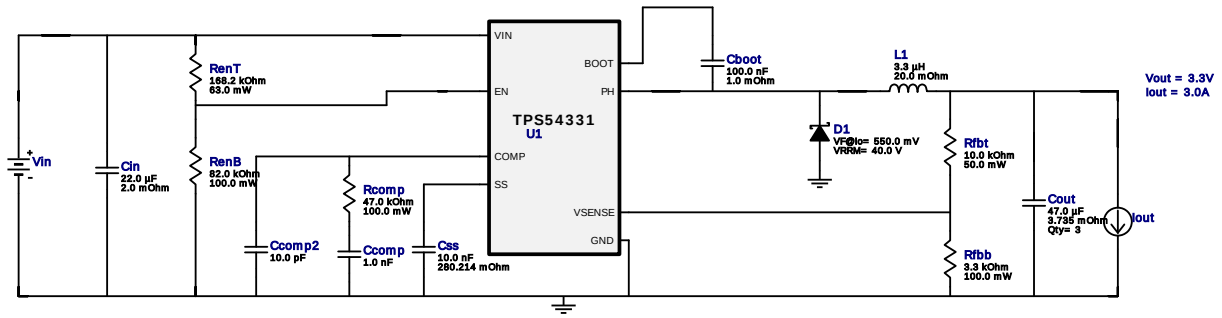
VinMin = 4.5V
VinMax = 5.5V
Vout = 3.3V
Iout = 3.0A

Device = TPS54331DDAR
Topology = Buck
Created = 2022-01-06 05:55:26.189
BOM Cost = NA
BOM Count = 16
Total Pd = 1.48W

WEBENCH® Design Report

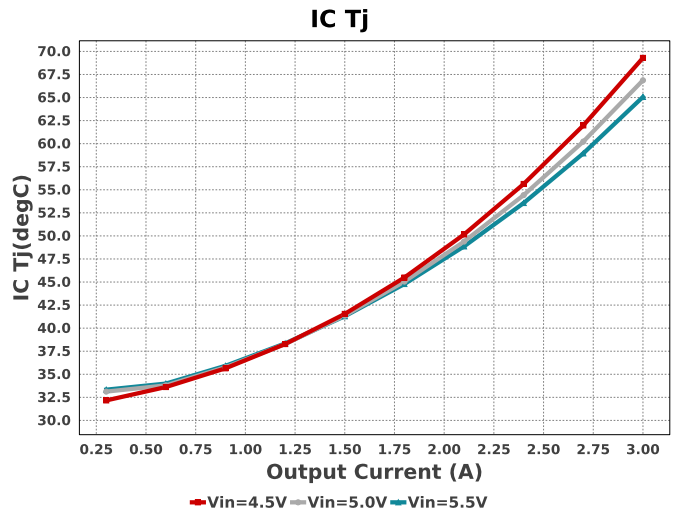
Design : 4 TPS54331DDAR
TPS54331DDAR 5V-5V to 3.30V @ 3A

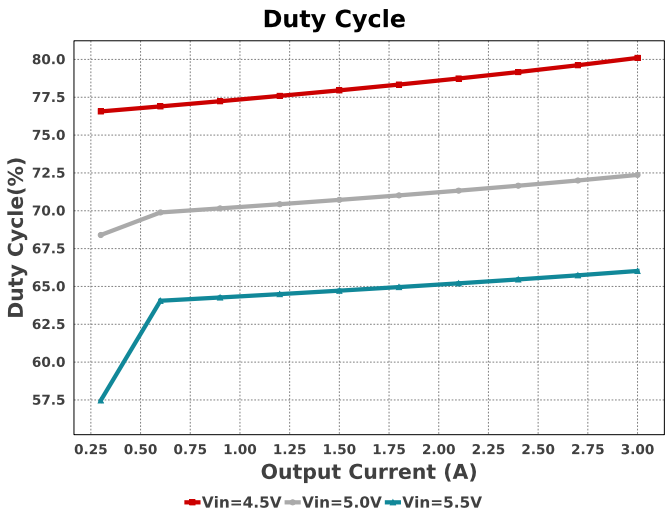


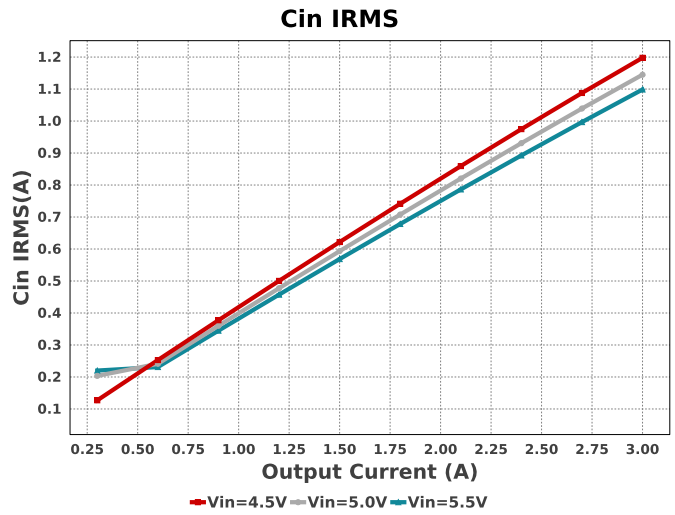
Electrical BOM

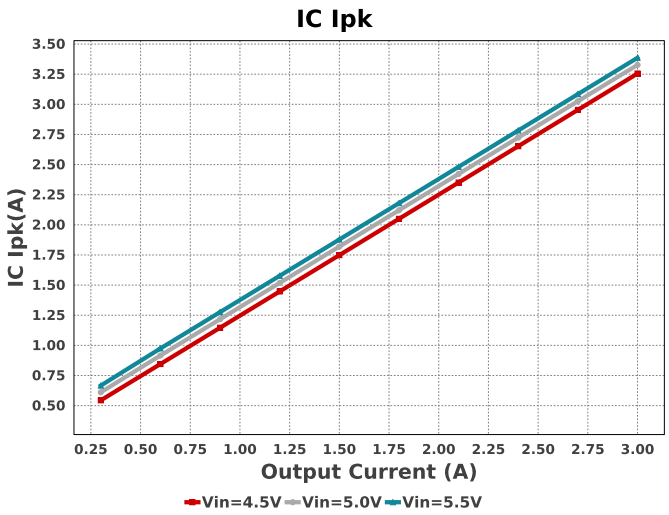
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	GRM0335C1H100JA01D Series= C0G/NP0	Cap= 10.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cin	MuRata	GRM32ER61C226ME20L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 16.0 V IRMS= 3.68 A	1	$0.55	1210 15 mm^2
Cout	MuRata	GRM31CR60J476ME19L Series= X5R	Cap= 47.0 uF ESR= 3.735 mOhm VDC= 6.3 V IRMS= 4.091 A	3	$0.23	1206_190 11 mm^2
Css	TDK	CGA1A2X7R1A103K030BA Series= X7R	Cap= 10.0 nF ESR= 280.21 mOhm VDC= 10.0 V IRMS= 245.72 mA	1	$0.01	0201_033 2 mm^2
D1	Fairchild Semiconductor	SS24FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.05	SOD-123F 12 mm^2
L1	TDK	VLP8040T-3R3N	L= 3.3 µH 20.0 mOhm	1	$0.22	VLP8040 113 mm^2
Rcomp	Yageo	RC0603FR-0747KL Series= ?	Res= 47.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
RenB	Yageo	RC0603FR-0782KL Series= ?	Res= 82.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
RenT	CUSTOM	CUSTOM Series= CRCW..e3	Res= 168.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	NA	0402 0 mm^2

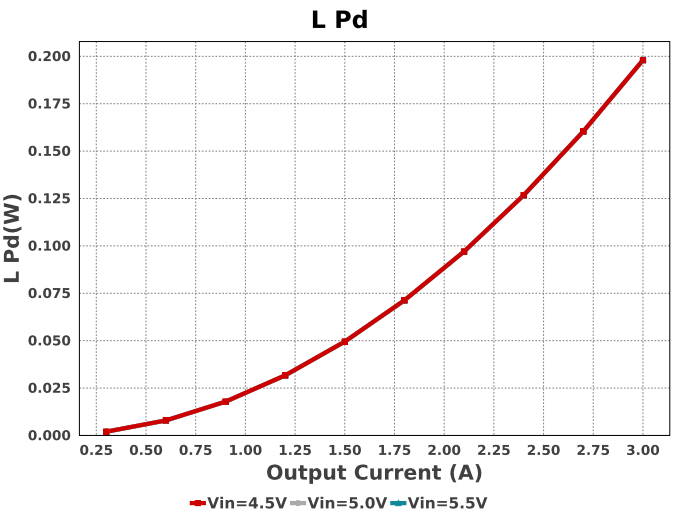
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Yageo	RC0603FR-073K3L Series= ?	Res= 3.3 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
U1	Texas Instruments	TPS54331DDAR	Switcher	1	$0.56	DDA0008H 55 mm²

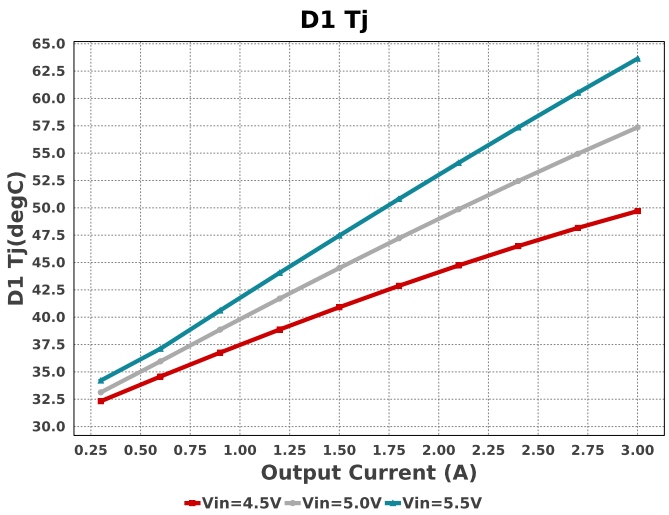


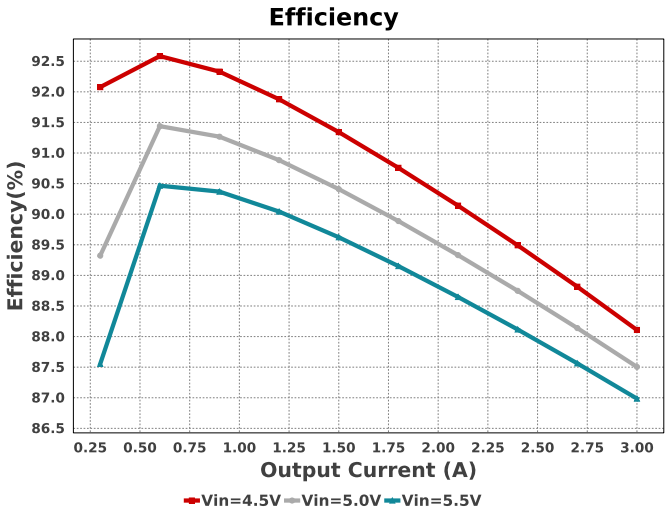


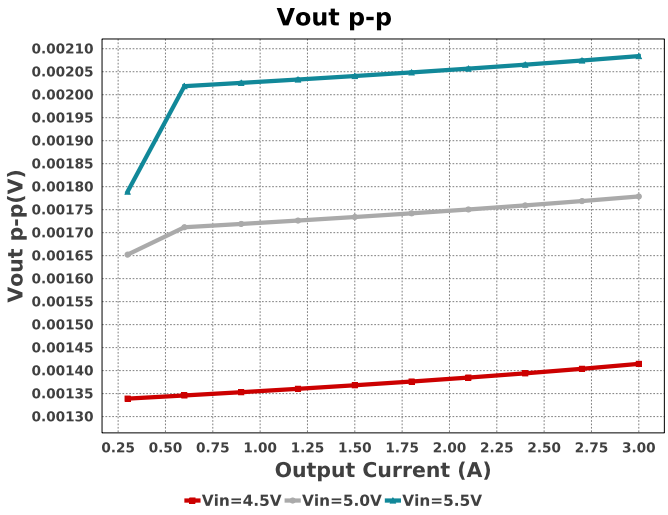


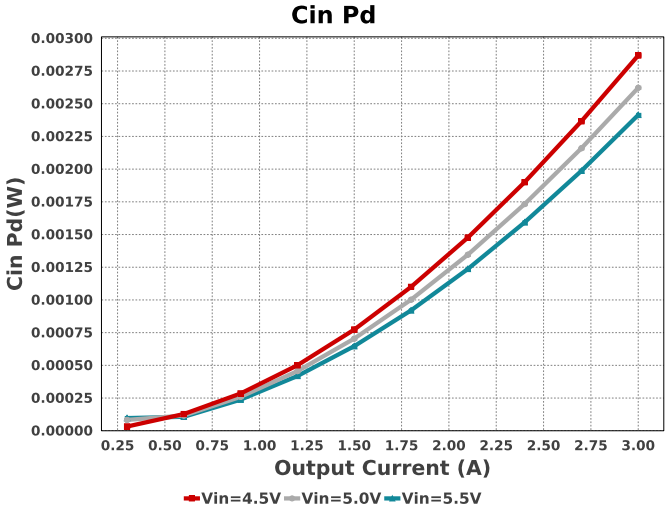


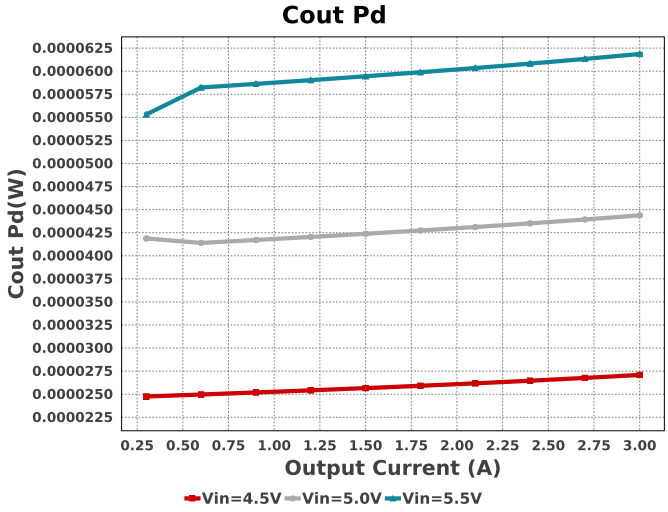


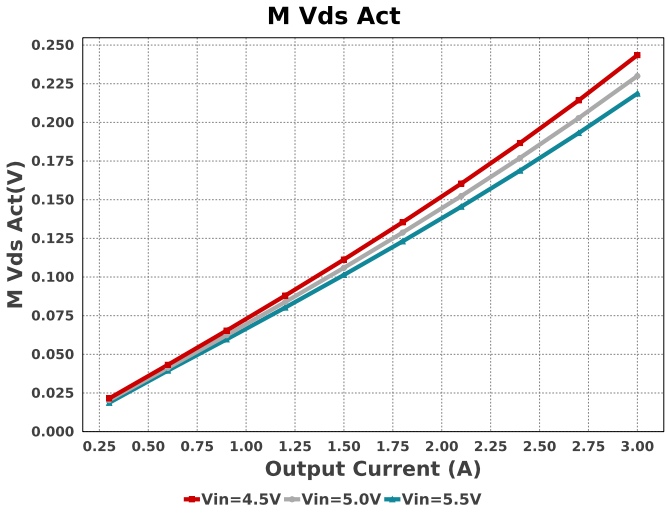


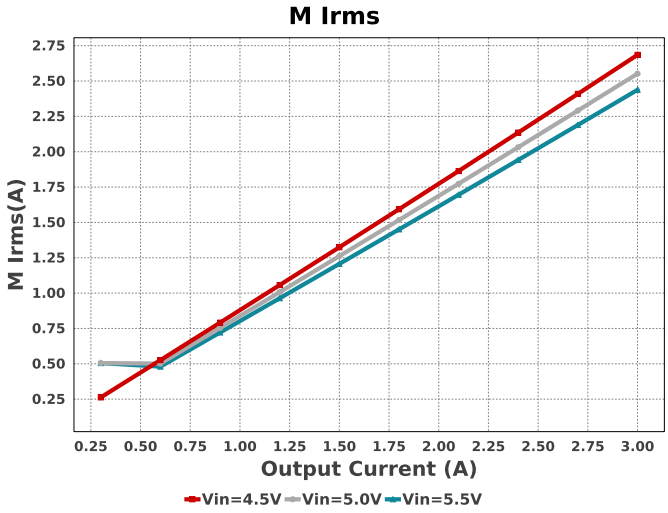


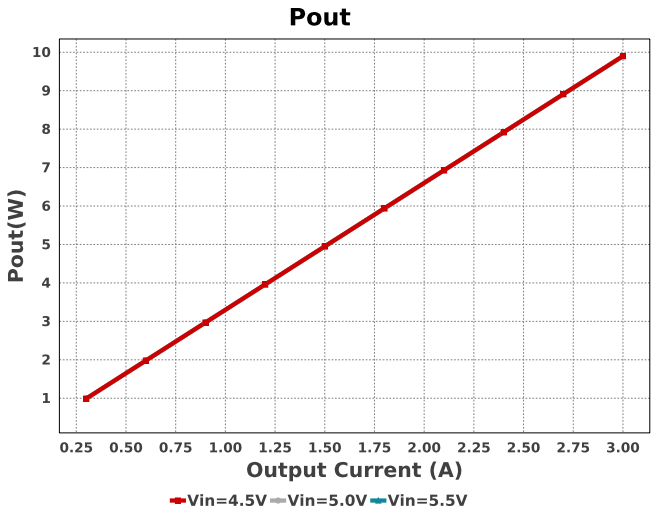


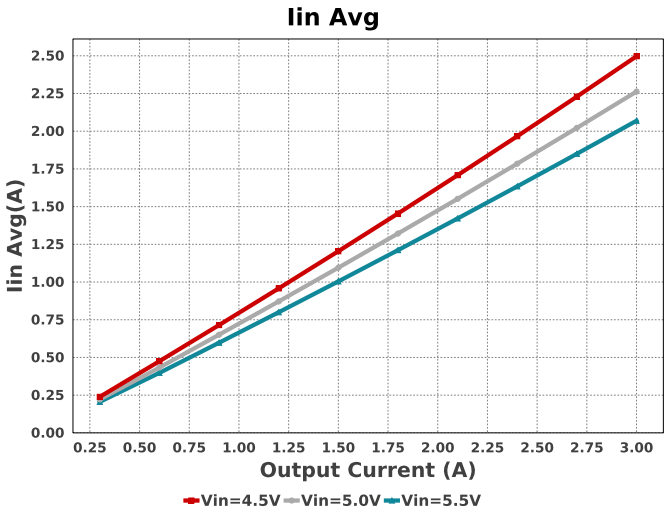


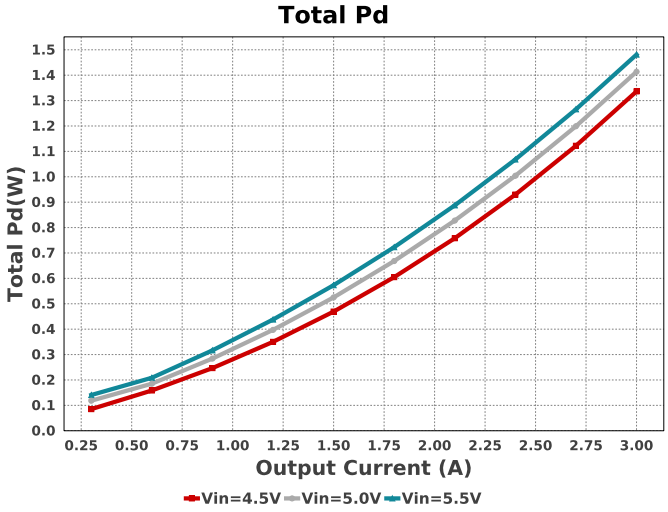


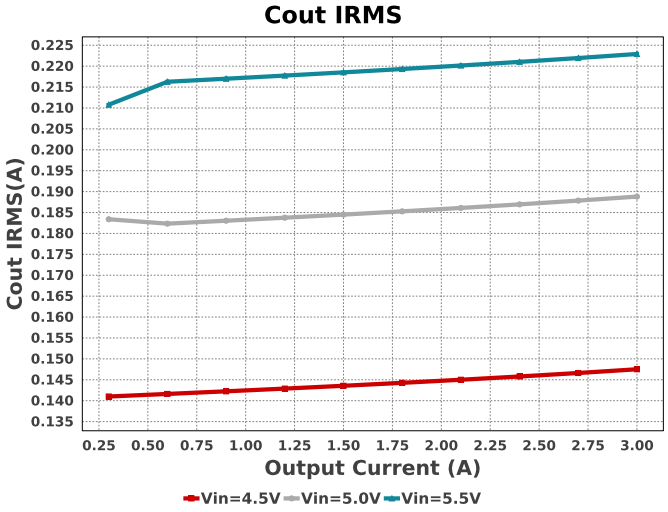


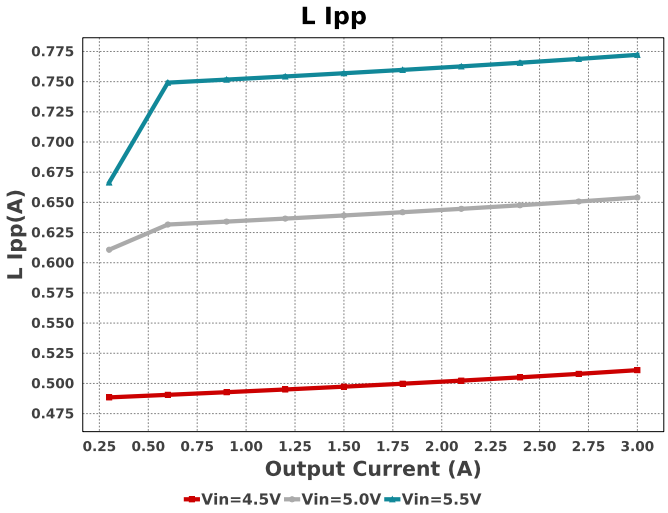


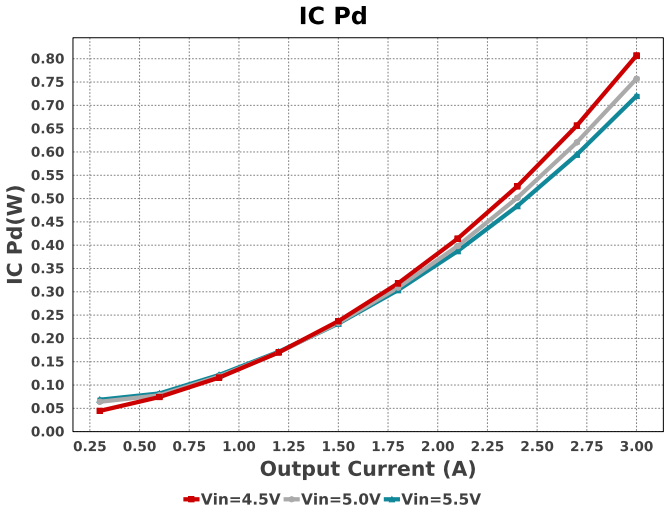


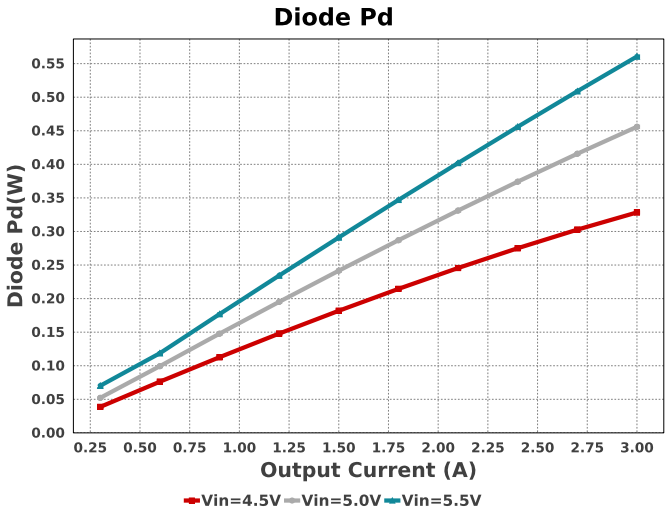


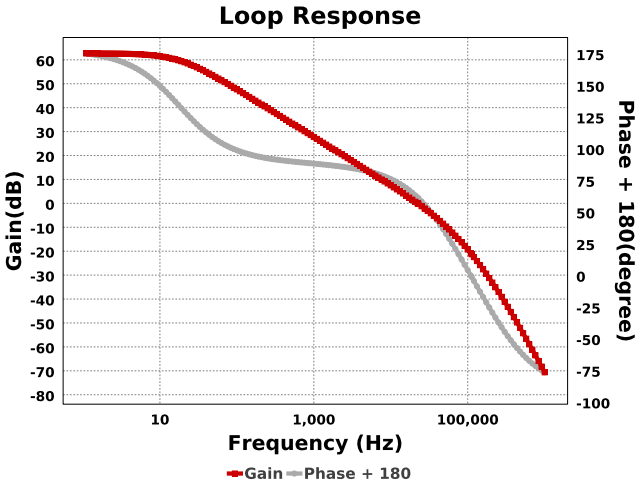












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	16		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	1.099 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	2.414 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	222.912 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	61.864 µW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	63.638 degC	Diode	D1 junction temperature
8.	Diode Pd	560.63 mW	Diode	Diode power dissipation
9.	IC Ipk	3.386 A	IC	Peak switch current in IC
10.	IC Pd	720.07 mW	IC	IC power dissipation
11.	IC Tj	65.068 degC	IC	IC junction temperature
12.	ICThetaJA	48.7 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	2.069 A	IC	Average input current
14.	L Ipp	772.19 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	198.0 mW	Inductor	Inductor power dissipation
16.	M Irms	2.438 A	Mosfet	MOSFET RMS ripple current
17.	M Vds Act	218.629 mV	Mosfet	Voltage drop across the MosFET
18.	Cin Pd	2.414 mW	Power	Input capacitor power dissipation
19.	Cout Pd	61.864 µW	Power	Output capacitor power dissipation
20.	Diode Pd	560.63 mW	Power	Diode power dissipation
21.	IC Pd	720.07 mW	Power	IC power dissipation
22.	L Pd	198.0 mW	Power	Inductor power dissipation
23.	Total Pd	1.481 W	Power	Total Power Dissipation
24.	Cross Freq	22.309 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	66.022 %	System Information	Duty cycle
26.	Efficiency	86.986 %	System Information	Steady state efficiency
27.	FootPrint	257.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	570.0 kHz	System Information	Switching frequency
29.	Gain Marg	-21.287 dB	System Information	Bode Plot Gain Margin
30.	Iout	3.0 A	System Information	Iout operating point
31.	Low Freq Gain	62.671 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	62.769 deg	System Information	Bode Plot Phase Margin
34.	Pout	9.9 W	System Information	Total output power
35.	Vin	5.5 V	System Information	Vin operating point
36.	Vout	3.3 V	System Information	Operational Output Voltage
37.	Vout Actual	3.224 V	System Information	Vout Actual calculated based on selected voltage divider resistors

#	Name	Value	Category	Description
38.	Vout Tolerance	5.072 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	2.084 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
SoftStart	4.0 ms	Soft Start Time (ms)
VinMax	5.5	Maximum input voltage
VinMin	4.5	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS54331	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

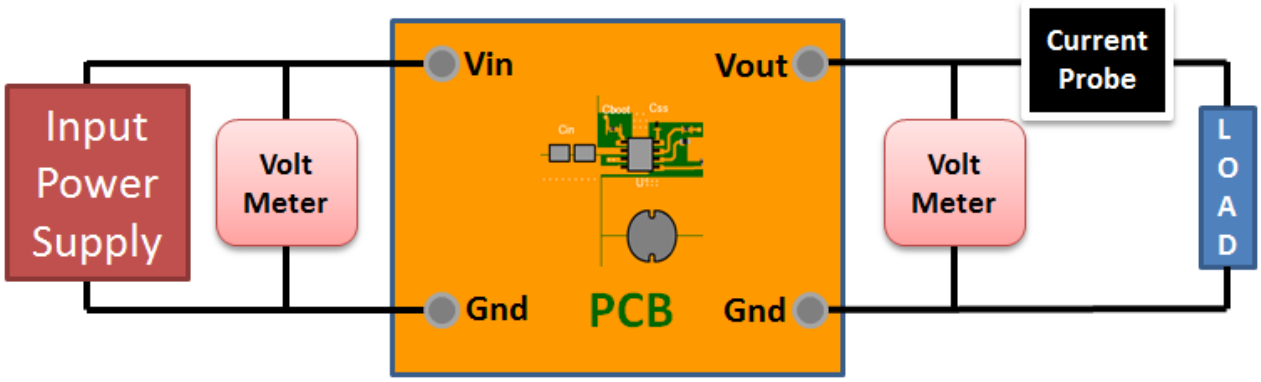
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.5V 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

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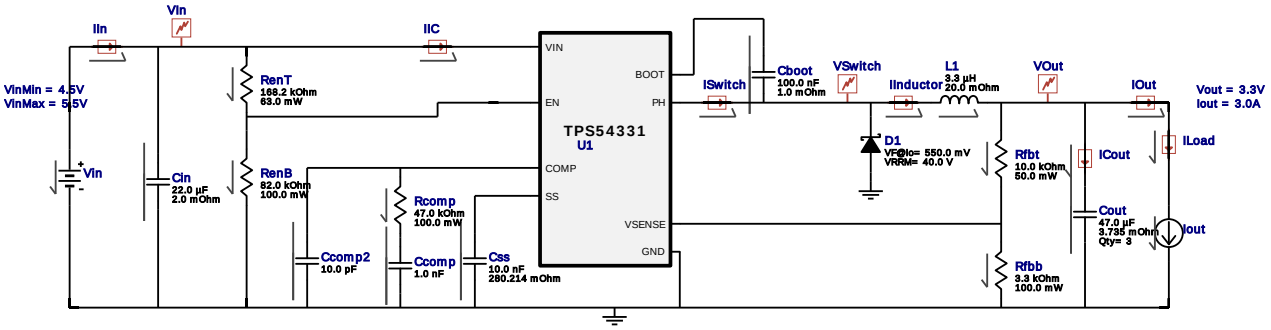
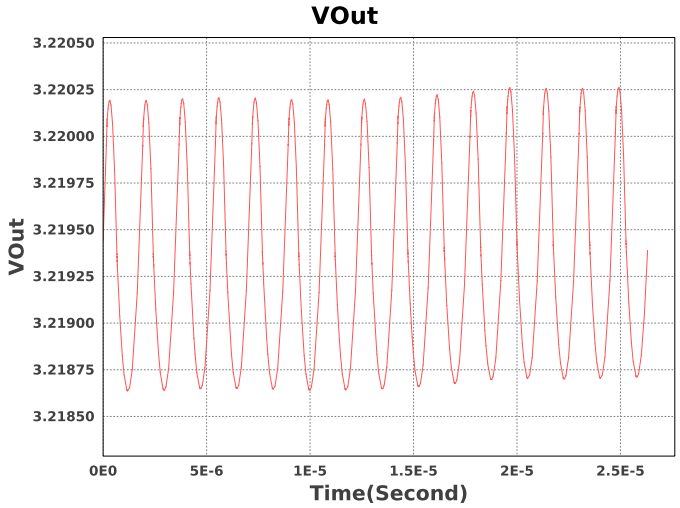
sim_id = 1

Simulation Type = Steady State



Simulation Parameters

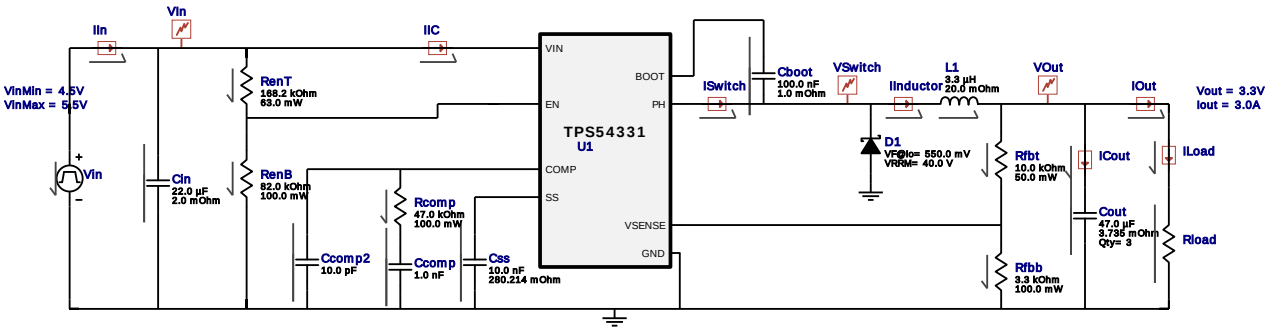
#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Voltage	1 V
2.	Cboot	IC	Initial Voltage	5.0 V
3.	L1	IC	Initial Current	3.0 A
4.	Iout	I	Load Current	3.0 A



Design Id = 4

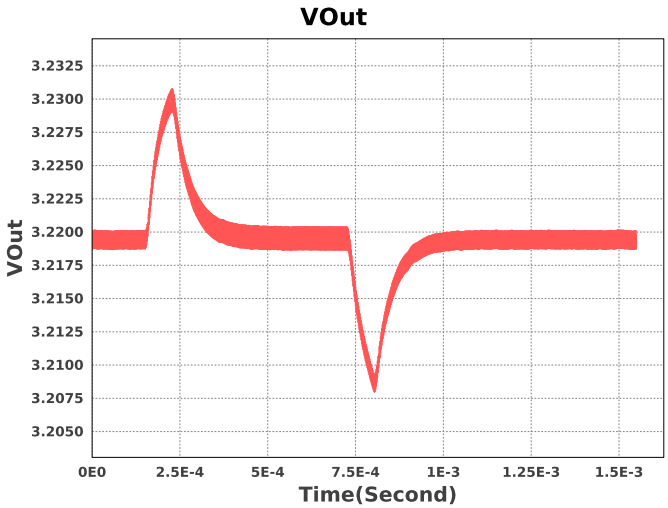
sim_id = 2

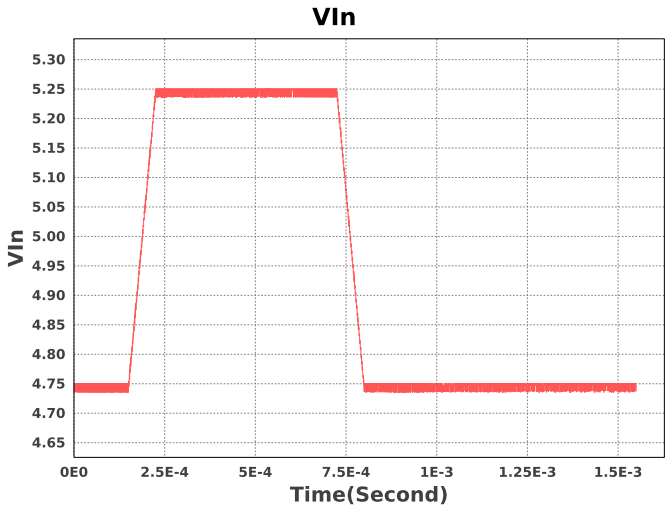
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Condition	1 V
2.	Cboot	IC	Initial Voltage	5.0 V
3.	L1	IC	Initial Current	3.0 A
4.	Rload	R	Load Resistance	1.0999999999999999 Ohm

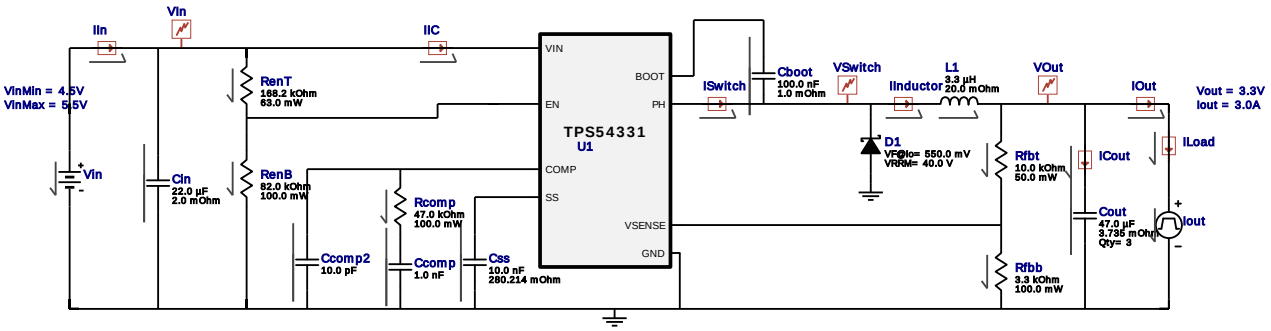




Design Id = 4

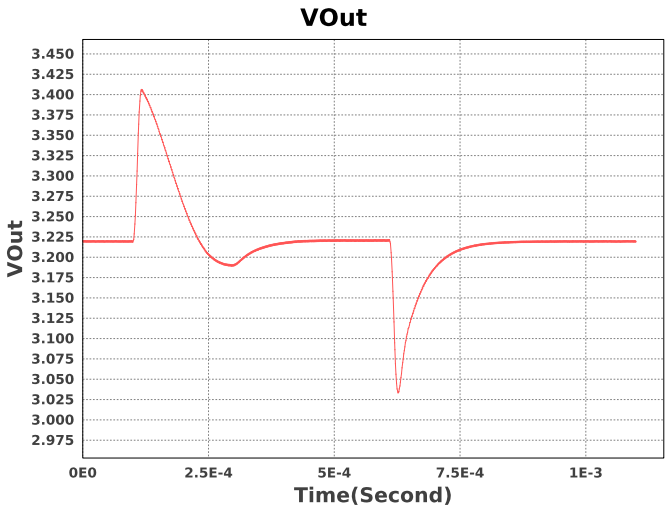
sim_id = 3

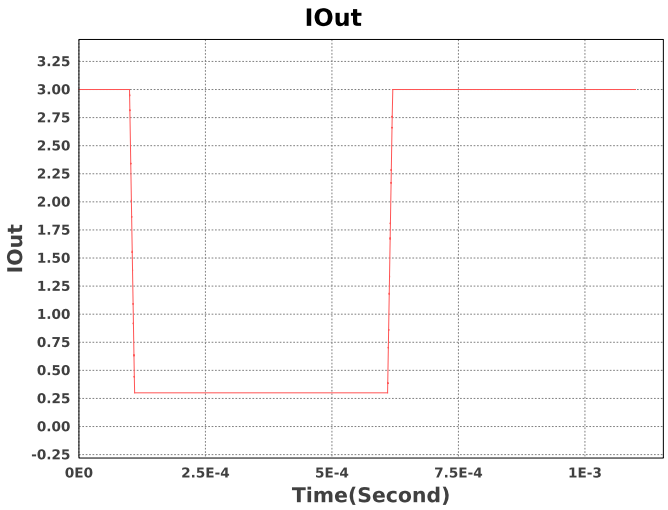
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Voltage	1 V
2.	Cboot	IC	Initial Voltage	5.0 V
3.	L1	IC	Initial Current	3.0 A
4.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	3.0 A
		I2	Minimum Load Current	0.3 A
		Td	Initial Time Delay	100u s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	500u s

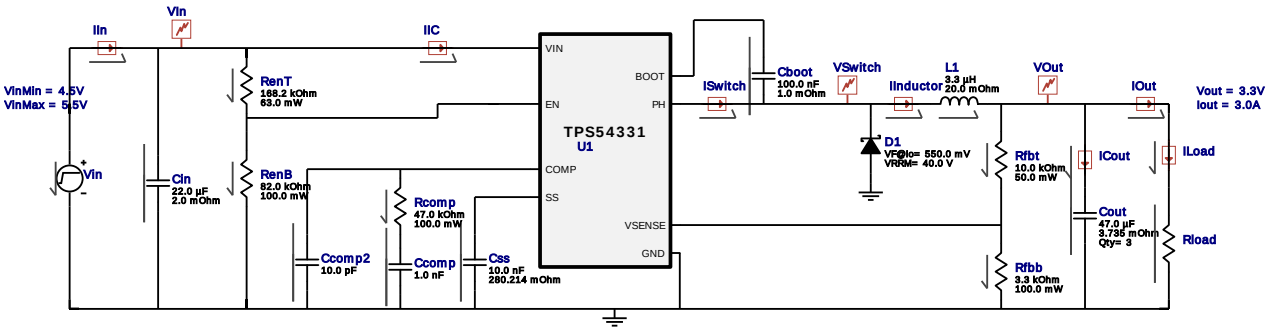




Design Id = 4

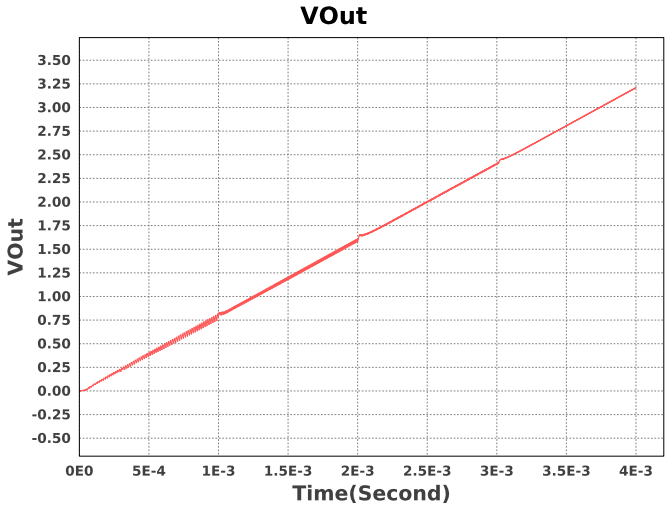
sim_id = 4

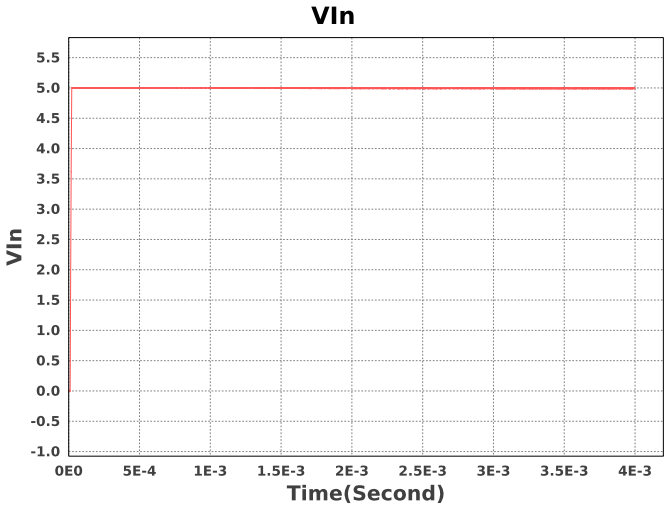
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	1.0999999999999999 Ohm





Design Assistance

1. Master key : CB899E537F3BB804[v1]
2. **TPS54331** Product Folder : http://www.ti.com/product/TPS54331 : contains the data sheet and other resources.