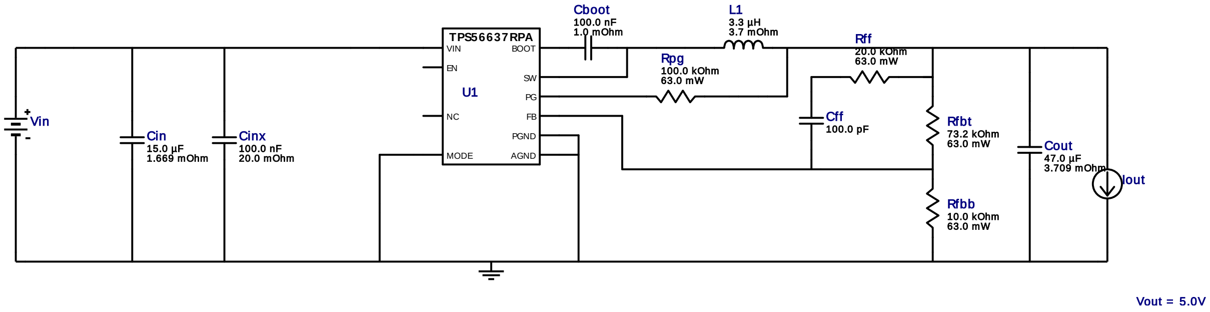
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 10.0V
VinMax = 22.0V
Vout = 5.0V
Iout = 3.0A

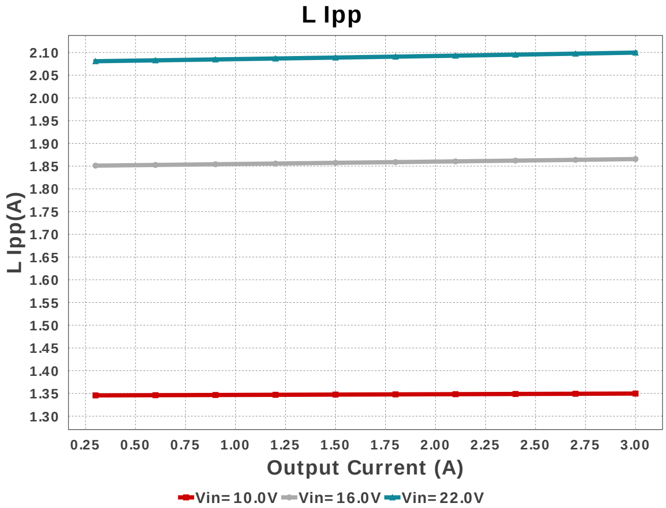
Device = TPS56637RPAR
Topology = Buck
Created = 2020-06-11 23:38:40.977
BOM Cost = $3.58
BOM Count = 11
Total Pd = 0.95W

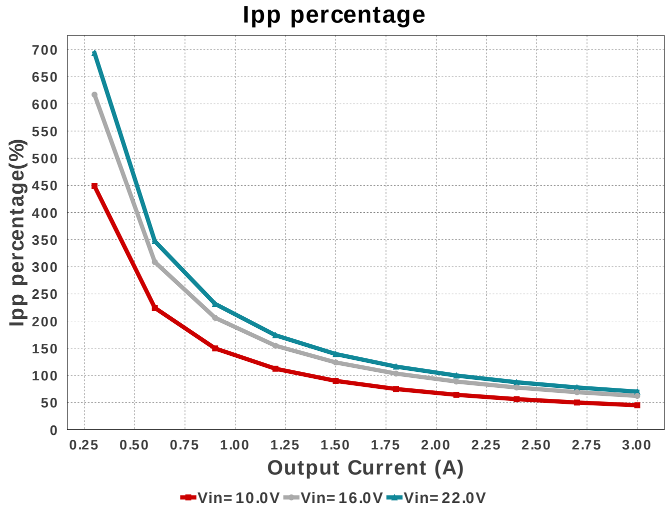
Design : 11 TPS56637RPAR
TPS56637RPAR 10V-22V to 5.00V @ 3A

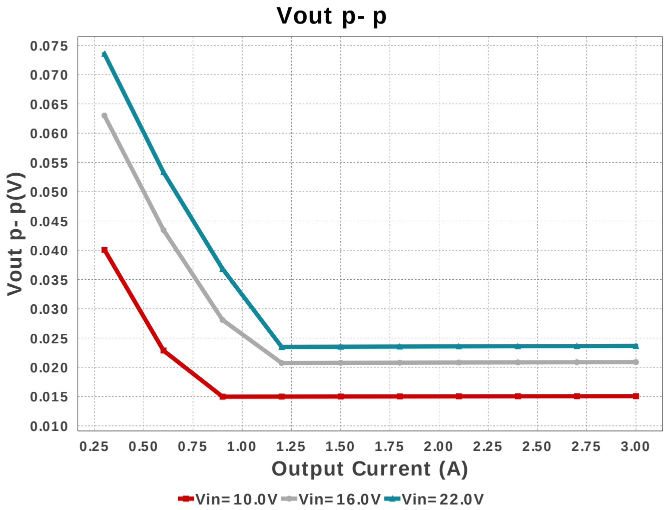


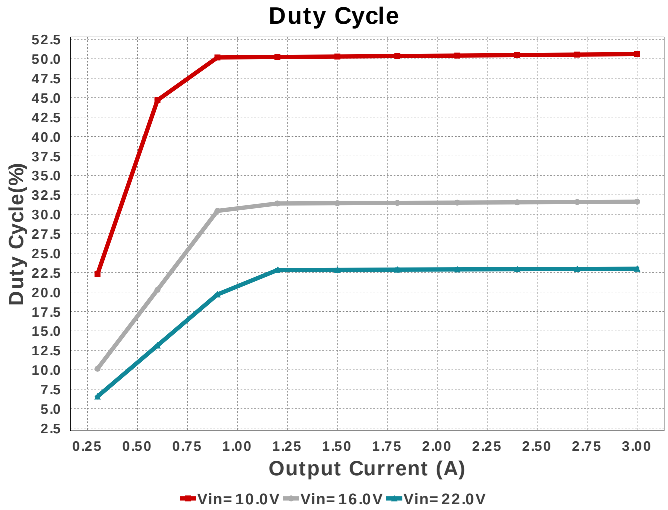
Electrical BOM

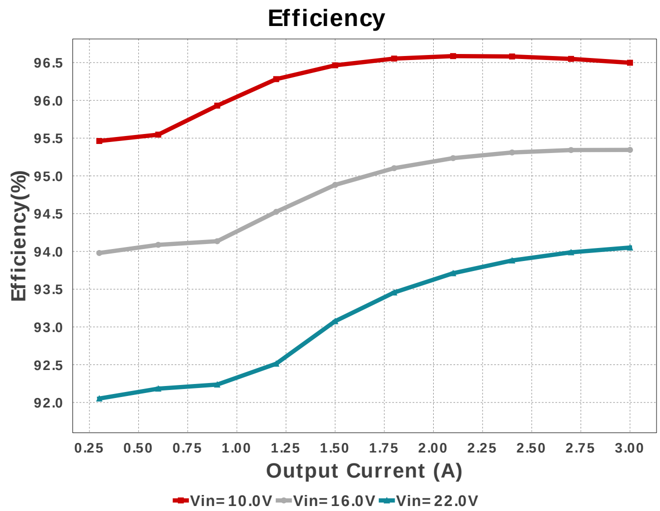
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cff	Kemet	C0402C101K4GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	TDK	C2012X5R1V156M125AC Series= X5R	Cap= 15.0 uF ESR= 1.669 mOhm VDC= 35.0 V IRMS= 5.0498 A	1	$0.21	0805 7 mm^2
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm^2
Cout	MuRata	GRM31CR61A476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.709 mOhm VDC= 10.0 V IRMS= 4.2862 A	1	$0.26	1206_190 11 mm^2
L1	Coilcraft	XAL1010-332MEB	L= 3.3 µH 3.7 mOhm	1	$1.71	XAL1010 160 mm^2
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW040273K2FKED Series= CRCW..e3	Res= 73.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rff	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS56637RPAR	Switcher	1	$1.32	RPA0010A 16 mm^2

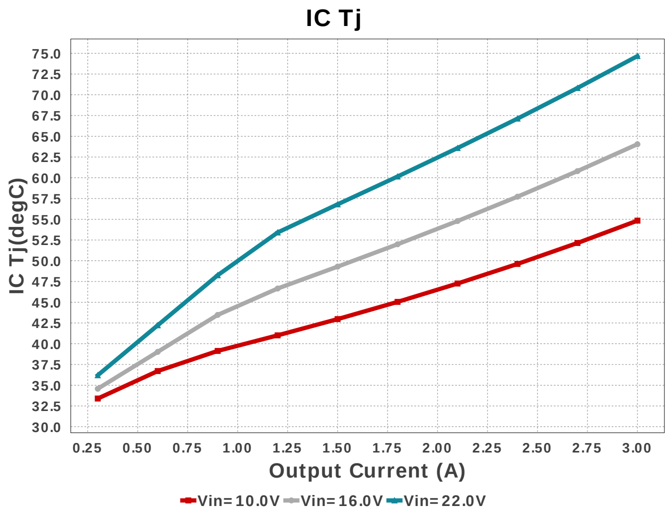

L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

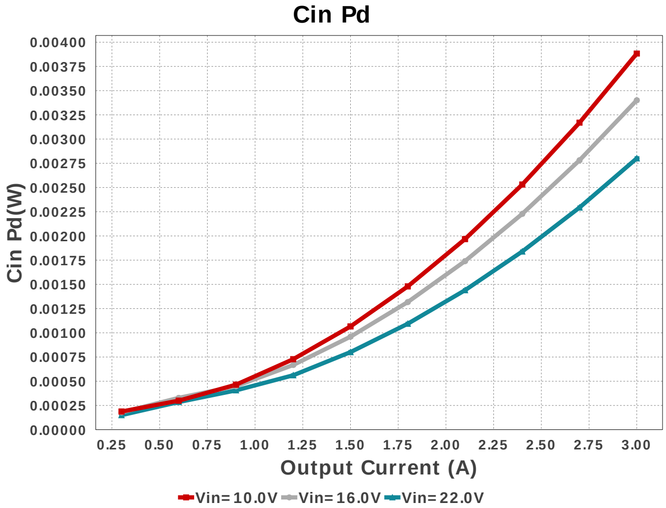

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

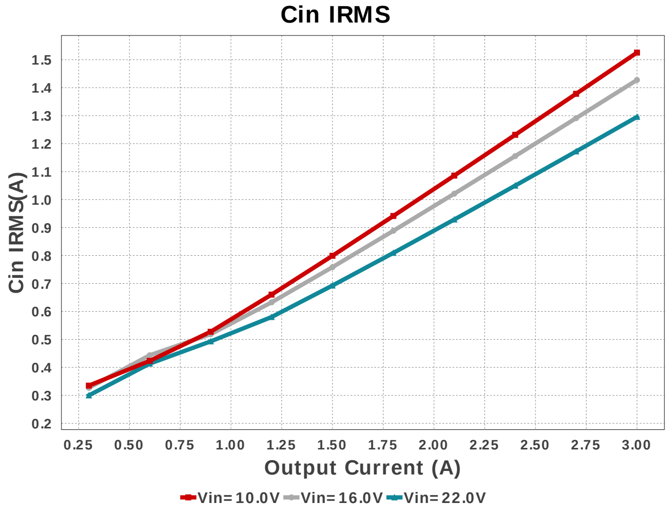

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

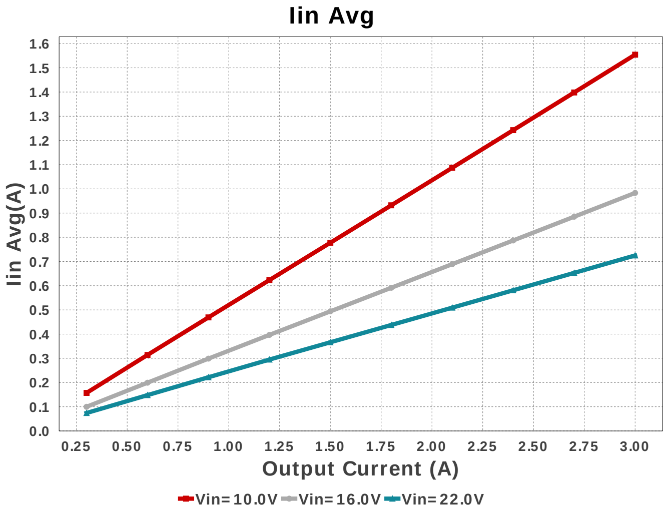

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

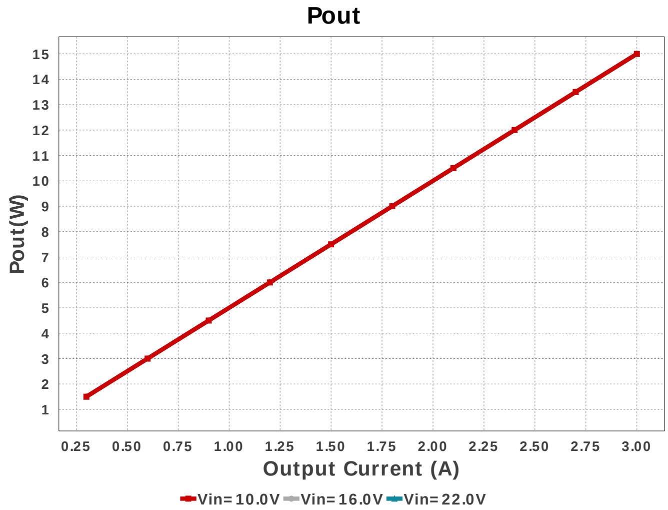

Efficiency
Efficiency(%)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

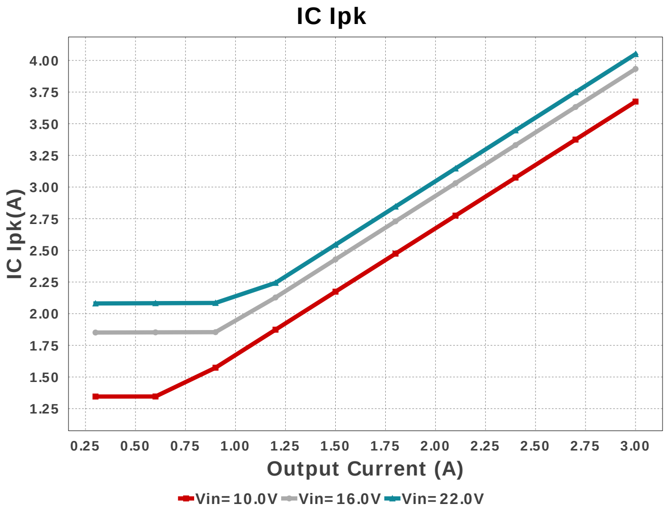

IC Tj
IC Tj(degC)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

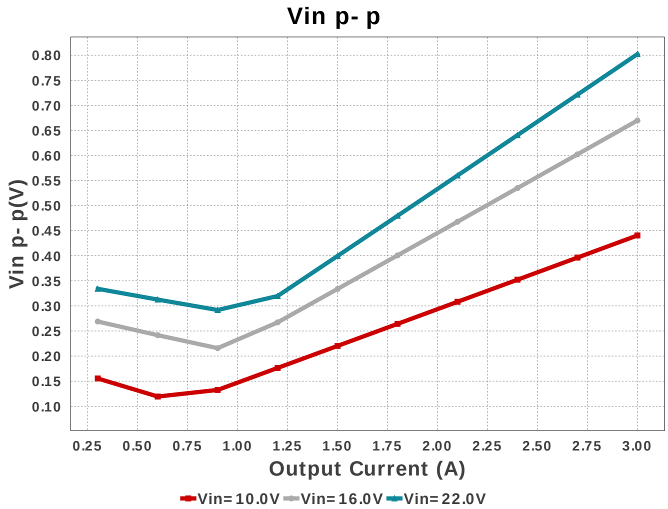

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

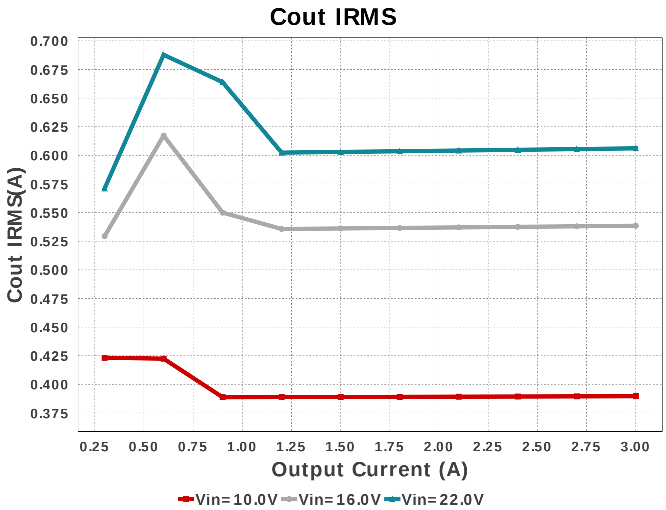

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

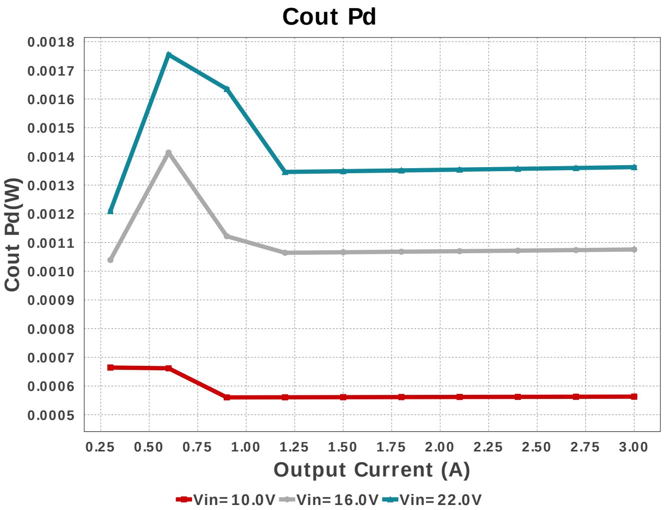

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

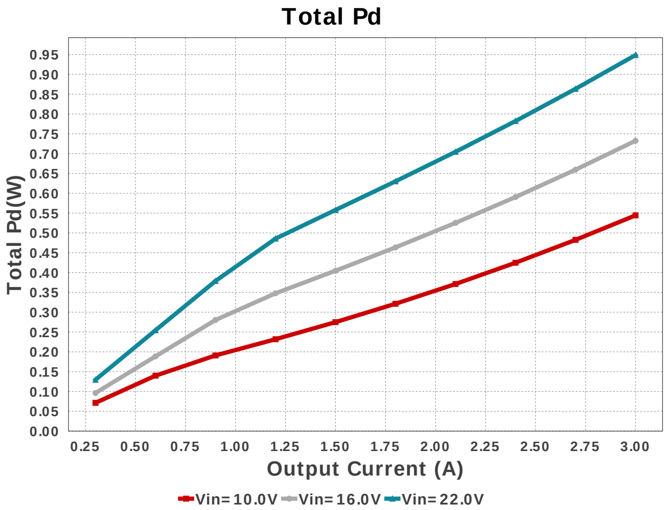

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

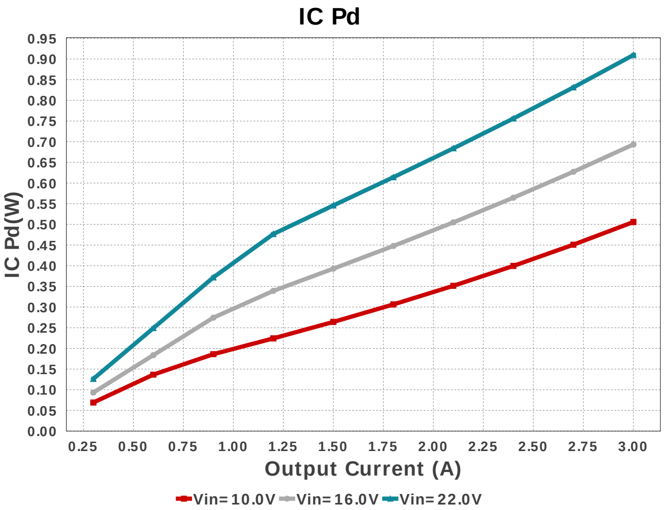

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

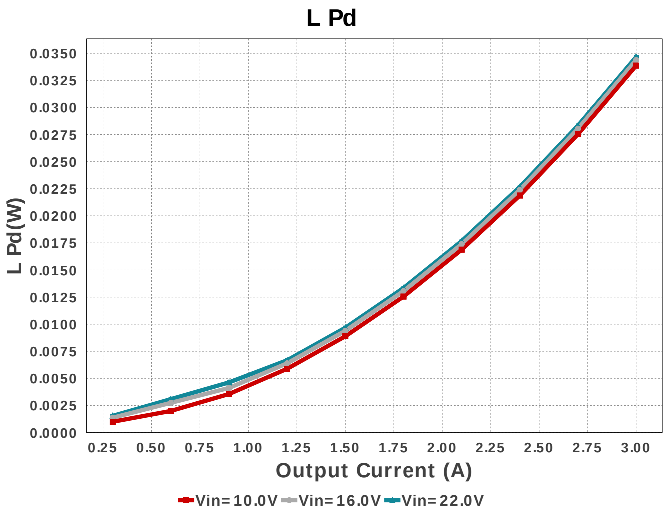

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

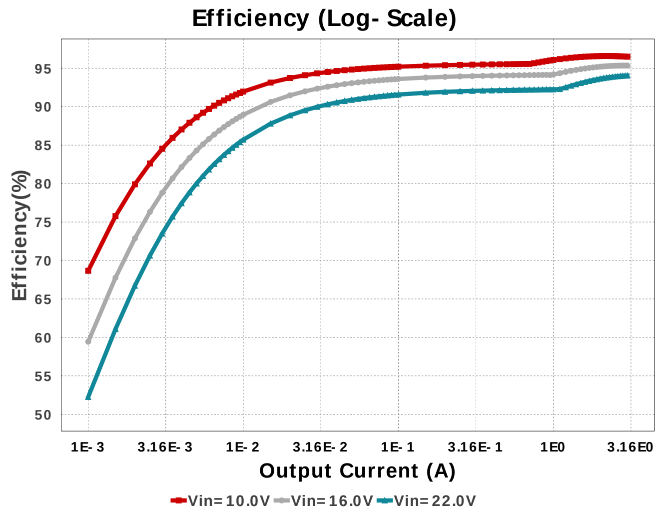












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.295 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.801 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	606.134 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.363 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	4.05 A	IC	Peak switch current in IC
6.	IC Pd	909.63 mW	IC	IC power dissipation
7.	IC Tj	74.663 degC	IC	IC junction temperature
8.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	49.1 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	724.94 mA	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	69.99 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	2.1 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	34.659 mW	Inductor	Inductor power dissipation
14.	Cin Pd	2.801 mW	Power	Input capacitor power dissipation
15.	Cout Pd	1.363 mW	Power	Output capacitor power dissipation
16.	IC Pd	909.63 mW	Power	IC power dissipation
17.	L Pd	34.659 mW	Power	Inductor power dissipation
18.	Total Pd	948.787 mW	Power	Total Power Dissipation
19.	BOM Count	11	System Information	Total Design BOM count
20.	Duty Cycle	22.998 %	System Information	Duty cycle
21.	Efficiency	94.051 %	System Information	Steady state efficiency
22.	FootPrint	216.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	561.764 kHz	System Information	Switching frequency
24.	Iout	3.0 A	System Information	Iout operating point
25.	Mode	CCM	System Information	Conduction Mode
26.	Pout	15.0 W	System Information	Total output power
27.	Total BOM	$3.58	System Information	Total BOM Cost
28.	Vin	22.0 V	System Information	Vin operating point
29.	Vin p-p	802.128 mV	System Information	Peak-to-peak input voltage
30.	Vout	5.0 V	System Information	Operational Output Voltage
31.	Vout Actual	4.992 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	3.474 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	23.667 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	22.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
VinTyp	12.0	Typical input voltage
Vout	5.0	Output Voltage
base_pn	TPS56637	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

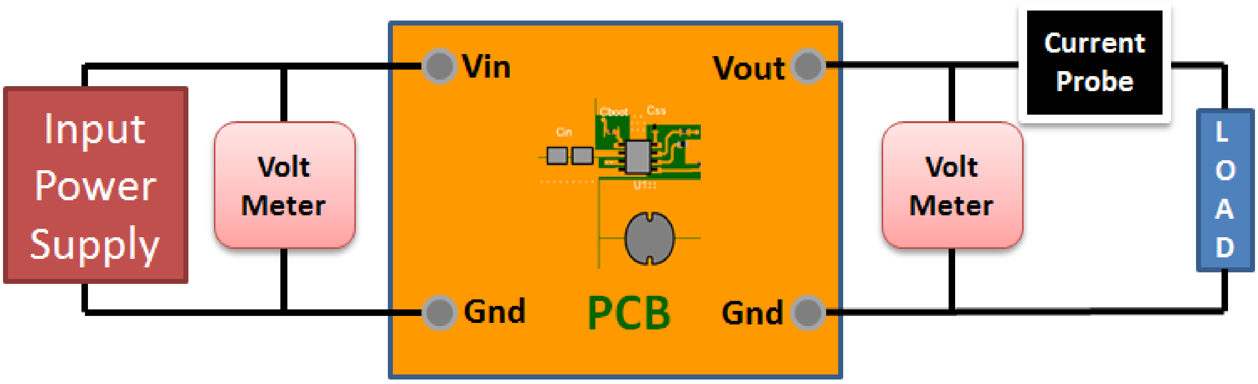
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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 : 84E05F9E8AACC473[v1]

2. **TPS56637** Product Folder : http://www.ti.com/product/TPS56637 : contains the data sheet and other resources.