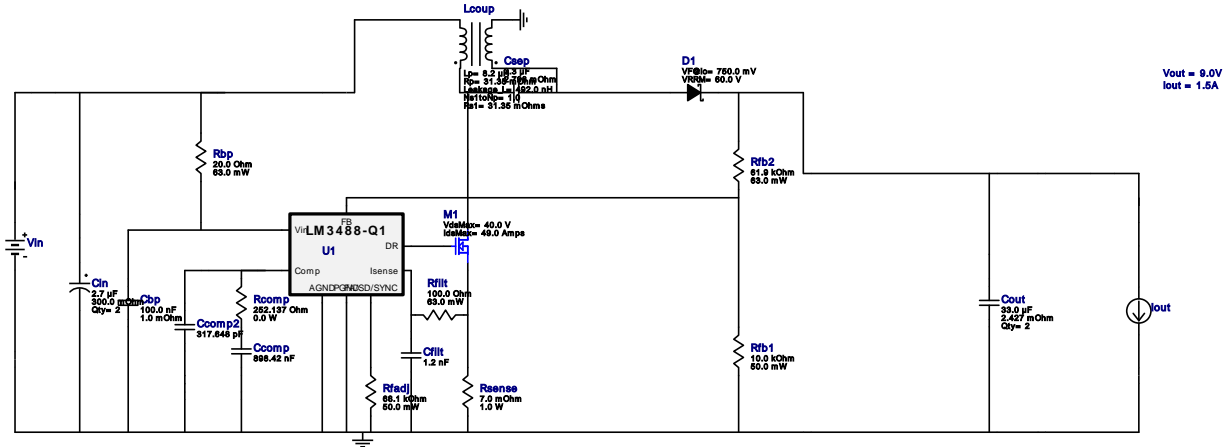


WEBENCH[®] Design Report

Design : 4 LM3488QMM/NOPB
LM3488QMM/NOPB 3V-22V to 12.00V @ 1A

VinMin = 3.0V
VinMax = 24.0V
Vout = 9.0V
Iout = 1.5A

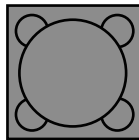







Device = LM3488QMM/NOPB
Topology = SEPIC
Created = 2022-02-09 19:24:12.025
BOM Cost = NA
BOM Count = 20
Total Pd = 4.14W

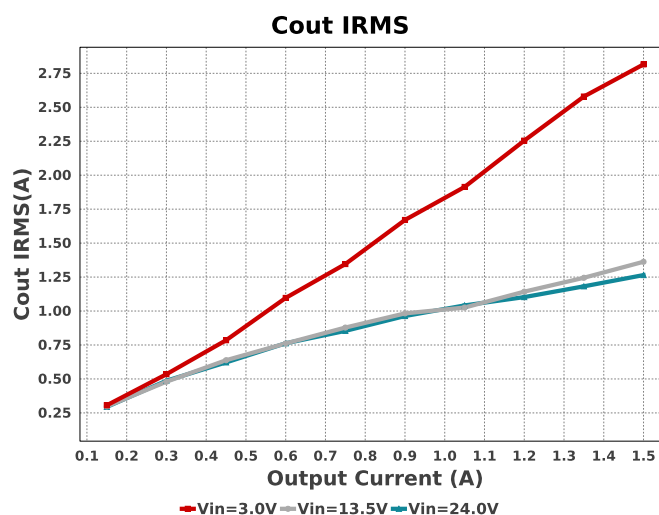
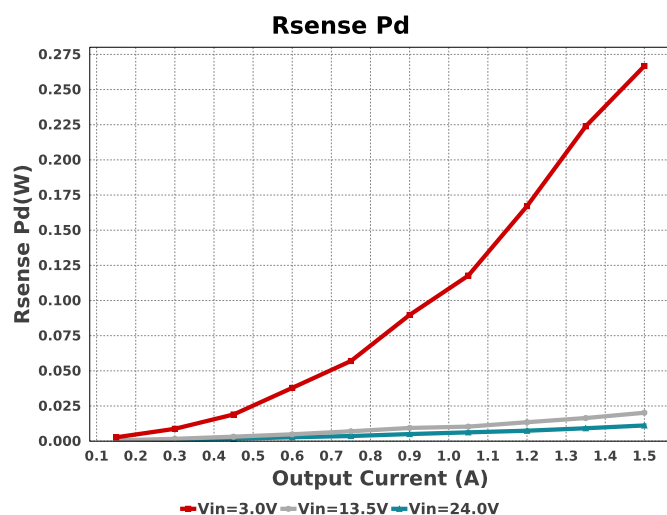


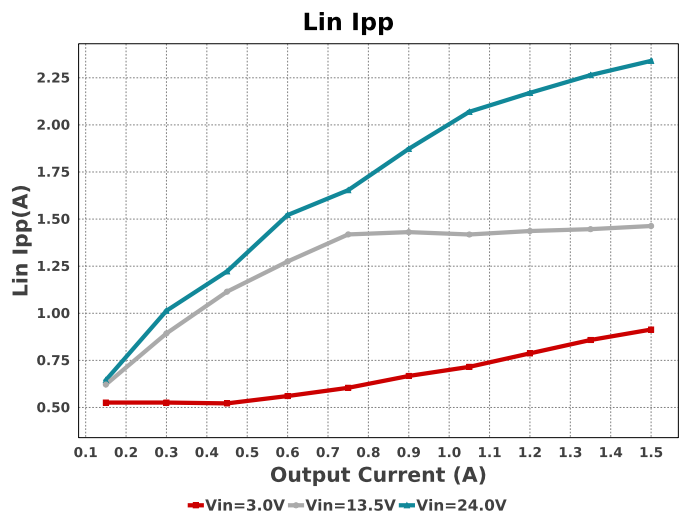
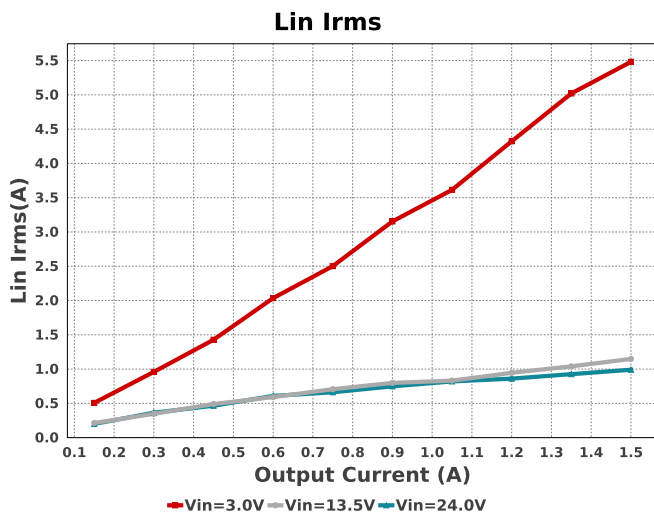
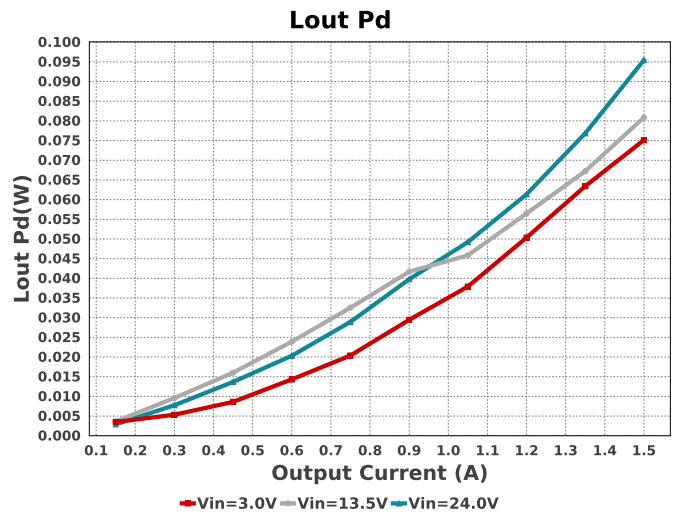
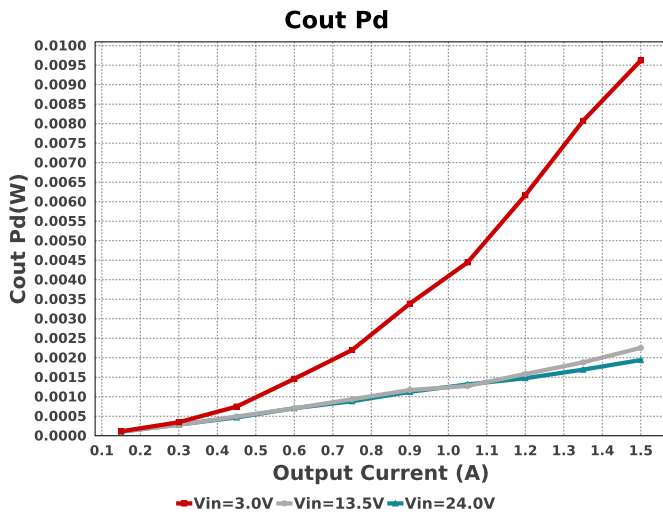
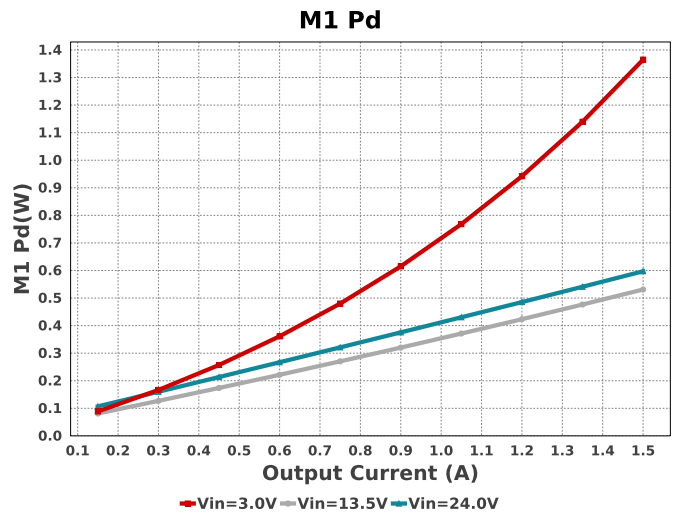
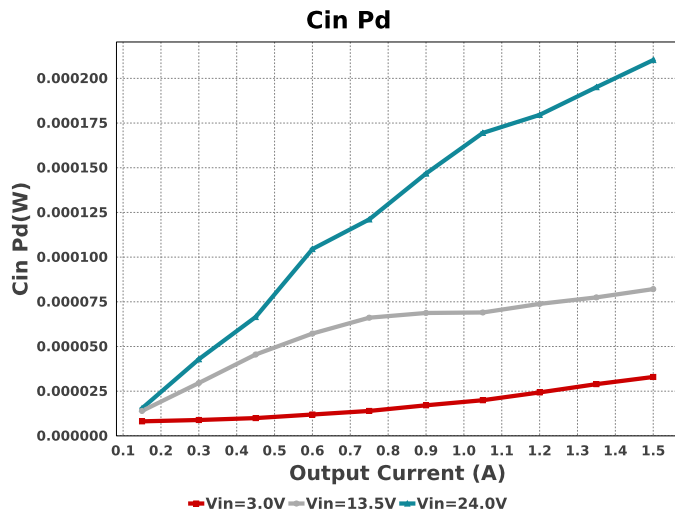
1. Please note that Loop/ stability model has not been implemented for this device. The operating values and charts related to loop model are disabled.

Electrical BOM

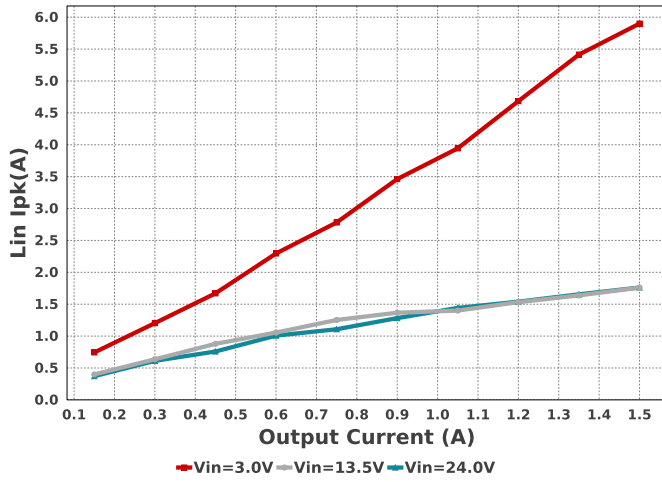
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	Yageo	CC0805KRX7R9BB104 Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.02	0805 7 mm ²
Ccomp	CUSTOM	CUSTOM Series= ?	Cap= 898.42 nF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm ²
Ccomp2	CUSTOM	CUSTOM Series= ?	Cap= 317.648 pF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm ²
Cfilt	Samsung Electro-Mechanics	CL21C122JBFNNNE Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.02	0805 7 mm ²
Cin	Panasonic	35TQC2R7MYF Series= TQC	Cap= 2.7 uF ESR= 300.0 mOhm VDC= 35.0 V IRMS= 800.0 mA	2	\$0.46	3528-21 17 mm ²
Cout	TDK	C4532X5R1C336M250KA Series= X5R	Cap= 33.0 uF ESR= 2.427 mOhm VDC= 16.0 V IRMS= 4.9234 A	2	\$0.41	1812_280 23 mm ²
Csep	TDK	CGA4J1X7R1V335K125AC Series= X7R	Cap= 3.3 uF ESR= 2.798 mOhm VDC= 35.0 V IRMS= 3.90156 A	1	\$0.13	0805 7 mm ²
D1	Vishay-Semiconductor	SS36-E3/57T	VF@Io= 750.0 mV VRRM= 60.0 V	1	\$0.20	SMC 83 mm ²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Lcoup	Coiltronics	DRQ127-8R2-R	Lp= 8.2 μ H Rp= 31.35 mOhm Leakage_L= 492.0 nH Ns1toNp= 1.0 Rs1= 31.35 mOhms	1	\$1.19	 DRQ127 210 mm ²
M1	Infineon Technologies	BSC093N04LS G	VdsMax= 40.0 V IdsMax= 49.0 Amps	1	\$0.40	 PG-TDSON-8 55 mm ²
Rbp	Vishay-Dale	CRCW040220R0FKED Series= CRCW..e3	Res= 20.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rcomp	CUSTOM	CUSTOM Series= ?	Res= 252.137 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm ²
Rfadj	Yageo	RC0201FR-7D68K1L Series= ?	Res= 68.1 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	 0201 2 mm ²
Rfb1	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	 0201 2 mm ²
Rfb2	Vishay-Dale	CRCW040261K9FKED Series= CRCW..e3	Res= 61.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rfilt	Vishay-Dale	CRCW0402100RFBKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rsense	Susumu Co Ltd	PRL1632-R007-F-T1 Series= PRL1632	Res= 7.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	\$0.20	 0612 11 mm ²
U1	Texas Instruments	LM3488QMM/NOPB	Switcher	1	\$1.18	 MUA08A 24 mm ²

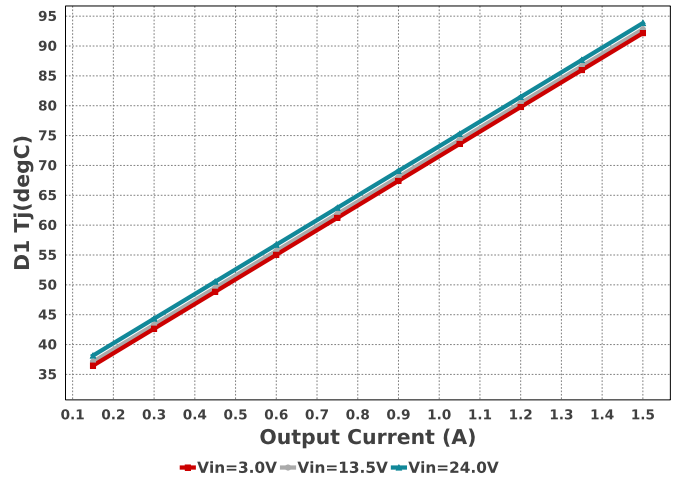




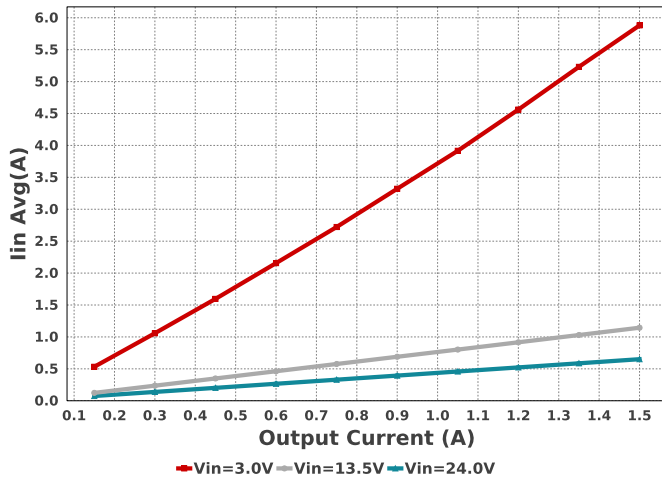
Lin Ipk



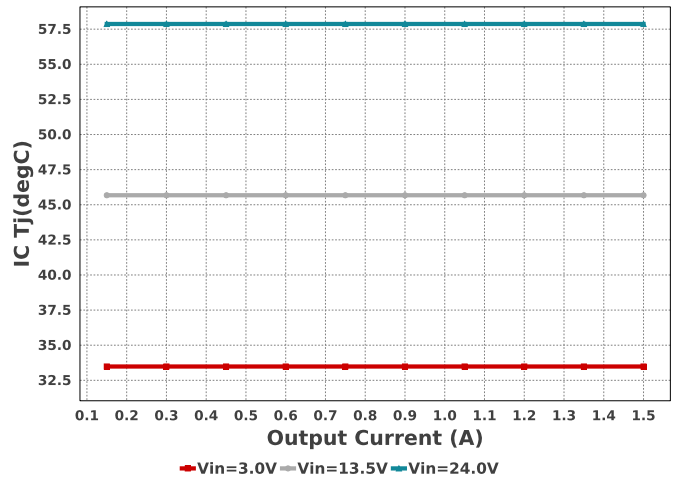
D1 Tj



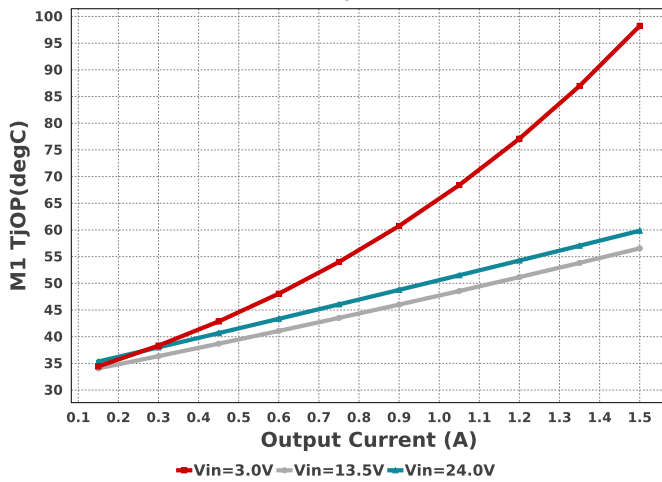
Iin Avg



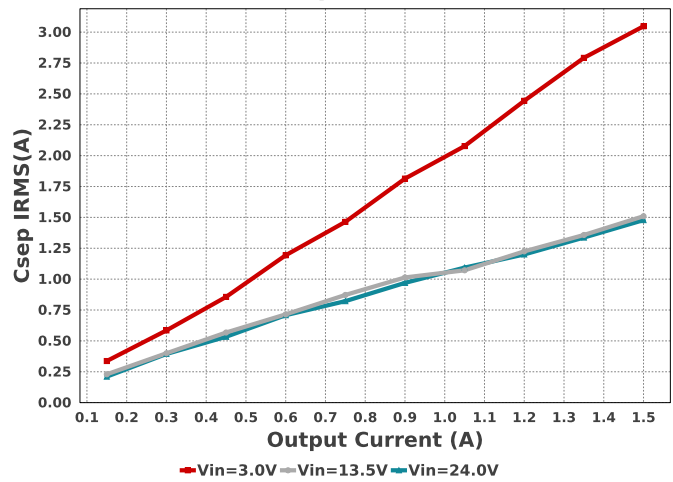
IC Tj

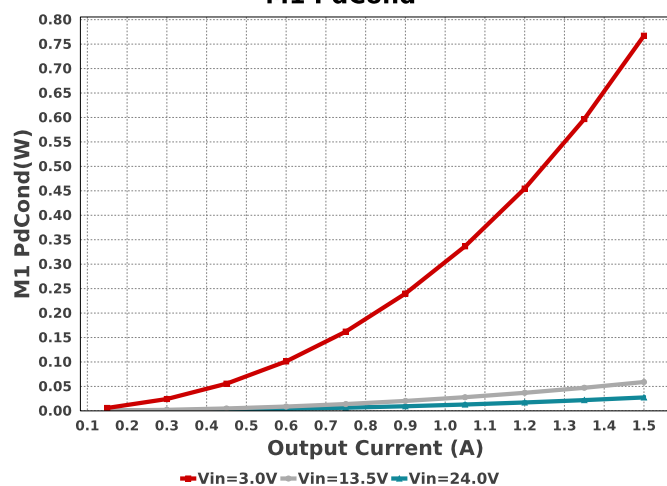
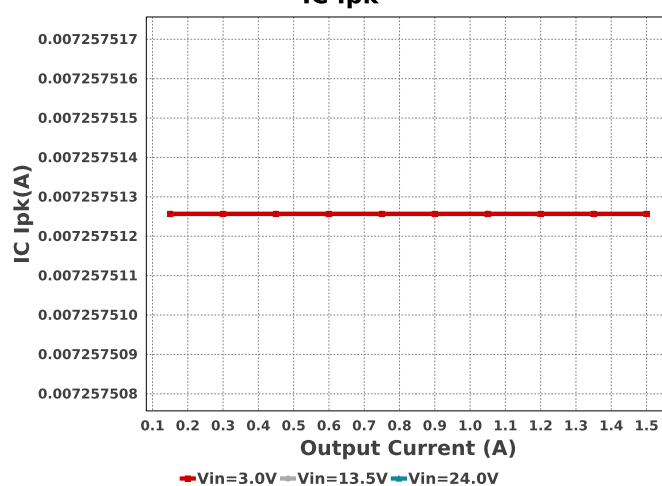
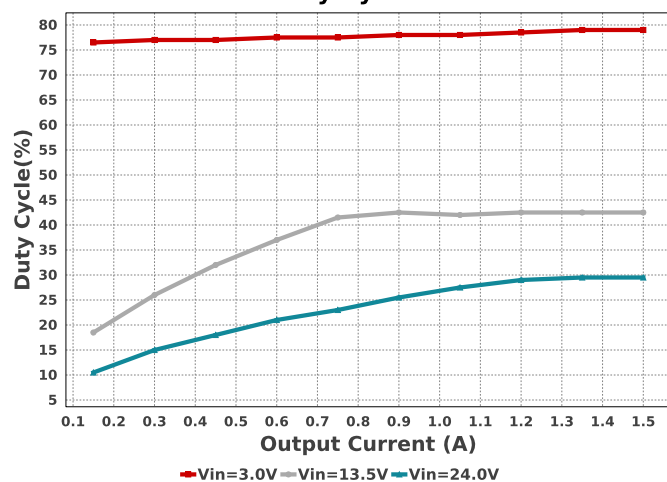
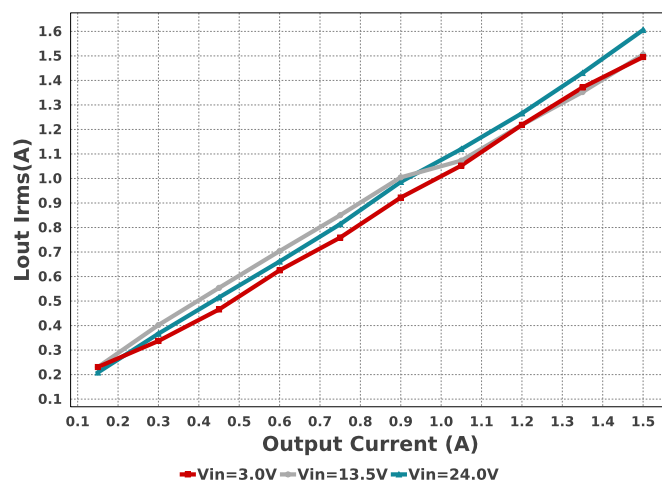
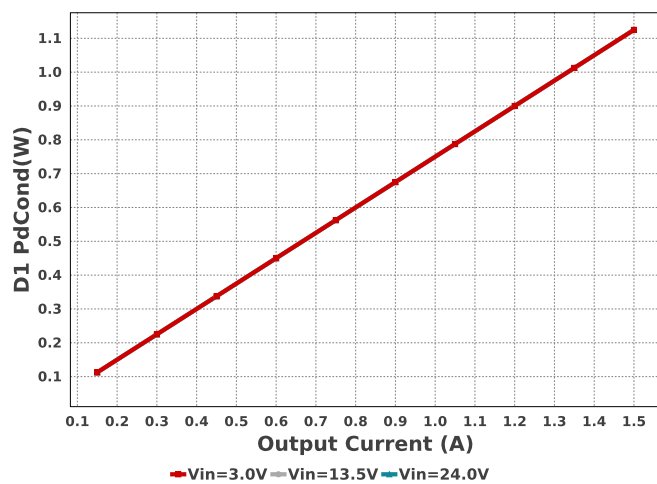
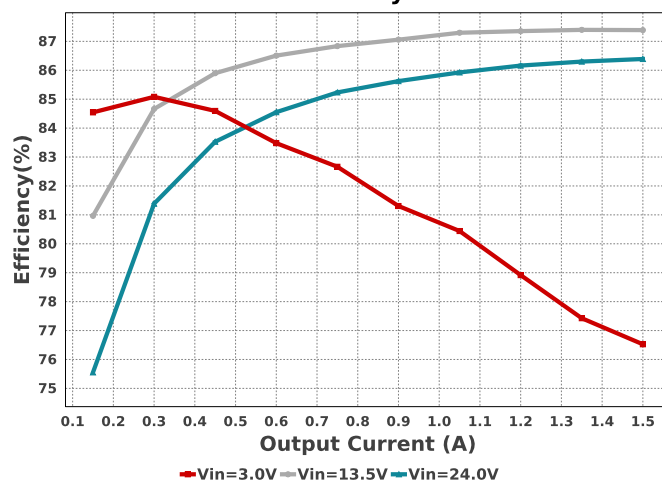


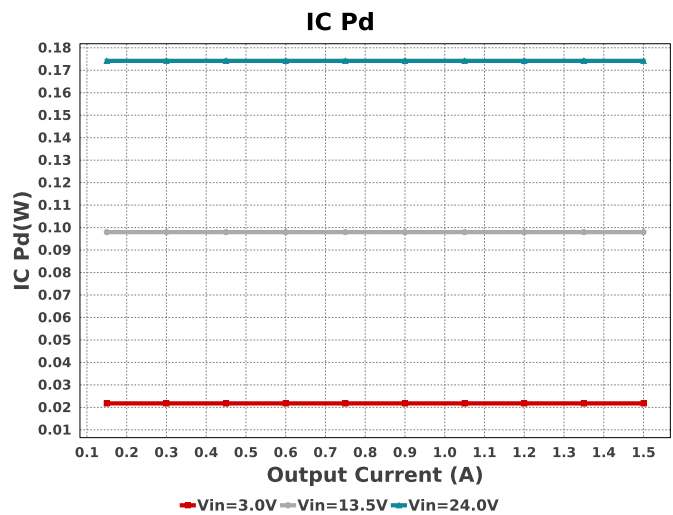
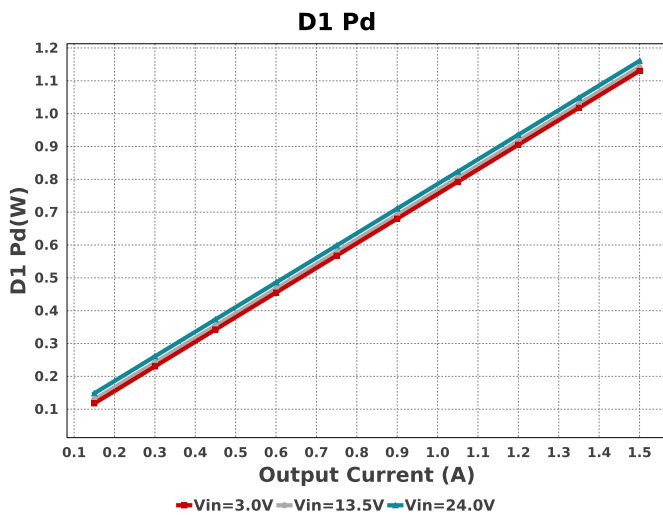
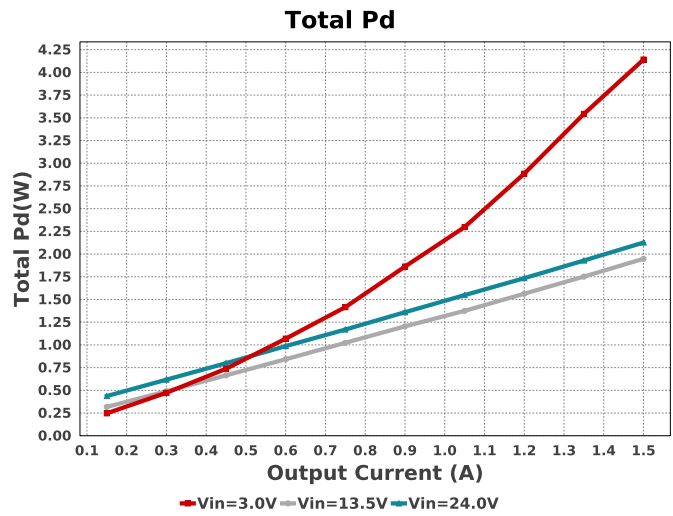
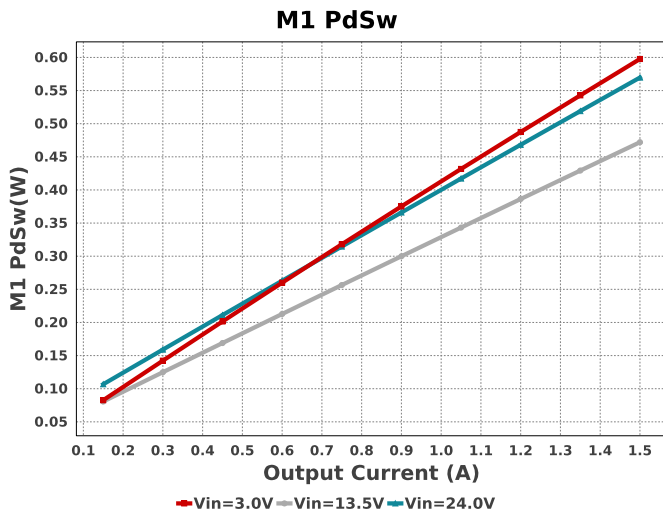
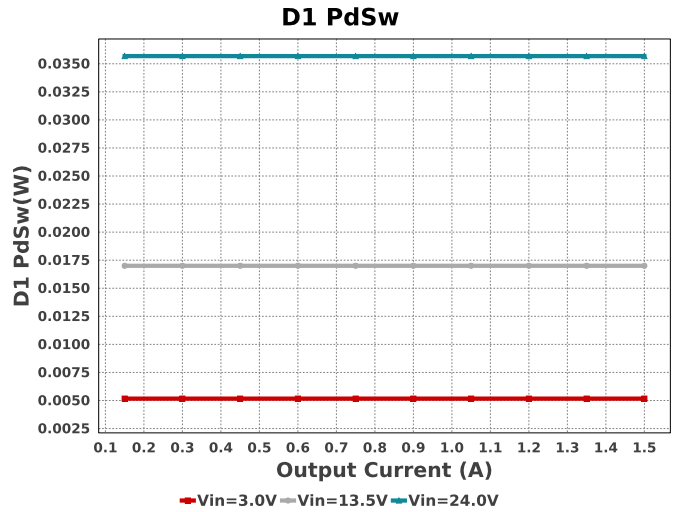
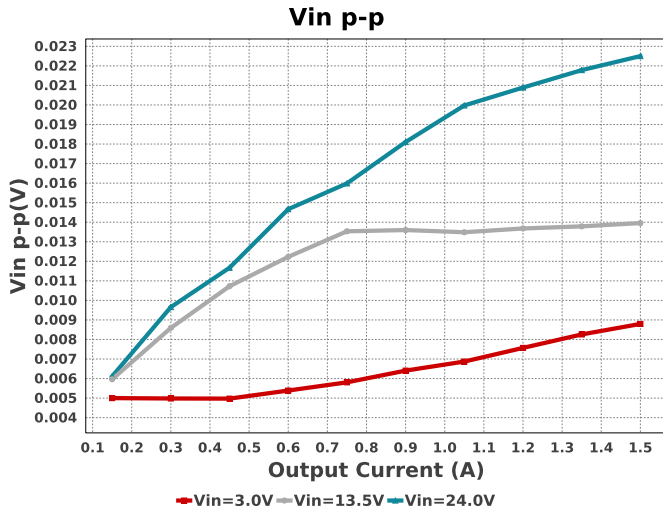
M1 TjOP

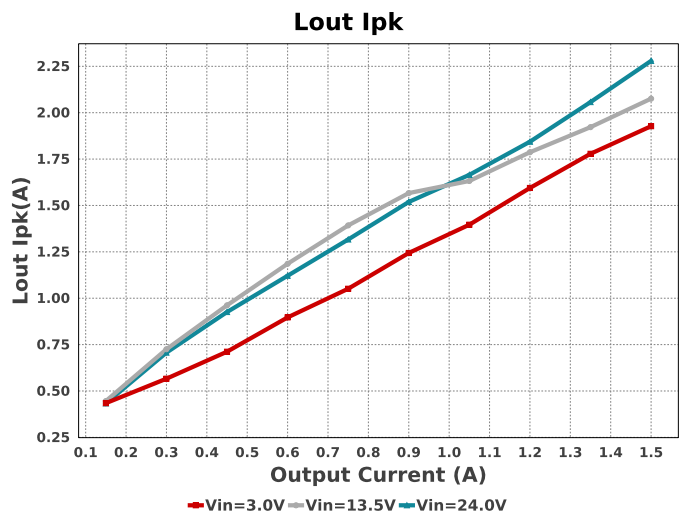
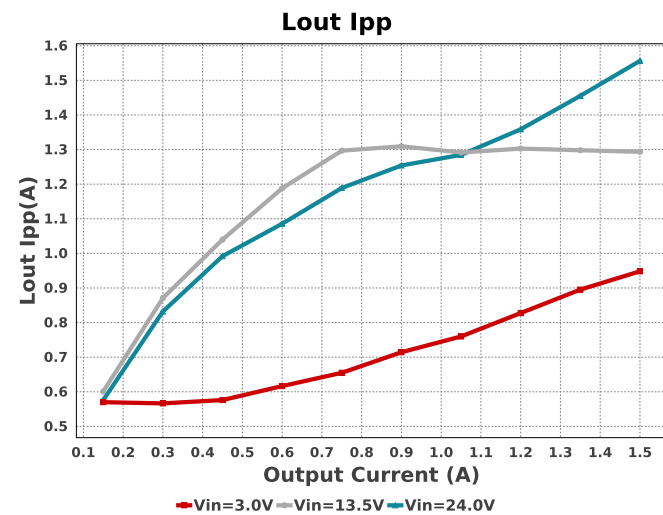
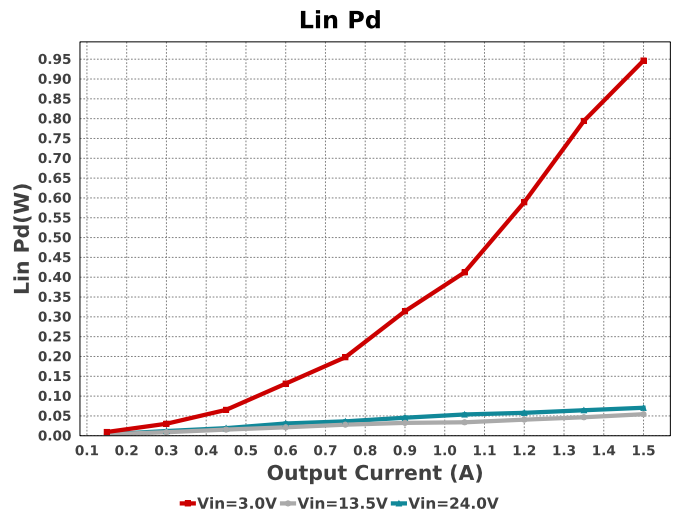
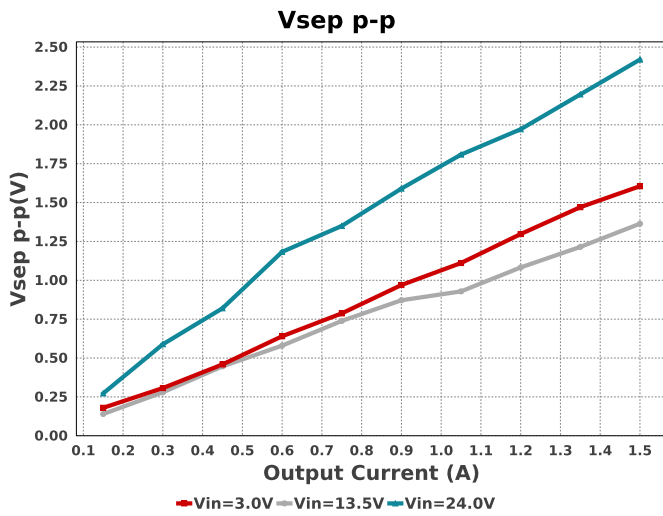
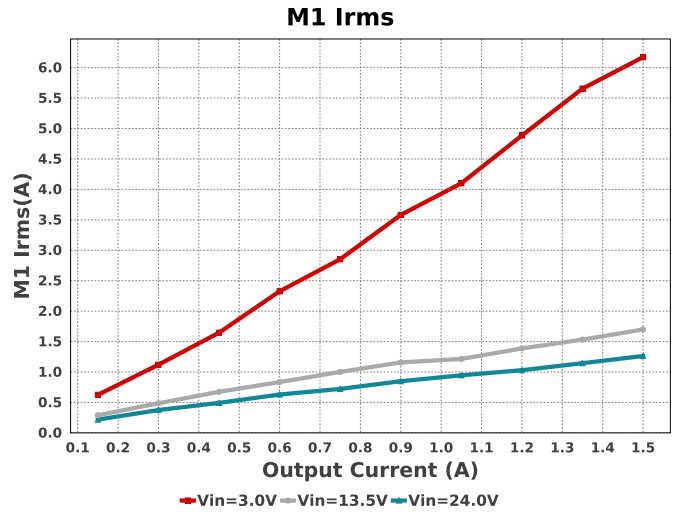
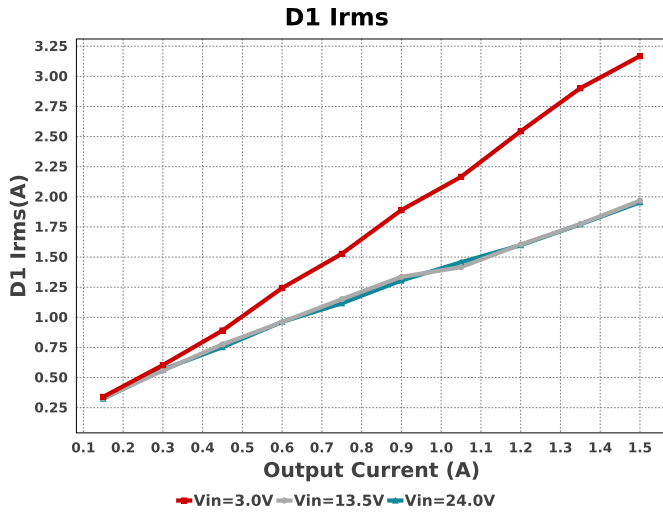


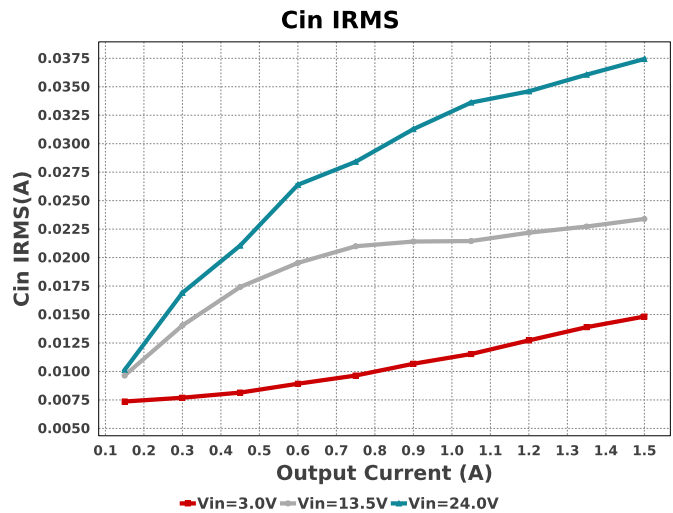
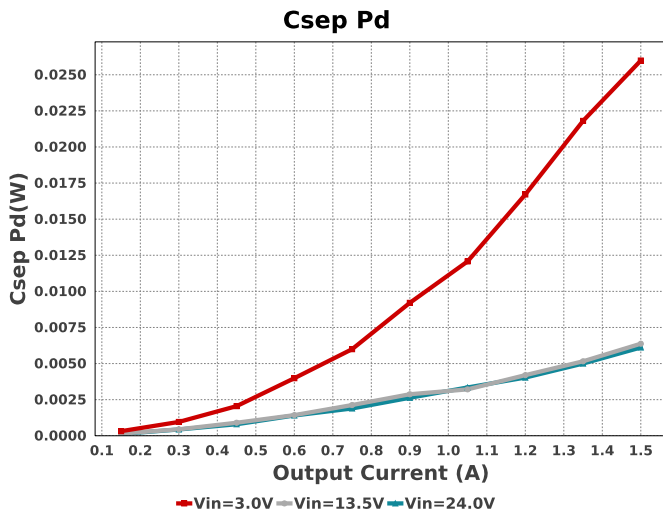
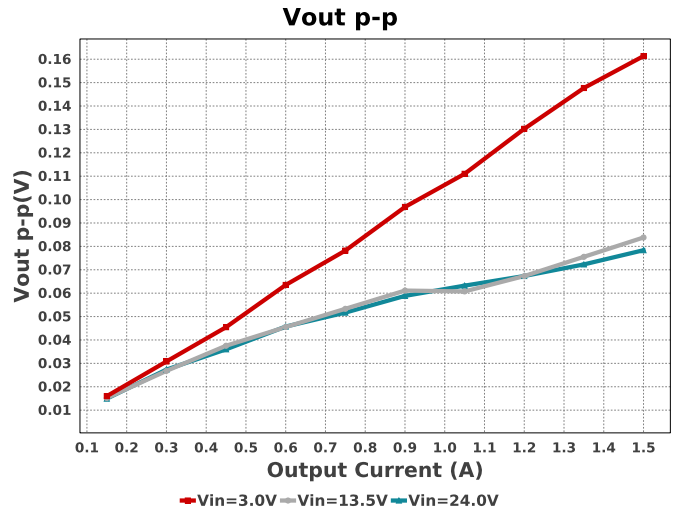
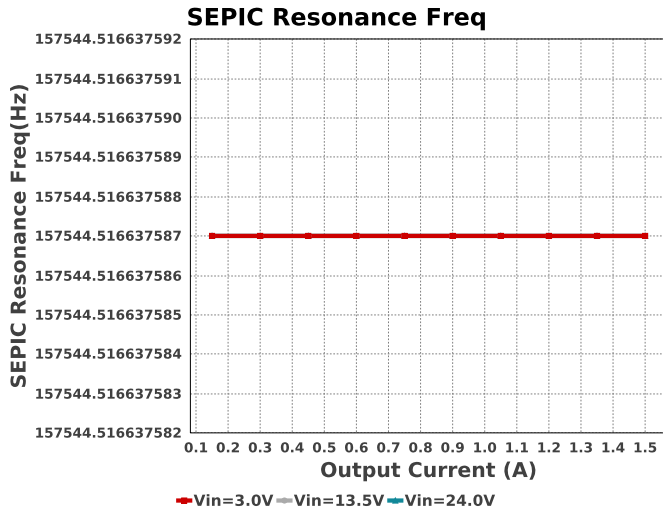
Csep IRMS



M1 PdCond**IC Ipk****Duty Cycle****Lout Irms****D1 PdCond****Efficiency**







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	14.708 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	32.449 μ W	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.816 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	9.621 mW	Capacitor	Output capacitor power dissipation
5.	Csep IRMS	3.045 A	Capacitor	SEPIC capacitor RMS ripple current
6.	Csep Pd	25.941 mW	Capacitor	SEPIC capacitor power dissipation
7.	D1 Irms	3.168 A	Current	D1 Irms
8.	Lin Ipk	5.895 A	Current	Lin peak current
9.	Lin Irms	5.481 A	Current	Lin ripple current
10.	Lout Ipk	1.923 A	Current	Lout peak current
11.	Lout Irms	1.495 A	Current	Lout ripple current
12.	D1 Pd	1.13 W	Diode	Diode power dissipation
13.	D1 PdCond	1.125 W	Diode	Diode conduction losses
14.	D1 PdSw	5.192 mW	Diode	Diode switching losses
15.	D1 Tj	92.161 degC	Diode	D1 junction temperature
16.	IC Ipk	7.28 mA	IC	Peak switch current in IC
17.	IC Pd	174.72 mW	IC	IC power dissipation
18.	IC Tj	57.955 degC	IC	IC junction temperature
19.	IC Tolerance	15.3 mV	IC	IC Feedback Tolerance
20.	Iin Avg	5.881 A	IC	Average input current
21.	SEPIC Resonance Freq	157.545 kHz	IC	SEPIC Resonance Frequency
22.	Vsep p-p	1.596 V	IC	Peak-to-peak sepic voltage
23.	Lin Ipp	904.908 mA	Inductor	Peak-to-peak input inductor ripple current
24.	Lout Ipp	939.05 mA	Inductor	Peak-to-peak output inductor ripple current
25.	M1 Irms	6.173 A	Mosfet	M1 MOSFET Irms
26.	M1 Pd	1.368 W	Mosfet	M1 MOSFET total power dissipation
27.	M1 PdCond	767.6 mW	Mosfet	M1 MOSFET conduction losses
28.	M1 PdSw	600.522 mW	Mosfet	M1 MOSFET switching losses
29.	M1 TjOP	98.407 degC	Mosfet	M1 MOSFET junction temperature
30.	IOUT_OP	1.5 A	Op Point	Iout operating point
31.	VIN_OP	3.0 V	Op Point	Vin operating point

#	Name	Value	Category	Description
32.	Lin Pd	946.344 mW	Power	Lin power dissipation
33.	Lout Pd	74.995 mW	Power	Lout power dissipation
34.	Total Pd	4.144 W	Power	Total Power Dissipation
35.	Rsense Pd	266.72 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	20	System	Total Design BOM count
			Information	
37.	Duty Cycle	79.0 %	System	Duty cycle
			Information	
38.	Efficiency	76.513 %	System	Steady state efficiency
			Information	
39.	FootPrint	512.0 mm ²	System	Total Foot Print Area of BOM components
			Information	
40.	Frequency	260.0 kHz	System	Switching frequency
			Information	
41.	Mode	CCM	System	Conduction Mode
			Information	
42.	Total BOM	NA	System	Total BOM Cost
			Information	
43.	Vin p-p	8.711 mV	System	Peak-to-peak input voltage
			Information	
44.	Vout p-p	160.592 mV	System	Peak-to-peak output ripple voltage
			Information	

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	3.0	Minimum input voltage
Vout	9.0	Output Voltage
base_pn	LM3488-Q1	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 C_{in} and C_{out} , 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

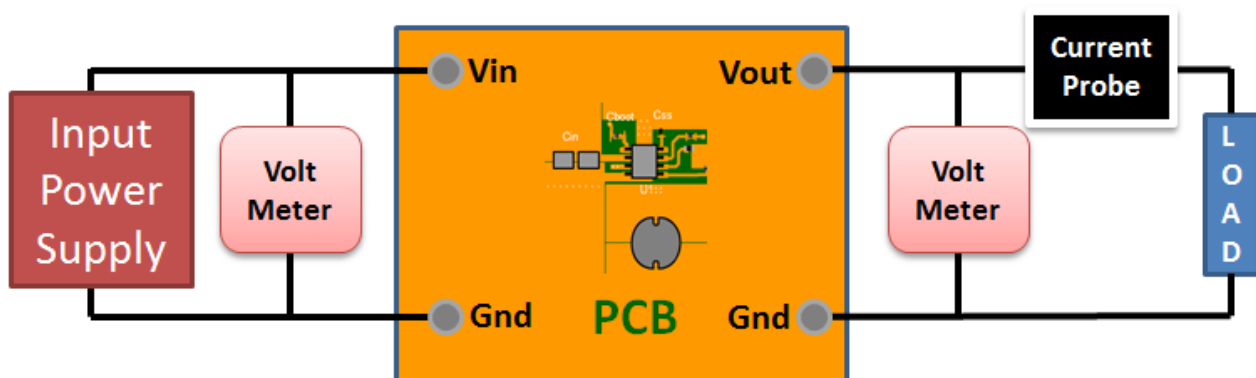
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down 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 3.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to V_{in} and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from V_{out} 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 V_{in} and GND, a load is connected between V_{out} and GND and a current meter is connected in series between V_{out} 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 : 65BC0DD889F4D082[v1]
2. **LM3488-Q1** Product Folder : <http://www.ti.com/product/LM3488Q%2DQ1> : contains the data sheet and other resources.

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