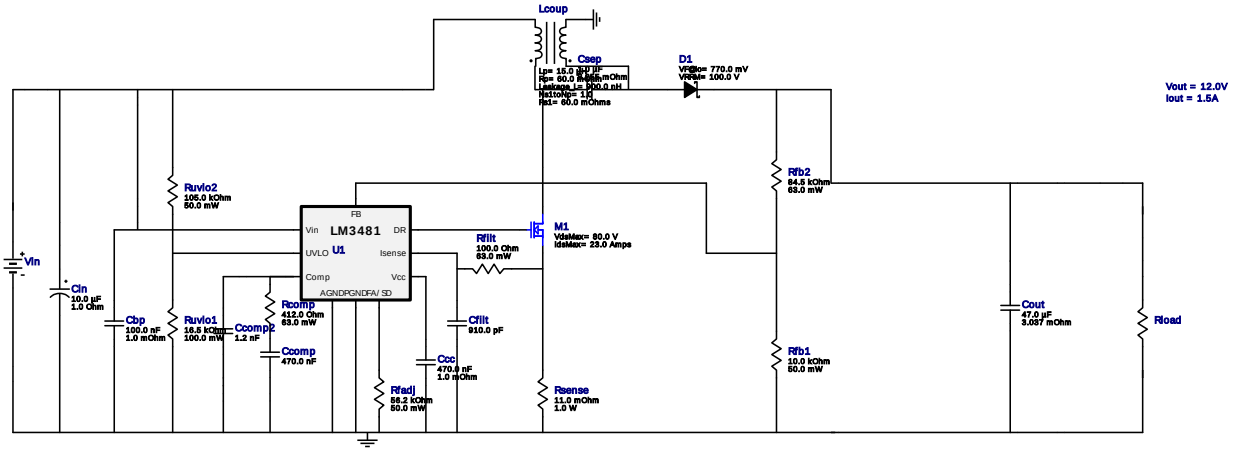
WEBENCH® Design Report

VinMin = 11.0V
VinMax = 45.0V
Vout = 12.0V
Iout = 1.5A

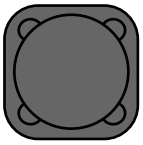
Device = LM3481MM/NOPB
Topology = SEPIC
Created = 2020-04-21 12:22:21.154
BOM Cost = $7.34
BOM Count = 20
Total Pd = 2.05W

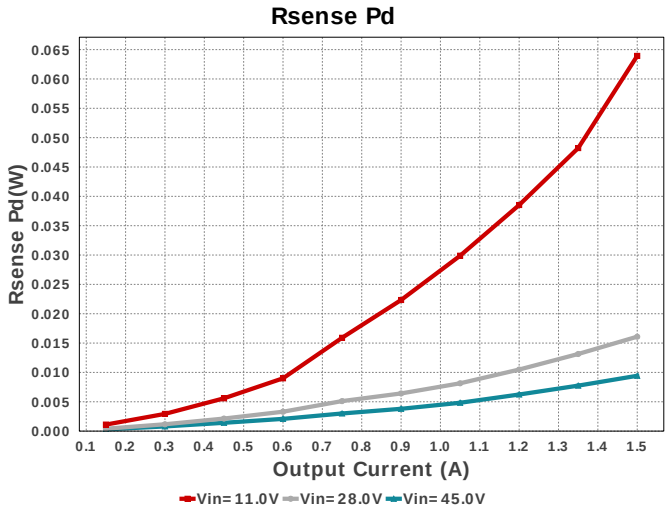
Design : 96 LM3481MM/NOPB
LM3481MM/NOPB 11V-32V to 12.00V @ 1.5A

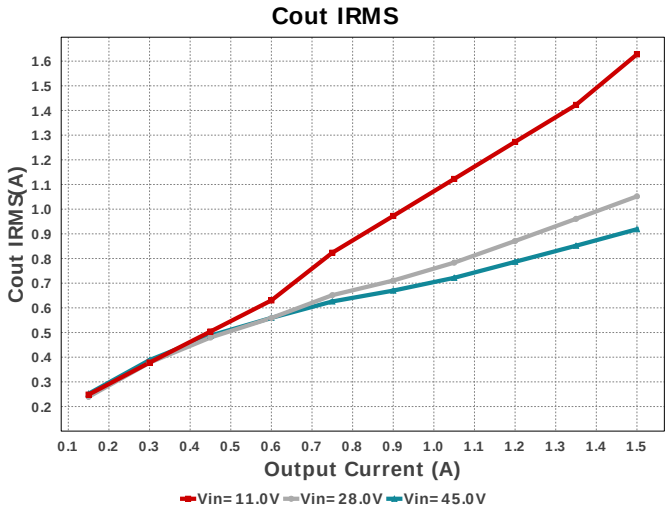


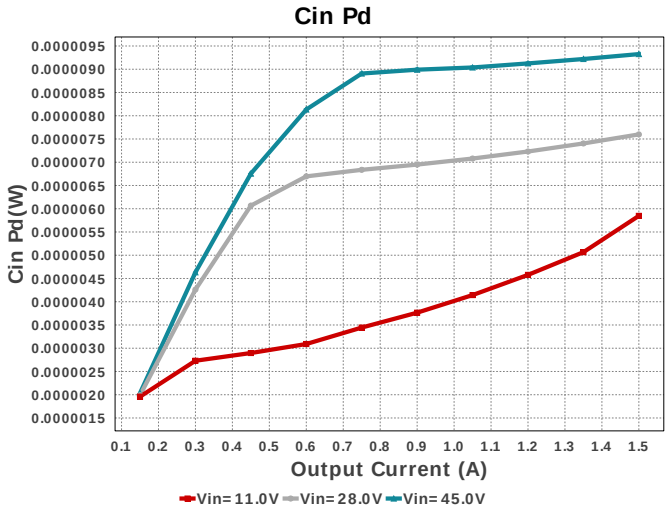
Electrical BOM

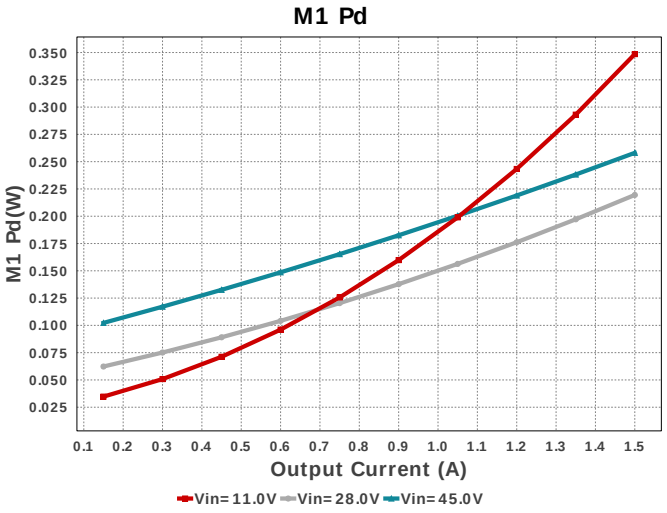
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	TDK	C2012X7T2E104K125AA Series= X7T	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 250.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm²
Ccc	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
Ccomp	Panasonic	ECPU1C474MA5 Series= ECPU(A)	Cap= 470.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.20	1206 11 mm²
Ccomp2	Samsung Electro-Mechanics	CL21C122JBFNNNE Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cflt	Samsung Electro-Mechanics	CL21C911JBCNNNC Series= C0G/NP0	Cap= 910.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.20	0805 7 mm²
Cin	Vishay-Sprague	293D106X9063E2TE3 Series= 293D	Cap= 10.0 uF ESR= 1.0 Ohm VDC= 63.0 V IRMS= 580.0 mA	1	$3.42	3216-18 11 mm²
Cout	MuRata	GRM32ER61C476ME15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	1	$0.38	1210_280 15 mm²
Csep	TDK	C2012X7S2A105K125AB Series= X7S	Cap= 1.0 uF ESR= 8.255 mOhm VDC= 100.0 V IRMS= 2.27442 A	1	$0.12	0805 7 mm²
D1	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.80	DPAK 102 mm²

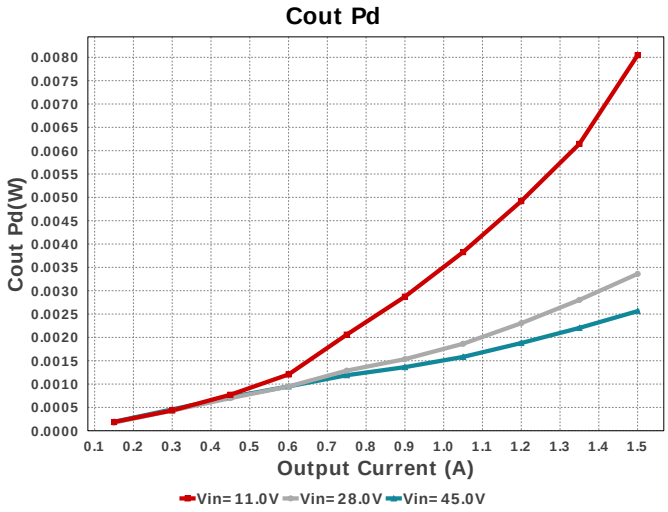
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Lcoup	Coiltronics	DRQ125-150-R	Lp= 15.0 µH Rp= 60.0 mOhm Leakage_L= 900.0 nH Ns1toNp= 1.0 Rs1= 60.0 mOhms	1	$0.91	 DRQ125 210 mm^2
M1	Infineon Technologies	BSC340N08NS3 G	VdsMax= 80.0 V IdsMax= 23.0 Amps	1	$0.24	 PG-TDSON-8 55 mm^2
Rcomp	Vishay-Dale	CRCW0402412RFKED Series= CRCW..e3	Res= 412.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
Rfadj	Yageo	RC0201FR-0756K2L Series= ?	Res= 56.2 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	CRCW040284K5FKED Series= CRCW..e3	Res= 84.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
Rfilt	Vishay-Dale	CRCW0402100RFKED 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-R011-F-T1 Series= PRL1632	Res= 11.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	 0612 11 mm^2
Ruvlo1	Vishay-Dale	CRCW060316K5FKEA Series= CRCW..e3	Res= 16.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
Ruvlo2	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm^2
U1	Texas Instruments	LM3481MM/NOPB	Switcher	1	$0.70	 MUB10A 24 mm^2

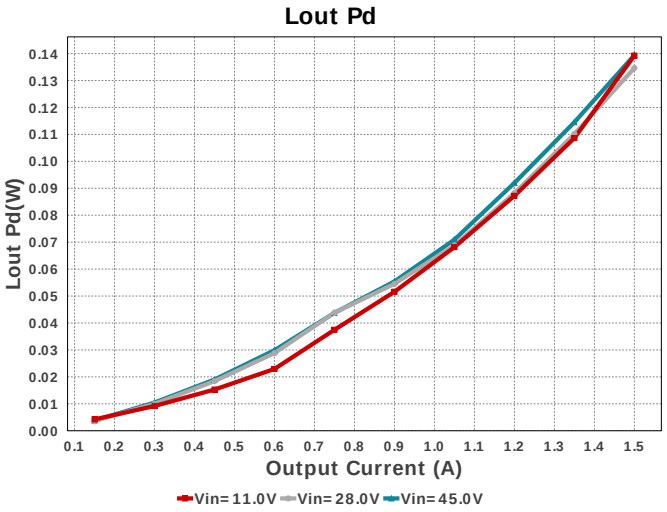


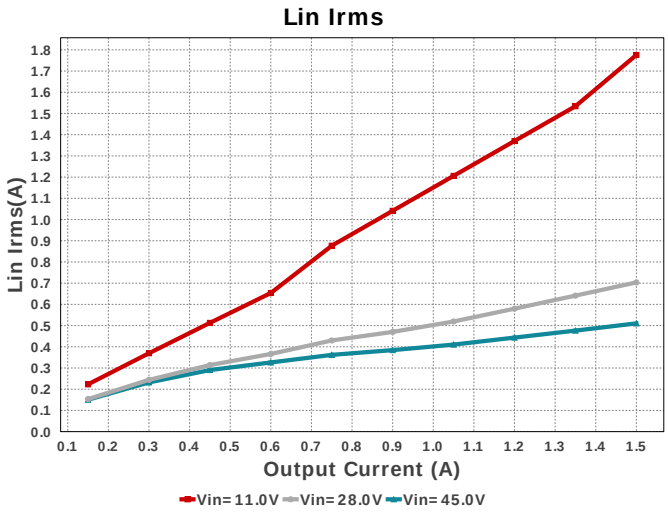


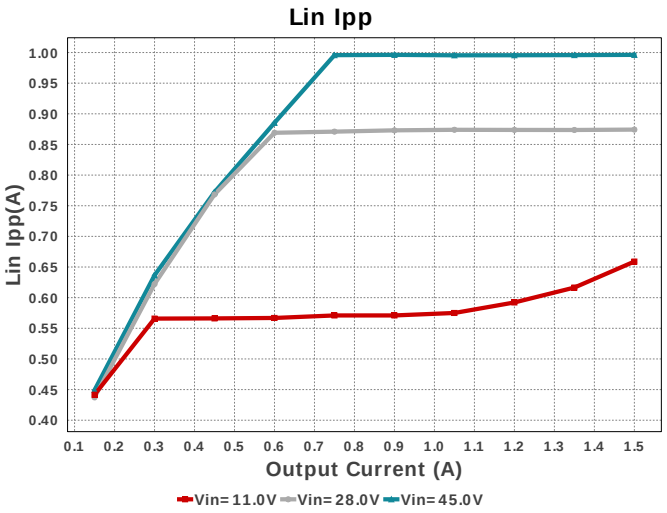


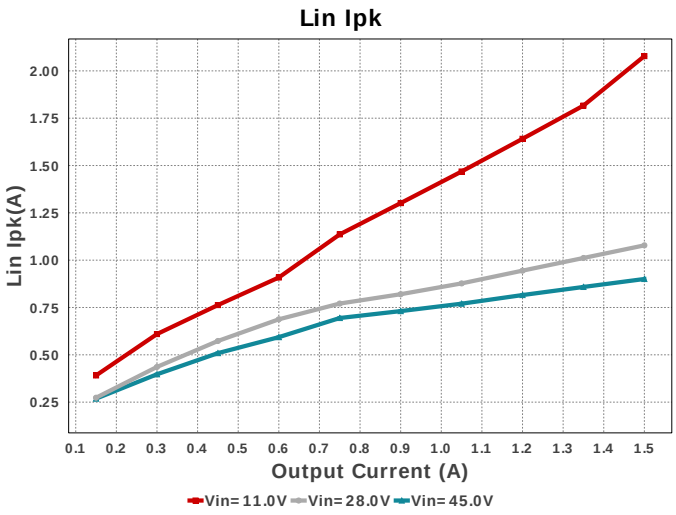


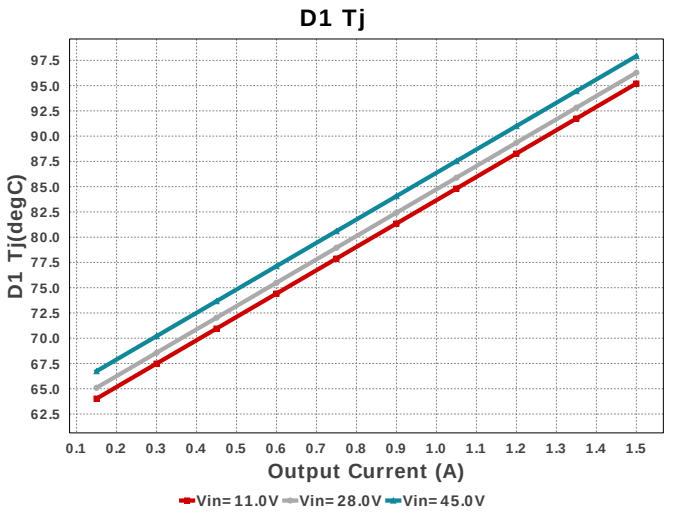


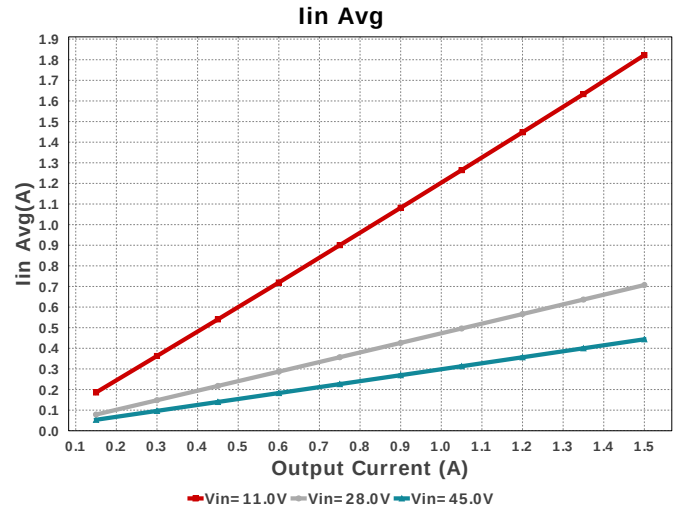


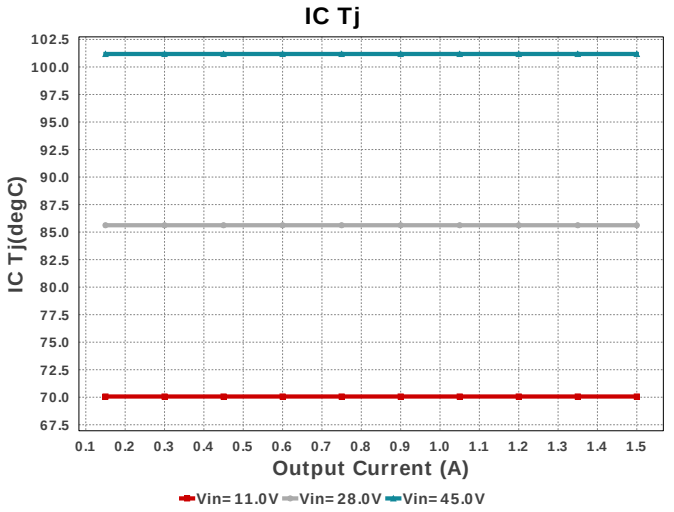


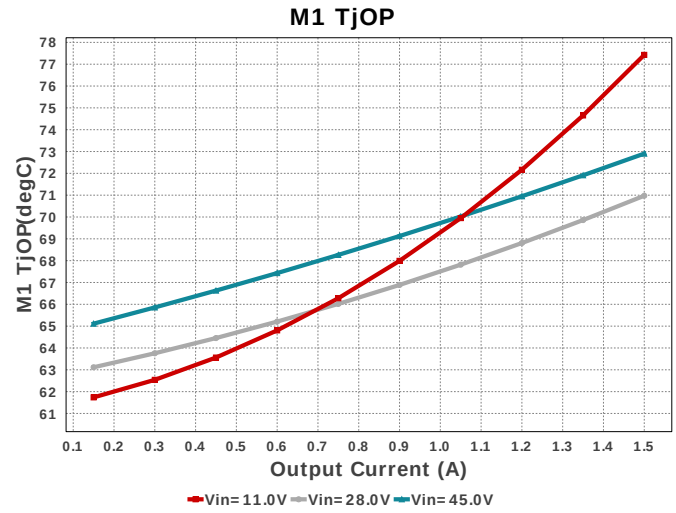


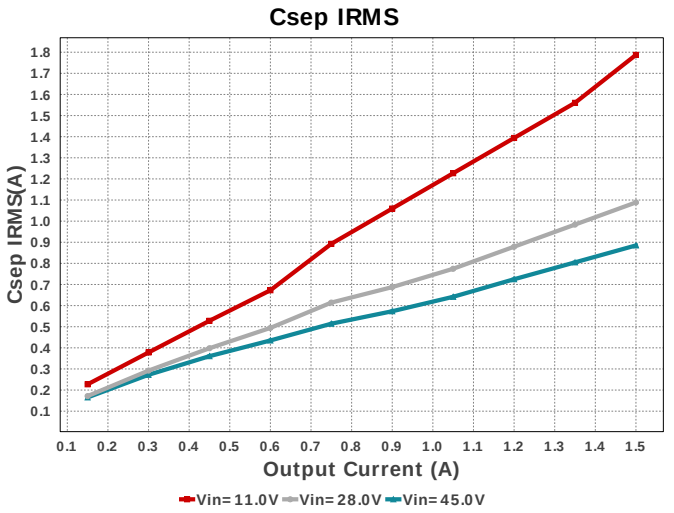




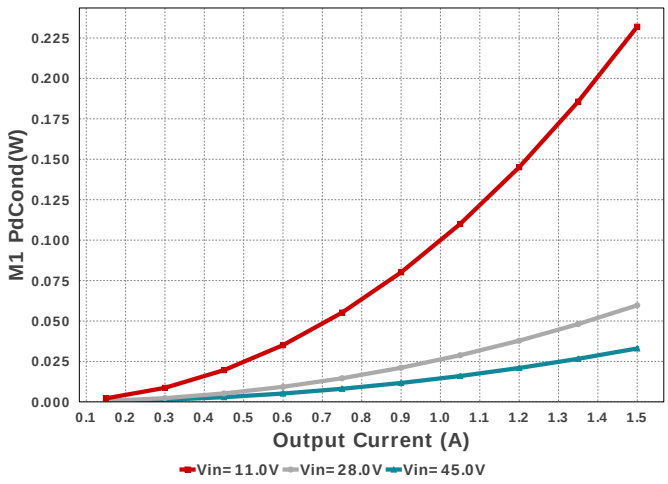




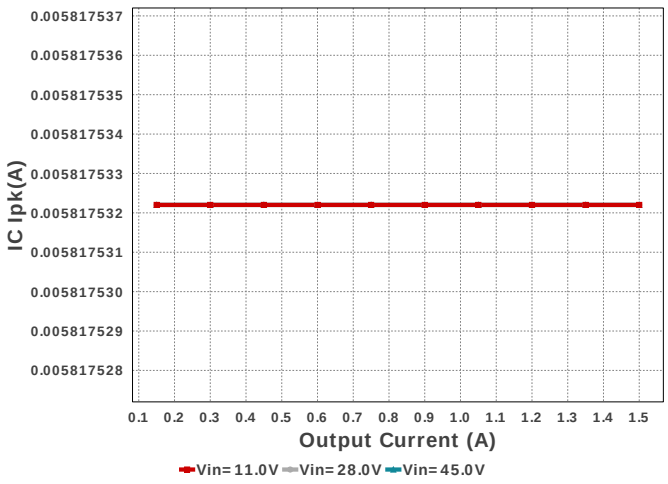




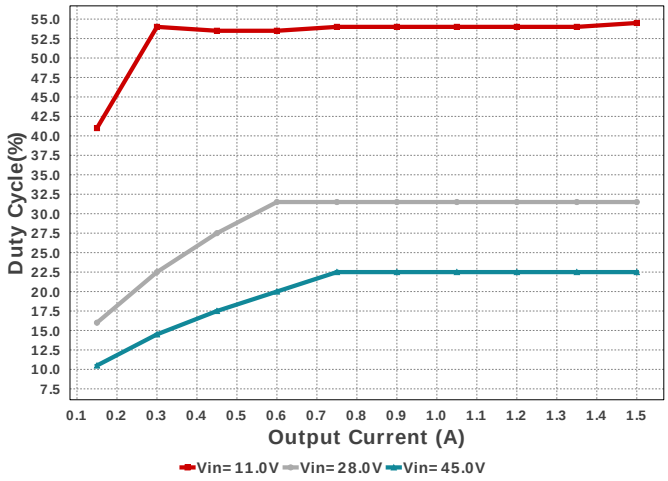
M1 PdCond



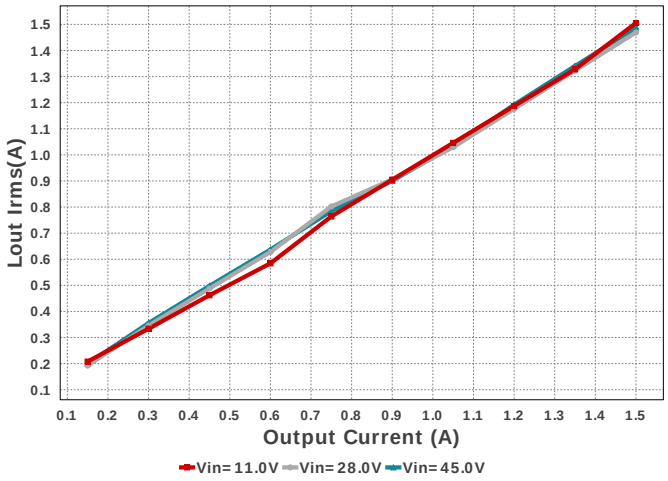
IC Ipk



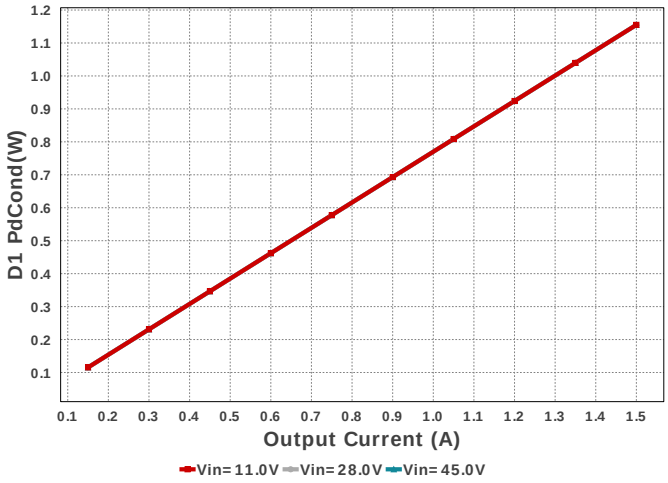
Duty Cycle



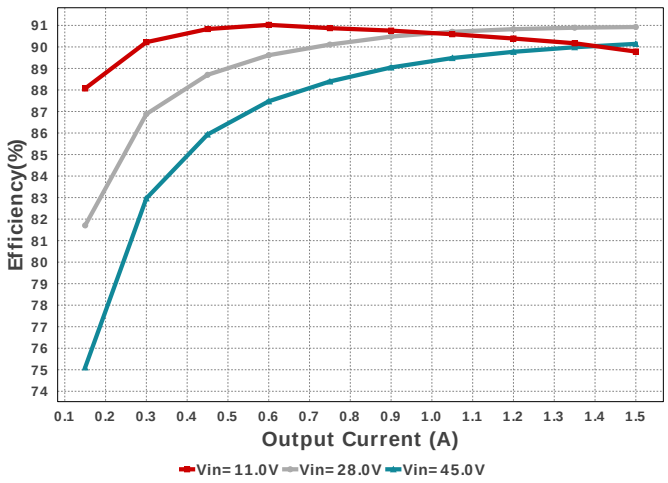
Lout Irms



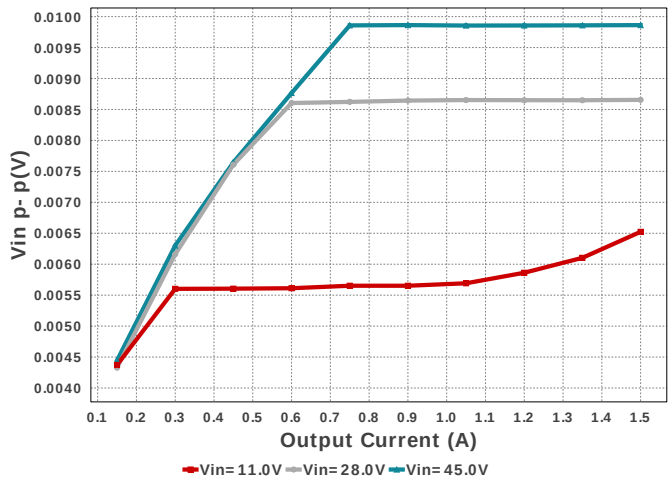
D1 PdCond



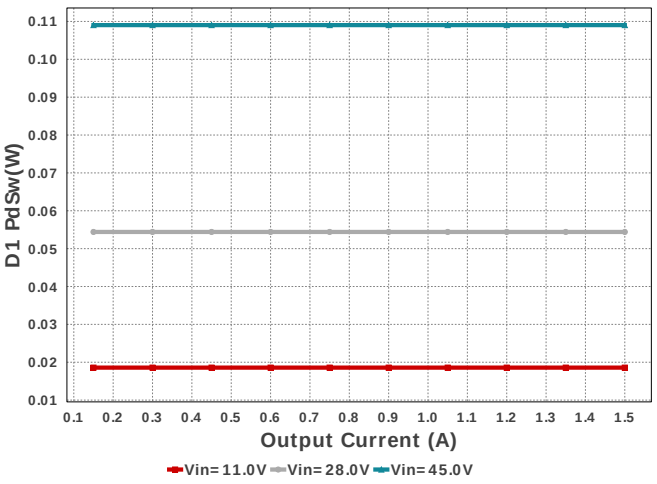
Efficiency



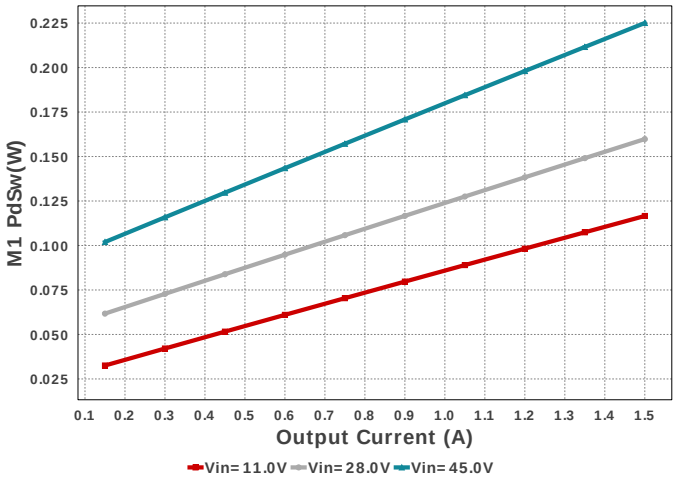
Vin p- p



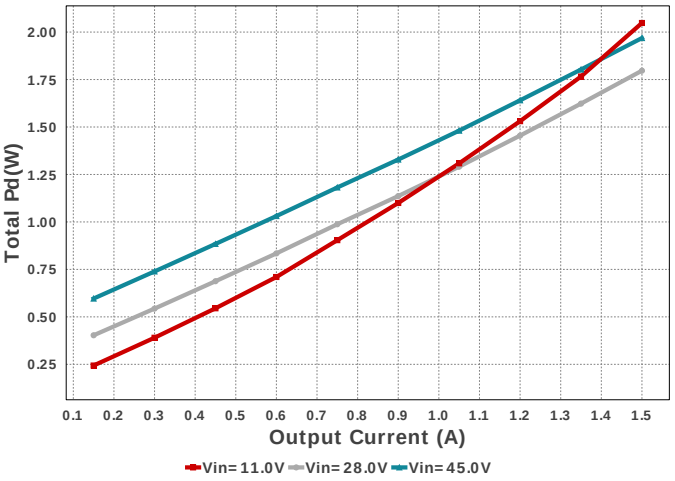
D1 PdSw



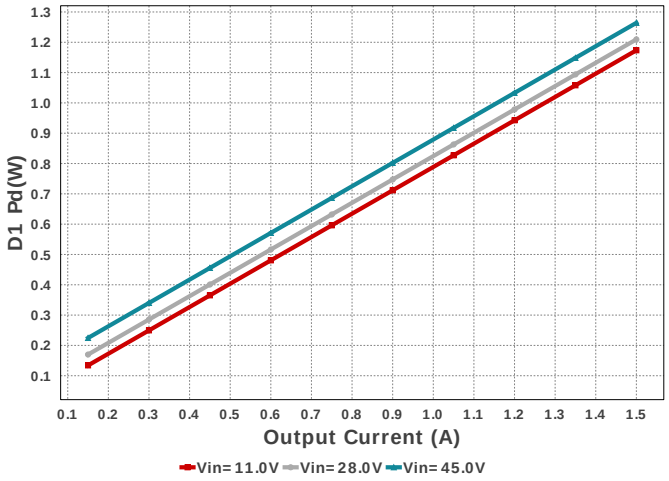
M1 PdSw



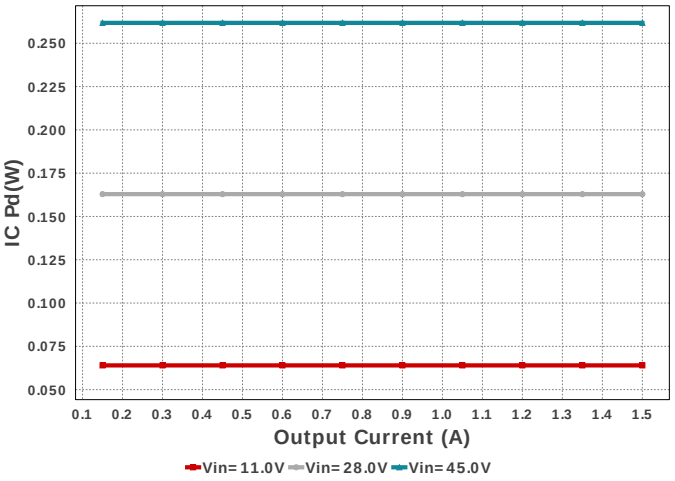
Total Pd

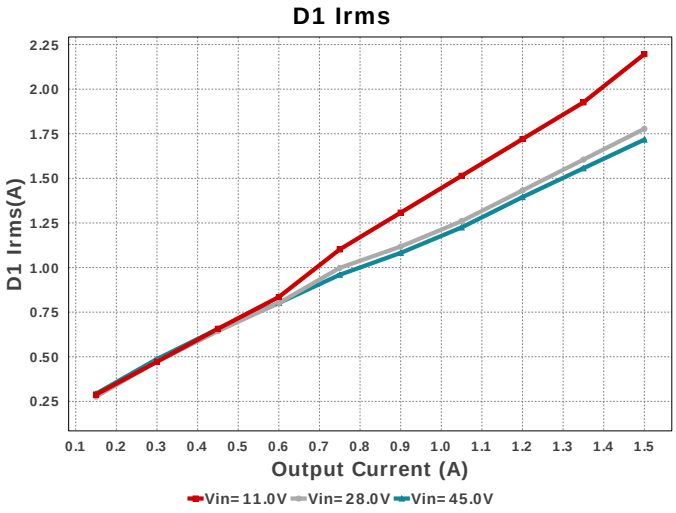


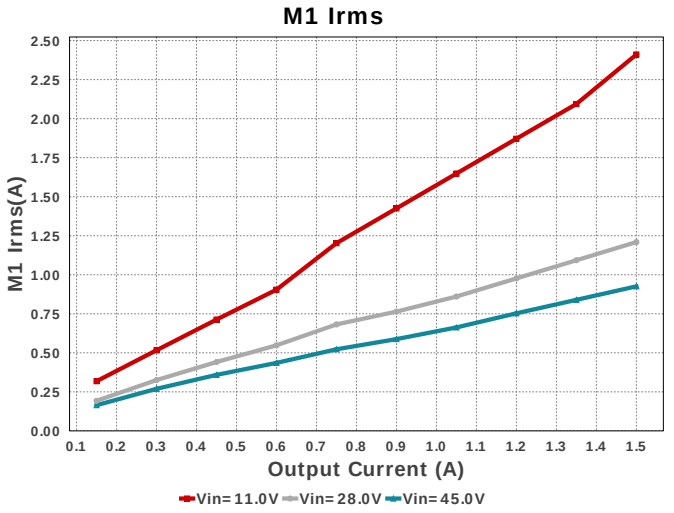
D1 Pd

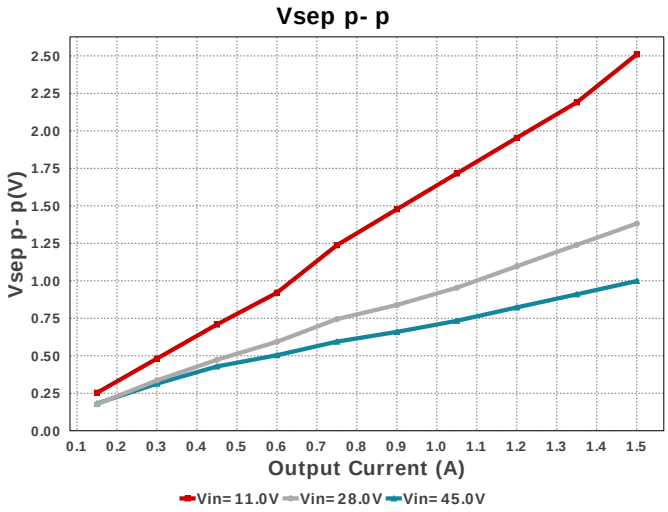


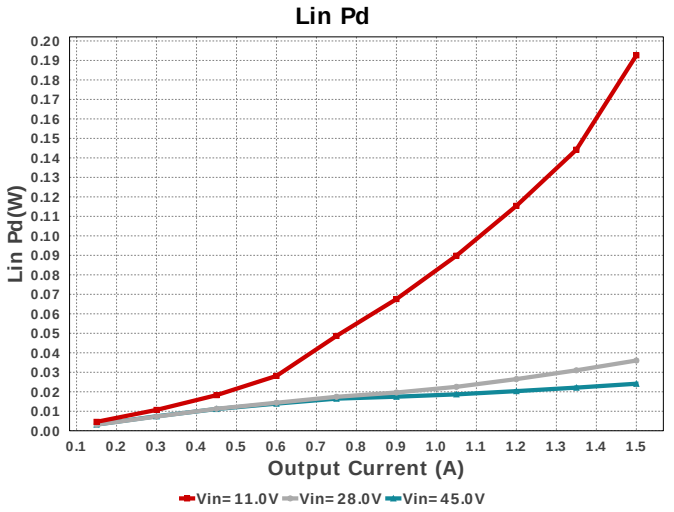
IC Pd

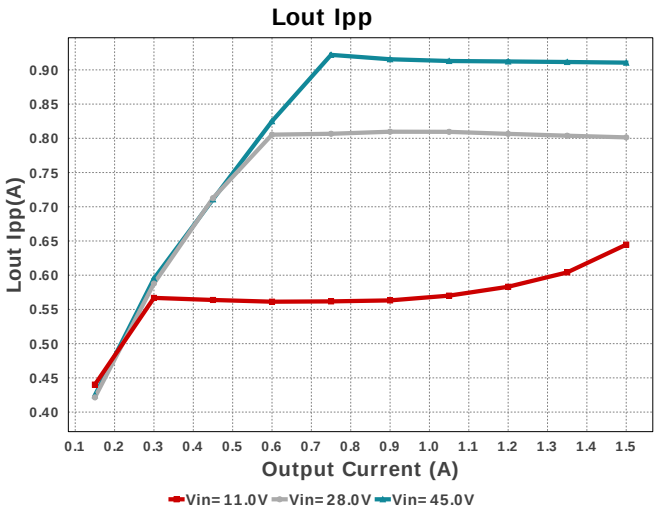


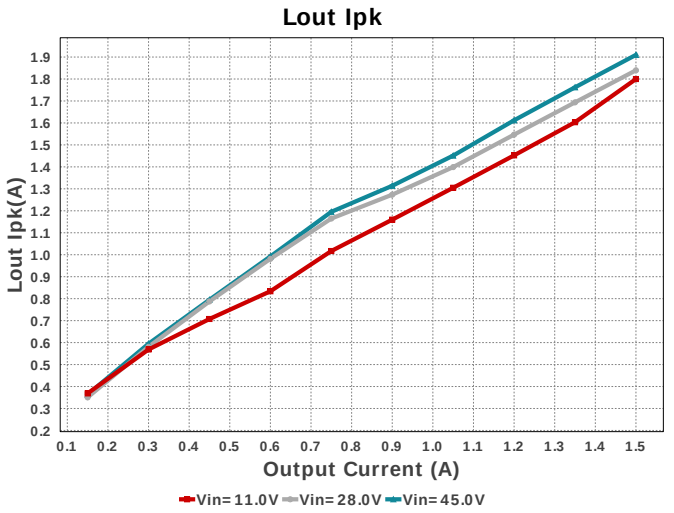


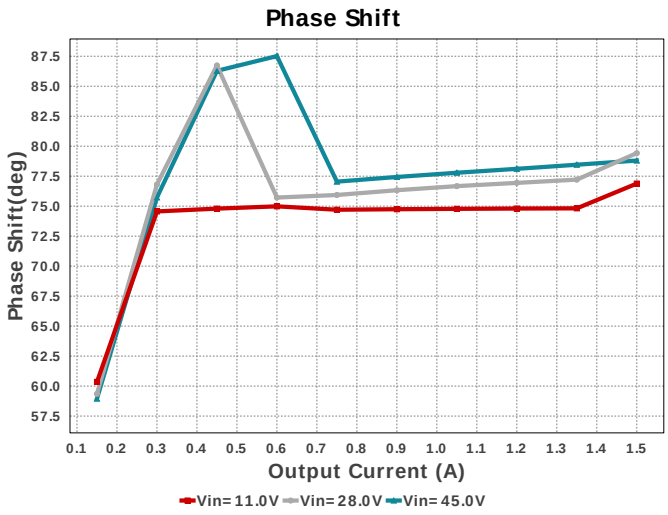


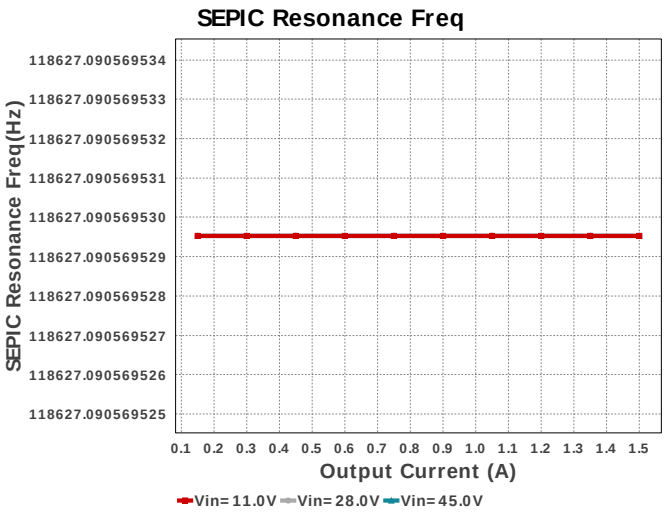


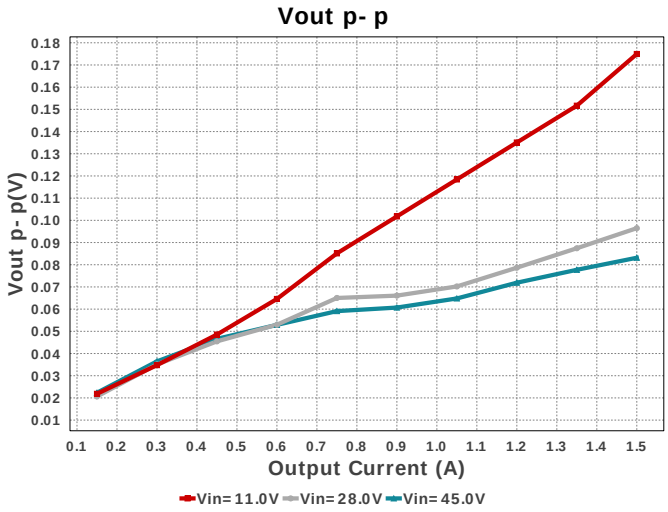


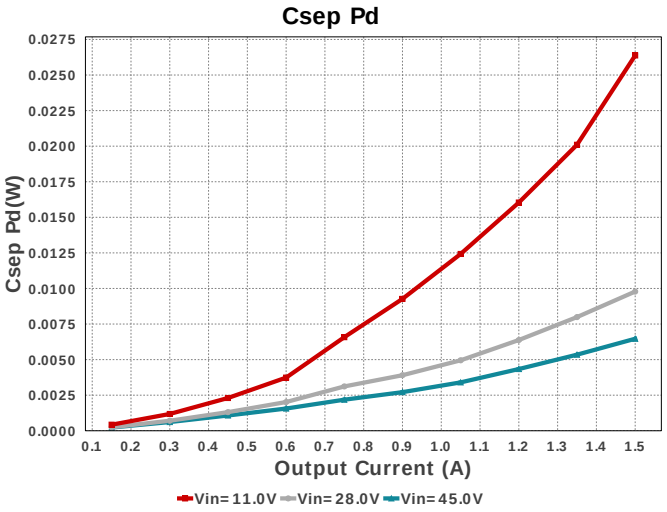


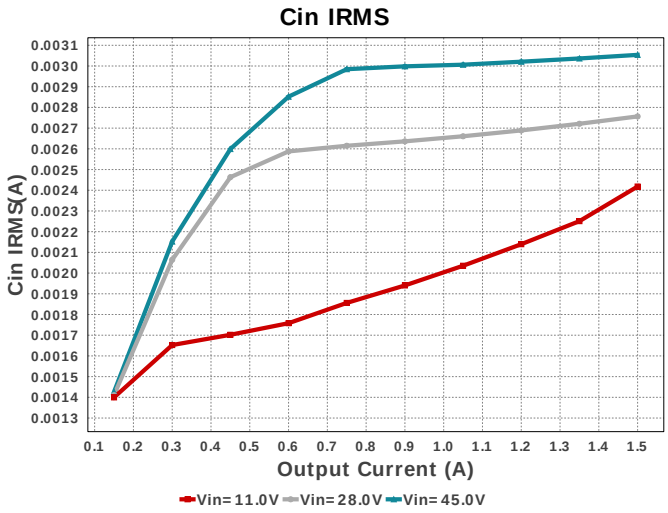


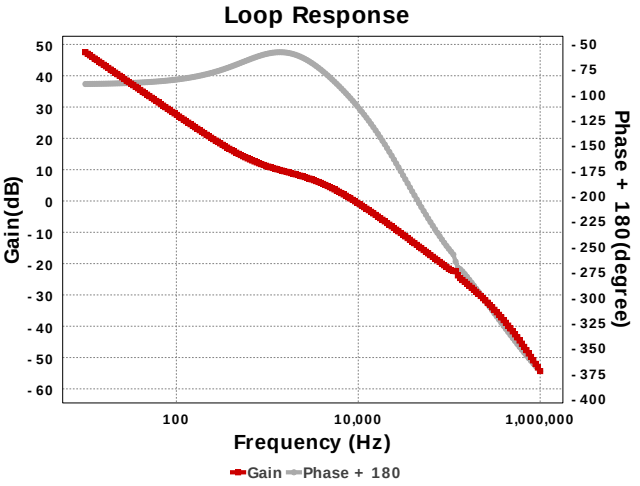












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.316 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	5.366 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.632 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	8.087 mW	Capacitor	Output capacitor power dissipation
5.	Csep IRMS	1.783 A	Capacitor	SEPIC capacitor RMS ripple current
6.	Csep Pd	26.243 mW	Capacitor	SEPIC capacitor power dissipation
7.	D1 Irms	2.203 A	Current	D1 Irms
8.	Lin Ipk	2.07 A	Current	Lin peak current
9.	Lin Irms	1.78 A	Current	Lin ripple current
10.	Lout Ipk	1.791 A	Current	Lout peak current
11.	Lout Irms	1.508 A	Current	Lout ripple current

#	Name	Value	Category	Description
12.	D1 Pd	1.174 W	Diode	Diode power dissipation
13.	D1 PdCond	1.155 W	Diode	Diode conduction losses
14.	D1 PdSw	19.077 mW	Diode	Diode switching losses
15.	D1 Tj	95.222 degC	Diode	D1 junction temperature
16.	IC Ipk	5.84 mA	IC	Peak switch current in IC
17.	IC Pd	262.778 mW	IC	IC power dissipation
18.	IC Tj	101.335 degC	IC	IC junction temperature
19.	IC Tolerance	19.0 mV	IC	IC Feedback Tolerance
20.	Iin Avg	1.823 A	IC	Average input current
21.	SEPIC Resonance Freq	118.627 kHz	IC	SEPIC Resonance Frequency
22.	Vsep p-p	2.44 V	IC	Peak-to-peak sepic voltage
23.	Lin Ipp	632.176 mA	Inductor	Peak-to-peak input inductor ripple current
24.	Lout Ipp	618.485 mA	Inductor	Peak-to-peak output inductor ripple current
25.	M1 Irms	2.417 A	Mosfet	M1 MOSFET Irms
26.	M1 Pd	351.861 mW	Mosfet	M1 MOSFET total power dissipation
27.	M1 PdCond	232.133 mW	Mosfet	M1 MOSFET conduction losses
28.	M1 PdSw	119.728 mW	Mosfet	M1 MOSFET switching losses
29.	M1 TjOP	77.594 degC	Mosfet	M1 MOSFET junction temperature
30.	IOUT_OP	1.5 A	Op Point	Iout operating point
31.	VIN_OP	11.0 V	Op Point	Vin operating point
32.	Lin Pd	193.305 mW	Power	Lin power dissipation
33.	Lout Pd	139.584 mW	Power	Lout power dissipation
34.	Total Pd	2.053 W	Power	Total Power Dissipation
35.	Rsense Pd	64.281 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	20	System Information	Total Design BOM count
37.	Cross Freq	8.704 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	54.5 %	System Information	Duty cycle
39.	Efficiency	89.761 %	System Information	Steady state efficiency
40.	FootPrint	488.0 mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	365.0 kHz	System Information	Switching frequency
42.	Gain Marg	11.312 db	System Information	Bode Plot Gain Margin
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	73.866 deg	System Information	Bode Plot Phase Margin
45.	Phase Shift	76.417 deg	System Information	Bode Plot Phase Shift
46.	Total BOM	$7.34	System Information	Total BOM Cost
47.	Vin p-p	6.259 mV	System Information	Peak-to-peak input voltage
48.	Vout p-p	171.635 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	45.0	Maximum input voltage
VinMin	11.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM3481	Base Product Number
source	DC	Input Source Type
Ta	60.0	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

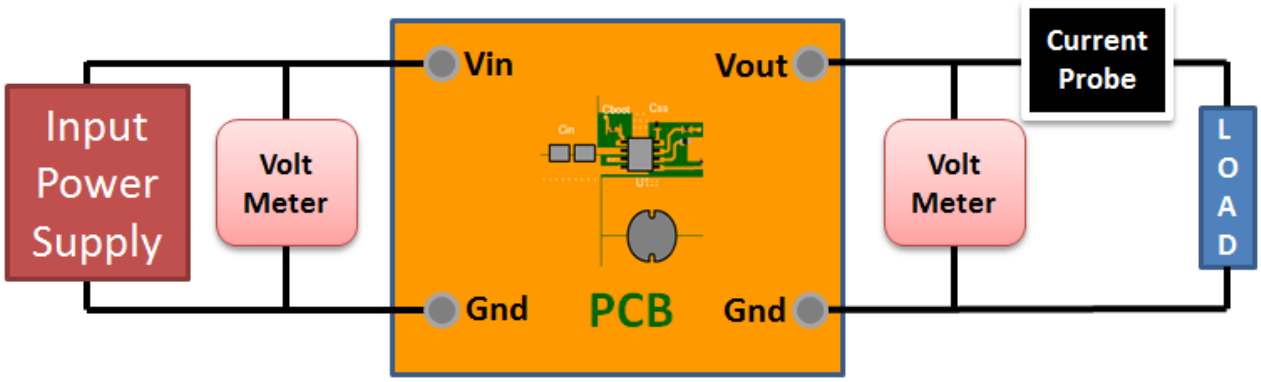
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 11.0V 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.

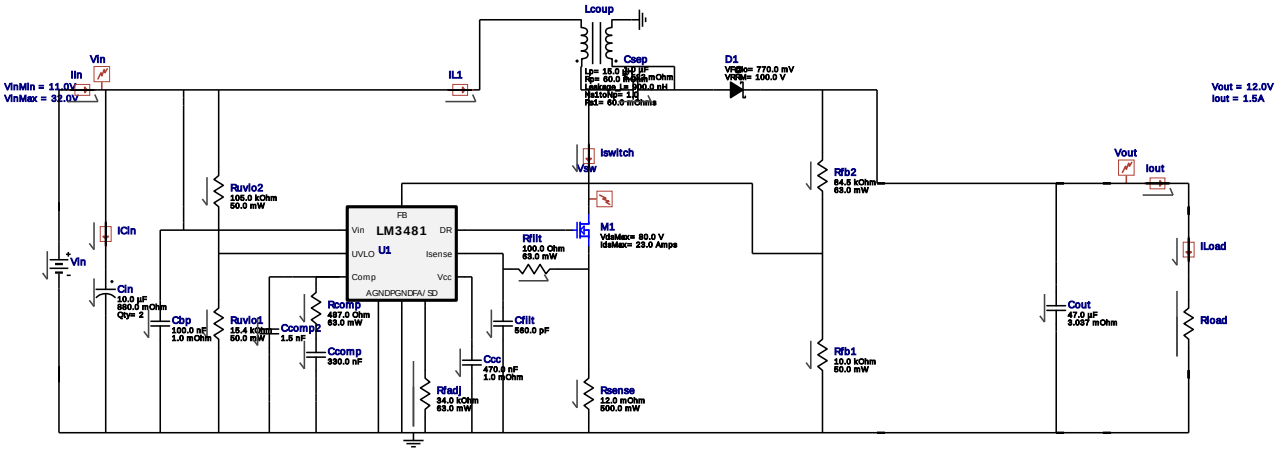


WEBENCH® Electrical Simulation Report

Design Id = 96

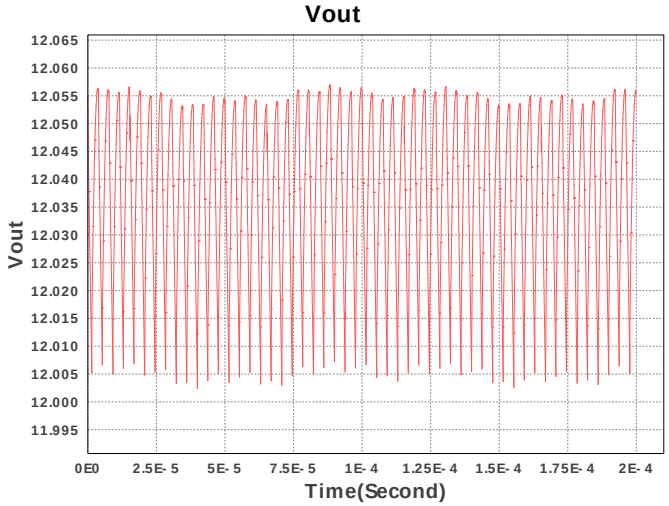
sim_id = 2

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Vzero1	V	Zero Volt Source	0 V
2.	Vzero2	V	Zero Volt Source	0 V
3.	Vzero1	V	Zero Volt Source	0 V
4.	Rload	R	Load Resistance	8.0 Ohm



Design Assistance

1. Master key : DA4DD7499264D266[v1]
2. **LM3481** Product Folder : http://www.ti.com/product/LM3481 : contains the data sheet and other resources.