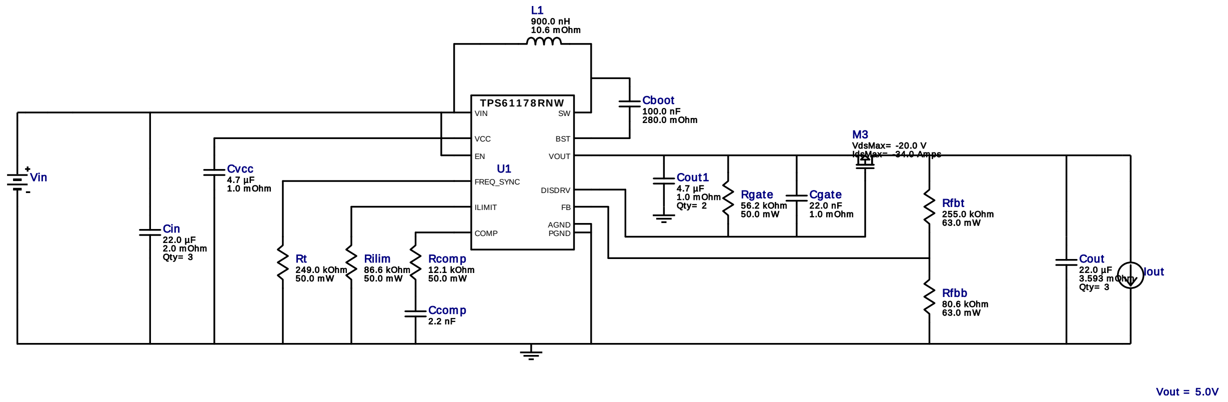
VinMin = 2.7V
VinMax = 4.2V
Vout = 5.0V
Iout = 2.5A

Device = TPS61178RNWR
Topology = Boost
Created = 2024-02-29 19:15:55.293
BOM Cost = $4.02
BOM Count = 21
Total Pd = 0.84W

WEBENCH ® Design Report

Design : 19 TPS61178RNWR
TPS61178RNWR 2.7V-4.2V to 5.00V @ 2A



Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccomp	Samsung Electro-Mechanics	CL21C222JBFNNNE Series= C0G/NP0	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
Cgate	MuRata	GRM155R71E223KA61D Series= X7R	Cap= 22.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	3	$0.23	1210 15 mm^2
Cout	MuRata	GRM31CR71A226KE15L Series= X7R	Cap= 22.0 uF ESR= 3.593 mOhm VDC= 10.0 V IRMS= 3.5332 A	3	$0.12	1206_190 11 mm^2
Cout1	MuRata	GRM155R61A475MEAAD Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	2	$0.02	0402_065 3 mm^2
Cvcc	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
L1	Coilcraft	XAL6020-901MEB	L= 900.0 nH 10.6 mOhm	1	$0.76	XAL6020 75 mm^2
M3	Vishay-Siliconix	Si7633DP	VdsMax= -20.0 V IdsMax= -34.0 Amps	1	$1.11	PowerPAK_SO-8 55 mm^2
Rcomp	Yageo	RC0201FR-0712K1L Series= ?	Res= 12.1 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2

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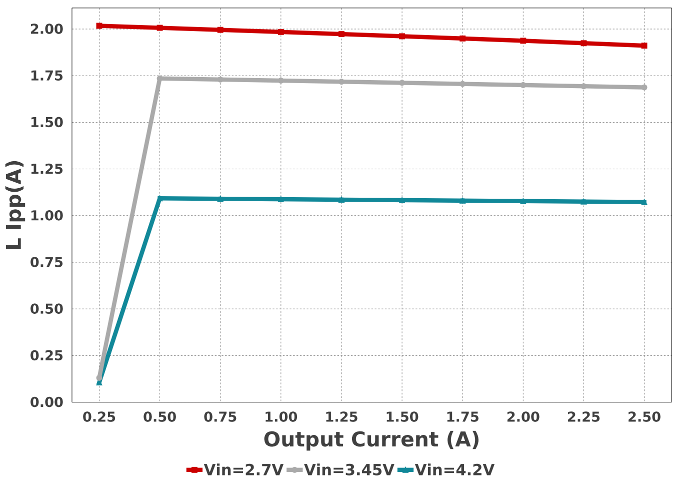
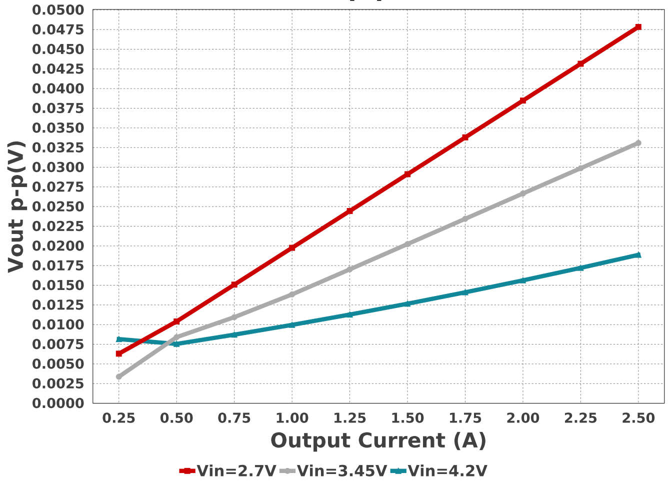
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Vishay-Dale	CRCW040280K6FKED Series= CRCW..e3	Res= 80.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW0402255KFKED Series= CRCW..e3	Res= 255.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rgate	Yageo	RC0201FR-0756K2L Series= ?	Res= 56.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rilim	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rt	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	TPS61178RNWR	Switcher	1	$0.90	RNW0013A 18 mm^2

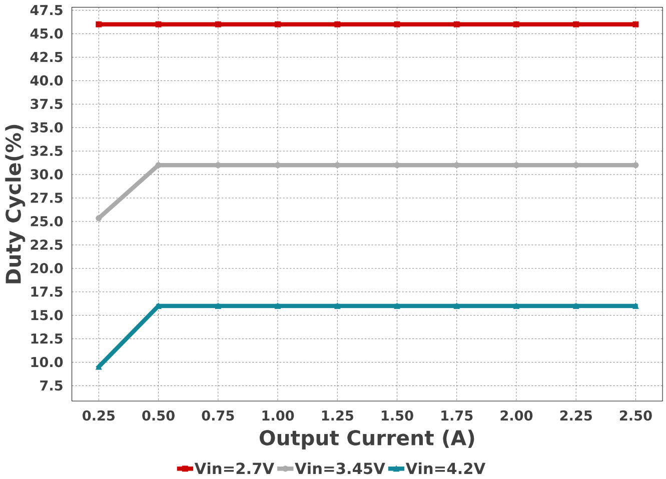
L Ipp



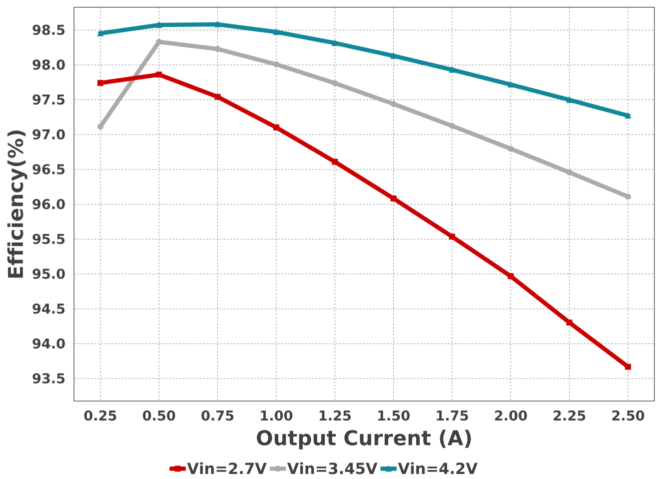
Vout p-p

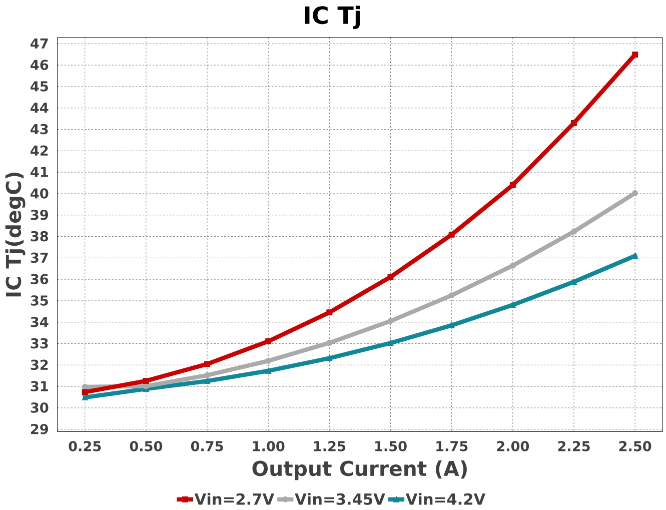


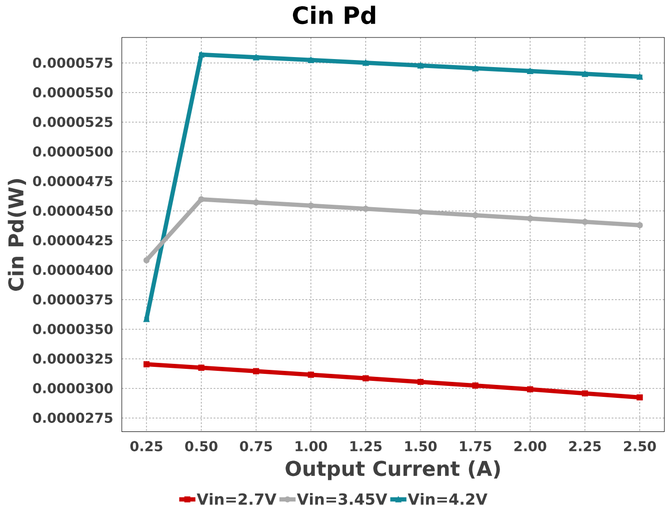
Duty Cycle

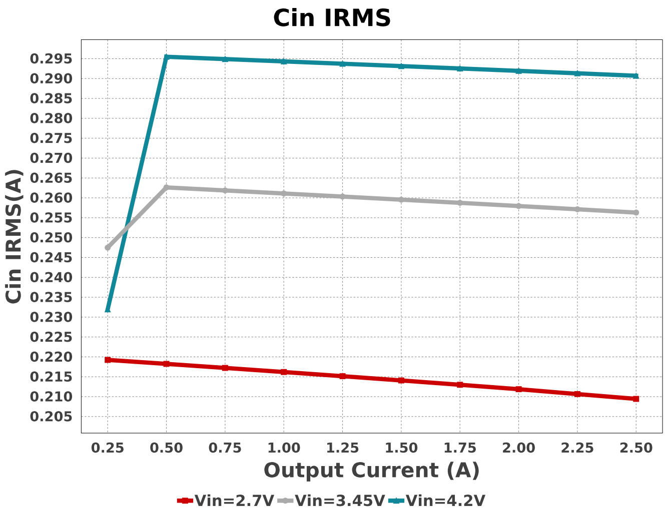


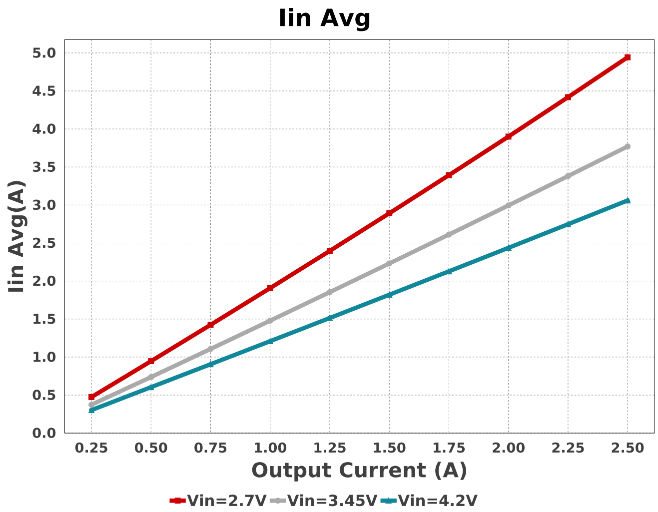
Efficiency

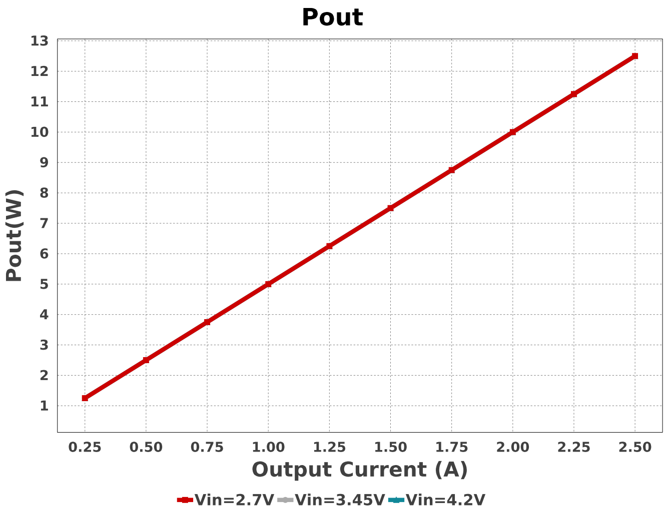


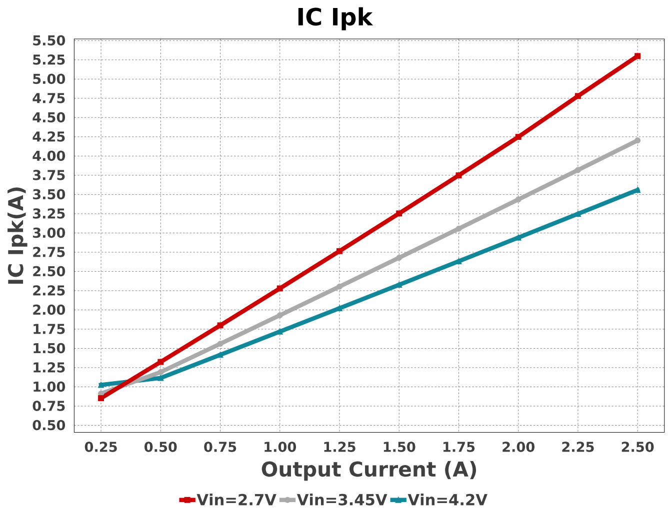

IC Tj
IC Tj(degC)
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

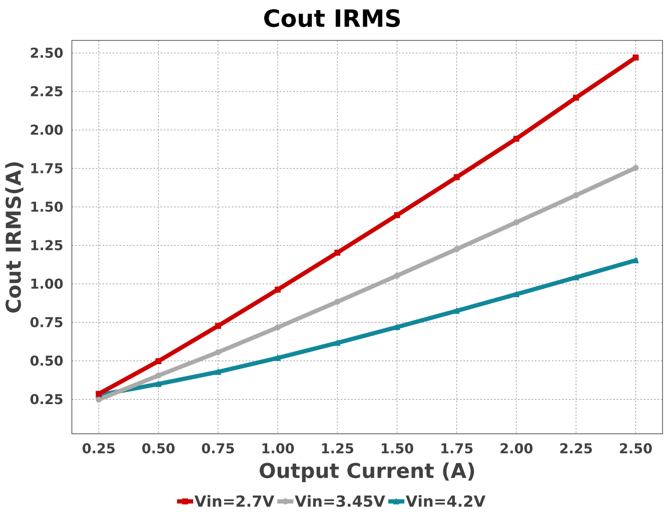

Cin Pd
Cin Pd(W)
0.0000575
0.0000550
0.0000525
0.0000500
0.0000475
0.0000450
0.0000425
0.0000400
0.0000375
0.0000350
0.0000325
0.0000300
0.0000275
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

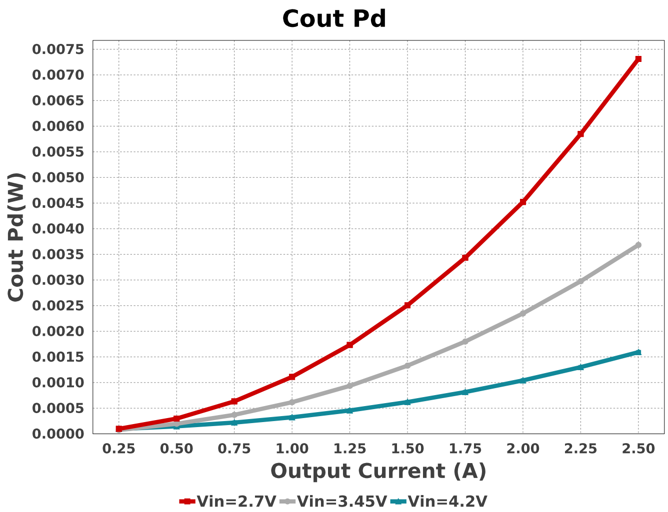

Cin IRMS
Cin IRMS(A)
0.295
0.290
0.285
0.280
0.275
0.270
0.265
0.260
0.255
0.250
0.245
0.240
0.235
0.230
0.225
0.220
0.215
0.210
0.205
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

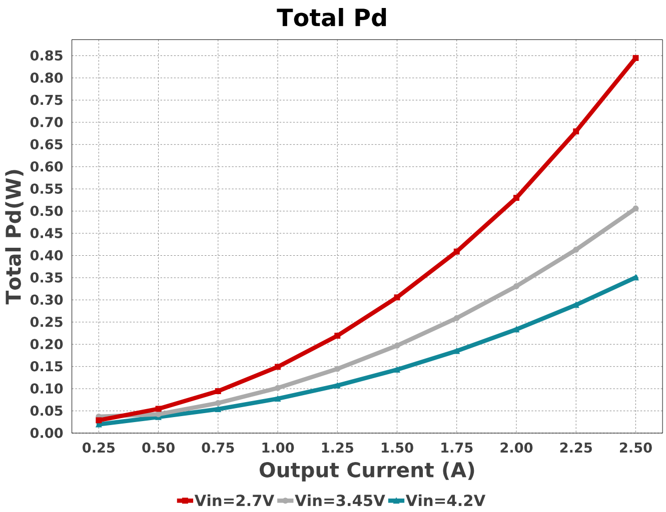

Iin Avg
Iin Avg(A)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

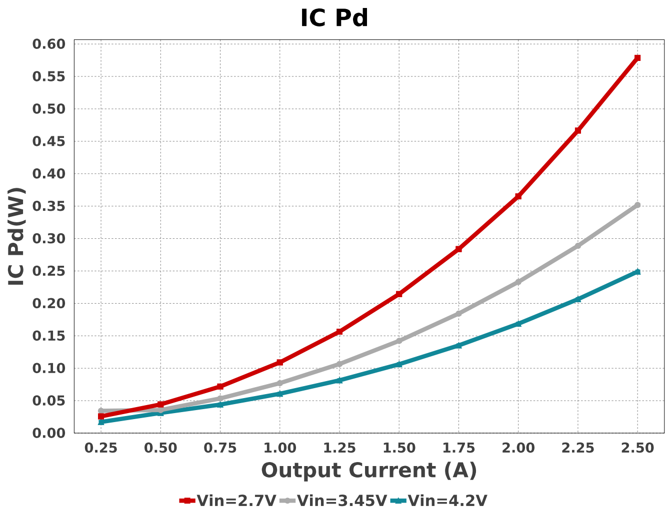

Pout
Pout(W)
13
12
11
10
9
8
7
6
5
4
3
2
1
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

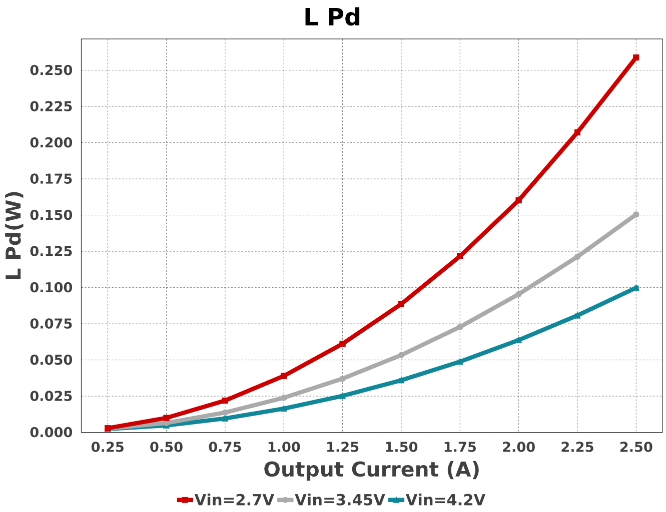

IC Ipk
IC Ipk(A)
5.50
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

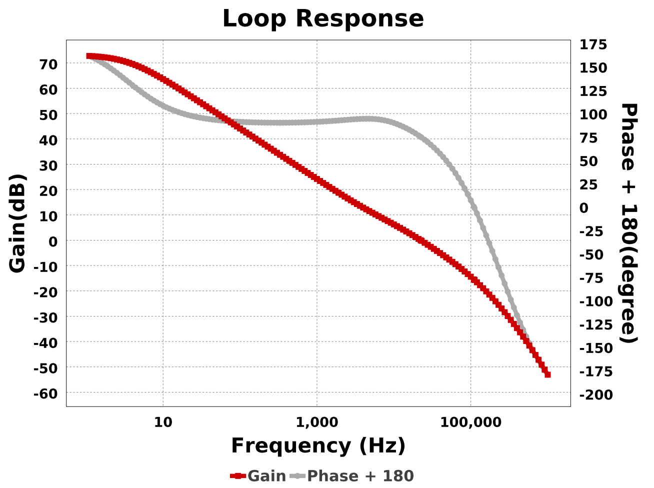

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V

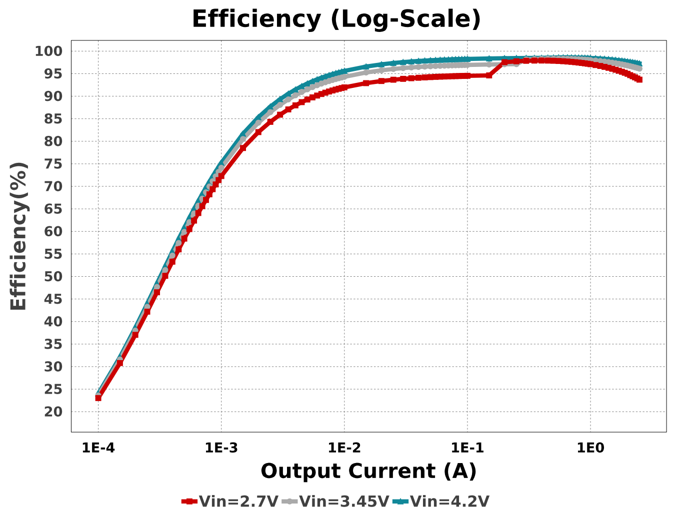

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V


Total Pd
Total Pd(W)
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V


IC Pd
IC Pd(W)
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V


L Pd
L Pd(W)
Output Current (A)
Vin=2.7V
Vin=3.45V
Vin=4.2V


Loop Response
Gain(dB)
Phase + 180(degree)
Frequency (Hz)
Gain
Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	209.437 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	29.243 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.471 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	7.311 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	5.299 A	IC	Peak switch current in IC
6.	IC Pd	578.62 mW	IC	IC power dissipation
7.	IC Tj	46.491 degC	IC	IC junction temperature
8.	ICThetaJA	28.5 degC/W	IC	IC junction-to-ambient thermal resistance
9.	Iin Avg	4.942 A	IC	Average input current
10.	L Ipp	1.911 A	Inductor	Peak-to-peak inductor ripple current
11.	L Pd	258.79 mW	Inductor	Inductor power dissipation
12.	Cin Pd	29.243 µW	Power	Input capacitor power dissipation
13.	Cout Pd	7.311 mW	Power	Output capacitor power dissipation
14.	IC Pd	578.62 mW	Power	IC power dissipation
15.	L Pd	258.79 mW	Power	Inductor power dissipation
16.	Total Pd	844.856 mW	Power	Total Power Dissipation
17.	BOM Count	21	System Information	Total Design BOM count
18.	Cross Freq	14.907 kHz	System Information	Bode plot crossover frequency
19.	Duty Cycle	46.0 %	System Information	Duty cycle
20.	Efficiency	93.669 %	System Information	Steady state efficiency
21.	FootPrint	269.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	680.394 kHz	System Information	Switching frequency
23.	Gain Marg	-14.366 dB	System Information	Bode Plot Gain Margin
24.	Iout	2.5 A	System Information	Iout operating point
25.	Low Freq Gain	71.767 dB	System Information	Gain at 1Hz
26.	Mode	BOOST PWM CCM	System Information	PWM/PFM Mode
27.	Phase Marg	72.935 deg	System Information	Bode Plot Phase Margin
28.	Pout	12.5 W	System Information	Total output power
29.	Total BOM	$4.02	System Information	Total BOM Cost
30.	Vin	2.7 V	System Information	Vin operating point
31.	Vout Actual	4.988 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	2.552 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	47.898 mV	System Information	Peak-to-peak output ripple voltage

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Design Inputs

Name	Value	Description
Iout	2.5	Maximum Output Current
VinMax	4.2	Maximum input voltage
VinMin	2.7	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS61178	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

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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

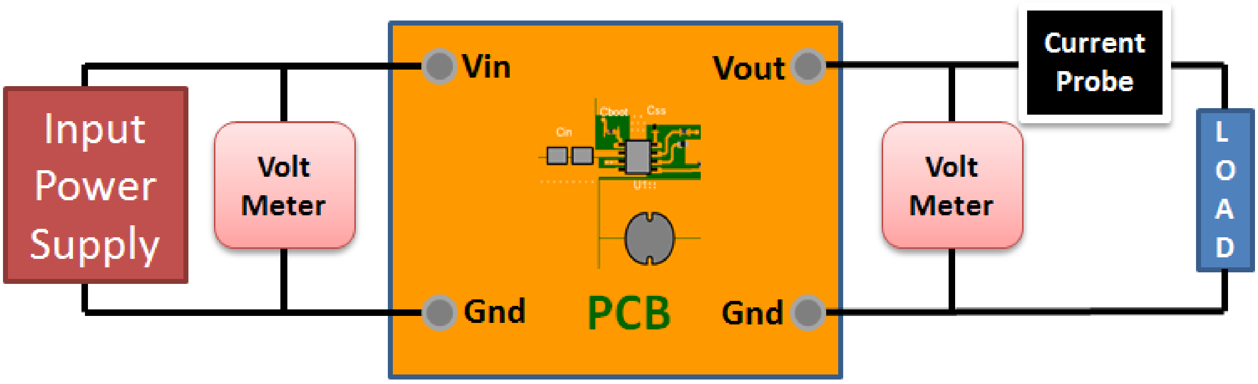
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 2.7V 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.

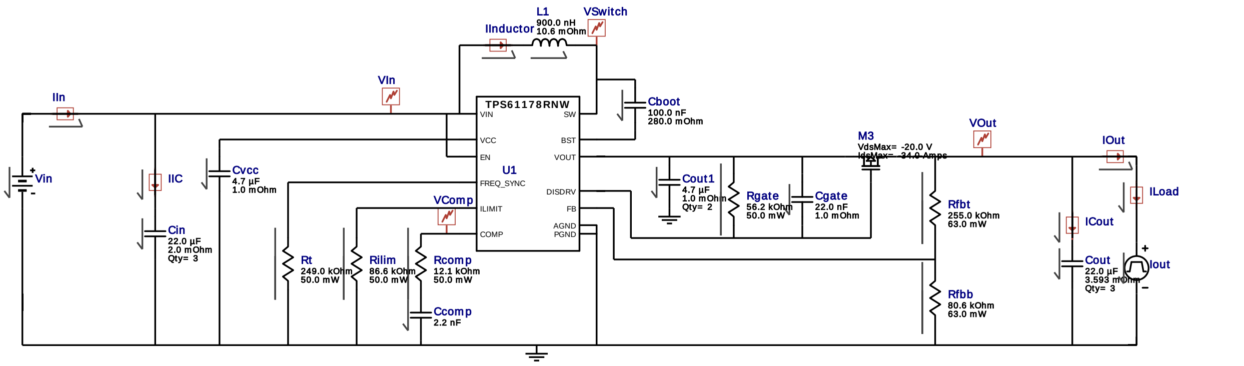


WEBENCH® Electrical Simulation Report

Design Id = 19

sim_id = 2

Simulation Type = Load Transient

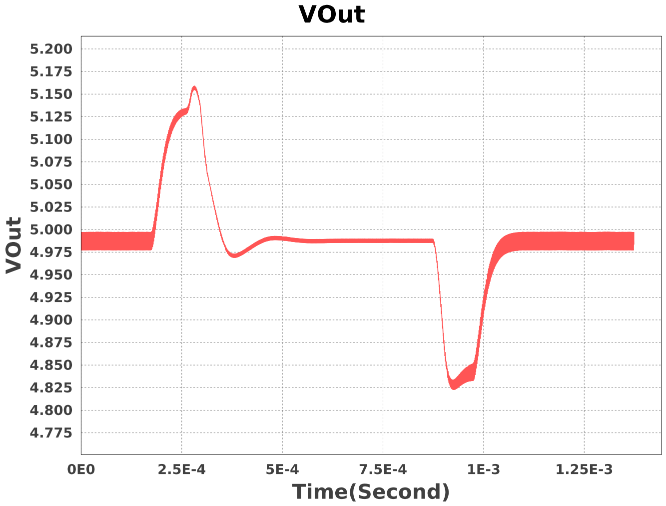


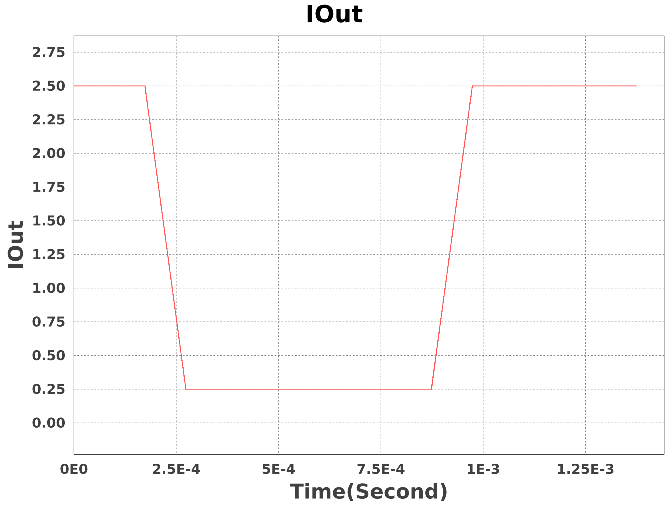
VinMin = 2.7V
VinMax = 4.2V

Vout = 5.0V
Iout = 2.5A

Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cvcc	IC	no description	6
2.	L1	IC	no description	2.5
3.	Cboot	IC	no description	6
4.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	2.5 A
		I2	Final Load Current	0.25 A
		Td	Initial Time Delay	1.734868124E-4 Sec
		Tf	Fall Time	100u Sec
		Tr	Rise Time	100u sec
		Pw	Pulse Width	6.0E-4 sec





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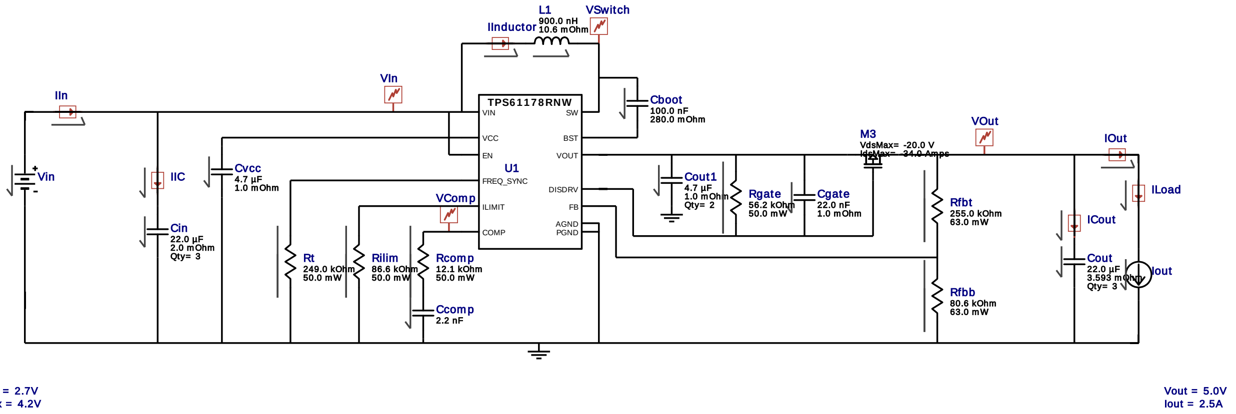
Design Id = 19

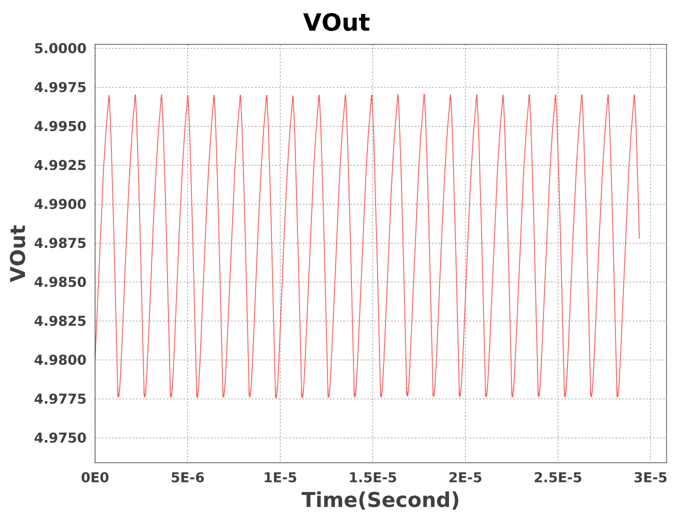
sim_id = 3

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cvcc	IC	Initial COndition	6
2.	L1	IC	Initial condition	2.5 A
3.	Cboot	IC	Initial COndition	6 V
4.	Iout	I	Load Current	2.5 A



Design Assistance

1. Master key : 66DEF575AC69D528[v1]

2. **TPS61178** Product Folder : http://www.ti.com/product/TPS61178 : contains the data sheet and other resources.

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