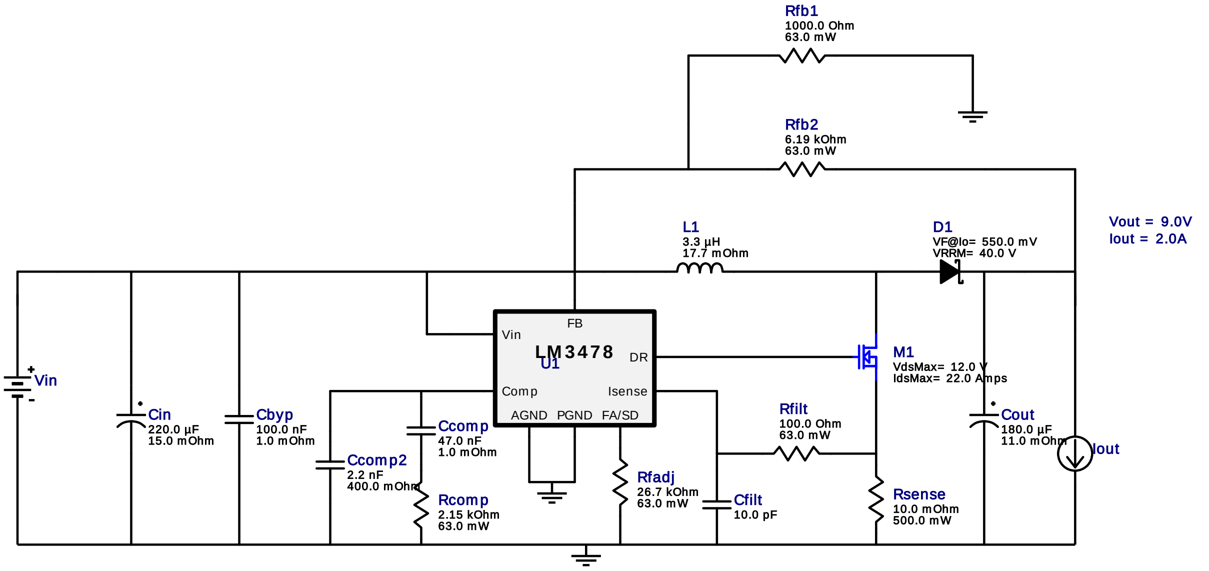
VinMin = 3.5V VinMax = 4.2V Vout = 9.0V Iout = 2.0A	Device = LM3478MM/NOPB Topology = Boost Created = 2022-08-25 10:14:14.945 BOM Cost = $2.92 BOM Count = 16 Total Pd = 2.14W

WEBENCH ® Design Report

Design : 5 LM3478MM/NOPB
LM3478MM/NOPB 3.5V-4.2V to 9.00V @ 2A

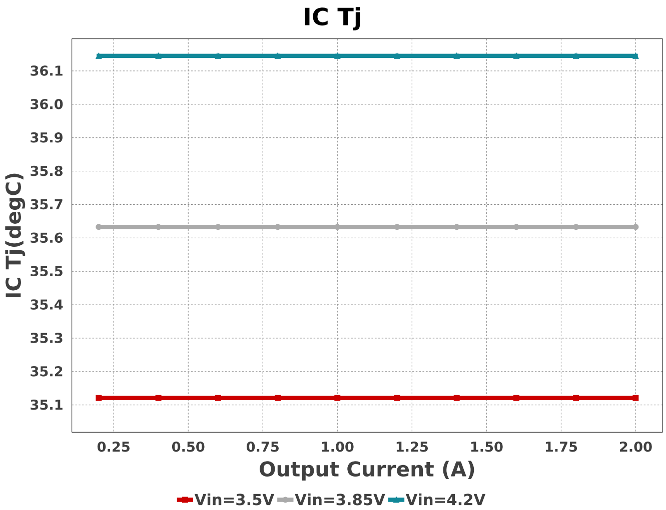


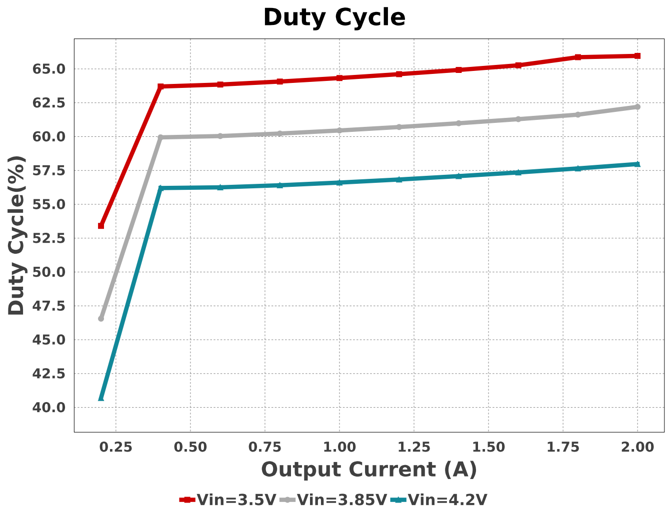
1. With the low turn of voltage of the LM34x8 your power supply may current limit before you reach your working input voltage. If this happens, or to preempt this from happening, you can include a low pass RC filter from input voltage to Vin on the IC. Make sure the rise time on the RC network is slower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

Electrical BOM

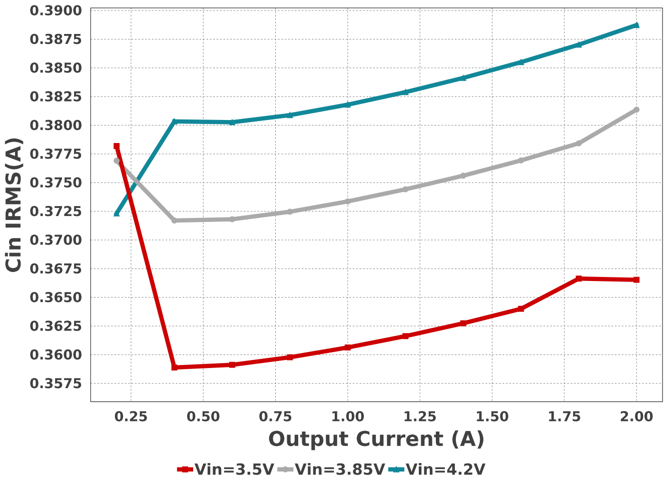
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbyp	MuRata	GRM155R70J104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM155R71C473KA01D Series= X7R	Cap= 47.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	Kemet	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
Cfilt	Samsung Electro-Mechanics	CL21C100JBANNNC Series= C0G/NP0	Cap= 10.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	Panasonic	6SVPE220MW Series= SVPE	Cap= 220.0 uF ESR= 15.0 mOhm VDC= 6.3 V IRMS= 3.15 A	1	$0.20	CAPSMT_62_E61 53 mm^2
Cout	Panasonic	16SVPE180M Series= SVPE	Cap= 180.0 uF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 4.46 A	1	$0.50	CAPSMT_62_C10 74 mm^2
D1	Diodes Inc.	B540C-13-F	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.17	SMC 83 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Vishay-Dale	IHLP3232DZER3R3M01	L= 3.3 µH 17.7 mOhm	1	$0.66	IHLP-3232DZ 112 mm²
M1	Texas Instruments	CSD13202Q2	VdsMax= 12.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm²
Rcomp	Vishay-Dale	CRCW04022K15FKED Series= CRCW..e3	Res= 2.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfadj	Vishay-Dale	CRCW040226K7FKED Series= CRCW..e3	Res= 26.7 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	CRCW04026K19FKED Series= CRCW..e3	Res= 6.19 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	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	1206 11 mm²
U1	Texas Instruments	LM3478MM/NOPB	Switcher	1	$1.05	MUA08A 24 mm²

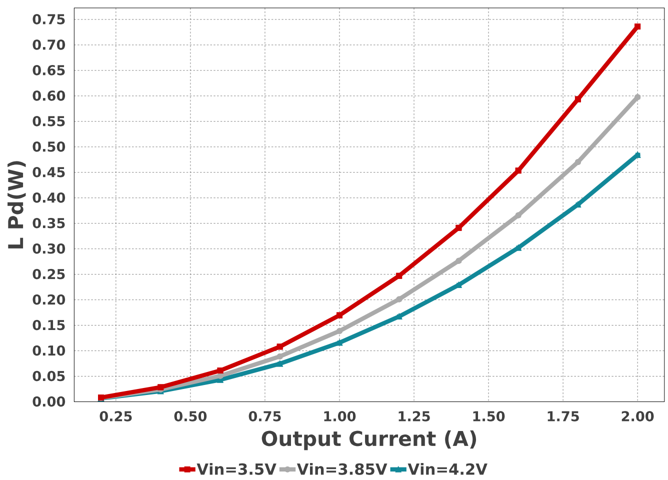




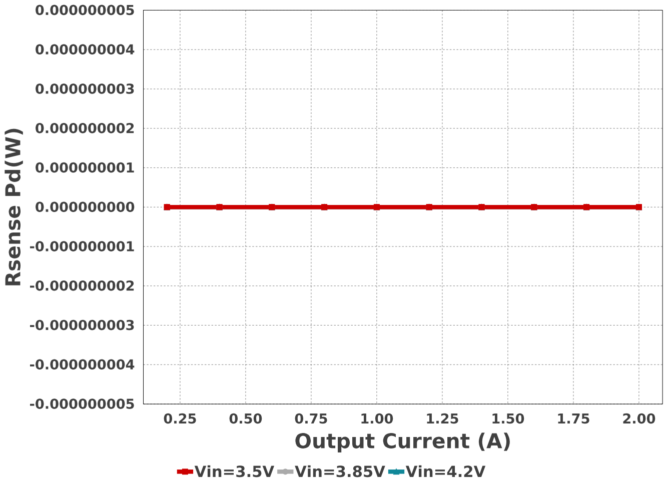
Cin IRMS



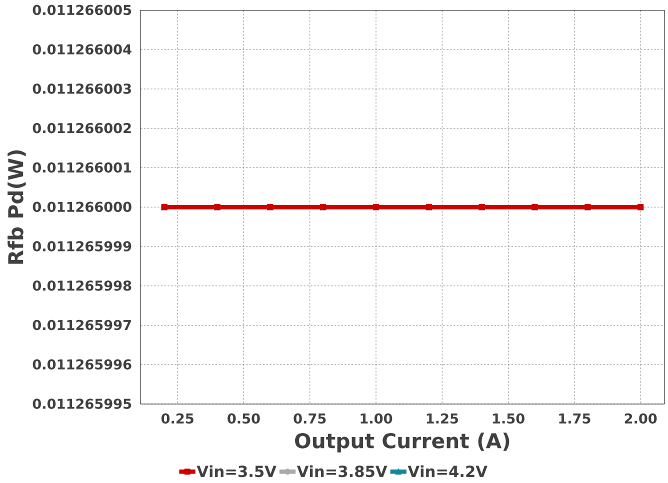
L Pd



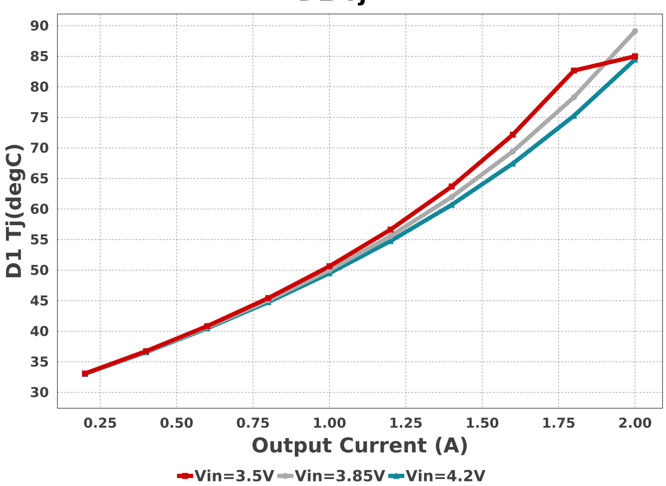
Rsense Pd



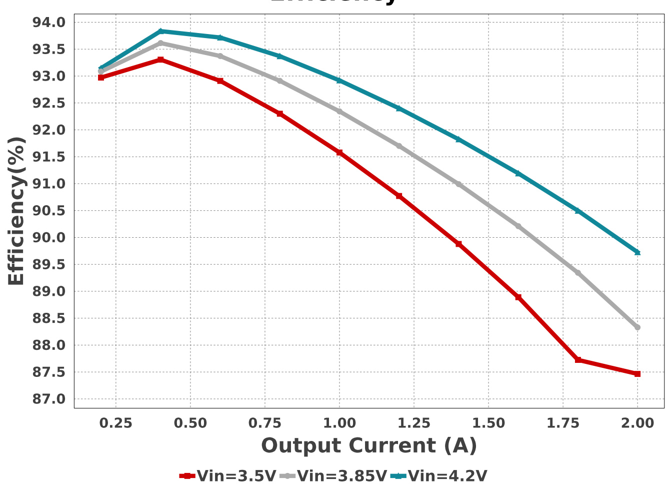
Rfb Pd

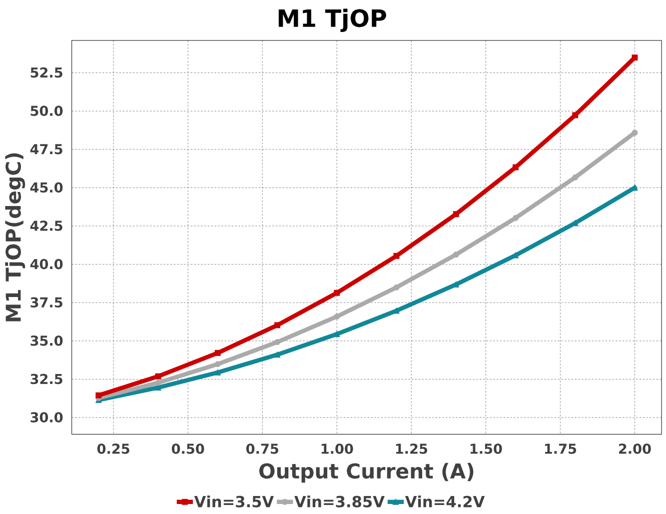


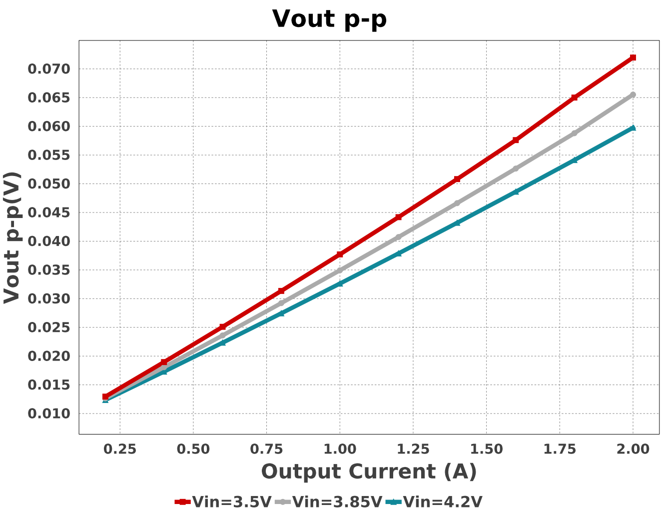
D1 Tj

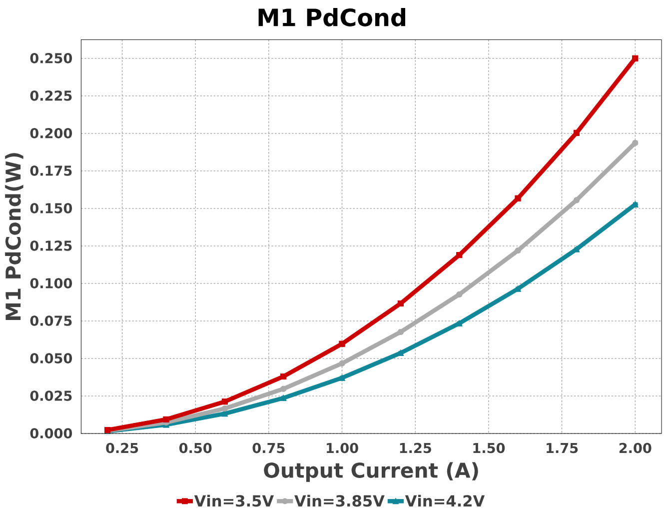


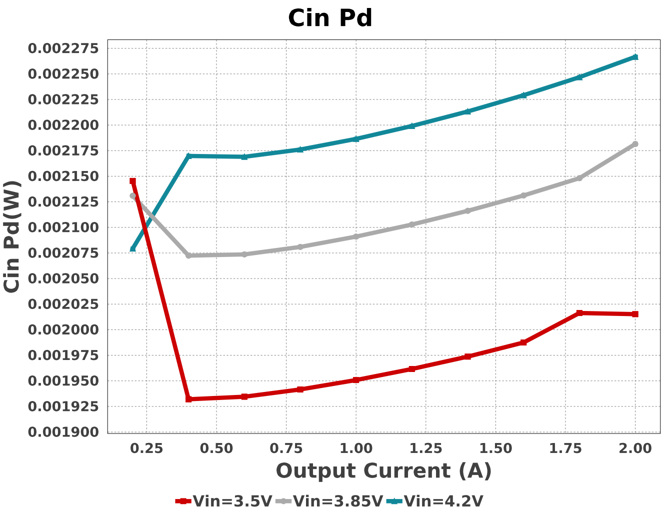
Efficiency

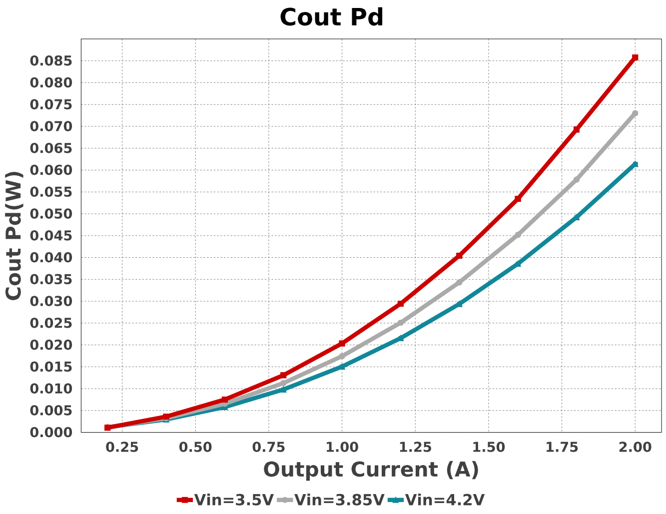


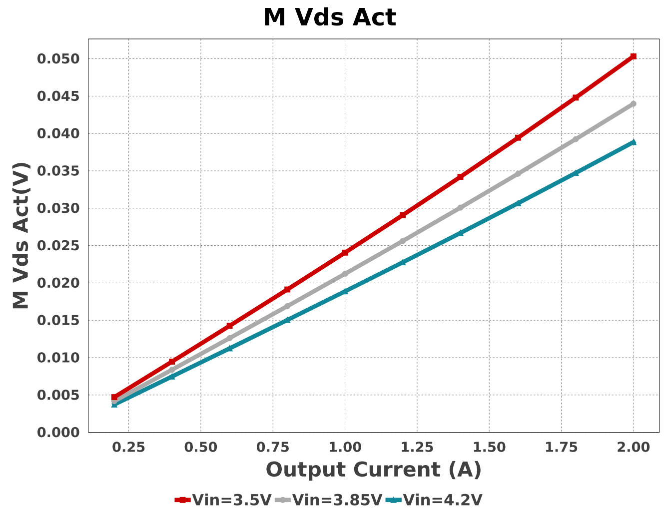

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

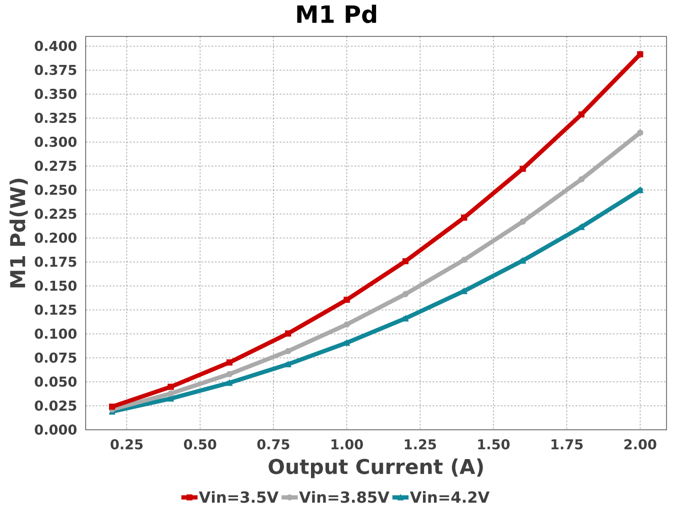

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

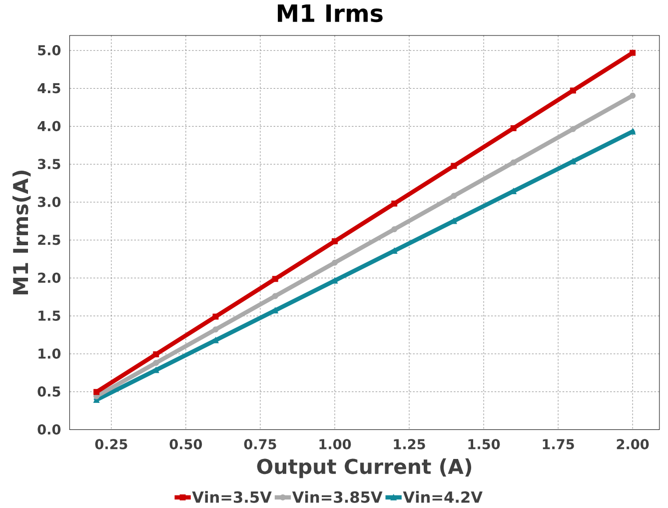

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

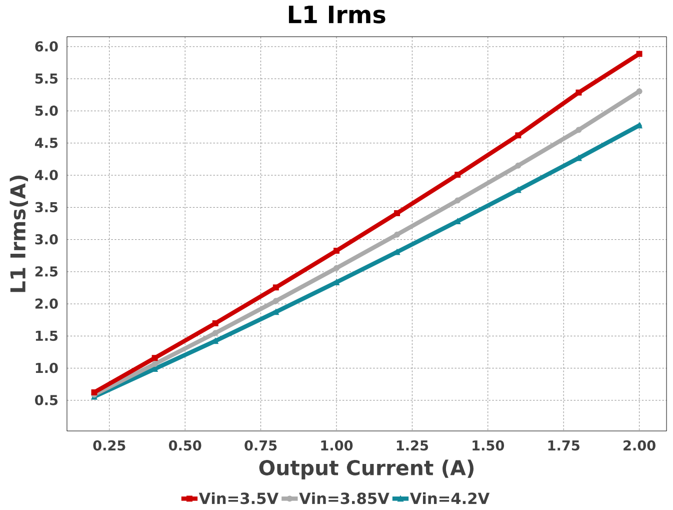

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

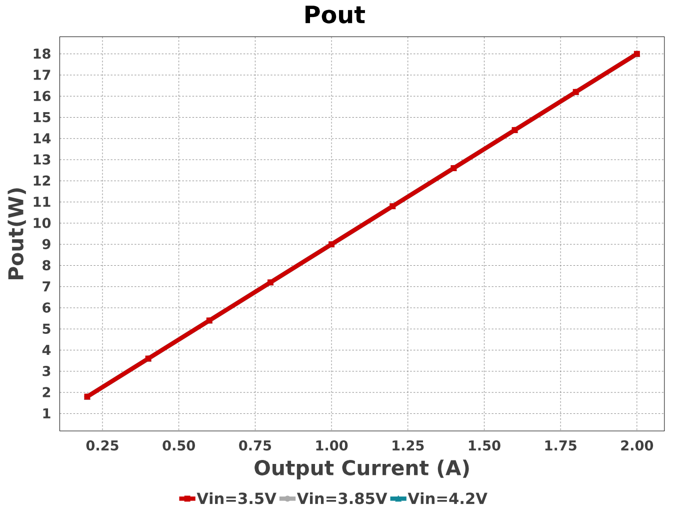

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

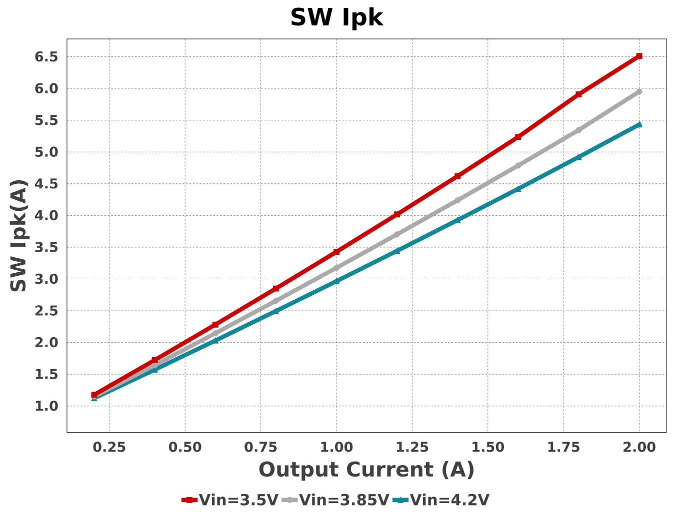

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=3.5V Vin=3.85V Vin=4.2V

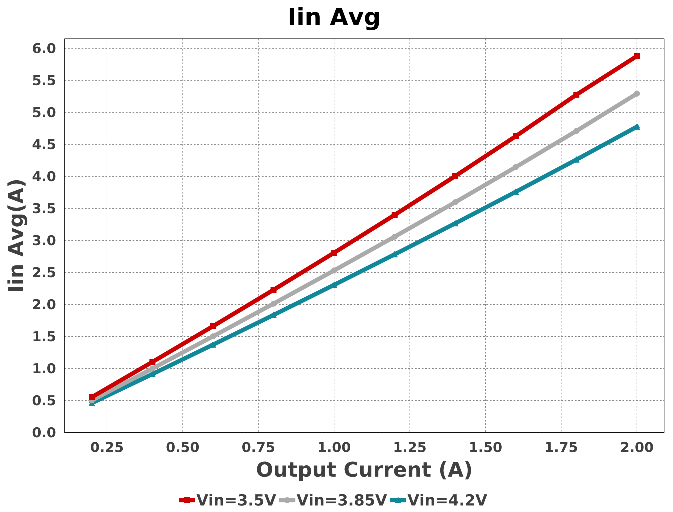

M1 Pd
M1 Pd(W)
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

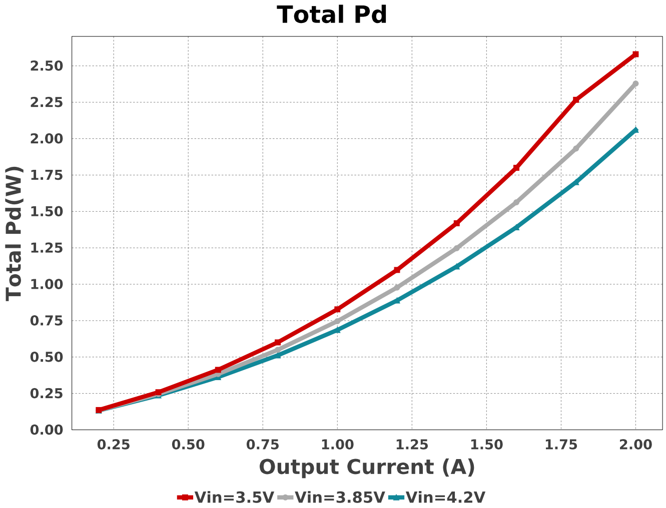

M1 Irms
M1 Irms(A)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

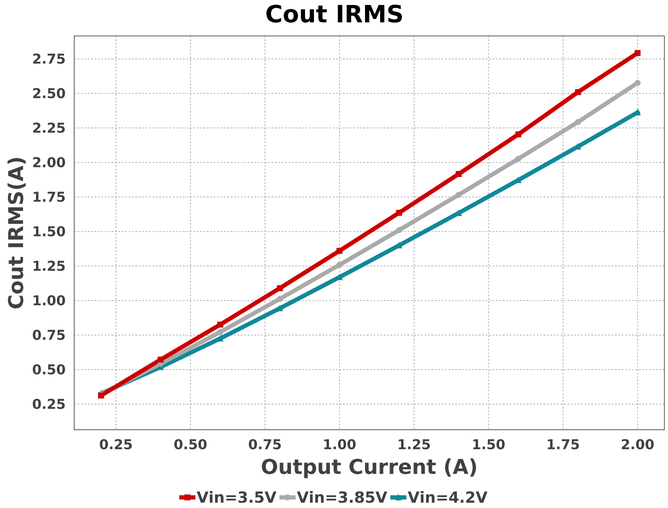

L1 Irms
L1 Irms(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

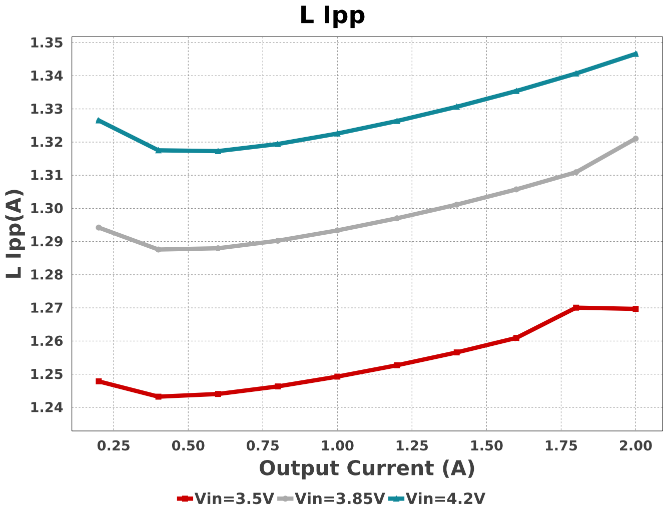

Pout
Pout(W)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

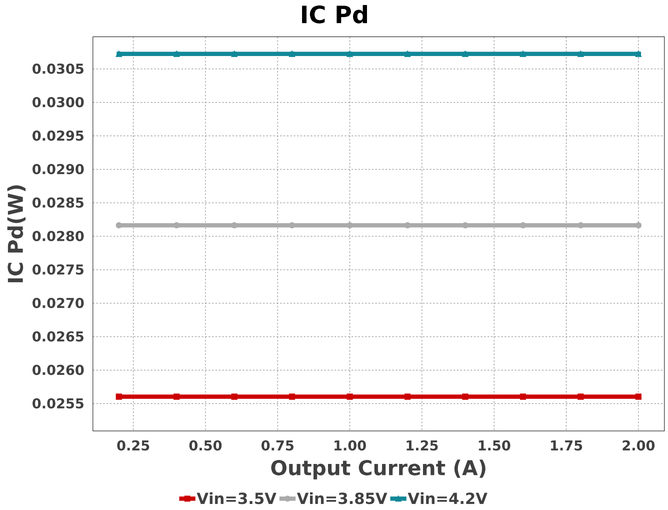

SW Ipk
SW Ipk(A)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

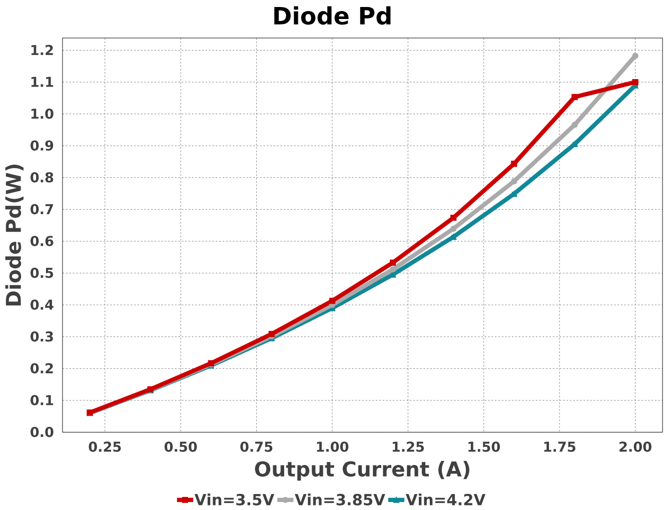

Iin Avg
Iin Avg(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

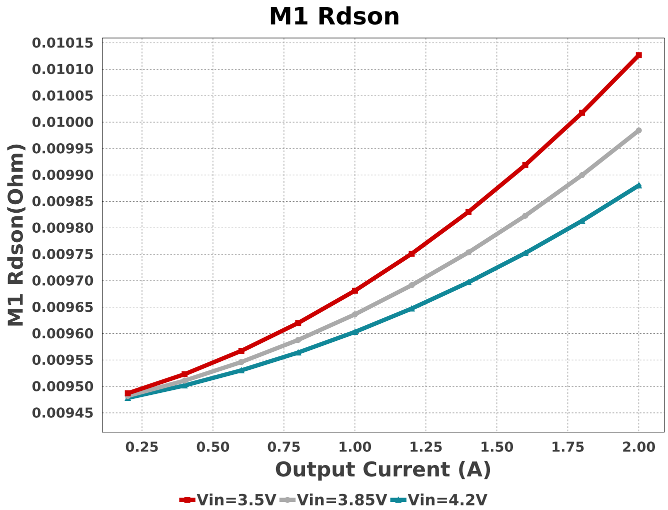

Total Pd
Total Pd(W)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

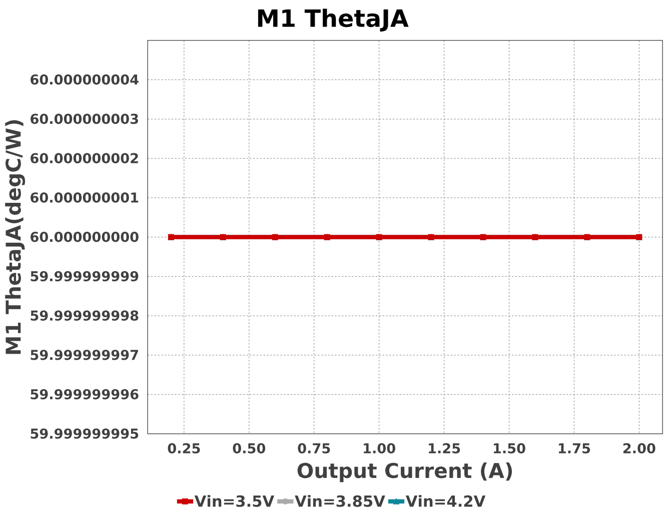

Cout IRMS
Cout IRMS(A)
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

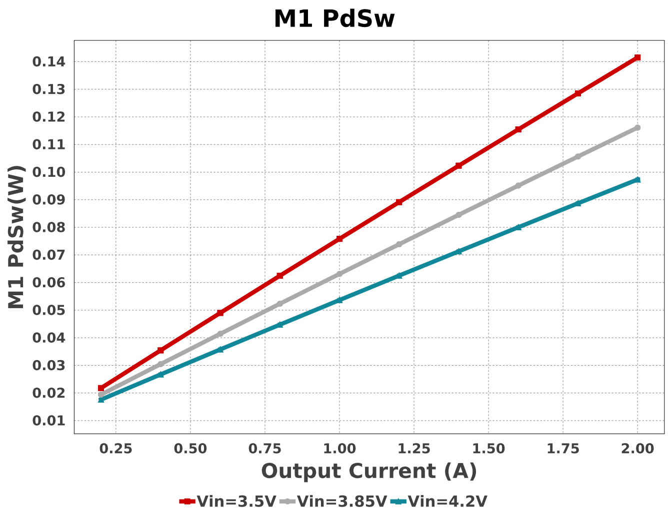

L Ipp
L Ipp(A)
1.24
1.25
1.26
1.27
1.28
1.29
1.30
1.31
1.32
1.33
1.34
1.35
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V

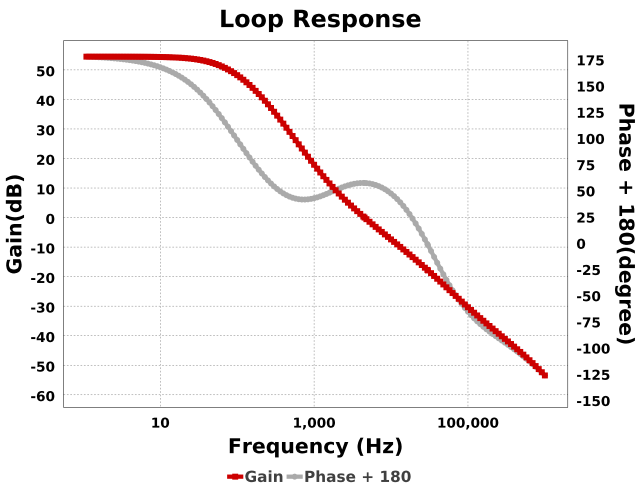

IC Pd
IC Pd(W)
0.0255
0.0260
0.0265
0.0270
0.0275
0.0280
0.0285
0.0290
0.0295
0.0300
0.0305
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V


Diode Pd
Diode Pd(W)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V


M1 Rdson
M1 Rdson(Ohm)
0.00945
0.00950
0.00955
0.00960
0.00965
0.00970
0.00975
0.00980
0.00985
0.00990
0.00995
0.01000
0.01005
0.01010
0.01015
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Output Current (A)
Vin=3.5V
Vin=3.85V
Vin=4.2V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	362.6 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	1.972 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.748 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	83.049 mW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	85.0 degC	Diode	D1 junction temperature
6.	Diode Pd	1.1 W	Diode	Diode power dissipation
7.	IC Pd	25.781 mW	IC	IC power dissipation
8.	IC Tj	35.156 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	5.755 A	IC	Average input current
12.	L Ipp	1.256 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	705.55 mW	Inductor	Inductor power dissipation
14.	L1 Irms	5.764 A	Inductor	Inductor ripple current
15.	M Vds Act	50.339 mV	Mosfet	M Vds
16.	M1 Irms	4.969 A	Mosfet	M1 MOSFET Irms
17.	M1 Pd	393.79 mW	Mosfet	M1 MOSFET total power dissipation
18.	M1 PdCond	250.13 mW	Mosfet	M1 MOSFET conduction losses
19.	M1 PdSw	143.66 mW	Mosfet	M1 MOSFET switching losses
20.	M1 Rdson	10.131 mOhm	Mosfet	Drain-Source On-resistance
21.	M1 ThetaJA	60.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
22.	M1 TjOP	53.628 degC	Mosfet	M1 MOSFET junction temperature
23.	Cin Pd	1.972 mW	Power	Input capacitor power dissipation
24.	Cout Pd	83.049 mW	Power	Output capacitor power dissipation
25.	Diode Pd	1.1 W	Power	Diode power dissipation
26.	IC Pd	25.781 mW	Power	IC power dissipation
27.	L Pd	705.55 mW	Power	Inductor power dissipation
28.	M1 Pd	393.79 mW	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	250.13 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	143.66 mW	Power	M1 MOSFET switching losses
31.	Rfb Pd	11.266 mW	Power	Rfb Power Dissipation
32.	Rsense Pd	264.49 mW	Power	LED Current Rsns Power Dissipation

#	Name	Value	Category	Description
33.	Total Pd	2.143 W	Power	Total Power Dissipation
34.	Rfb Pd	11.266 mW	Resistor	Rfb Power Dissipation
35.	Rsense Pd	264.49 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	16	System Information	Total Design BOM count
37.	Cross Freq	3.847 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	65.23 %	System Information	Duty cycle
39.	Efficiency	89.359 %	System Information	Steady state efficiency
40.	FootPrint	400.0 mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	541.734 kHz	System Information	Switching frequency
42.	Gain Marg	-16.404 dB	System Information	Bode Plot Gain Margin
43.	Iout	2.0 A	System Information	Iout operating point
44.	Low Freq Gain	52.83 dB	System Information	Gain at 1Hz
45.	Mode	CCM	System Information	Conduction Mode
46.	Phase Marg	55.72 deg	System Information	Bode Plot Phase Margin
47.	Pout	18.0 W	System Information	Total output power
48.	SW Ipk	6.38 A	System Information	Peak switch current
49.	Total BOM	$2.92	System Information	Total BOM Cost
50.	Vin	3.5 V	System Information	Vin operating point
51.	Vout	9.0 V	System Information	Operational Output Voltage
52.	Vout Actual	9.059 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	3.701 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	70.544 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	4.2	Maximum input voltage
VinMin	3.5	Minimum input voltage
Vout	9.0	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

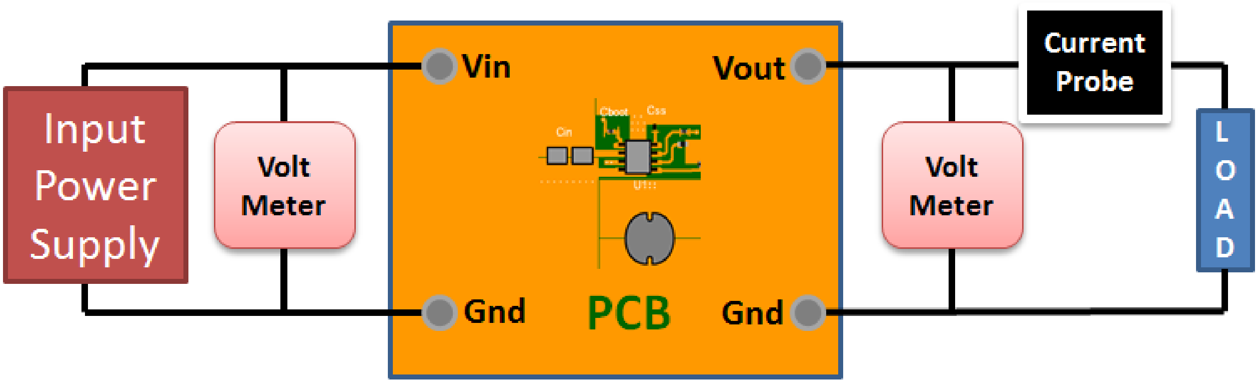
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.5V 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.

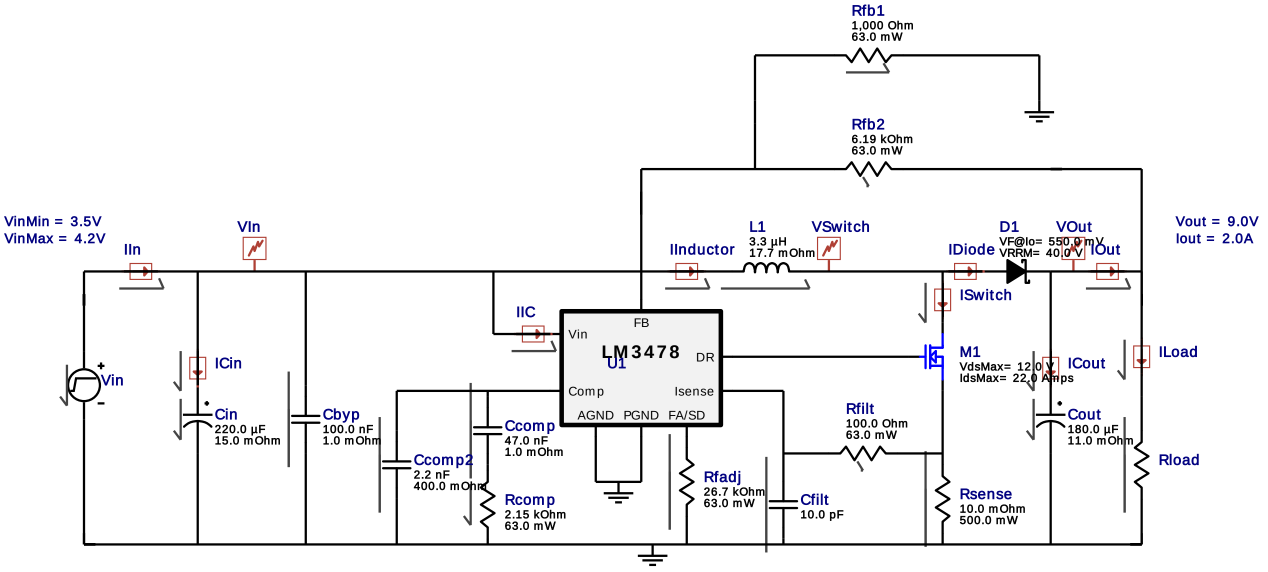


WEBENCH® Electrical Simulation Report

Design Id = 5

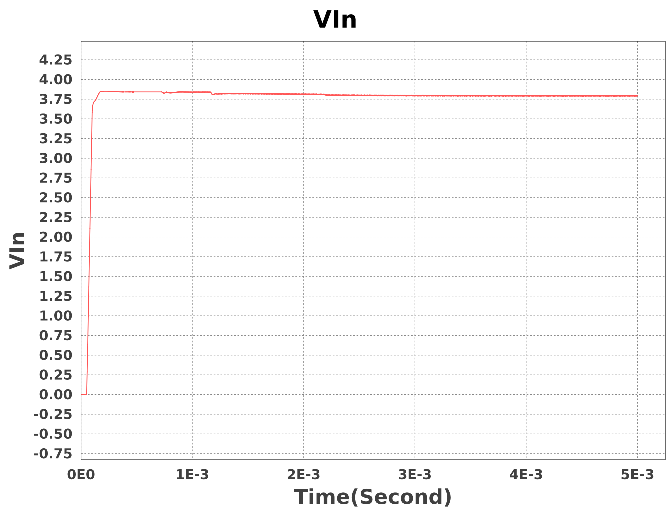
sim_id = 1

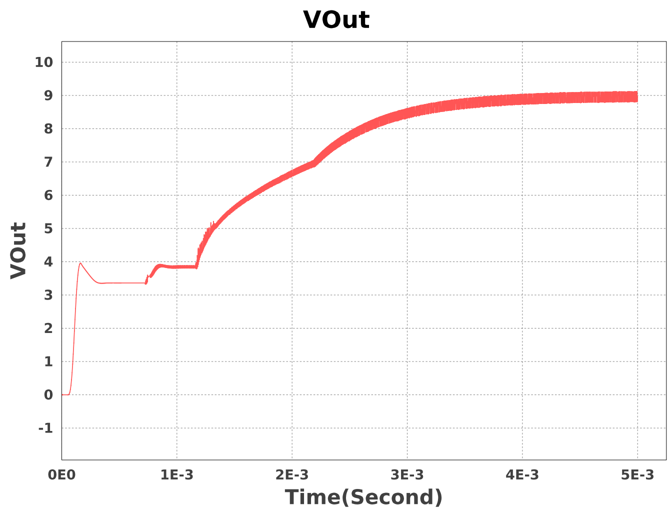
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	4.5 Ohm





Design Assistance

1. Master key : 9852E6C16827247CB7E100346849B713[v1]

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