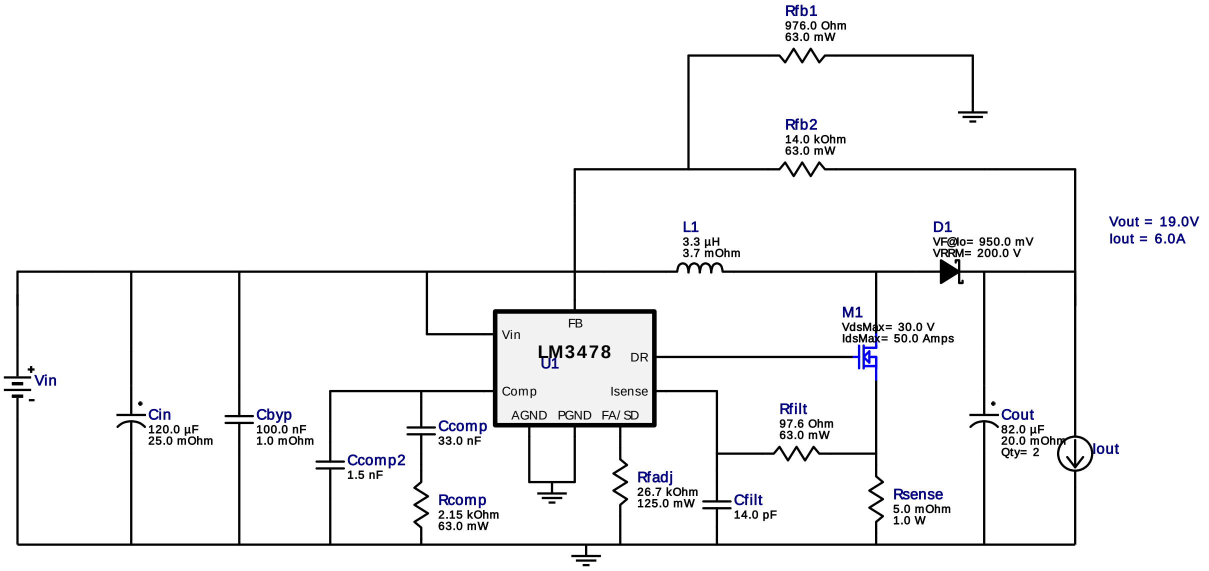
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 10.6V
VinMax = 12.6V
Vout = 19.0V
Iout = 6.0A

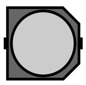
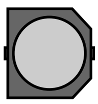
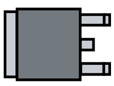
Device = LM3478MMX/NOPB
Topology = Boost
Created = 2019-04-02 19:34:18.540
BOM Cost = $5.00
BOM Count = 17
Total Pd = 8.35W

Design : 56 LM3478MMX/NOPB
LM3478MMX/NOPB 10.6V-12.6V to 19.00V @ 6A

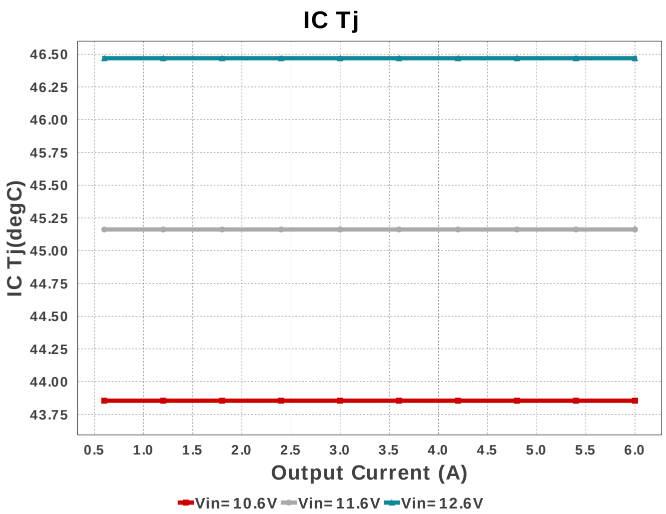


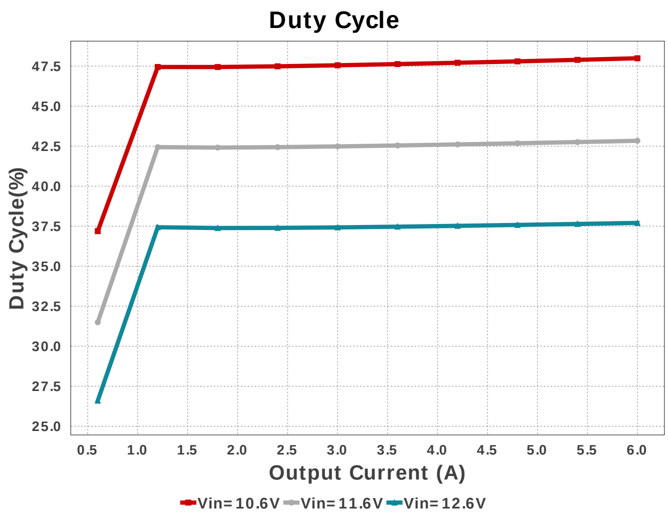
1. With the low turn of voltage of the LM34x8 your power supply may current limit before you reach your working input voltage. If this happens, or to preempt this from happening, you can include a low pass RC filter from input voltage to Vin on the IC. Make sure the rise time on the RC network is slower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

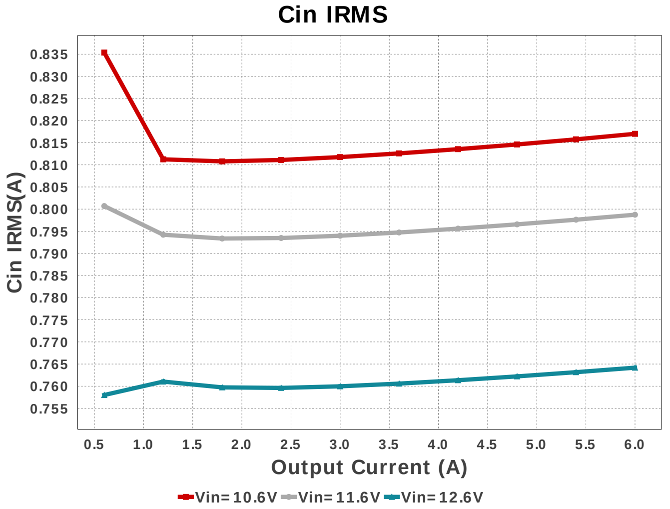
Electrical BOM

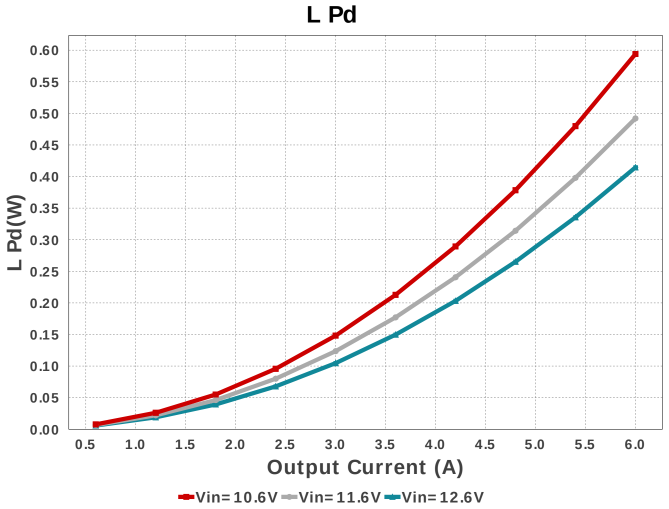
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbyp	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	TDK	CGA4J2C0G1H333J125AA Series= C0G/NP0	Cap= 33.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	0805 7 mm²
Ccomp2	MuRata	GRM2195C1H152JA01D Series= C0G/NP0	Cap= 1.5 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
Cfilt	Samsung Electro-Mechanics	CL21C140JBANNNC Series= C0G/NP0	Cap= 14.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	Panasonic	20SVPF120M Series= SVPF	Cap= 120.0 uF ESR= 25.0 mOhm VDC= 20.0 V IRMS= 3.2 A	1	$0.44	 CAPSMT_62_F61 74 mm²
Cout	Panasonic	35SVPF82M Series= SVPF	Cap= 82.0 uF ESR= 20.0 mOhm VDC= 35.0 V IRMS= 4.0 A	2	$0.63	 CAPSMT_62_E12 106 mm²
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm²

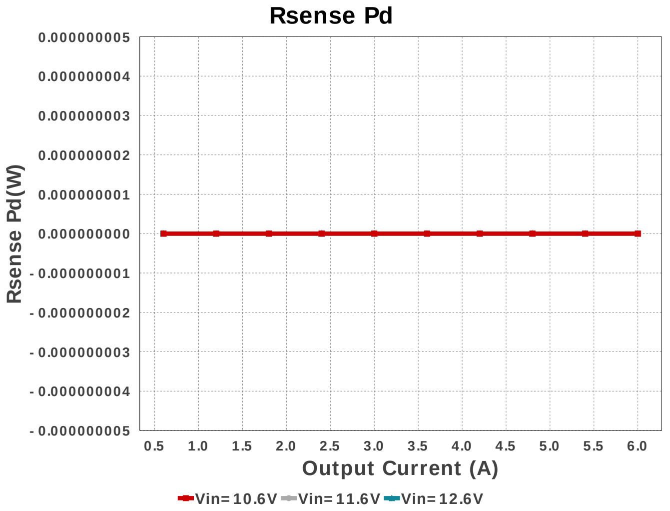
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	XAL1010-332MEB	L= 3.3 µH 3.7 mOhm	1	$1.71	XAL1010 160 mm^2
M1	Texas Instruments	CSD17308Q3	VdsMax= 30.0 V IdsMax= 50.0 Amps	1	$0.25	DQG0008A 18 mm^2
Rcomp	Vishay-Dale	CRCW04022K15FKED Series= CRCW..e3	Res= 2.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfadj	Vishay-Dale	CRCW080526K7FKEA Series= CRCW..e3	Res= 26.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfb1	Vishay-Dale	CRCW0402976RFKED Series= CRCW..e3	Res= 976.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfb2	Vishay-Dale	CRCW040214K0FKED Series= CRCW..e3	Res= 14.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfilt	Vishay-Dale	CRCW040297R6FKED Series= CRCW..e3	Res= 97.6 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Susumu Co Ltd	PRL1632-R005-F-T1 Series= PRL1632	Res= 5.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	0612 11 mm^2
U1	Texas Instruments	LM3478MMX/NOPB	Switcher	1	$0.83	MUA08A 24 mm^2

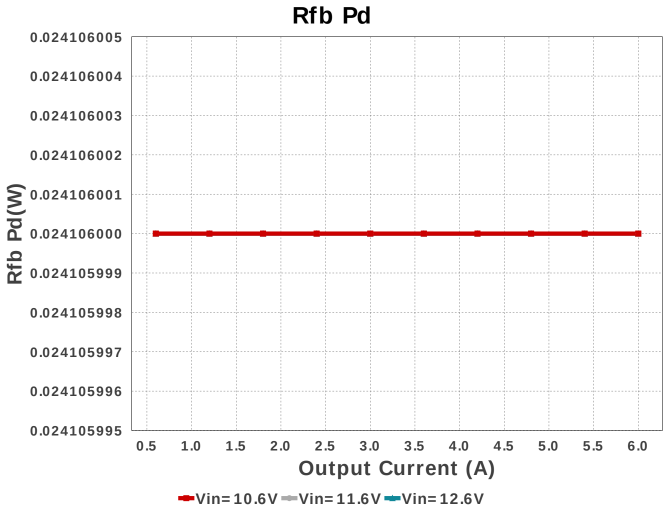


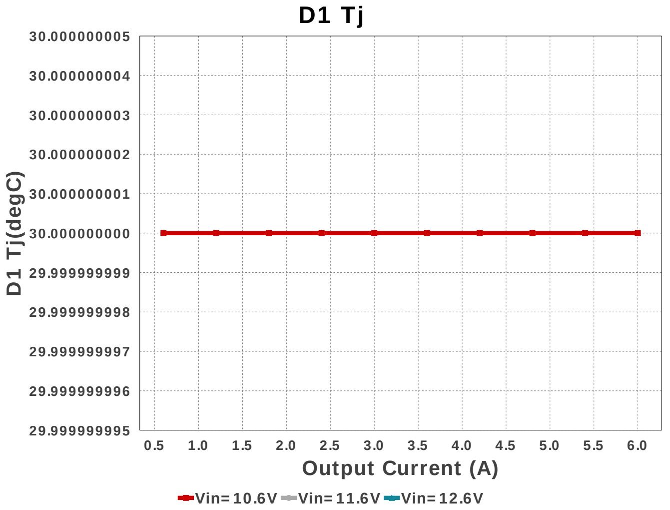


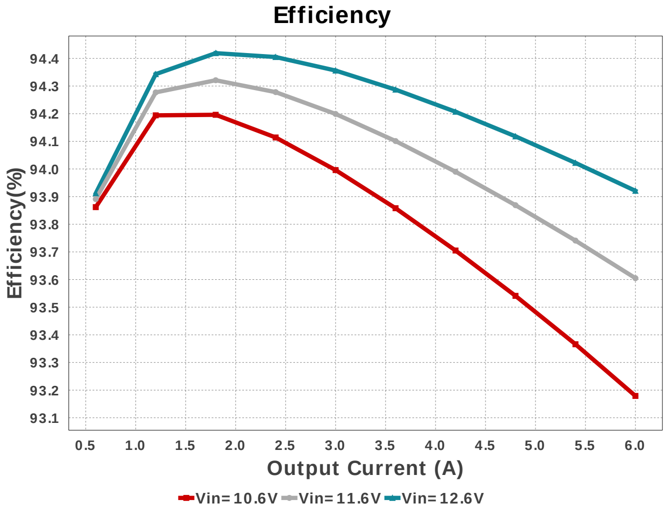

Cin IRMS
Cin IRMS(A)
0.835
0.830
0.825
0.820
0.815
0.810
0.805
0.800
0.795
0.790
0.785
0.780
0.775
0.770
0.765
0.760
0.755
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

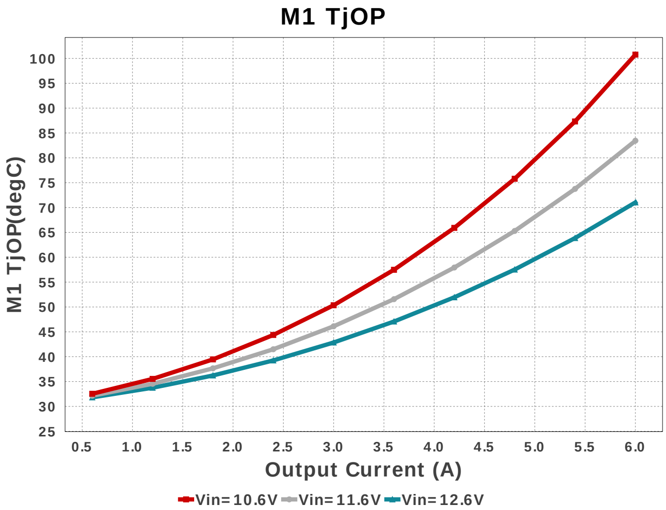

L Pd
L Pd(W)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

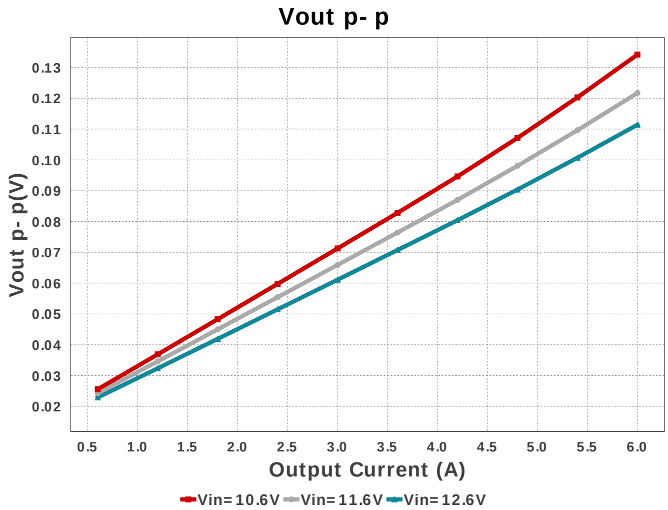

Rsense Pd
Rsense Pd(W)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
- 0.000000001
- 0.000000002
- 0.000000003
- 0.000000004
- 0.000000005
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

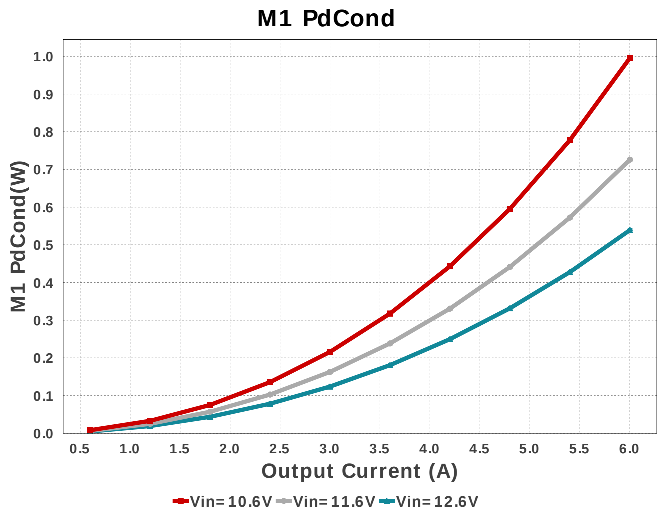

Rfb Pd
Rfb Pd(W)
0.024106005
0.024106004
0.024106003
0.024106002
0.024106001
0.024106000
0.024105999
0.024105998
0.024105997
0.024105996
0.024105995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

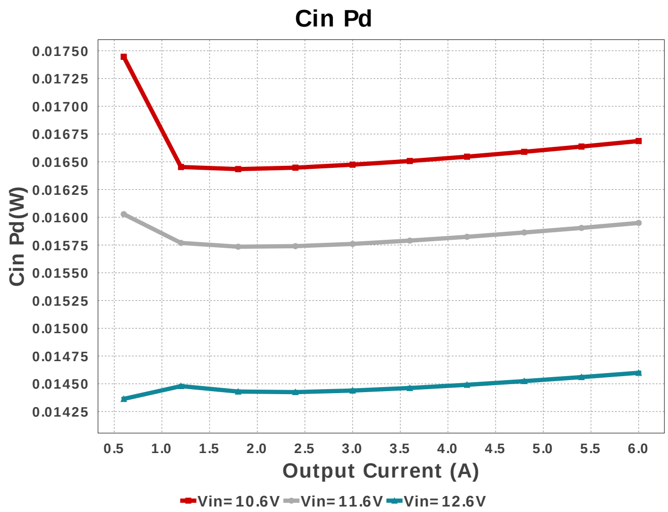

D1 Tj
D1 Tj(degC)
30.000000005
30.000000004
30.000000003
30.000000002
30.000000001
30.000000000
29.999999999
29.999999998
29.999999997
29.999999996
29.999999995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

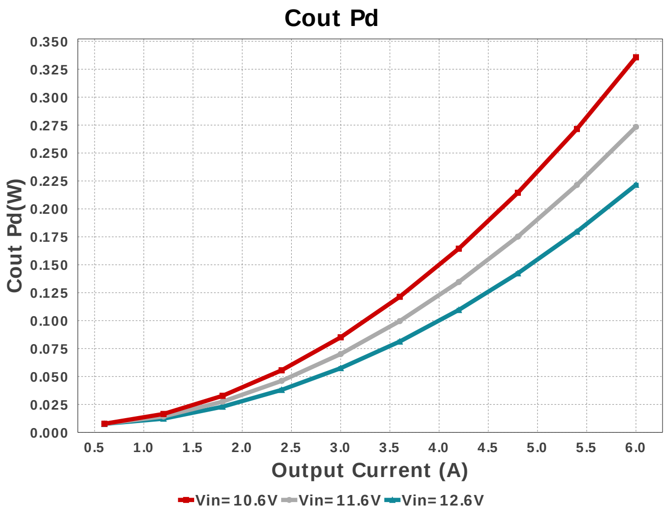

Efficiency
Efficiency(%)
94.4
94.3
94.2
94.1
94.0
93.9
93.8
93.7
93.6
93.5
93.4
93.3
93.2
93.1
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

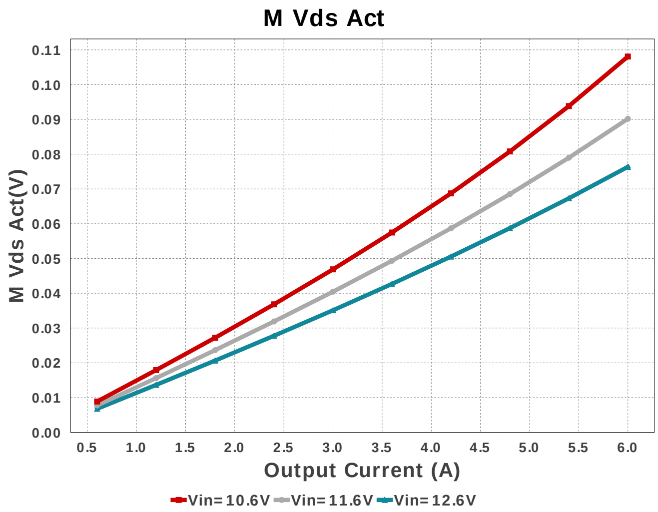

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

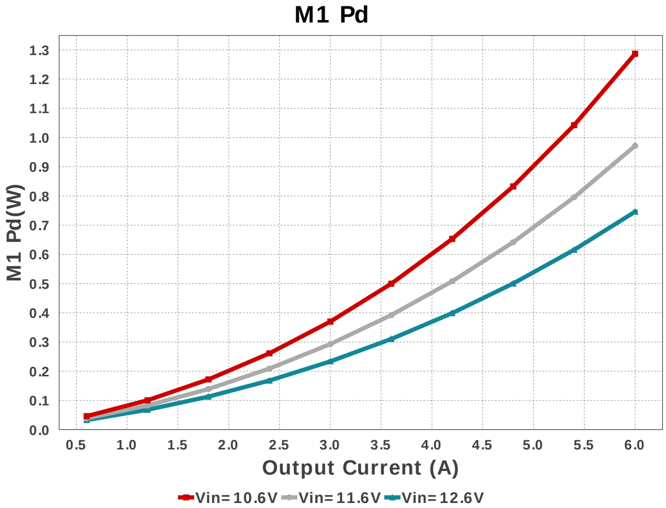

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

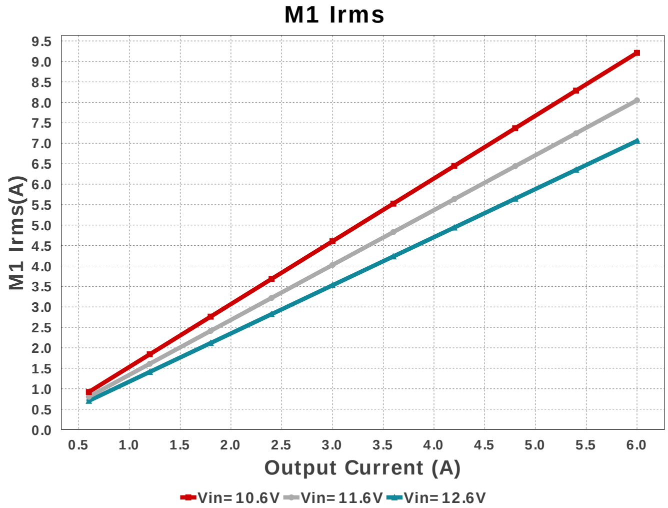

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

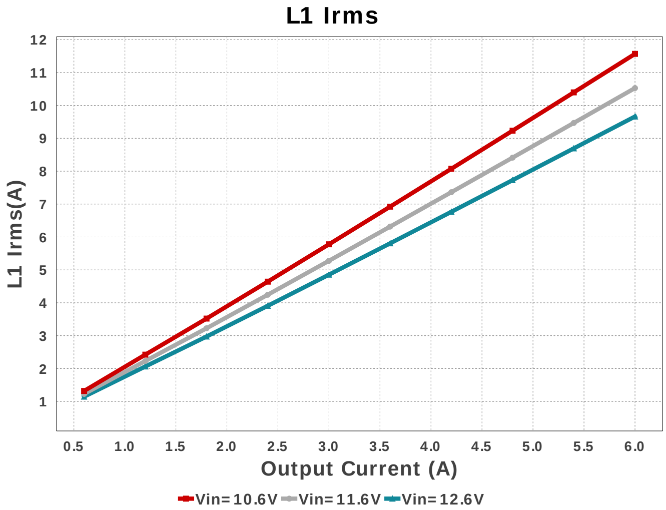

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

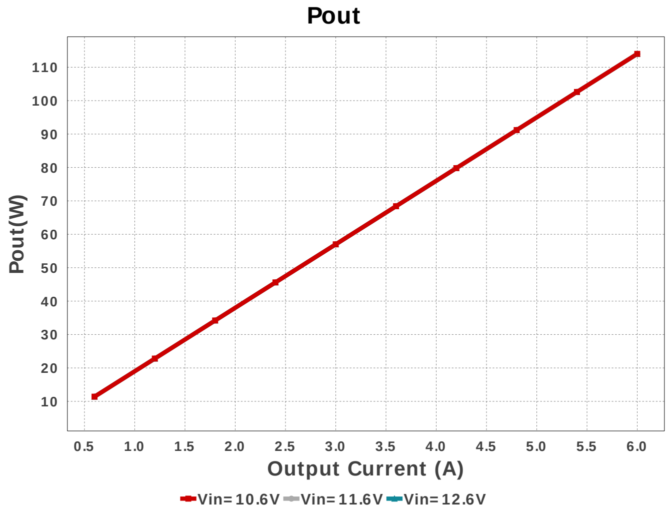

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

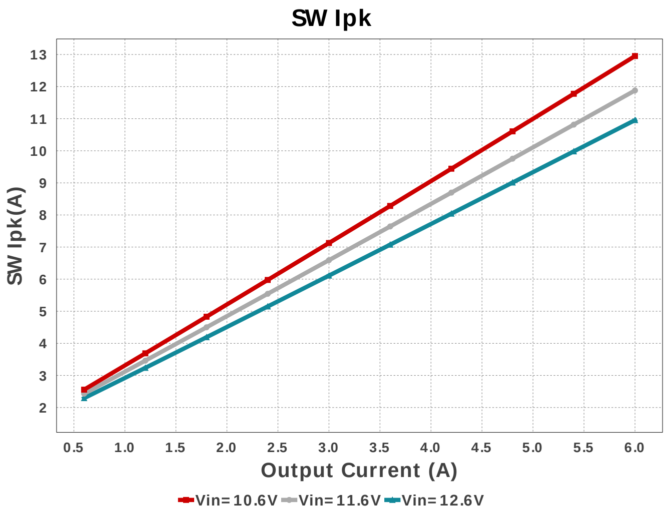

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

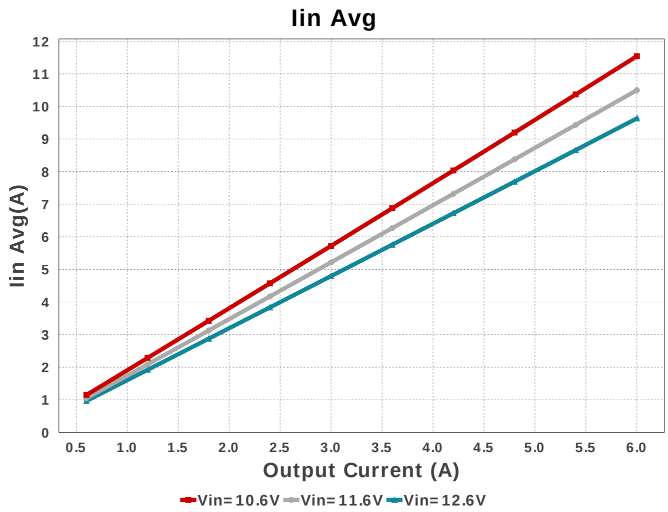

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

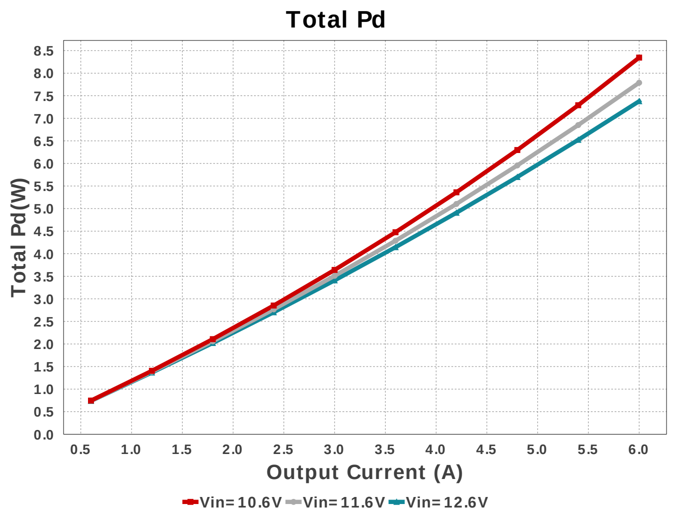

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

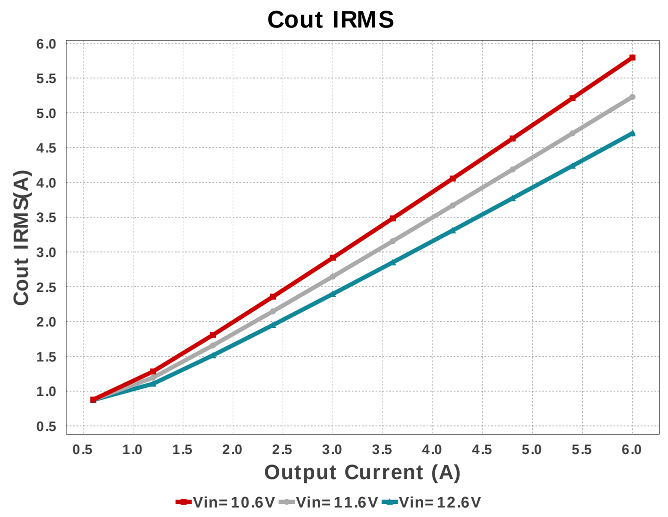

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

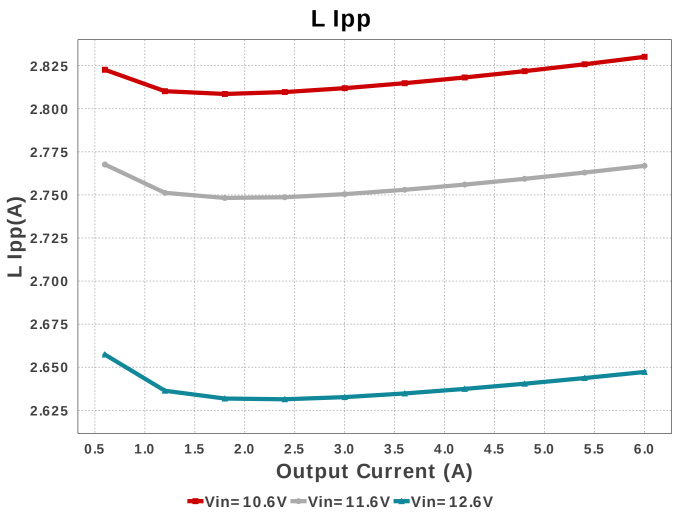

Pout
Pout(W)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

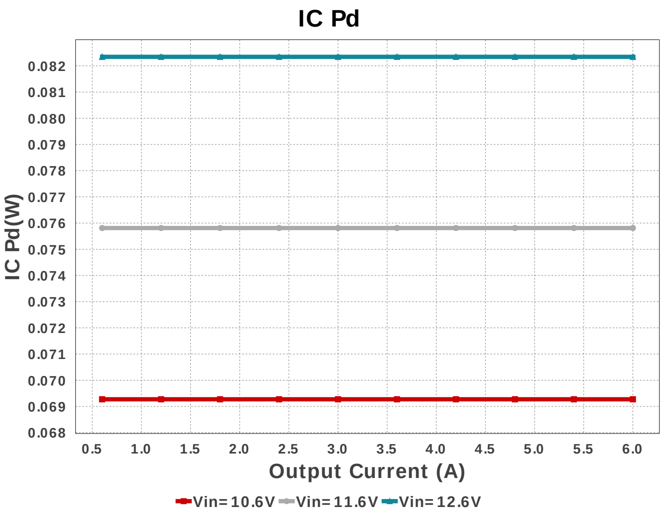

SW Ipk
SW Ipk(A)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

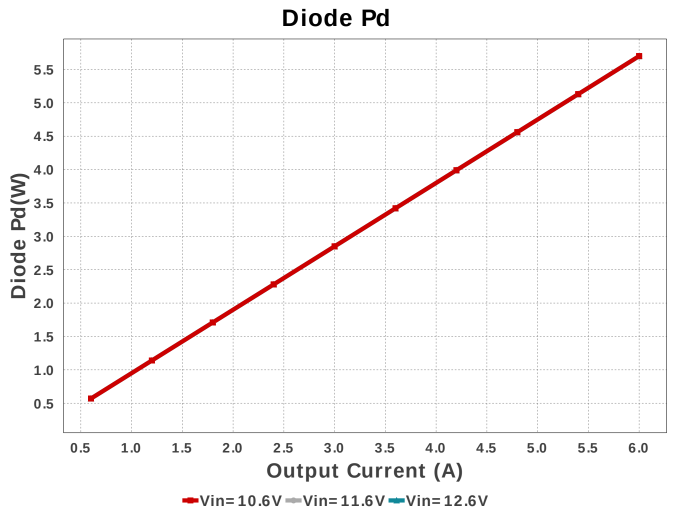

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.6V
Vin=11.6V
Vin=12.6V

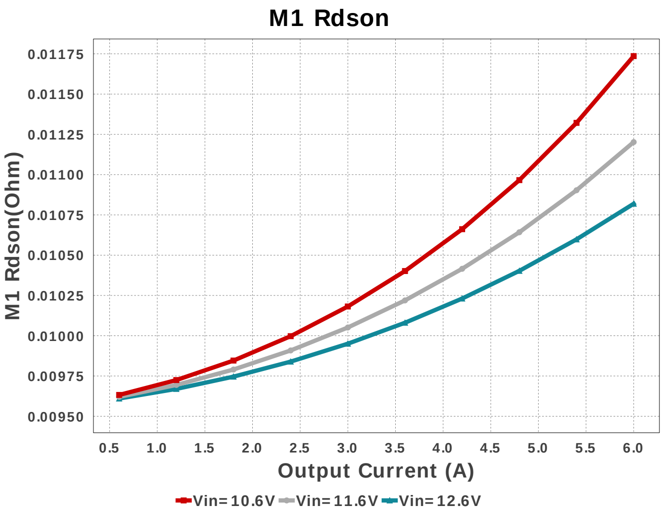

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

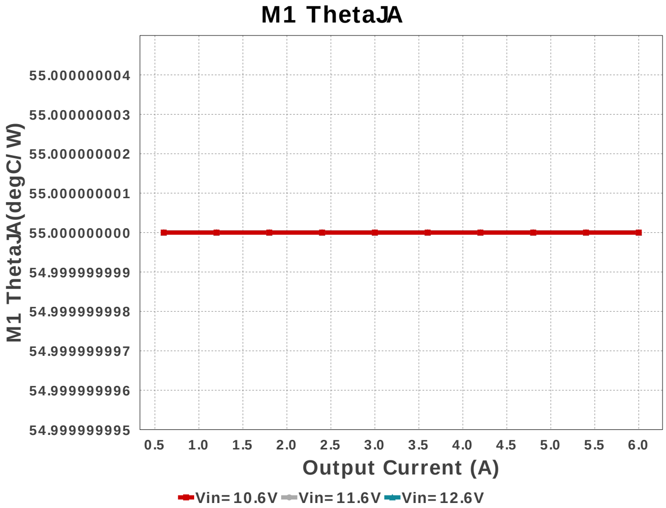

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

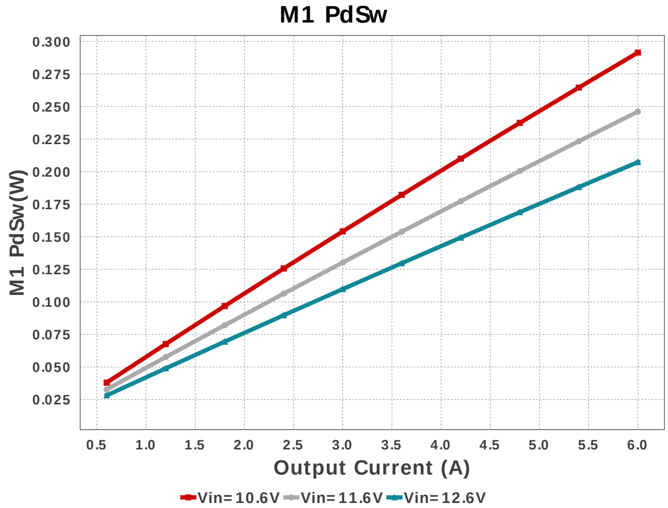

L Ipp
L Ipp(A)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V

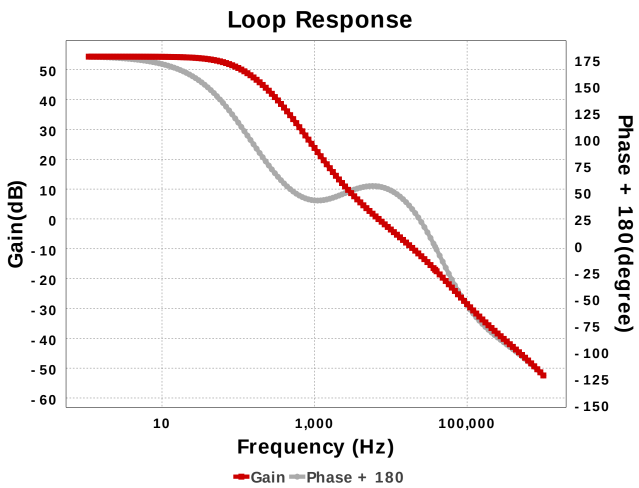

IC Pd
IC Pd(W)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V


Diode Pd
Diode Pd(W)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V


M1 Rdson
M1 Rdson(Ohm)
Output Current (A)
Vin=10.6V Vin=11.6V Vin=12.6V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	804.762 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	16.191 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	5.793 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	335.61 mW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	30.0 degC	Diode	D1 junction temperature
6.	Diode Pd	5.7 W	Diode	Diode power dissipation
7.	IC Pd	69.684 mW	IC	IC power dissipation
8.	IC Tj	43.937 degC	IC	IC junction temperature
9.	IC Tolerance	24.3 mV	IC	IC Feedback Tolerance
10.	ICThetaJA	200.0 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	11.543 A	IC	Average input current
12.	L Ipp	2.788 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	593.89 mW	Inductor	Inductor power dissipation
14.	L1 Irms	11.565 A	Inductor	Inductor ripple current
15.	M Vds Act	108.156 mV	Mosfet	M Vds
16.	M1 Irms	9.209 A	Mosfet	M1 MOSFET Irms
17.	M1 Pd	1.292 W	Mosfet	M1 MOSFET total power dissipation
18.	M1 PdCond	996.0 mW	Mosfet	M1 MOSFET conduction losses
19.	M1 PdSw	295.79 mW	Mosfet	M1 MOSFET switching losses
20.	M1 Rdson	11.745 mOhm	Mosfet	Drain-Source On-resistance
21.	M1 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
22.	M1 TjOP	101.05 degC	Mosfet	M1 MOSFET junction temperature
23.	Cin Pd	16.191 mW	Power	Input capacitor power dissipation
24.	Cout Pd	335.61 mW	Power	Output capacitor power dissipation
25.	Diode Pd	5.7 W	Power	Diode power dissipation
26.	IC Pd	69.684 mW	Power	IC power dissipation
27.	L Pd	593.89 mW	Power	Inductor power dissipation
28.	M1 Pd	1.292 W	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	996.0 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	295.79 mW	Power	M1 MOSFET switching losses
31.	Rfb Pd	24.106 mW	Power	Rfb Power Dissipation
32.	Rsense Pd	637.6 mW	Power	LED Current Rsns Power Dissipation

#	Name	Value	Category	Description
33.	Total Pd	8.351 W	Power	Total Power Dissipation
34.	Rfb Pd	24.106 mW	Resistor	Rfb Power Dissipation
35.	Rsense Pd	637.6 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	17	System Information	Total Design BOM count
37.	Cross Freq	5.897 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	47.995 %	System Information	Duty cycle
39.	Efficiency	93.175 %	System Information	Steady state efficiency
40.	FootPrint	642.0 mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	550.0 kHz	System Information	Switching frequency
42.	Gain Marg	-15.97 dB	System Information	Bode Plot Gain Margin
43.	Iout	6.0 A	System Information	Iout operating point
44.	Low Freq Gain	52.806 dB	System Information	Gain at 1Hz
45.	Mode	CCM	System Information	Conduction Mode
46.	Phase Marg	55.207 deg	System Information	Bode Plot Phase Margin
47.	Pout	114.0 W	System Information	Total output power
48.	SW Ipk	12.931 A	System Information	Peak switch current
49.	Total BOM	$5.0	System Information	Total BOM Cost
50.	Vin	10.6 V	System Information	Vin operating point
51.	Vout	19.0 V	System Information	Operational Output Voltage
52.	Vout Actual	19.334 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	3.854 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	133.856 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	6.0	Maximum Output Current
VinMax	12.6	Maximum input voltage
VinMin	10.6	Minimum input voltage
Vout	19.0	Output Voltage
base_pn	LM3478	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

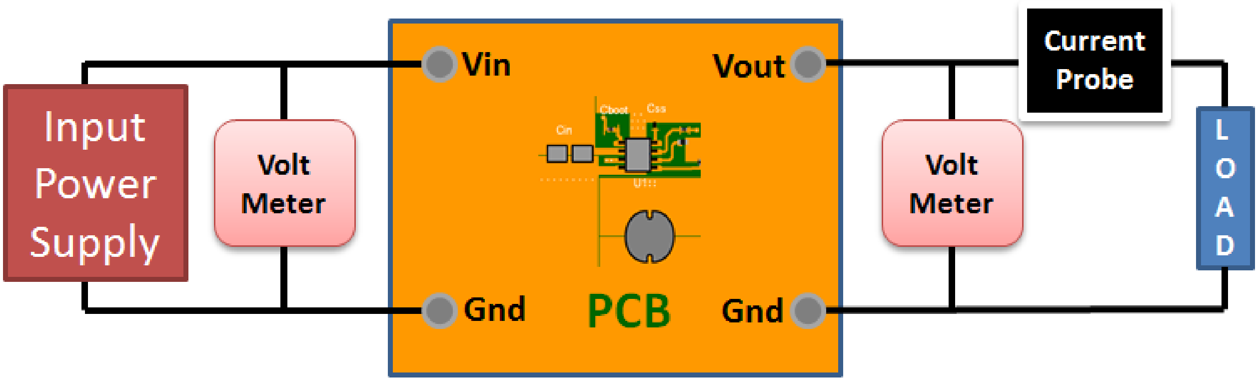
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.6V 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 : 871E1182B8FD56BD[v1]

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