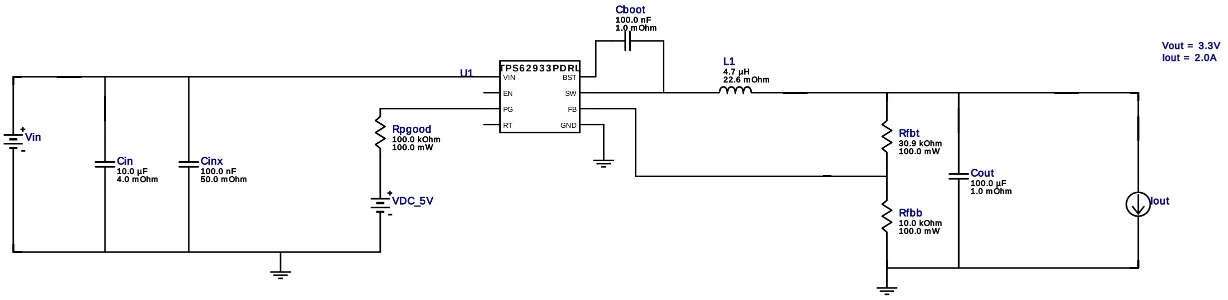
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.8V
VinMax = 15.0V
Vout = 3.3V
Iout = 2.0A

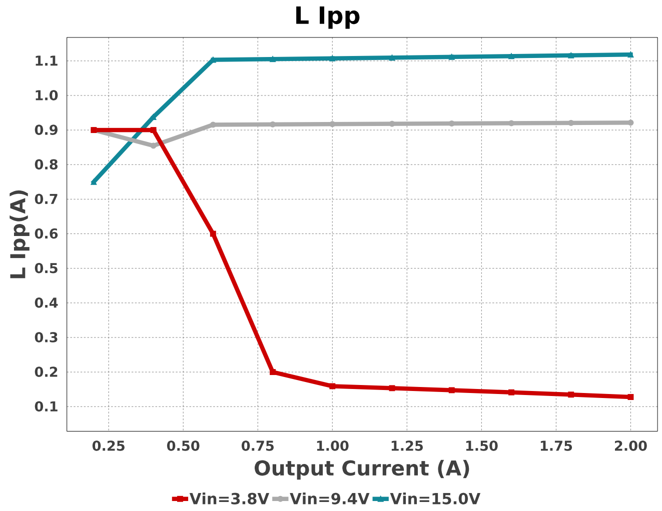
Device = TPS62933PDRL
Topology = Buck
Created = 2024-09-20 19:19:22.224
BOM Cost = $1.57
BOM Count = 9
Total Pd = 0.86W

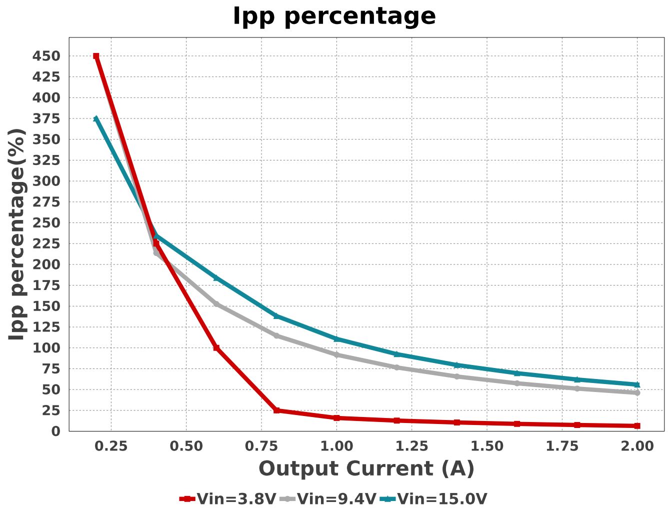
Design : 13 TPS62933PDRL
TPS62933PDRL 3.8V-15V to 3.30V @ 2A

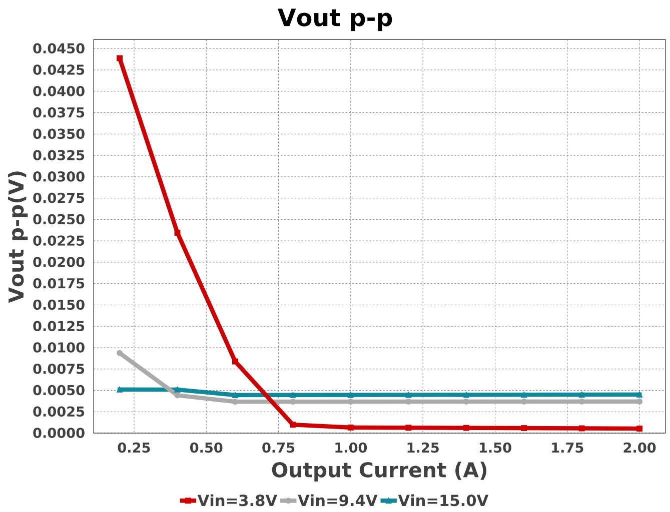


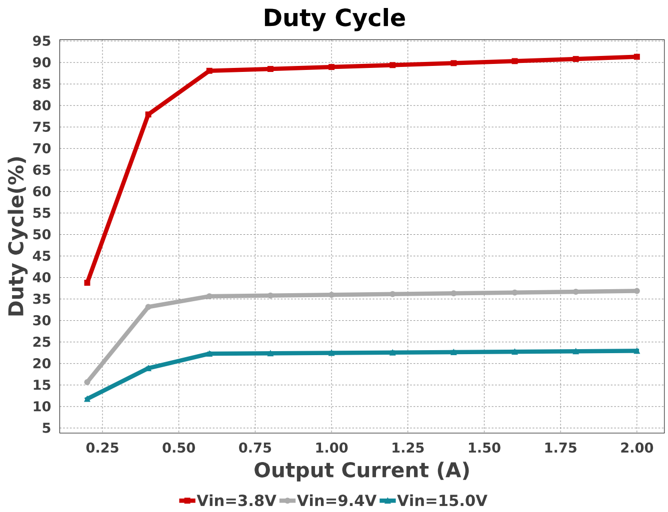
Electrical BOM

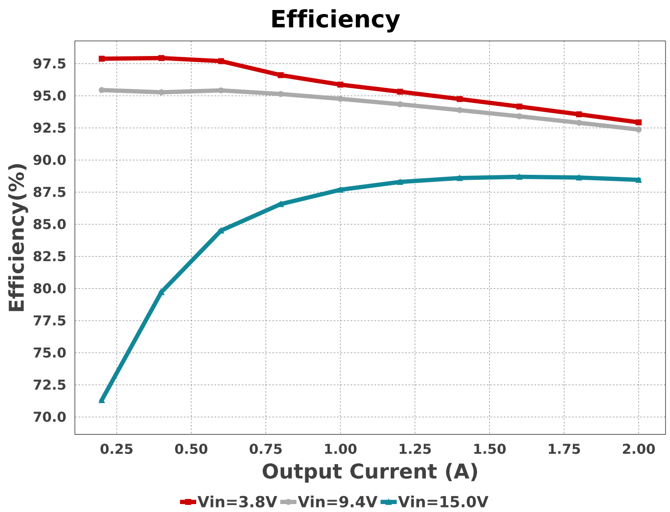
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0603C104Z4VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cin	MuRata	GRM21BR61E106MA73L Series= X5R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 2.8 A	1	$0.04	0805 7 mm²
Cinx	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cout	MuRata	GRM32EC80J107ME20L Series= X6S	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.17	1210_270 15 mm²
L1	Vishay-Dale	IHLP3232DZER4R7M11	L= 4.7 µH 22.6 mOhm	1	$0.71	IHLP-3232DZ 112 mm²
Rfbb	Vishay-Dale	CRCW060310K0FKEA Series= CRCW..e3	Res= 10.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Yageo	RC0603FR-0730K9L Series= ?	Res= 30.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rpgood	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	TPS62933PDRL	Switcher	1	$0.60	DRL0008A-MFG 9 mm²

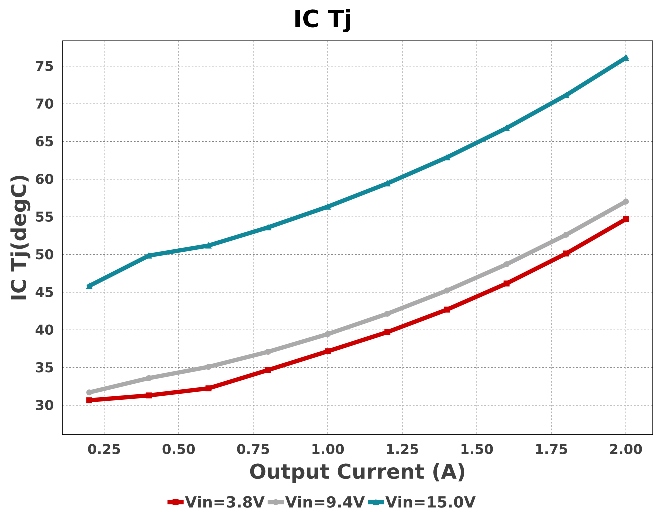

L Ipp
L Ipp(A)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V

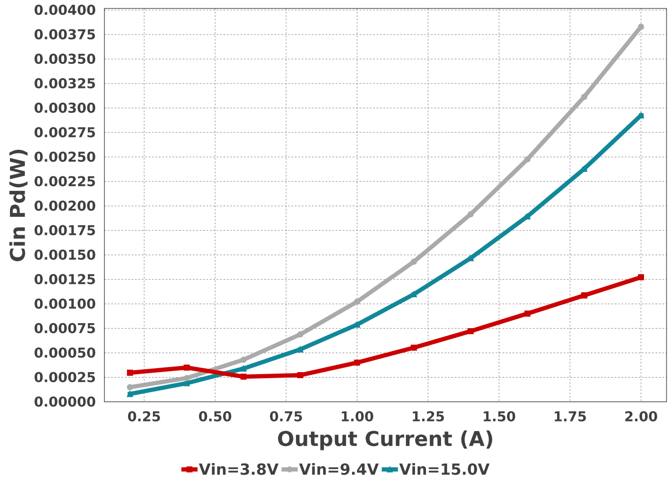

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V

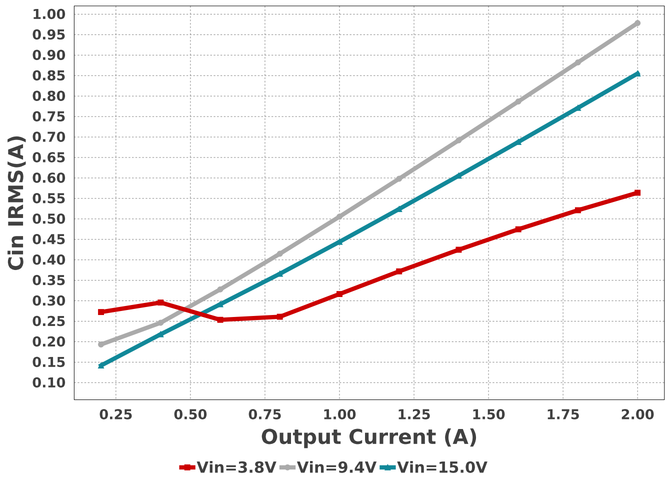

Efficiency
Efficiency(%)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


IC Tj
IC Tj(degC)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V

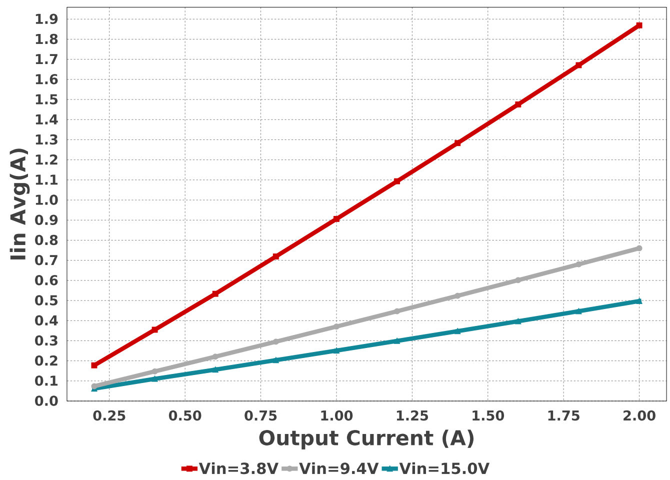
Cin Pd



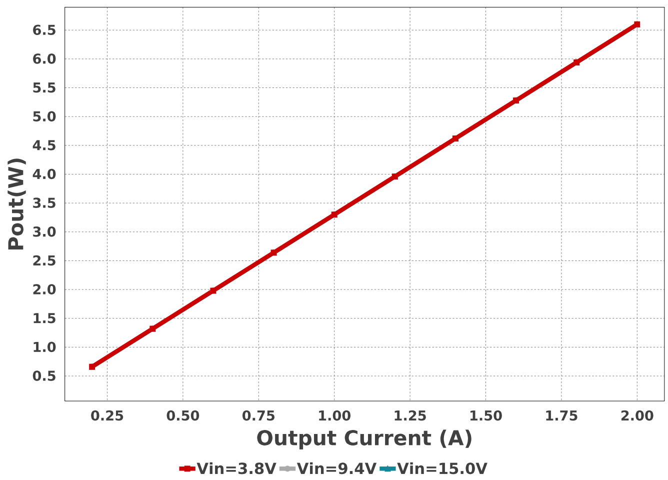
Cin IRMS



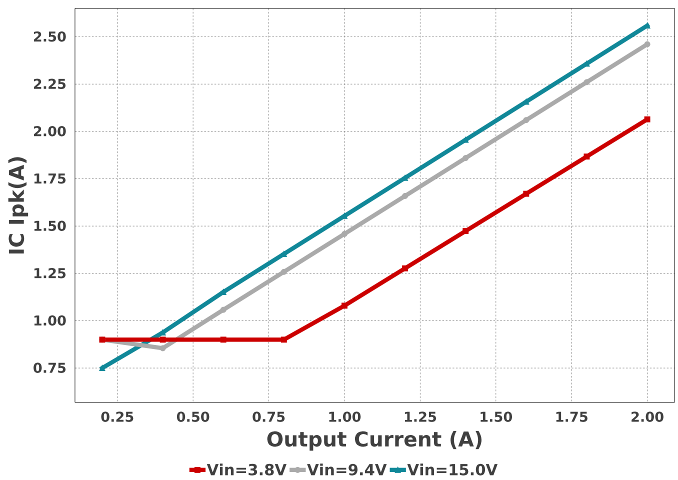
Iin Avg



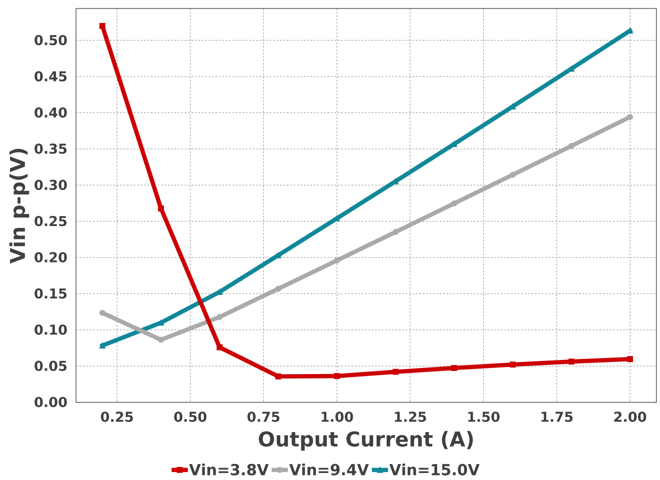
Pout

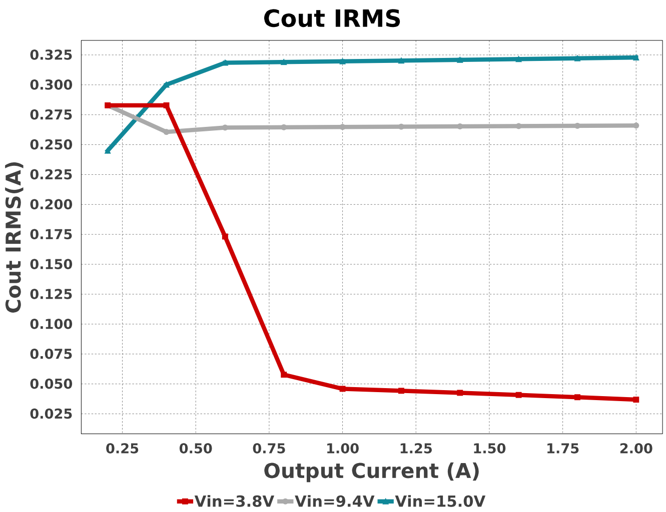


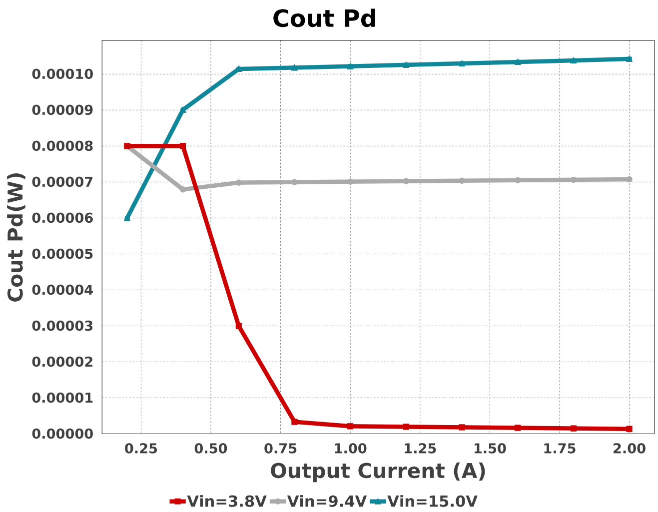
IC Ipk

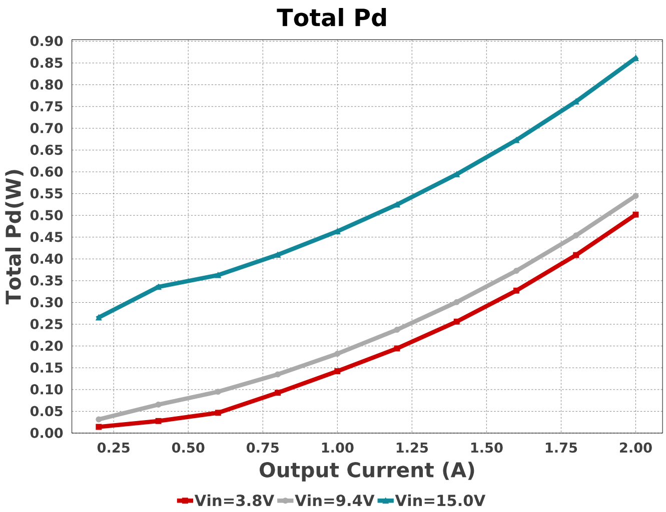


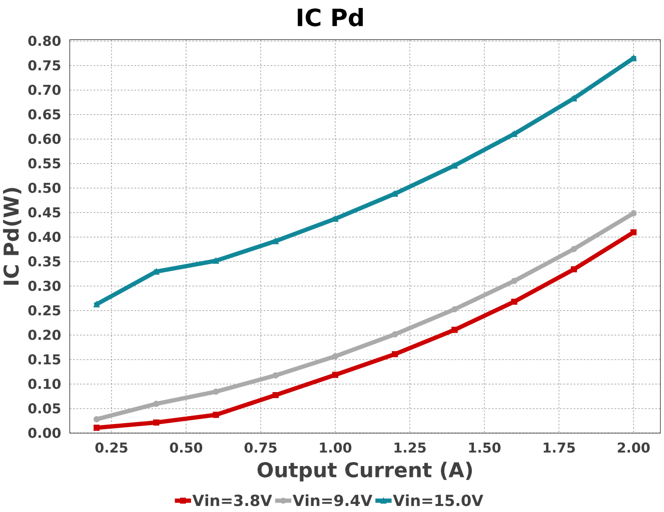
Vin p-p

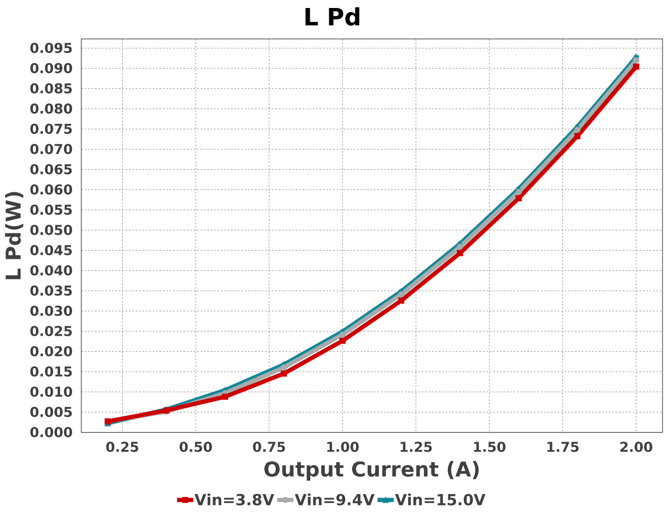


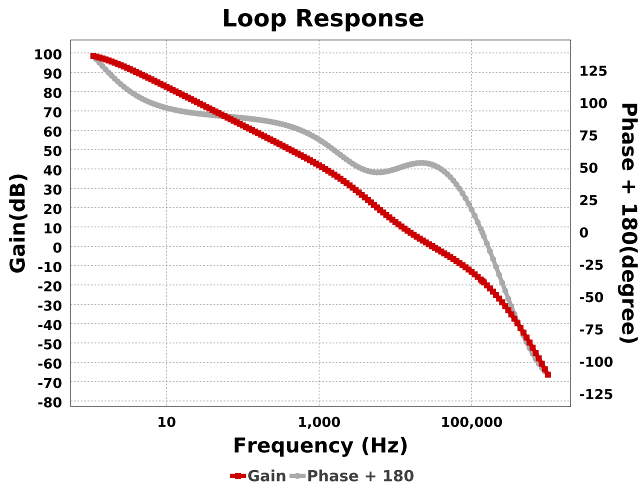

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V

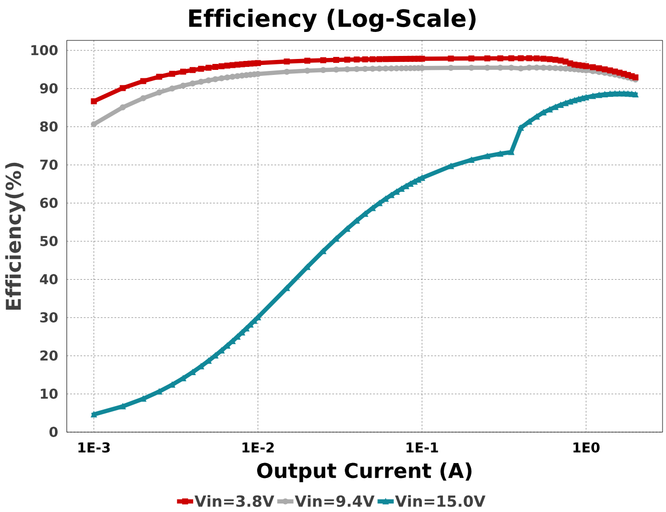

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


L Pd
L Pd(W)
Output Current (A)
Vin=3.8V Vin=9.4V Vin=15.0V


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



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	9		Total Design BOM count
2.	Total BOM	$1.57		Total BOM Cost
3.	Cin IRMS	855.091 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	2.925 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	322.831 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	104.22 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	2.559 A	IC	Peak switch current in IC
8.	IC Pd	765.16 mW	IC	IC power dissipation
9.	IC Tj	76.101 degC	IC	IC junction temperature
10.	IC Tolerance	16.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	60.25 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	497.41 mA	IC	Average input current
13.	Ipp percentage	55.916 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	1.118 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	92.755 mW	Inductor	Inductor power dissipation
16.	Cin Pd	2.925 mW	Power	Input capacitor power dissipation
17.	Cout Pd	104.22 µW	Power	Output capacitor power dissipation
18.	IC Pd	765.16 mW	Power	IC power dissipation
19.	L Pd	92.755 mW	Power	Inductor power dissipation
20.	Total Pd	861.166 mW	Power	Total Power Dissipation
21.	Cross Freq	30.569 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	22.948 %	System Information	Duty cycle
23.	Efficiency	88.458 %	System Information	Steady state efficiency
24.	FootPrint	165.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	500.0 kHz	System Information	Switching frequency
26.	Gain Marg	-17.939 dB	System Information	Bode Plot Gain Margin
27.	Inductor ripple current requirement used for Inductor selection	40.0 %	System Information	Custom Inductor ripple current (% of average inductor current) requirement used for Inductor selection
28.	Iout	2.0 A	System Information	Iout operating point
29.	Iout transient step used for Cout calculations	1.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
30.	Low Freq Gain	98.455 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Overshoot Value	11.235 mV	System Information	Theoretical Vout Overshoot Value
33.	Phase Marg	52.546 deg	System Information	Bode Plot Phase Margin
34.	Pout	6.6 W	System Information	Total output power
35.	Undershoot Value	27.78 mV	System Information	Theoretical Vout Undershoot Value

#	Name	Value	Category	Description
36.	Vin	15.0 V	System Information	Vin operating point
37.	Vin p-p	513.372 mV	System Information	Peak-to-peak input voltage
38.	Vout	3.3 V	System Information	Operational Output Voltage
39.	Vout Actual	3.272 V	System Information	Vout Actual calculated based on selected voltage divider resistors
40.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
41.	Vout Tolerance	3.557 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	4.511 mV	System Information	Peak-to-peak output ripple voltage
43.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	15.0	Maximum input voltage
VinMin	3.8	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS62933P	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	500.0 k	Customer Selected Frequency

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

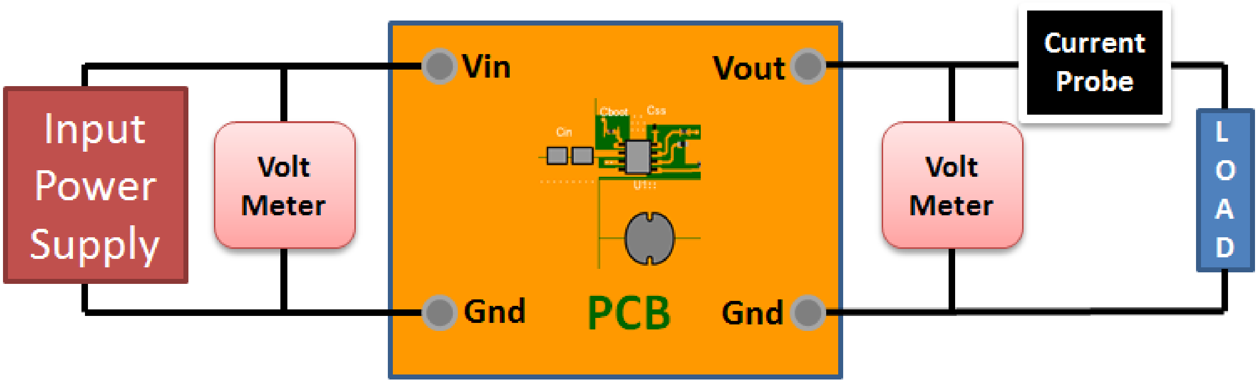
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.8V 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.

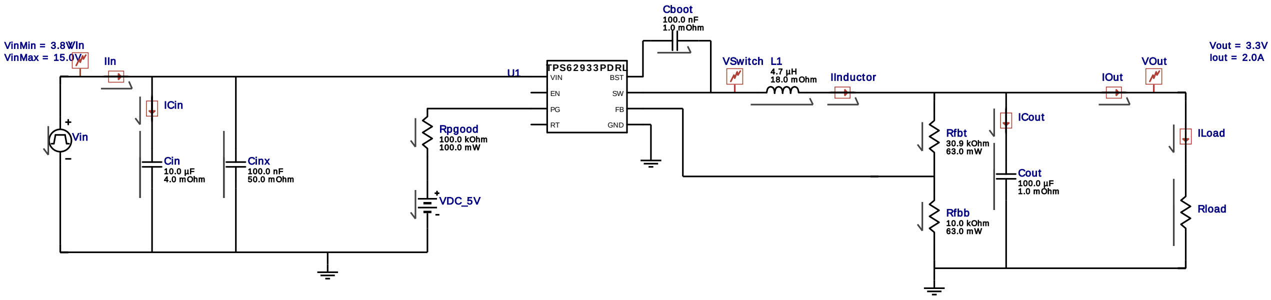


WEBENCH® Electrical Simulation Report

Design Id = 13

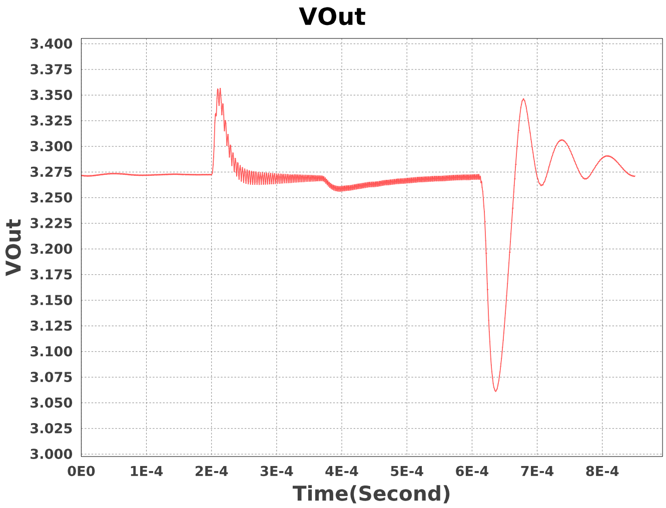
sim_id = 5

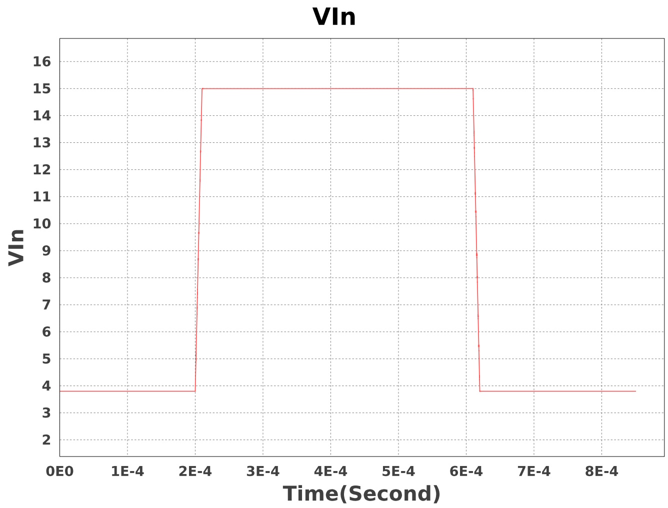
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	initial condition	3.3 V
2.	L1	IC	Initial Current	2.0 A
3.	Rload	R	Load Resistance	1.65 ohm

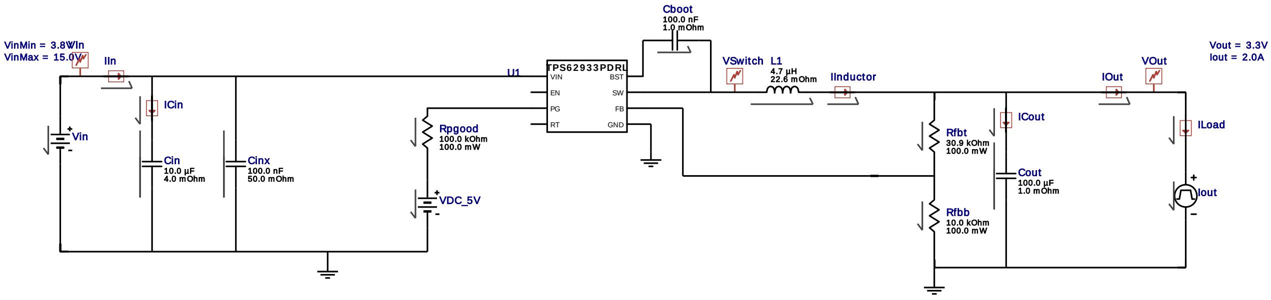




Design Id = 13

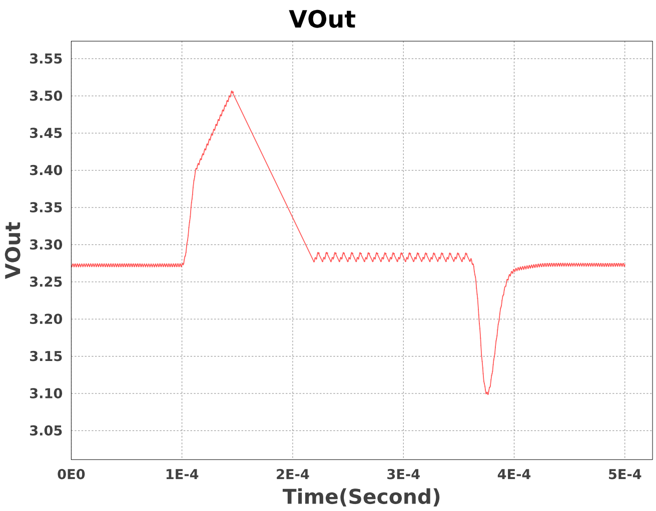
sim_id = 6

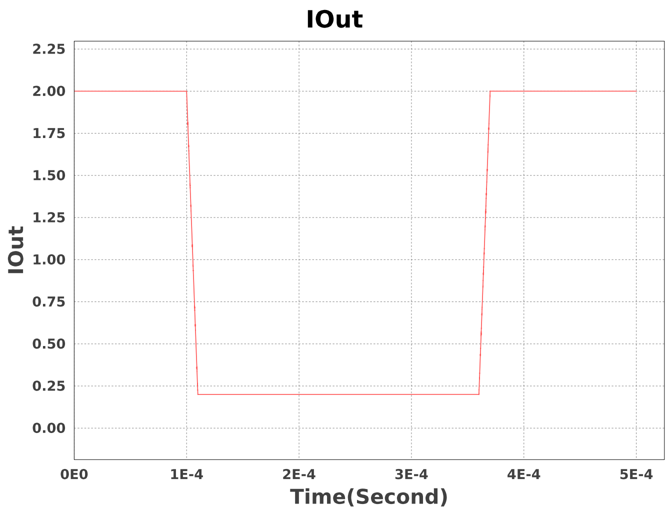
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Condition	3.3 V
2.	L1	IC	initial current	2.0
3.	ILoad	I	Load Current	ILoad1 A
4.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	2.0 A
		I2	Minimum Load Current	0.2 A
		Td	Initial Time Delay	0.1m s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	0.25m s





Design Assistance

1. Master key : A1B40F3D1A652764031E2B93F10D1CC6[v1]

2. **TPS62933P** Product Folder : http://www.ti.com/product/TPS62933P : contains the data sheet and other resources.