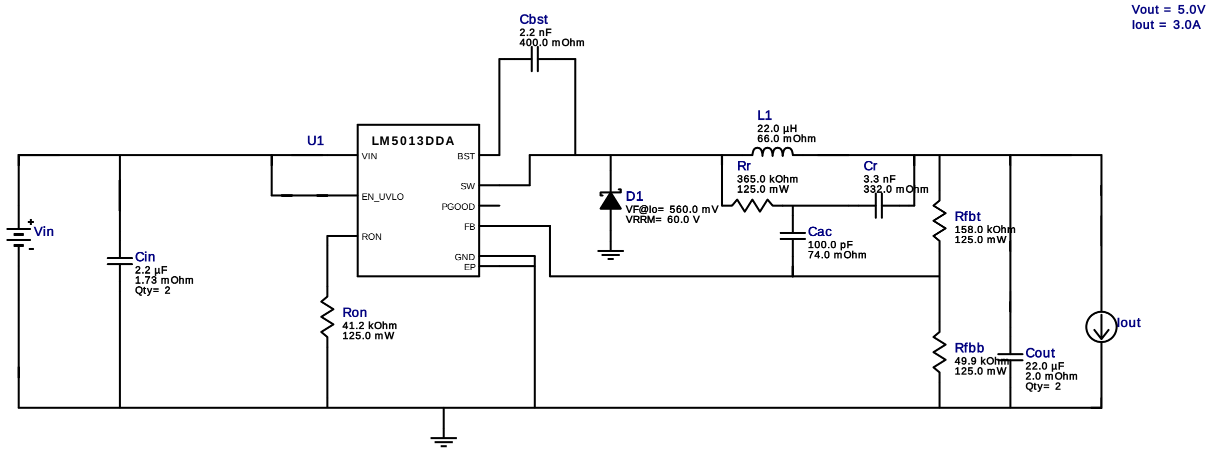
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 48.0V
VinMax = 48.0V
Vout = 5.0V
Iout = 3.0A

Device = LM5013DDAR
Topology = Buck
Created = 2025-01-20 10:05:03.461
BOM Cost = $3.57
BOM Count = 14
Total Pd = 2.54W

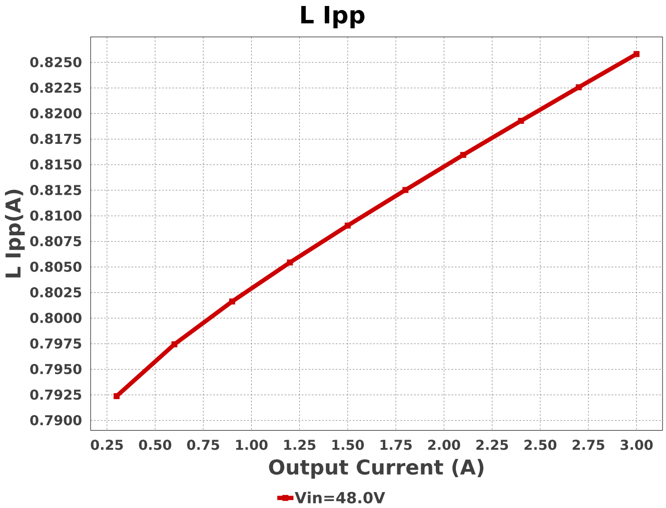
Design : 17 LM5013DDAR
LM5013DDAR 48V-48V to 5.00V @ 3A

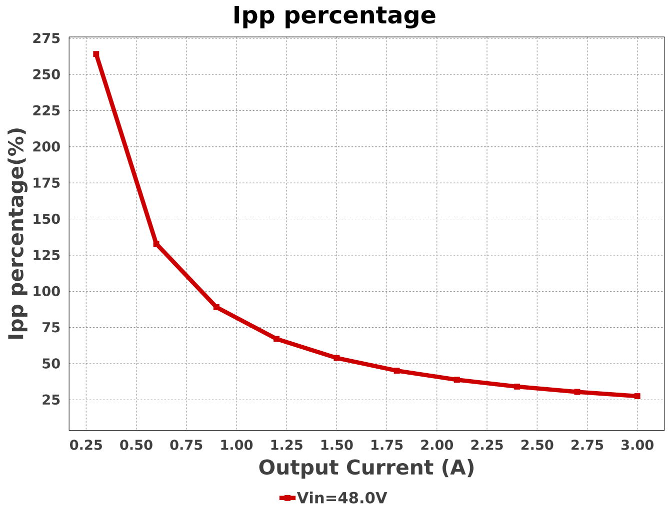


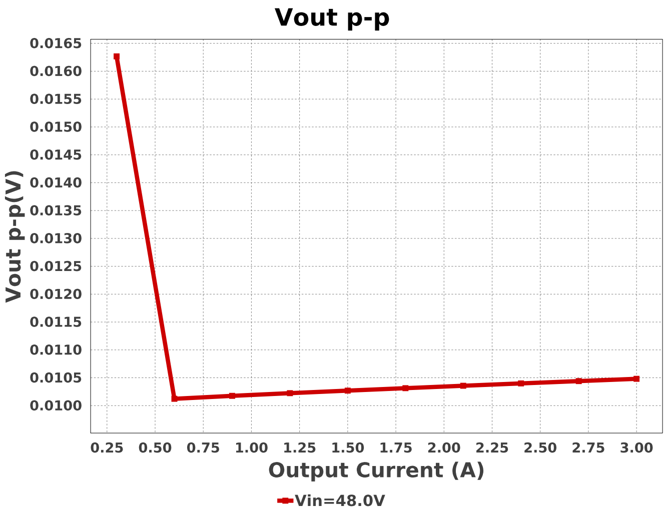
Electrical BOM

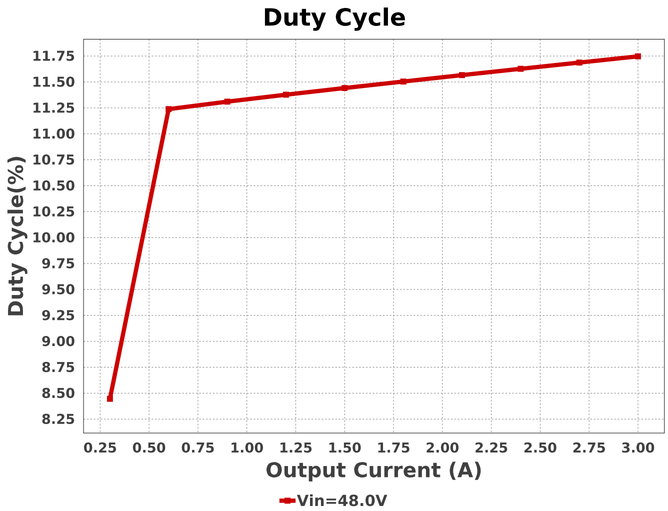
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	Kemet	C0805C101K5GACTU Series= C0G/NP0	Cap= 100.0 pF ESR= 74.0 mOhm VDC= 50.0 V IRMS= 524.0 mA	1	$0.01	0805 7 mm^2
Cbst	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm^2
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	2	$0.21	1210_250 15 mm^2
Cout	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	2	$0.23	1210 15 mm^2
Cr	Kemet	C0805C332K5RACTU Series= X7R	Cap= 3.3 nF ESR= 332.0 mOhm VDC= 50.0 V IRMS= 319.0 mA	1	$0.01	0805 7 mm^2
D1	Diodes Inc.	PDS760-13	VF@Io= 560.0 mV VRRM= 60.0 V	1	$0.36	PowerDI5 50 mm^2
L1	Vishay-Dale	IHLP4040DZER220M11	L= 22.0 µH 66.0 mOhm	1	$0.72	IHLP-4040DZ 166 mm^2
Rfbb	Vishay-Dale	CRCW080549K9FKEA Series= CRCW..e3	Res= 49.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbt	Vishay-Dale	CRCW0805158KFKEA Series= CRCW..e3	Res= 158.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2

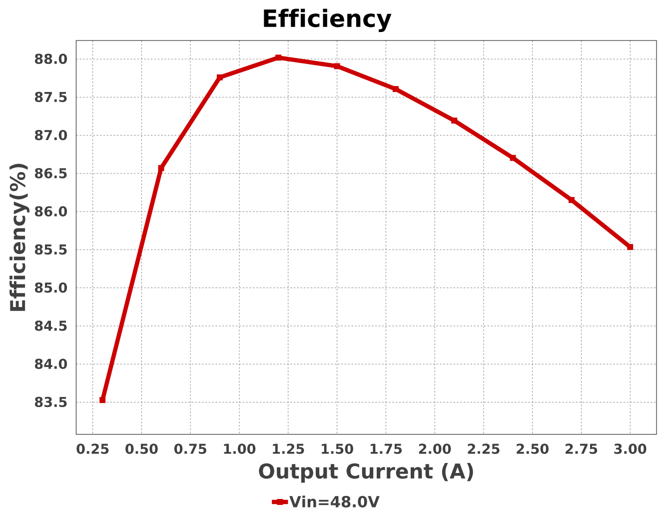
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ron	Vishay-Dale	CRCW080541K2FKEA Series= CRCW..e3	Res= 41.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rr	Vishay-Dale	CRCW0805365KFKEA Series= CRCW..e3	Res= 365.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	LM5013DDAR	Switcher	1	$1.54	DDA0008E-MFG 55 mm^2

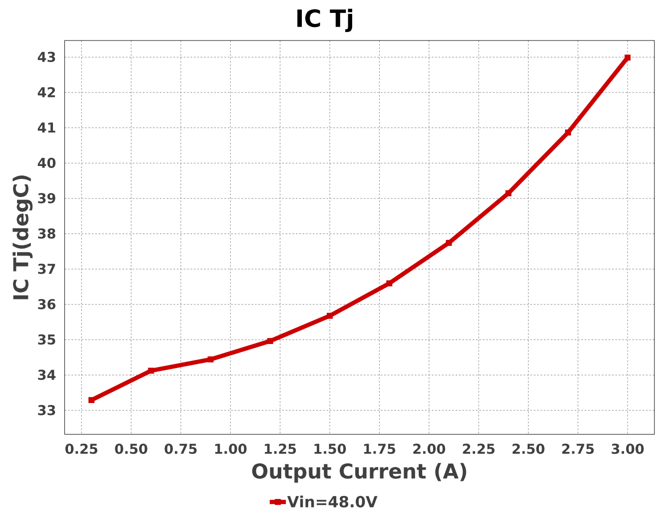


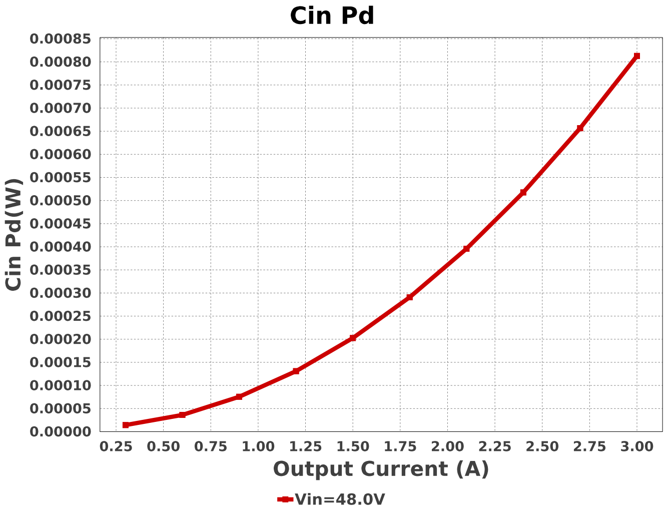


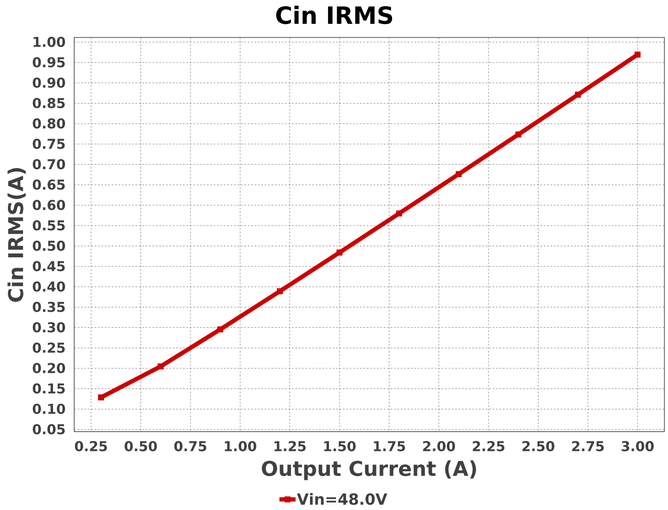


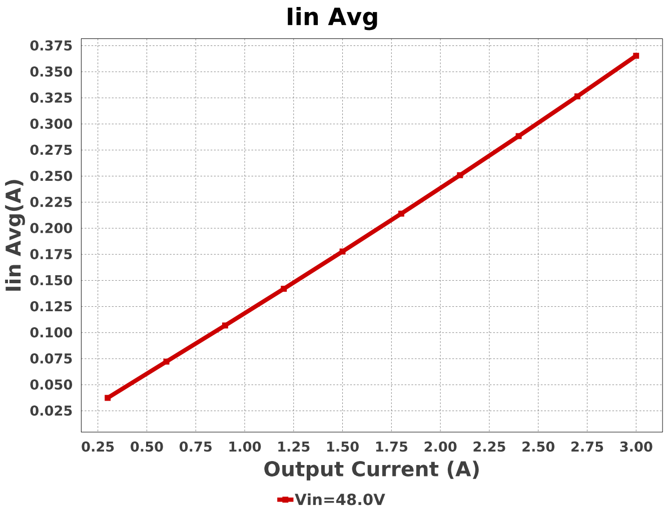


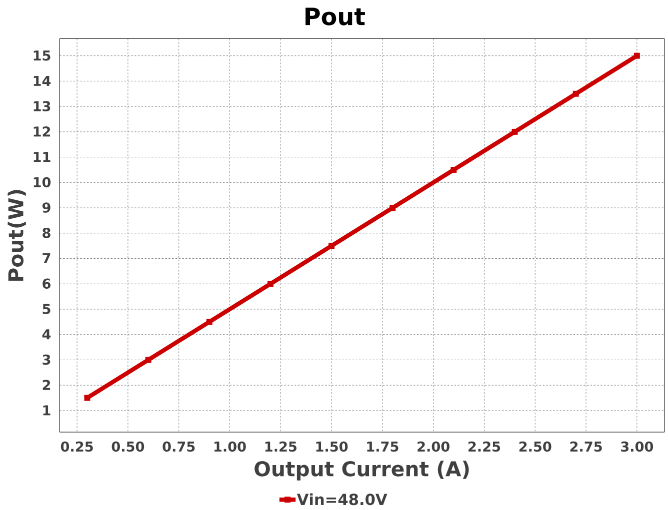


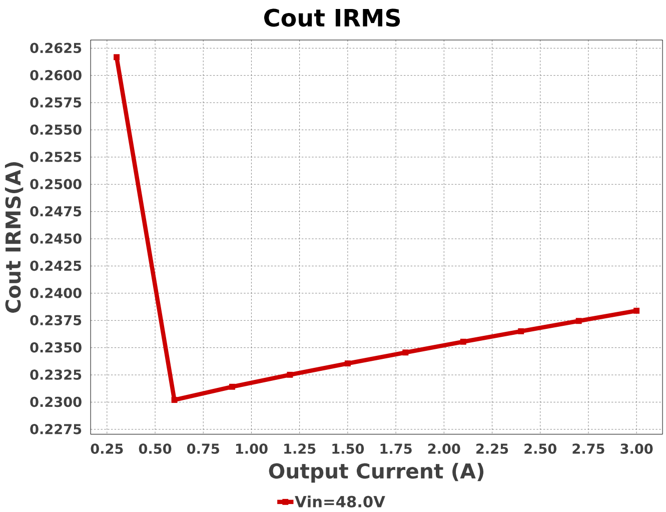


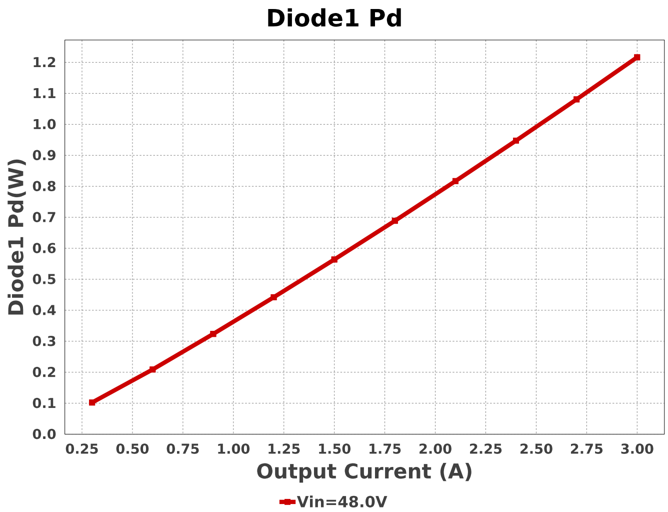

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=48.0V


Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=48.0V

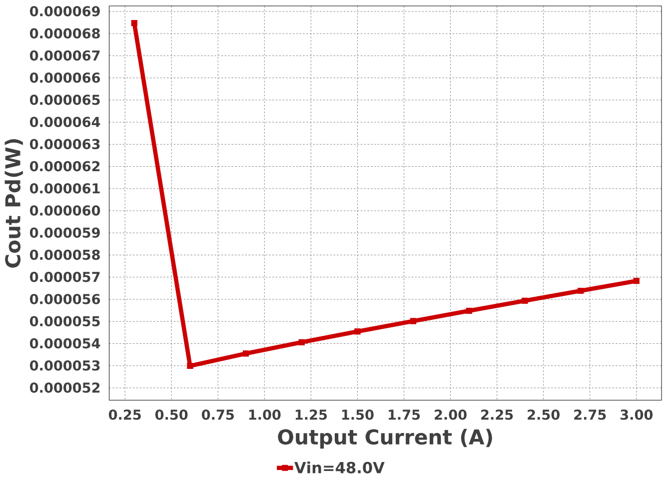

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=48.0V


Pout
Pout(W)
Output Current (A)
Vin=48.0V

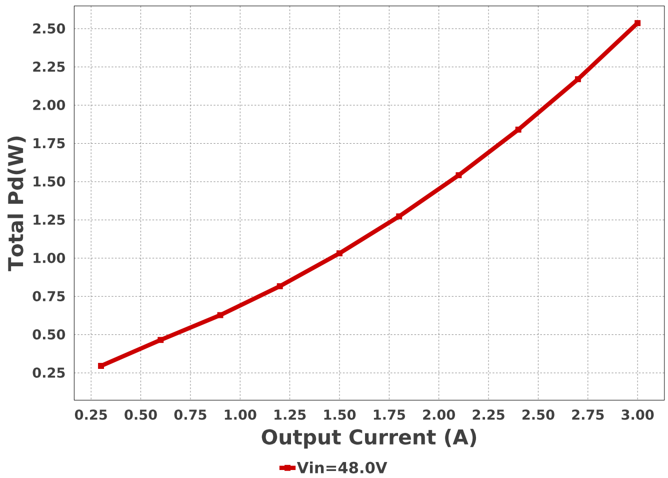

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=48.0V


Diode1 Pd
Diode1 Pd(W)
Output Current (A)
Vin=48.0V

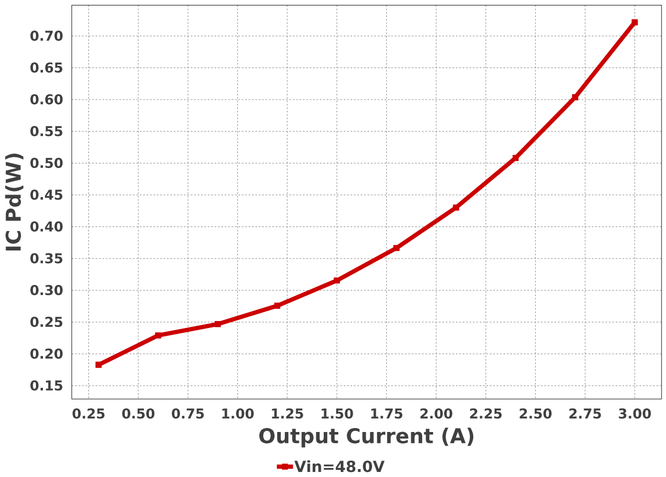
Cout Pd



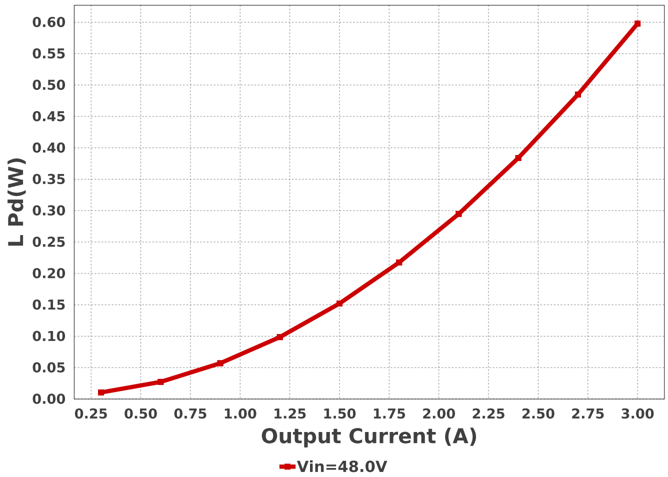
Total Pd



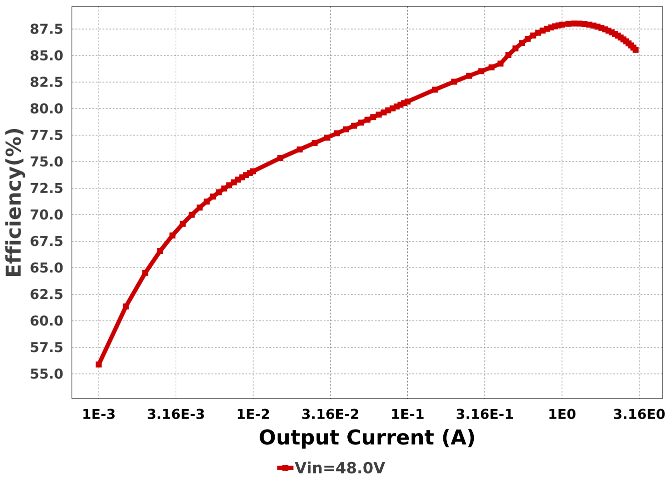
IC Pd



L Pd



Efficiency (Log-Scale)



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	14		Total Design BOM count
2.	Total BOM	$3.573		Total BOM Cost
3.	Cin IRMS	969.385 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	812.85 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	238.393 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	56.831 µW	Capacitor	Output capacitor power dissipation
7.	Diode1 Pd	1.216 W	Diode	Diode1 power dissipation
8.	IC Pd	721.47 mW	IC	IC power dissipation
9.	IC Tj	42.986 degC	IC	IC junction temperature
10.	IC Tolerance	19.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	18.0 degC/W	IC	IC junction-to-ambient thermal resistance

#	Name	Value	Category	Description
12.	Iin Avg	365.35 mA	IC	Average input current
13.	Ipp percentage	27.527 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	825.817 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	597.75 mW	Inductor	Inductor power dissipation
16.	Cin Pd	812.85 µW	Power	Input capacitor power dissipation
17.	Cout Pd	56.831 µW	Power	Output capacitor power dissipation
18.	Diode1 Pd	1.216 W	Power	Diode1 power dissipation
19.	IC Pd	721.47 mW	Power	IC power dissipation
20.	L Pd	597.75 mW	Power	Inductor power dissipation
21.	Total Pd	2.537 W	Power	Total Power Dissipation
22.	Duty Cycle	11.747 %	System Information	Duty cycle
23.	Efficiency	85.535 %	System Information	Steady state efficiency
24.	FootPrint	377.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	274.817 kHz	System Information	Switching frequency
26.	Iout	3.0 A	System Information	Iout operating point
27.	Mode	CCM	System Information	Conduction Mode
28.	Pout	15.0 W	System Information	Total output power
29.	Vin	48.0 V	System Information	Vin operating point
30.	Vout	5.0 V	System Information	Operational Output Voltage
31.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	3.143 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	10.481 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	48.0	Maximum input voltage
VinMin	48.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5013	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

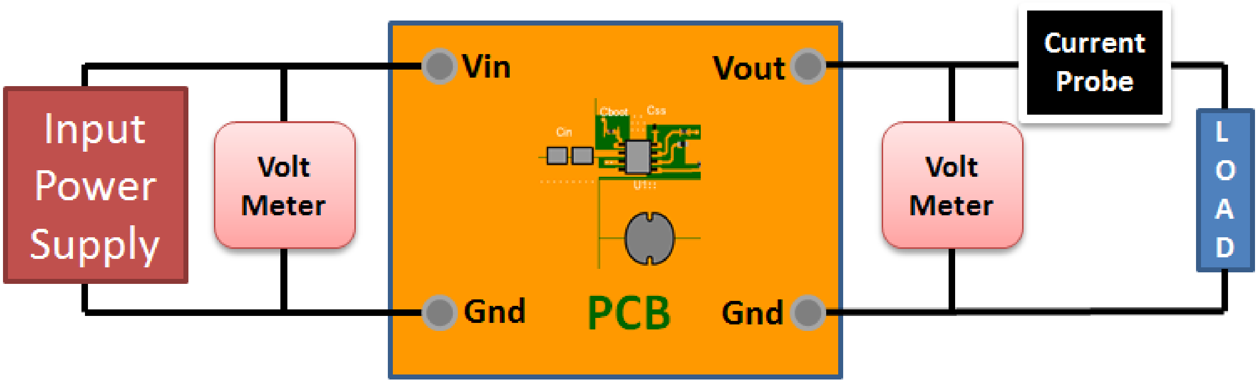
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 48.0V 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 : 8D46410E296FCE97B33F99C6313555A5[v1]

2. **LM5013** Product Folder : http://www.ti.com/product/LM5013 : contains the data sheet and other resources.

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