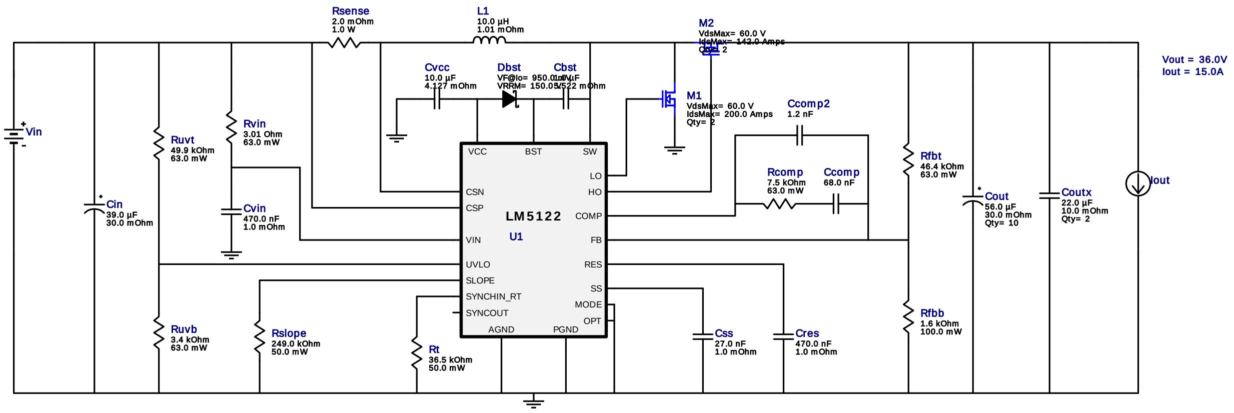
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 22.0V
VinMax = 23.0V
Vout = 36.0V
Iout = 15.0A

Device = LM5122MH/NOPB
Topology = Boost
Created = 2025-01-02 00:27:17.436
BOM Cost = $34.94
BOM Count = 36
Total Pd = 11.41W

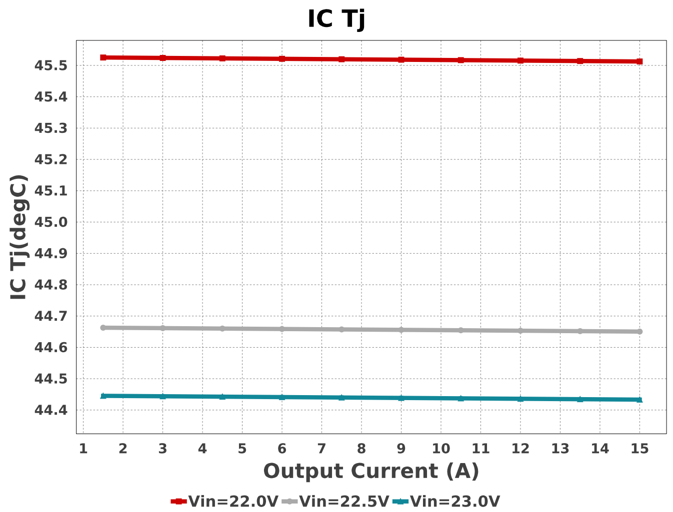
Design : 59 LM5122MH/NOPB
LM5122MH/NOPB 22V-30V to 36.00V @ 15A

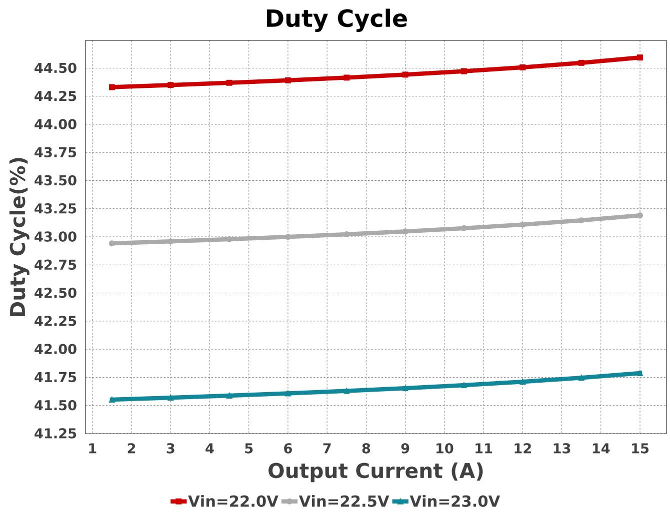


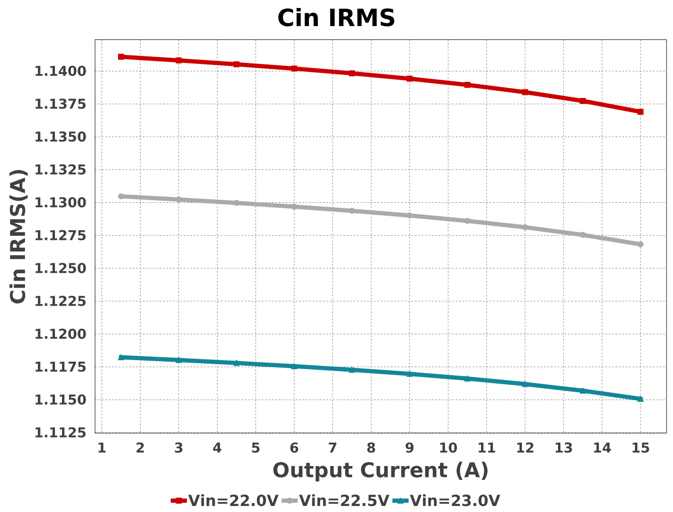
Electrical BOM

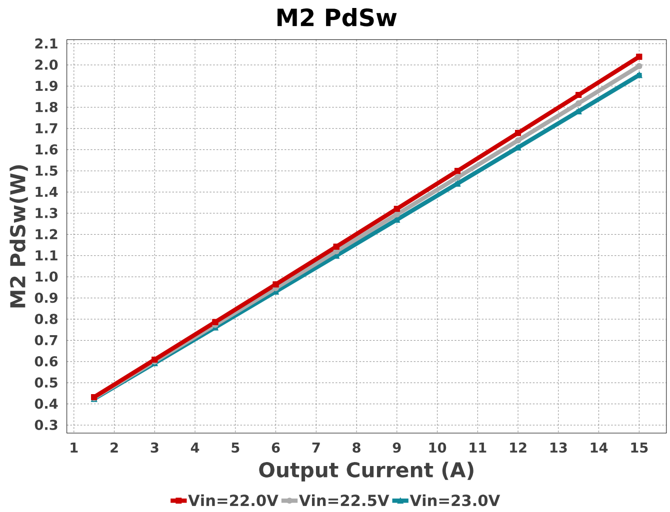
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.03	0603 5 mm²
Ccomp	TDK	CGA5L2C0G1H683J160AD Series= C0G/NP0	Cap= 68.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.26	1206 11 mm²
Ccomp2	TDK	C2012C0G1H122J060AA Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cin	Panasonic	35SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 30.0 mOhm VDC= 35.0 V IRMS= 2.8 A	1	$0.67	CAPSMT_62_E7 106 mm²
Cout	Panasonic	EEHZA1J560P Series= ZA	Cap= 56.0 uF ESR= 30.0 mOhm VDC= 63.0 V IRMS= 1.8 A	10	$0.93	Panasonic_G 151 mm²
Coutx	TDK	CKG57NX5R1H226M500JH Series= X5R	Cap= 22.0 uF ESR= 10.0 mOhm VDC= 50.0 V IRMS= 4.6 A	2	$1.77	CKG57N 56 mm²
Cres	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
Css	MuRata	GRM155R71A273KA01D Series= X7R	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvcc	MuRata	GRM21BR61C106KE15L Series= X5R	Cap= 10.0 uF ESR= 4.127 mOhm VDC= 16.0 V IRMS= 2.46634 A	1	$0.03	0805 7 mm²

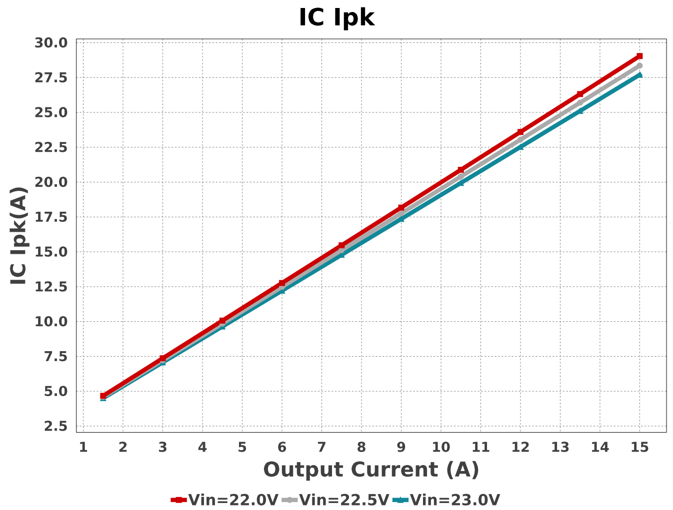
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvin	MuRata	GRM21BR71H474KA88L Series= X7R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm^2
Dbst	SMC Diode Solutions	SK215ATR	VF@Io= 950.0 mV VRRM= 150.0 V	1	$0.06	SMA 37 mm^2
L1	Wurth Elektronik	7843763540100	L= 10.0 µH 1.01 mOhm	1	$15.05	WE-HCFAT_3540 0 mm^2
M1	Texas Instruments	CSD18540Q5B	VdsMax= 60.0 V IdsMax= 200.0 Amps	2	$0.75	DNK0008A 56 mm^2
M2	ON Semiconductor	NTMFS5C670NLT1G	VdsMax= 60.0 V IdsMax= 142.0 Amps	2	$1.02	SO-8FL 58 mm^2
Rcomp	Vishay-Dale	CRCW04027K50FKED Series= CRCW..e3	Res= 7.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0603FR-071K6L Series= ?	Res= 1.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Vishay-Dale	CRCW040246K4FKED Series= CRCW..e3	Res= 46.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Stackpole Electronics Inc	CSNL1206FT2L00 Series= CSNL	Res= 2.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.19	1206 11 mm^2
Rslope	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rt	Yageo	RC0201FR-0736K5L Series= ?	Res= 36.5 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Ruvb	Vishay-Dale	CRCW04023K40FKED Series= CRCW..e3	Res= 3.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruvt	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvin	Vishay-Dale	CRCW04023R01FKED Series= CRCW..e3	Res= 3.01 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM5122MH/NOPB	Switcher	1	$2.09	MXA20A 71 mm^2

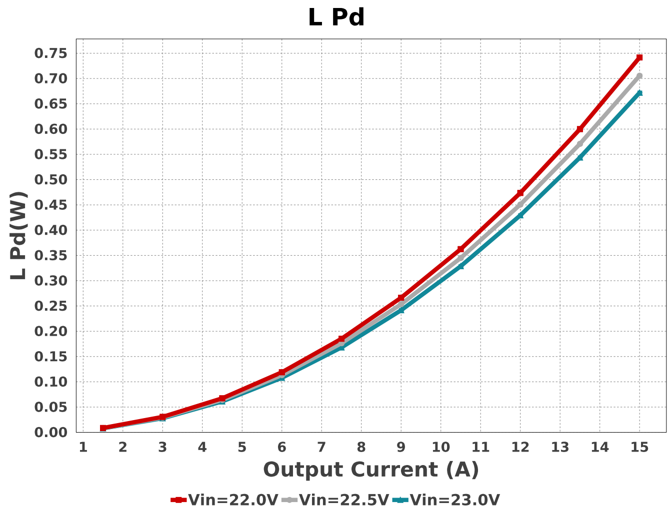

IC Tj
IC Tj(degC)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

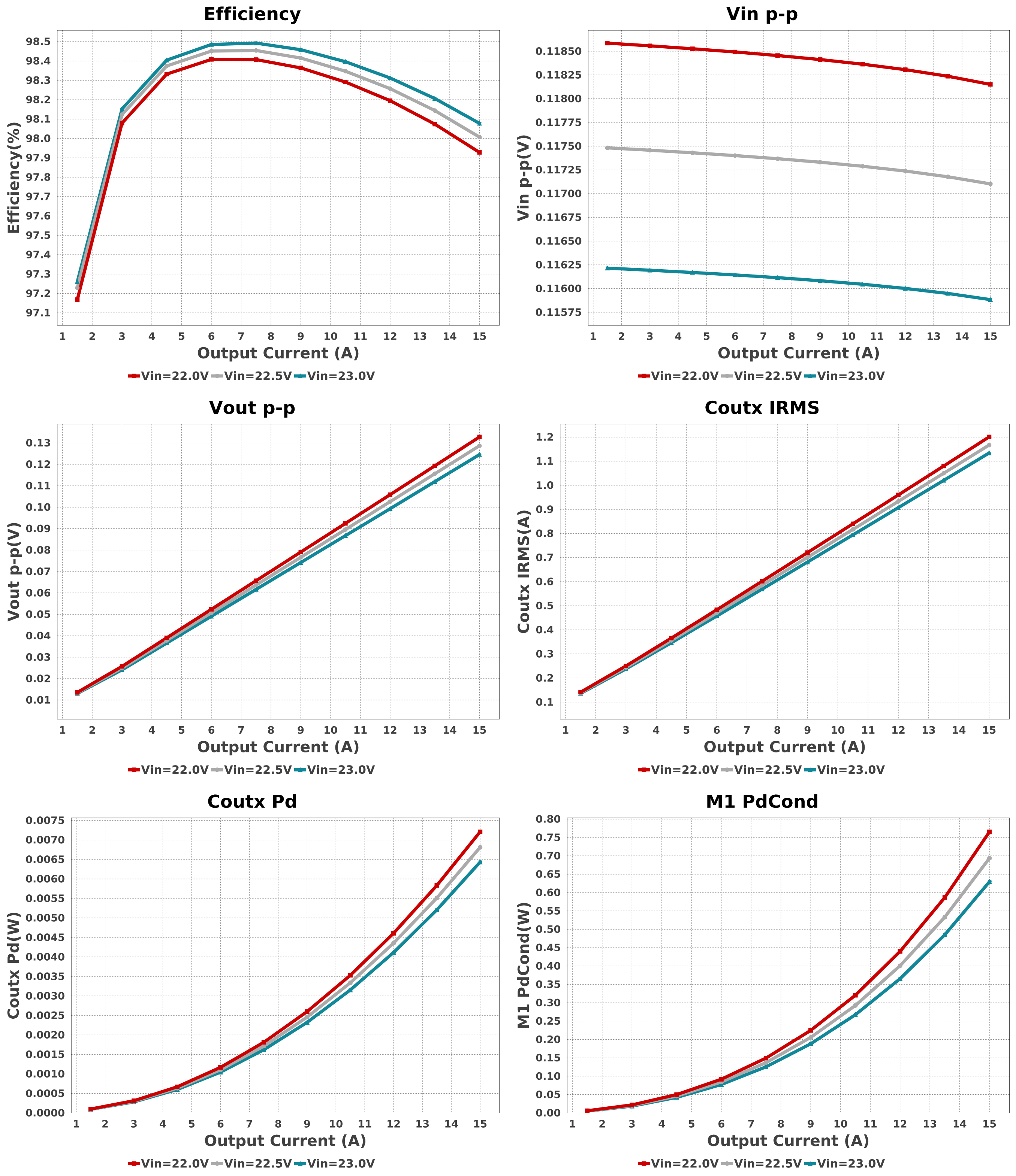

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

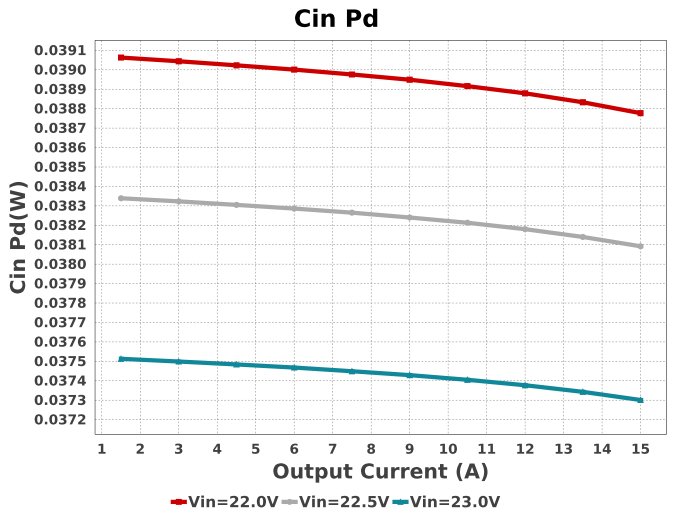

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

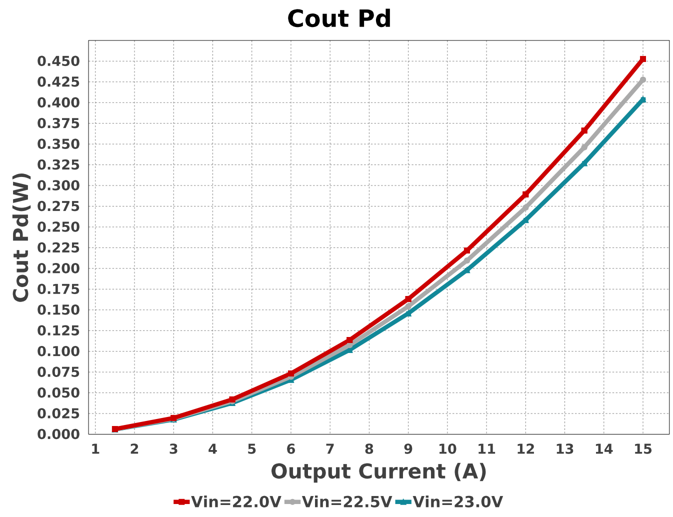

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

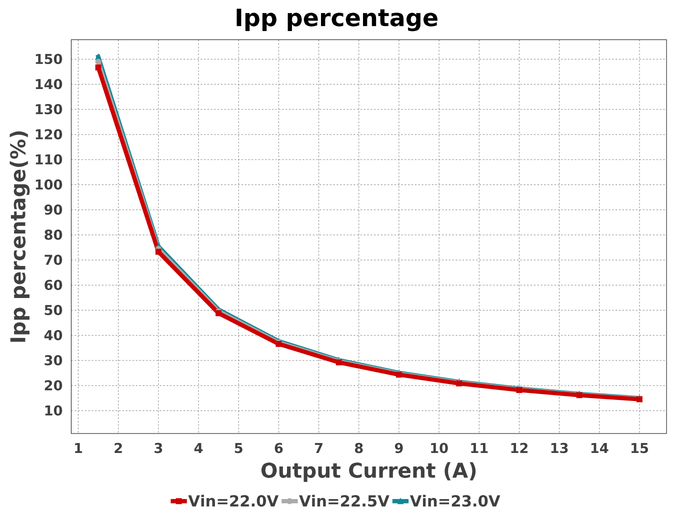

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

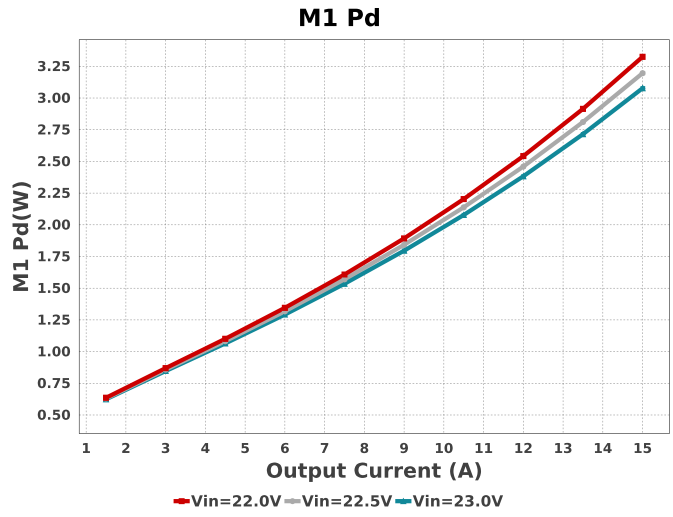

L Pd
L Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

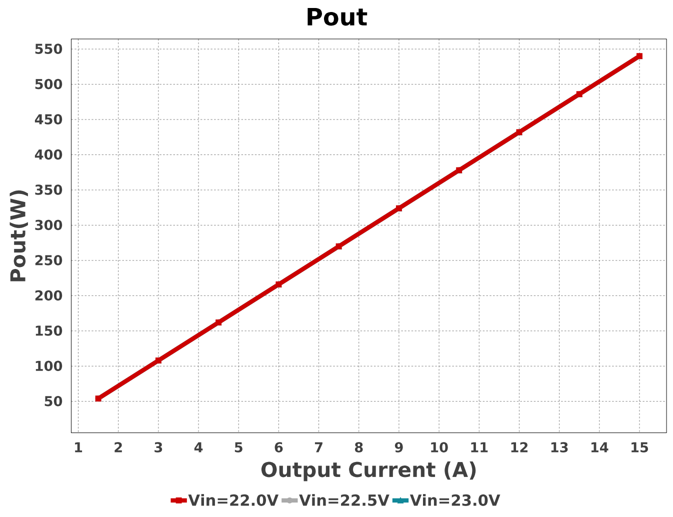

Efficiency
Efficiency(%)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V
Vin p-p
Vin p-p(V)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V
Vout p-p
Vout p-p(V)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V
Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V
Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V
M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

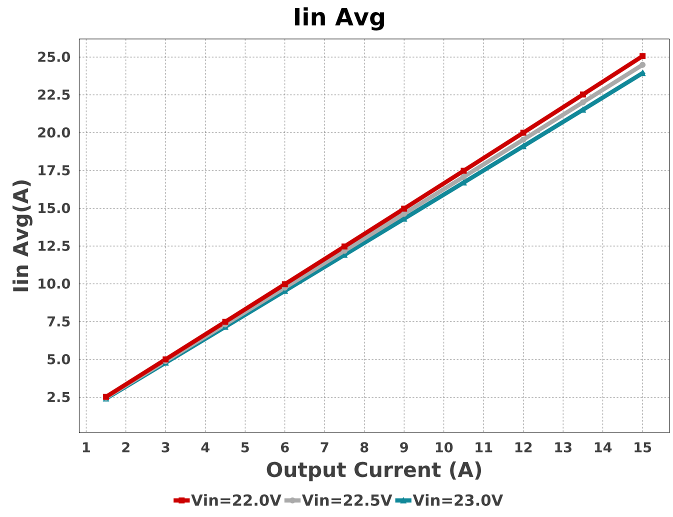

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

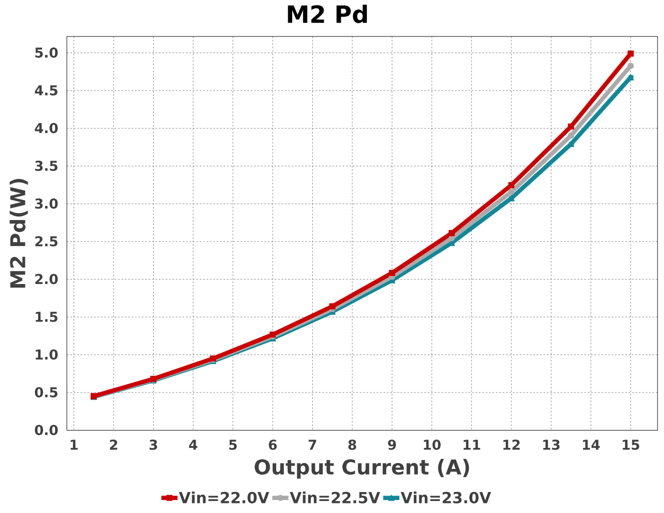

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

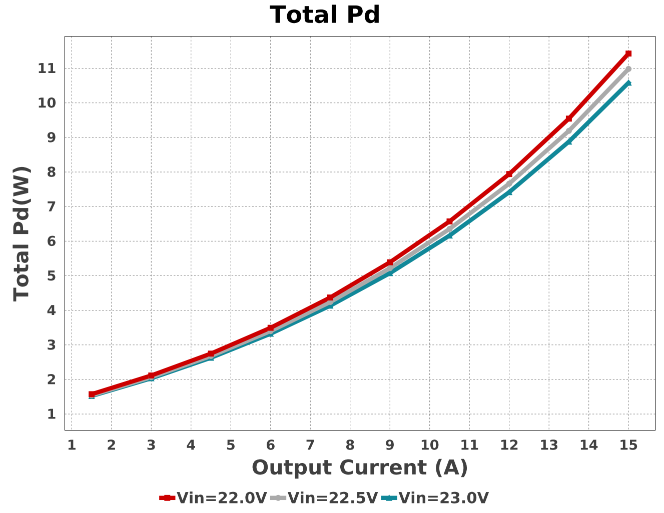

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

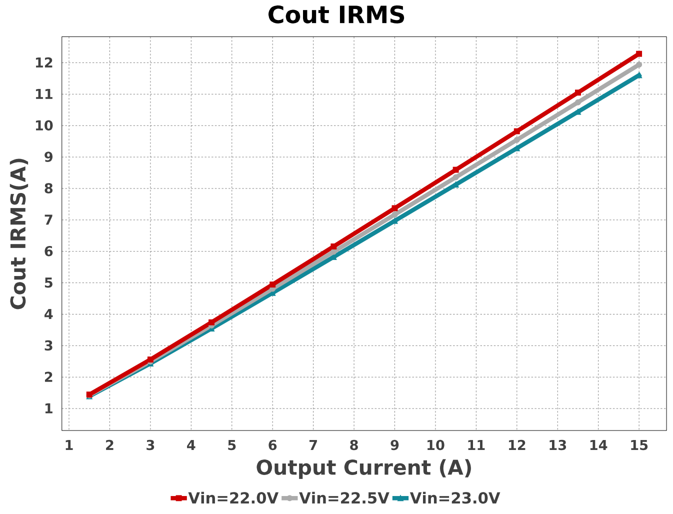

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

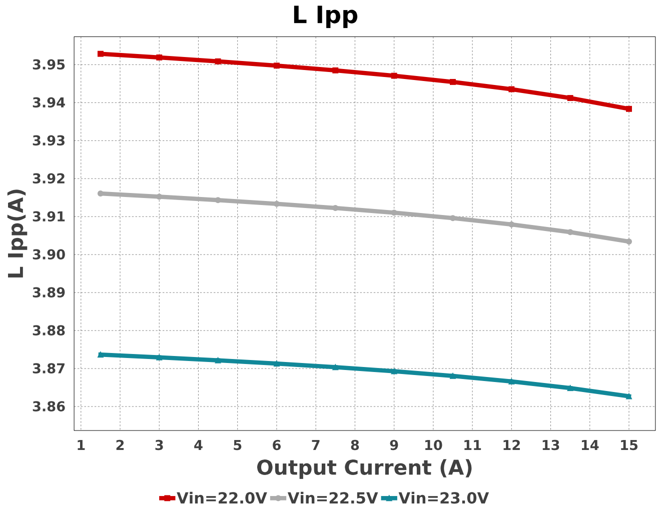

Pout
Pout(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

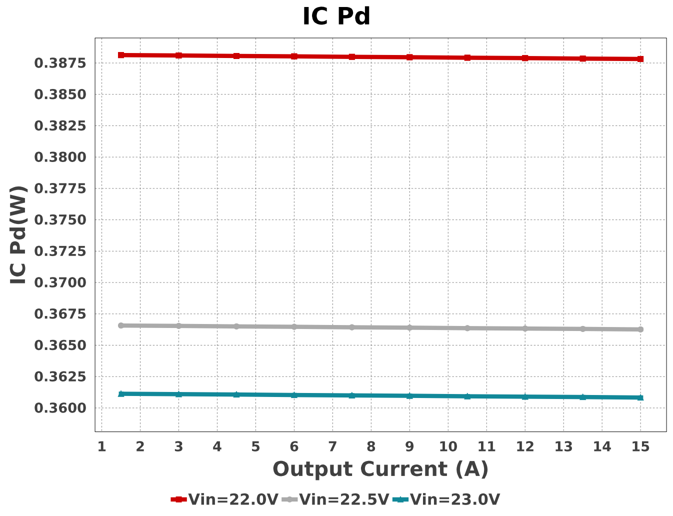

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

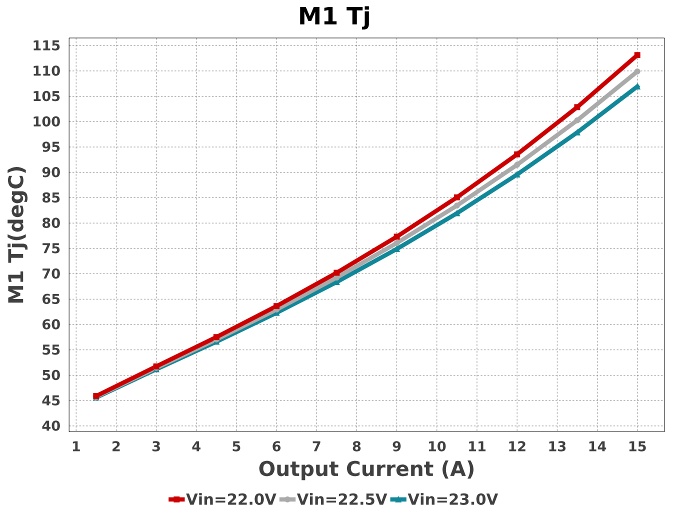

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

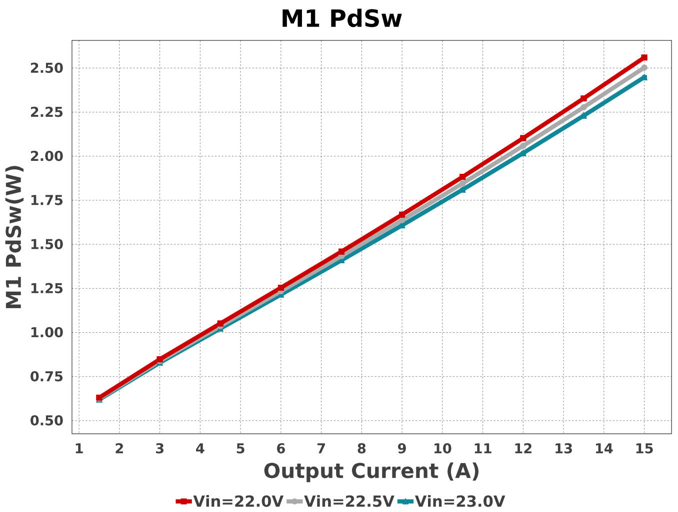

Total Pd
Total Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

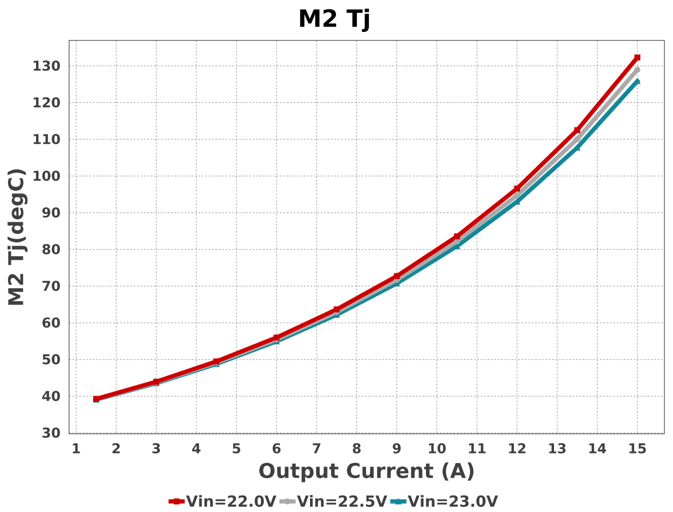

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

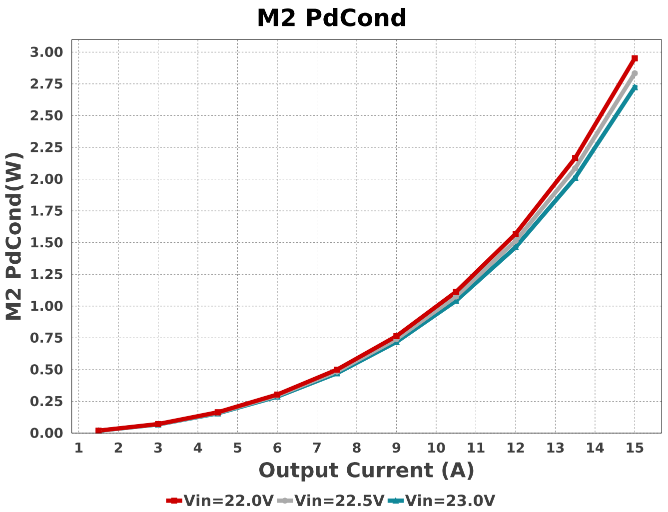

L Ipp
L Ipp(A)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V

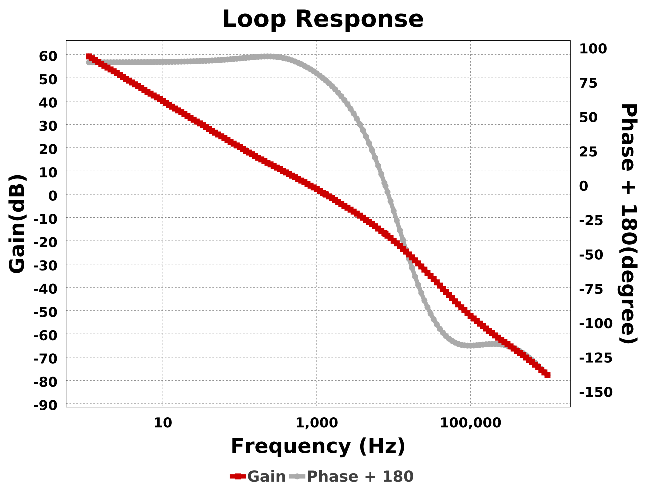

IC Pd
IC Pd(W)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V


M1 Tj
M1 Tj(degC)
Output Current (A)
Vin=22.0V Vin=22.5V Vin=23.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.137 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	38.777 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	12.283 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	452.63 mW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	1.201 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	7.208 mW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	29.042 A	IC	Peak switch current in IC
8.	IC Pd	387.82 mW	IC	IC power dissipation
9.	IC Tj	45.513 degC	IC	IC junction temperature
10.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	25.064 A	IC	Average input current
13.	Ipp percentage	14.547 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	3.938 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	741.59 mW	Inductor	Inductor power dissipation
16.	M1 Pd	3.325 W	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	765.15 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	2.56 W	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	113.12 degC	Mosfet	M1 MOSFET junction temperature
20.	M2 Pd	4.99 W	Mosfet	M2 MOSFET total power dissipation
21.	M2 PdCond	2.951 W	Mosfet	M2 MOSFET conduction losses
22.	M2 PdSw	2.038 W	Mosfet	M2 MOSFET switching losses
23.	M2 Tj	132.29 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	38.777 mW	Power	Input capacitor power dissipation
25.	Cout Pd	452.63 mW	Power	Output capacitor power dissipation
26.	Coutx Pd	7.208 mW	Power	Output capacitor_x power loss
27.	IC Pd	387.82 mW	Power	IC power dissipation
28.	L Pd	741.59 mW	Power	Inductor power dissipation
29.	M1 Pd	3.325 W	Power	M1 MOSFET total power dissipation
30.	M1 PdCond	765.15 mW	Power	M1 MOSFET conduction losses
31.	M1 PdSw	2.56 W	Power	M1 MOSFET switching losses

#	Name	Value	Category	Description
32.	M2 Pd	4.99 W	Power	M2 MOSFET total power dissipation
33.	M2 PdCond	2.951 W	Power	M2 MOSFET conduction losses
34.	M2 PdSw	2.038 W	Power	M2 MOSFET switching losses
35.	Total Pd	11.409 W	Power	Total Power Dissipation
36.	BOM Count	36	System Information	Total Design BOM count
37.	Cross Freq	1.24 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	44.595 %	System Information	Duty cycle
39.	Efficiency	97.931 %	System Information	Steady state efficiency
40.	FootPrint	2.949 k mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	246.575 kHz	System Information	Switching frequency
42.	Gain Marg	-16.947 dB	System Information	Bode Plot Gain Margin
43.	Iout	15.0 A	System Information	Iout operating point
44.	Low Freq Gain	59.324 dB	System Information	Gain at 1Hz
45.	Mode	CCM	System Information	Conduction Mode
46.	Phase Marg	76.745 deg	System Information	Bode Plot Phase Margin
47.	Pout	540.0 W	System Information	Total output power
48.	Total BOM	$34.94	System Information	Total BOM Cost
49.	Vin	22.0 V	System Information	Vin operating point
50.	Vin p-p	118.151 mV	System Information	Peak-to-peak input voltage
51.	Vout	36.0 V	System Information	Operational Output Voltage
52.	Vout Actual	36.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	3.482 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	132.792 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	15.0	Maximum Output Current
SoftStart	1.0 ms	Soft Start Time (ms)
VinMax	23.0	Maximum input voltage
VinMin	22.0	Minimum input voltage
Vout	36.0	Output Voltage
base_pn	LM5122	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	250.0 k	Customer Selected Frequency

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

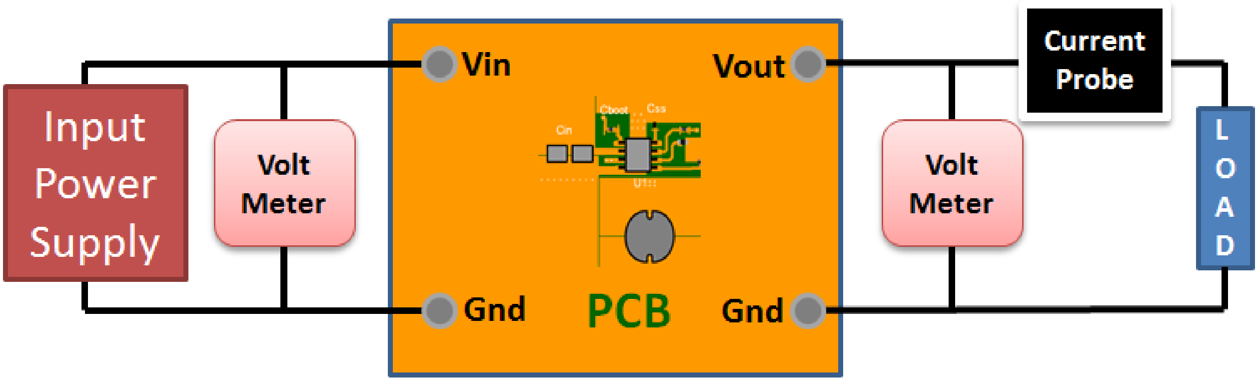
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 22.0V 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.



Design Assistance

1. The LM5122 is a wide range boost controller which is operable in an ultra wide input range of 4.5 to 65V. A boost regulator can maintain regulation for input voltages lower than the output voltage.

2. Master key : 8994E03221D551FE[v1]

3. **LM5122** Product Folder : http://www.ti.com/product/LM5122 : contains the data sheet and other resources.

Important Notice and Disclaimer