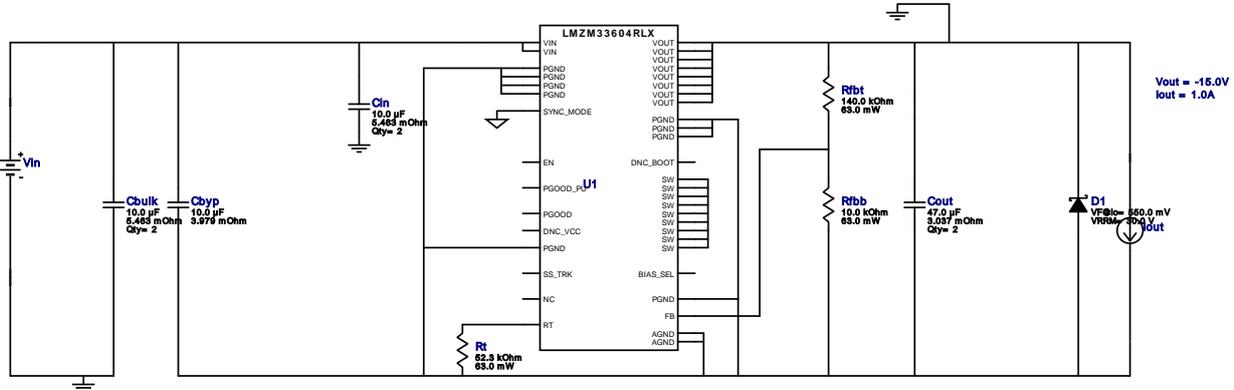
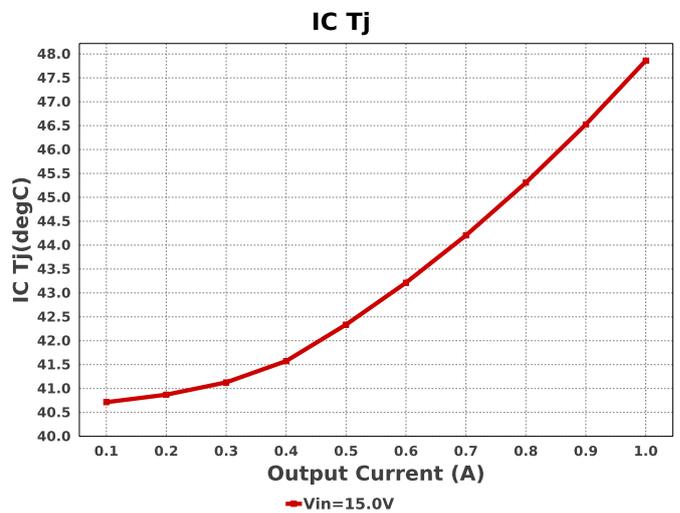
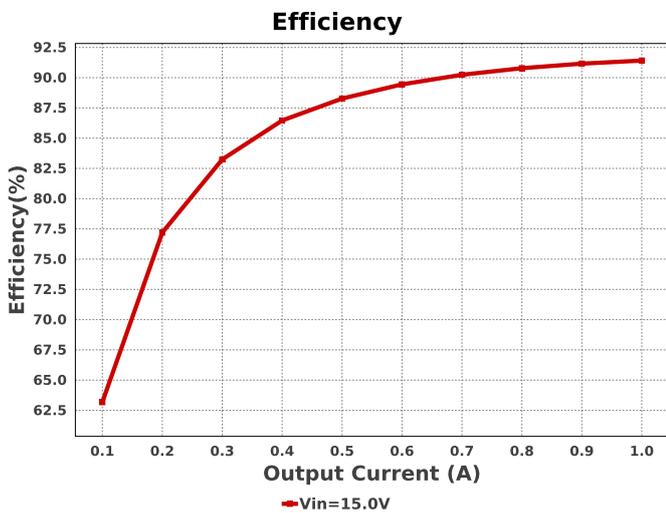
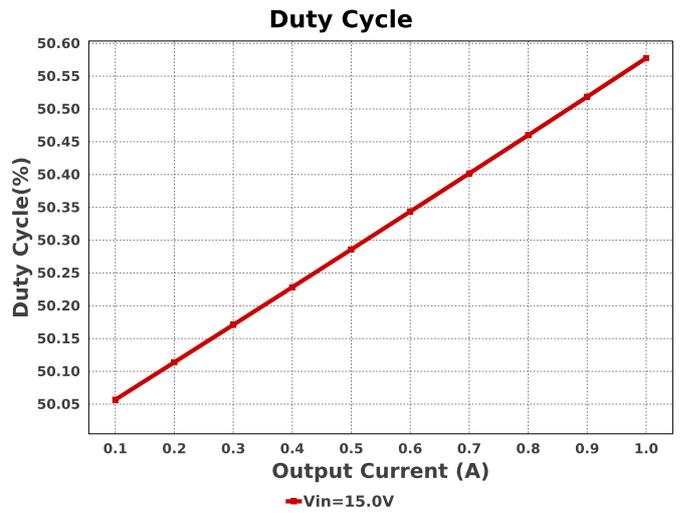
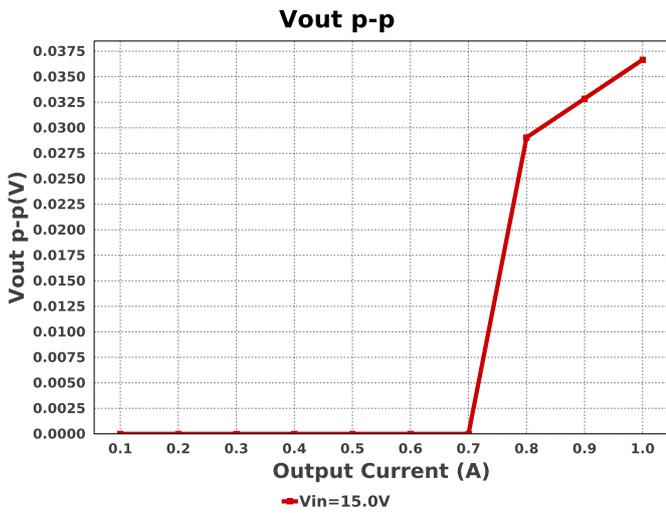
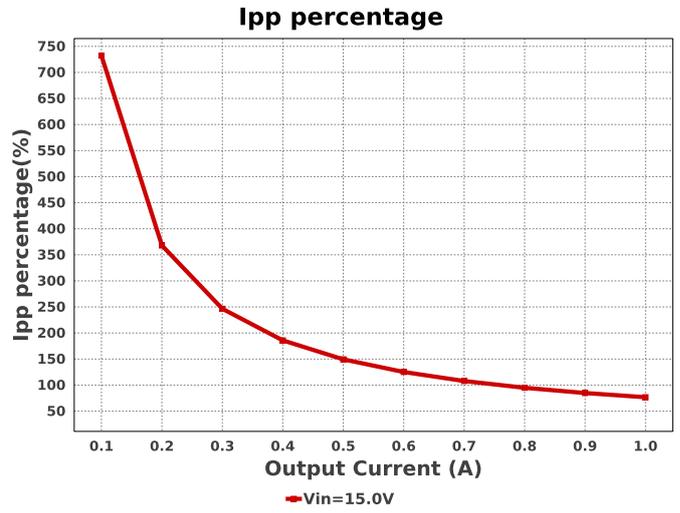
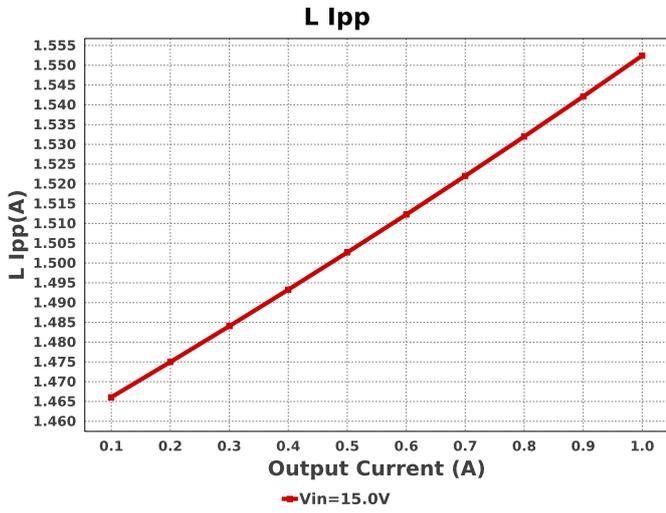
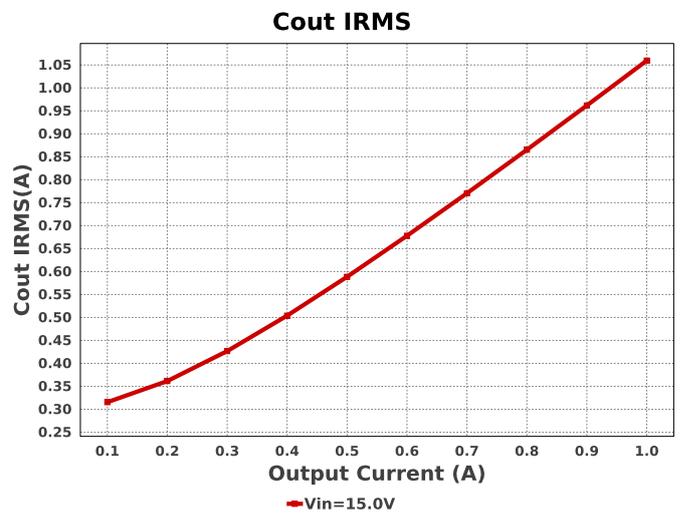
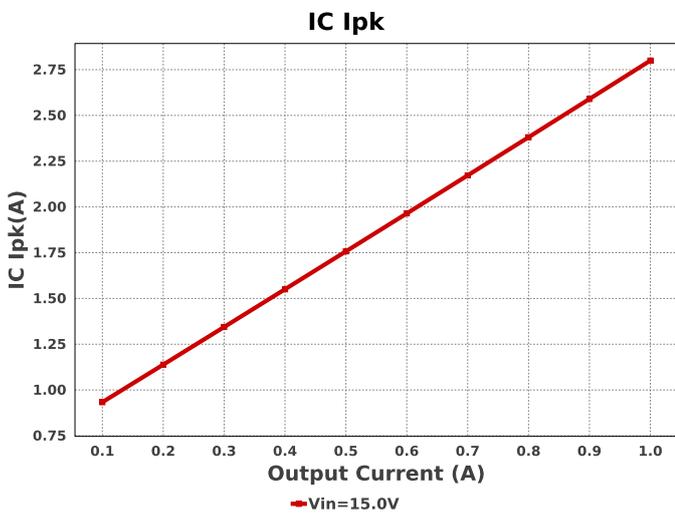
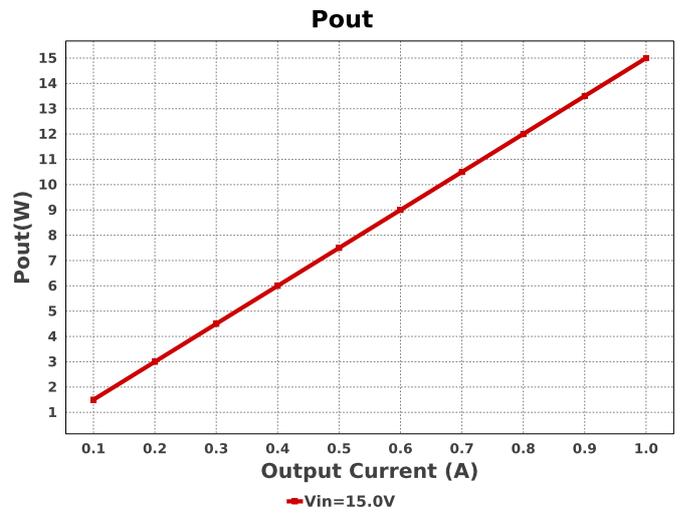
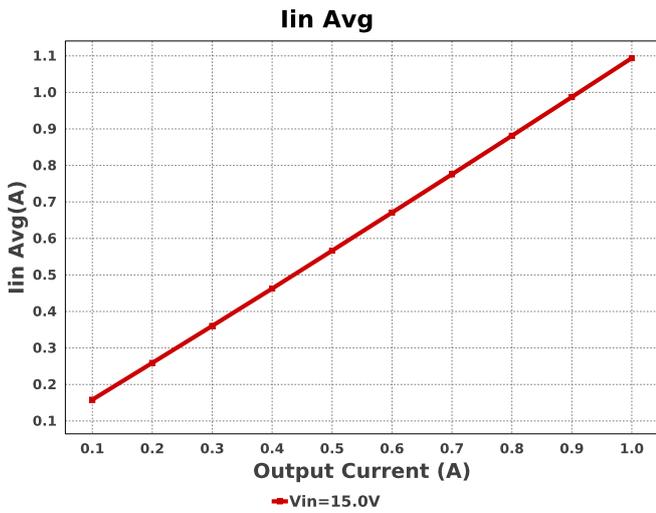
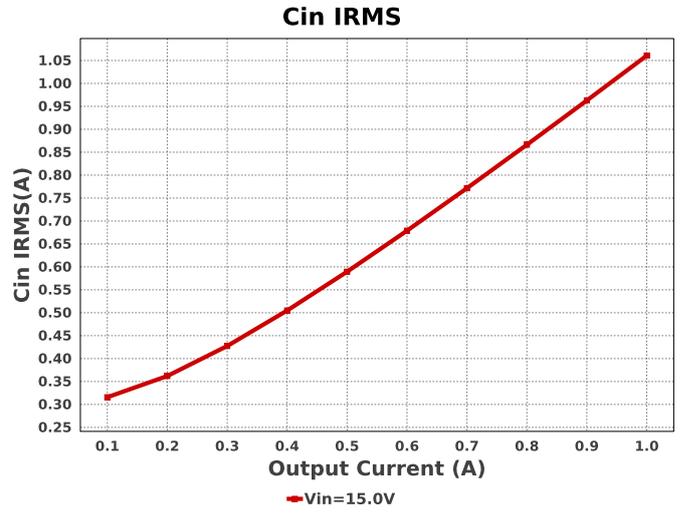
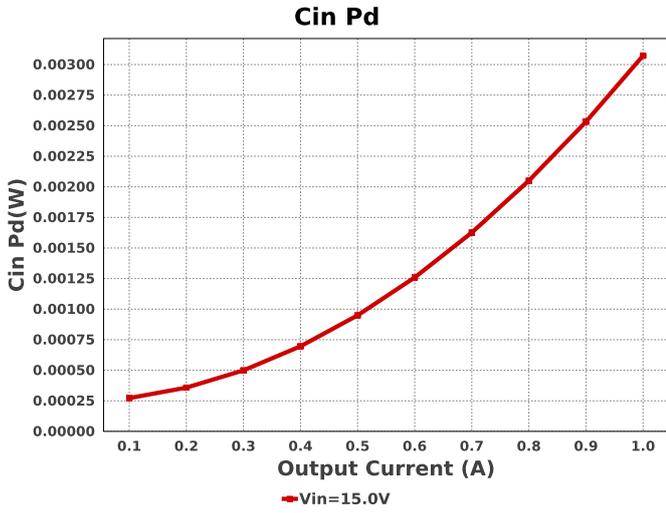


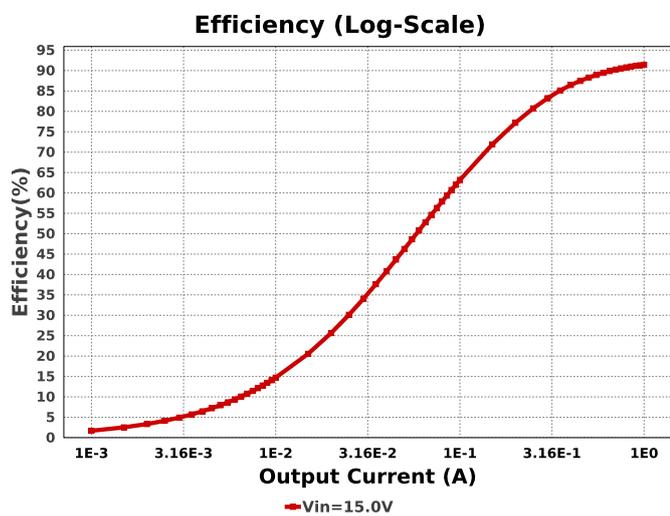
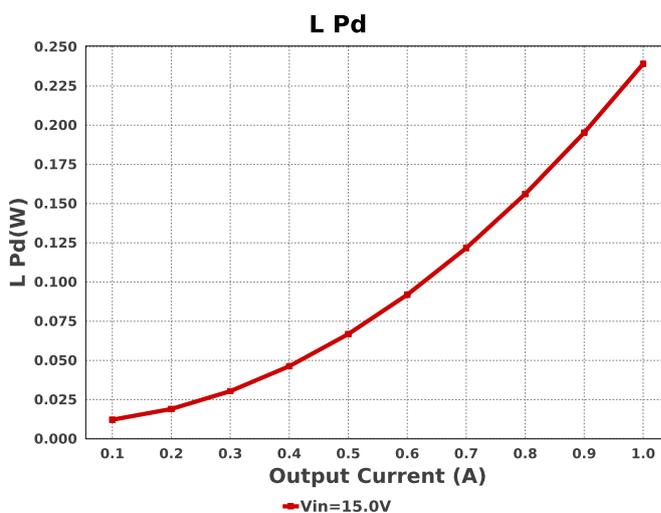
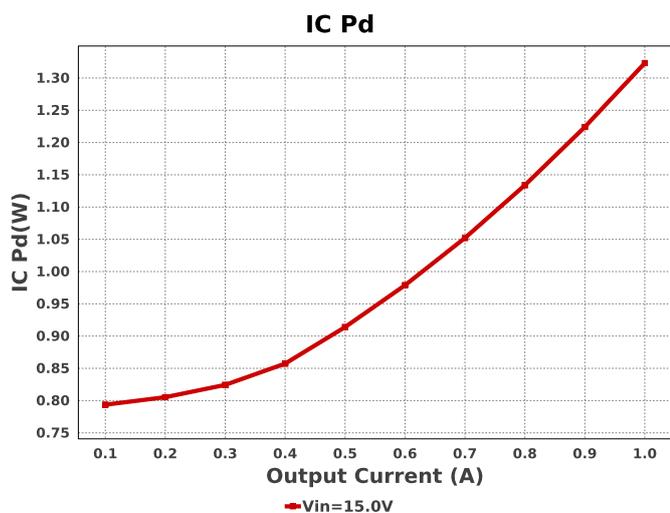
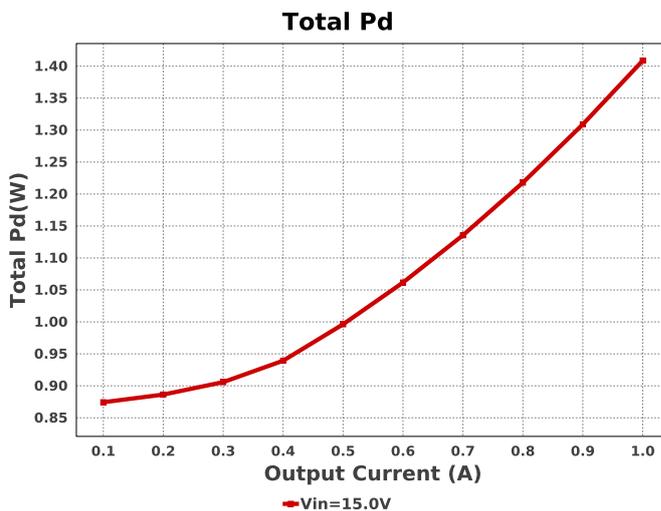
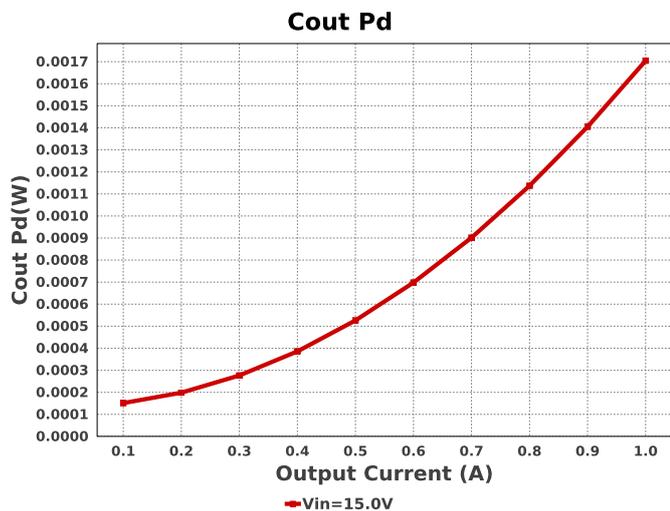
WEBENCH® Design Report

 Design : 40 LMZM33604RLXR
 LMZM33604RLXR 15V-15V to -15.00V @ 1A

Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbulk	Taiyo Yuden	MSAST21GGB5106MTNA01 Series= X5R	Cap= 10.0 uF ESR= 5.463 mOhm VDC= 25.0 V IRMS= 2.36768 A	2	\$0.04	0805 7 mm ²
Cbyp	Taiyo Yuden	MSASU32MSB5106KPNA01 Series= X5R	Cap= 10.0 uF ESR= 3.979 mOhm VDC= 50.0 V IRMS= 3.4821 A	1	\$0.16	1210 15 mm ²
Cin	Taiyo Yuden	MSAST21GGB5106MTNA01 Series= X5R	Cap= 10.0 uF ESR= 5.463 mOhm VDC= 25.0 V IRMS= 2.36768 A	2	\$0.04	0805 7 mm ²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	2	\$0.17	1210_280 15 mm ²
D1	Panasonic	DB2S31600L	VF@Io= 550.0 mV VRRM= 30.0 V	1	\$0.03	SOD-523 5 mm ²
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Rfbb	Vishay-Dale	CRCW0402140KFKED Series= CRCW..e3	Res= 140.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Rt	Vishay-Dale	CRCW040252K3FKED Series= CRCW..e3	Res= 52.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
U1	Texas Instruments	LMZM33604RLXR	Switcher	1	\$7.90	RLX0041A 216 mm ²







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.061 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	3.073 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.06 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.705 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	2.8 A	IC	Peak switch current in IC
6.	IC Pd	1.323 W	IC	IC power dissipation
7.	IC Tj	47.862 degC	IC	IC junction temperature
8.	IC Tolerance	20.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	13.5 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	1.094 A	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	76.725 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	1.552 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	239.15 mW	Inductor	Inductor power dissipation
14.	Cin Pd	3.073 mW	Power	Input capacitor power dissipation
15.	Cout Pd	1.705 mW	Power	Output capacitor power dissipation
16.	IC Pd	1.323 W	Power	IC power dissipation
17.	L Pd	239.15 mW	Power	Inductor power dissipation
18.	Total Pd	1.409 W	Power	Total Power Dissipation
19.	BOM Count	12	System	Total Design BOM count
20.	Duty Cycle	50.578 %	System Information	Duty cycle
21.	Efficiency	91.414 %	System Information	Steady state efficiency
22.	FootPrint	301.0 mm ²	System Information	Total Foot Print Area of BOM components
23.	Frequency	714.774 kHz	System Information	Switching frequency
24.	Iout	1.0 A	System Information	Iout operating point
25.	Mode	FCCM	System Information	Conduction Mode
26.	Pout	15.0 W	System Information	Total output power
27.	Total BOM	\$8.62	System Information	Total BOM Cost
28.	Vin	15.0 V	System Information	Vin operating point
29.	Vout	-15.0 V	System Information	Operational Output Voltage
30.	Vout Actual	15.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
31.	Vout Tolerance	3.923 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	36.667 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	15.0	Maximum input voltage
VinMin	15.0	Minimum input voltage
Vout	-15.0	Output Voltage
base_pn	LMZM33604	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

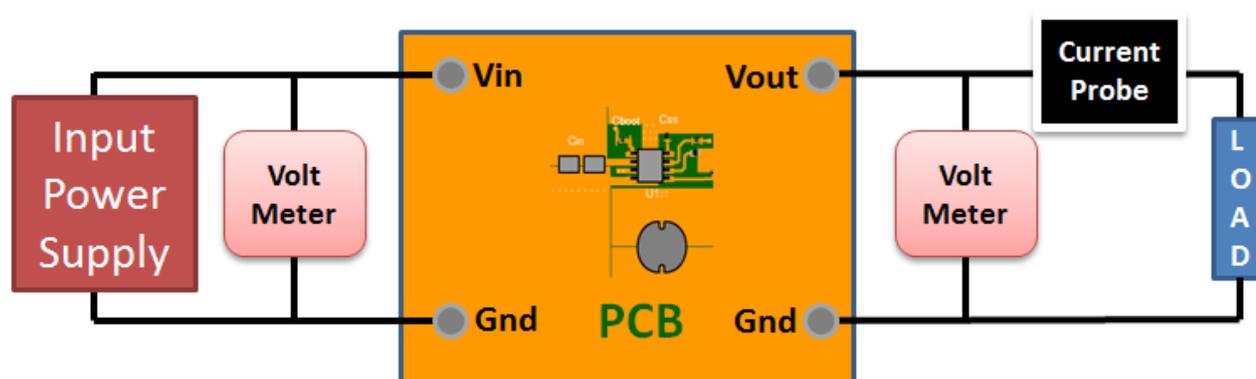
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 15.0V 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 : 3ECAB487A5B30749[v1]
2. **LMZM33604** Product Folder : <http://www.ti.com/product/LMZM33604> : contains the data sheet and other resources.

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