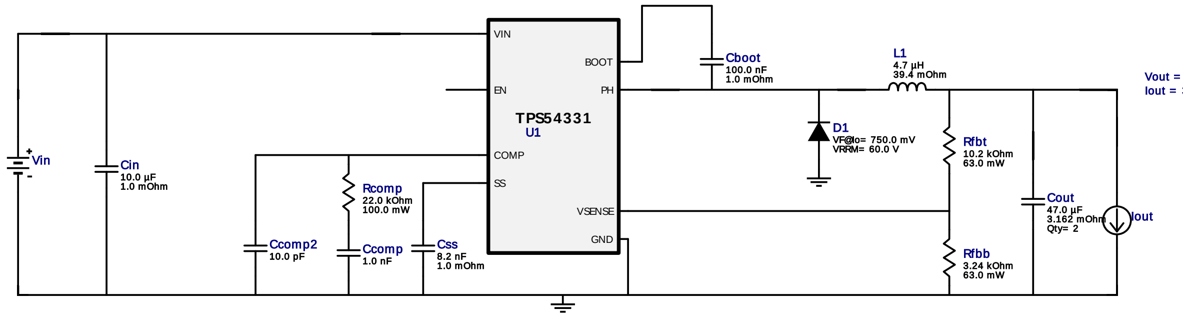
TEXAS INSTRUMENTS

VinMin = 5.0V
VinMax = 8.0V
Vout = 3.3V
Iout = 3.0A

Device = TPS54331DDAR
Topology = Buck
Created = 2021-02-06 04:40:23.808
BOM Cost = $3.10
BOM Count = 13
Total Pd = 2.01W

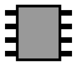
WEBENCH ® Design Report

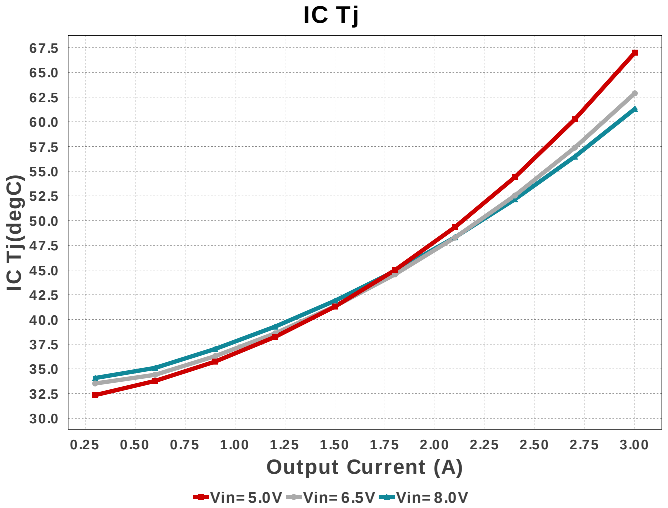
Design : 2 TPS54331DDAR
TPS54331DDAR 5V-8V to 3.30V @ 3A

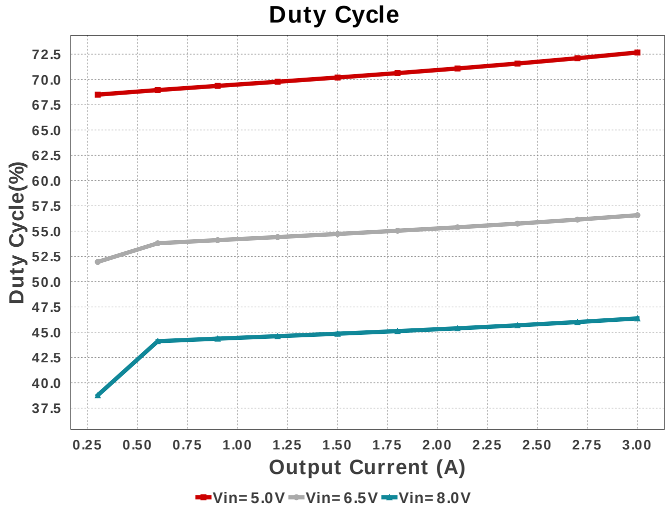


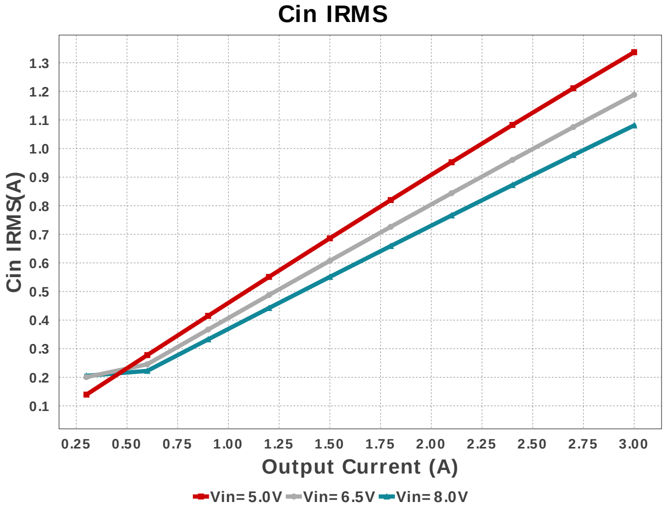
Electrical BOM

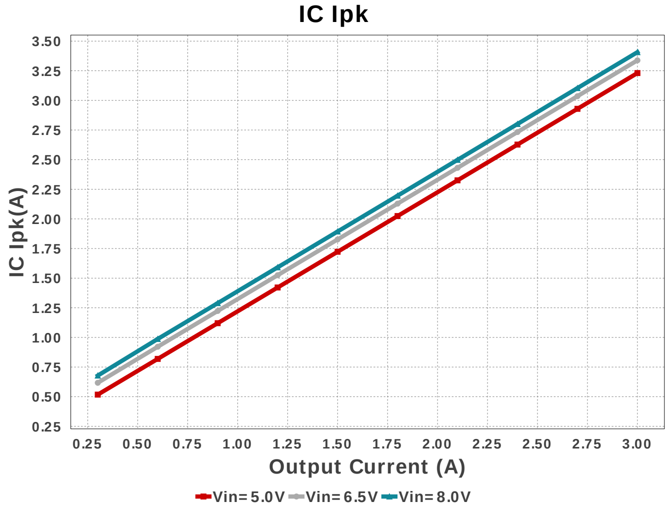
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	Samsung Electro-Mechanics	CL21C100JBANNNC Series= C0G/NP0	Cap= 10.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	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 mm^2
Cout	TDK	CGA9N3X7R1C476M230KB Series= X7R	Cap= 47.0 uF ESR= 3.162 mOhm VDC= 16.0 V IRMS= 5.1344 A	2	$0.74	2220_250 54 mm^2
Css	MuRata	GRM033R71A822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
D1	Vishay-Semiconductor	SS36-E3/57T	VF@Io= 750.0 mV VRRM= 60.0 V	1	$0.20	SMC 83 mm^2
L1	TDK	SPM6530T-4R7M	L= 4.7 µH 39.4 mOhm	1	$0.56	SPM6530 77 mm^2
Rcomp	Yageo	RC0603FR-0722KL Series= ?	Res= 22.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbb	Vishay-Dale	CRCW04023K24FKED Series= CRCW..e3	Res= 3.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

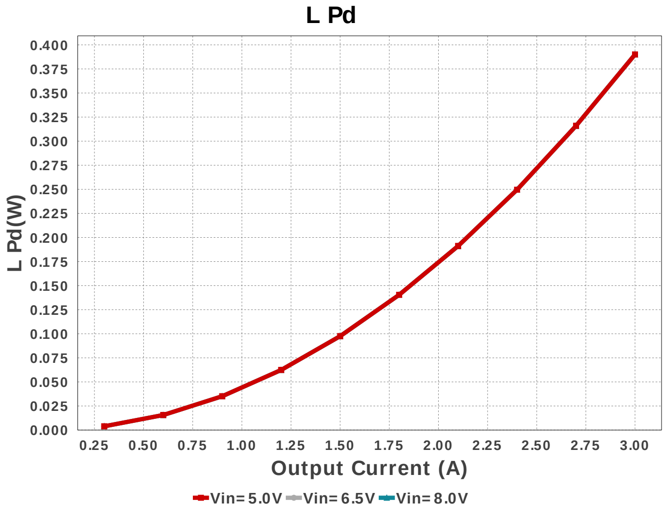
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	TPS54331DDAR	Switcher	1	$0.51	 DDA0008H 55 mm²

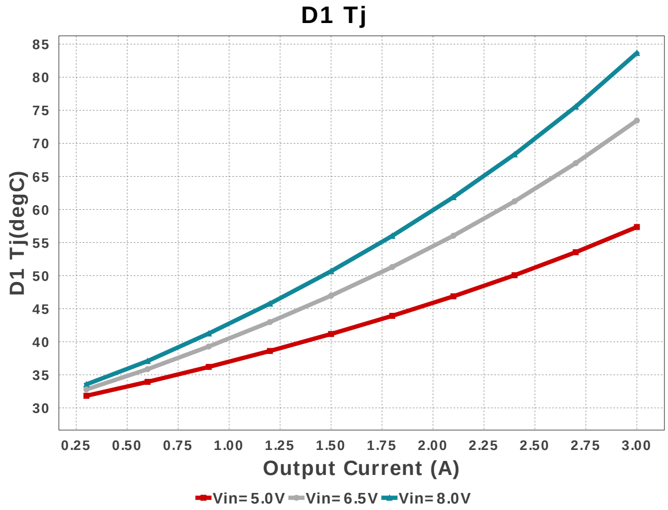


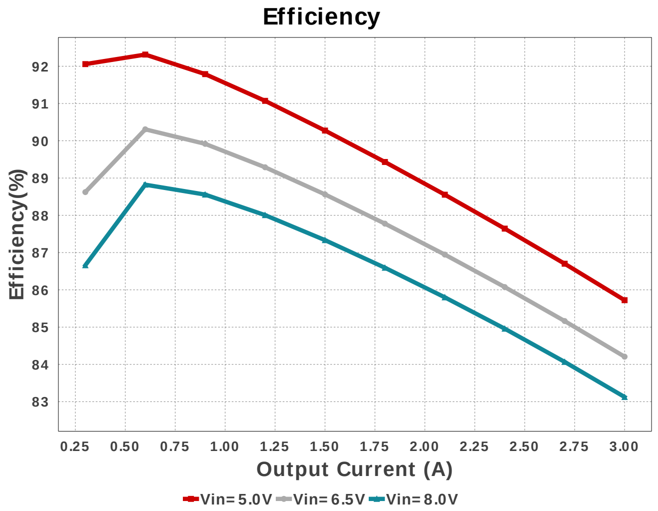


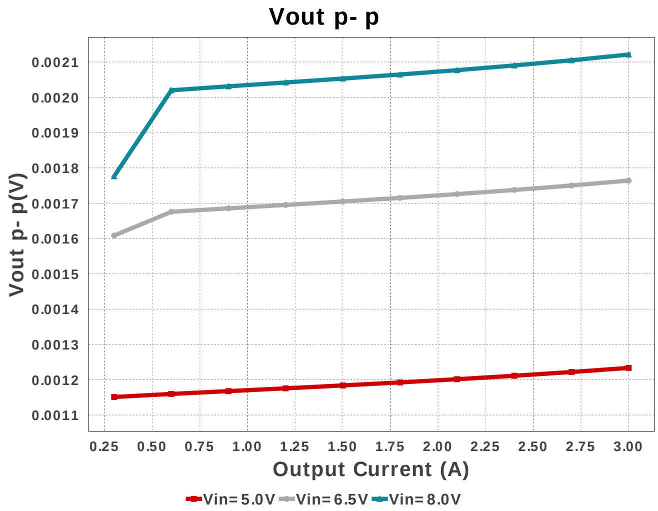


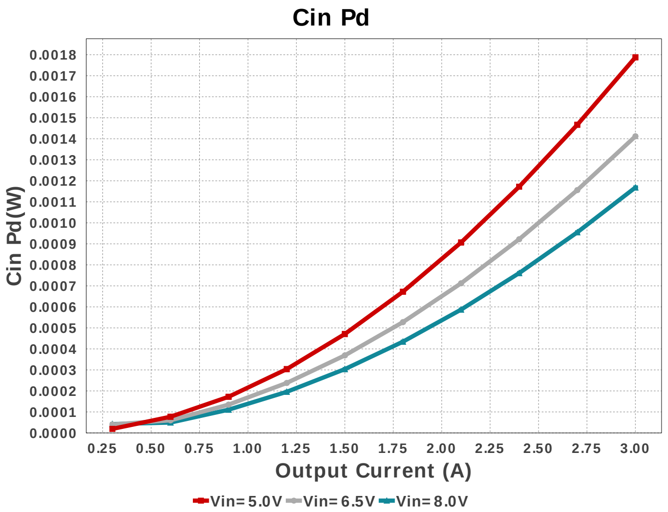


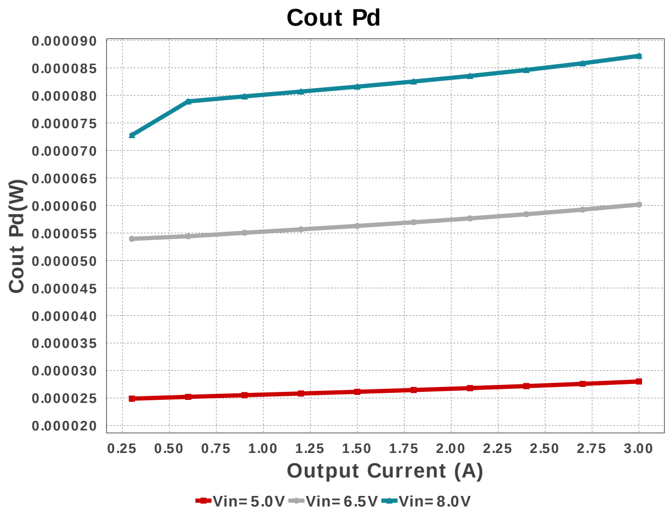


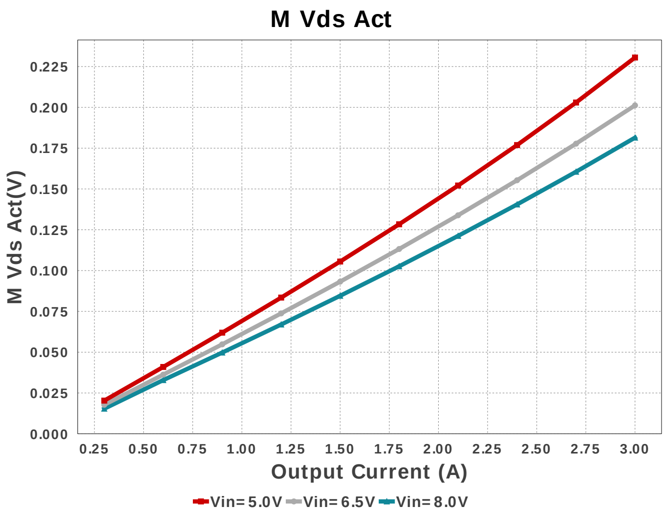


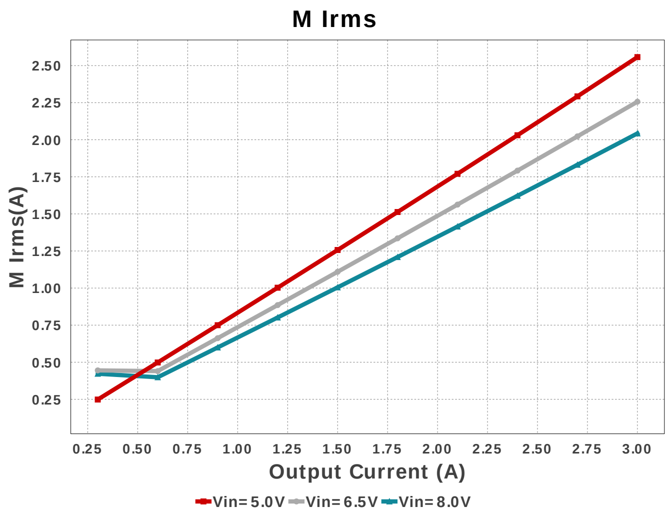

Efficiency
Efficiency(%)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

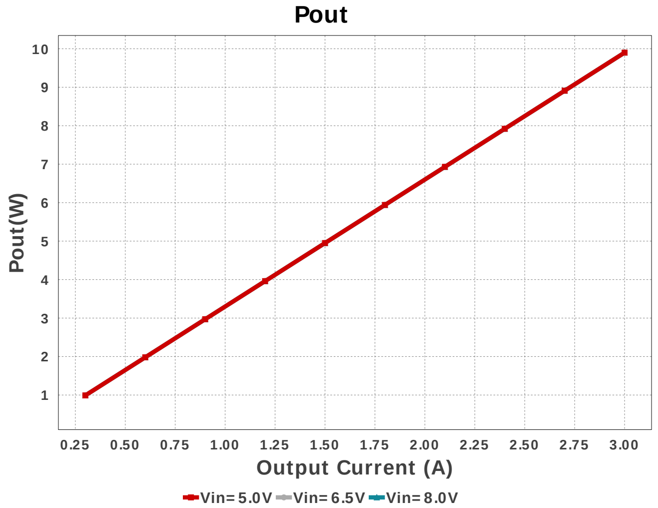

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

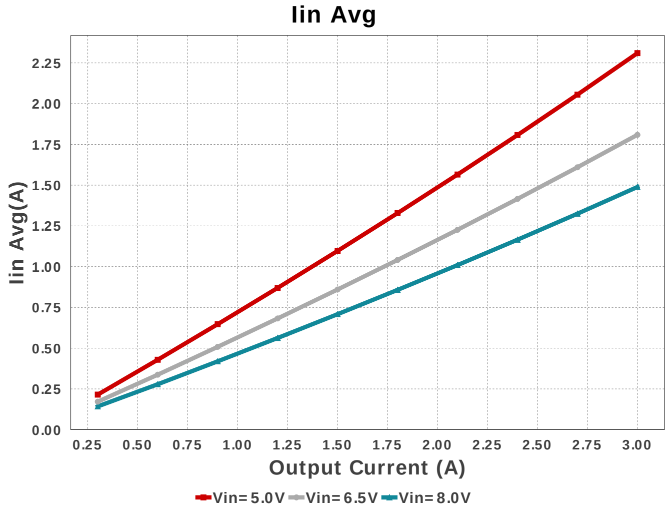

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

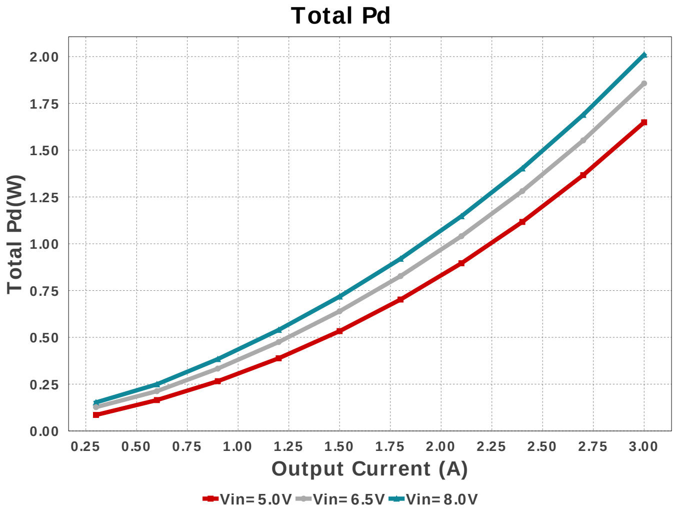

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

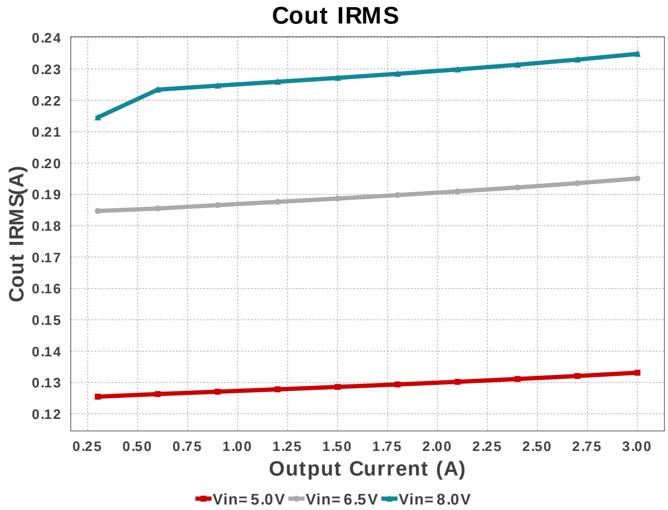

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

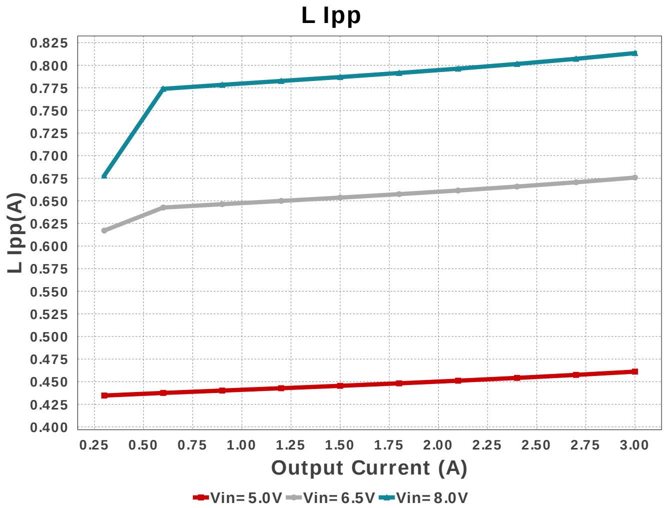

M Irms
M Irms(A)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

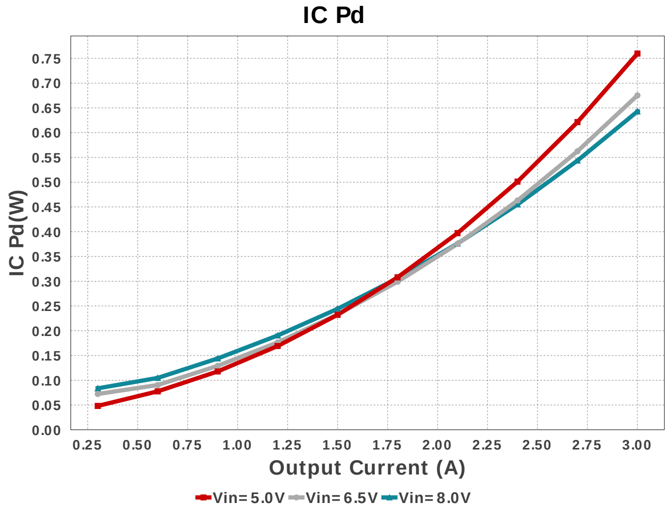

Pout
Pout(W)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

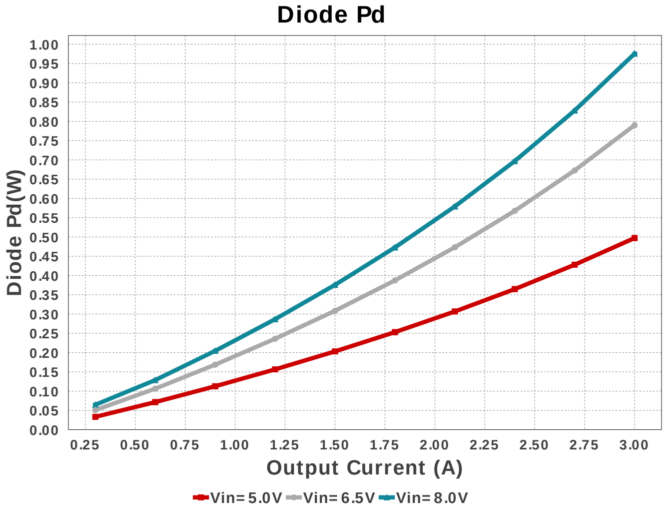

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V

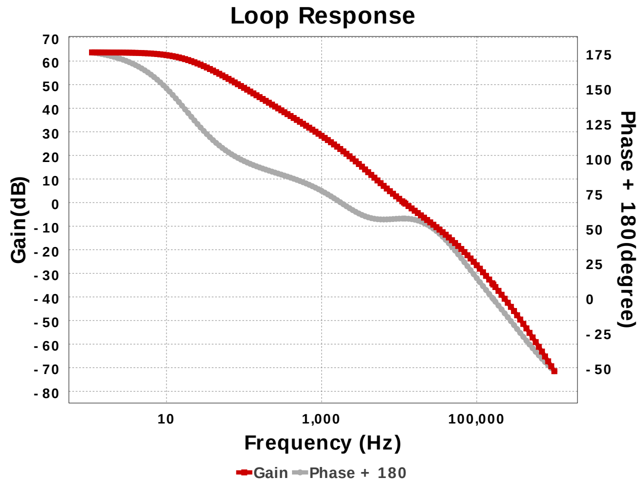

Total Pd
Total Pd(W)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=5.0V Vin=6.5V Vin=8.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	13		Total Design BOM count
2.	Total BOM	$3.1		Total BOM Cost
3.	Cin IRMS	1.081 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	1.168 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	234.823 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	87.18 µW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	83.66 degC	Diode	D1 junction temperature
8.	Diode Pd	975.64 mW	Diode	Diode power dissipation
9.	IC Ipk	3.407 A	IC	Peak switch current in IC
10.	IC Pd	642.85 mW	IC	IC power dissipation
11.	IC Tj	61.307 degC	IC	IC junction temperature
12.	ICThetaJA	48.7 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	1.489 A	IC	Average input current
14.	L Ipp	813.452 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	390.06 mW	Inductor	Inductor power dissipation
16.	M Irms	2.043 A	Mosfet	MOSFET RMS ripple current
17.	M Vds Act	181.441 mV	Mosfet	Voltage drop across the MosFET
18.	Cin Pd	1.168 mW	Power	Input capacitor power dissipation
19.	Cout Pd	87.18 µW	Power	Output capacitor power dissipation
20.	Diode Pd	975.64 mW	Power	Diode power dissipation
21.	IC Pd	642.85 mW	Power	IC power dissipation
22.	L Pd	390.06 mW	Power	Inductor power dissipation
23.	Total Pd	2.01 W	Power	Total Power Dissipation
24.	Cross Freq	11.548 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	46.367 %	System Information	Duty cycle
26.	Efficiency	83.125 %	System Information	Steady state efficiency
27.	FootPrint	364.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	570.0 kHz	System Information	Switching frequency
29.	Gain Marg	-34.747 dB	System Information	Bode Plot Gain Margin
30.	Iout	3.0 A	System Information	Iout operating point
31.	Low Freq Gain	63.672 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	57.623 deg	System Information	Bode Plot Phase Margin
34.	Pout	9.9 W	System Information	Total output power
35.	Vin	8.0 V	System Information	Vin operating point
36.	Vout	3.3 V	System Information	Operational Output Voltage
37.	Vout Actual	3.319 V	System Information	Vout Actual calculated based on selected voltage divider resistors

#	Name	Value	Category	Description
38.	Vout Tolerance	5.087 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	2.121 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	8.0	Maximum input voltage
VinMin	5.0	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

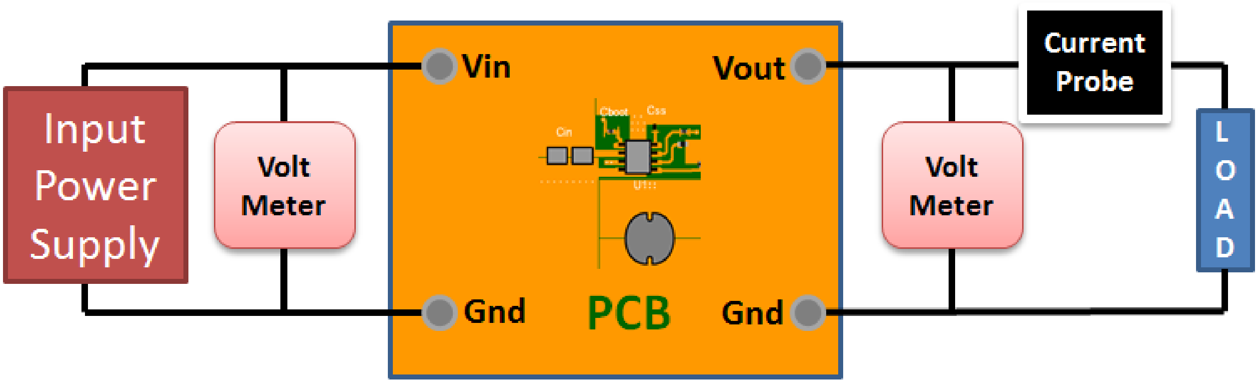
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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.

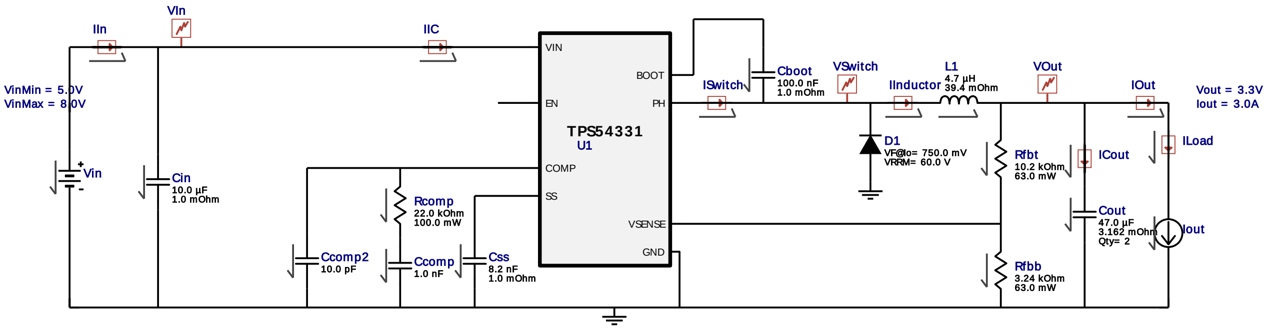


WEBENCH® Electrical Simulation Report

Design Id = 2

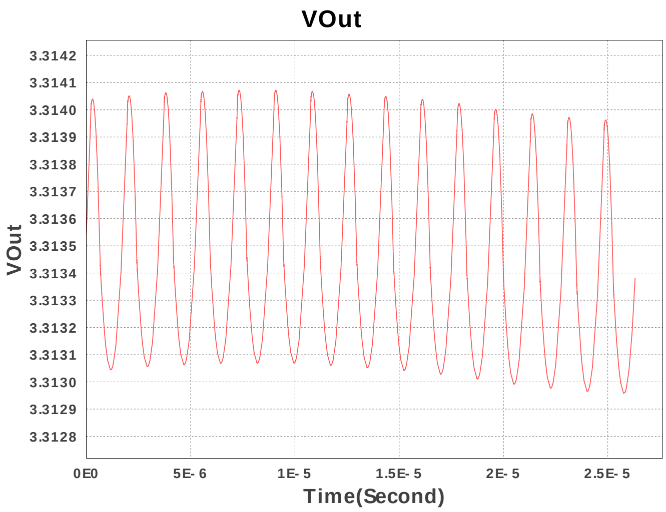
sim_id = 4

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Voltage	1 V
2.	Cboot	IC	Initial Voltage	6.5 V
3.	L1	IC	Initial Current	3.0 A
4.	Iout	I	Load Current	3.0 A



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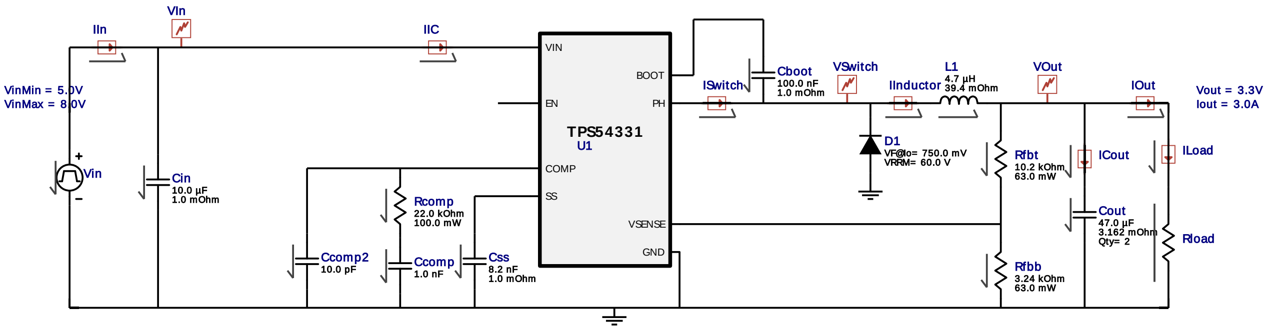
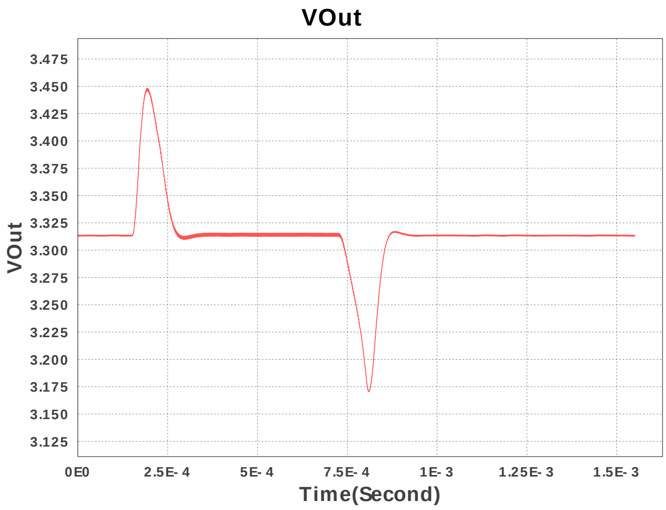
sim_id = 5

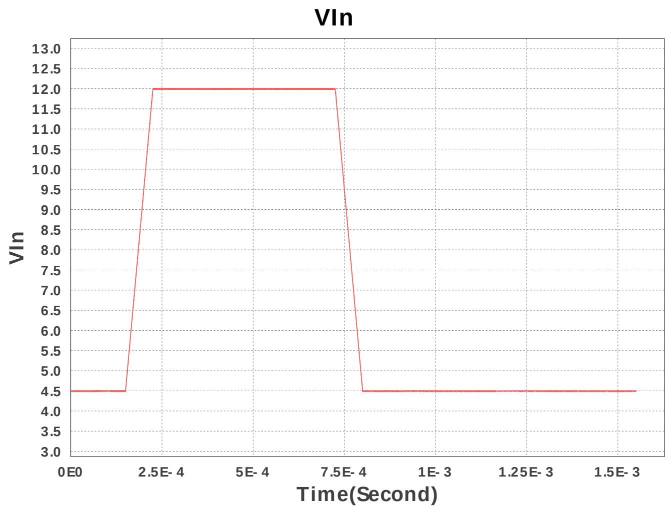
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Condition	1 V
2.	Cboot	IC	Initial Voltage	6.5 V
3.	L1	IC	Initial Current	3.0 A
4.	Rload	R	Load Resistance	1.0999999999999999 Ohm

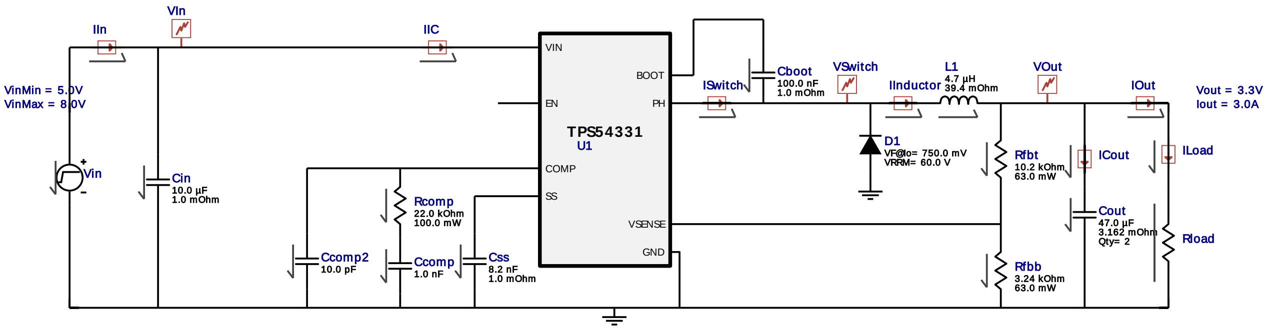




Design Id = 2

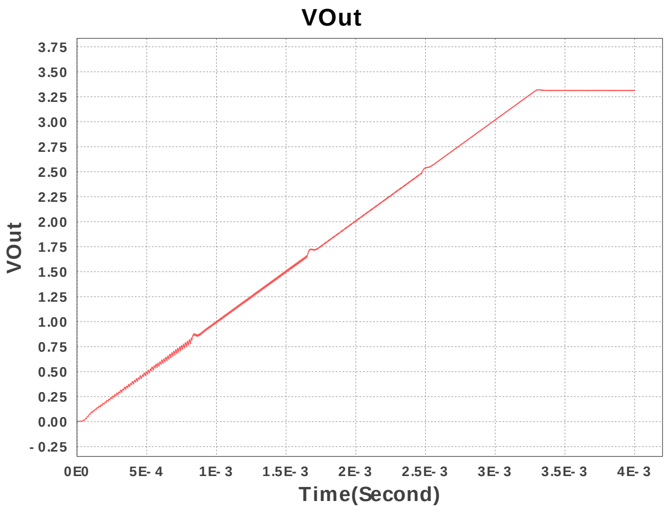
sim_id = 7

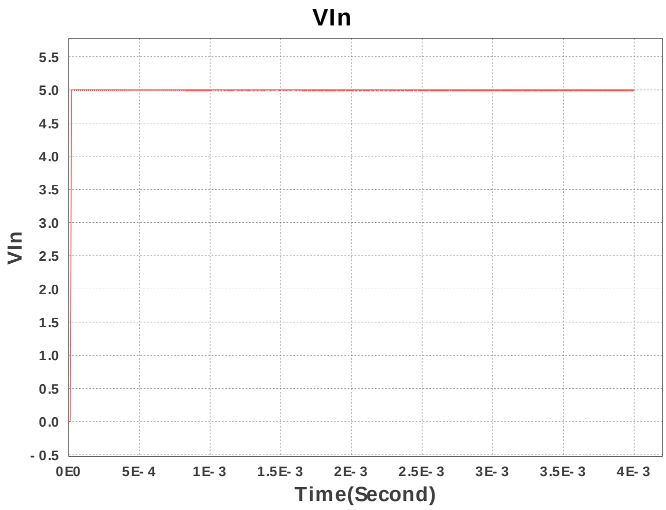
Simulation Type = Startup



Simulation Parameters

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

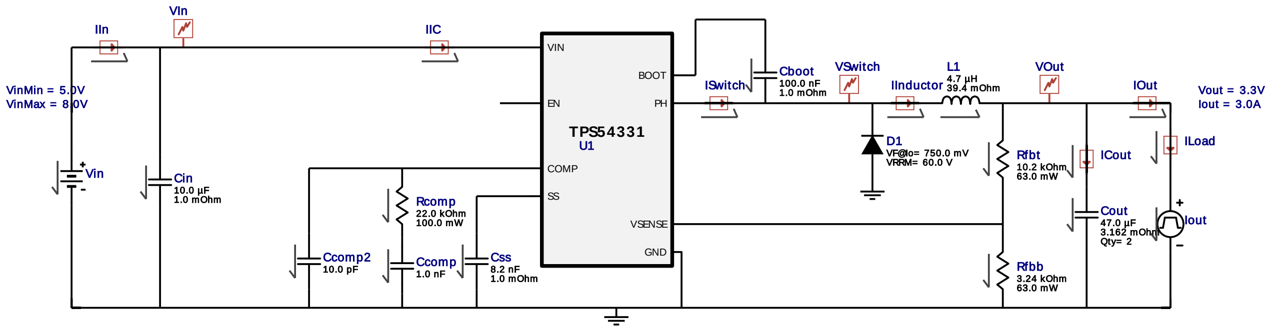




Design Id = 2

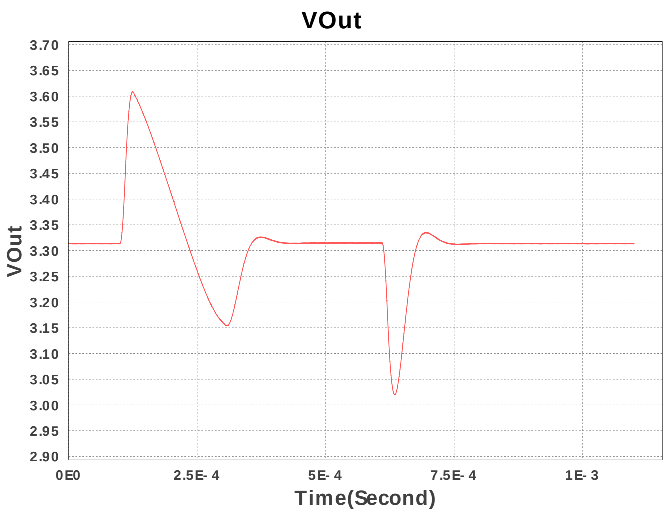
sim_id = 8

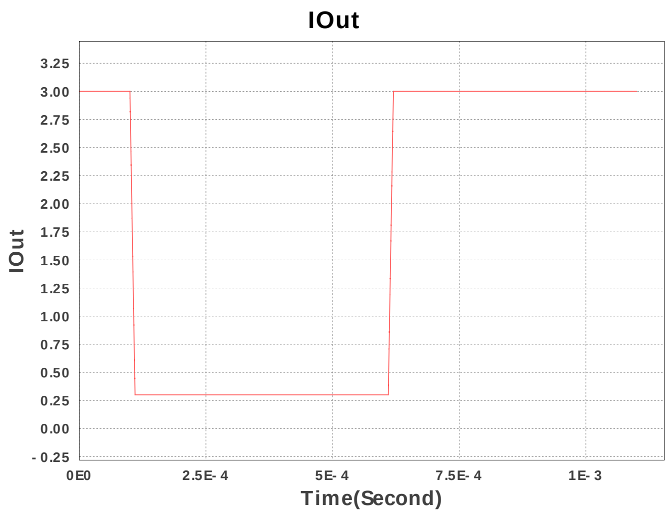
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Css	IC	Initial Voltage	1 V
2.	Cboot	IC	Initial Voltage	6.5 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 Assistance

1. Master key : 40A5C15DA7147E65[v1]

2. **TPS54331** Product Folder : http://www.ti.com/product/TPS54331 : contains the data sheet and other resources.