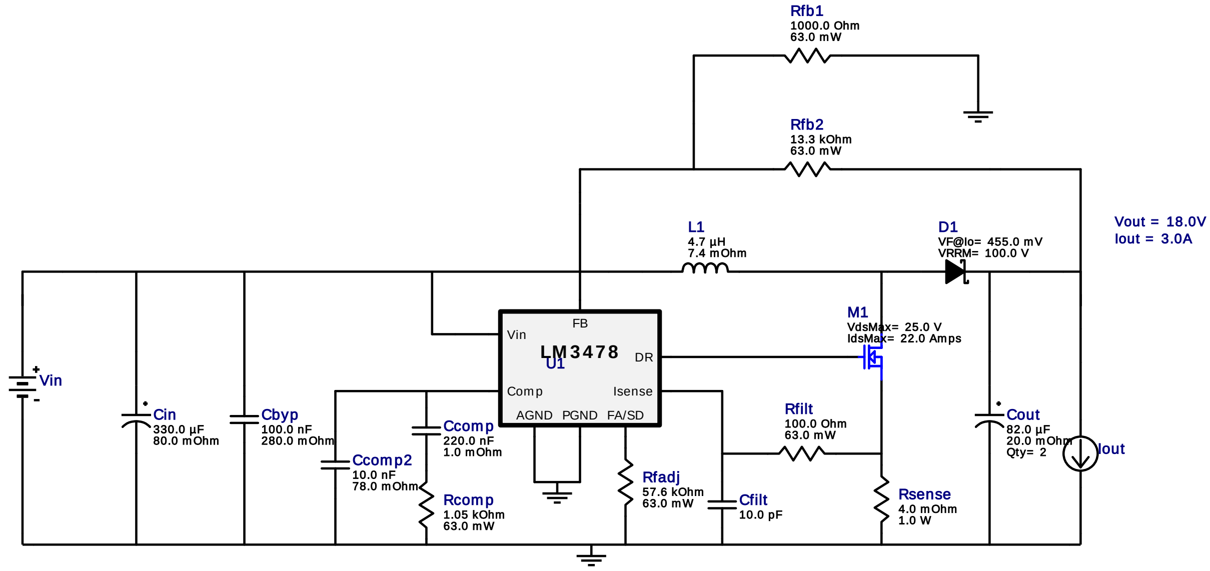
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 5.0V
VinMax = 14.0V
Vout = 18.0V
Iout = 3.0A

Device = LM3478MM/NOPB
Topology = Boost
Created = 2024-08-02 11:06:07.033
BOM Cost = NA
BOM Count = 17
Total Pd = 4.6W

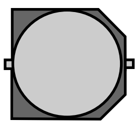
Design : 84 LM3478MM/NOPB
LM3478MM/NOPB 5V-14V to 18.00V @ 3A

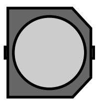


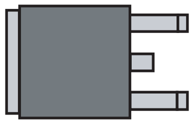
1. With the low turn of voltage of the LM34x8 your power supply may current limit before you reach your working input voltage. If this happens, or to preempt this from happening, you can include a low pass RC filter from input voltage to Vin on the IC. Make sure the rise time on the RC network is slower than your supply's rise time.

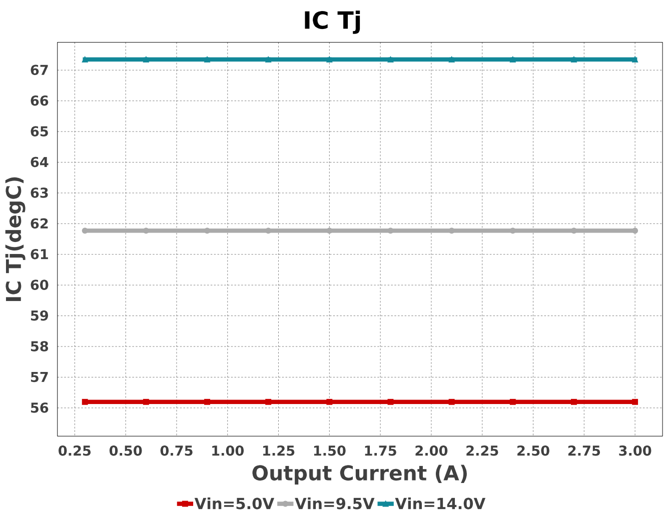
Electrical BOM

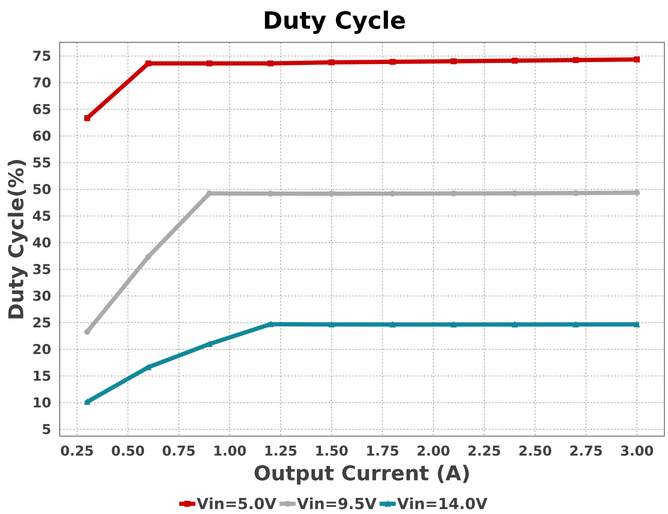
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbyp	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccomp	Kemet	C0603C224Z4VACTU Series= Y5V	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp2	AVX	08055C103KAT2A Series= X7R	Cap= 10.0 nF ESR= 78.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cfilt	Yageo	CC0805JRNPO9BN100 Series= C0G/NP0	Cap= 10.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	Panasonic	EEE-FK1V331P Series= FK	Cap= 330.0 uF ESR= 80.0 mOhm VDC= 35.0 V IRMS= 850.0 mA	1	$0.42	SM_RADIAL_G 172 mm^2
Cout	Panasonic	35SVPF82M Series= SVPF	Cap= 82.0 uF ESR= 20.0 mOhm VDC= 35.0 V IRMS= 4.0 A	2	$1.17	CAPSMT_62_E12 106 mm^2

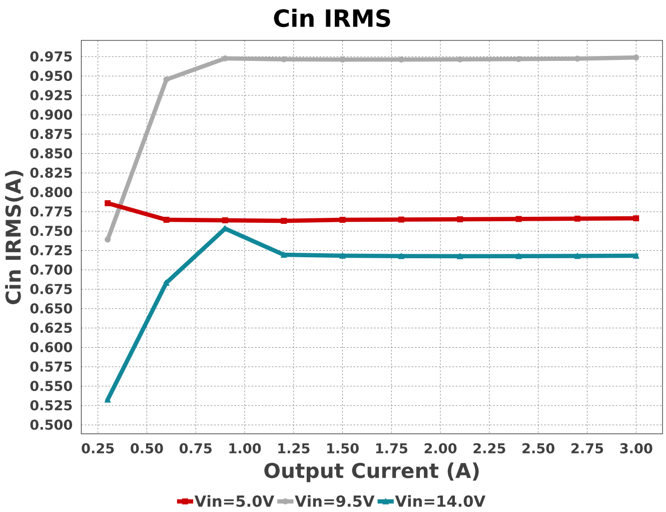


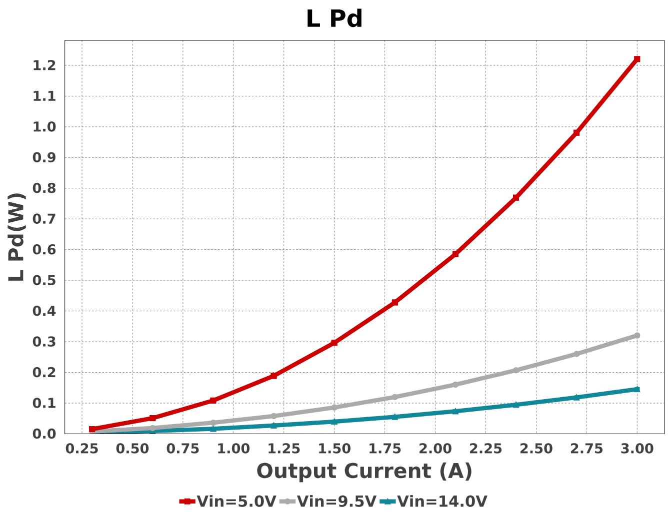


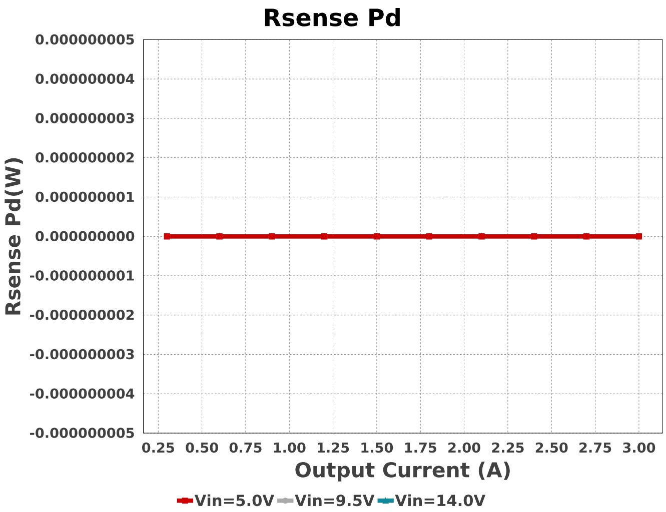
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D1	STMicroelectronics	STPS20M100SG-TR	VF@Io= 455.0 mV VRRM= 100.0 V	1	$1.94	 DDPAK 210 mm²
L1	CUSTOM	CUSTOM	L= 4.7 µH 7.4 mOhm	1	NA	 XAL1010 0 mm²
M1	Texas Instruments	CSD16327Q3	VdsMax= 25.0 V IdsMax= 22.0 Amps	1	$0.32	 DQG0008A 18 mm²
Rcomp	Vishay-Dale	CRCW04021K05FKED Series= CRCW..e3	Res= 1.05 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfadj	Vishay-Dale	CRCW040257K6FKED Series= CRCW..e3	Res= 57.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb2	Vishay-Dale	CRCW040213K3FKED Series= CRCW..e3	Res= 13.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfilt	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsense	Panasonic	ERJ-M1WTF4M0U Series= ERJ	Res= 4.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.17	 2512 43 mm²
U1	Texas Instruments	LM3478MM/NOPB	Switcher	1	$1.05	 MUA08A 24 mm²

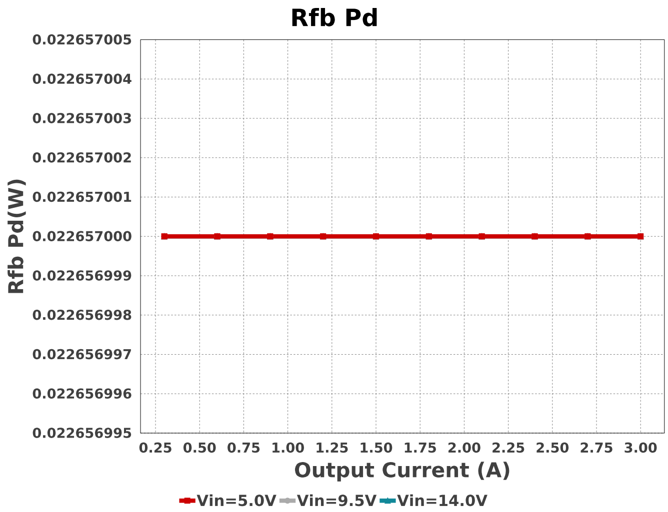


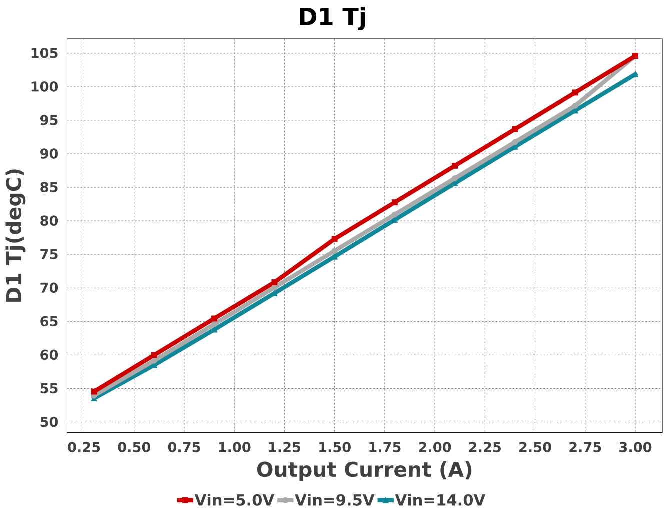


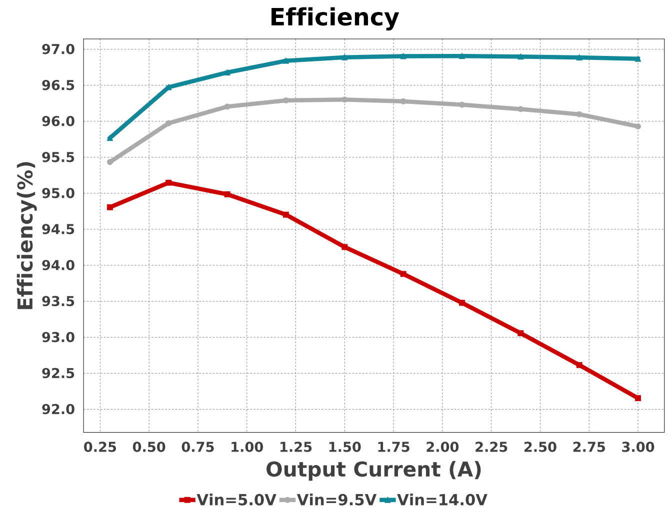

Cin IRMS
Cin IRMS(A)
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0.800
0.775
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

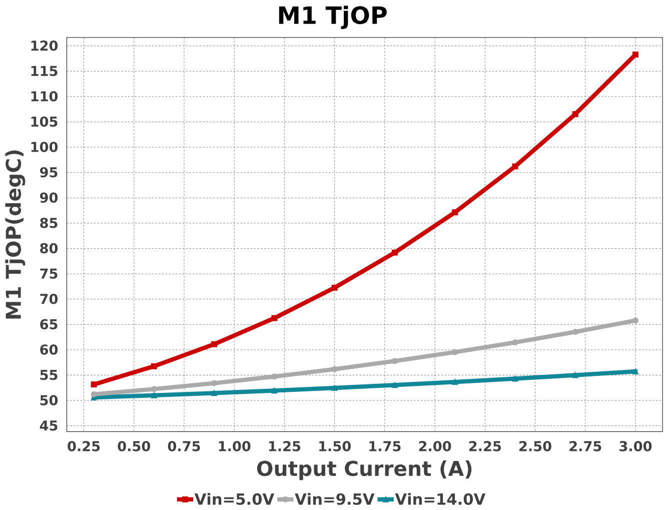

L Pd
L Pd(W)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

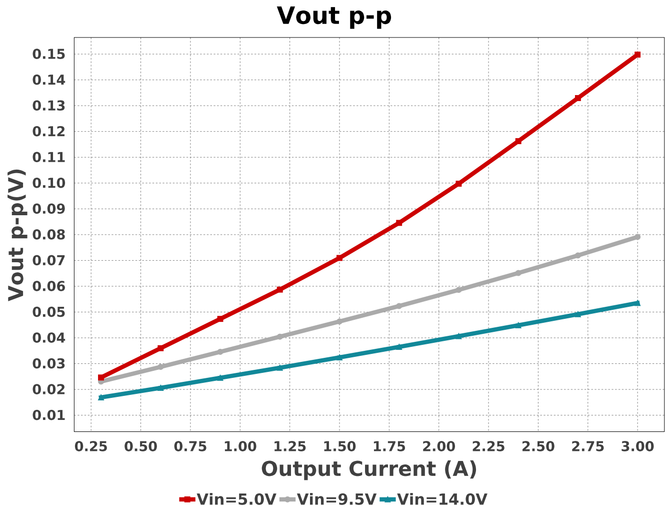

Rsense Pd
Rsense Pd(W)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

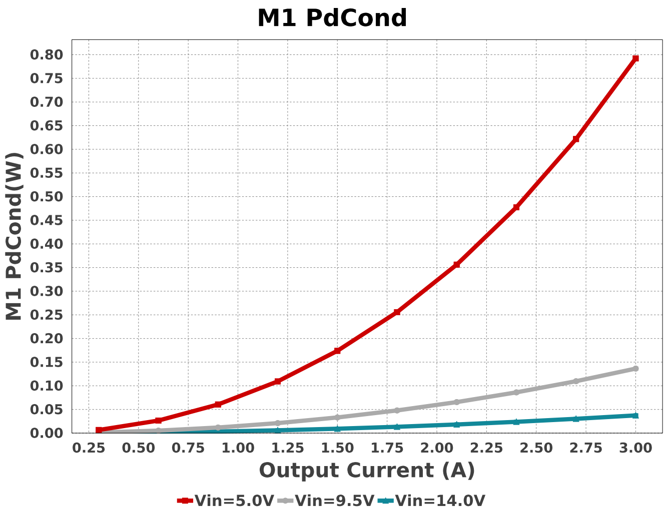

Rfb Pd
Rfb Pd(W)
0.022657005
0.022657004
0.022657003
0.022657002
0.022657001
0.022657000
0.022656999
0.022656998
0.022656997
0.022656996
0.022656995
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

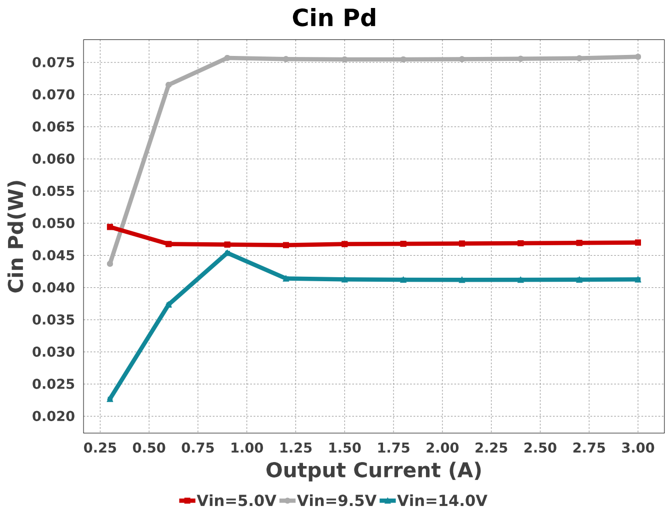

D1 Tj
D1 Tj(degC)
105
100
95
90
85
80
75
70
65
60
55
50
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

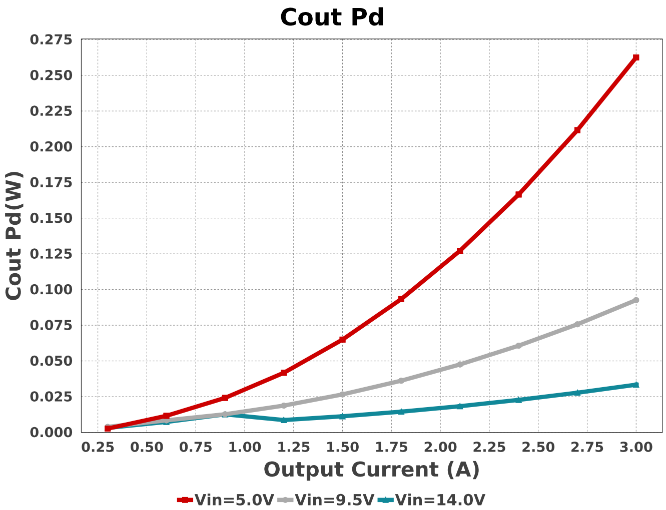

Efficiency
Efficiency(%)
97.0
96.5
96.0
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

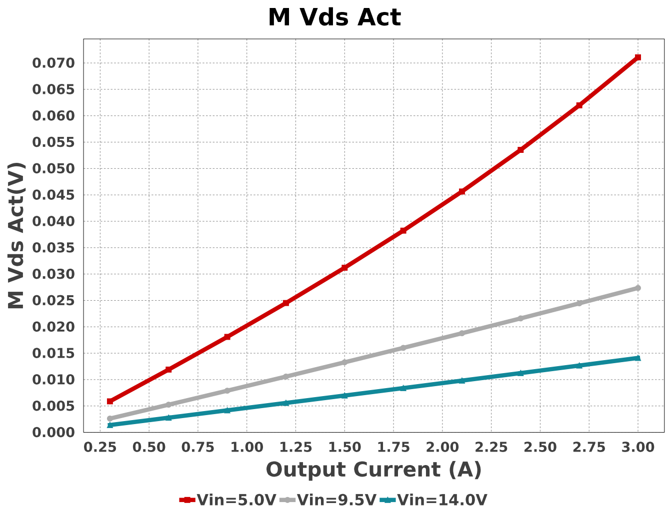

M1 TjOP
M1 TjOP(degC)
120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

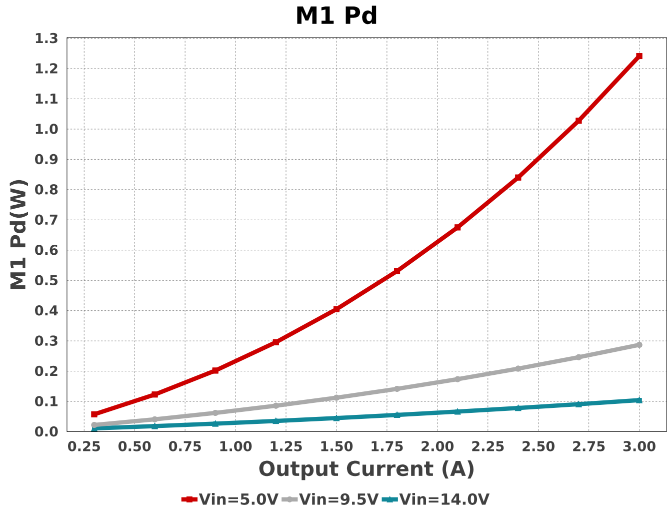

Vout p-p
Vout p-p(V)
0.15 0.14 0.13 0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

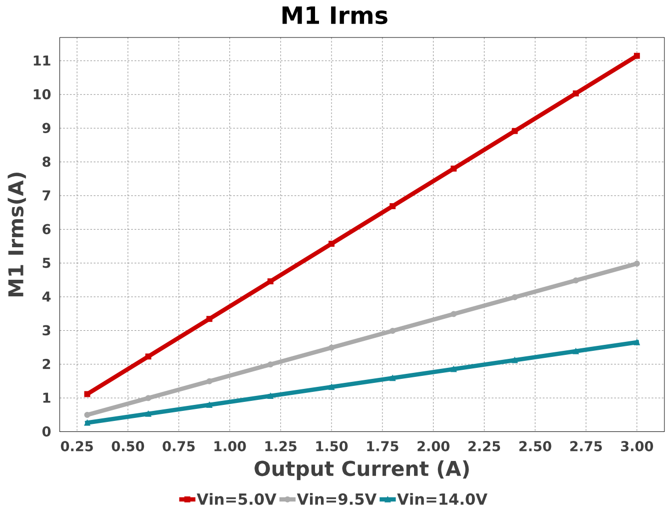

M1 PdCond
M1 PdCond(W)
0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 0.20 0.15 0.10 0.05 0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

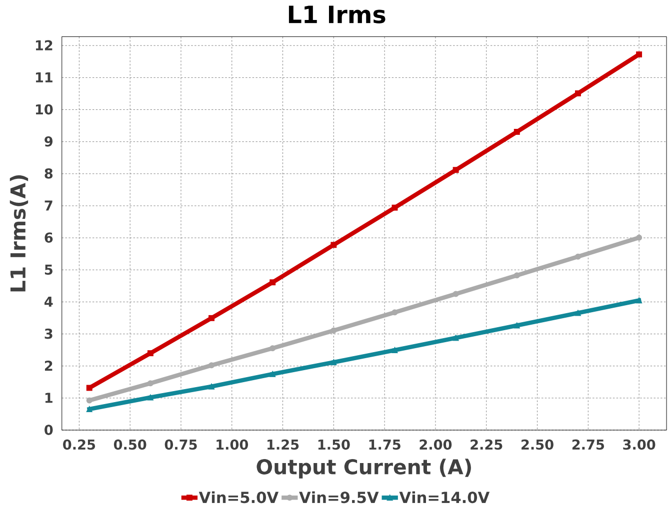

Cin Pd
Cin Pd(W)
0.075 0.070 0.065 0.060 0.055 0.050 0.045 0.040 0.035 0.030 0.025 0.020
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

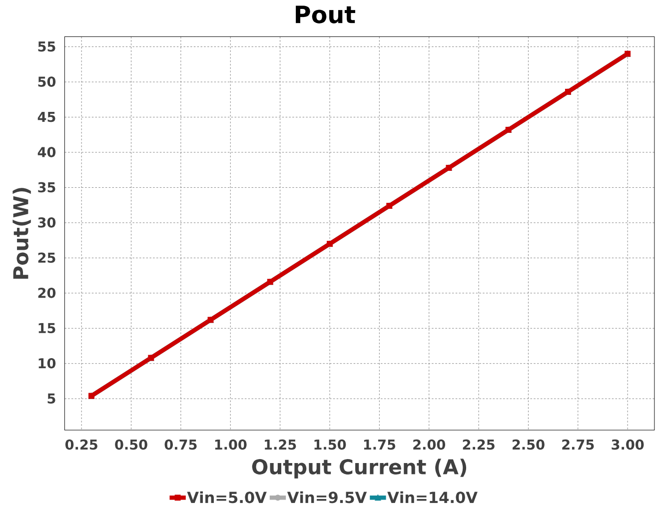

Cout Pd
Cout Pd(W)
0.275 0.250 0.225 0.200 0.175 0.150 0.125 0.100 0.075 0.050 0.025 0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

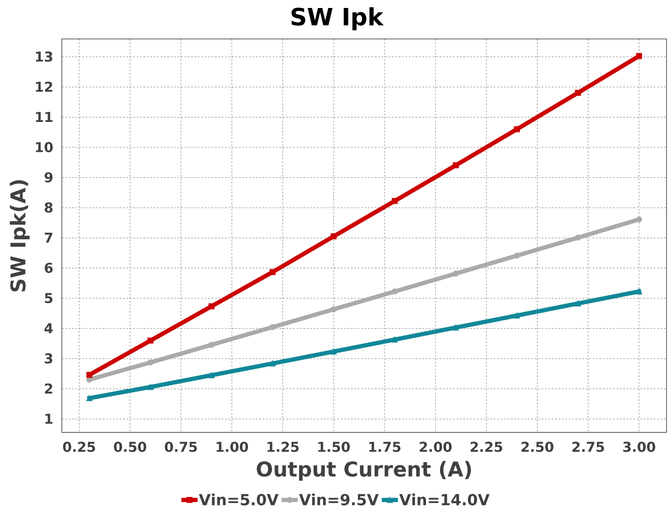

M Vds Act
M Vds Act(V)
0.070 0.065 0.060 0.055 0.050 0.045 0.040 0.035 0.030 0.025 0.020 0.015 0.010 0.005 0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

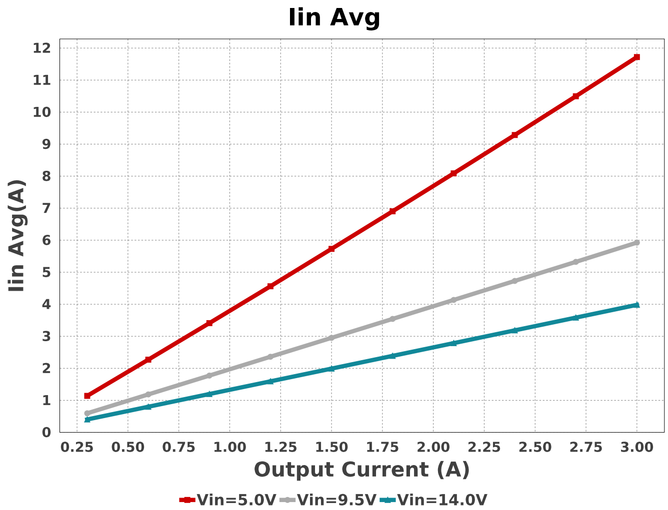

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

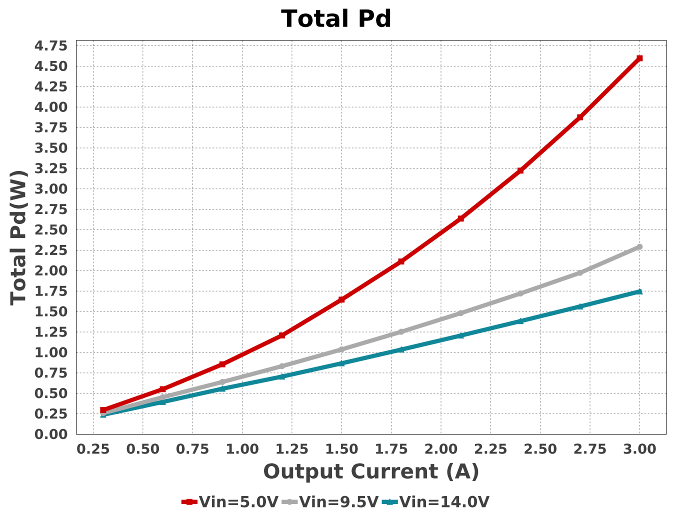

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

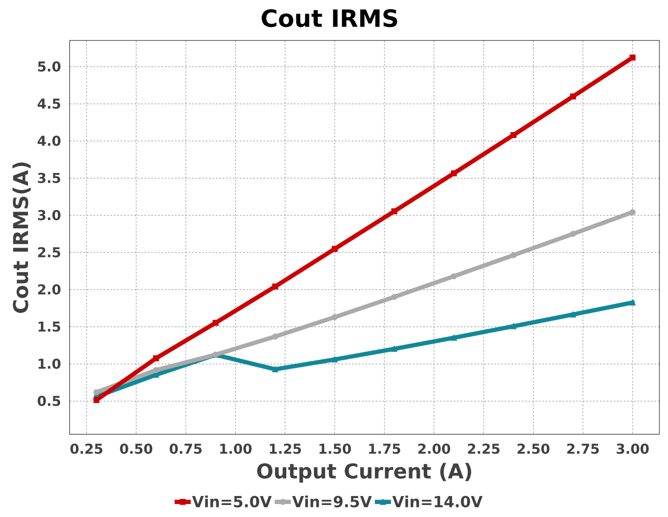

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

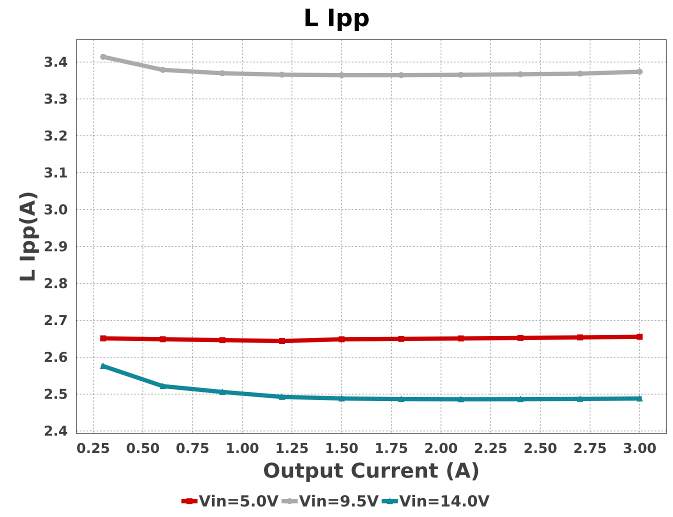

Pout
Pout(W)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

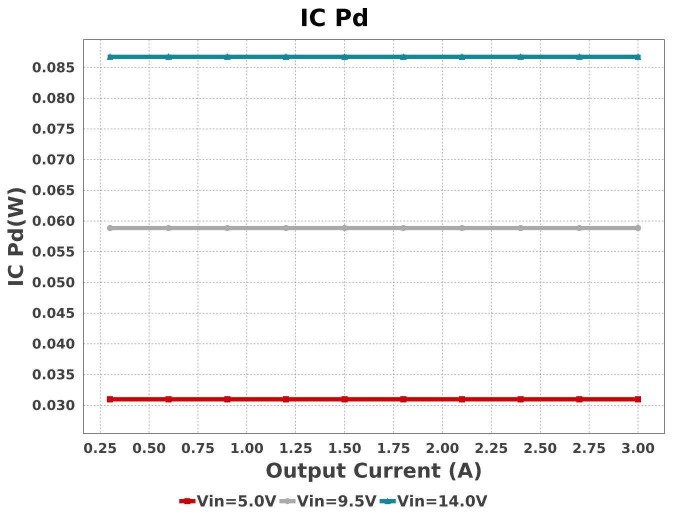

SW Ipk
SW Ipk(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

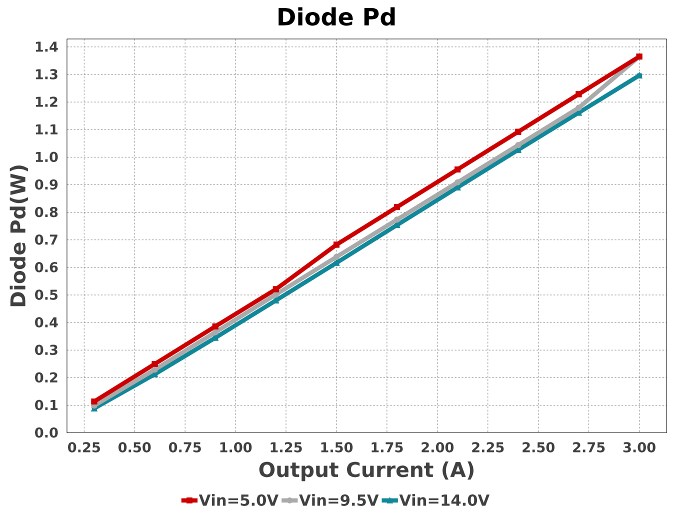

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

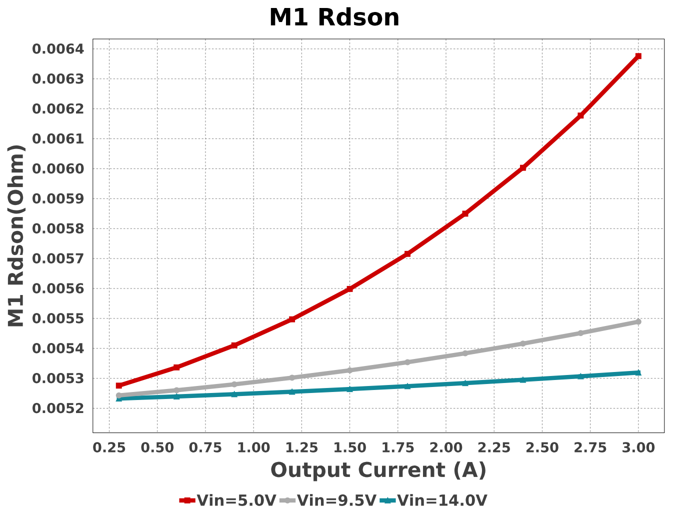

Total Pd
Total Pd(W)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

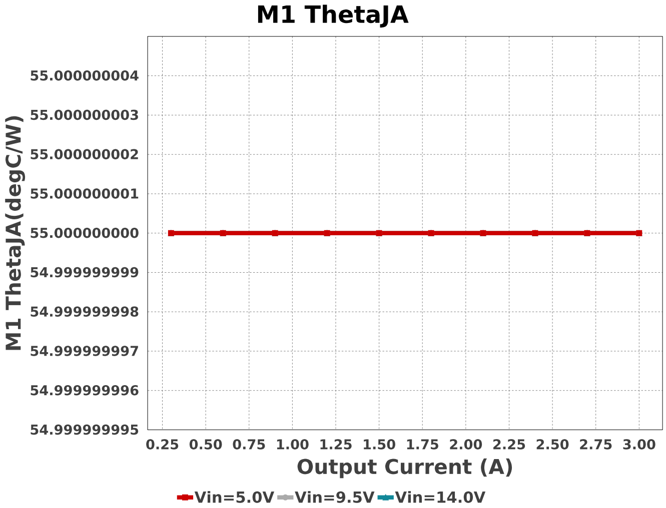

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

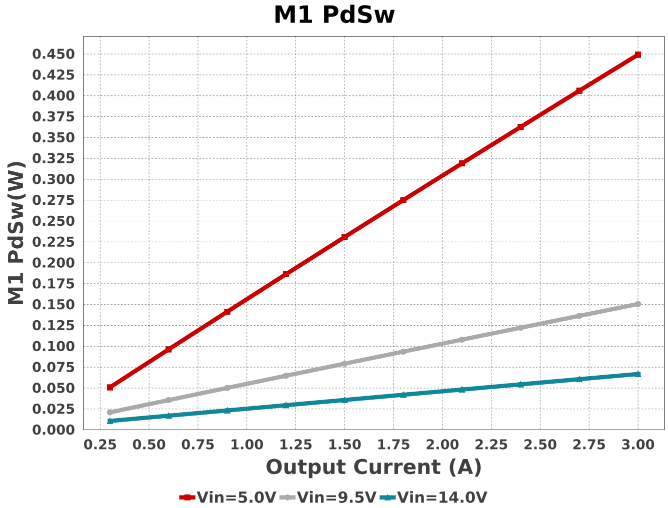

L Ipp
L Ipp(A)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V

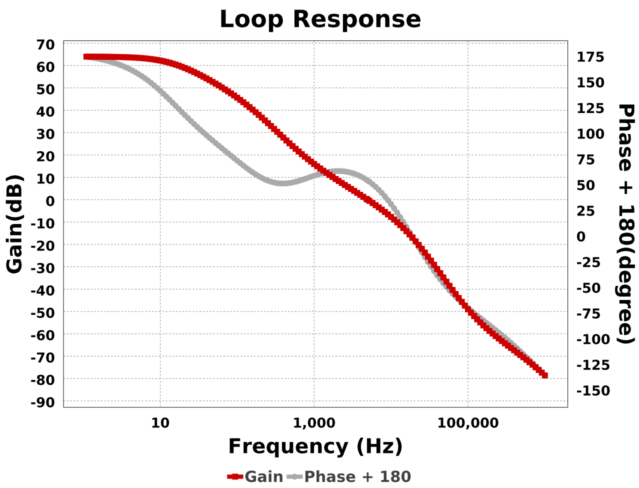

IC Pd
IC Pd(W)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V


Diode Pd
Diode Pd(W)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V


M1 Rdson
M1 Rdson(Ohm)
Output Current (A)
Vin=5.0V Vin=9.5V Vin=14.0V







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	17		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	766.504 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	47.002 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	5.123 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	262.46 mW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	104.6 degC	Diode	D1 junction temperature
8.	Diode Pd	1.365 W	Diode	Diode power dissipation
9.	IC Pd	30.978 mW	IC	IC power dissipation
10.	IC Tj	56.196 degC	IC	IC junction temperature
11.	IC Tolerance	24.3 mV	IC	IC Feedback Tolerance
12.	ICThetaJA	200.0 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	11.719 A	IC	Average input current
14.	L Ipp	2.655 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	1.22 W	Inductor	Inductor power dissipation
16.	L1 Irms	11.723 A	Inductor	Inductor ripple current
17.	M Vds Act	71.07 mV	Mosfet	M Vds
18.	M1 Irms	11.147 A	Mosfet	M1 MOSFET Irms
19.	M1 Pd	1.241 W	Mosfet	M1 MOSFET total power dissipation
20.	M1 PdCond	792.19 mW	Mosfet	M1 MOSFET conduction losses
21.	M1 PdSw	449.14 mW	Mosfet	M1 MOSFET switching losses
22.	M1 Rdson	6.376 mOhm	Mosfet	Drain-Source On-resistance
23.	M1 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
24.	M1 TjOP	118.273 degC	Mosfet	M1 MOSFET junction temperature
25.	Cin Pd	47.002 mW	Power	Input capacitor power dissipation
26.	Cout Pd	262.46 mW	Power	Output capacitor power dissipation
27.	Diode Pd	1.365 W	Power	Diode power dissipation
28.	IC Pd	30.978 mW	Power	IC power dissipation
29.	L Pd	1.22 W	Power	Inductor power dissipation
30.	M1 Pd	1.241 W	Power	M1 MOSFET total power dissipation
31.	M1 PdCond	792.19 mW	Power	M1 MOSFET conduction losses
32.	M1 PdSw	449.14 mW	Power	M1 MOSFET switching losses

#	Name	Value	Category	Description
33.	Rfb Pd	22.657 mW	Power	Rfb Power Dissipation
34.	Rsense Pd	0.0 W	Power	LED Current Rsns Power Dissipation
35.	Total Pd	4.597 W	Power	Total Power Dissipation
36.	Rfb Pd	22.657 mW	Resistor	Rfb Power Dissipation
37.	Rsense Pd	0.0 W	Resistor	LED Current Rsns Power Dissipation
38.	Cross Freq	1.901 kHz	System Information	Bode plot crossover frequency
39.	Duty Cycle	74.355 %	System Information	Duty cycle
40.	Efficiency	92.155 %	System Information	Steady state efficiency
41.	FootPrint	879.0 mm^2	System Information	Total Foot Print Area of BOM components
42.	Frequency	295.118 kHz	System Information	Switching frequency
43.	Gain Marg	-15.708 dB	System Information	Bode Plot Gain Margin
44.	Iout	3.0 A	System Information	Iout operating point
45.	Low Freq Gain	54.598 dB	System Information	Gain at 1Hz
46.	Mode	CCM	System Information	Conduction Mode
47.	Phase Marg	58.018 deg	System Information	Bode Plot Phase Margin
48.	Pout	54.0 W	System Information	Total output power
49.	SW Ipk	13.026 A	System Information	Peak switch current
50.	Vin	5.0 V	System Information	Vin operating point
51.	Vout	18.0 V	System Information	Operational Output Voltage
52.	Vout Actual	18.018 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	3.844 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	149.796 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	14.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
VinTyp	12.0	Typical input voltage
Vout	18.0	Output Voltage
base_pn	LM3478	Base Product Number
source	DC	Input Source Type
Ta	50.0	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

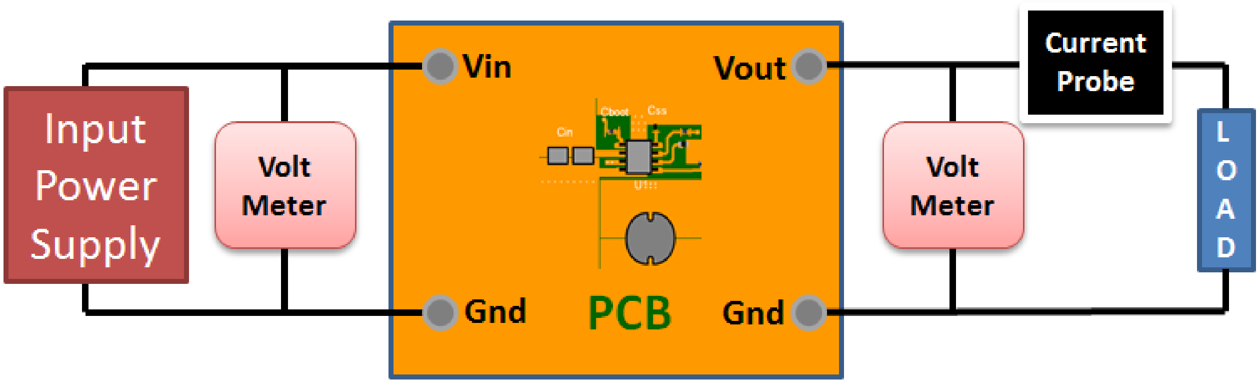
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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 : F9884934EAC7C183[v1]

2. **LM3478** Product Folder : http://www.ti.com/product/LM3478 : contains the data sheet and other resources.

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