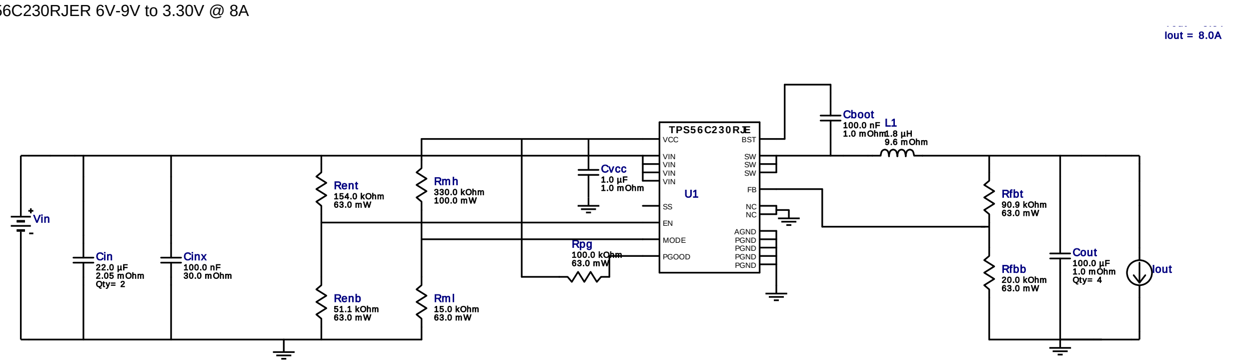
VinMin = 6.0V
VinMax = 9.0V
Vout = 3.3V
Iout = 8.0A

Device = TPS56C230RJER
Topology = Buck
Created = 2023-01-23 12:26:32.652
BOM Cost = $3.41
BOM Count = 18
Total Pd = 2.12W

WEBENCH ® Design Report

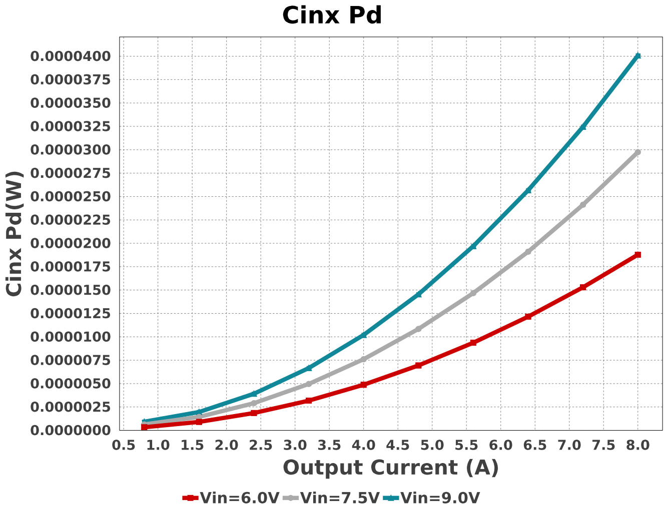
Design : 2 TPS56C230RJER
TPS56C230RJER 6V-9V to 3.30V @ 8A

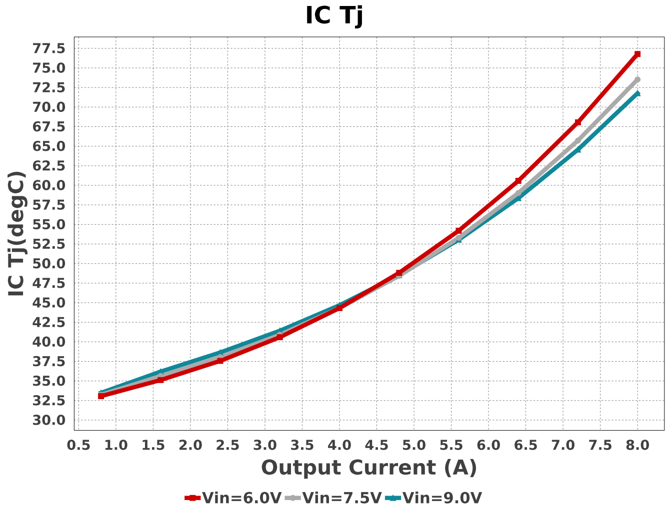


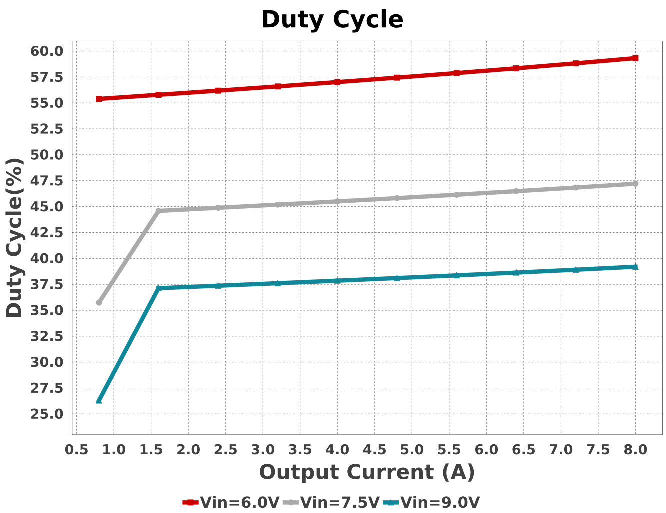
Electrical BOM

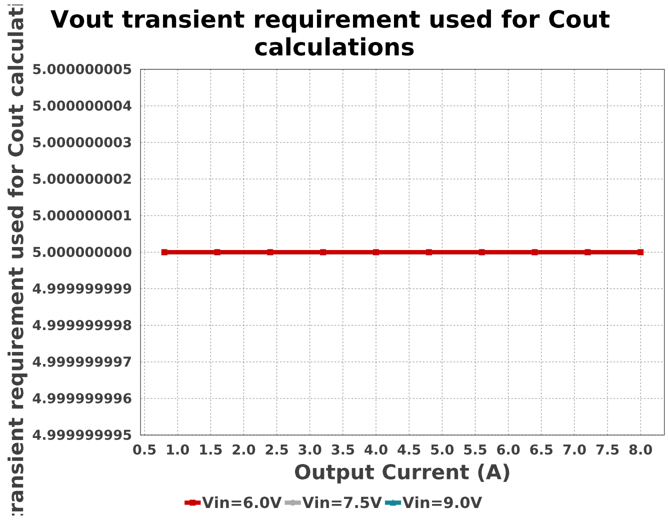
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	2	$0.31	0805 7 mm²
Cinx	MuRata	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 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	4	$0.17	1210_270 15 mm²
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
L1	Coilcraft	XAL6030-182MEB	L= 1.8 µH 9.6 mOhm	1	$0.65	XAL6030 72 mm²
Renb	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rent	Vishay-Dale	CRCW0402154KFKED Series= CRCW..e3	Res= 154.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW040290K9FKED Series= CRCW..e3	Res= 90.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rmh	Yageo	RC0603FR-07330KL Series= ?	Res= 330.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²

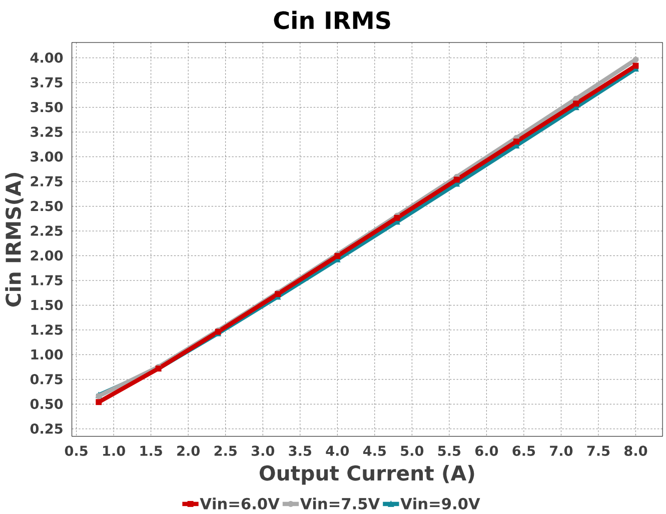
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rml	Vishay-Dale	CRCW040215K0FKED Series= CRCW..e3	Res= 15.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS56C230RJER	Switcher	1	$1.36	RJE0020B 16 mm²

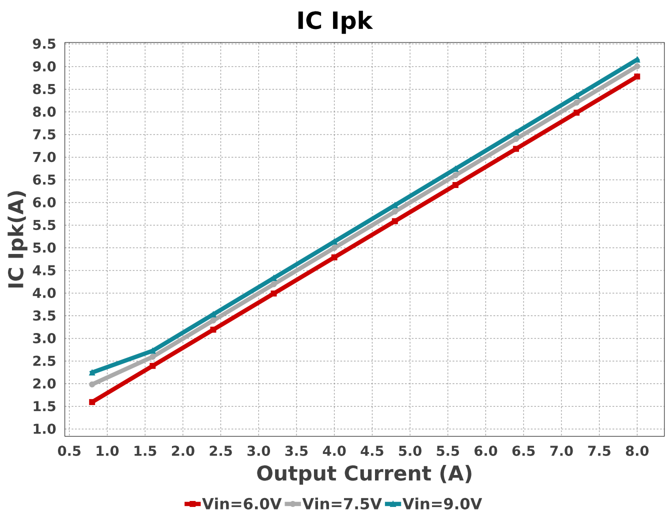


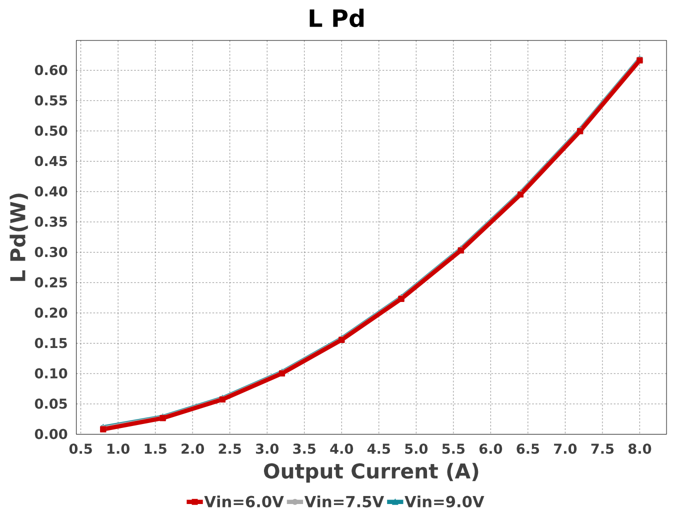


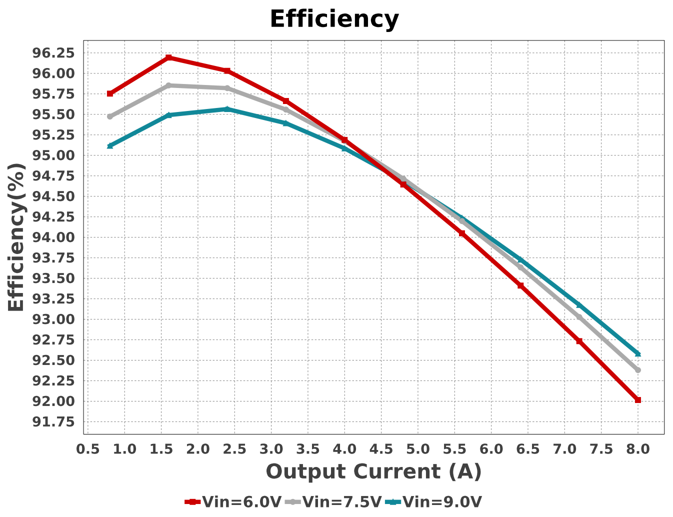


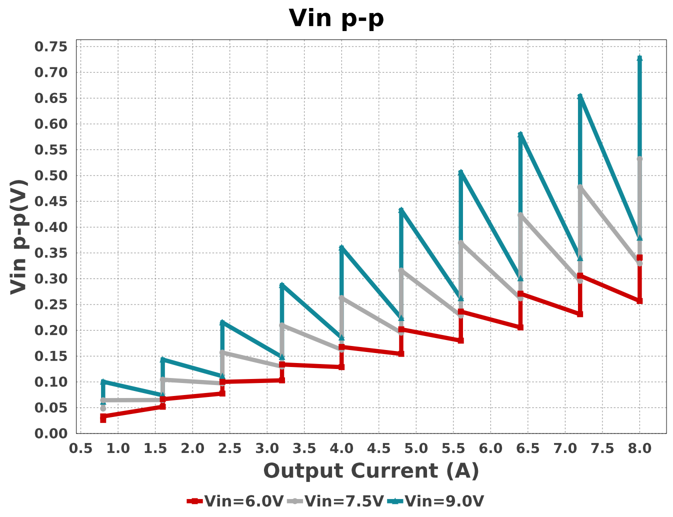


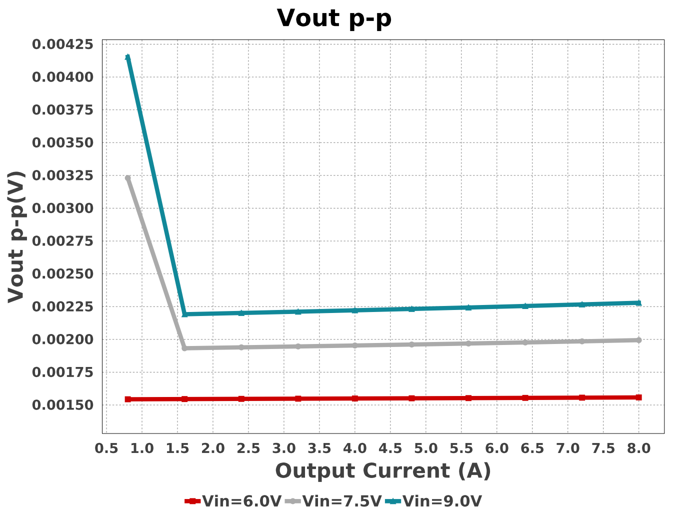


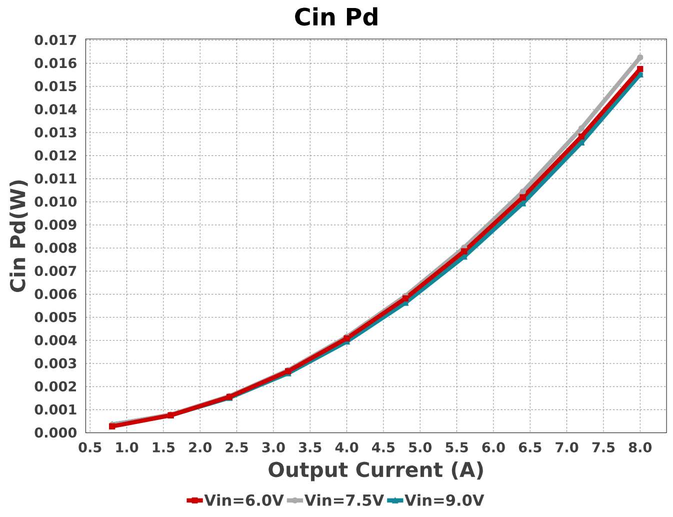


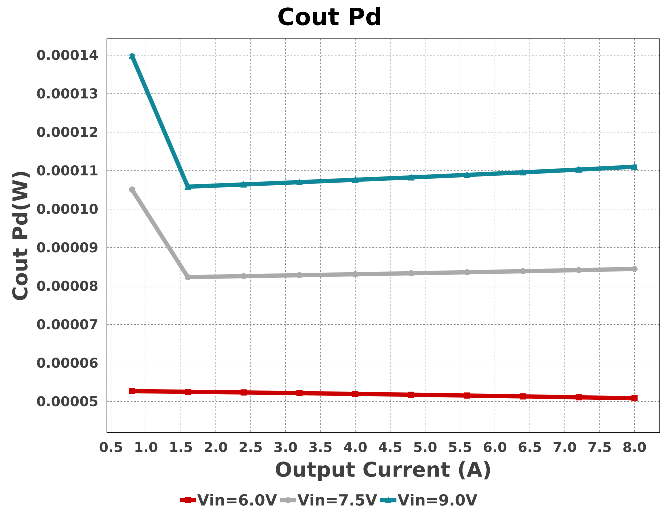

L Pd
L Pd(W)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

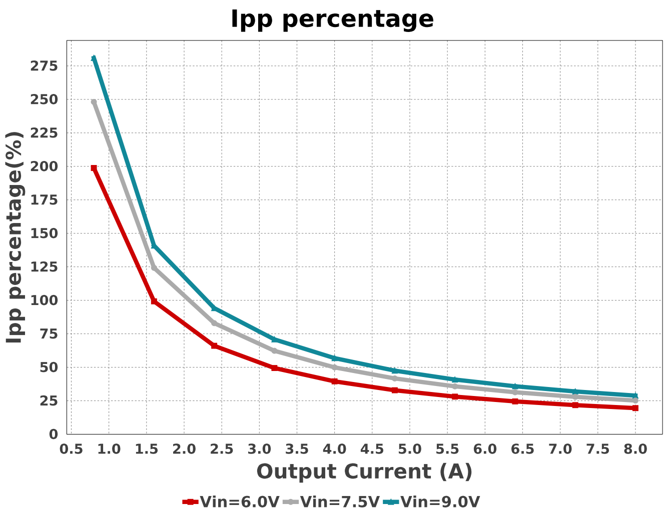

Efficiency
Efficiency(%)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

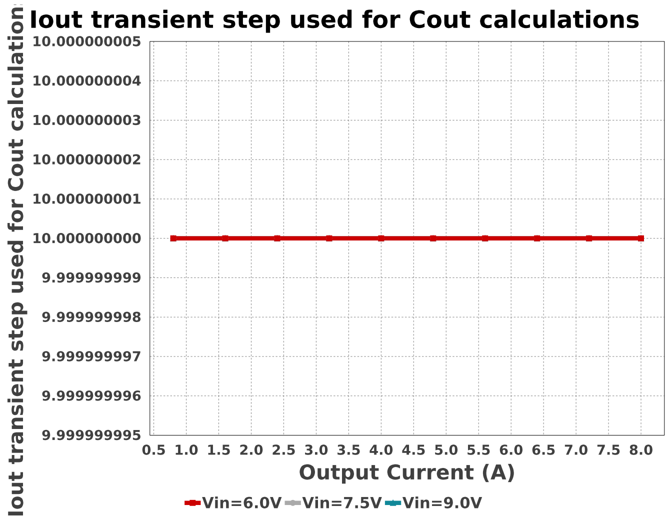

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

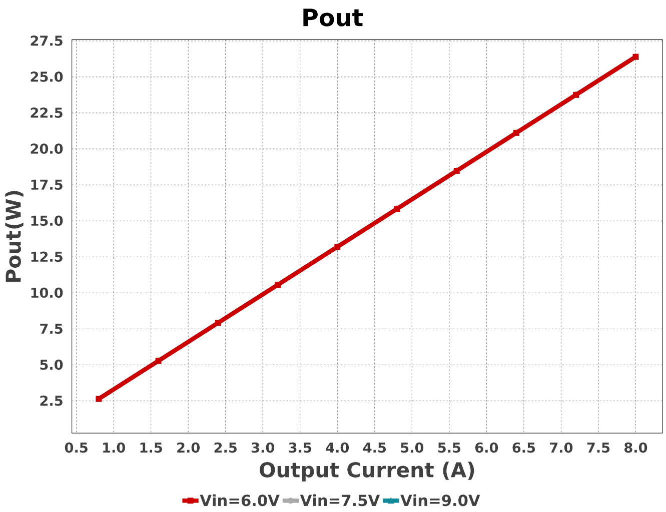

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

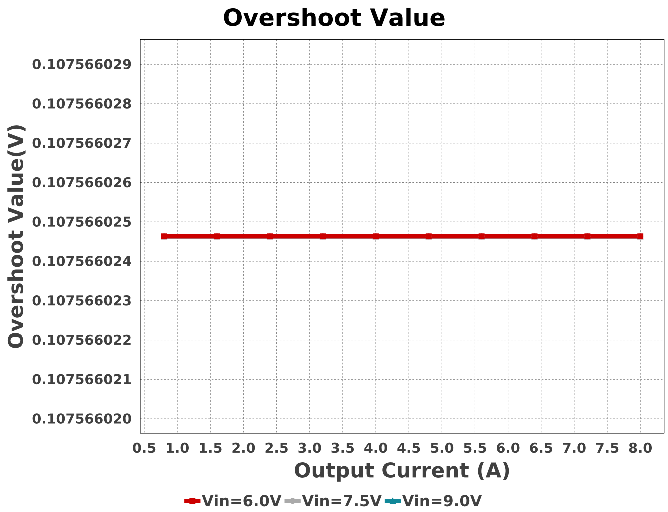

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

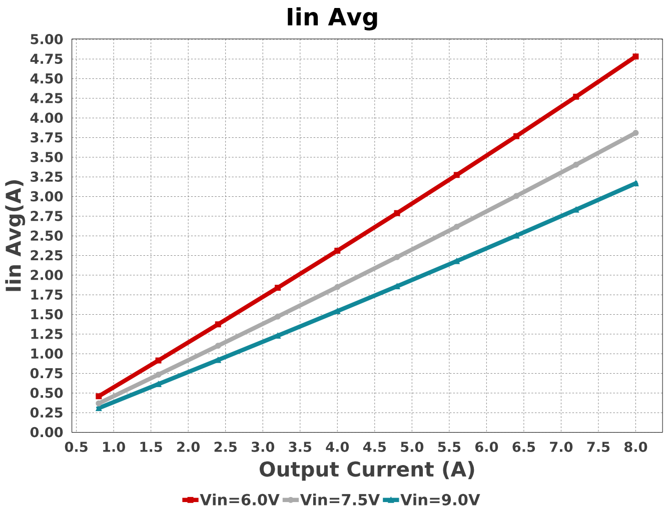

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

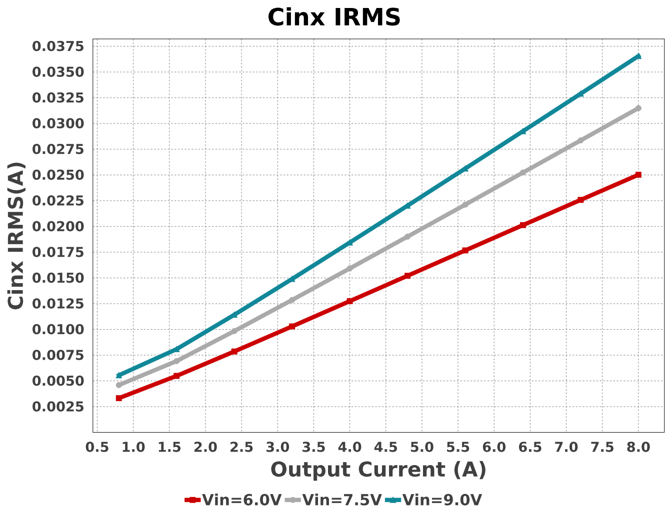

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

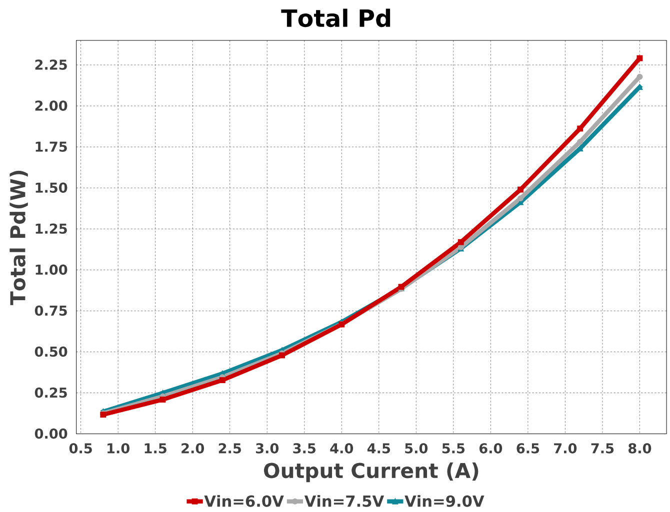

Iout transient step used for Cout calculations
Iout transient step used for Cout calculation
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

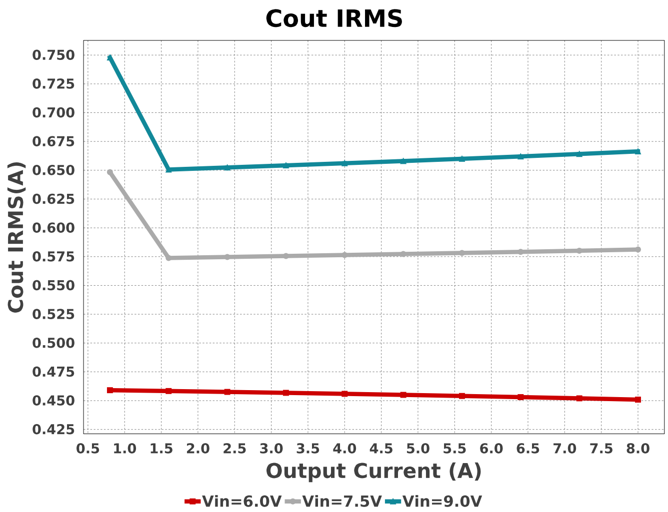

Pout
Pout(W)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

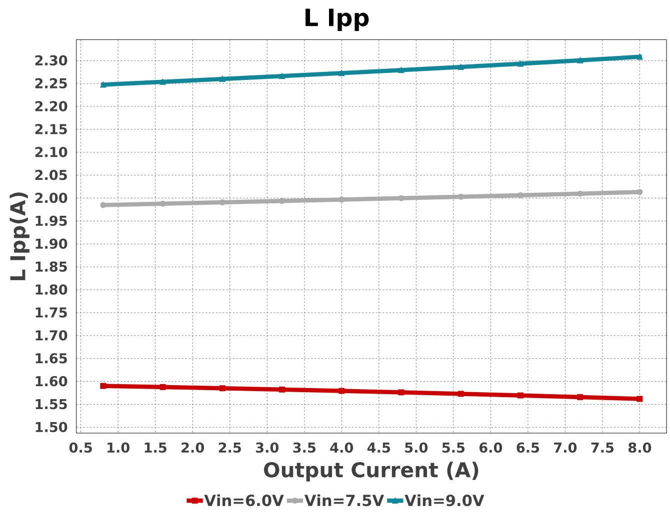

Overshoot Value
Overshoot Value(V)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

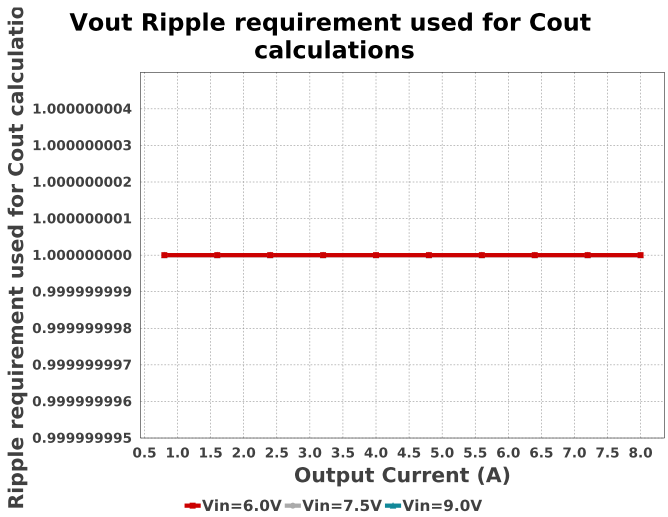

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

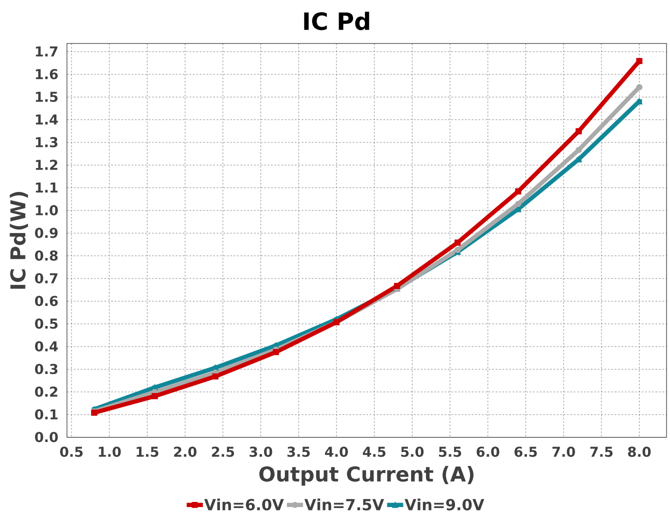

Cinx IRMS
Cinx IRMS(A)
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

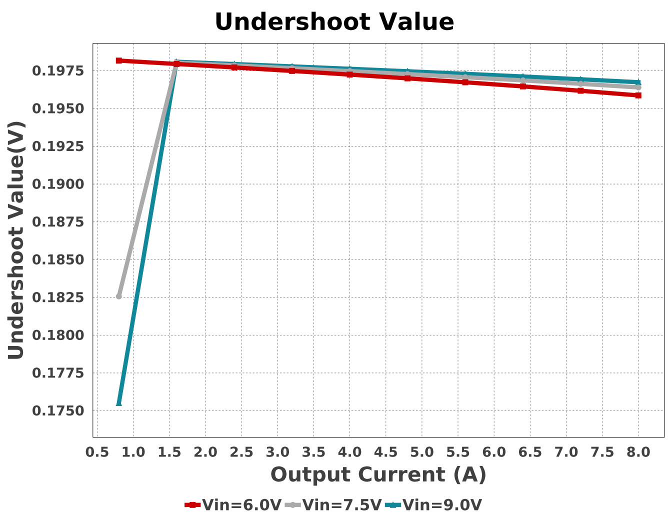

Total Pd
Total Pd(W)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V

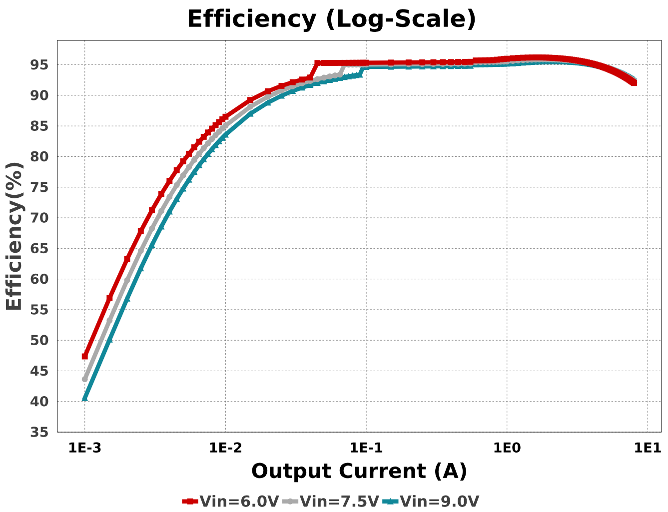

Cout IRMS
Cout IRMS(A)
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.475
0.450
0.425
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V


L Ipp
L Ipp(A)
2.30
2.25
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V


Vout Ripple requirement used for Cout calculations
Ripple requirement used for Cout calculatio
1.000000004
1.000000003
1.000000002
1.000000001
1.000000000
0.999999999
0.999999998
0.999999997
0.999999996
0.999999995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V


IC Pd
IC Pd(W)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V


Undershoot Value
Undershoot Value(V)
0.1975
0.1950
0.1925
0.1900
0.1875
0.1850
0.1825
0.1800
0.1775
0.1750
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Output Current (A)
Vin=6.0V Vin=7.5V Vin=9.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.891 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	15.52 mW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	36.549 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	40.075 µW	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	666.37 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	111.01 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	9.154 A	IC	Peak switch current in IC
8.	IC Pd	1.481 W	IC	IC power dissipation
9.	IC Tj	71.768 degC	IC	IC junction temperature
10.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	28.2 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	3.168 A	IC	Average input current
13.	Ipp percentage	28.855 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	2.308 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	618.66 mW	Inductor	Inductor power dissipation
16.	Cin Pd	15.52 mW	Power	Input capacitor power dissipation
17.	Cinx Pd	40.075 µW	Power	Bulk capacitor power dissipation
18.	Cout Pd	111.01 µW	Power	Output capacitor power dissipation
19.	IC Pd	1.481 W	Power	IC power dissipation
20.	L Pd	618.66 mW	Power	Inductor power dissipation
21.	Total Pd	2.116 W	Power	Total Power Dissipation
22.	BOM Count	18	System Information	Total Design BOM count
23.	Duty Cycle	39.201 %	System Information	Duty cycle
24.	Efficiency	92.581 %	System Information	Steady state efficiency
25.	FootPrint	195.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	507.999 kHz	System Information	Switching frequency
27.	Iout	8.0 A	System Information	Iout operating point
28.	Iout transient step used for Cout calculations	10.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
29.	Mode	CCM	System Information	Conduction Mode
30.	Overshoot Value	107.566 mV	System Information	Theoretical Vout Overshoot Value
31.	Pout	26.4 W	System Information	Total output power
32.	Total BOM	$3.41	System Information	Total BOM Cost
33.	Undershoot Value	196.74 mV	System Information	Theoretical Vout Undershoot Value
34.	Vin	9.0 V	System Information	Vin operating point
35.	Vin p-p	379.501 mV	System Information	Peak-to-peak input voltage
36.	Vin p-p	728.188 mV	System Information	Peak-to-peak input voltage

#	Name	Value	Category	Description
37.	Vout	3.3 V	System Information	Operational Output Voltage
38.	Vout Actual	3.327 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
40.	Vout Tolerance	2.672 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	2.279 mV	System Information	Peak-to-peak output ripple voltage
42.	Vout transient requirement used for Cout calculations	5.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	8.0	Maximum Output Current
SoftStart	1.2 ms	Soft Start Time (ms)
VinMax	9.0	Maximum input voltage
VinMin	6.0	Minimum input voltage
VinTyp	8.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	TPS56C230	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

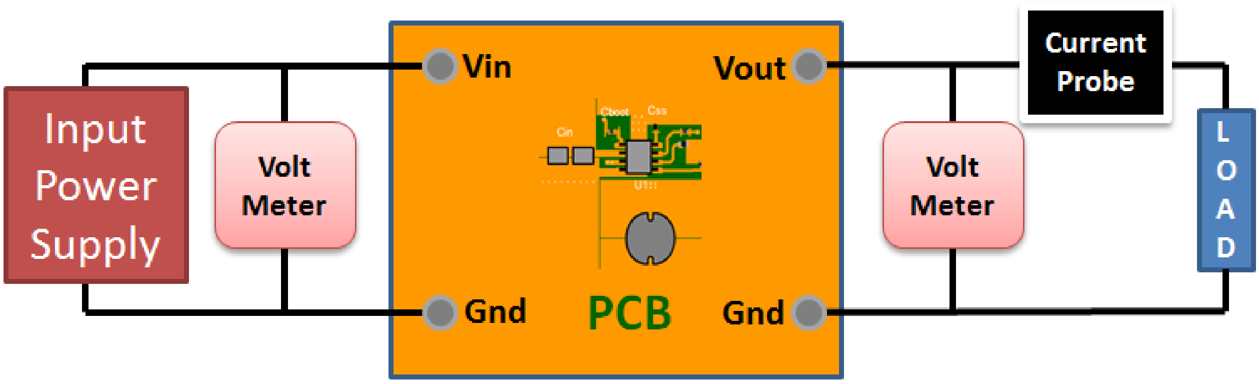
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.0V 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.



Design Assistance

1. Master key : 94C3582DA5B7420FD41257BB1976C9A4[v1]

2. **TPS56C230** Product Folder : http://www.ti.com/product/TPS56C230 : contains the data sheet and other resources.

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