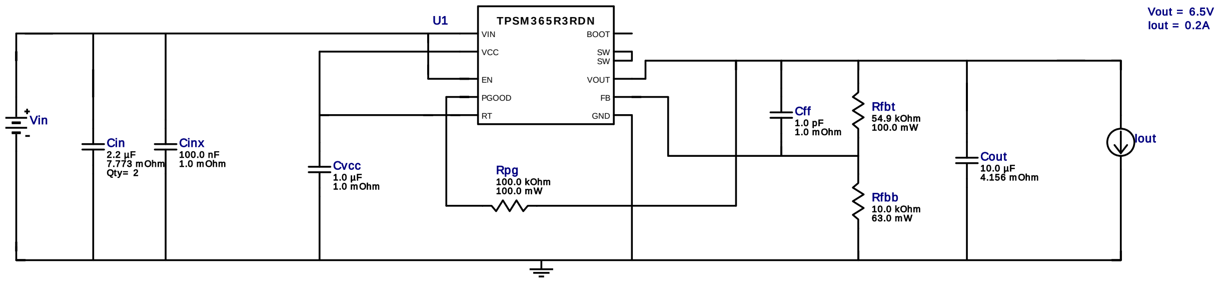
VinMin = 14.0V
VinMax = 15.0V
Vout = 6.5V
Iout = 0.2A

Device = TPSM365R3RDNR
Topology = Buck
Created = 2024-04-15 13:42:19.728
BOM Cost = $1.84
BOM Count = 10
Total Pd = 0.05W

WEBENCH ® Design Report

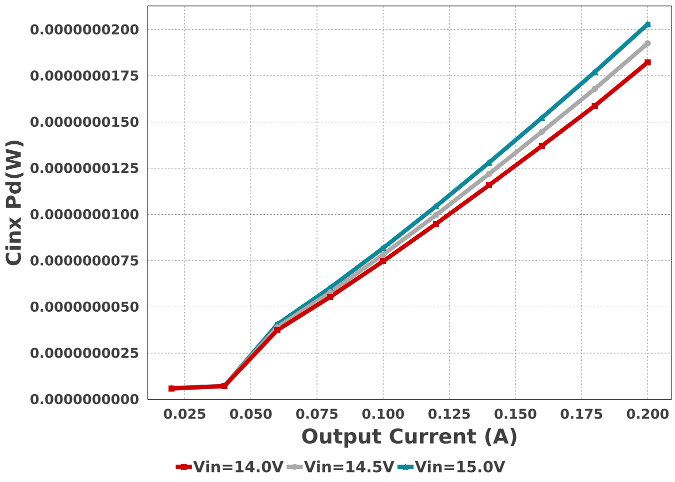
Design : 57 TPSM365R3RDNR
TPSM365R3RDNR 14V-15V to 6.5V @ 0.2A



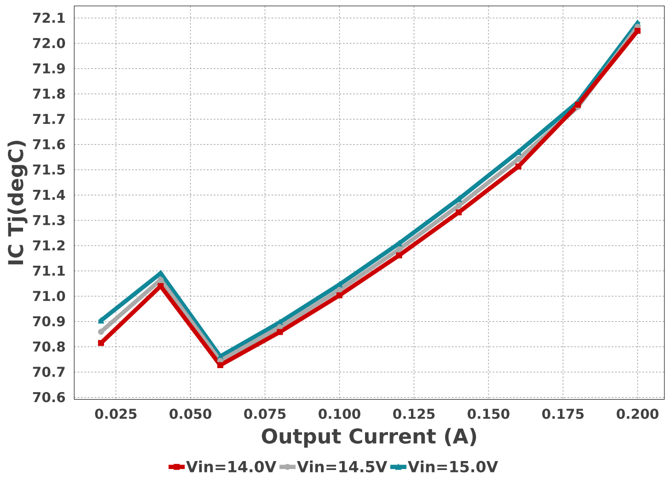
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cff	MuRata	GRM1555C1H1R0CA01D Series= C0G/NP0	Cap= 1.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM21BR71E225KA73L Series= X7R	Cap= 2.2 uF ESR= 7.773 mOhm VDC= 25.0 V IRMS= 1.35654 A	2	$0.14	0805 7 mm²
Cinx	MuRata	GRM21BR71H104KA01L Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 3.85 A	1	$0.03	0805 7 mm²
Cout	MuRata	GRM31CR71C106KAC7L Series= X7R	Cap= 10.0 uF ESR= 4.156 mOhm VDC= 16.0 V IRMS= 2.59073 A	1	$0.08	1206_190 11 mm²
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 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	CRCW060354K9FKEA Series= CRCW..e3	Res= 54.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	TPSM365R3RDNR	Switcher	1	$1.40	RDN0011A 25 mm²

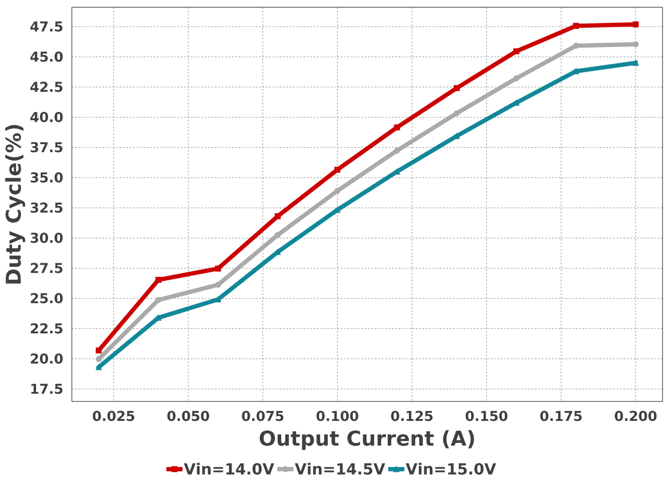
Cinx Pd



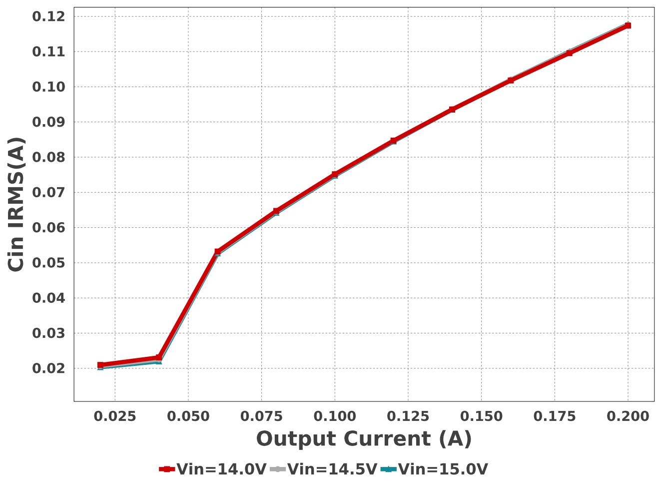
IC Tj



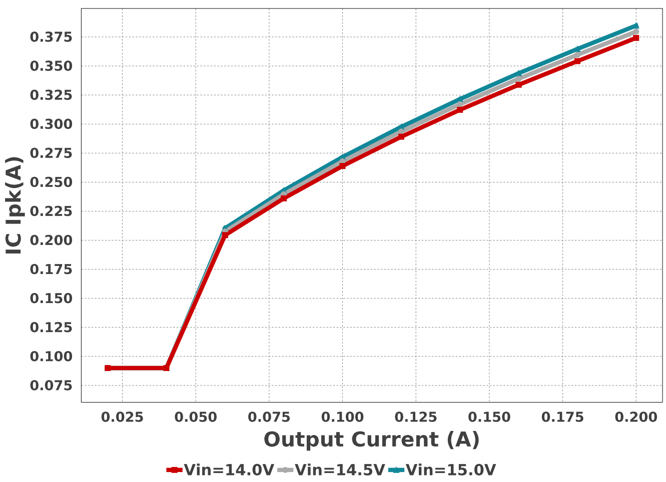
Duty Cycle



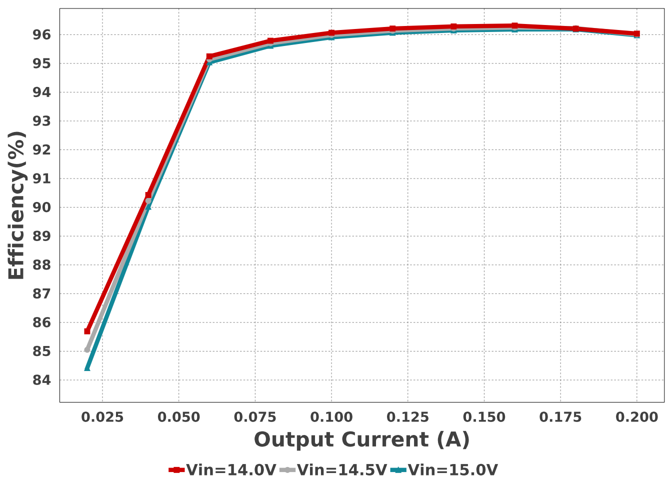
Cin IRMS

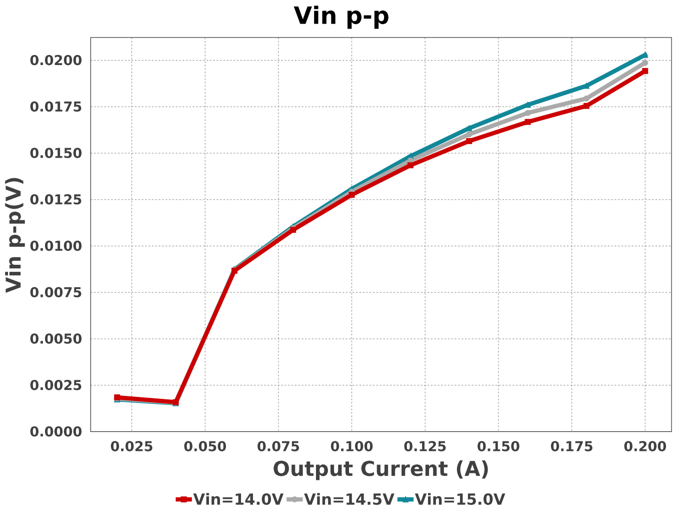


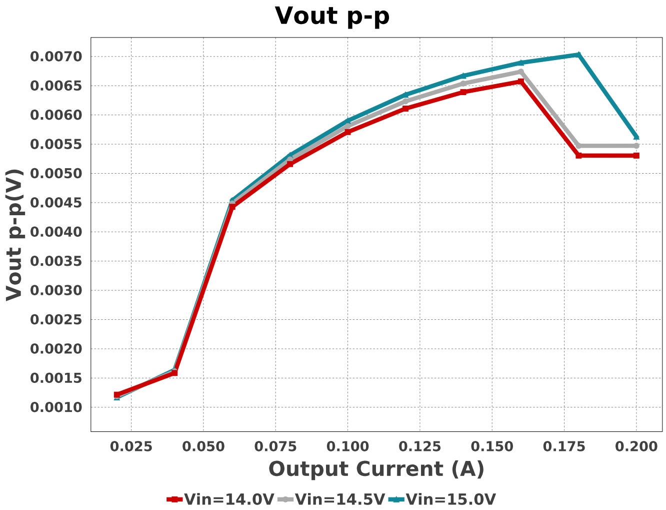
IC Ipk

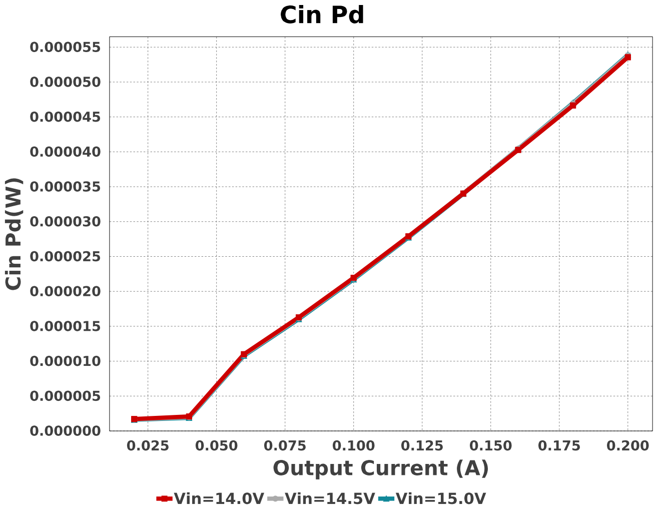


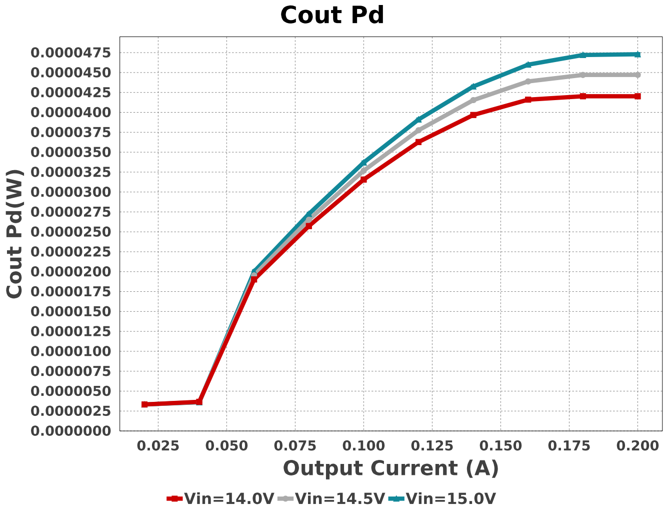
Efficiency

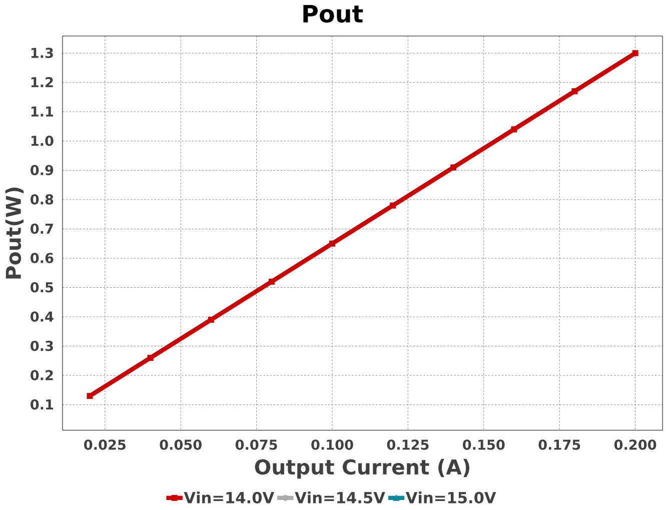


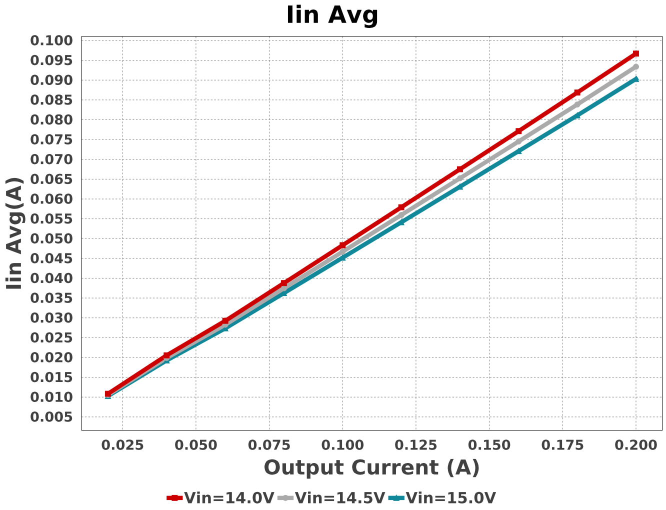

Vin p-p
Vin p-p(V)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

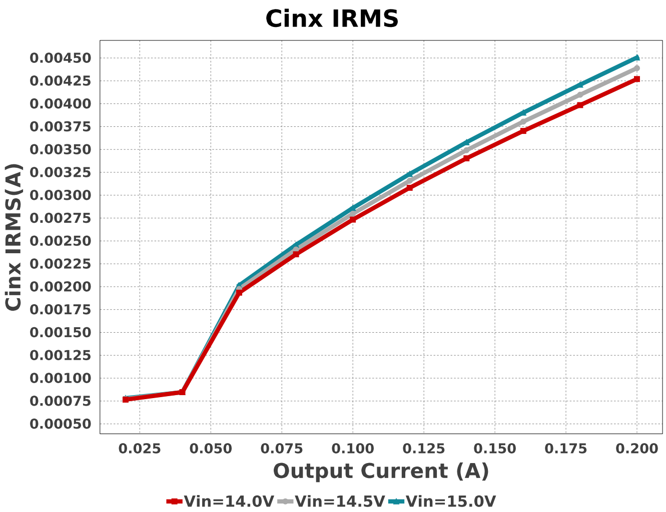

Vout p-p
Vout p-p(V)
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

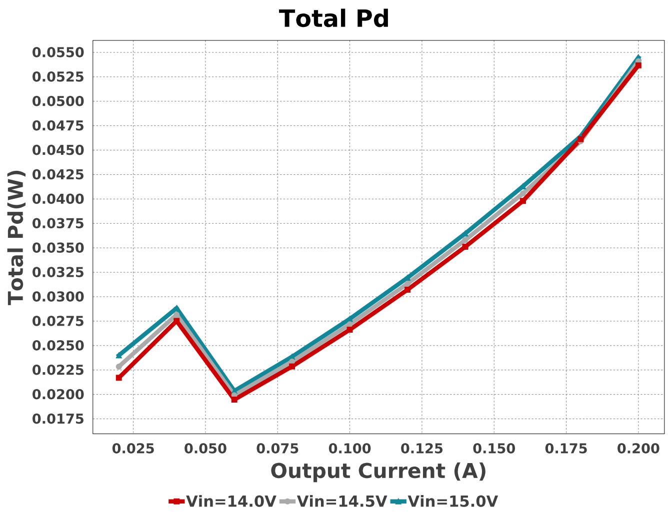

Cin Pd
Cin Pd(W)
0.000055
0.000050
0.000045
0.000040
0.000035
0.000030
0.000025
0.000020
0.000015
0.000010
0.000005
0.000000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

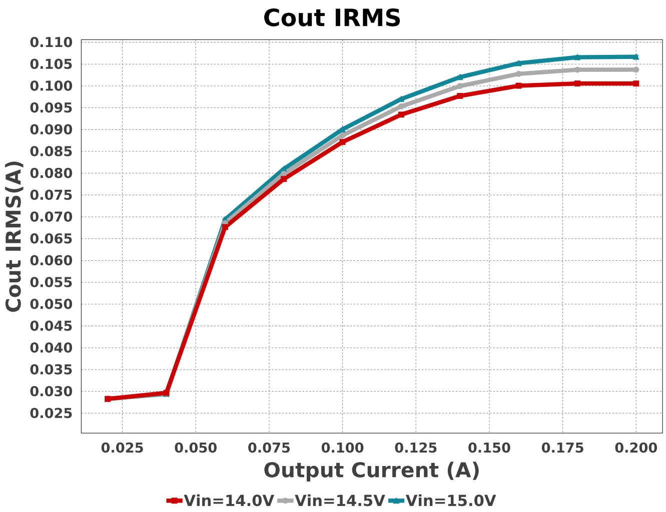

Cout Pd
Cout Pd(W)
0.0000475
0.0000450
0.0000425
0.0000400
0.0000375
0.0000350
0.0000325
0.0000300
0.0000275
0.0000250
0.0000225
0.0000200
0.0000175
0.0000150
0.0000125
0.0000100
0.0000075
0.0000050
0.0000025
0.0000000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

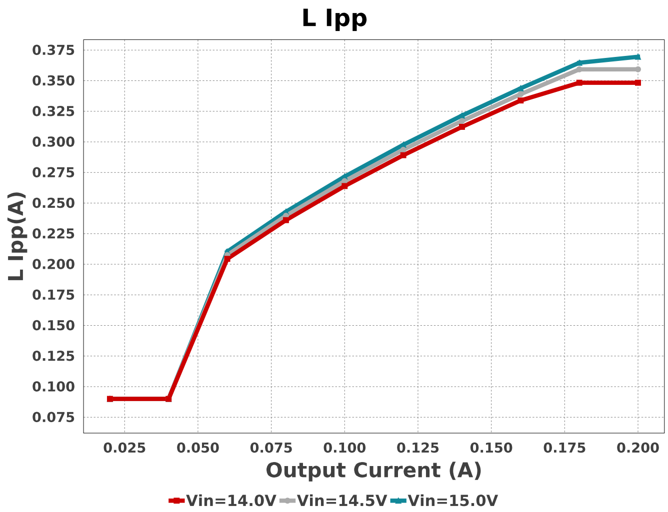

Pout
Pout(W)
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

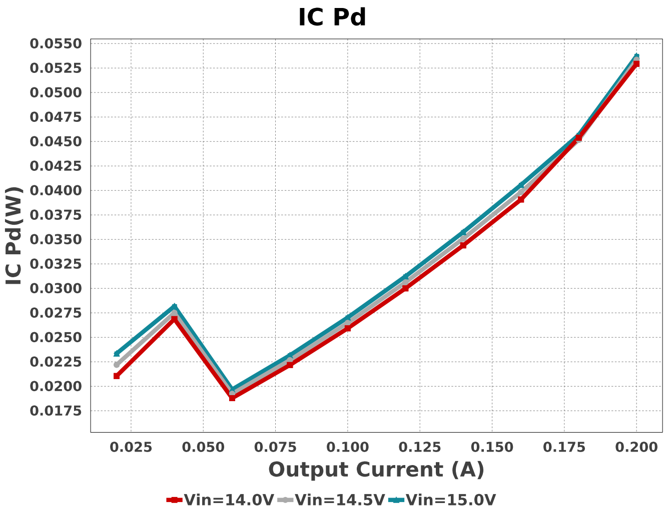

Iin Avg
Iin Avg(A)
0.100
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

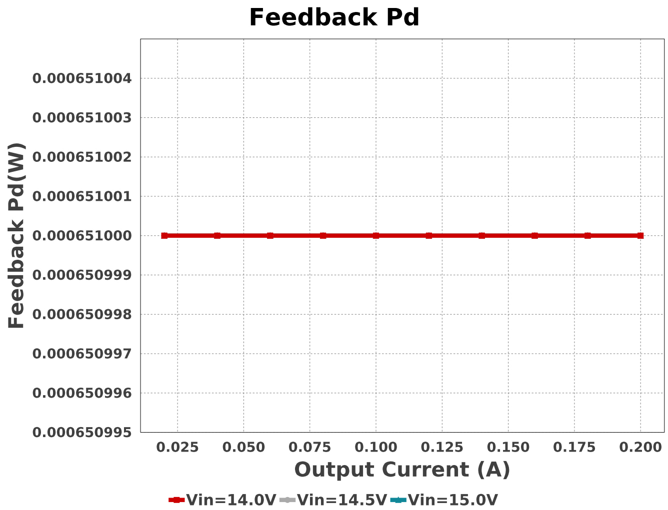

Cinx IRMS
Cinx IRMS(A)
0.00450
0.00425
0.00400
0.00375
0.00350
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

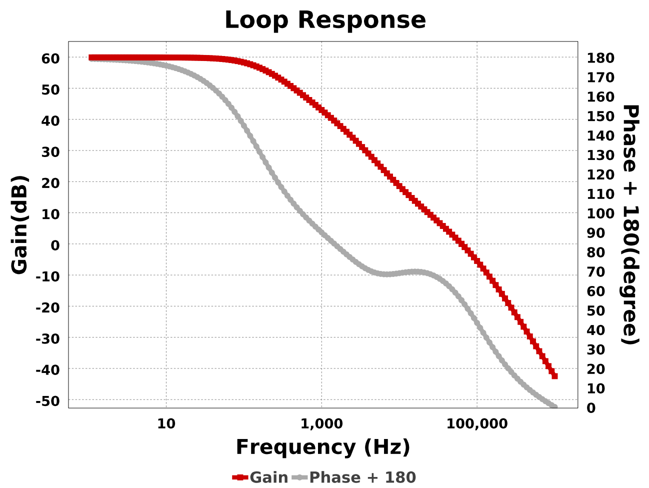

Total Pd
Total Pd(W)
0.0550
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V

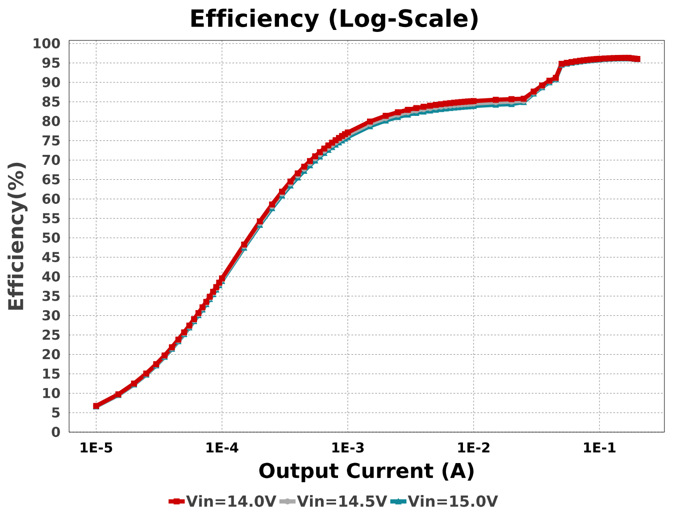

Cout IRMS
Cout IRMS(A)
0.110
0.105
0.100
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V


L Ipp
L Ipp(A)
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
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V


IC Pd
IC Pd(W)
0.0550
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V


Feedback Pd
Feedback Pd(W)
0.000651004
0.000651003
0.000651002
0.000651001
0.000651000
0.000650999
0.000650998
0.000650997
0.000650996
0.000650995
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=14.0V Vin=14.5V Vin=15.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	10		Total Design BOM count
2.	Total BOM	$1.84		Total BOM Cost
3.	Cin IRMS	117.741 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	53.878 µW	Capacitor	Input capacitor power dissipation
5.	Cinx IRMS	4.505 mA	Capacitor	Bulk capacitor RMS ripple current
6.	Cinx Pd	20.296 nW	Capacitor	Bulk capacitor power dissipation
7.	Cout IRMS	106.678 mA	Capacitor	Output capacitor RMS ripple current
8.	Cout Pd	47.296 µW	Capacitor	Output capacitor power dissipation
9.	IC Ipk	384.771 mA	IC	Peak switch current in IC
10.	IC Pd	53.725 mW	IC	IC power dissipation
11.	IC Tj	72.08 degC	IC	IC junction temperature
12.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA Effective	38.72 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
14.	Iin Avg	90.298 mA	IC	Average input current
15.	Cin Pd	53.878 µW	Power	Input capacitor power dissipation
16.	Cinx Pd	20.296 nW	Power	Bulk capacitor power dissipation
17.	Cout Pd	47.296 µW	Power	Output capacitor power dissipation
18.	Feedback Pd	651.0 µW	Power	Power Dissipation in Feedback Resistors
19.	IC Pd	53.725 mW	Power	IC power dissipation
20.	Total Pd	54.477 mW	Power	Total Power Dissipation
21.	Feedback Pd	651.0 µW	Resistor	Power Dissipation in Feedback Resistors
22.	Cross Freq	63.199 kHz	System Information	Bode plot crossover frequency
23.	Duty Cycle	44.506 %	System Information	Duty cycle
24.	Efficiency	95.978 %	System Information	Steady state efficiency
25.	FootPrint	76.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	1000.0 kHz	System Information	Switching frequency
27.	Gain Marg	-43.365 dB	System Information	Bode Plot Gain Margin
28.	Iout	200.0 mA	System Information	Iout operating point
29.	L Ipp	369.542 mA	System Information	Peak-to-peak inductor ripple current
30.	Low Freq Gain	59.898 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	55.421 deg	System Information	Bode Plot Phase Margin
33.	Pout	1.3 W	System Information	Total output power
34.	Vin	15.0 V	System Information	Vin operating point
35.	Vin p-p	20.293 mV	System Information	Peak-to-peak input voltage
36.	Vout	6.5 V	System Information	Operational Output Voltage

#	Name	Value	Category	Description
37.	Vout Actual	6.49 V	System Information	Vout Actual calculated based on selected voltage divider resistors
38.	Vout Tolerance	4.252 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	5.629 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	15.0	Maximum input voltage
VinMin	14.0	Minimum input voltage
Vout	6.5	Output Voltage
base_pn	TPSM365R3	Base Product Number
source	DC	Input Source Type
Ta	70.0	Ambient temperature
UserFsw	1000.0 k	Customer Selected Frequency

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

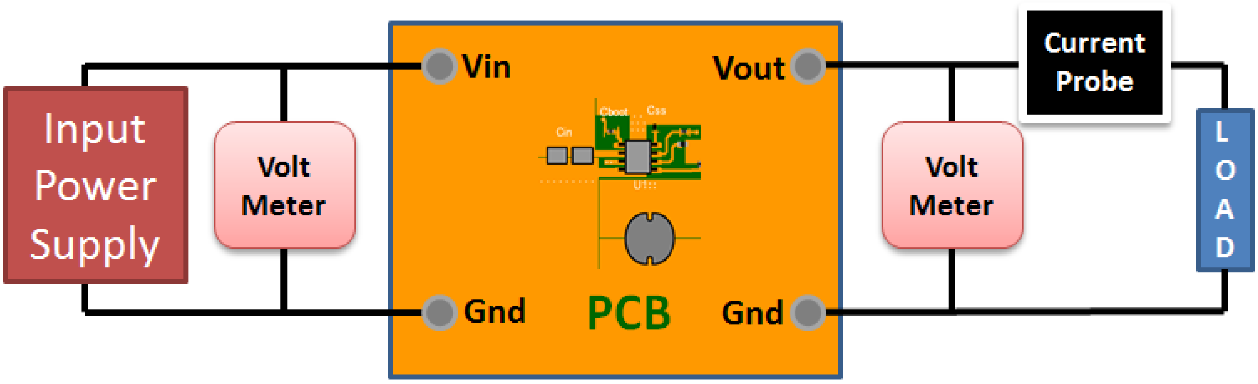
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 14.0V 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 : 45C2F5646F1C5D9C2BD9140D9F80B456[v1]

2. **TPSM365R3** Product Folder : https://www.ti.com/product/TPSM365R3 : contains the data sheet and other resources.

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