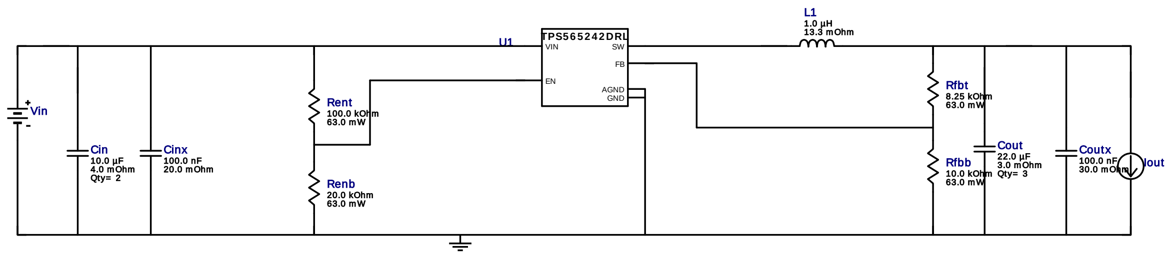
Texas Instruments

WEBENCH® Design Report

VinMin = 9.0V
VinMax = 15.0V
Vout = 1.1V
Iout = 4.0A

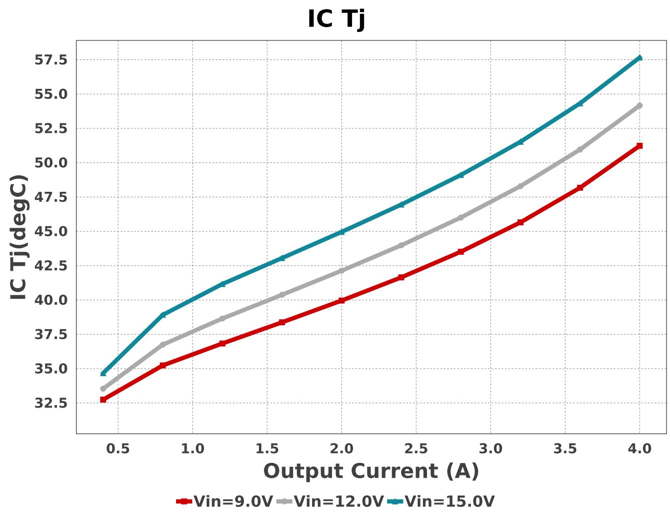
Device = TPS565242DRLR
Topology = Buck
Created = 2025-04-16 09:47:19.694
BOM Cost = $1.20
BOM Count = 13
Total Pd = 0.87W

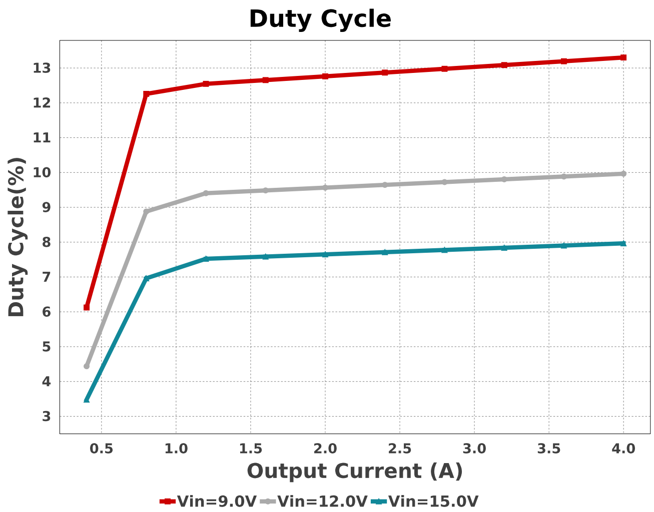
Design : 15 TPS565242DRLR
TPS565242DRLR 9V-15V to 1.10V @ 4A

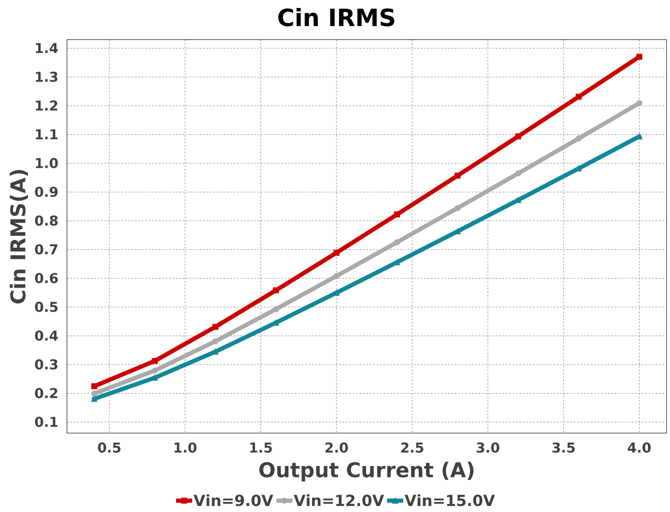


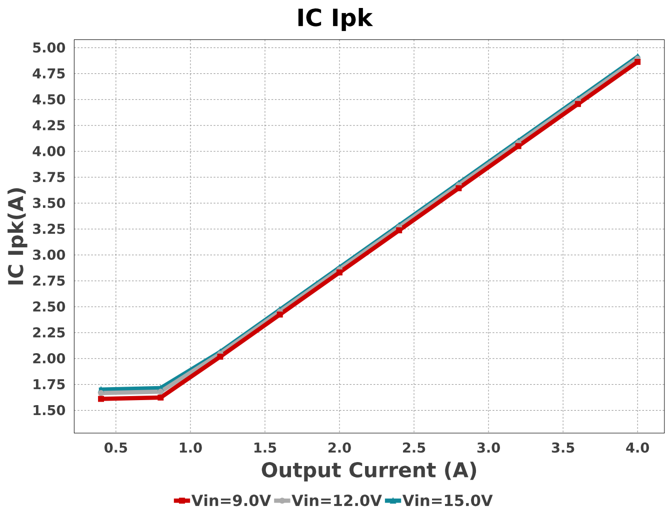
Electrical BOM

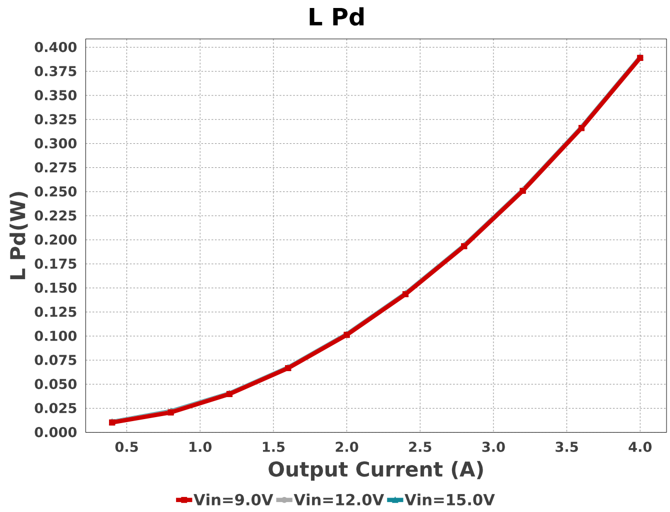
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	MuRata	GRM21BR61E106MA73L Series= X5R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 2.8 A	2	$0.04	0805 7 mm²
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm²
Cout	MuRata	GRM21BR61A226ME44L Series= X5R	Cap= 22.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 3.84 A	3	$0.09	0805 7 mm²
Coutx	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
L1	Coilcraft	XAL4020-102MEB	L= 1.0 µH 13.3 mOhm	1	$0.60	XAL4020 28 mm²
Renb	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rent	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 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	CRCW04028K25FKED Series= CRCW..e3	Res= 8.25 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS565242DRLR	Switcher	1	$0.18	DRL0006A 7 mm²

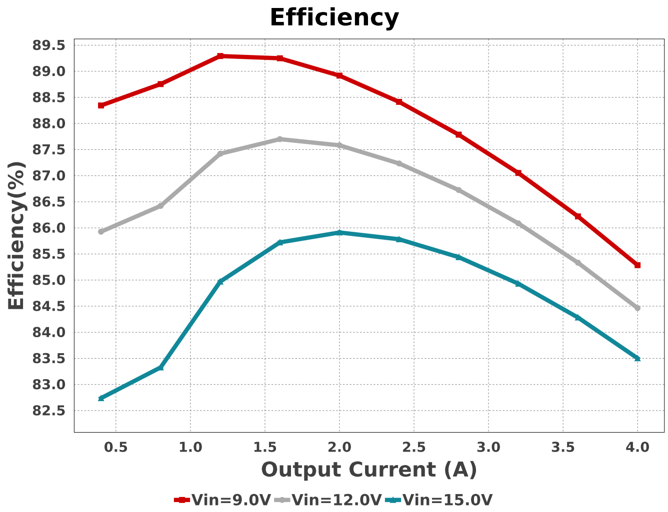

IC Tj
IC Tj(degC)
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

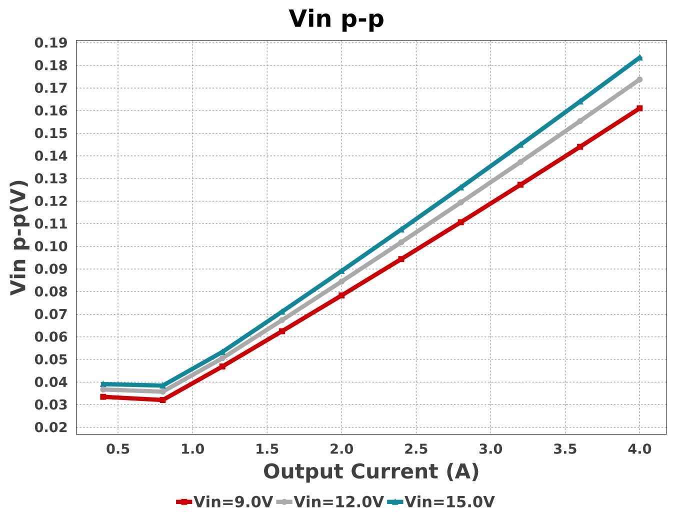

Duty Cycle
Duty Cycle(%)
13 12 11 10 9 8 7 6 5 4 3
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

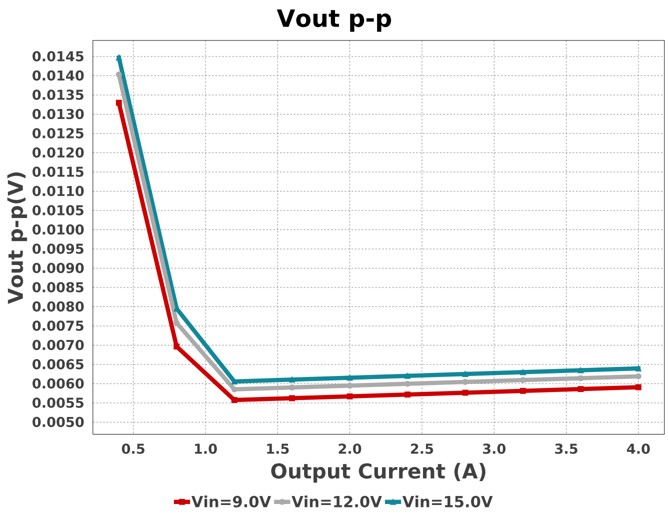

Cin IRMS
Cin IRMS(A)
1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

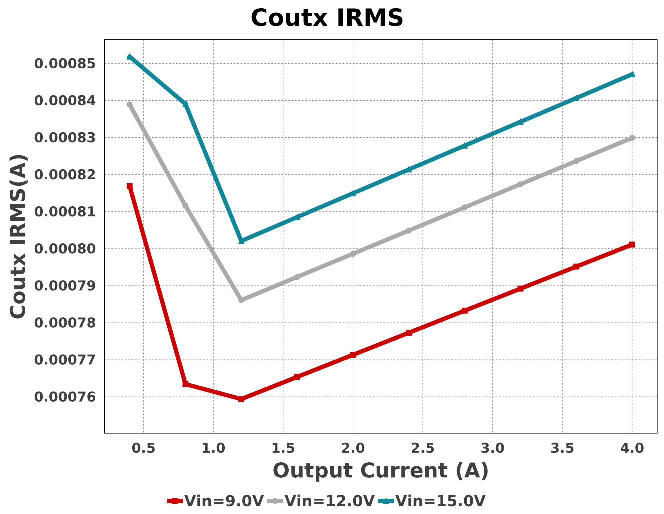

IC Ipk
IC Ipk(A)
5.00 4.75 4.50 4.25 4.00 3.75 3.50 3.25 3.00 2.75 2.50 2.25 2.00 1.75 1.50
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

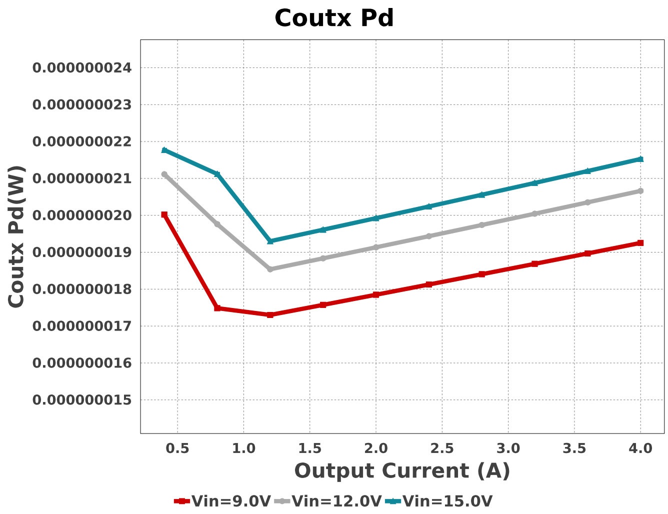

L Pd
L Pd(W)
0.400 0.375 0.350 0.325 0.300 0.275 0.250 0.225 0.200 0.175 0.150 0.125 0.100 0.075 0.050 0.025 0.000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

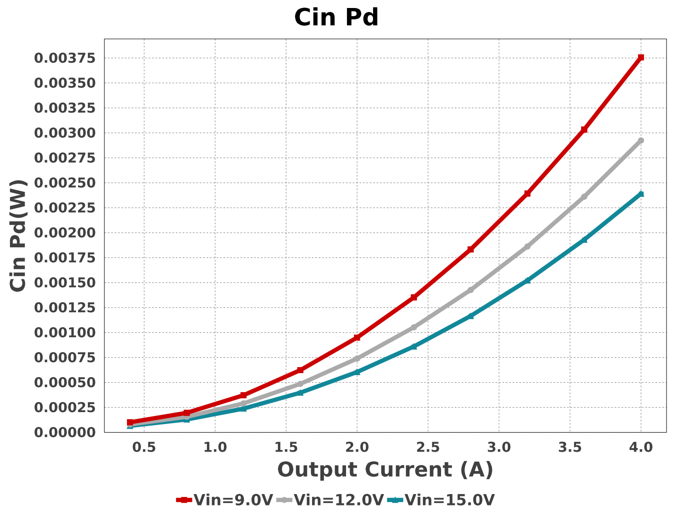

Efficiency
Efficiency(%)
89.5 89.0 88.5 88.0 87.5 87.0 86.5 86.0 85.5 85.0 84.5 84.0 83.5 83.0 82.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

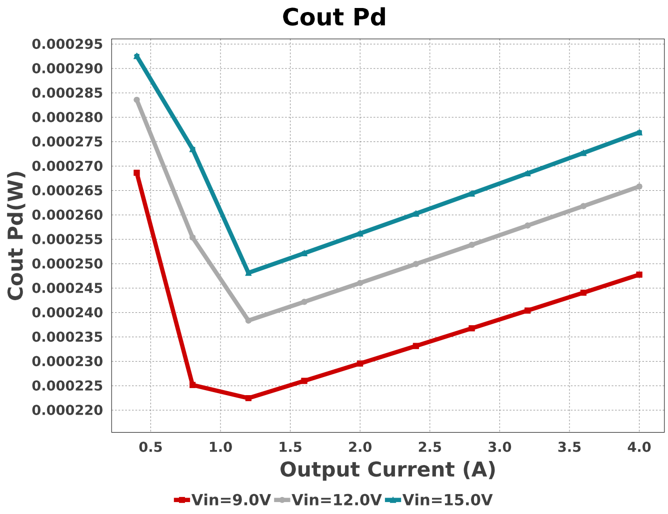

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

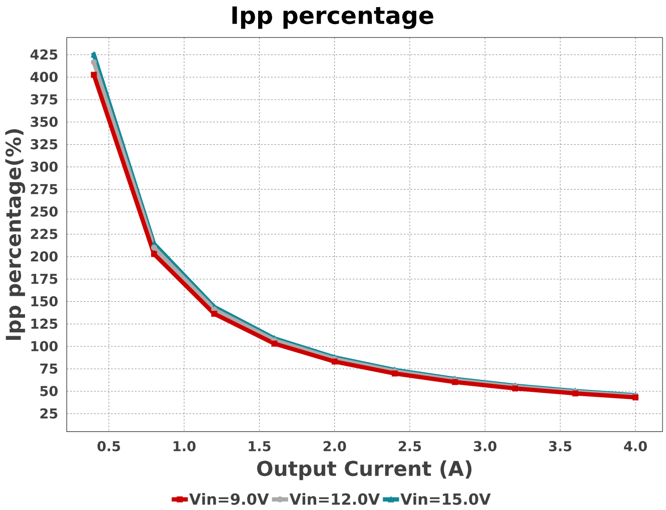

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

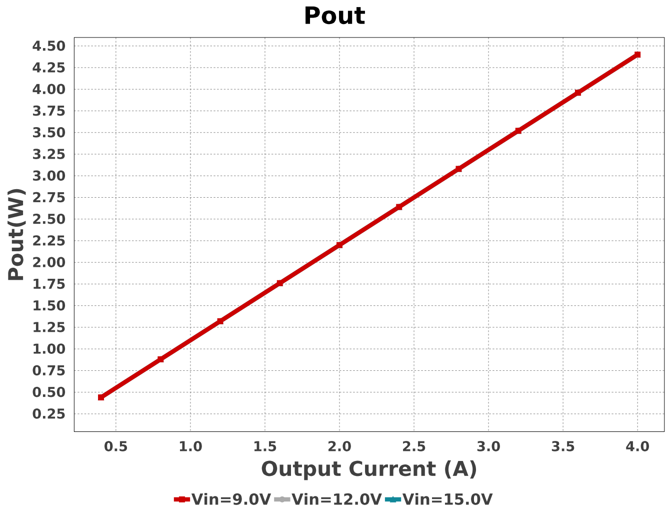

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

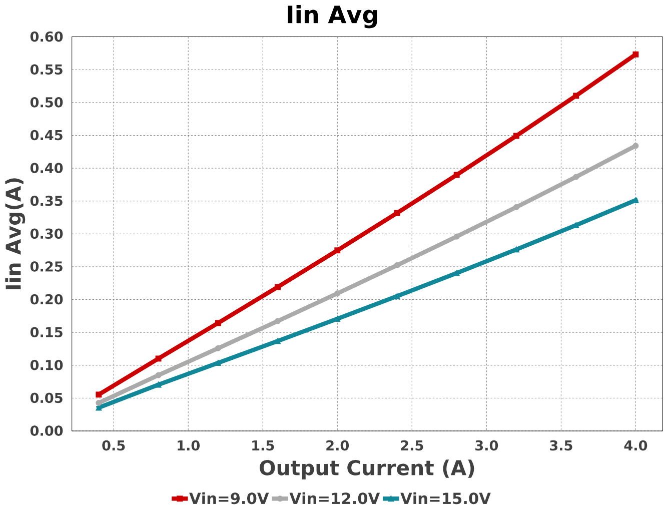

Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

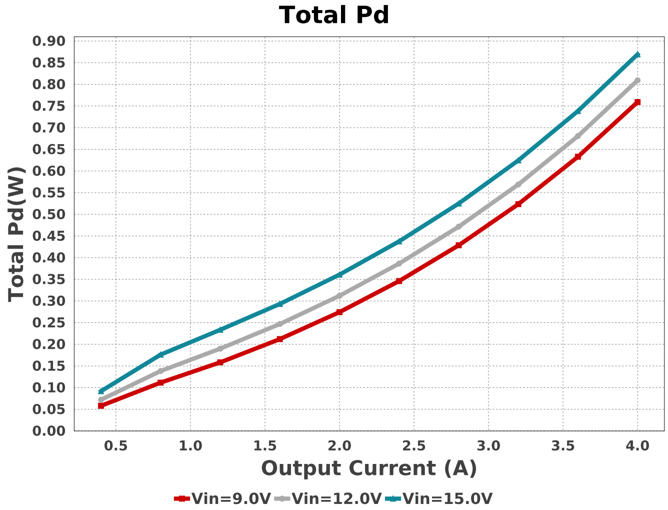

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

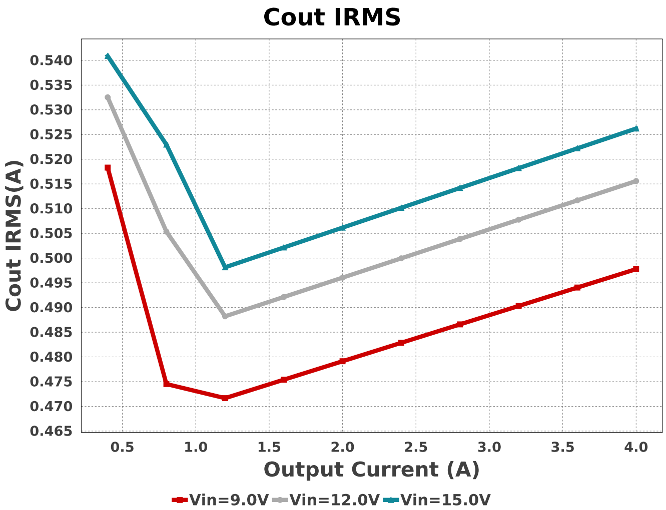

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

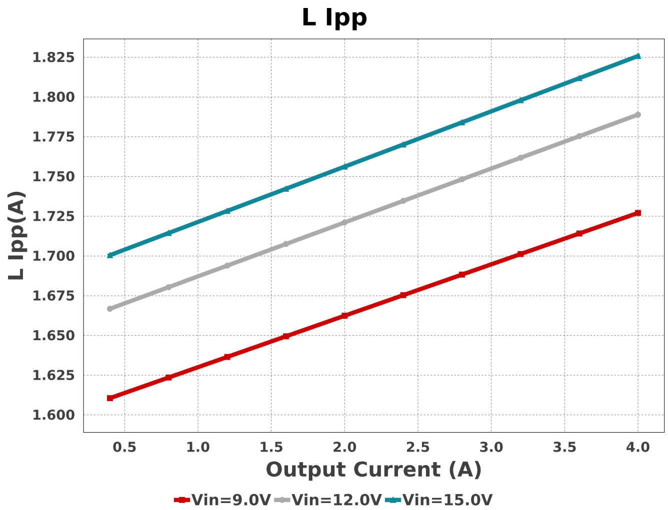

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

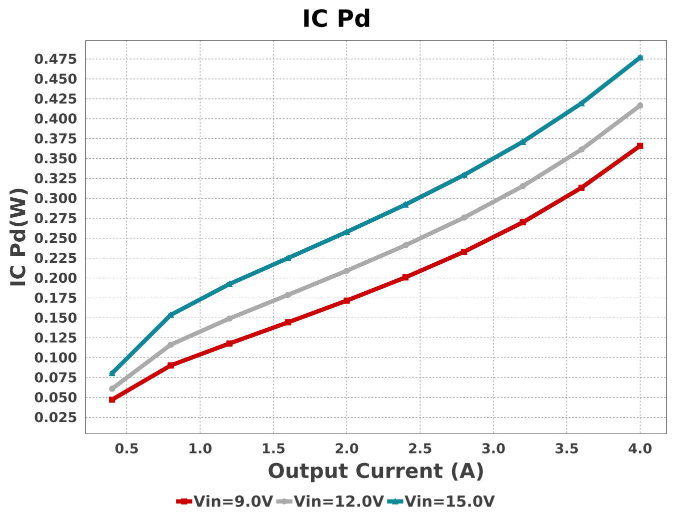

Pout
Pout(W)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V

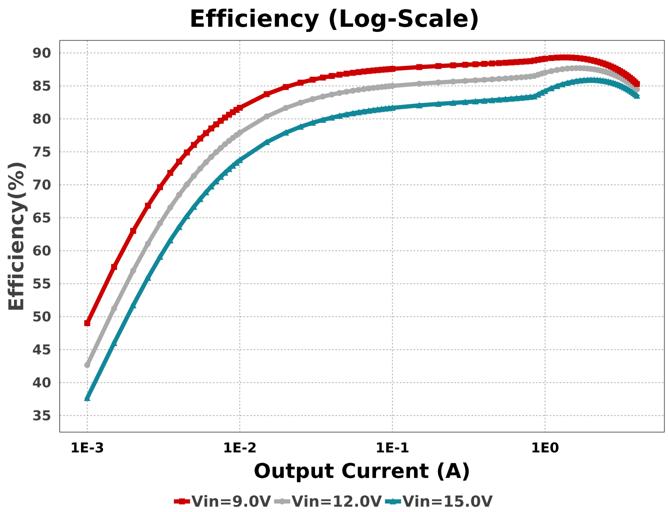

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=9.0V Vin=12.0V Vin=15.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	13		Total Design BOM count
2.	Total BOM	$1.2		Total BOM Cost
3.	Cin IRMS	1.093 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	2.39 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	526.21 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	276.9 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	847.086 µA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	21.527 nW	Capacitor	Output capacitor_x power loss
9.	IC Ipk	4.913 A	IC	Peak switch current in IC
10.	IC Pd	476.92 mW	IC	IC power dissipation
11.	IC Tj	57.661 degC	IC	IC junction temperature
12.	IC Tolerance	11.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA Effective	58.0 degC/W	IC	IC junction-to-ambient thermal resistance with TI EVM
14.	Iin Avg	351.29 mA	IC	Average input current
15.	Ipp percentage	45.644 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
16.	L Ipp	1.826 A	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	389.69 mW	Inductor	Inductor power dissipation
18.	Cin Pd	2.39 mW	Power	Input capacitor power dissipation
19.	Cout Pd	276.9 µW	Power	Output capacitor power dissipation
20.	Coutx Pd	21.527 nW	Power	Output capacitor_x power loss
21.	IC Pd	476.92 mW	Power	IC power dissipation
22.	L Pd	389.69 mW	Power	Inductor power dissipation
23.	Total Pd	869.337 mW	Power	Total Power Dissipation
24.	Duty Cycle	7.966 %	System Information	Duty cycle
25.	Efficiency	83.502 %	System Information	Steady state efficiency
26.	FootPrint	90.0 mm^2	System Information	Total Foot Print Area of BOM components
27.	Frequency	600.678 kHz	System Information	Switching frequency
28.	Iout	4.0 A	System Information	Iout operating point
29.	Mode	CCM	System Information	Conduction Mode
30.	Pout	4.4 W	System Information	Total output power
31.	Vin	15.0 V	System Information	Vin operating point
32.	Vin p-p	183.478 mV	System Information	Peak-to-peak input voltage
33.	Vout	1.1 V	System Information	Operational Output Voltage
34.	Vout Actual	1.095 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	2.763 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	6.397 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	4.0	Maximum Output Current
VinMax	15.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	1.1	Output Voltage
base_pn	TPS565242	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

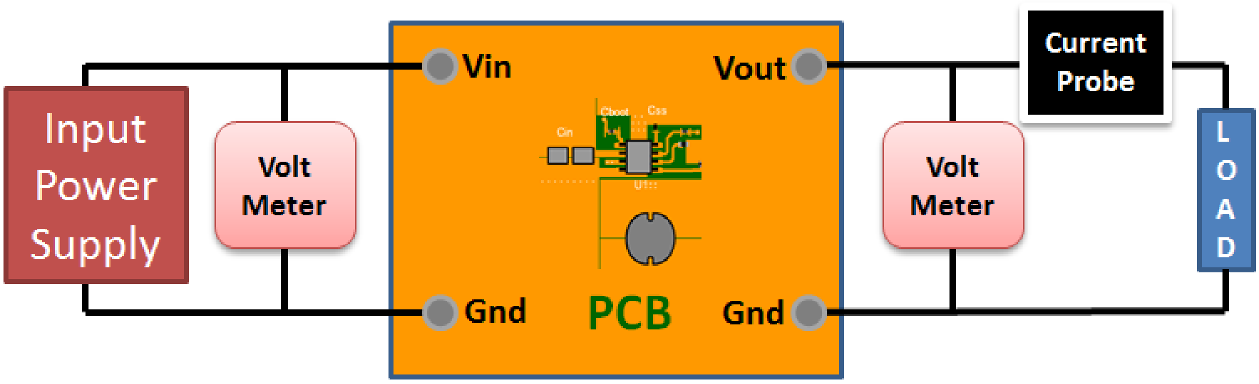
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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

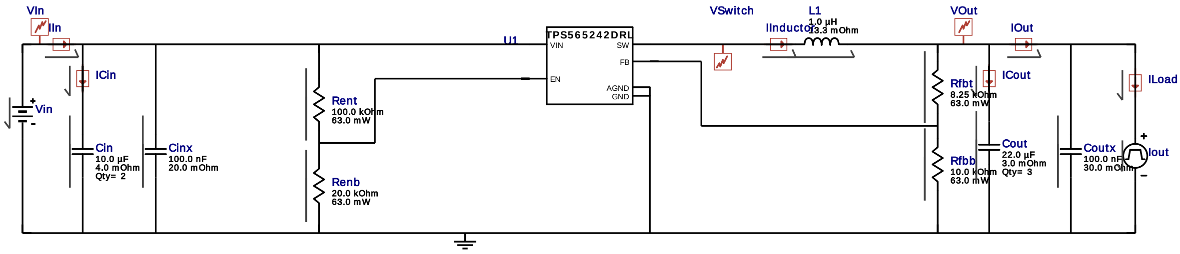


WEBENCH® Electrical Simulation Report

Design Id = 15

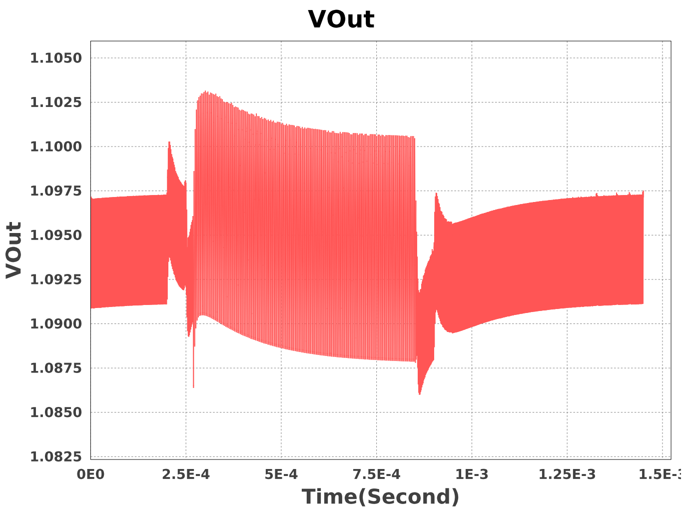
sim_id = 1

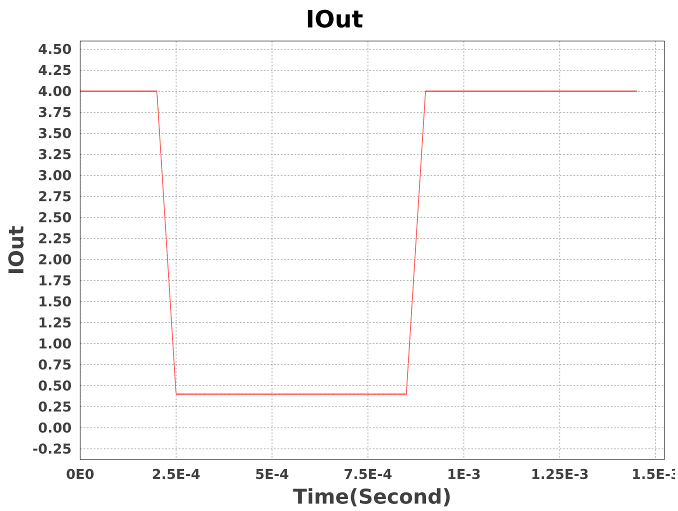
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Current	4.0 A
2.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	4.0 A
		I2	Minimum Load Current	0.4 A
		Td	Initial Time Delay	200u s
		Tf	Fall Time	50u s
		Tr	Rise Time	50u s
		Pw	Pulse Width	600u s





Design Assistance

1. Master key : 7184E8B77D068D1CE343DD0BE1E418A5[v1]

2. **TPS565242** Product Folder : http://www.ti.com/product/TPS565242 : contains the data sheet and other resources.