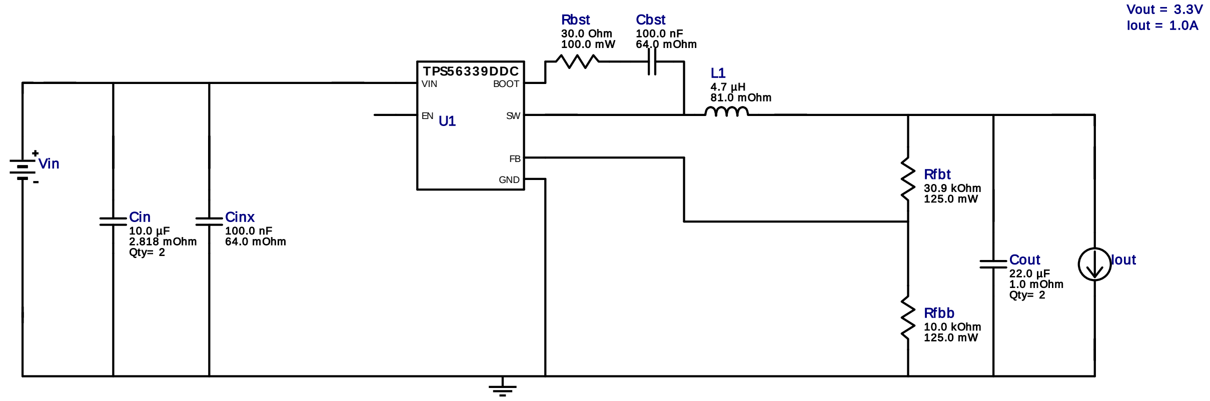
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 9.0V
VinMax = 22.0V
Vout = 3.3V
Iout = 1.0A

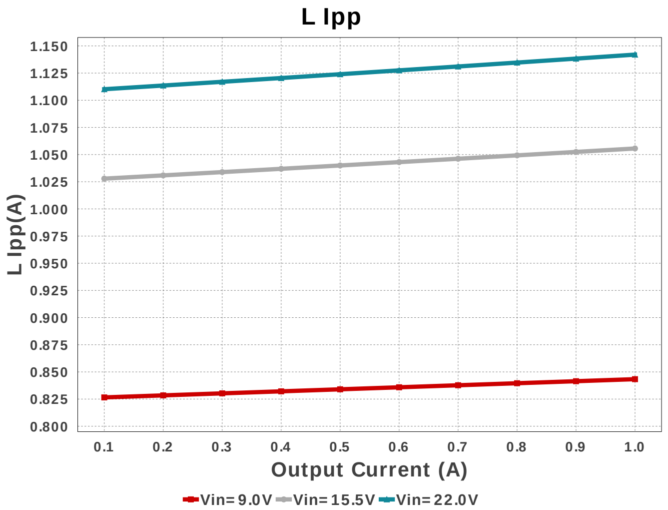
Device = TPS56339DDCR
Topology = Buck
Created = 2019-11-05 14:03:17.406
BOM Cost = $1.81
BOM Count = 11
Total Pd = 0.35W

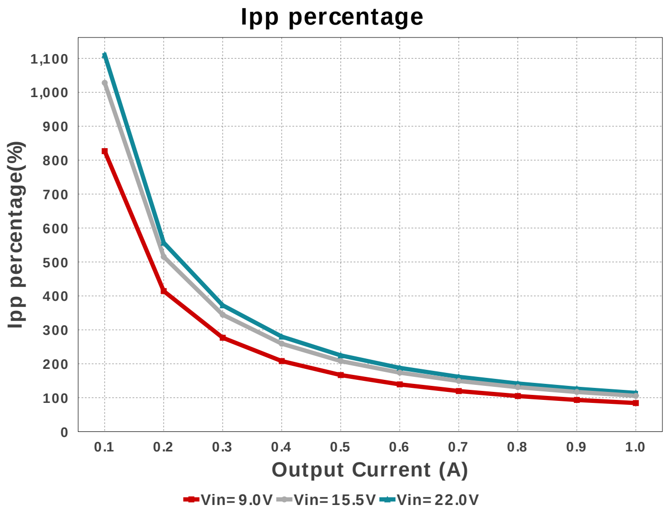
Design : 5 TPS56339DDCR
TPS56339DDCR 9V-22V to 3.30V @ 1A

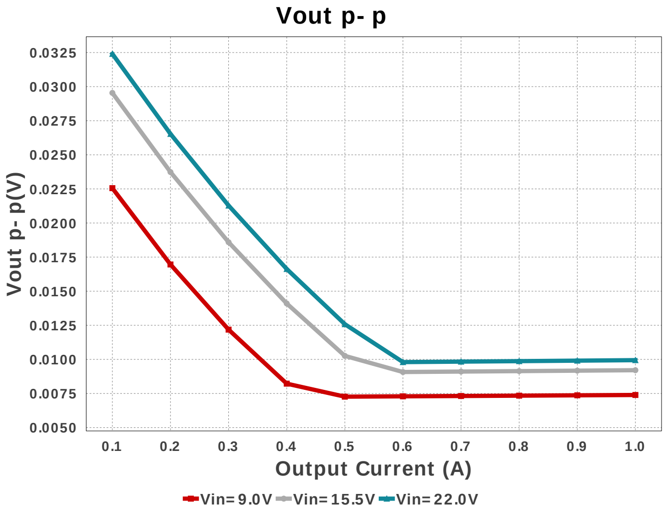


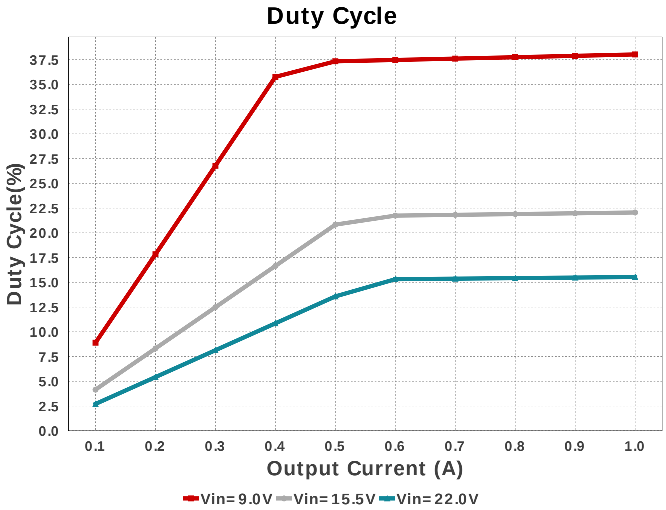
Electrical BOM

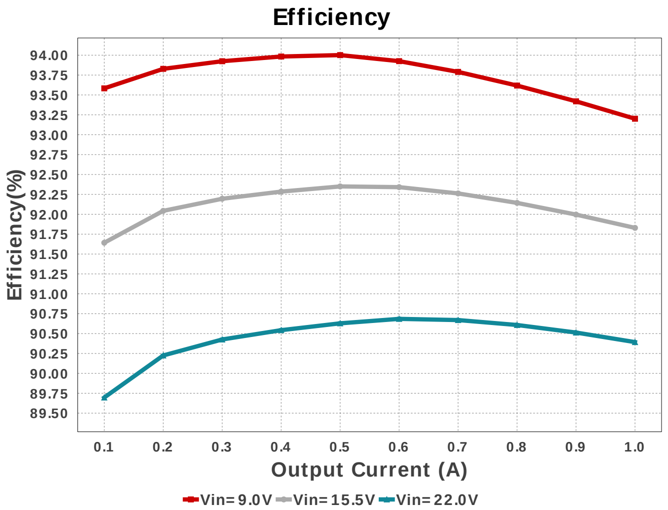
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
Cin	TDK	C2012X5R1V106K085AC Series= X5R	Cap= 10.0 uF ESR= 2.818 mOhm VDC= 35.0 V IRMS= 3.8868 A	2	$0.17	0805 7 mm^2
Cinx	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
Cout	TDK	C2012X7S1A226M125AC Series= X7S	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	2	$0.29	0805 7 mm^2
L1	TDK	LTF5022T-4R7N2R0-LC	L= 4.7 µH 81.0 mOhm	1	$0.41	LTF5022T 51 mm^2
Rbst	Susumu Co Ltd	RR1220Q-300-D Series= RR12	Res= 30.0 Ohm Power= 100.0 mW Tolerance= 0.5%	1	$0.01	0805 7 mm^2
Rfbb	Vishay-Dale	CRCW080510K0FKEA Series= CRCW..e3	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbt	Vishay-Dale	CRCW080530K9FKEA Series= CRCW..e3	Res= 30.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	TPS56339DDCR	Switcher	1	$0.43	DDC0006A_N 10 mm^2

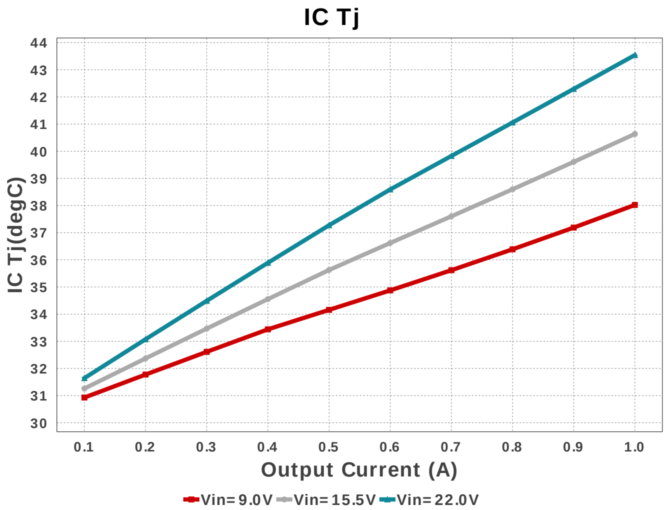

L Ipp
L Ipp(A)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

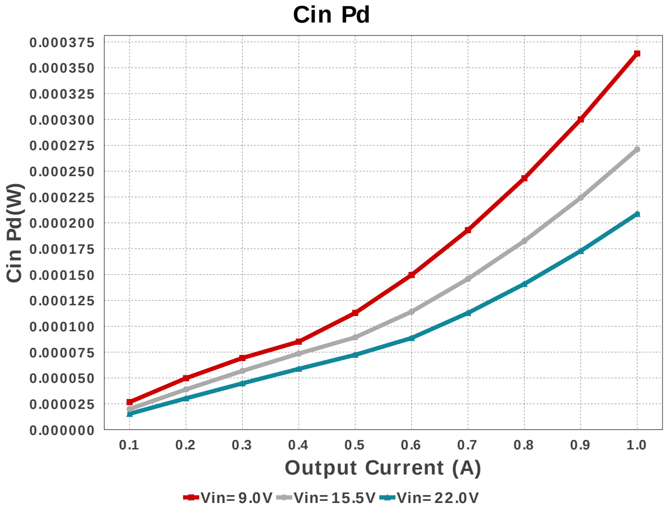

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

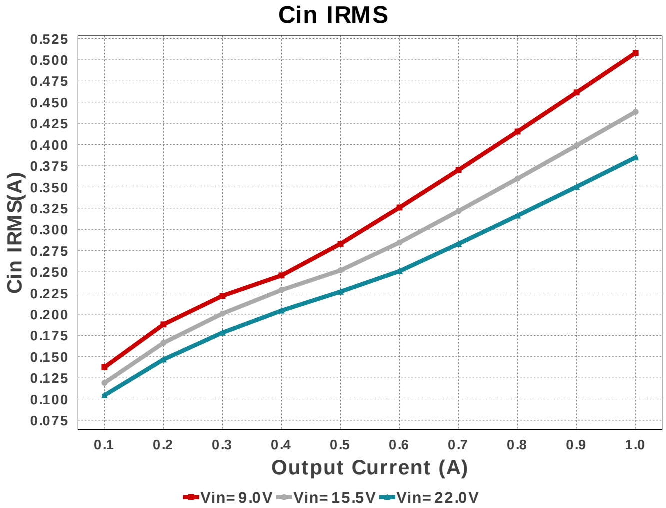

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

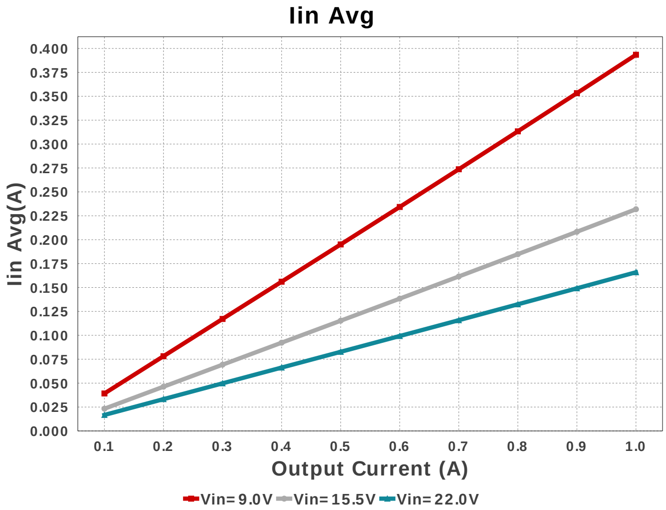

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

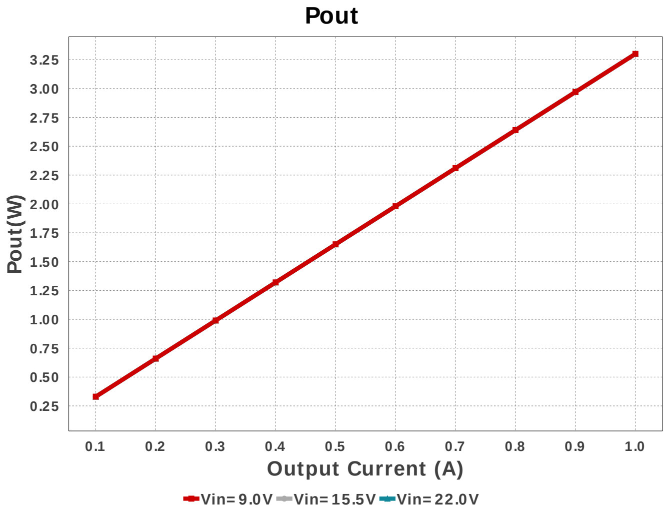

Efficiency
Efficiency(%)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

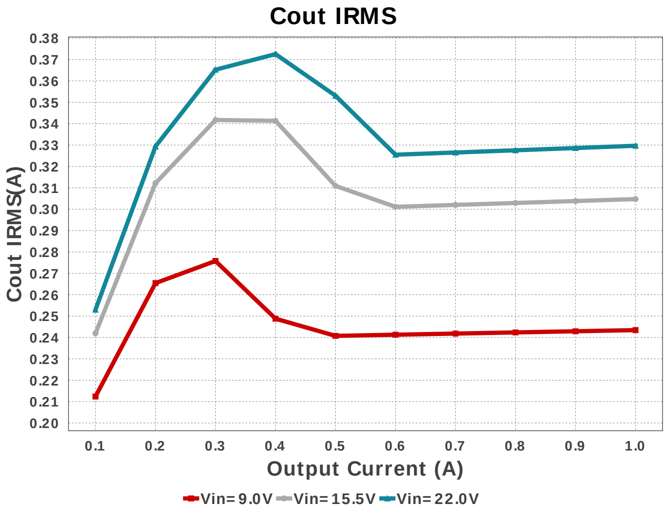

IC Tj
IC Tj(degC)
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

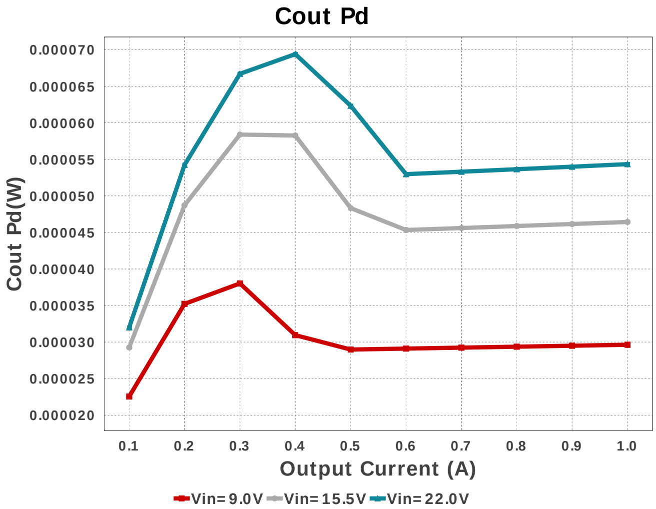

Cin Pd
Cin Pd(W)
0.000375
0.000350
0.000325
0.000300
0.000275
0.000250
0.000225
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

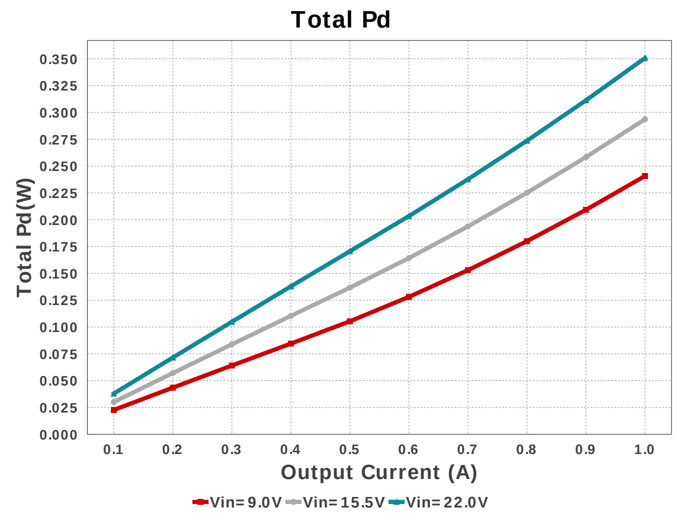

Cin IRMS
Cin IRMS(A)
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

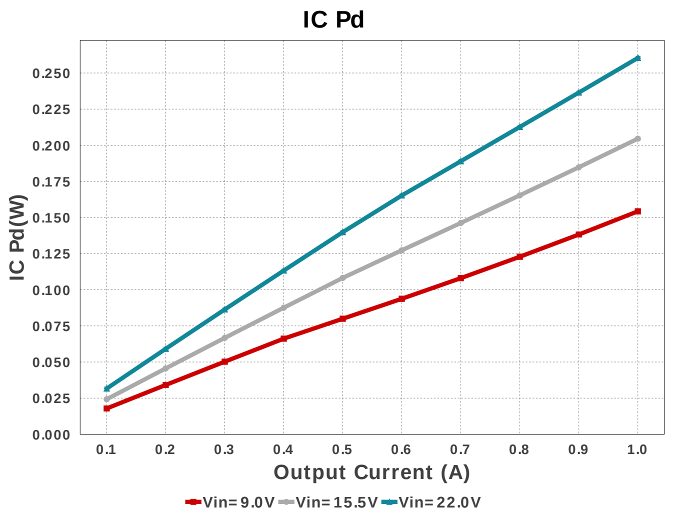

Iin Avg
Iin Avg(A)
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

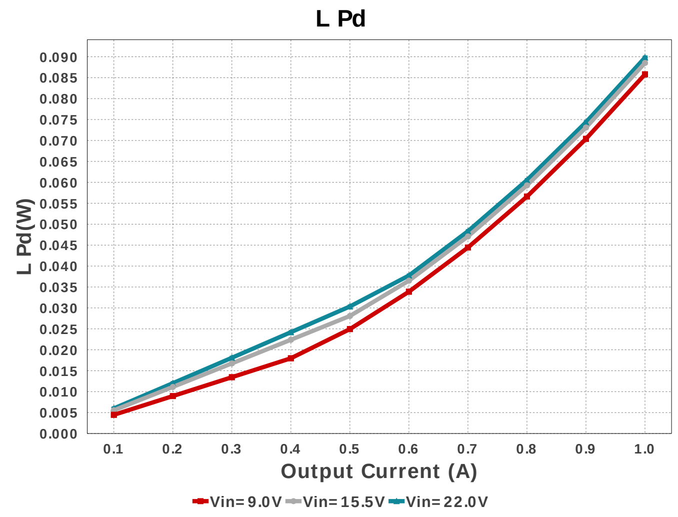

Pout
Pout(W)
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V

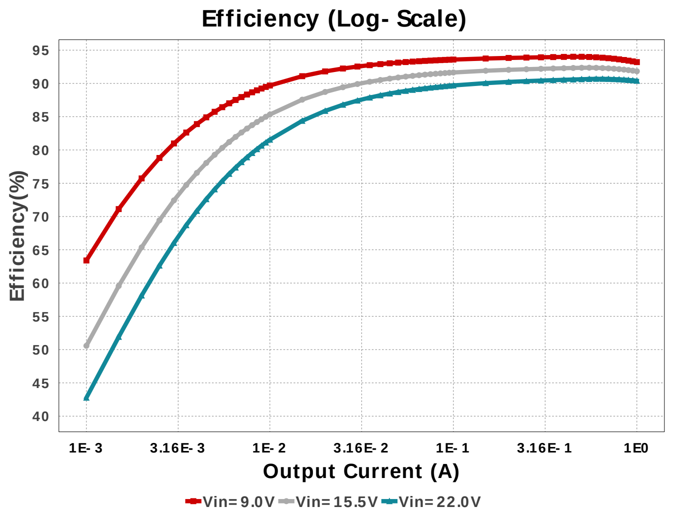

Cout IRMS
Cout IRMS(A)
0.38
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V


Cout Pd
Cout Pd(W)
0.000070
0.000065
0.000060
0.000055
0.000050
0.000045
0.000040
0.000035
0.000030
0.000025
0.000020
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=9.0V Vin=15.5V Vin=22.0V









Operating Values

#	Name	Value	Category	Description
1.	BOM Count	11		Total Design BOM count
2.	Total BOM	$1.81		Total BOM Cost
3.	Cin IRMS	384.851 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	208.69 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	329.665 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	54.34 µW	Capacitor	Output capacitor power dissipation
7.	IC Pd	260.4 mW	IC	IC power dissipation
8.	IC Tj	43.541 degC	IC	IC junction temperature
9.	ICThetaJA Effective	52.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	165.94 mA	IC	Average input current
11.	Ipp percentage	114.199 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	1.142 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	89.803 mW	Inductor	Inductor power dissipation
14.	Cin Pd	208.69 µW	Power	Input capacitor power dissipation
15.	Cout Pd	54.34 µW	Power	Output capacitor power dissipation
16.	IC Pd	260.4 mW	Power	IC power dissipation
17.	L Pd	89.803 mW	Power	Inductor power dissipation
18.	Total Pd	350.721 mW	Power	Total Power Dissipation
19.	Duty Cycle	15.536 %	System Information	Duty cycle
20.	Efficiency	90.393 %	System Information	Steady state efficiency
21.	FootPrint	122.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	536.978 kHz	System Information	Switching frequency
23.	Iout	1.0 A	System Information	Iout operating point
24.	Mode	CCM	System Information	Conduction Mode

#	Name	Value	Category	Description
25.	Pout	3.3 W	System Information	Total output power
26.	Vin	22.0 V	System Information	Vin operating point
27.	Vout	3.3 V	System Information	Operational Output Voltage
28.	Vout Actual	3.272 V	System Information	Vout Actual calculated based on selected voltage divider resistors
29.	Vout Tolerance	4.064 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
30.	Vout p-p	9.945 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	22.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
VinTyp	12.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	TPS56339	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

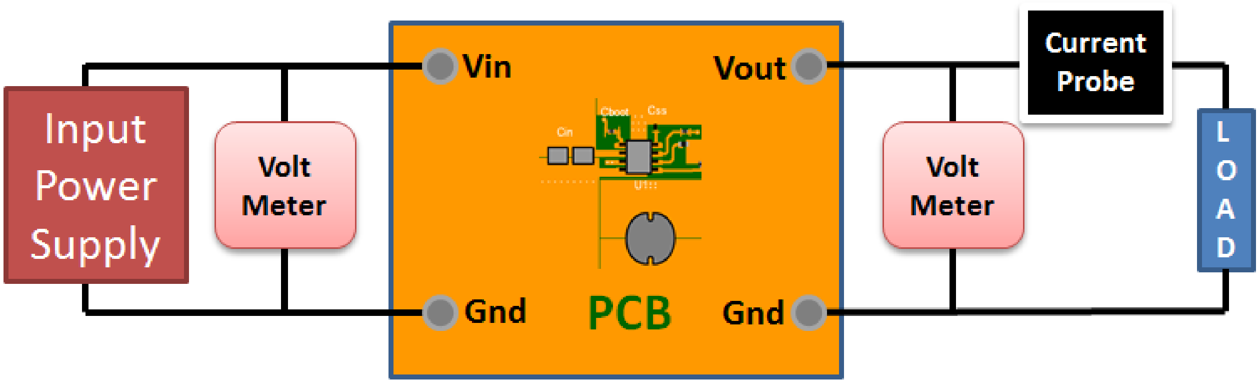
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 9.0V 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 : 2128C7AEB785B442[v1]

2. **TPS56339** Product Folder : http://www.ti.com/product/TPS56339 : contains the data sheet and other resources.

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