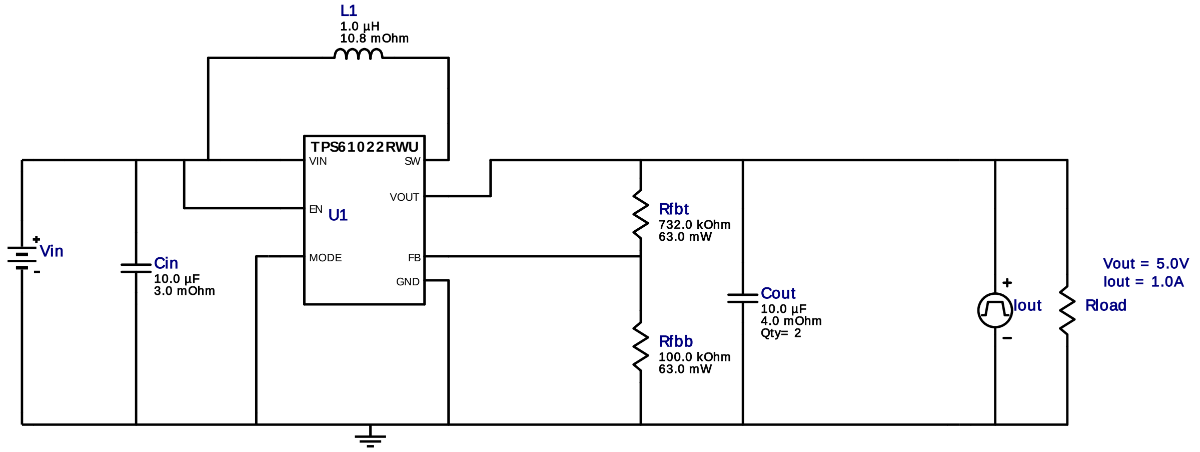
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.0V
VinMax = 3.0V
Vout = 5.0V
Iout = 1.0A

Device = TPS61022RWUR
Topology = Boost_PassThrough
Created = 2019-11-10 03:06:44.629
BOM Cost = $1.59
BOM Count = 7
Total Pd = 0.24W

Design : 57 TPS61022RWUR
TPS61022RWUR 3V-3V to 5.00V @ 1A



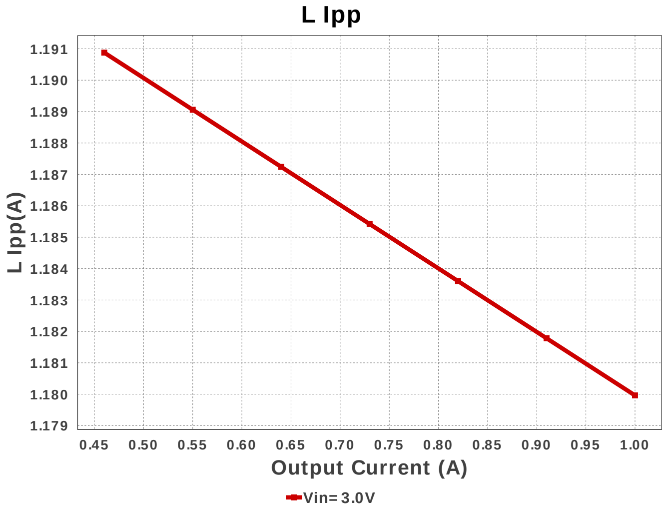
Design Alerts

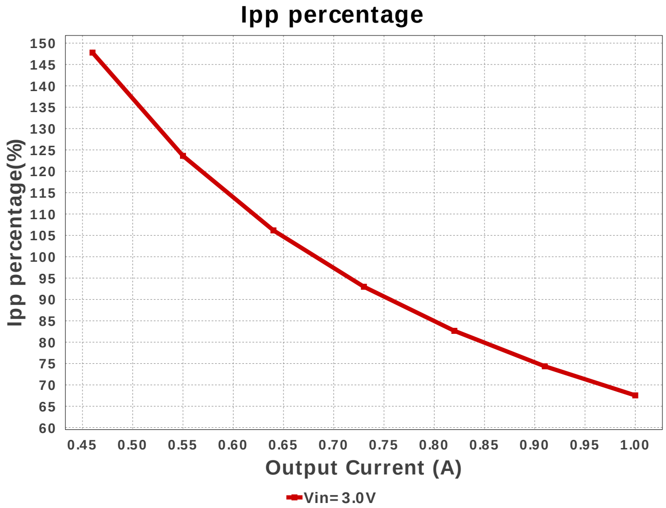
Component Selection Information

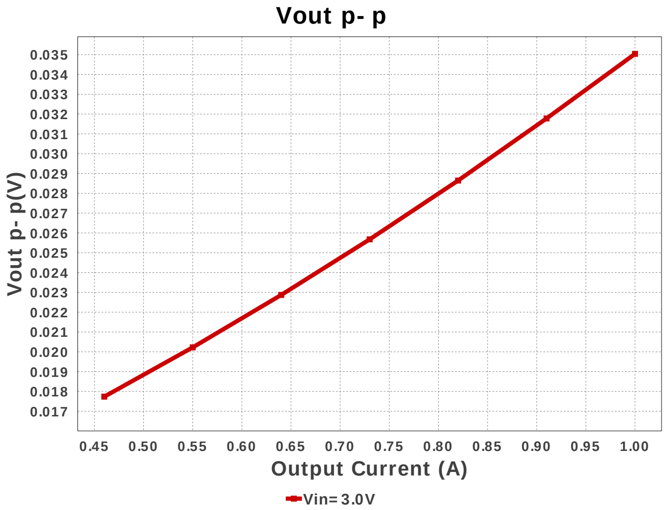
1. The TPS61022 Device will operate in Pass-Through mode when Vin is greater than Vout. In Pass-Through mode, Vout is not regulated to the set Vout, instead Vout is Vin with the drop across the FET?s on-resistance and the DCR of the inductor. 2. This is a Boost Converter with 0.5V ultra-low input voltage. 3. The efficiency validation is done only for FPWM mode. Charts may be inaccurate for AutoMode at light loads and hence they are disabled for light loads.

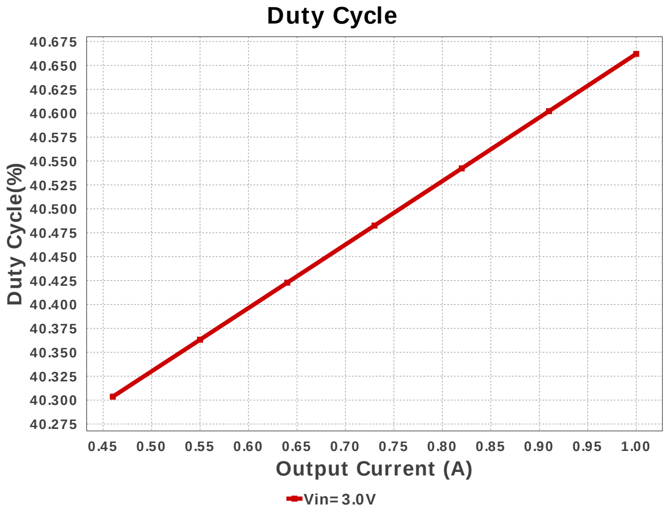
Electrical BOM

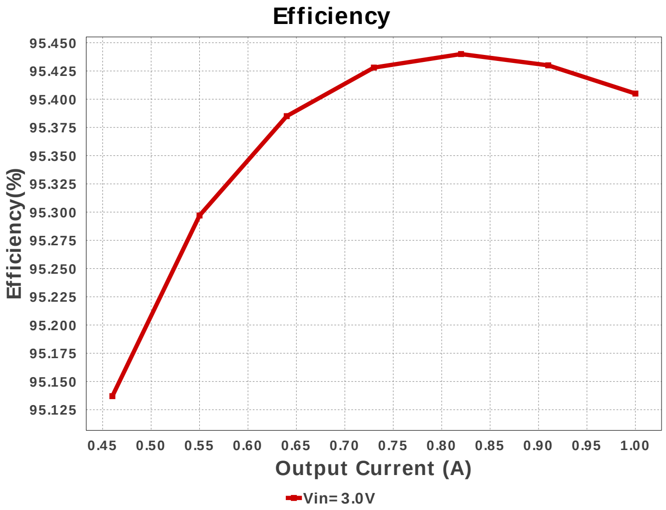
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm^2
Cout	MuRata	GRM21BR71A106KE51L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 10.0 V IRMS= 4.35 A	2	$0.14	0805 7 mm^2
L1	Coilcraft	XFL4020-102MEB	L= 1.0 µH 10.8 mOhm	1	$0.61	XFL4020 25 mm^2
Rfbb	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW0402732KFKED Series= CRCW..e3	Res= 732.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS61022RWUR	Switcher	1	$0.65	RWU0007A 9 mm^2

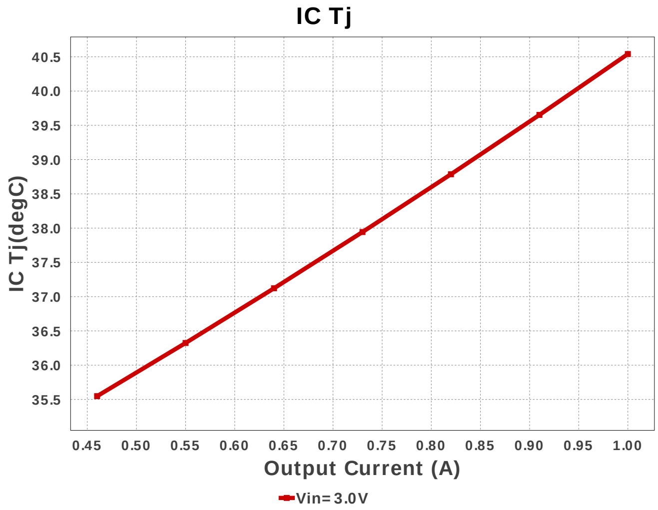

L Ipp
L Ipp(A)
1.191
1.190
1.189
1.188
1.187
1.186
1.185
1.184
1.183
1.182
1.181
1.180
1.179
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

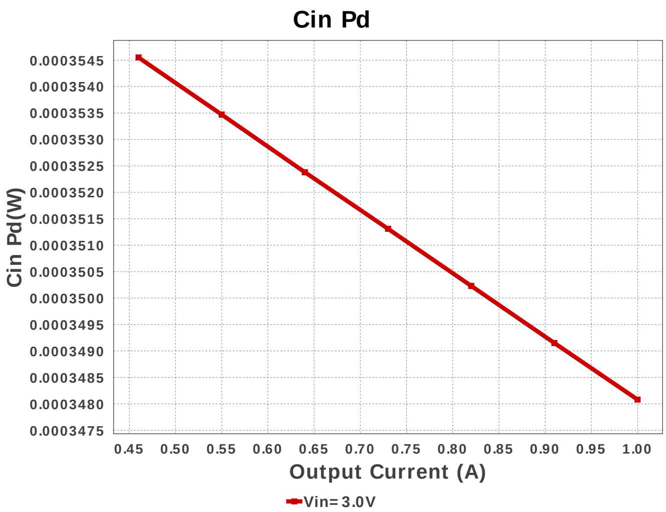

Ipp percentage
Ipp percentage(%)
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

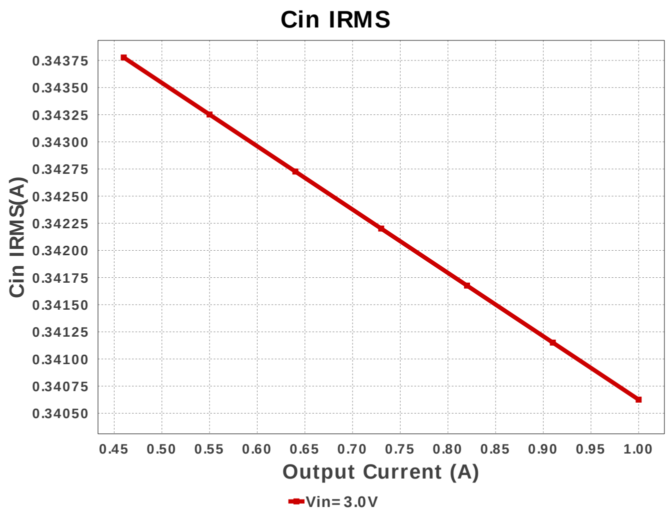

Vout p- p
Vout p- p(V)
0.035
0.034
0.033
0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

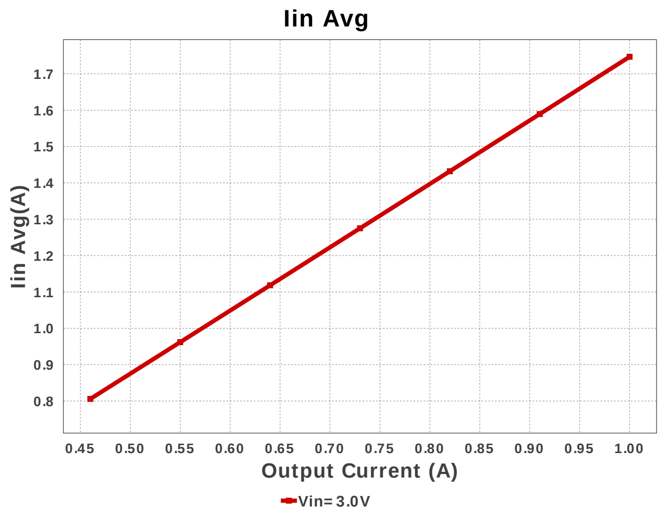

Duty Cycle
Duty Cycle(%)
40.675
40.650
40.625
40.600
40.575
40.550
40.525
40.500
40.475
40.450
40.425
40.400
40.375
40.350
40.325
40.300
40.275
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

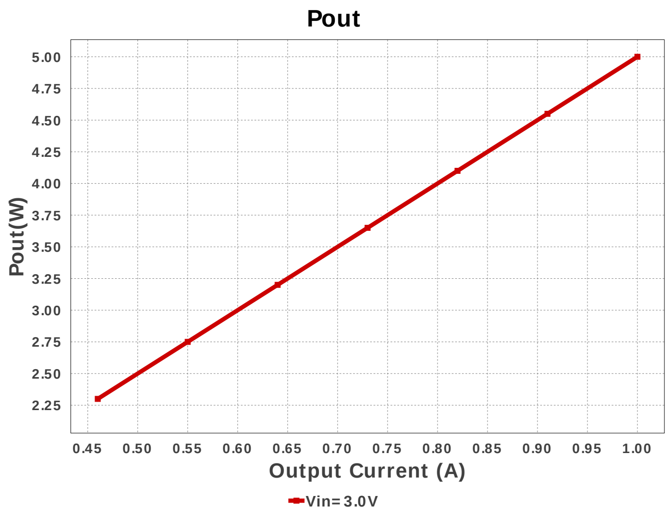

Efficiency
Efficiency(%)
95.450
95.425
95.400
95.375
95.350
95.325
95.300
95.275
95.250
95.225
95.200
95.175
95.150
95.125
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

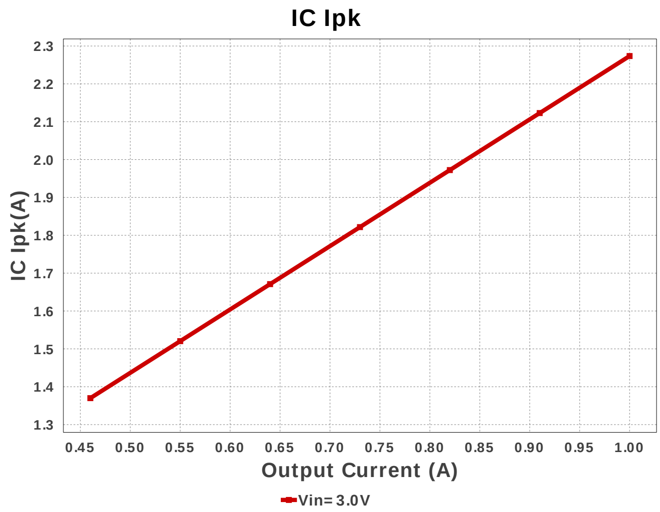

IC Tj
IC Tj(degC)
40.5
40.0
39.5
39.0
38.5
38.0
37.5
37.0
36.5
36.0
35.5
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

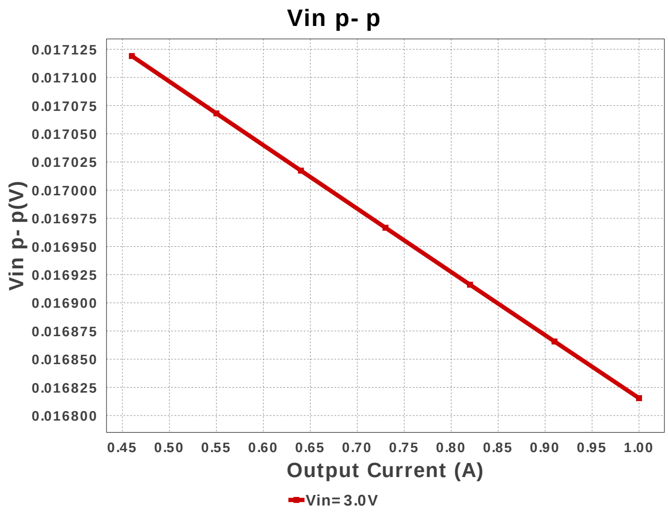

Cin Pd
Cin Pd(W)
0.0003545
0.0003540
0.0003535
0.0003530
0.0003525
0.0003520
0.0003515
0.0003510
0.0003505
0.0003500
0.0003495
0.0003490
0.0003485
0.0003480
0.0003475
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

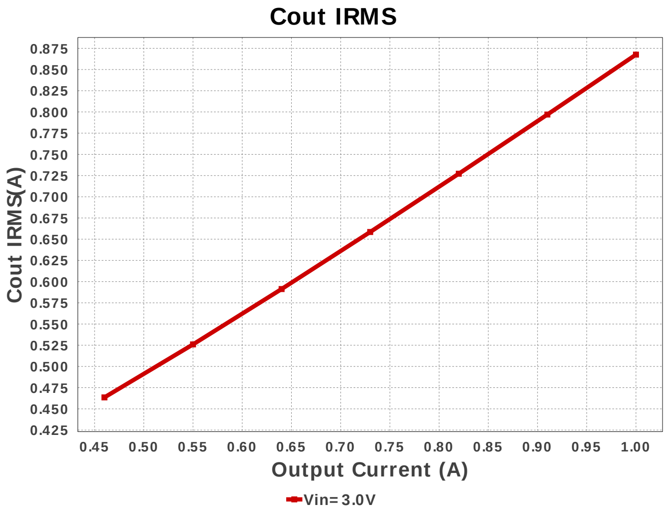

Cin IRMS
Cin IRMS(A)
0.34375
0.34350
0.34325
0.34300
0.34275
0.34250
0.34225
0.34200
0.34175
0.34150
0.34125
0.34100
0.34075
0.34050
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

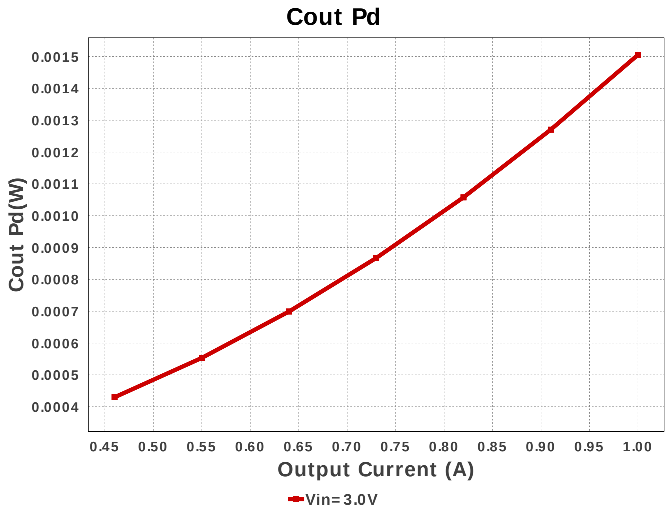

Iin Avg
Iin Avg(A)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

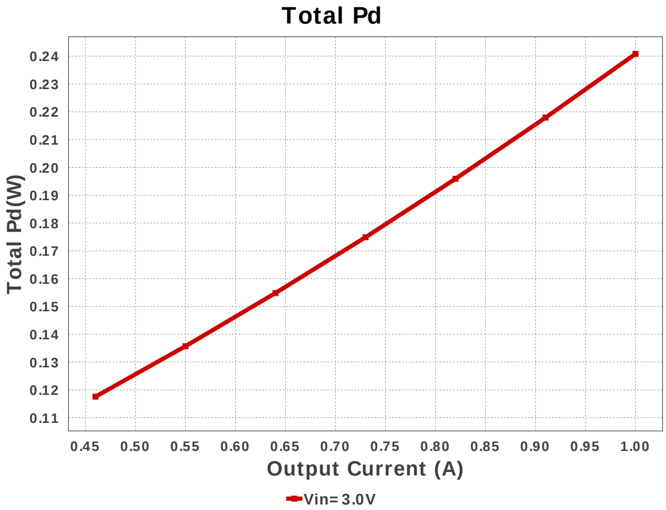

Pout
Pout(W)
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

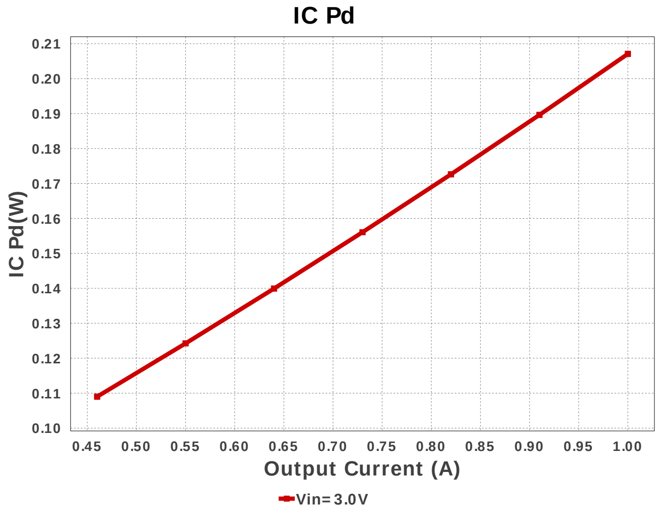

IC Ipk
IC Ipk(A)
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

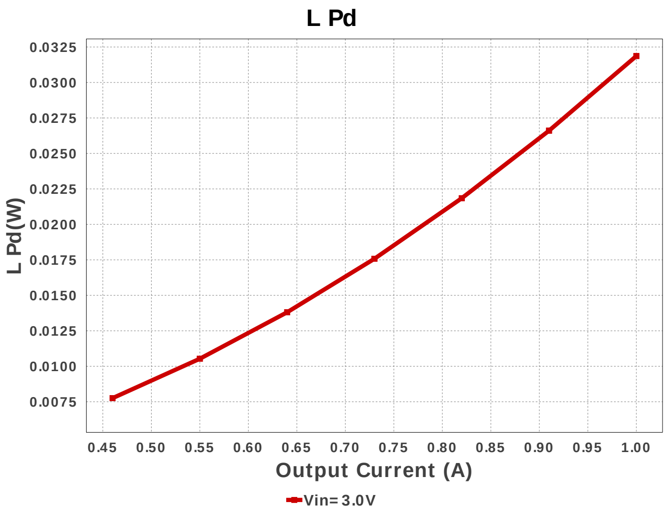

Vin p- p
Vin p- p(V)
0.017125
0.017100
0.017075
0.017050
0.017025
0.017000
0.016975
0.016950
0.016925
0.016900
0.016875
0.016850
0.016825
0.016800
0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00
Output Current (A)
Vin= 3.0V

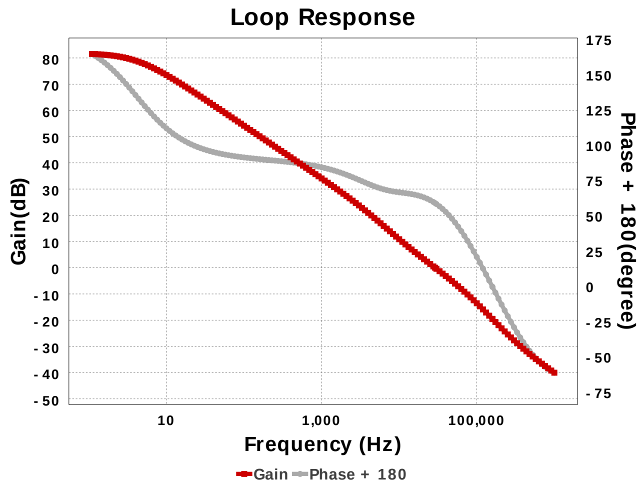












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	340.626 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	348.08 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	867.576 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.505 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	2.273 A	IC	Peak switch current in IC
6.	IC Pd	207.08 mW	IC	IC power dissipation
7.	IC Tj	40.54 degC	IC	IC junction temperature
8.	IC Tolerance	15.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	50.9 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	1.747 A	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	67.544 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	1.18 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	31.863 mW	Inductor	Inductor power dissipation
14.	Cin Pd	348.08 µW	Power	Input capacitor power dissipation
15.	Cout Pd	1.505 mW	Power	Output capacitor power dissipation
16.	IC Pd	207.08 mW	Power	IC power dissipation
17.	L Pd	31.863 mW	Power	Inductor power dissipation
18.	Total Pd	240.81 mW	Power	Total Power Dissipation
19.	BOM Count	7	System Information	Total Design BOM count
20.	Cross Freq	29.003 kHz	System Information	Bode plot crossover frequency
21.	Duty Cycle	40.662 %	System Information	Duty cycle
22.	Efficiency	95.405 %	System Information	Steady state efficiency
23.	FootPrint	60.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	1.016 MHz	System Information	Switching frequency
25.	Gain Marg	-19.601 dB	System Information	Bode Plot Gain Margin
26.	Iout	1.0 A	System Information	Iout operating point
27.	Low Freq Gain	81.533 dB	System Information	Gain at 1Hz
28.	Mode	CCM	System Information	Conduction Mode
29.	Phase Marg	59.472 deg	System Information	Bode Plot Phase Margin
30.	Pout	5.0 W	System Information	Total output power
31.	Total BOM	$1.59	System Information	Total BOM Cost
32.	Vin	3.0 V	System Information	Vin operating point
33.	Vin p-p	16.815 mV	System Information	Peak-to-peak input voltage
34.	Vout	5.0 V	System Information	Operational Output Voltage
35.	Vout Actual	4.992 V	System Information	Vout Actual calculated based on selected voltage divider resistors
36.	Vout Tolerance	4.322 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
37.	Vout p-p	35.039 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	3.0	Maximum input voltage
VinMin	3.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS61022	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

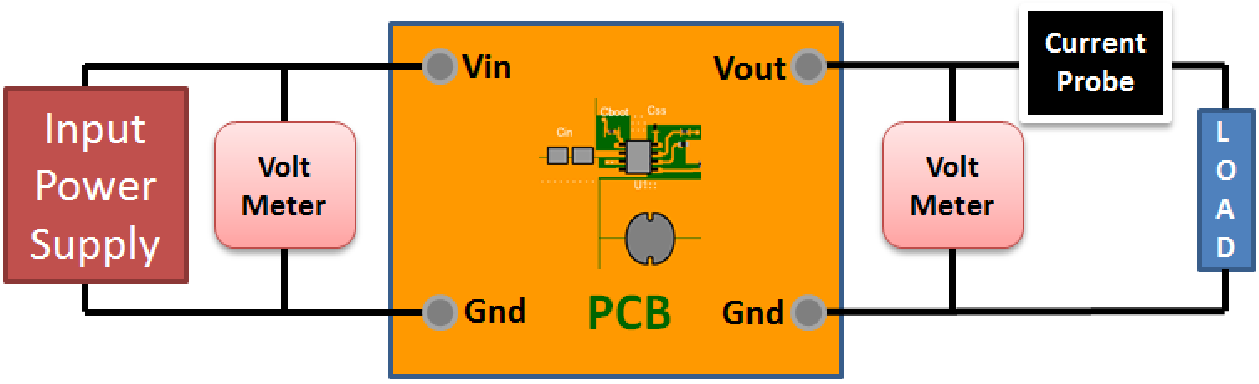
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.0V 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.

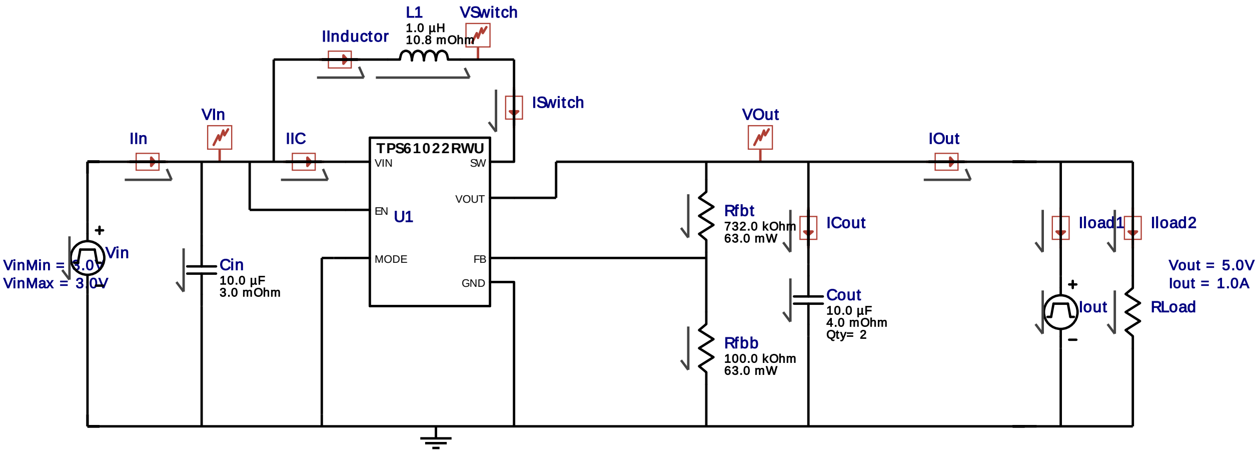


WEBENCH® Electrical Simulation Report

Design Id = 57

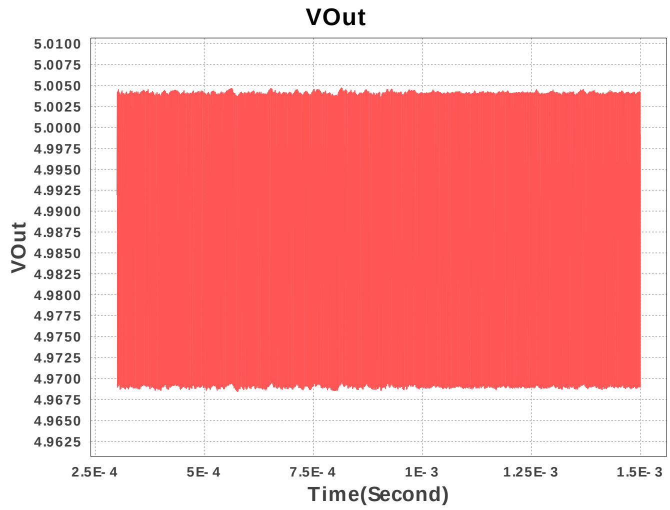
sim_id = 1

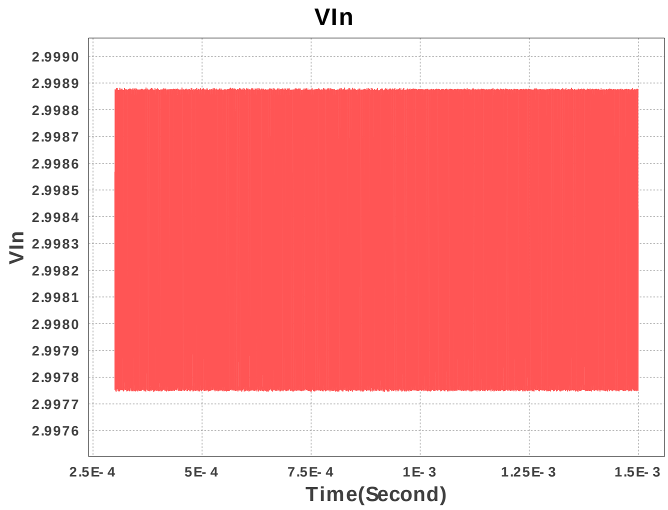
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	0 A
		I2	Minimum Load Current	0.0 A
		Td	Initial Time Delay	200u sec
		Tr	Rise Time	1u sec
2.	RLoad	R	Load Resistance	5.0 ohm





Design Assistance

1. Feature Highlights: 1. Device will operate in Pass-Through mode when Vin is greater than Vout. In Pass-Through mode, Vout is not regulated to the set Vout, instead Vout is Vin with the drop across the FET?s on-resistance and the DCR of the inductor. 2. Device will operate in PassThrough Mode When Vin is greater than Vout

2. Master key : B331BB6DC89D8D2D[v1]

3. **TPS61022** Product Folder : http://www.ti.com/product/TPS61022 : contains the data sheet and other resources.

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