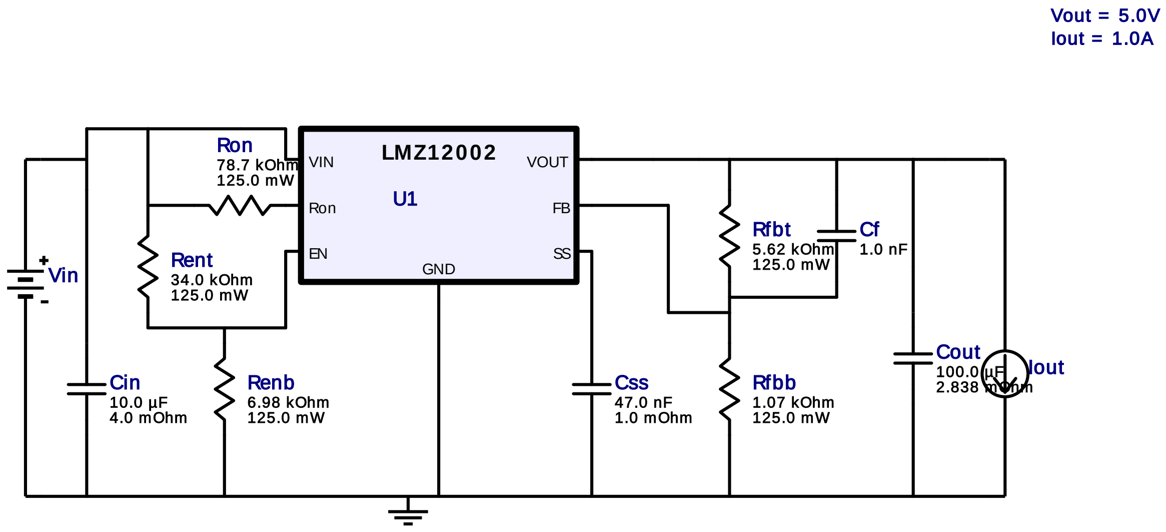
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 7.0V
VinMax = 8.6V
Vout = 5.0V
Iout = 1.0A

Device = LMZ12002TZ-ADJ/NOPB
Topology = Buck
Created = 2021-05-15 13:10:21.330
BOM Cost = $4.66
BOM Count = 10
Total Pd = 0.45W

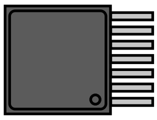
Design : 4 LMZ12002TZ-ADJ/NOPB
LMZ12002TZ-ADJ/NOPB 7V-8.6V to 5.00V @ 1A

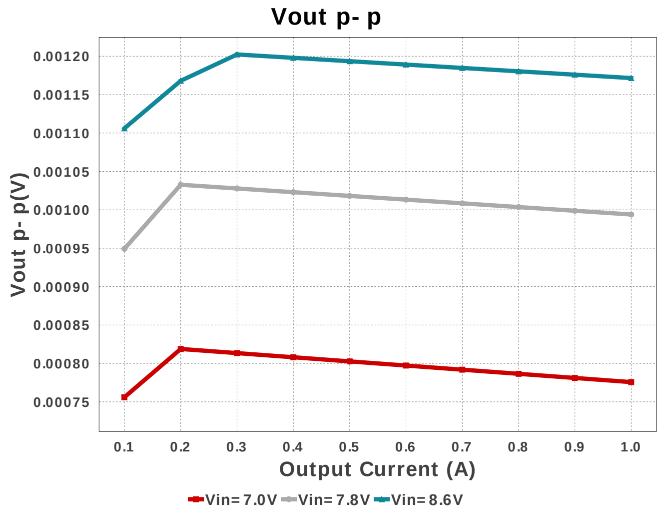


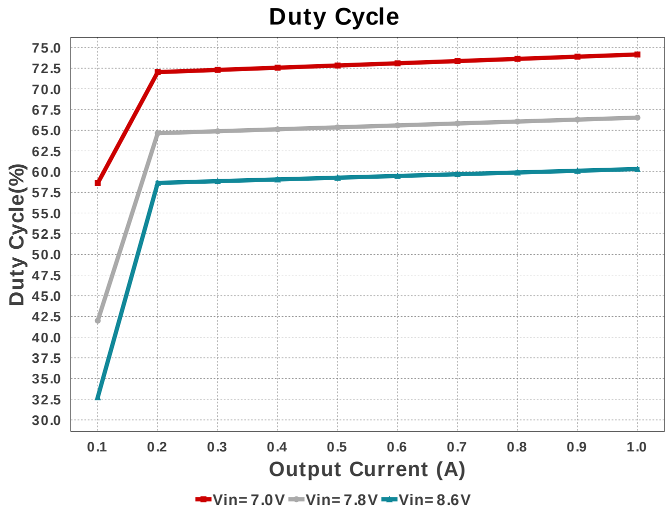
Electrical BOM

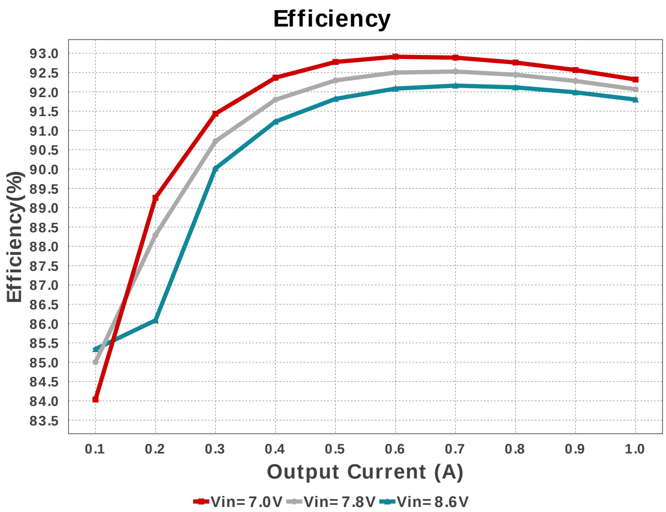
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cf	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM21BR61E106MA73L Series= X5R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 2.8 A	1	$0.05	0805 7 mm²
Cout	TDK	C3216X5R1A107M160AC Series= X5R	Cap= 100.0 uF ESR= 2.838 mOhm VDC= 10.0 V IRMS= 4.3069 A	1	$0.50	1206_190 11 mm²
Css	MuRata	GRM21BR71H473KA01L Series= X7R	Cap= 47.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Renb	Panasonic	ERJ-6ENF6981V Series= ERJ-6E	Res= 6.98 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rent	Vishay-Dale	CRCW080534K0FKEA Series= CRCW..e3	Res= 34.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rfbb	Panasonic	ERJ-6ENF1071V Series= ERJ-6E	Res= 1.07 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rfbt	Panasonic	ERJ-6ENF5621V Series= ERJ-6E	Res= 5.62 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Ron	Vishay-Dale	CRCW080578K7FKEA Series= CRCW..e3	Res= 78.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²

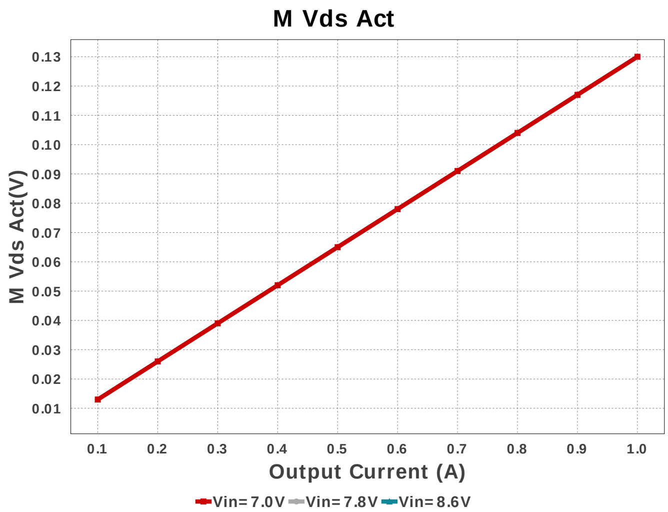
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LMZ12002TZ-ADJ/NOPB	Switcher	1	$4.02	TZA07A 199 mm^2

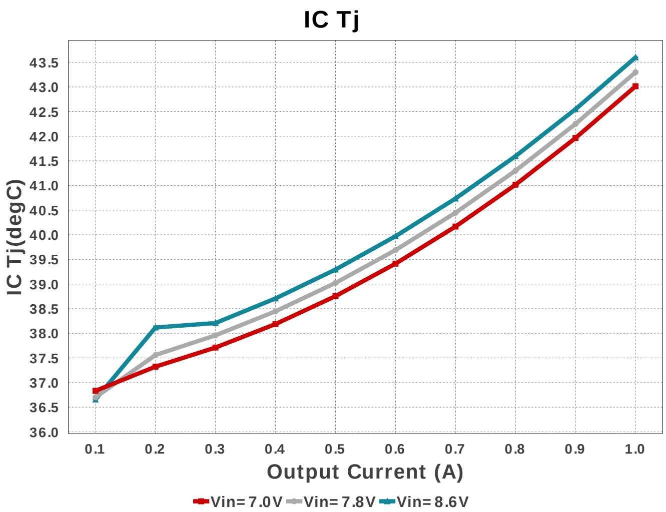


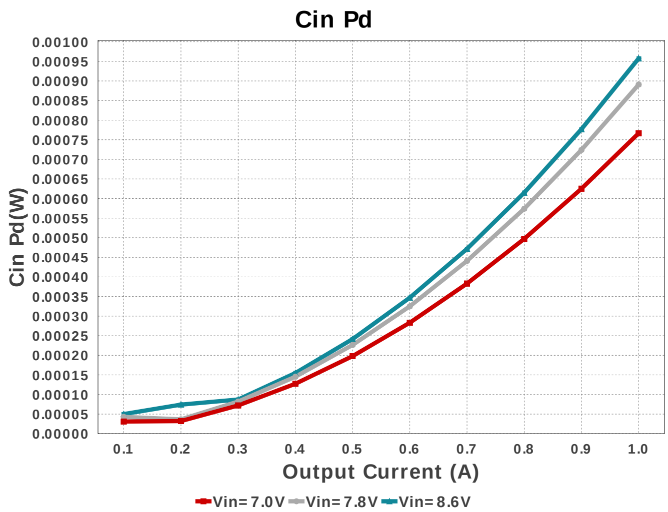


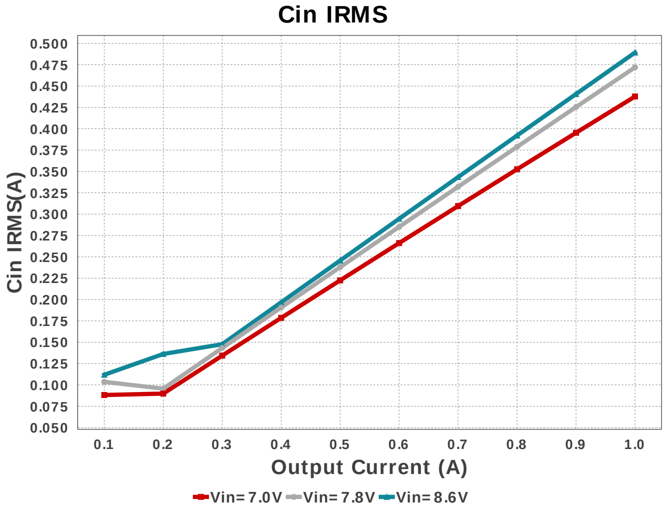


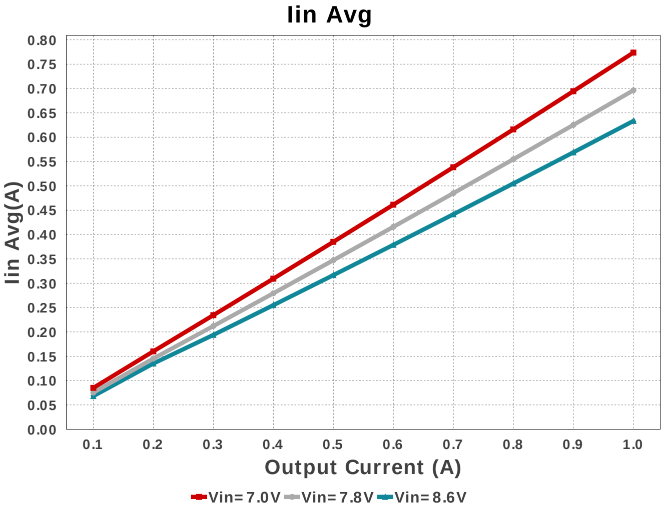


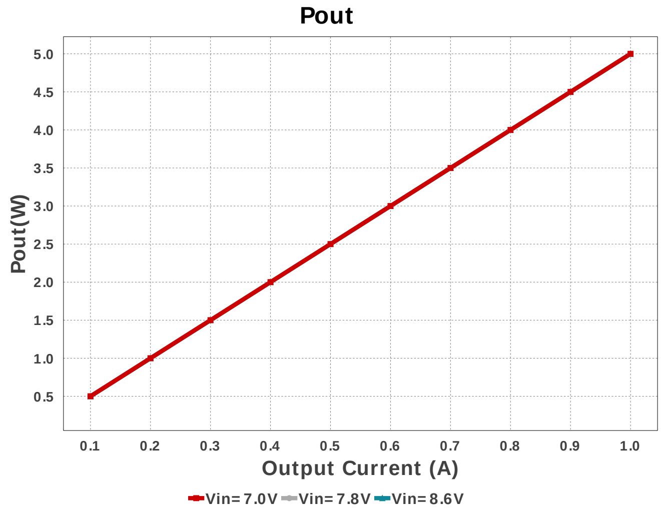


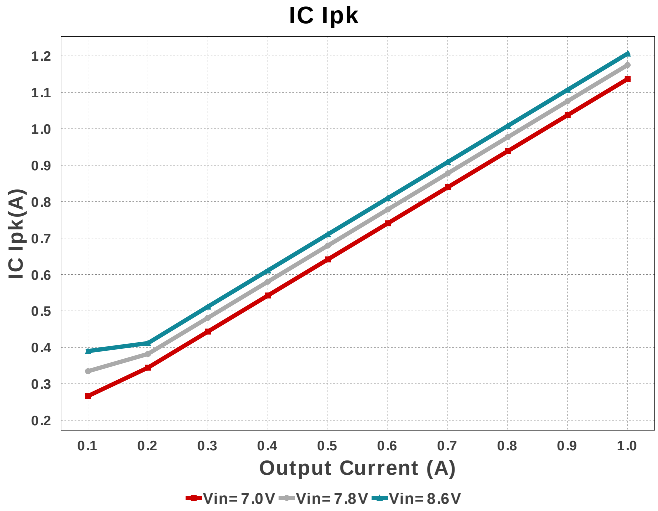


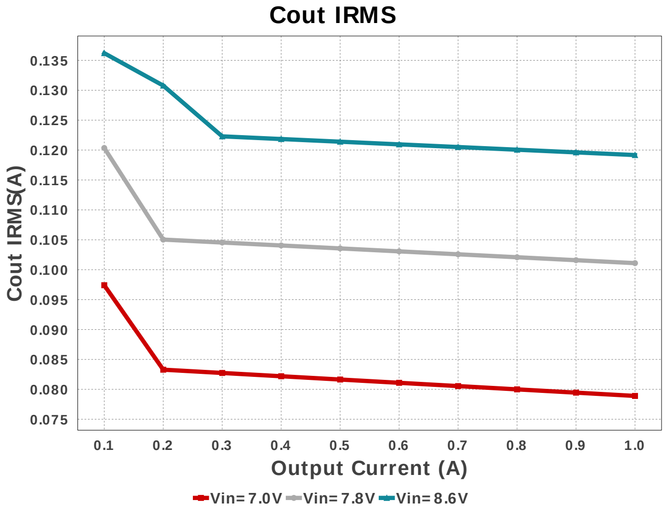


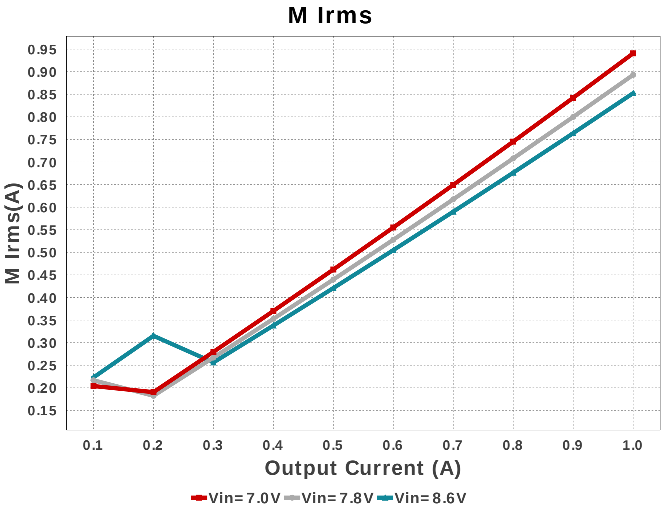

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V

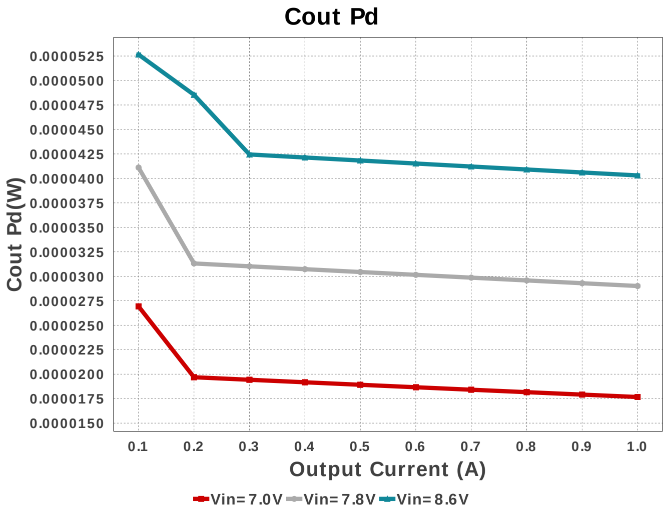

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V

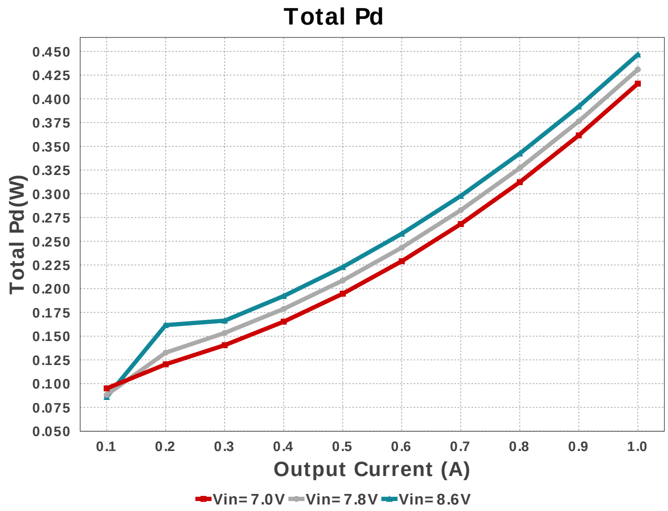

Pout
Pout(W)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V

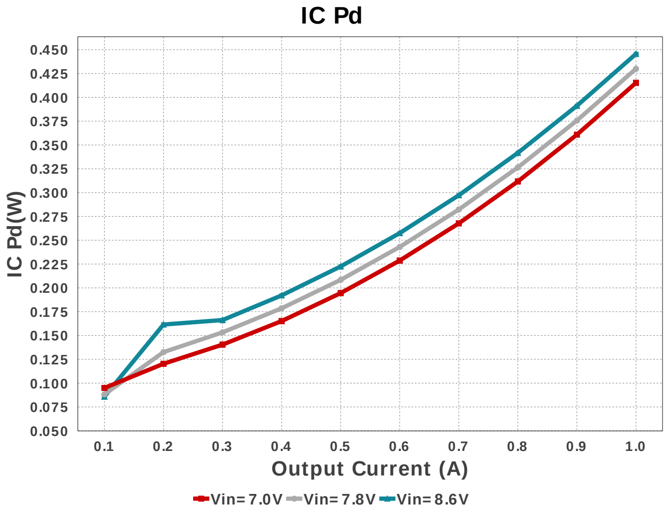

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V


M Irms
M Irms(A)
Output Current (A)
Vin=7.0V Vin=7.8V Vin=8.6V







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	10		Total Design BOM count
2.	Total BOM	$4.655		Total BOM Cost
3.	Cin IRMS	489.245 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	957.44 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	119.168 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	40.302 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	1.206 A	IC	Peak switch current in IC
8.	IC Pd	445.62 mW	IC	IC power dissipation
9.	IC Tj	43.601 degC	IC	IC junction temperature
10.	IC Tolerance	20.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	19.3 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	633.33 mA	IC	Average input current
13.	M1 Irms	852.42 mA	Mosfet	Q Iavg
14.	M Vds Act	130.0 mV	Mosfet	Voltage drop across the MosFET
15.	Cin Pd	957.44 µW	Power	Input capacitor power dissipation
16.	Cout Pd	40.302 µW	Power	Output capacitor power dissipation
17.	IC Pd	445.62 mW	Power	IC power dissipation
18.	Total Pd	446.624 mW	Power	Total Power Dissipation
19.	Duty Cycle	60.314 %	System Information	Duty cycle
20.	Efficiency	91.8 %	System Information	Steady state efficiency
21.	FootPrint	260.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	488.711 kHz	System Information	Switching frequency
23.	Iout	1.0 A	System Information	Iout operating point
24.	Mode	CCM	System Information	Conduction Mode
25.	Pout	5.0 W	System Information	Total output power

#	Name	Value	Category	Description
26.	Vin	8.6 V	System Information	Vin operating point
27.	Vout	5.0 V	System Information	Operational Output Voltage
28.	Vout Actual	5.002 V	System Information	Vout Actual calculated based on selected voltage divider resistors
29.	Vout Tolerance	4.24 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
30.	Vout p-p	1.172 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
SoftStart	5.0 ms	Soft Start Time (ms)
VinMax	8.6	Maximum input voltage
VinMin	7.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMZ12002	Base Product Number
source	DC	Input Source Type
Ta	35.0	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

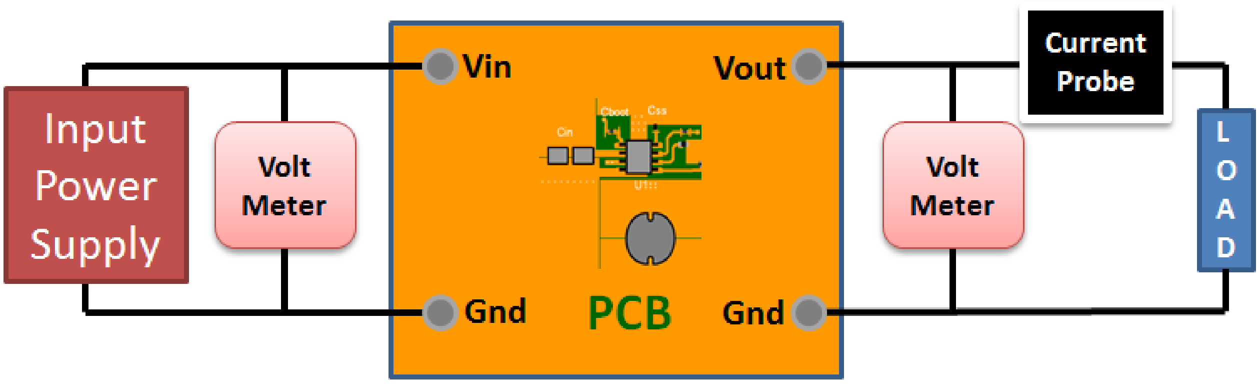
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 7.0V 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.

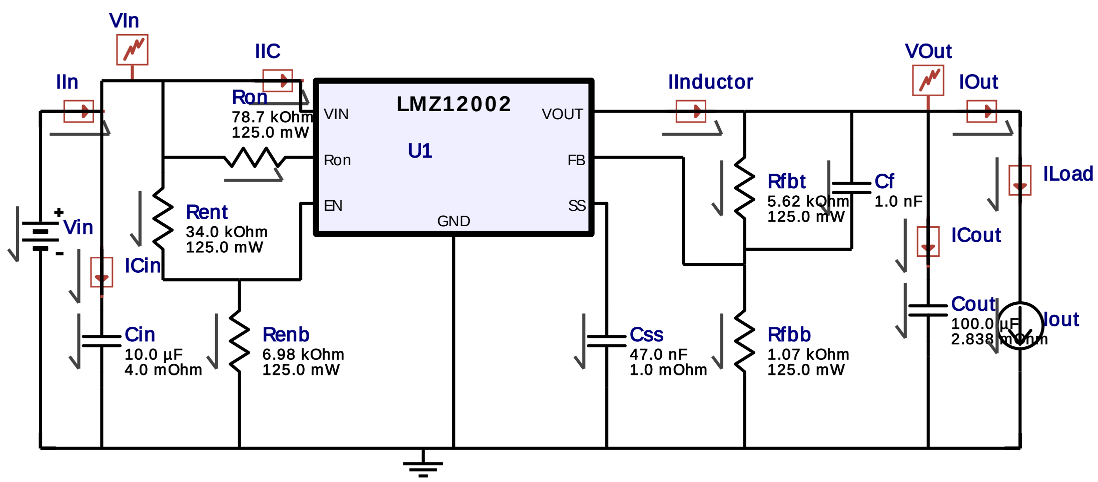


WEBENCH® Electrical Simulation Report

Design Id = 4

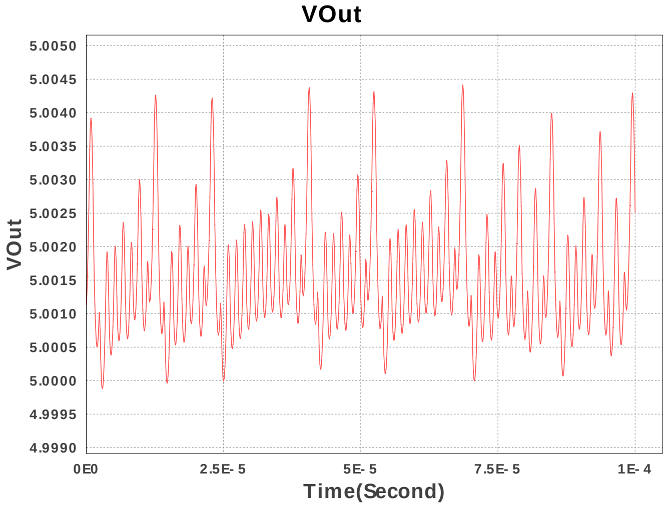
sim_id = 4

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cin	IC	Initial Condition Across Cin	7.8 V
2.	Cout	IC	Initial Condition Across Cout	5.0 V
3.	Css	IC	Initial Condition across the startup capacitor	0.5 V
4.	Iout	I	Load Current	1.0 A



Design Assistance

1. Master key : F3A704CE6B97FACA[v1]

2. **LMZ12002** Product Folder : http://www.ti.com/product/LMZ12002 : contains the data sheet and other resources.

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