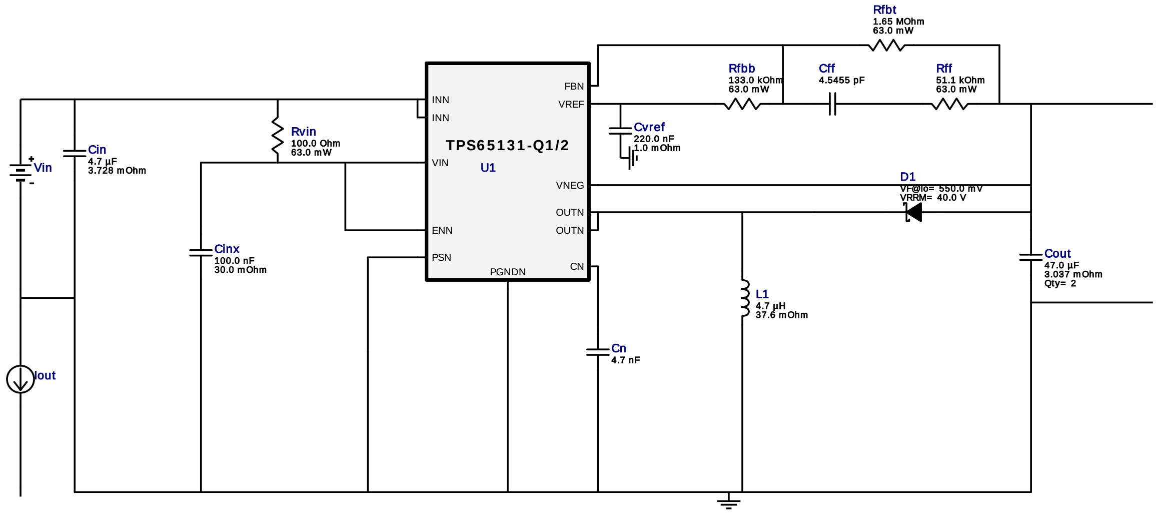
VinMin = 5.0V
VinMax = 5.0V
Vout = -15.0V
Iout = 0.2A

Device = TPS65131TRGERQ1
Topology = Inverting_Buck_Boost
Created = 2024-11-19 00:59:40.513
BOM Cost = NA
BOM Count = 14
Total Pd = 0.18W

WEBENCH ® Design Report

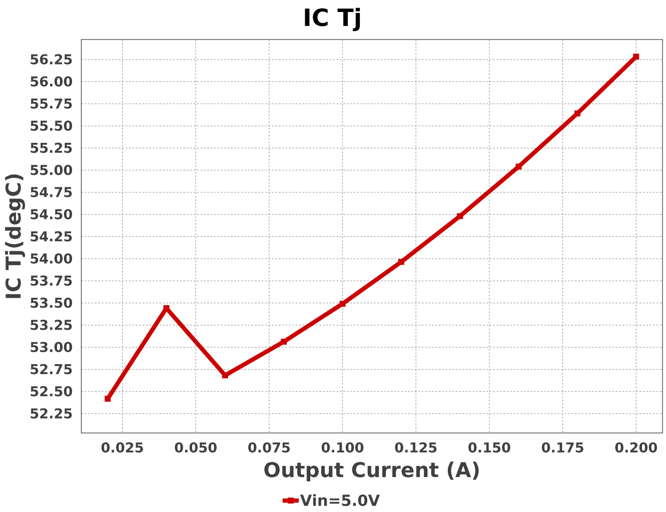
Design : 177 TPS65131TRGERQ1
TPS65131TRGERQ1 5V-5V to -15.00V @ 0.2A

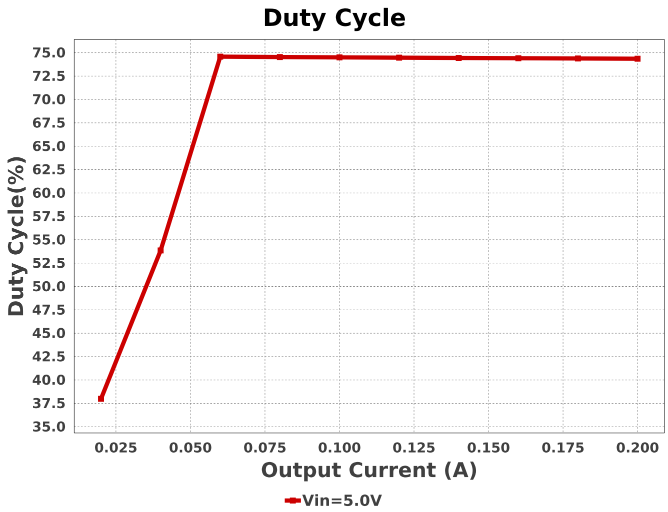


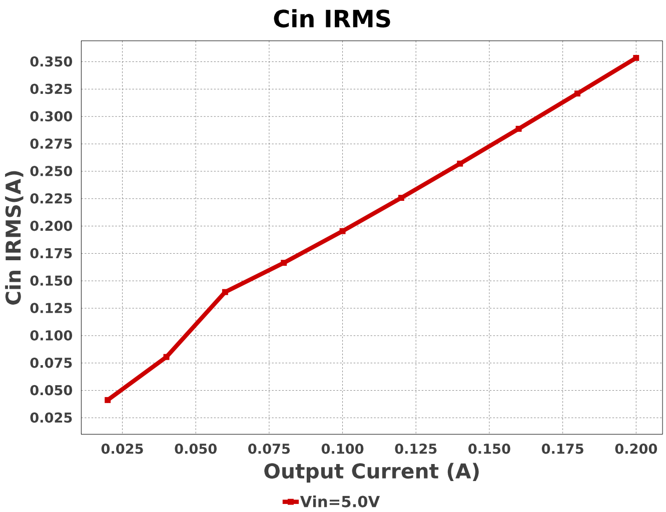
Electrical BOM

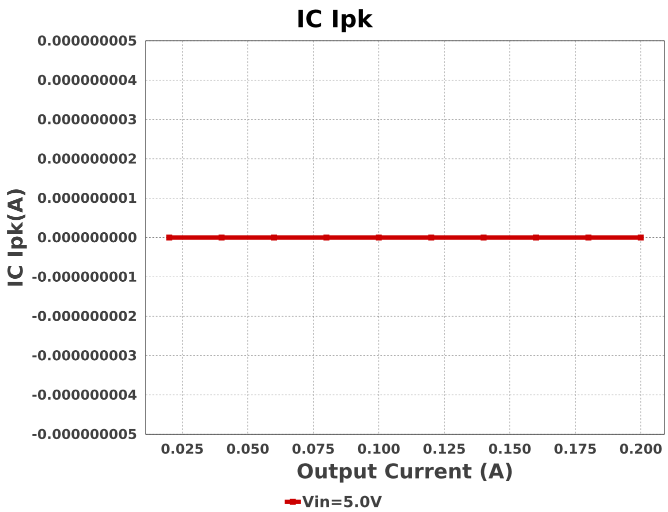
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cff	CUSTOM	CUSTOM Series= ?	Cap= 4.5455 pF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm²
Cin	TDK	C1608X7S1A475K080AC Series= X7S	Cap= 4.7 uF ESR= 3.728 mOhm VDC= 10.0 V IRMS= 2.69359 A	1	$0.05	0603 5 mm²
Cinx	MuRata	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 A	1	$0.01	0603 5 mm²
Cn	TDK	C1608C0G1H472J080AA Series= C0G/NP0	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0603 5 mm²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	2	$0.17	1210_280 15 mm²
Cvref	MuRata	GRM155R61A224KE19D Series= X5R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
D1	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.03	SOD-123F 12 mm²
L1	Bourns	SRN6045-4R7Y	L= 4.7 µH 37.6 mOhm	1	$0.25	SRN6045 64 mm²
Rfbb	Vishay-Dale	CRCW0402133KFKED Series= CRCW..e3	Res= 133.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW04021M65FKED Series= CRCW..e3	Res= 1.65 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

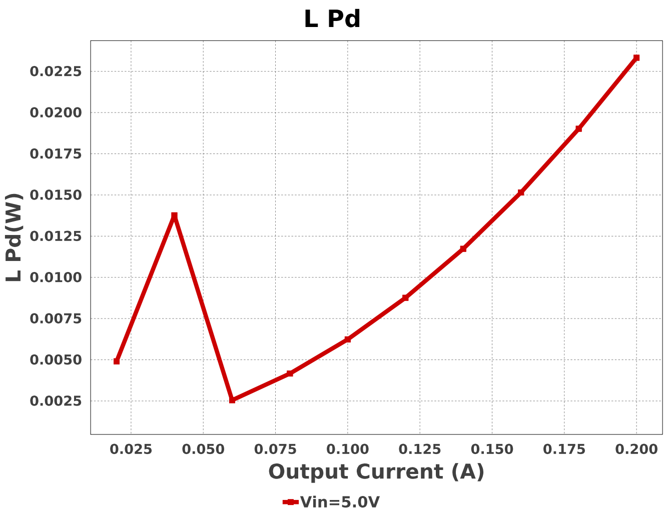
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rff	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvin	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS65131TRGERQ1	Switcher	1	$1.24	RGE0024B 25 mm^2

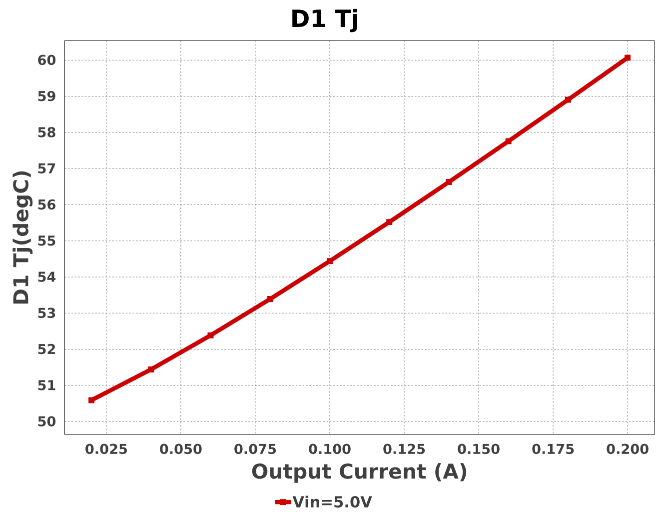


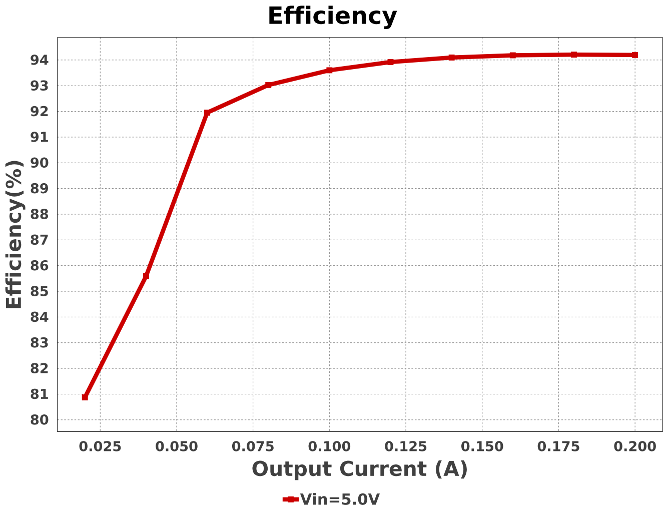


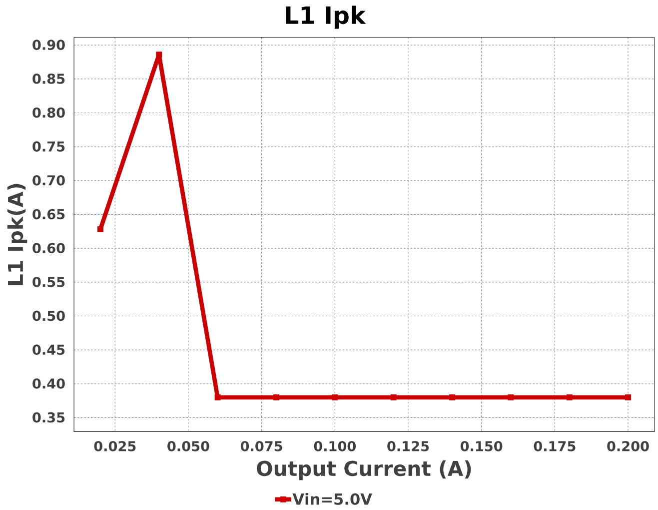


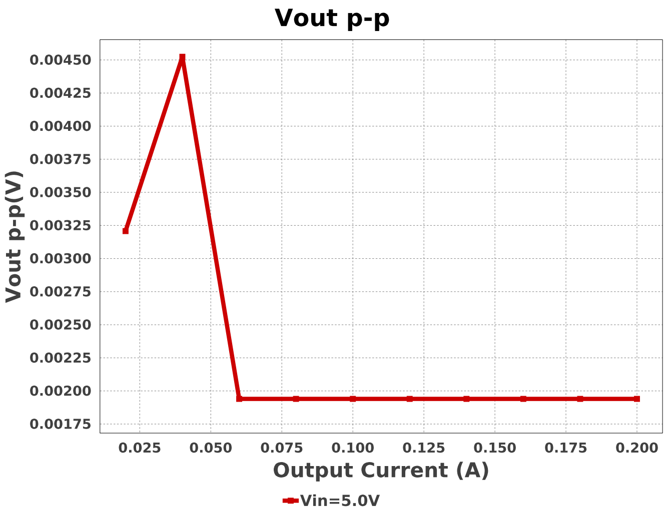


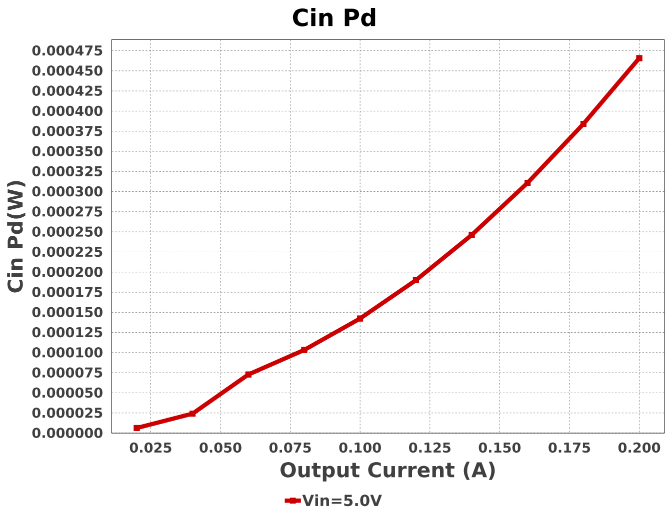


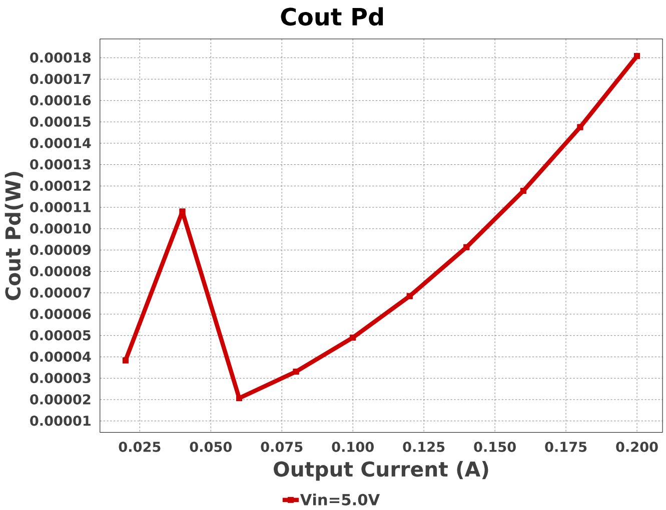


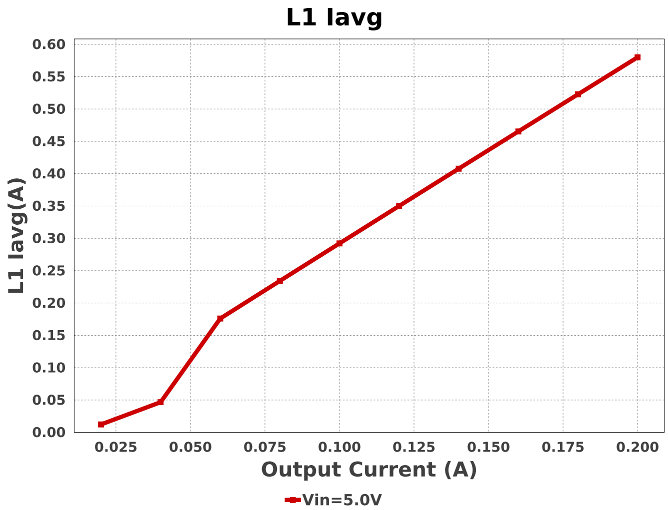

Efficiency
Efficiency(%)
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V


L1 Ipk
L1 Ipk(A)
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V

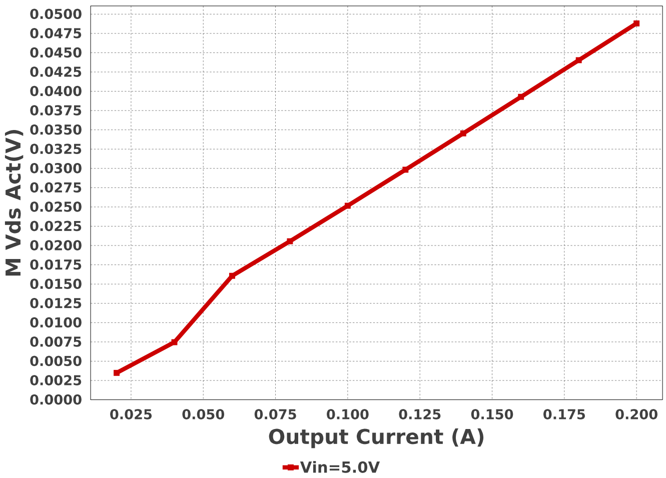

Vout p-p
Vout p-p(V)
0.00450
0.00425
0.00400
0.00375
0.00350
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
0.00175
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V


Cin Pd
Cin Pd(W)
0.000475
0.000450
0.000425
0.000400
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
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V

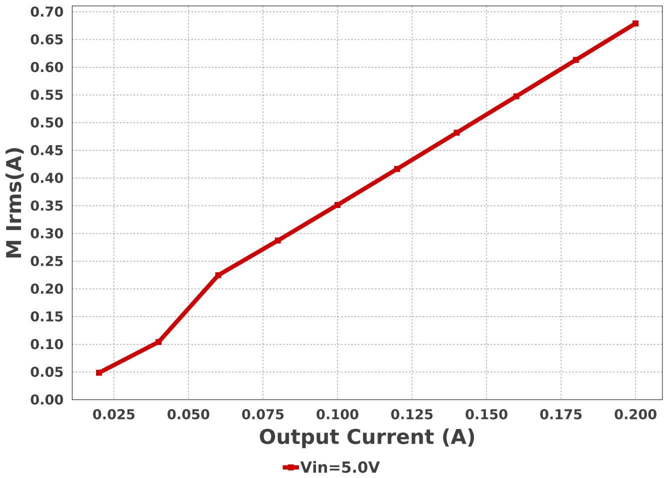

Cout Pd
Cout Pd(W)
0.00018
0.00017
0.00016
0.00015
0.00014
0.00013
0.00012
0.00011
0.00010
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V


L1 Iavg
L1 Iavg(A)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=5.0V

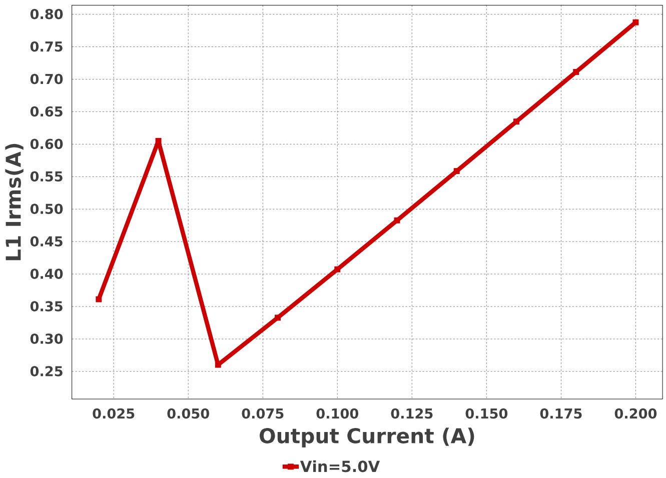
M Vds Act



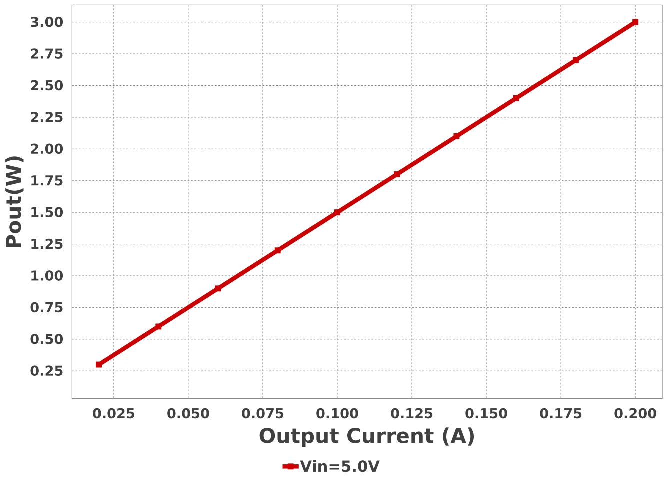
M Irms



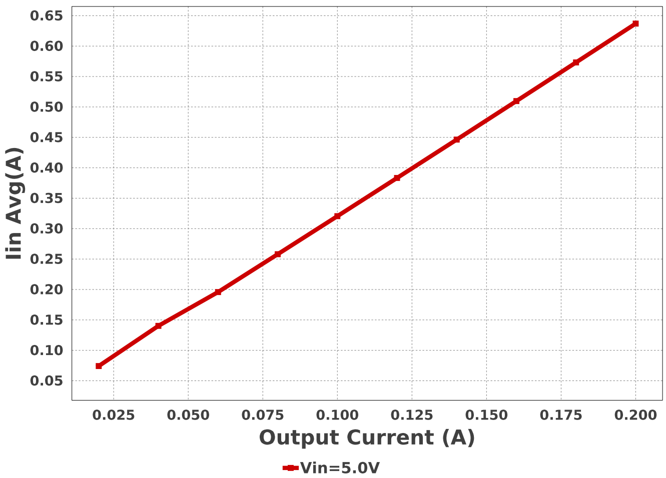
L1 Irms



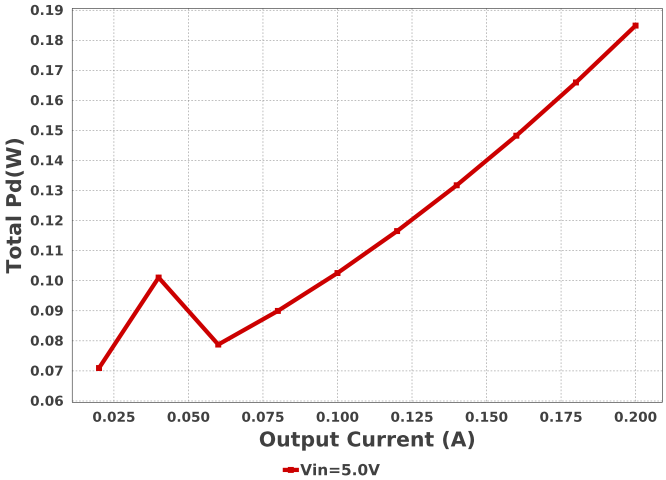
Pout

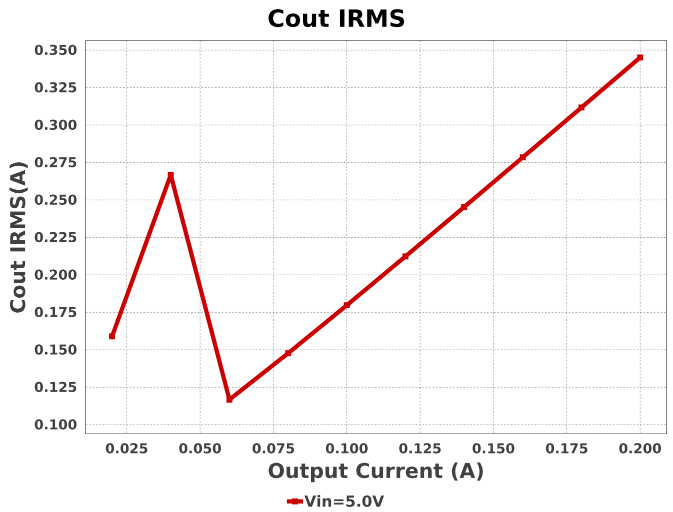


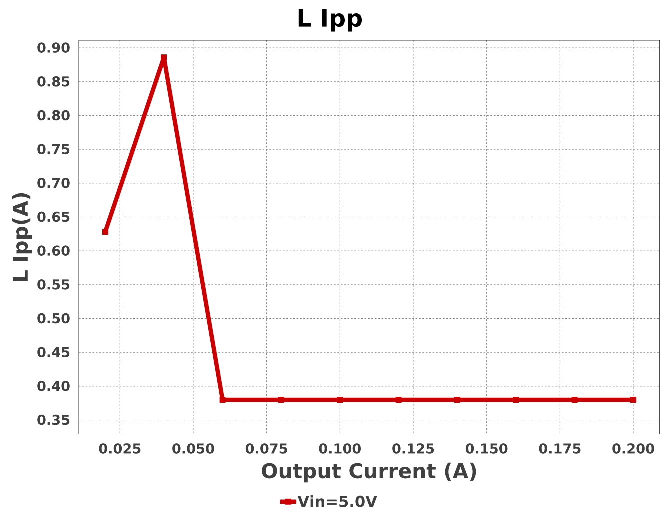
Iin Avg

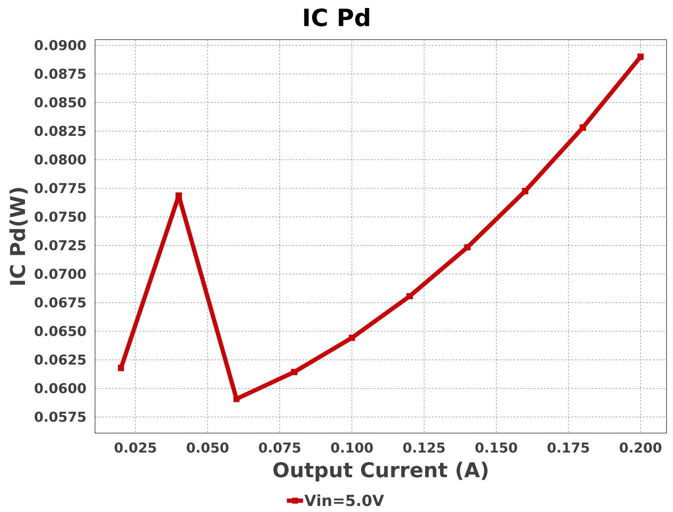


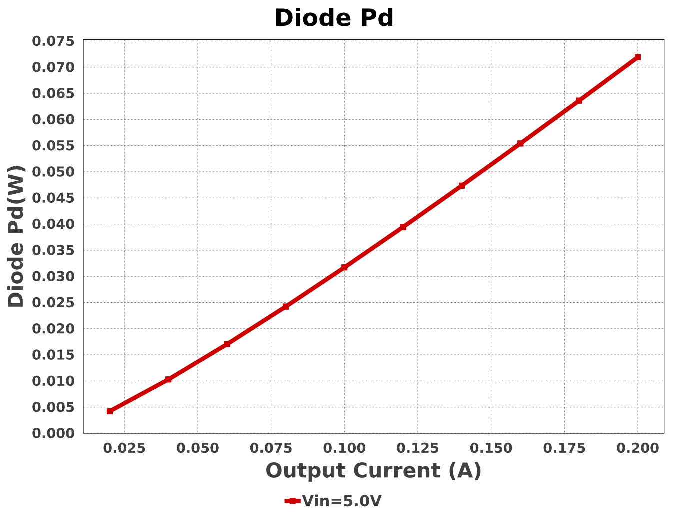
Total Pd

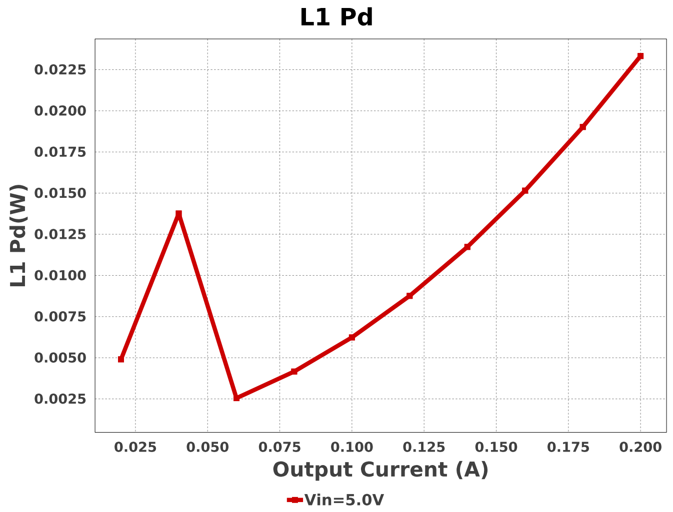












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	353.464 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	465.76 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	345.074 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	180.82 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	60.067 degC	Diode	D1 junction temperature
6.	Diode Pd	71.906 mW	Diode	Diode power dissipation
7.	IC Ipk	0.0 A	IC	Peak switch current in IC
8.	IC Pd	89.004 mW	IC	IC power dissipation
9.	IC Pd	89.004 mW	IC	IC power dissipation
10.	IC Tj	56.282 degC	IC	IC junction temperature
11.	IC Tolerance	24.0 mV	IC	IC Feedback Tolerance

#	Name	Value	Category	Description
12.	ICThetaJA	34.1 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	636.98 mA	IC	Average input current
14.	L Ipp	379.939 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	23.326 mW	Inductor	Inductor power dissipation
16.	L1 Iavg	579.959 mA	Inductor	Inductor average current
17.	L1 Ipk	379.939 mA	Inductor	Inductor peak current
18.	L1 Irms	787.633 mA	Inductor	Inductor ripple current
19.	L Pd	23.326 mW	Inductor	Power Dissipation in the Inductor
20.	M Irms	679.182 mA	Mosfet	MOSFET RMS ripple current
21.	M Vds Act	48.798 mV	Mosfet	Voltage drop across the MosFET
22.	Cin Pd	465.76 µW	Power	Input capacitor power dissipation
23.	Cout Pd	180.82 µW	Power	Output capacitor power dissipation
24.	Diode Pd	71.906 mW	Power	Diode power dissipation
25.	IC Pd	89.004 mW	Power	IC power dissipation
26.	IC Pd	89.004 mW	Power	IC power dissipation
27.	L Pd	23.326 mW	Power	Inductor power dissipation
28.	L Pd	23.326 mW	Power	Power Dissipation in the Inductor
29.	Total Pd	184.883 mW	Power	Total Power Dissipation
30.	BOM Count	14	System Information	Total Design BOM count
31.	Duty Cycle	74.358 %	System Information	Duty cycle
32.	Efficiency	94.195 %	System Information	Steady state efficiency
33.	FootPrint	164.0 mm^2	System Information	Total Foot Print Area of BOM components
34.	Frequency	1.26 MHz	System Information	Switching frequency
35.	Iout	200.0 mA	System Information	Iout operating point
36.	Mode	CCM	System Information	Conduction Mode
37.	Mode	CCM	System Information	Conduction Mode
38.	Pout	3.0 W	System Information	Total output power
39.	Total BOM	NA	System Information	Total BOM Cost
40.	Vin	5.0 V	System Information	Vin operating point
41.	Vout	-15.0 V	System Information	Operational Output Voltage
42.	Vout Actual	16.261 V	System Information	Vout Actual calculated based on selected voltage divider resistors
43.	Vout Tolerance	3.885 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
44.	Vout p-p	1.94 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	5.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	-15.0	Output Voltage
base_pn	TPS65131-Q1/2	Base Product Number
source	DC	Input Source Type
Ta	50.0	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

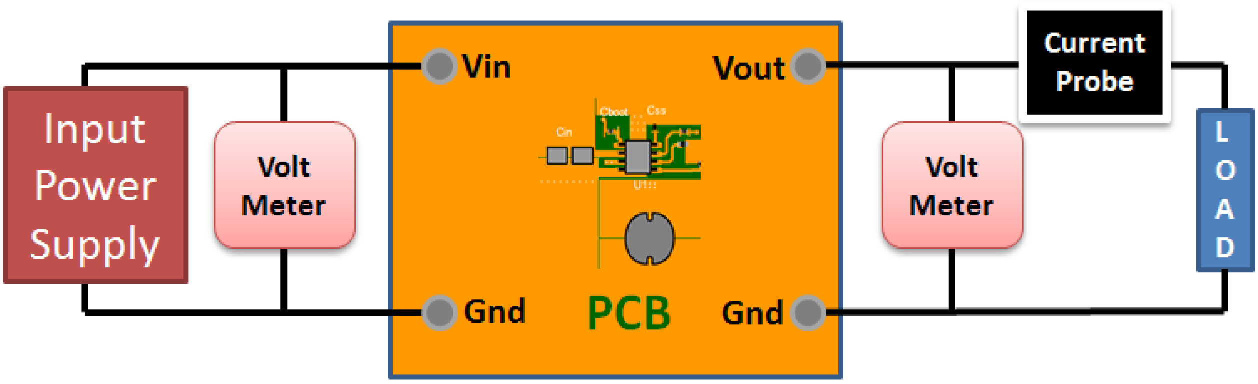
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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



Design Assistance

1. Master key : B813C5D1755B3B11[v1]

2. **TPS65131-Q1/2** Product Folder : http://www.ti.com/product/tps65131%2DQ1 : contains the data sheet and other resources.

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