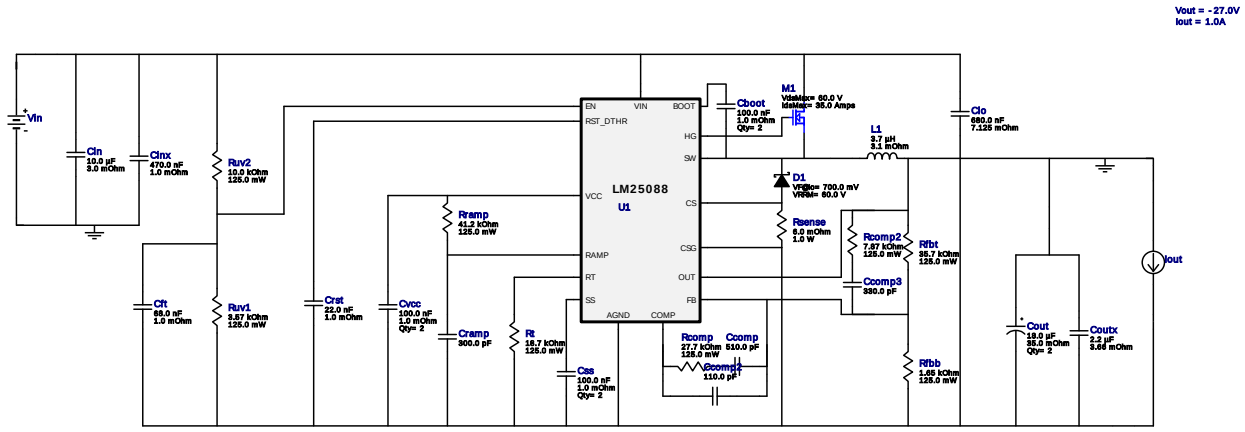
WEBENCH® Design Report

VinMin = 4.5V
VinMax = 5.5V
Vout = -27.0V
Iout = 1.0A

Device = LM25088MH-1/NOPB
Topology = Inverting_Buck_Boost
Created = 2019-06-20 12:54:44.415
BOM Cost = $5.31
BOM Count = 31
Total Pd = 3.37W

Design : 11 LM25088MH-1/NOPB
LM25088MH-1/NOPB 4.5V-5.5V to -27.00V @ 1A



Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Yageo	CC0805KRX7R9BB104 Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	2	$0.02	0805 7 mm²
Ccomp	Samsung Electro-Mechanics	CL21C511JBANNNC Series= C0G/NP0	Cap= 510.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.21	0805 7 mm²
Ccomp2	Samsung Electro-Mechanics	CL21C111JBANNNC Series= C0G/NP0	Cap= 110.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.10	0805 7 mm²
Ccomp3	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cft	MuRata	GRM219R71E683KA01D Series= X7R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
Cin	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm²
Cinx	Taiyo Yuden	TMK212BJ474KD-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 20.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cio	TDK	C1608X5R1H684K080AB Series= X5R	Cap= 680.0 nF ESR= 7.125 mOhm VDC= 50.0 V IRMS= 1.9522 A	1	$0.05	0603 5 mm²
Cout	Panasonic	50SVPF18M Series= SVPF	Cap= 18.0 uF ESR= 35.0 mOhm VDC= 50.0 V IRMS= 2.7 A	2	$0.54	CAPSMT_62_E7 106 mm²
Coutx	TDK	C2012X5R1H225K125AB Series= X5R	Cap= 2.2 uF ESR= 3.66 mOhm VDC= 50.0 V IRMS= 3.4121 A	1	$0.15	0805 7 mm²

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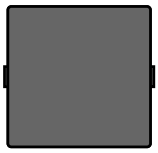
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cramp	Kemet	C0805C301J5GACTU Series= C0G/NP0	Cap= 300.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	 0805 7 mm²
Crst	MuRata	GRM216R71H223KA01D Series= X7R	Cap= 22.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.02	 0805 7 mm²
Css	Yageo	CC0805KRX7R9BB104 Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	2	$0.02	 0805 7 mm²
Cvcc	Yageo	CC0805KRX7R9BB104 Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	2	$0.02	 0805 7 mm²
D1	Diodes Inc.	B560C-13-F	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.17	 SMC 83 mm²
L1	Coilcraft	MLC1565-372MLB	L= 3.7 µH 3.1 mOhm	1	$1.05	 MLC1565 243 mm²
M1	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V IdsMax= 35.0 Amps	1	$0.27	 DNH0008A 18 mm²
Rcomp	Yageo	RT0805BRD0727K7L Series= RT0805	Res= 27.7 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.05	 0805 7 mm²
Rcomp2	Panasonic	ERJ-6ENF7871V Series= ERJ-6E	Res= 7.87 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rfbb	Vishay-Dale	CRCW08051K65FKEA Series= CRCW..e3	Res= 1.65 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rfbt	Panasonic	ERJ-6ENF3572V Series= ERJ-6E	Res= 35.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rramp	Vishay-Dale	CRCW080541K2FKEA Series= CRCW..e3	Res= 41.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rsense	Susumu Co Ltd	PRL1632-R006-F-T1 Series= PRL1632	Res= 6.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	 0612 11 mm²
Rt	Panasonic	ERJ-6ENF1872V Series= ERJ-6E	Res= 18.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Ruv1	Panasonic	ERJ-6ENF3571V Series= ERJ-6E	Res= 3.57 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Ruv2	Vishay-Dale	CRCW080510K0FKEA Series= CRCW..e3	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
U1	Texas Instruments	LM25088MH-1/NOPB	Switcher	1	$1.50	 MXA16A 59 mm²

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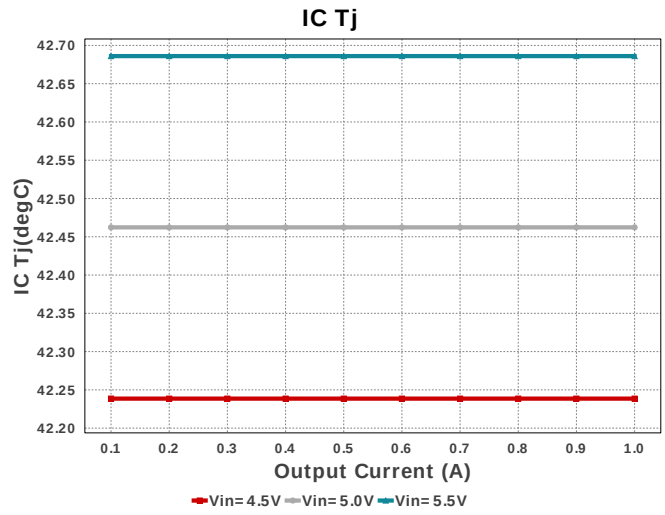

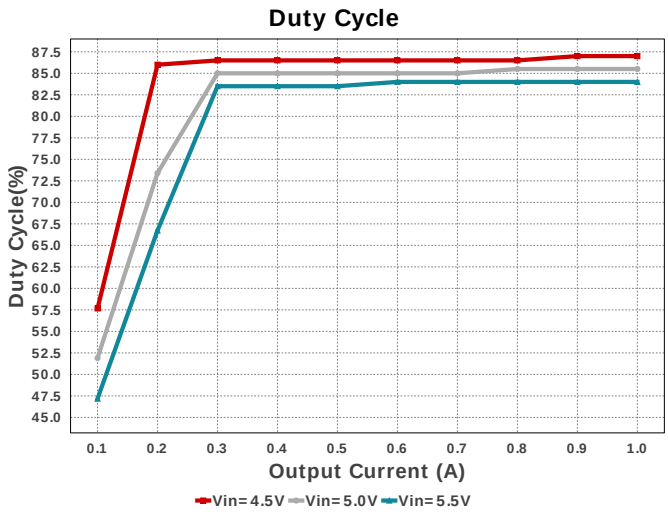

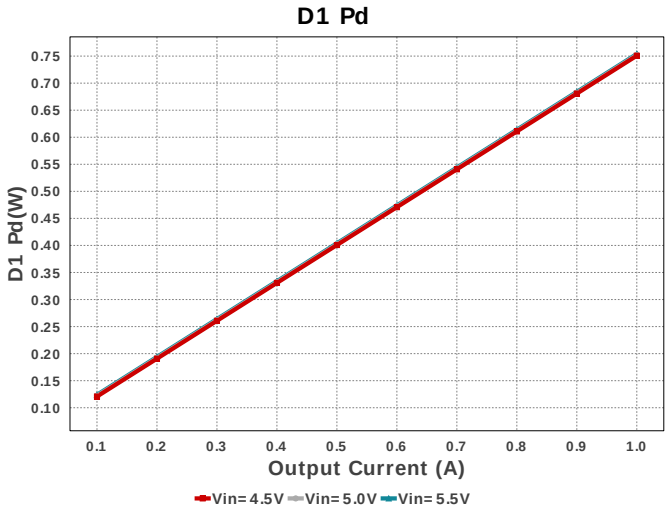

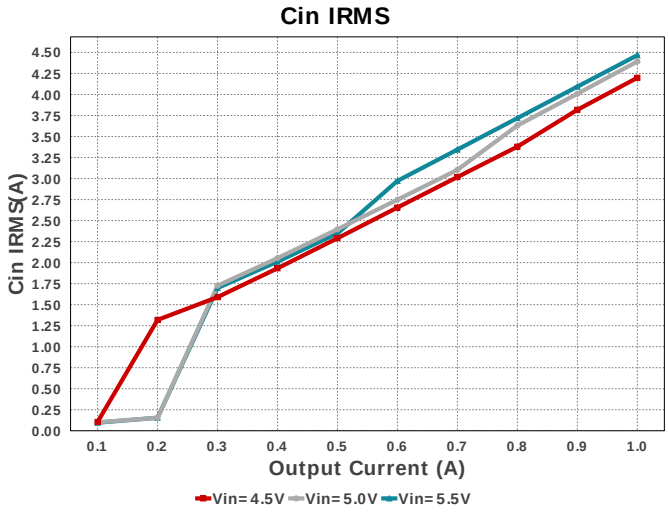

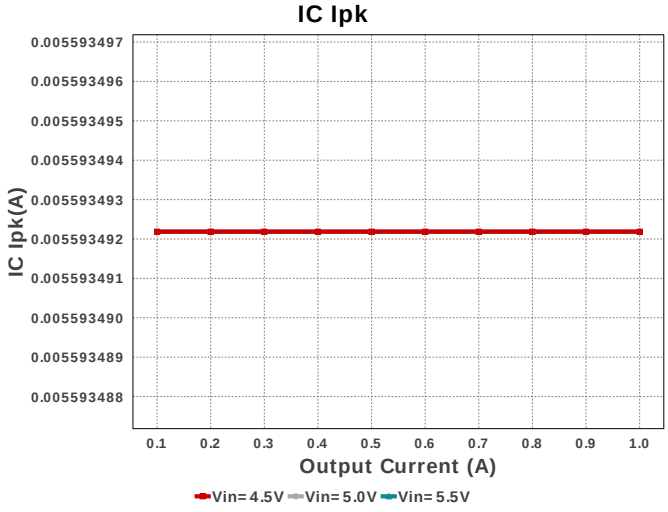

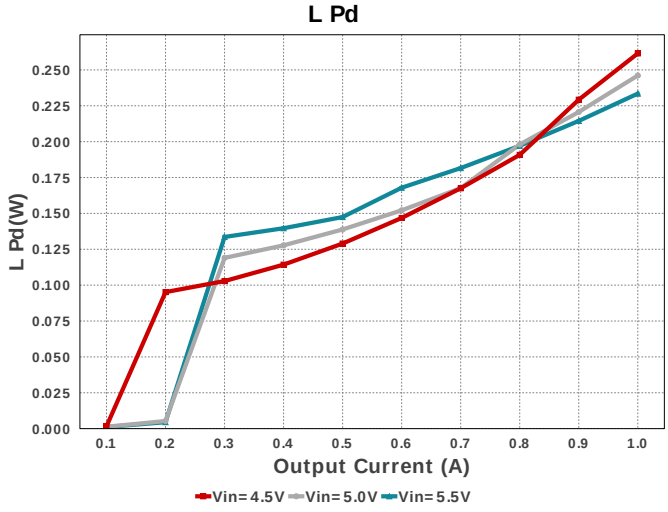

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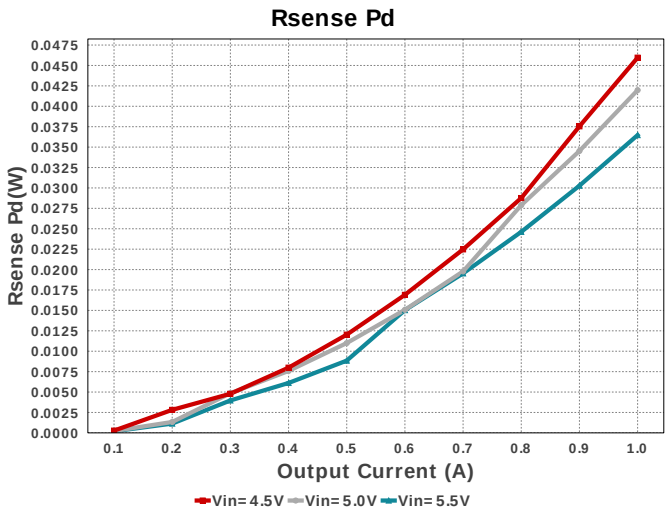

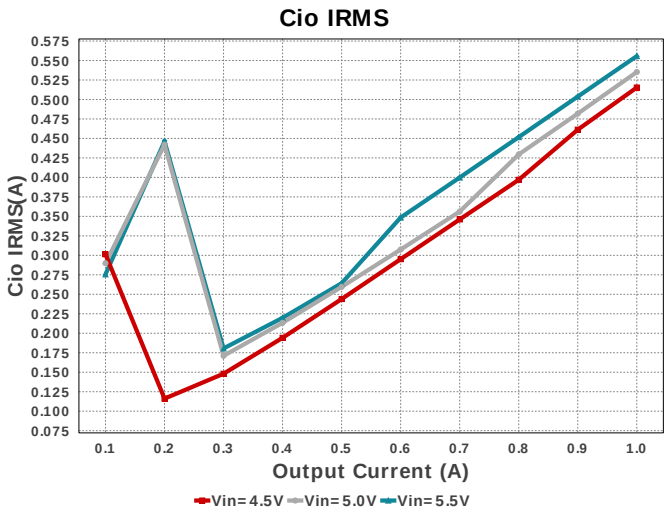

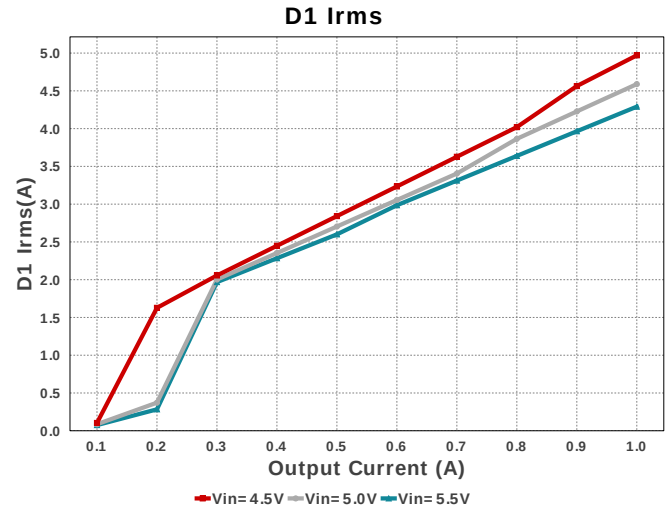

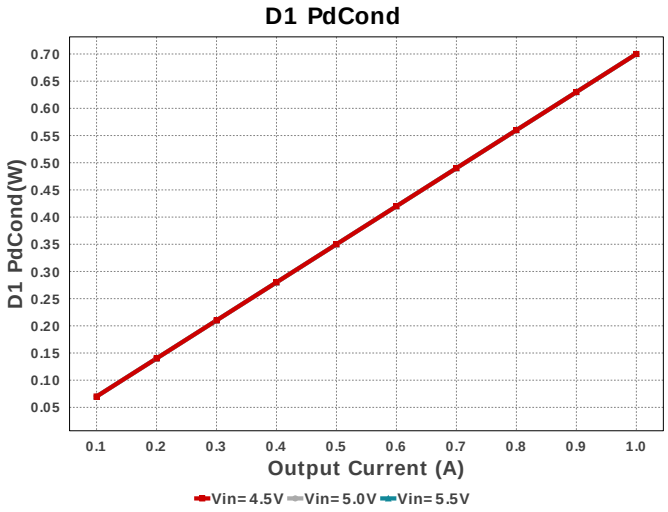

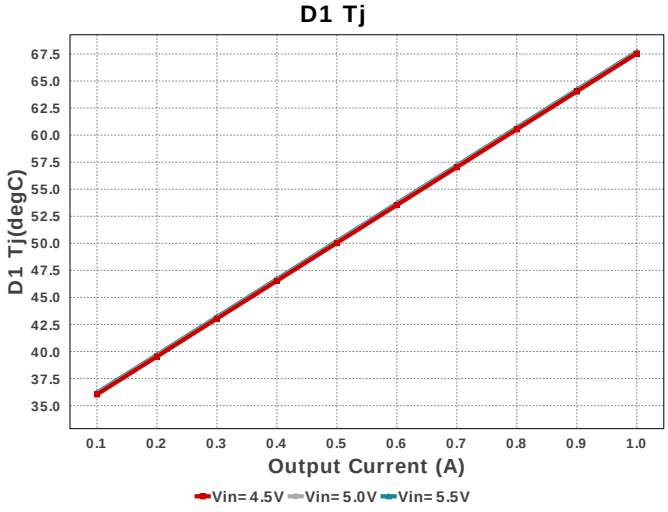

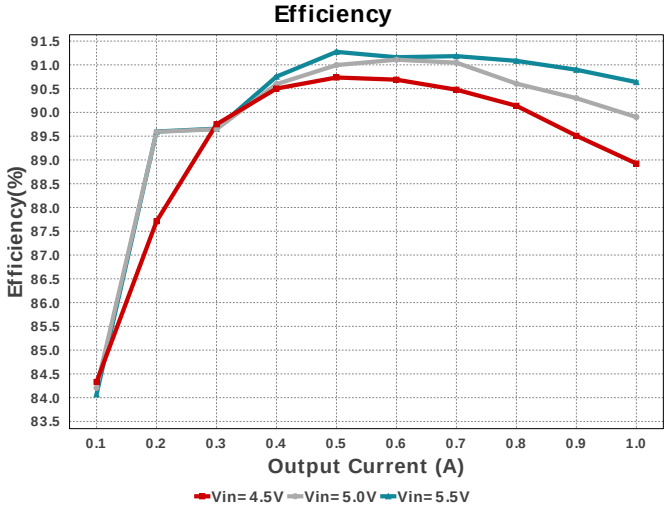

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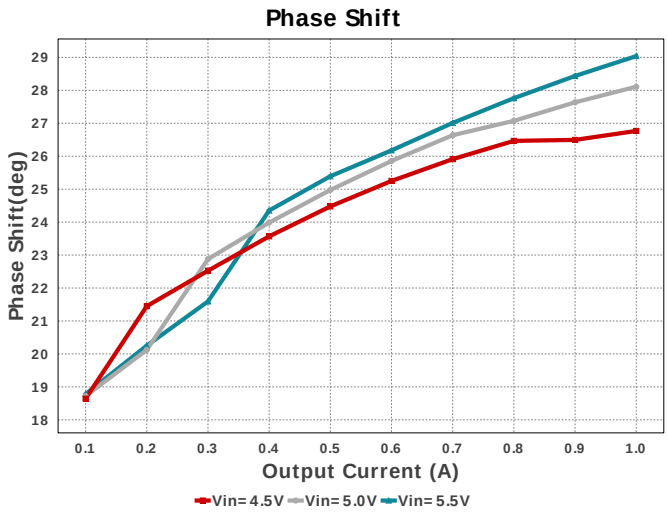

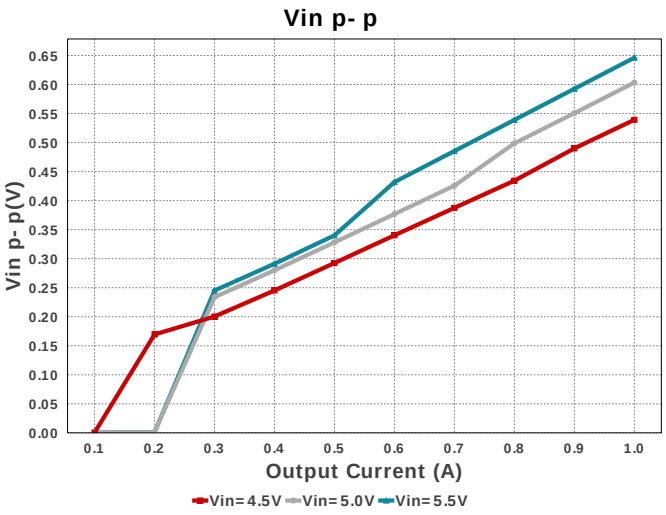

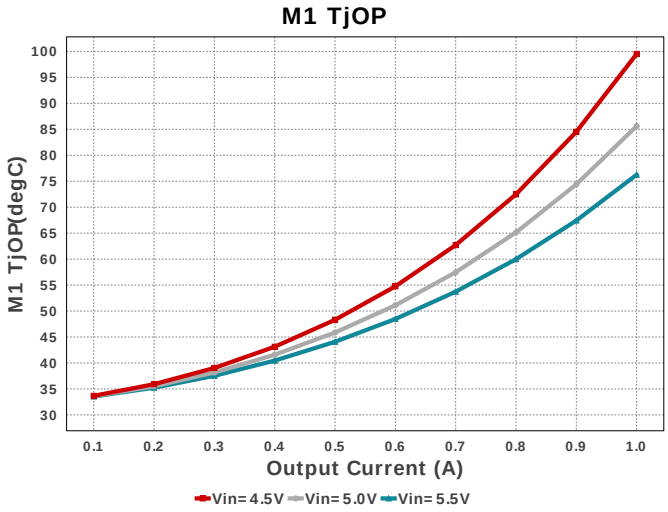

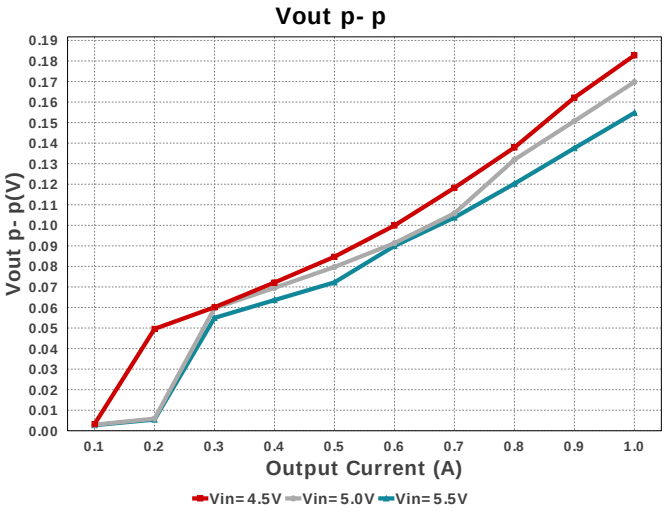

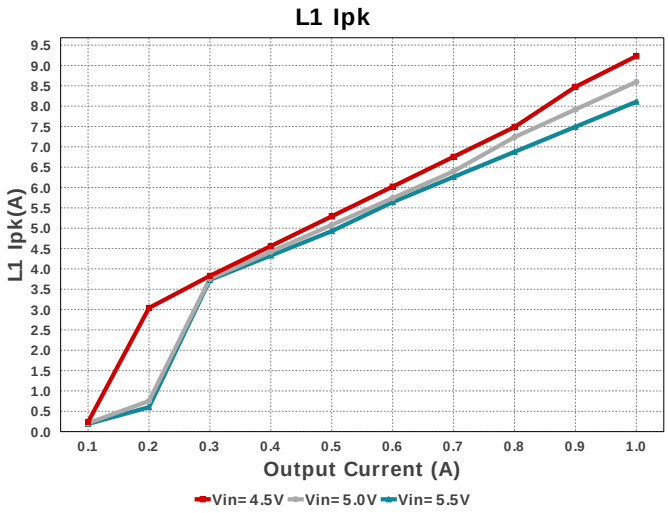

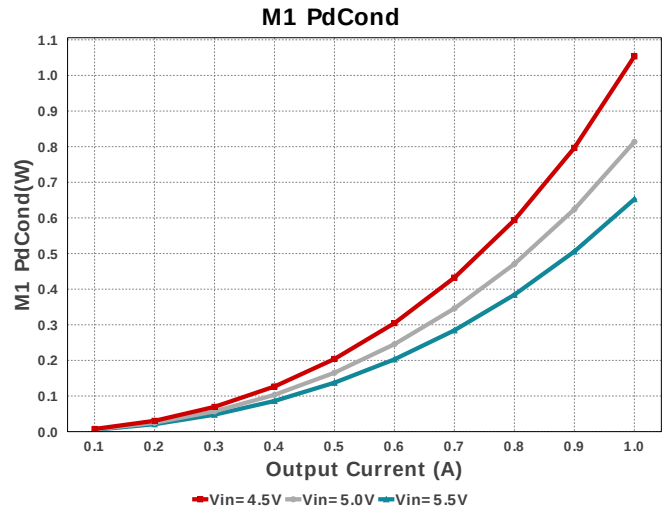

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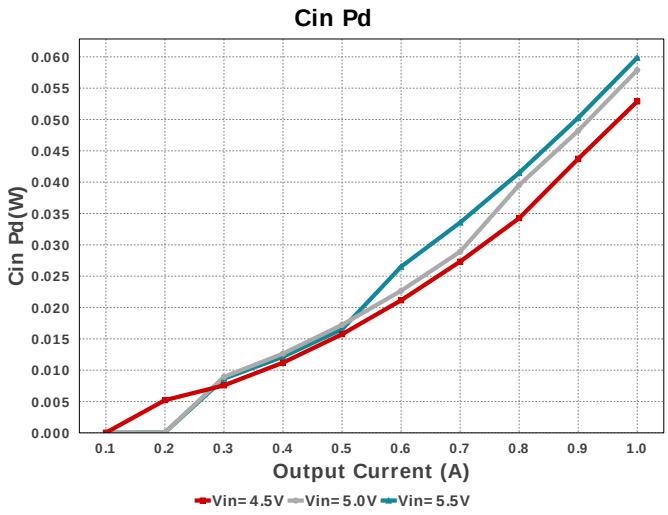

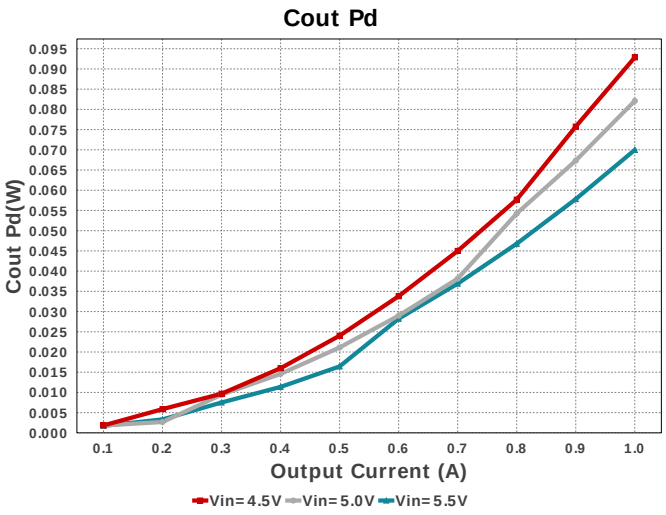

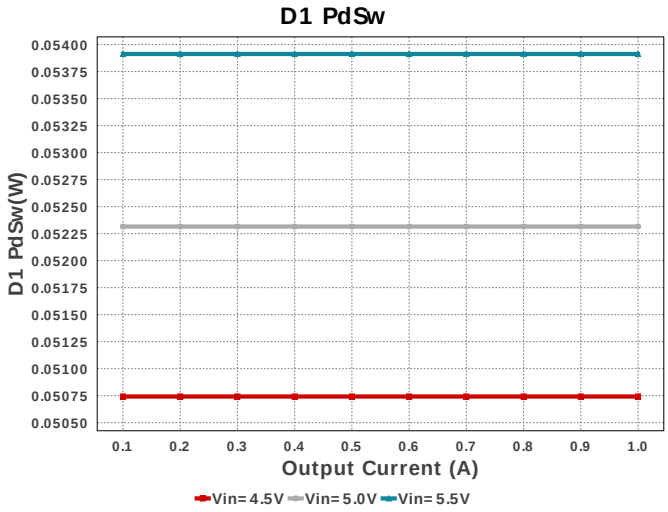

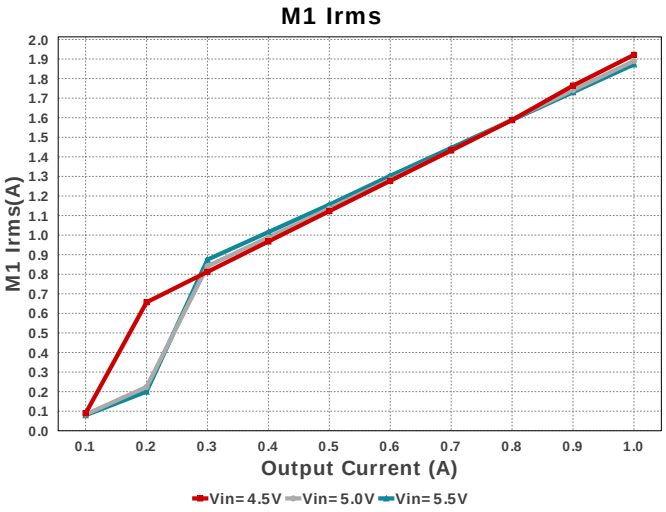

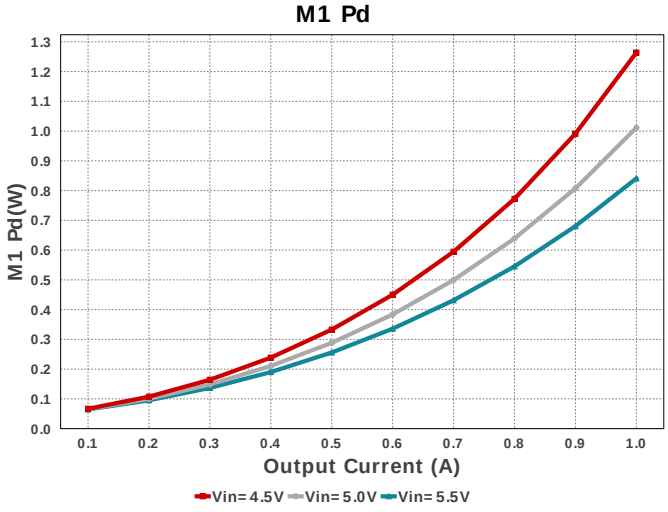

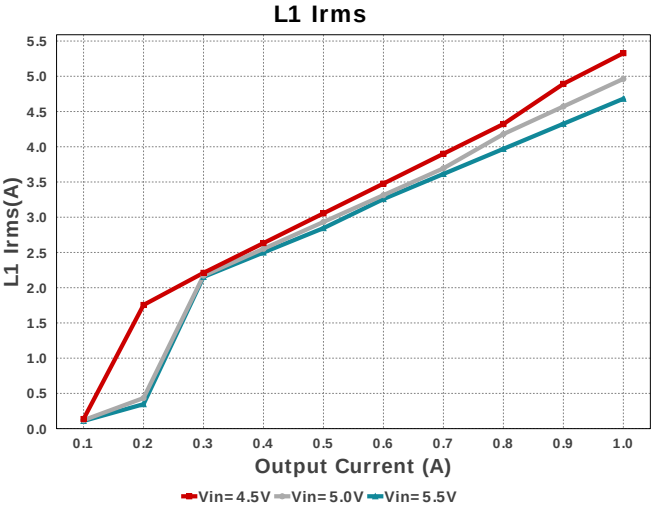

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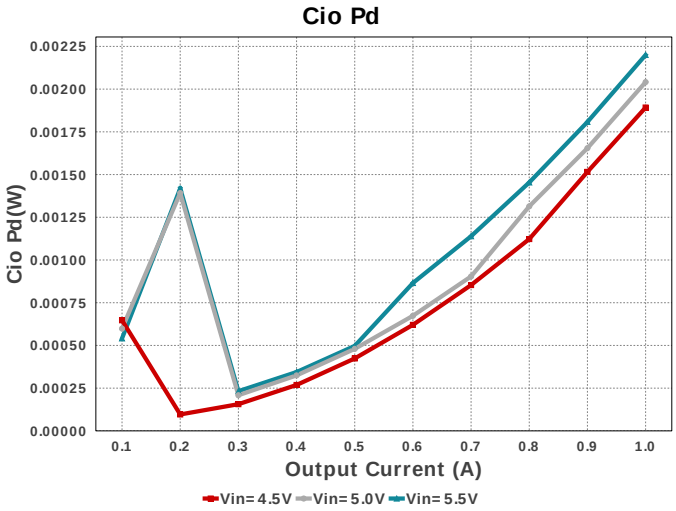

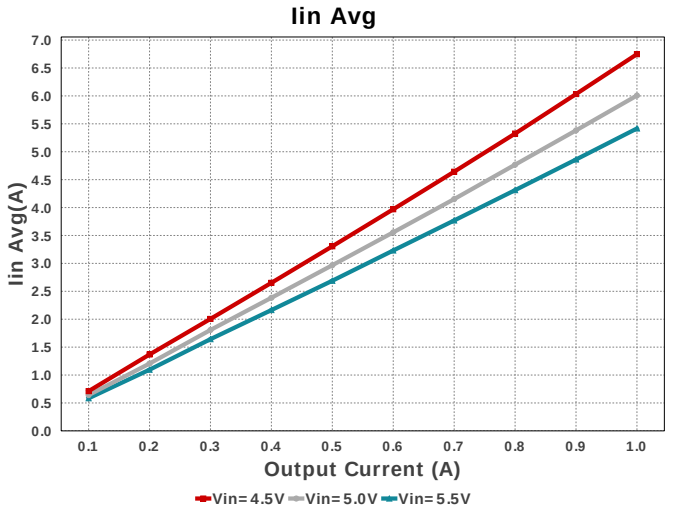

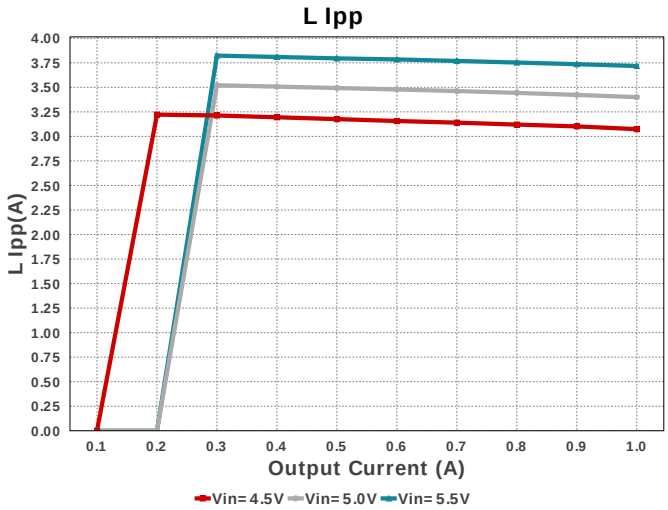

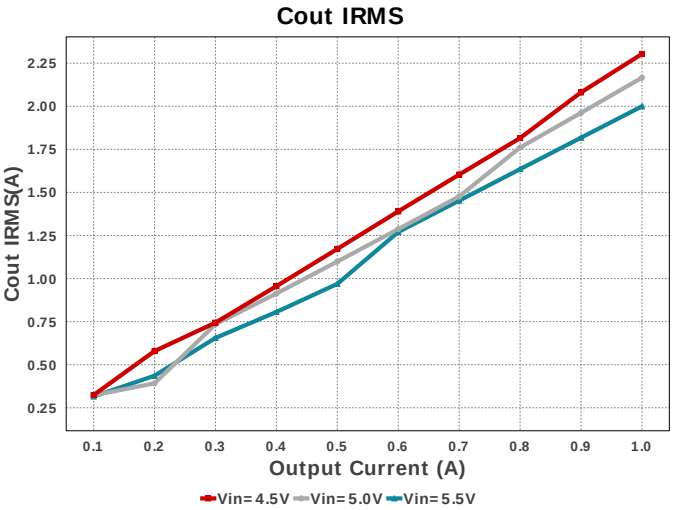

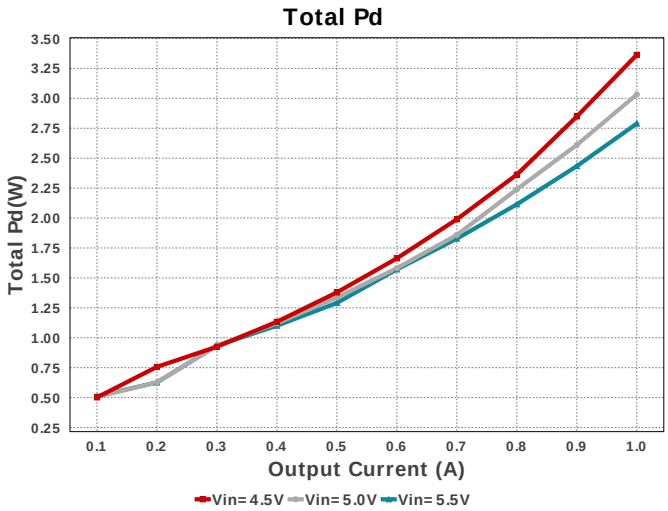

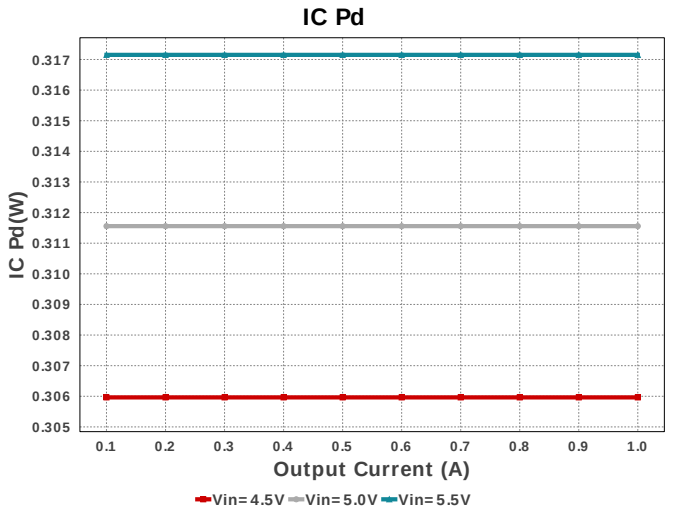

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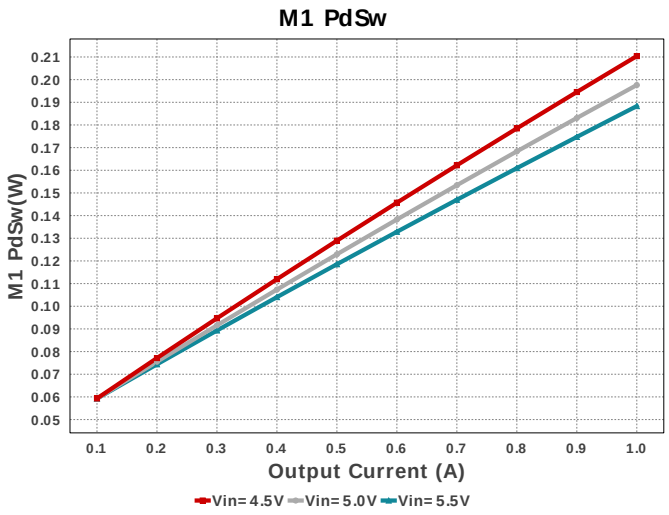

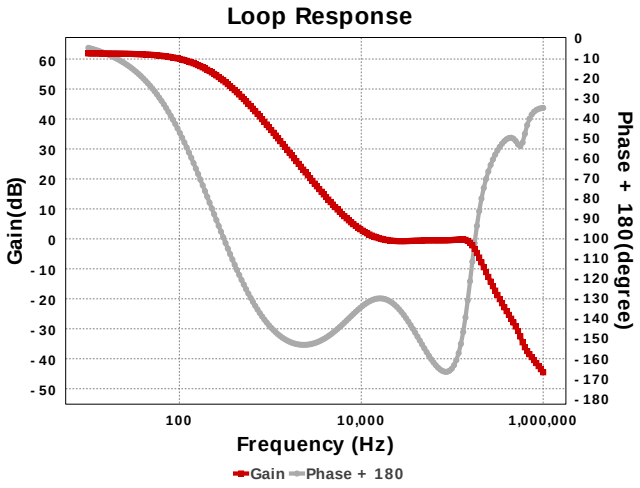

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	4.269 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	54.679 mW	Capacitor	Input capacitor power dissipation
3.	Cio IRMS	519.851 mA	Capacitor	Input to output capacitor RMS ripple current
4.	Cio Pd	1.925 mW	Capacitor	Input to output capacitor power dissipation
5.	Cout IRMS	2.304 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	92.896 mW	Capacitor	Output capacitor power dissipation
7.	D1 Irms	4.977 A	Current	D1 Irms
8.	D1 Pd	750.304 mW	Diode	Diode power dissipation
9.	D1 PdCond	700.0 mW	Diode	Diode conduction losses
10.	D1 PdSw	50.304 mW	Diode	Diode switching losses
11.	D1 Tj	67.515 degC	Diode	D1 junction temperature
12.	IC Ipk	5.578 mA	IC	Peak switch current in IC
13.	IC Pd	316.273 mW	IC	IC power dissipation
14.	IC Tj	42.651 degC	IC	IC junction temperature
15.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
16.	Iin Avg	6.749 A	IC	Average input current
17.	L Ipp	3.1 A	Inductor	Peak-to-peak output inductor ripple current
18.	L Pd	262.197 mW	Inductor	Inductor power dissipation
19.	L1 Ipk	9.242 A	Inductor	Inductor peak current
20.	L1 Irms	5.336 A	Inductor	Inductor ripple current
21.	M1 Irms	1.924 A	Mosfet	M1 MOSFET Irms
22.	M1 Pd	1.261 W	Mosfet	M1 MOSFET total power dissipation
23.	M1 PdCond	1.053 W	Mosfet	M1 MOSFET conduction losses
24.	M1 PdSw	208.567 mW	Mosfet	M1 MOSFET switching losses
25.	M1 TjOP	99.375 degC	Mosfet	M1 MOSFET junction temperature
26.	IOUT_OP	1.0 A	Op Point	Iout operating point
27.	VIN_OP	4.5 V	Op Point	Vin operating point
28.	Total Pd	3.369 W	Power	Total Power Dissipation
29.	Rsense Pd	45.983 mW	Resistor	LED Current Rsns Power Dissipation
30.	BOM Count	31	System Information	Total Design BOM count
31.	Cross Freq	16.447 kHz	System Information	Bode plot crossover frequency
32.	Duty Cycle	87.0 %	System Information	Duty cycle
33.	Efficiency	88.906 %	System Information	Steady state efficiency
34.	FootPrint	767.0 mm^2	System Information	Total Foot Print Area of BOM components
35.	Frequency	317.5 kHz	System Information	Switching frequency
36.	Gain Marg	44.519 db	System Information	Bode Plot Gain Margin
37.	Mode	DCM	System Information	Conduction Mode
38.	Phase Marg	49.938 deg	System Information	Bode Plot Phase Margin
39.	Phase Shift	26.776 deg	System Information	Bode Plot Phase Shift
40.	Total BOM	$5.31	System Information	Total BOM Cost

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#	Name	Value	Category	Description
41.	Vin p-p	552.36 mV	System Information	Peak-to-peak input voltage
42.	Vout p-p	183.707 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	5.5	Maximum input voltage
VinMin	4.5	Minimum input voltage
VinTyp	5.0	Typical input voltage
Vout	-27.0	Output Voltage
base_pn	LM25088	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	317.5 k	Customer Selected Frequency

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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

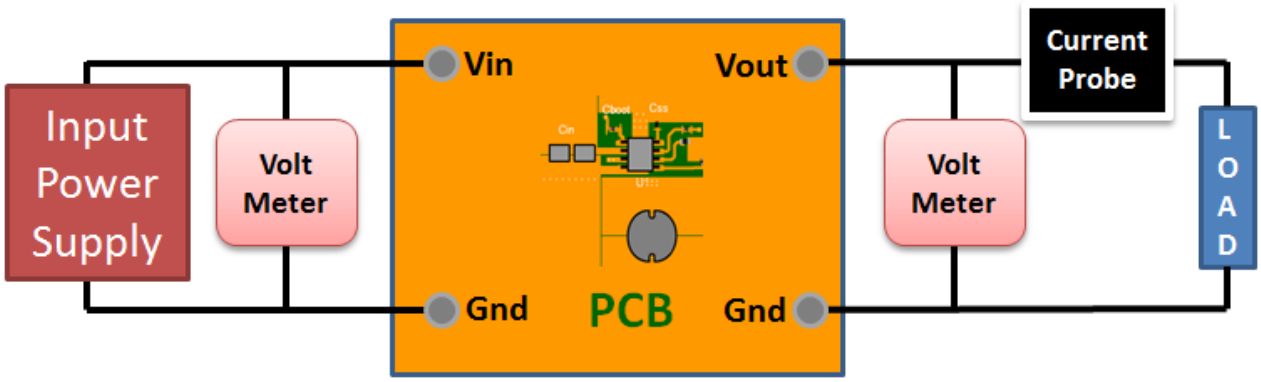
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.5V 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.



Design Assistance

1. Master key : E56AD4253327D321[v1]
2. **LM25088** Product Folder : http://www.ti.com/product/LM25088 : contains the data sheet and other resources.

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