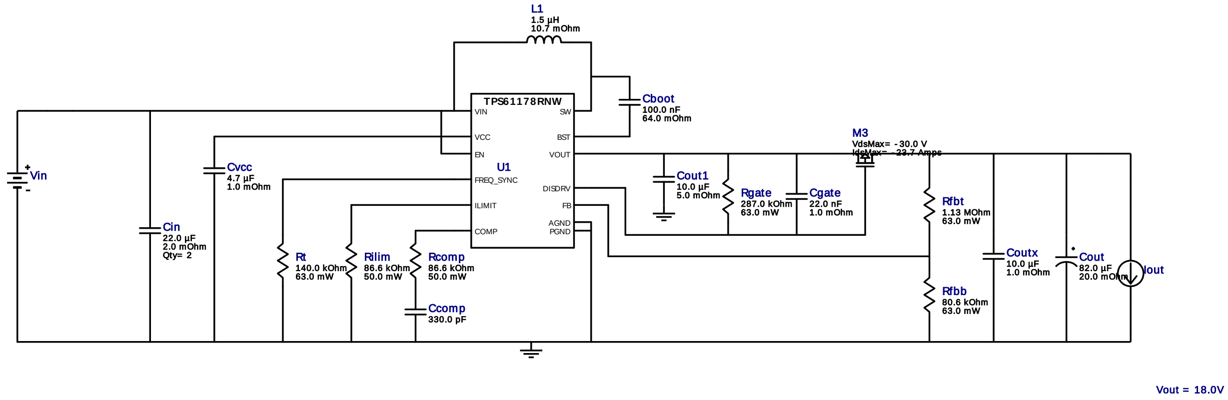
Texas Instruments

VinMin = 10.0V
VinMax = 12.0V
Vout = 18.0V
Iout = 3.0A

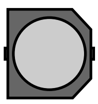
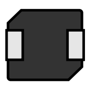
Device = TPS61178RNWR
Topology = Boost
Created = 2019-12-04 22:24:06.069
BOM Cost = $5.37
BOM Count = 18
Total Pd = 1.79W

WEBENCH ® Design Report

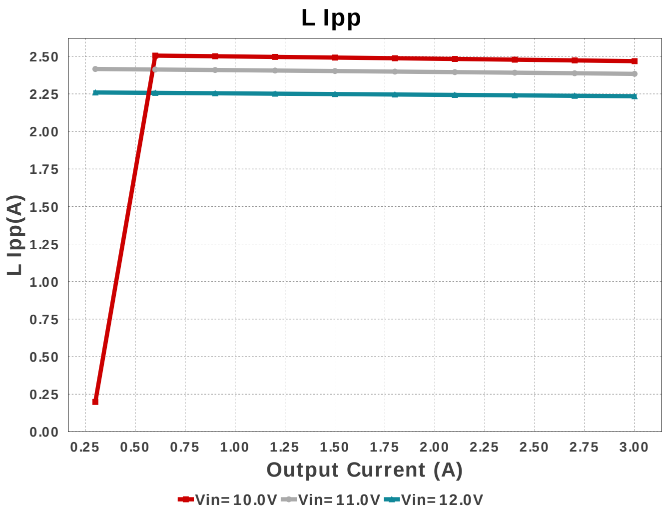
Design : 5 TPS61178RNWR
TPS61178RNWR 8.5V-12V to 18.00V @ 3A

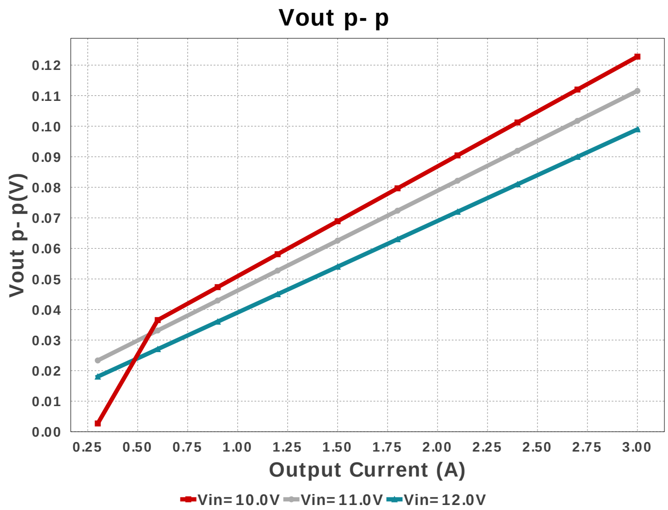


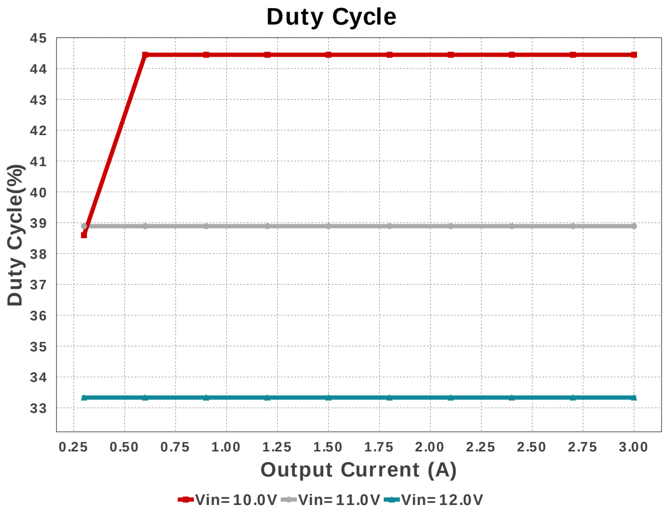
Electrical BOM

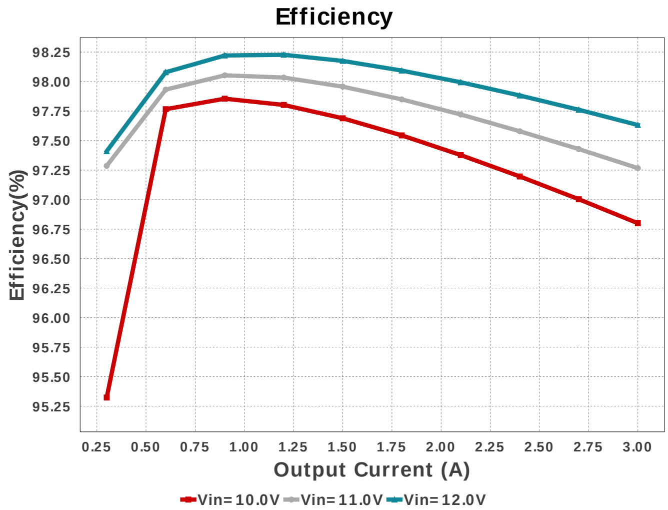
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Ccomp	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cgate	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 mm²
Cin	MuRata	GRM32ER61C226ME20L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 16.0 V IRMS= 3.68 A	2	$0.55	1210 15 mm²
Cout	Panasonic	35SVPF82M Series= SVPF	Cap= 82.0 uF ESR= 20.0 mOhm VDC= 35.0 V IRMS= 4.0 A	1	$0.63	 CAPSMT_62_E12 106 mm²
Cout1	Samsung Electro-Mechanics	CL32B106KBJNNWE Series= X7R	Cap= 10.0 uF ESR= 5.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.17	1210_270 15 mm²
Coutx	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	1	$0.28	1210 15 mm²
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 mm²
L1	TDK	SPM6530T-1R5M100	L= 1.5 µH 10.7 mOhm	1	$0.56	 SPM6530 77 mm²

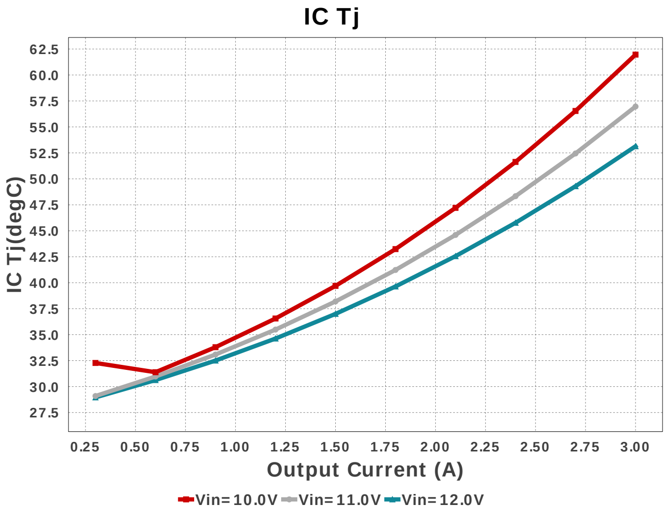
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
M3	Vishay-Siliconix	Si7149DP	VdsMax= -30.0 V IdsMax= -23.7 Amps	1	$0.68	PowerPAK_SO-8 55 mm^2
Rcomp	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbb	Vishay-Dale	CRCW040280K6FKED Series= CRCW..e3	Res= 80.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW04021M13FKED Series= CRCW..e3	Res= 1.13 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rgate	Vishay-Dale	CRCW0402287KFKED Series= CRCW..e3	Res= 287.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 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	Vishay-Dale	CRCW0402140KFKED Series= CRCW..e3	Res= 140.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS61178RNWR	Switcher	1	$1.80	RNW0013A 18 mm^2

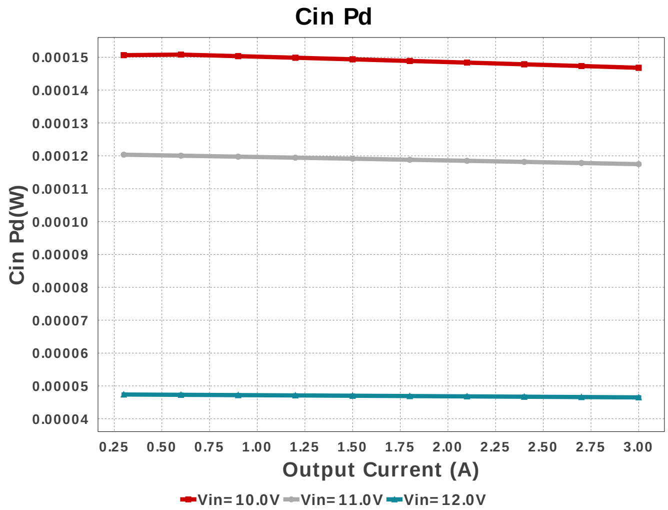


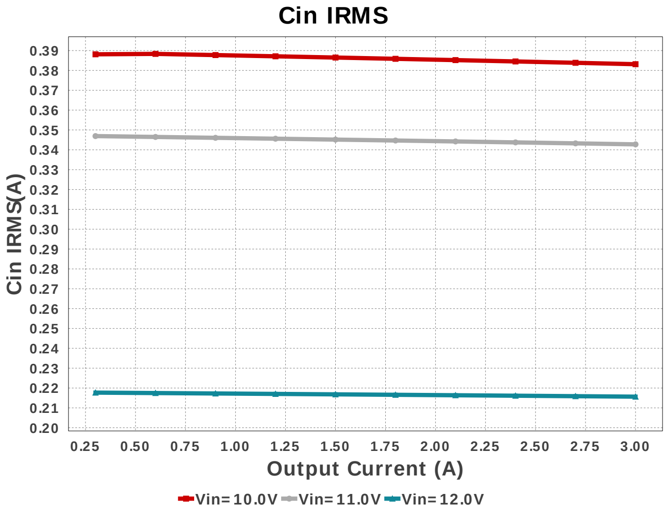


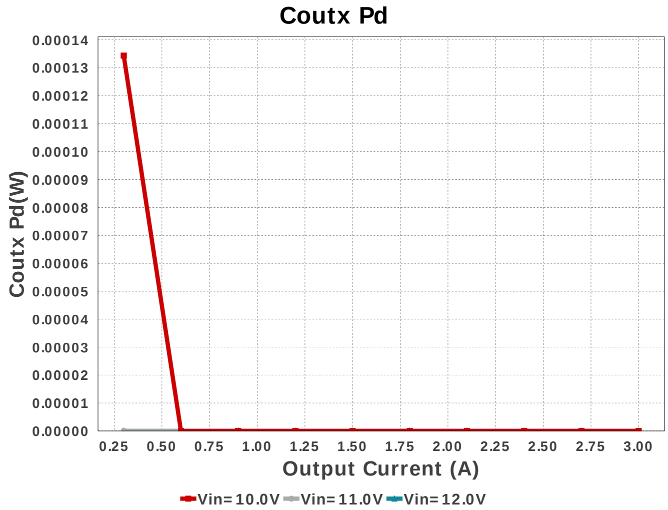


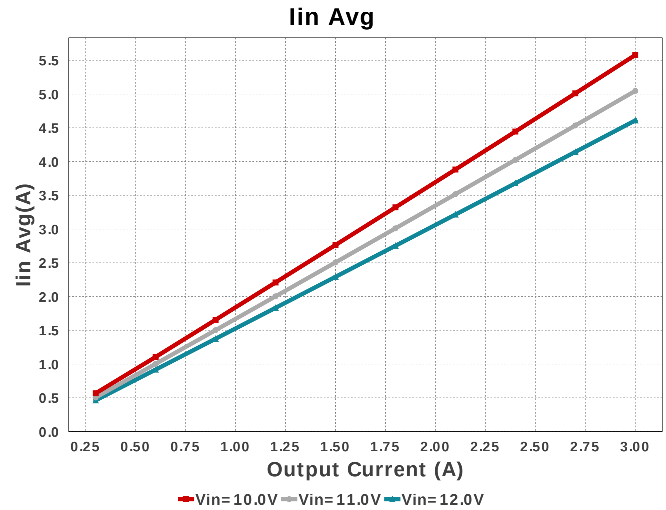


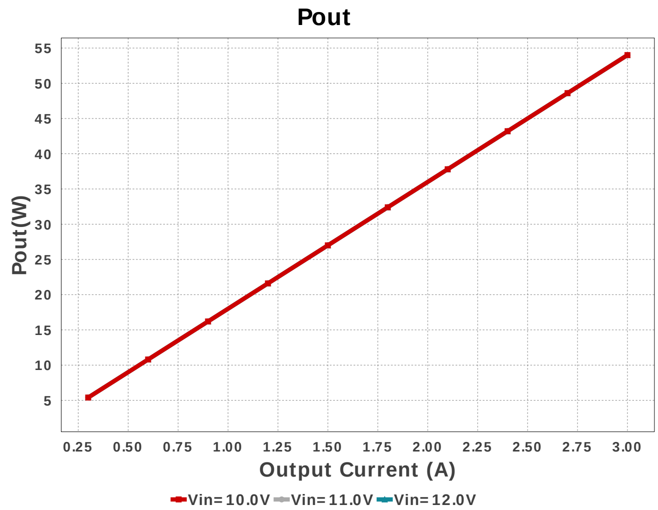

IC Tj
IC Tj(degC)
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

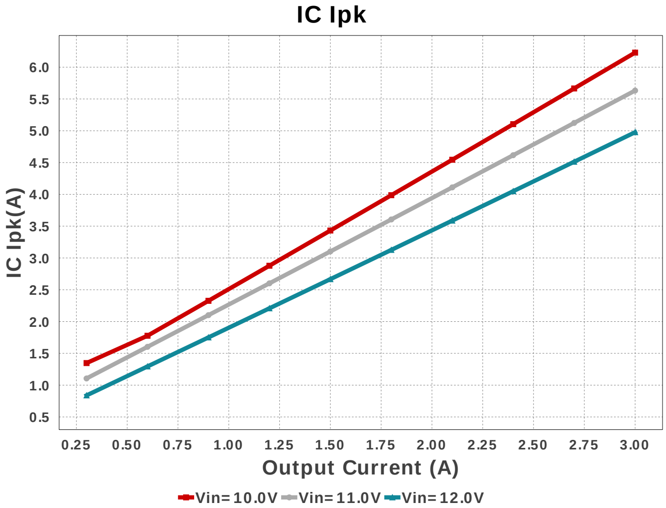

Cin Pd
Cin Pd(W)
0.00015
0.00014
0.00013
0.00012
0.00011
0.00010
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

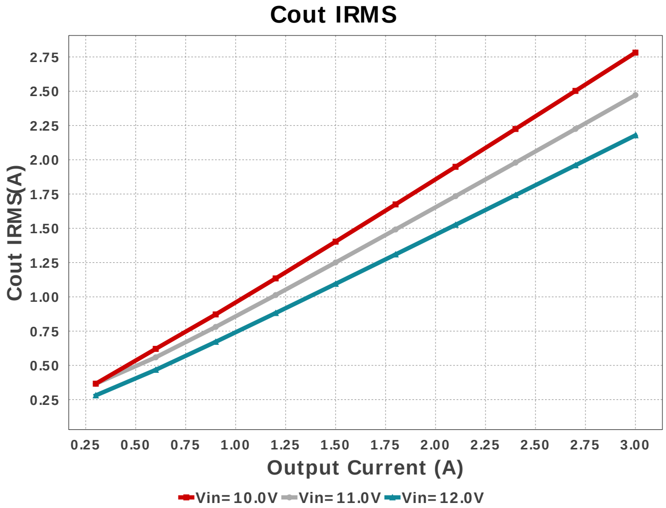

Cin IRMS
Cin IRMS(A)
0.39
0.38
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

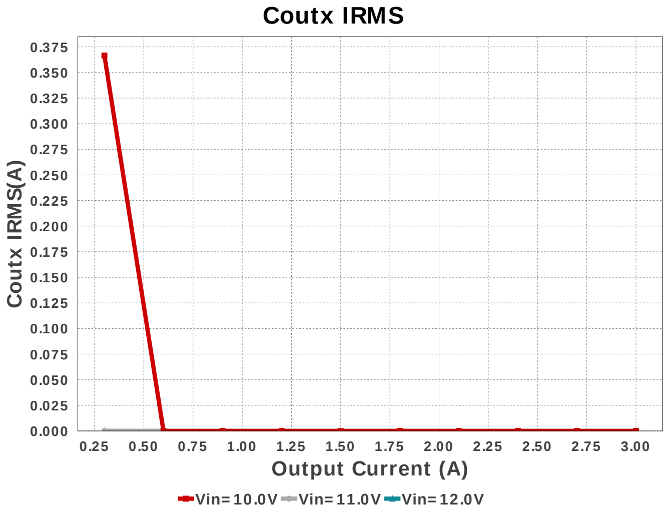

Coutx Pd
Coutx Pd(W)
0.00014
0.00013
0.00012
0.00011
0.00010
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

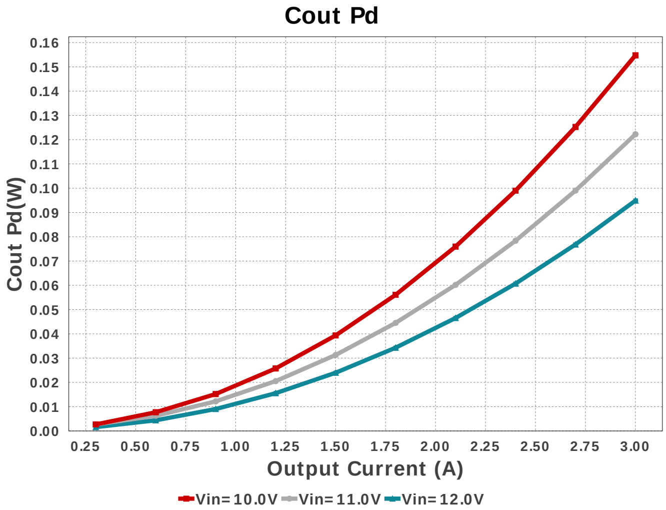

Iin Avg
Iin Avg(A)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

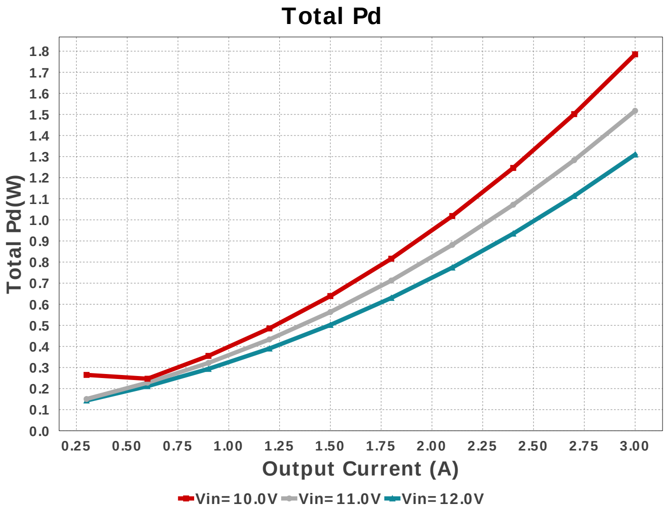

Pout
Pout(W)
55
50
45
40
35
30
25
20
15
10
5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

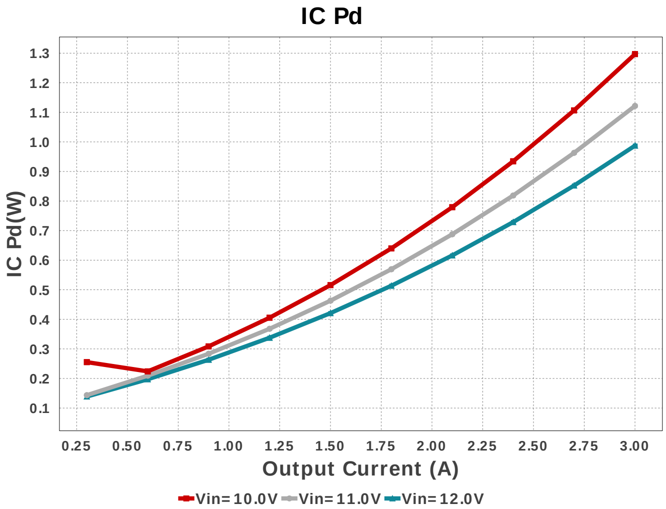

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

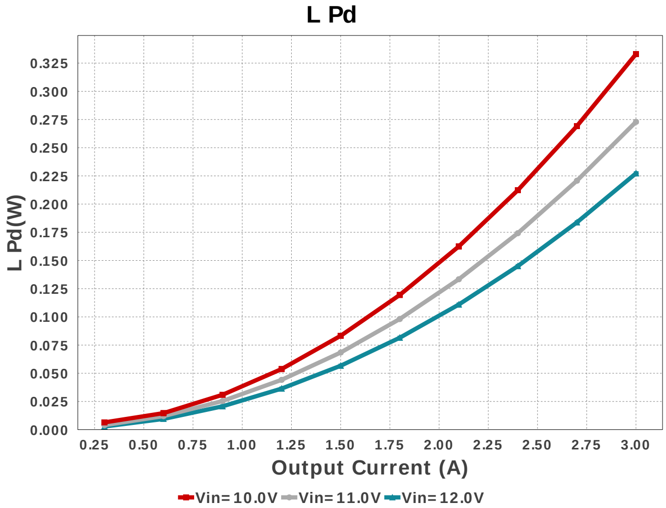

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

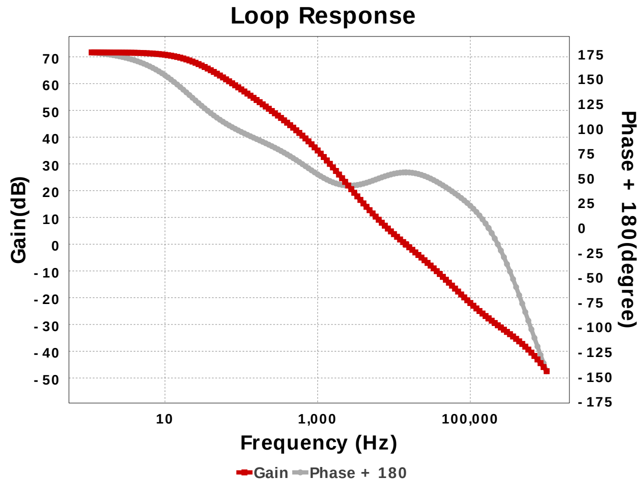

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

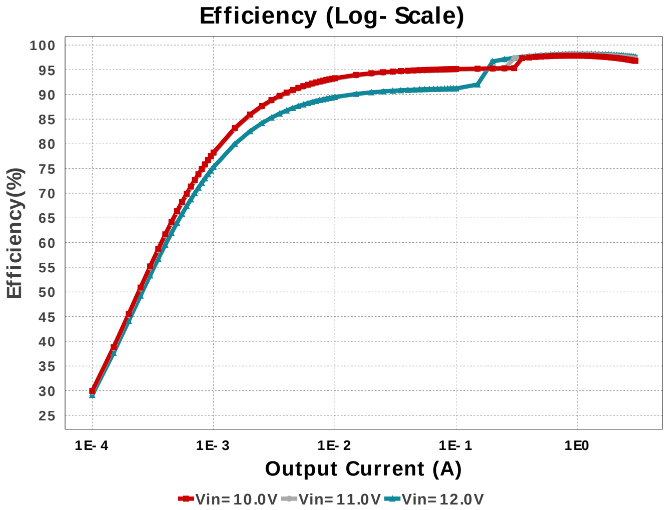

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	383.129 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	146.79 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.782 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	154.75 mW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	5.0 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	0.0 W	Capacitor	Output capacitor_x power loss
7.	IC Ipk	6.229 A	IC	Peak switch current in IC
8.	IC Pd	1.297 W	IC	IC power dissipation
9.	IC Tj	61.962 degC	IC	IC junction temperature
10.	ICThetaJA	28.5 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	5.578 A	IC	Average input current
12.	L Ipp	2.468 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	332.99 mW	Inductor	Inductor power dissipation
14.	Cin Pd	146.79 µW	Power	Input capacitor power dissipation
15.	Cout Pd	154.75 mW	Power	Output capacitor power dissipation
16.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
17.	IC Pd	1.297 W	Power	IC power dissipation
18.	L Pd	332.99 mW	Power	Inductor power dissipation
19.	Total Pd	1.785 W	Power	Total Power Dissipation
20.	BOM Count	18	System Information	Total Design BOM count
21.	Cross Freq	12.267 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	44.444 %	System Information	Duty cycle
23.	Efficiency	96.8 %	System Information	Steady state efficiency
24.	FootPrint	355.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	1.179 MHz	System Information	Switching frequency

#	Name	Value	Category	Description
26.	Gain Marg	-26.618 dB	System Information	Bode Plot Gain Margin
27.	Iout	3.0 A	System Information	Iout operating point
28.	Low Freq Gain	71.096 dB	System Information	Gain at 1Hz
29.	Mode	BOOST PWM CCM	System Information	PWM/PFM Mode
30.	Phase Marg	54.287 deg	System Information	Bode Plot Phase Margin
31.	Pout	54.0 W	System Information	Total output power
32.	Total BOM	$5.37	System Information	Total BOM Cost
33.	Vin	10.0 V	System Information	Vin operating point
34.	Vout Actual	17.994 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	2.906 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	122.772 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	12.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	18.0	Output Voltage
base_pn	TPS61178	Base Product Number
source	DC	Input Source Type
Ta	25.0	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

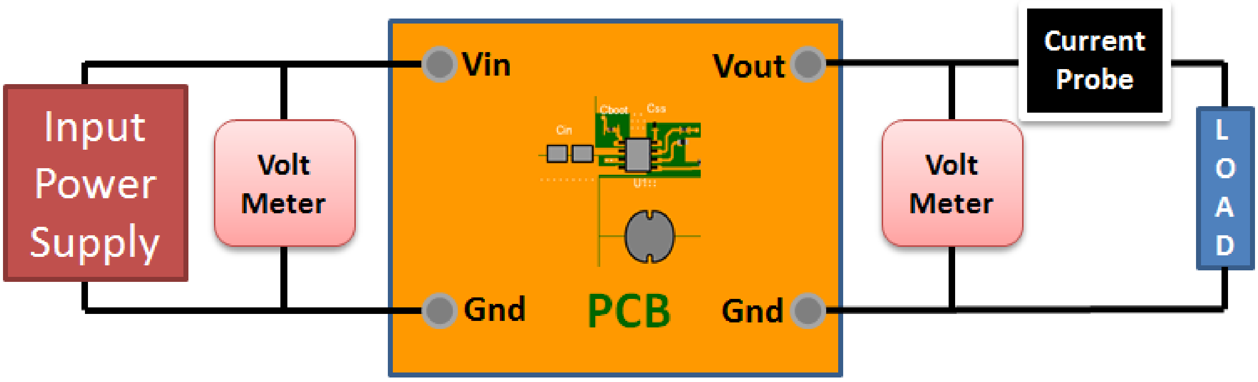
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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.

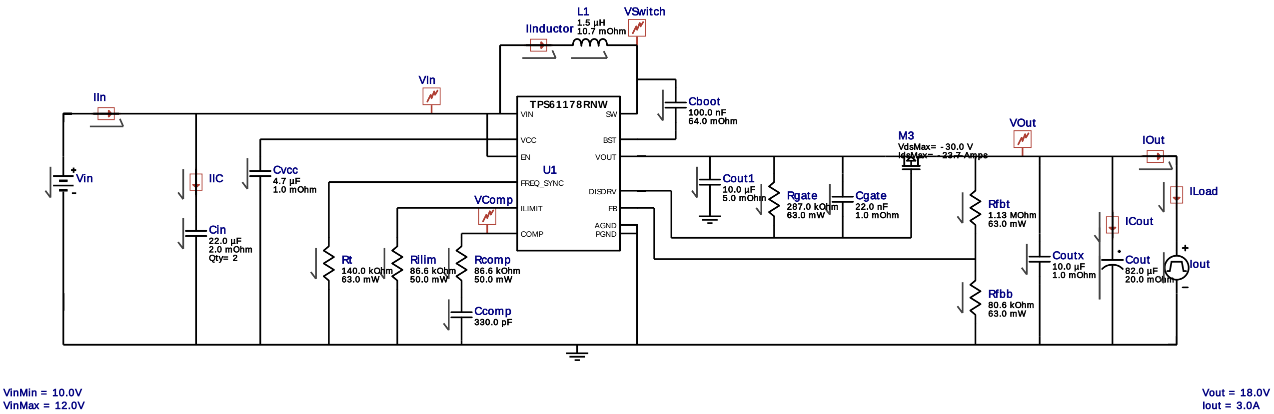


WEBENCH® Electrical Simulation Report

Design Id = 5

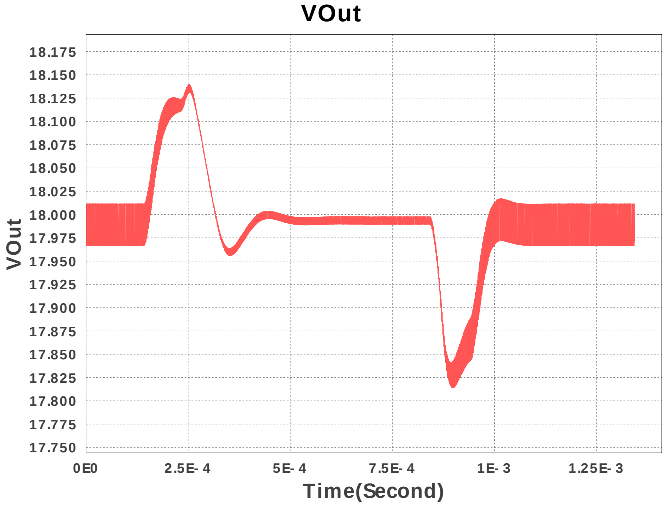
sim_id = 1

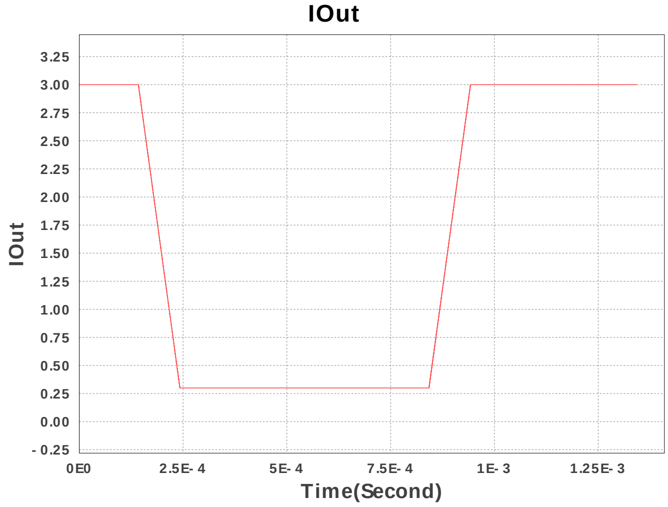
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cvcc	IC	no description	6
2.	Cboot	IC	no description	6
3.	L1	IC	no description	3.0
4.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	3.0 A
		I2	Final Load Current	0.3 A
		Td	Initial Time Delay	1.42412264E-4 Sec
		Tf	Fall Time	100u Sec
		Tr	Rise Time	100u sec
		Pw	Pulse Width	6.0E-4 sec

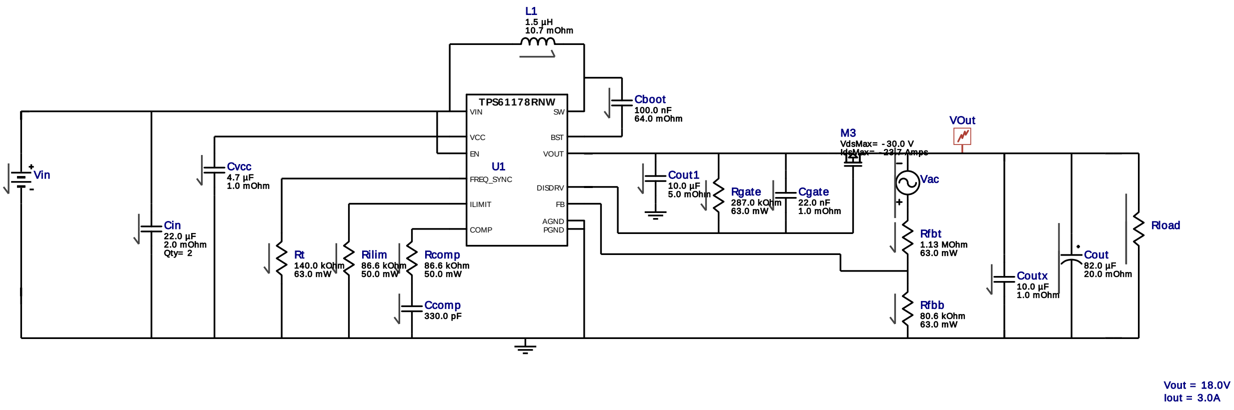




Design Id = 5

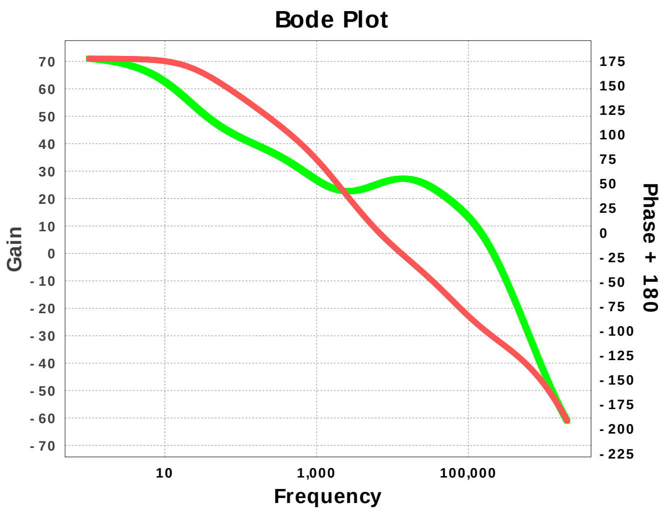
sim_id = 2

Simulation Type = Bode Plot



Simulation Parameters

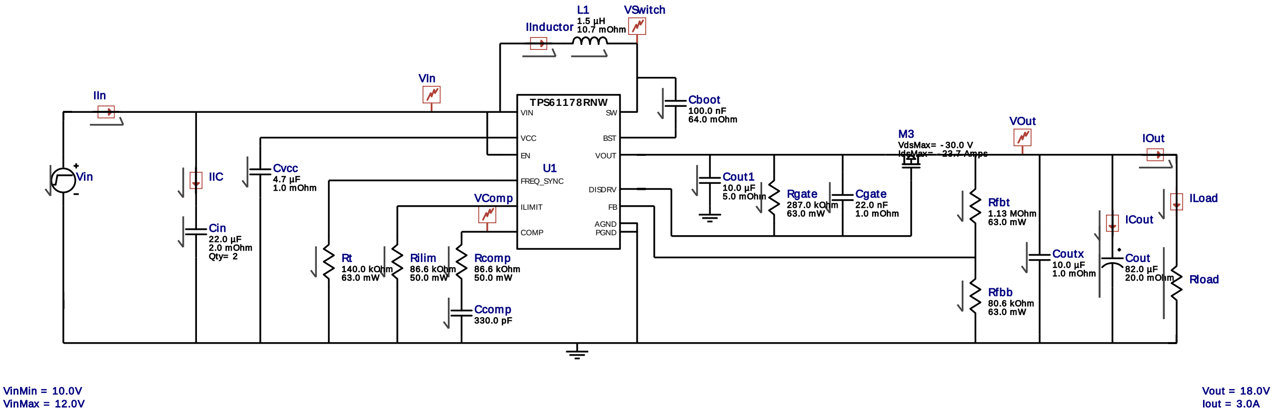
#	Name	Parameter Name	Description	Values
1.	Cout	IC	no description	no values
2.	Coutx	IC	no description	no values
3.	Cinj	C	Ac Injection Source	10000000 F
4.	Linj	L	AC Injection inductance	10000000 H
5.	Vinj	V	Ac Injection Source	AC=1 V
6.	Rload	R	Load resistance	6.0



Design Id = 5

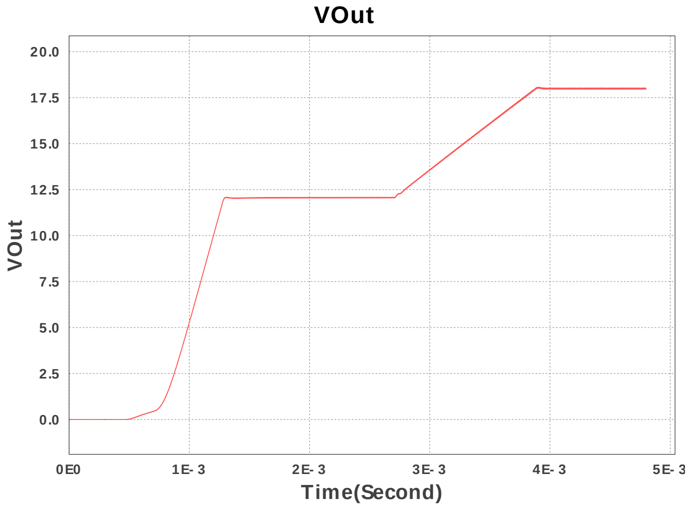
sim_id = 3

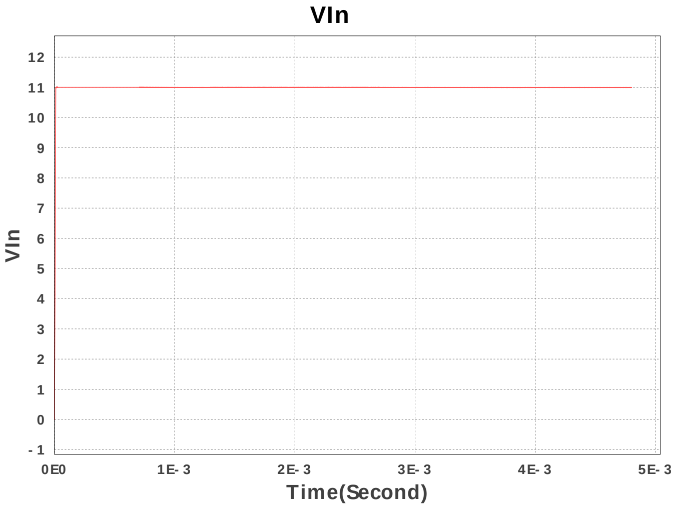
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Voltage	0 V
2.	Rload	R	Load Resistance	6.0 Ohm

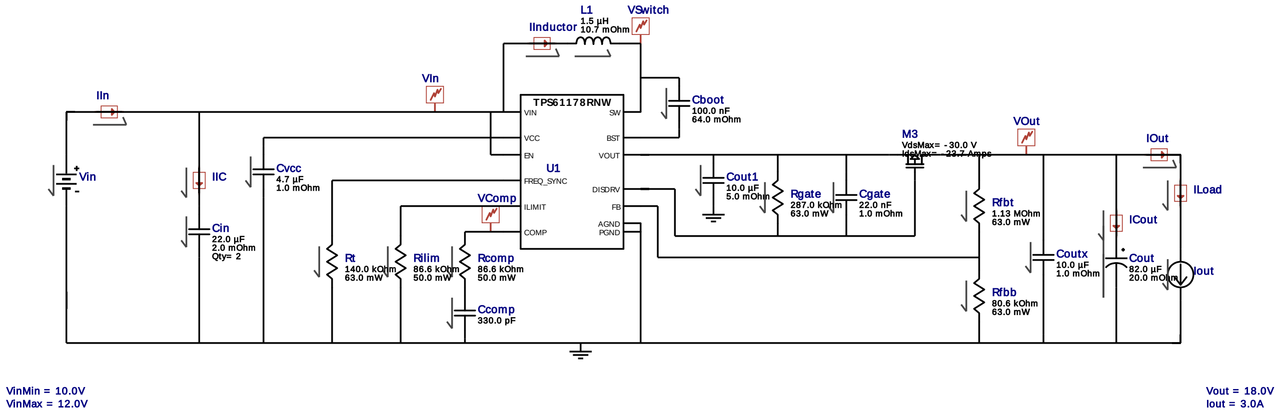




Design Id = 5

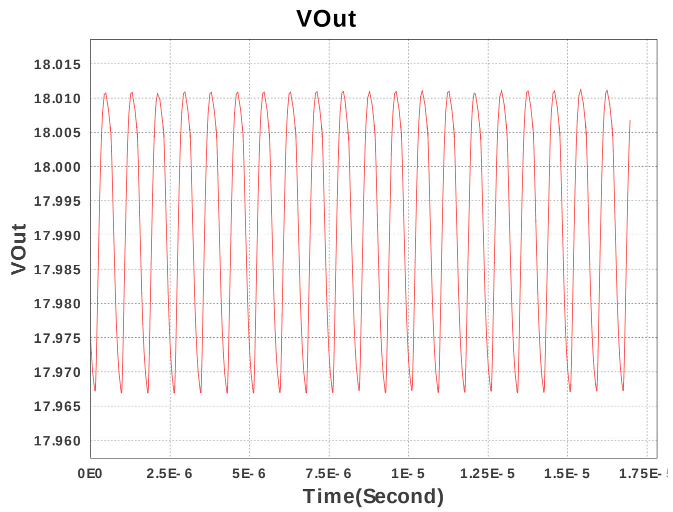
sim_id = 4

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cvcc	IC	Initial COndition	6
2.	Cboot	IC	Initial COndition	6 V
3.	L1	IC	Initial condition	3.0 A
4.	Iout	I	Load Current	3.0 A



Design Assistance

1. Master key : 8C8AA8B2C901FFD2[v1]

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

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