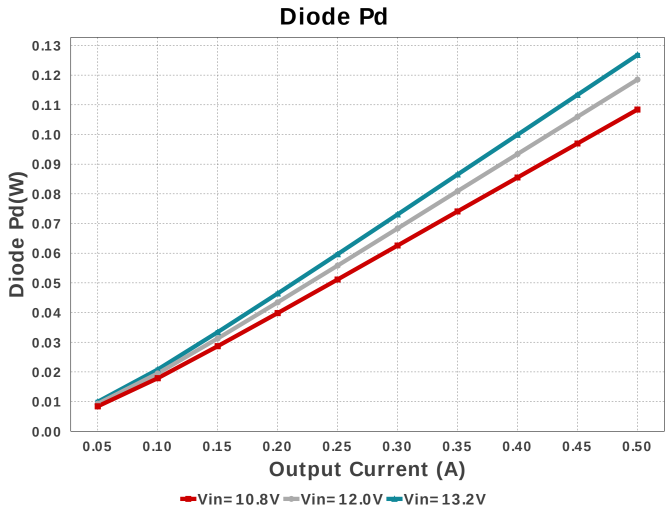
Iin Avg

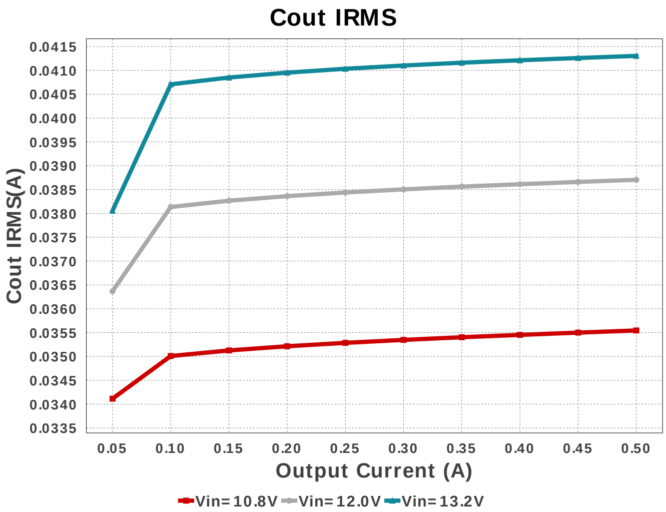


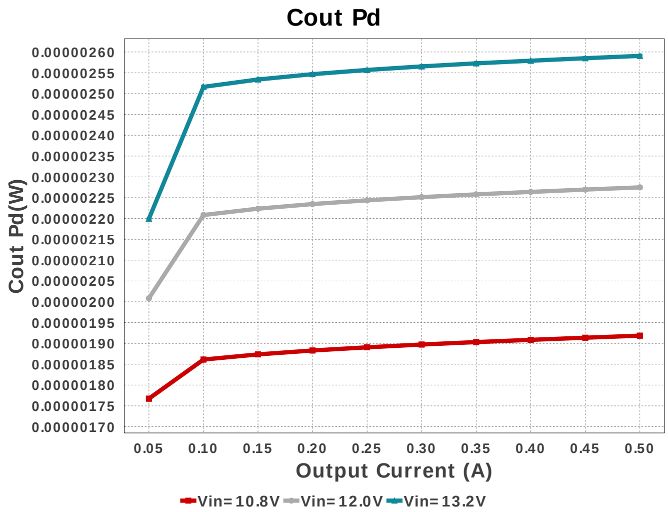
Pout

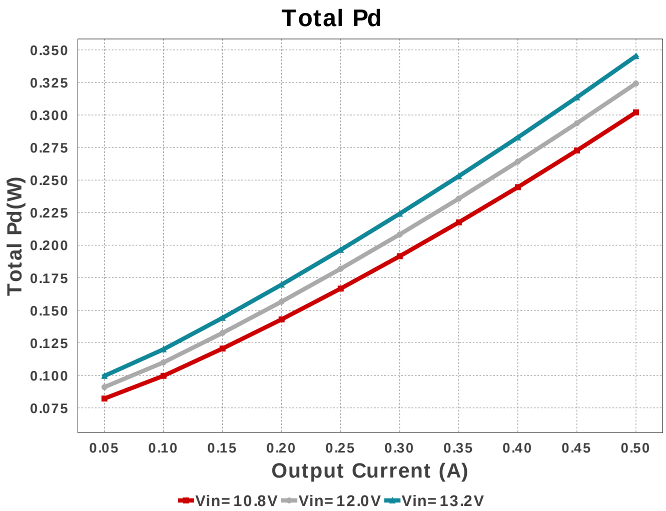


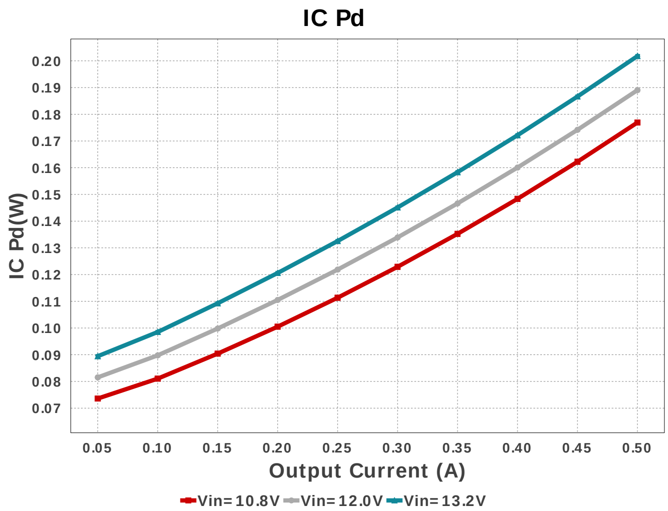

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

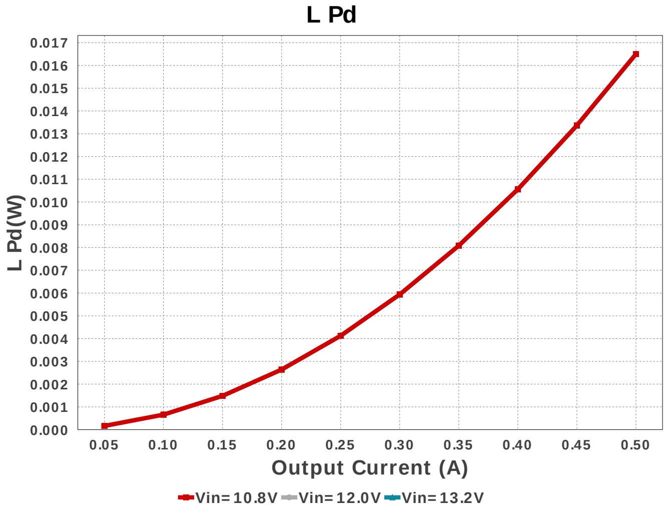

Diode Pd
Diode Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

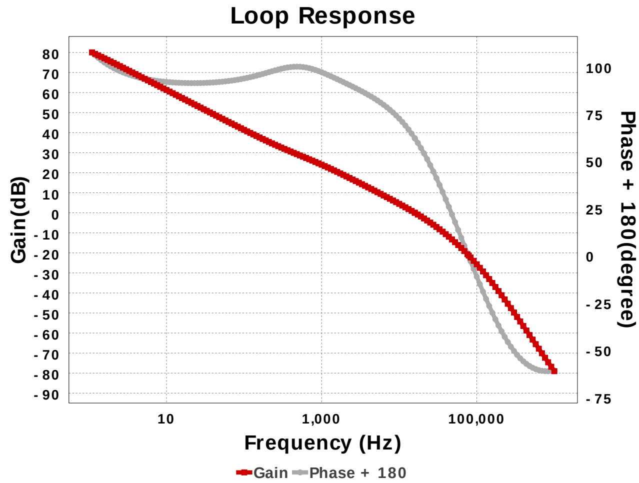

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


Total Pd
Total Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	226.669 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	190.36 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	41.304 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	2.591 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	47.749 degC	Diode	D1 junction temperature
6.	Diode Pd	126.78 mW	Diode	Diode power dissipation
7.	IC Ipk	0.0 A	IC	Peak switch current in IC
8.	IC Pd	201.78 mW	IC	IC power dissipation
9.	IC Tj	42.611 degC	IC	IC junction temperature
10.	ICThetaJA	62.5 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	215.55 mA	IC	Average input current
12.	L Ipp	143.08 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	16.5 mW	Inductor	Inductor power dissipation
14.	Cin Pd	190.36 µW	Power	Input capacitor power dissipation
15.	Cout Pd	2.591 µW	Power	Output capacitor power dissipation
16.	Diode Pd	126.78 mW	Power	Diode power dissipation
17.	IC Pd	201.78 mW	Power	IC power dissipation
18.	L Pd	16.5 mW	Power	Inductor power dissipation
19.	Total Pd	345.244 mW	Power	Total Power Dissipation
20.	BOM Count	16	System Information	Total Design BOM count
21.	Cross Freq	15.937 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	40.09 %	System Information	Duty cycle
23.	Efficiency	87.866 %	System Information	Steady state efficiency
24.	FootPrint	335.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	850.96 kHz	System Information	Switching frequency
26.	Gain Marg	-21.346 dB	System Information	Bode Plot Gain Margin
27.	Iout	500.0 mA	System Information	Iout operating point
28.	Low Freq Gain	80.051 dB	System Information	Gain at 1Hz
29.	Mode	CCM	System Information	Conduction Mode
30.	Phase Marg	62.581 deg	System Information	Bode Plot Phase Margin
31.	Pout	2.5 W	System Information	Total output power
32.	Total BOM	$2.76	System Information	Total BOM Cost
33.	Vin	13.2 V	System Information	Vin operating point
34.	Vout	5.0 V	System Information	Operational Output Voltage
35.	Vout Actual	4.984 V	System Information	Vout Actual calculated based on selected voltage divider resistors

#	Name	Value	Category	Description
36.	Vout Tolerance	2.713 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
37.	Vout p-p	368.596 µV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	13.2	Maximum input voltage
VinMin	10.8	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS54160	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

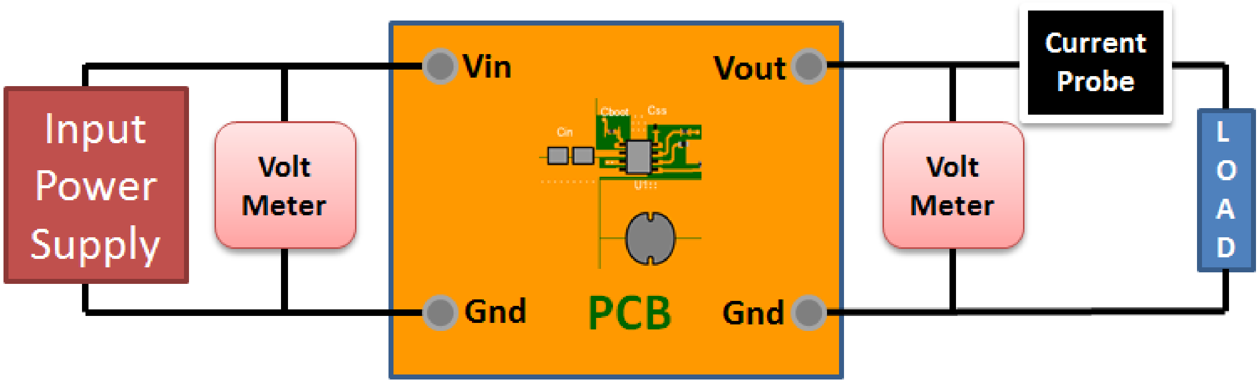
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.8V 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.

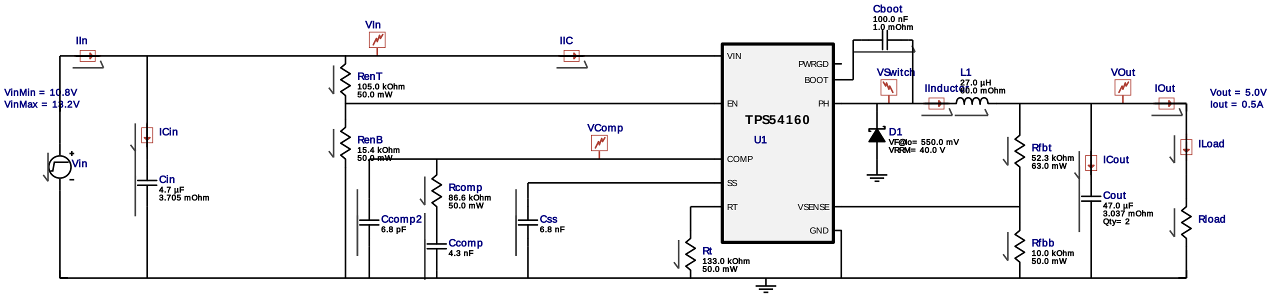


WEBENCH® Electrical Simulation Report

Design Id = 5

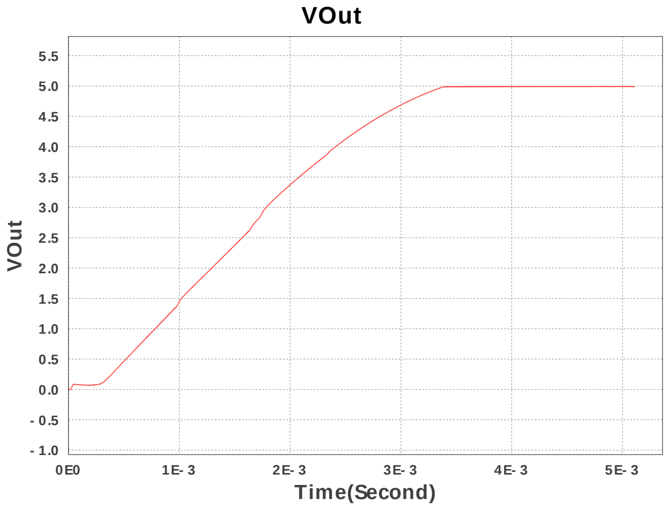
sim_id = 1

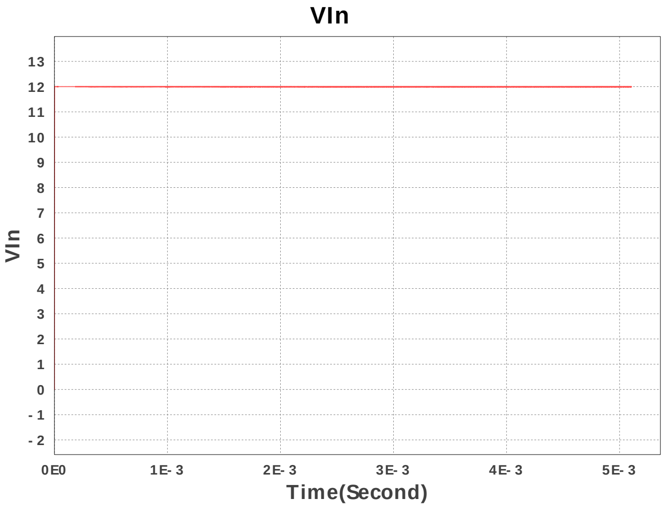
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	10.0 Ohm





Design Assistance

1. Master key : 9401D2699F8EAF4B[v1]
2. **TPS54160** Product Folder : http://www.ti.com/product/TPS54160 : contains the data sheet and other resources.