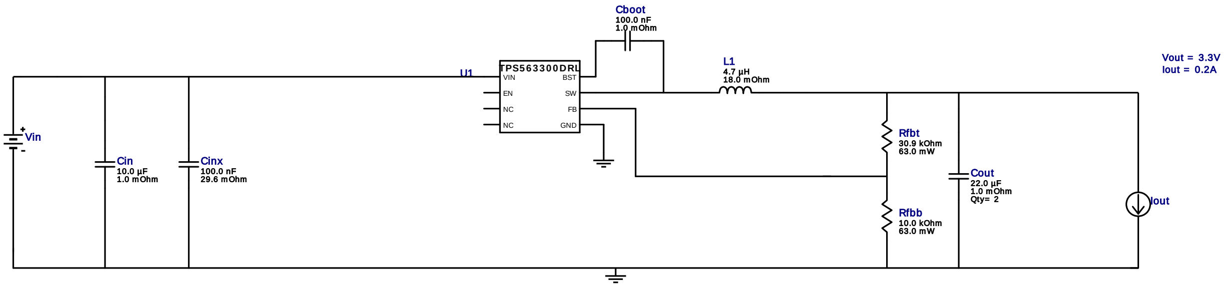
VinMin = 24.0V
VinMax = 24.0V
Vout = 3.3V
Iout = 0.2A

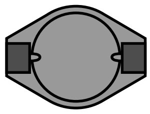
Device = TPS563300DRLR
Topology = Buck
Created = 2024-02-15 11:13:45.095
BOM Cost = $0.77
BOM Count = 9
Total Pd = 0.09W

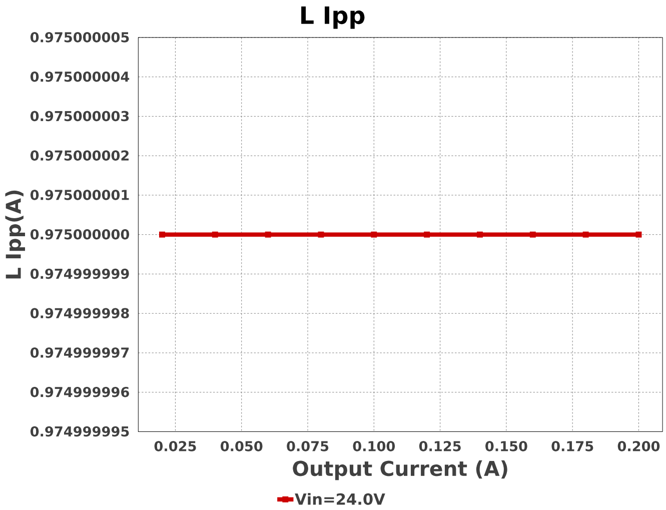
WEBENCH ® Design Report

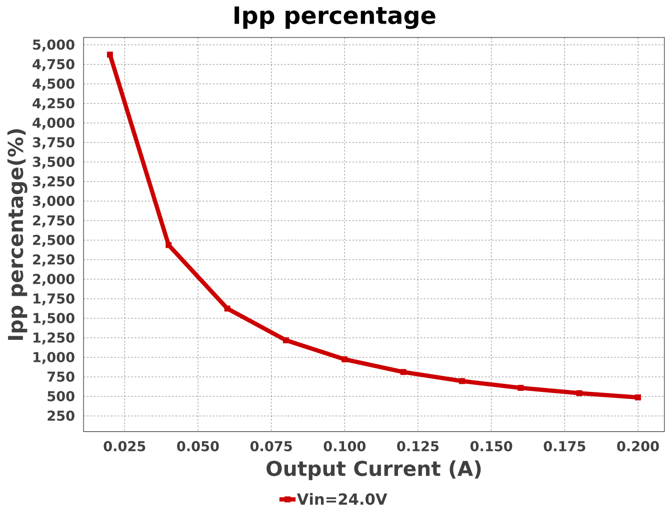
Design : 1 TPS563300DRLR
TPS563300DRLR 24V-24V to 3.30V @ 0.2A

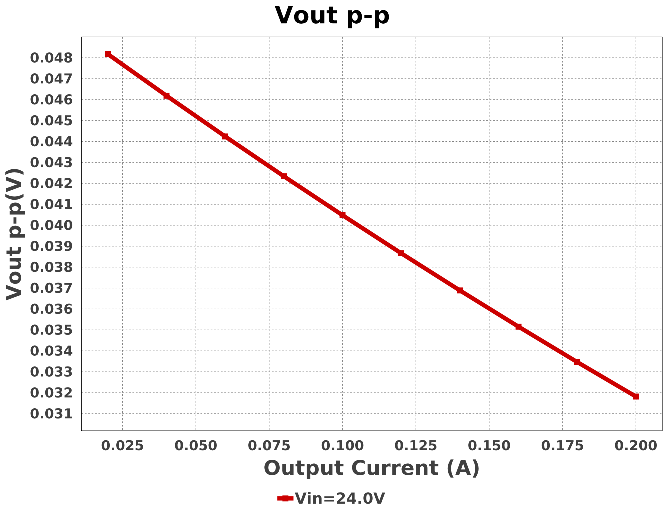


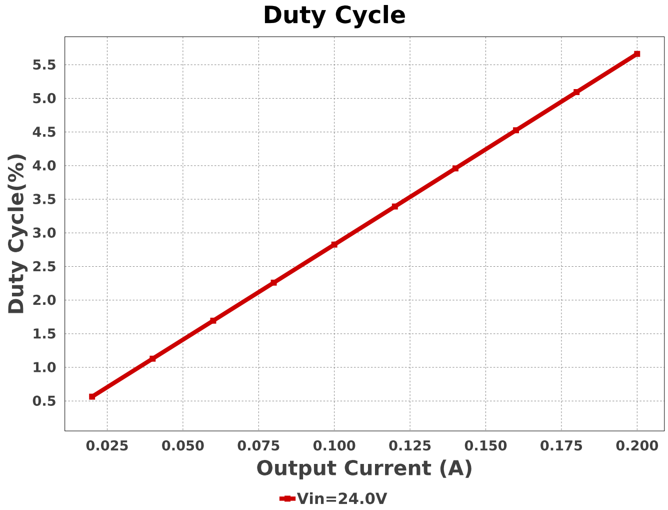
Electrical BOM

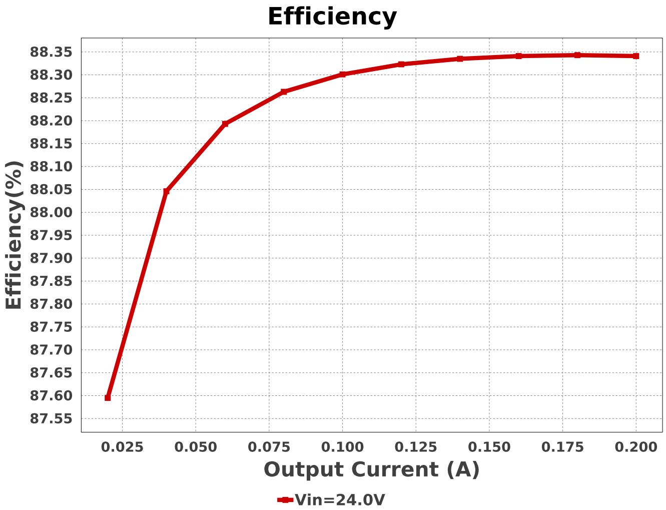
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	C3216X5R1H106K160AB Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.9 A	1	$0.24	1206_180 11 mm²
Cinx	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm²
Cout	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	2	$0.04	0603 5 mm²
L1	NIC Components	NPI31W4R7MTRF	L= 4.7 µH 18.0 mOhm	1	$0.23	 IND_NPI31W 172 mm²
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS563300DRLR	Switcher	1	$0.18	DRL0008A 8 mm²

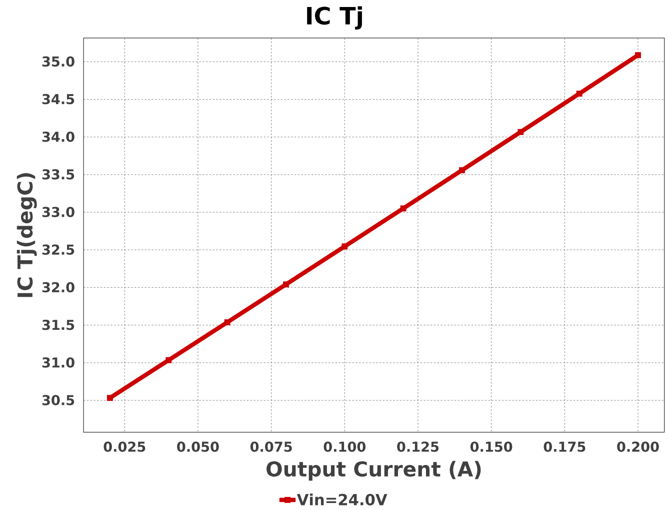

L Ipp
L Ipp(A)
0.975000005
0.975000004
0.975000003
0.975000002
0.975000001
0.975000000
0.974999999
0.974999998
0.974999997
0.974999996
0.974999995
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

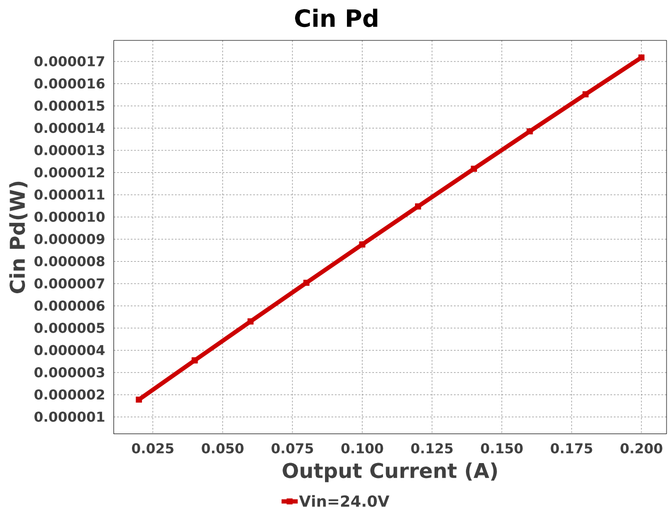

Ipp percentage
Ipp percentage(%)
5,000 4,750 4,500 4,250 4,000 3,750 3,500 3,250 3,000 2,750 2,500 2,250 2,000 1,750 1,500 1,250 1,000 750 500 250
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

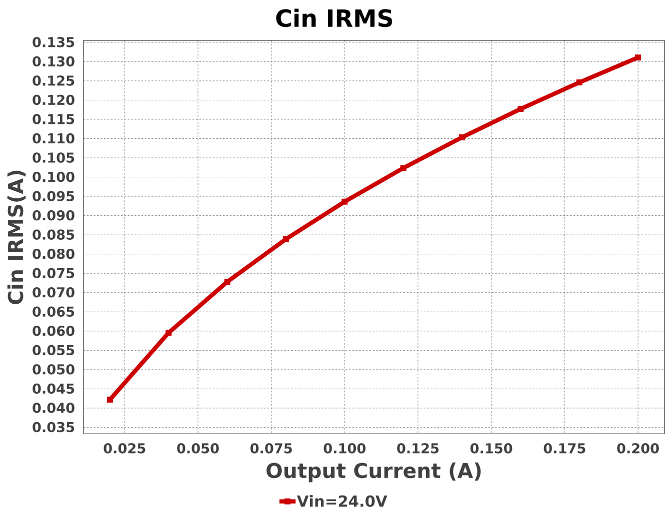

Vout p-p
Vout p-p(V)
0.048 0.047 0.046 0.045 0.044 0.043 0.042 0.041 0.040 0.039 0.038 0.037 0.036 0.035 0.034 0.033 0.032 0.031
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

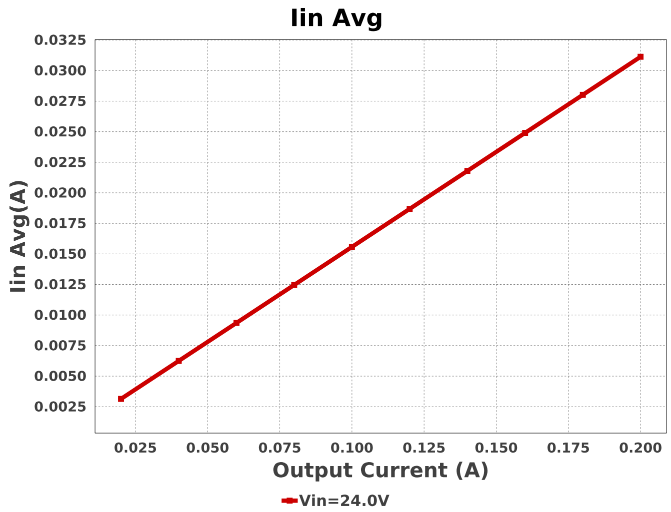

Duty Cycle
Duty Cycle(%)
5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

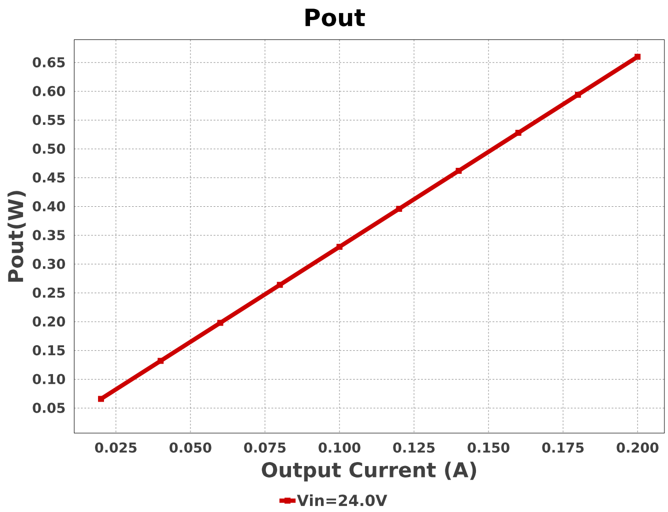

Efficiency
Efficiency(%)
88.35 88.30 88.25 88.20 88.15 88.10 88.05 88.00 87.95 87.90 87.85 87.80 87.75 87.70 87.65 87.60 87.55
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

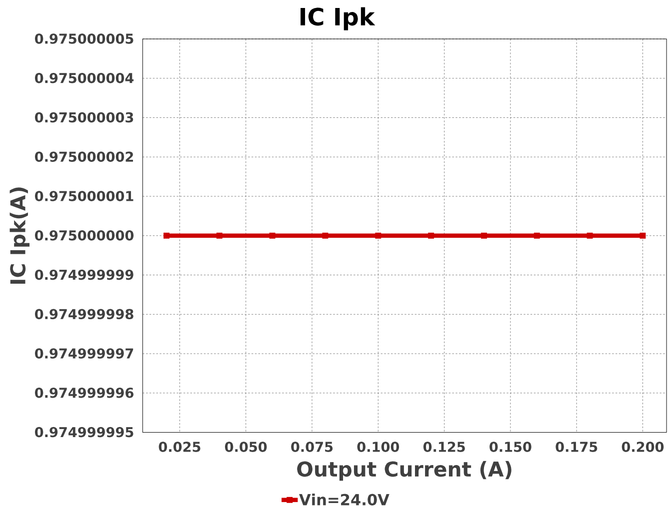

IC Tj
IC Tj(degC)
35.0 34.5 34.0 33.5 33.0 32.5 32.0 31.5 31.0 30.5
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=24.0V

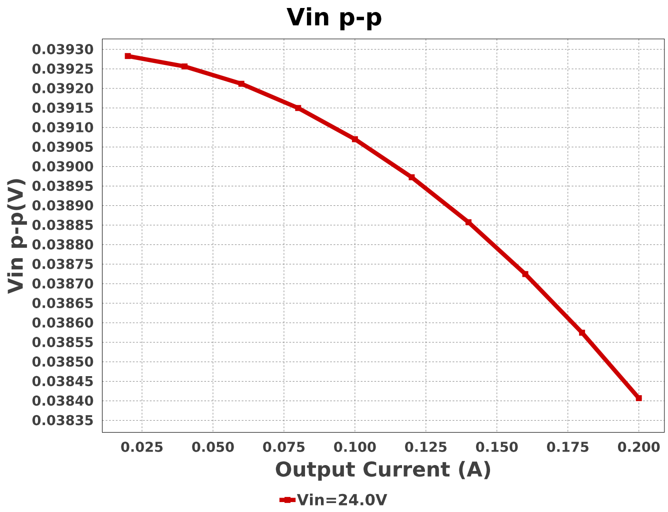

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=24.0V

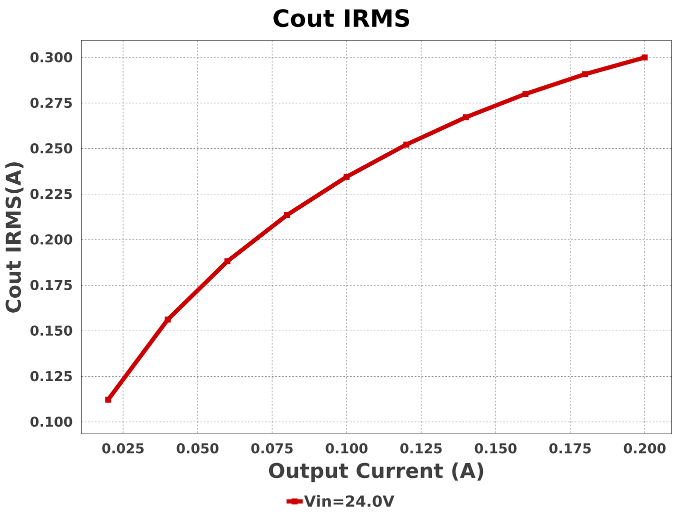

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=24.0V

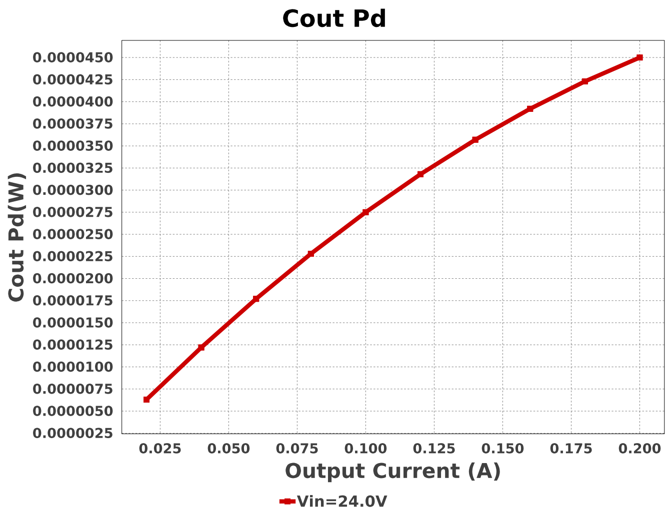

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=24.0V

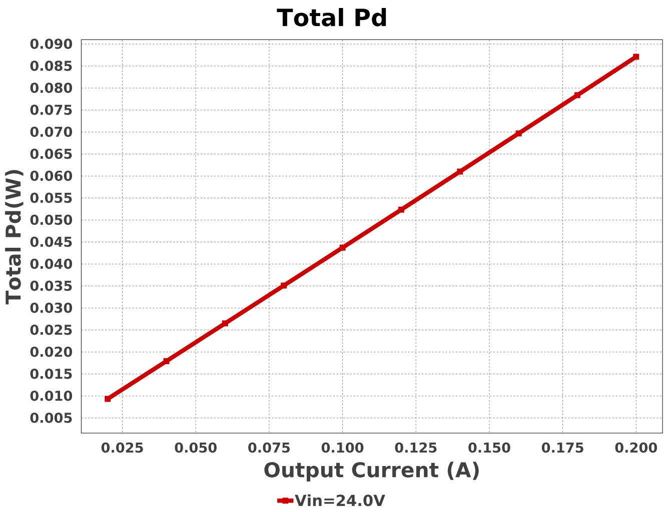

Pout
Pout(W)
Output Current (A)
Vin=24.0V

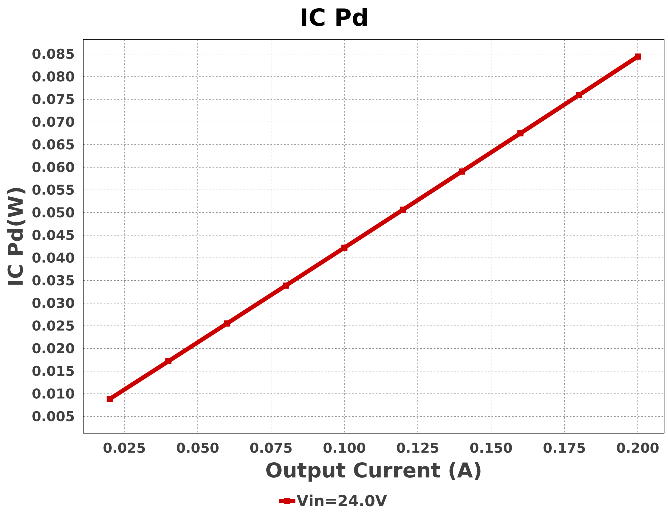

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=24.0V

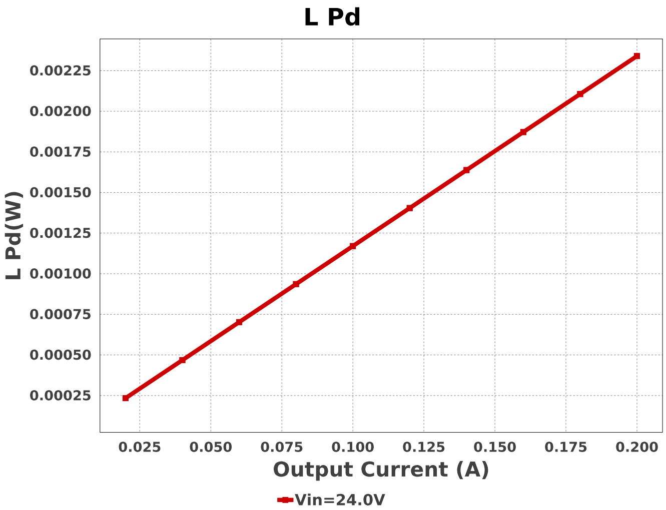

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=24.0V

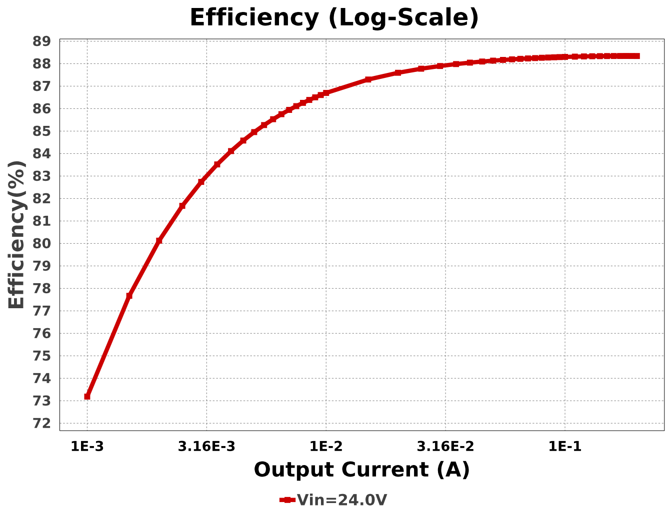












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	131.067 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	17.179 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	300.0 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	45.0 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	975.0 mA	IC	Peak switch current in IC
6.	IC Pd	84.437 mW	IC	IC power dissipation
7.	IC Tj	35.087 degC	IC	IC junction temperature
8.	IC Tolerance	16.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	60.25 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	31.129 mA	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	487.5 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	975.0 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	2.34 mW	Inductor	Inductor power dissipation
14.	Cin Pd	17.179 µW	Power	Input capacitor power dissipation
15.	Cout Pd	45.0 µW	Power	Output capacitor power dissipation
16.	IC Pd	84.437 mW	Power	IC power dissipation
17.	L Pd	2.34 mW	Power	Inductor power dissipation
18.	Total Pd	87.104 mW	Power	Total Power Dissipation
19.	BOM Count	9	System Information	Total Design BOM count
20.	Duty Cycle	5.662 %	System Information	Duty cycle
21.	Efficiency	88.341 %	System Information	Steady state efficiency
22.	FootPrint	215.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	255.496 kHz	System Information	Switching frequency
24.	Inductor ripple current requirement used for Inductor selection	40.0 %	System Information	Custom Inductor ripple current (% of average inductor current) requirement used for Inductor selection
25.	Iout	200.0 mA	System Information	Iout operating point
26.	Iout transient step used for Cout calculations	100.0 mA	System Information	Custom Transient current step requirement that was used for Cout selection (A).
27.	Mode	PFM	System Information	Conduction Mode
28.	Overshoot Value	451.101 µV	System Information	Theoretical Vout Overshoot Value
29.	Pout	660.0 mW	System Information	Total output power
30.	Total BOM	$0.77	System Information	Total BOM Cost
31.	Undershoot Value	21.456 mV	System Information	Theoretical Vout Undershoot Value
32.	Vin	24.0 V	System Information	Vin operating point
33.	Vin p-p	38.407 mV	System Information	Peak-to-peak input voltage
34.	Vout	3.3 V	System Information	Operational Output Voltage
35.	Vout Actual	3.272 V	System Information	Vout Actual calculated based on selected voltage divider resistors
36.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
37.	Vout Tolerance	3.557 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	31.818 mV	System Information	Peak-to-peak output ripple voltage
39.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS563300	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

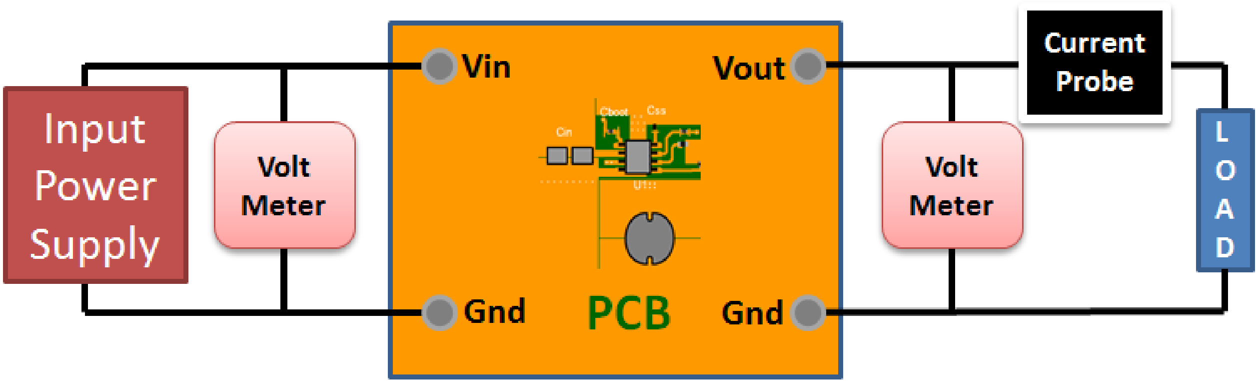
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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.

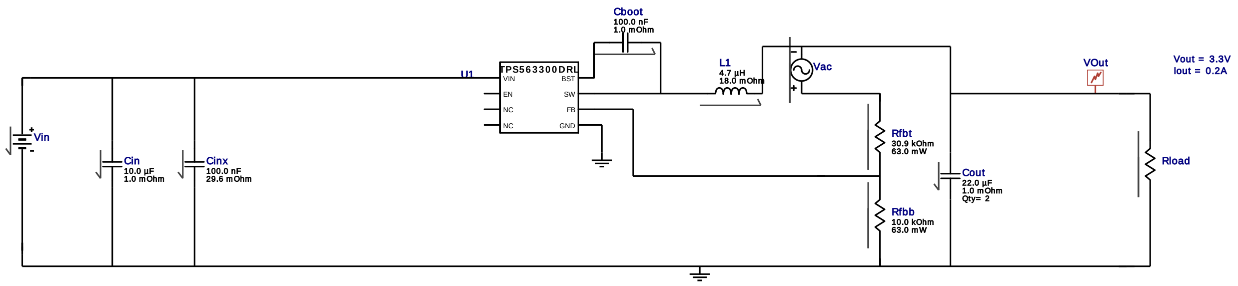


WEBENCH® Electrical Simulation Report

Design Id = 1

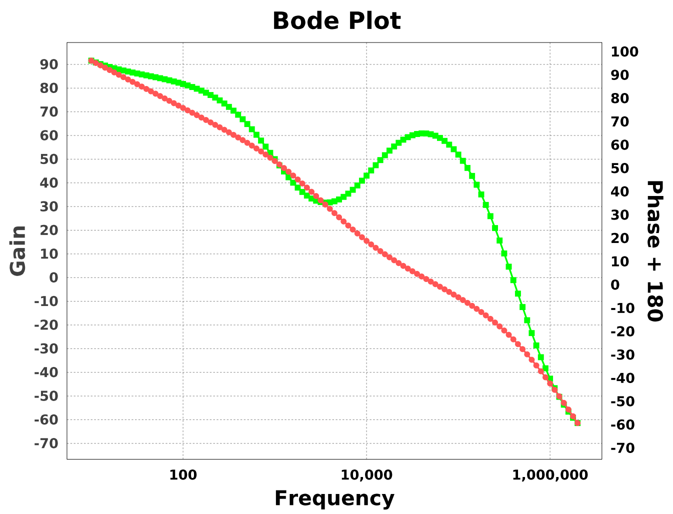
sim_id = 1

Simulation Type = Bode Plot



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	initial condition	no values
2.	Cinj	C	Injection Capacitance	10000000 F
3.	Linj	L	Injection Inductance	10000000 H
4.	Vinj	AC	AC voltage	1 V
5.	Rload	R	Load Resistance	16.499999999999996 ohm



Design Assistance

1. Master key : 37C3C50233B7D137384961381C9450C6[v1]

2. **TPS563300** Product Folder : https://www.ti.com/product/TPS563300 : contains the data sheet and other resources.

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