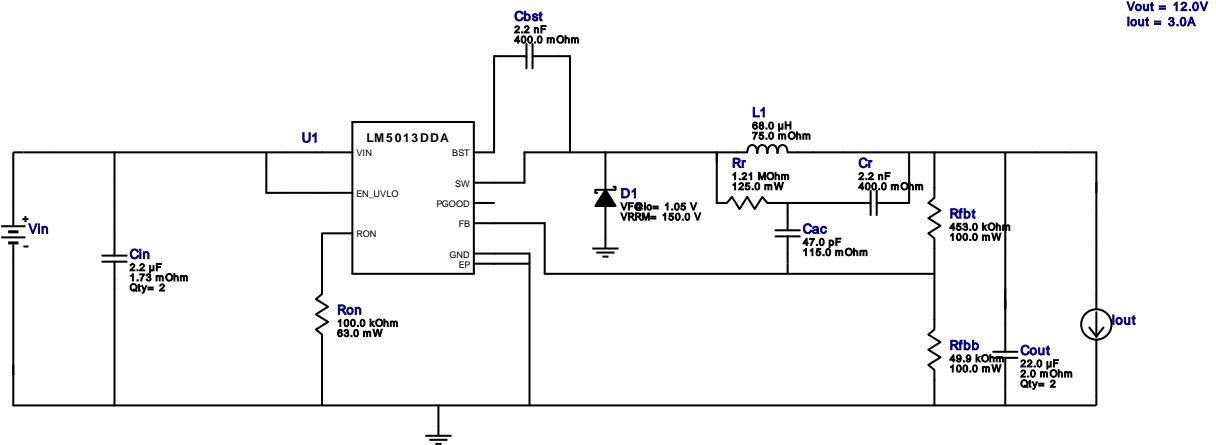


## WEBENCH® Design Report

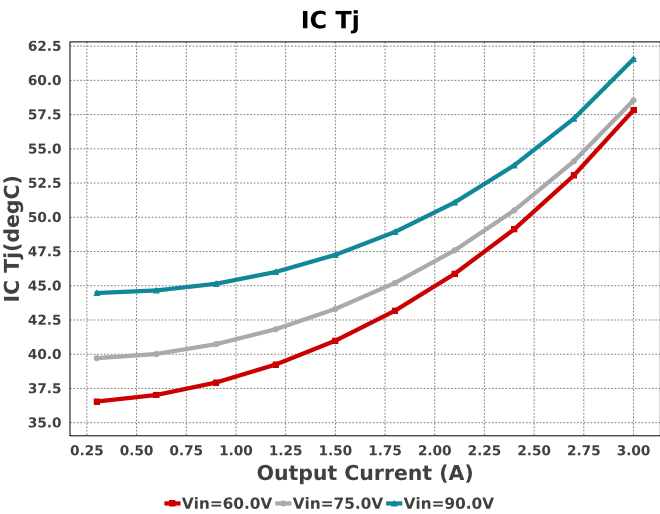
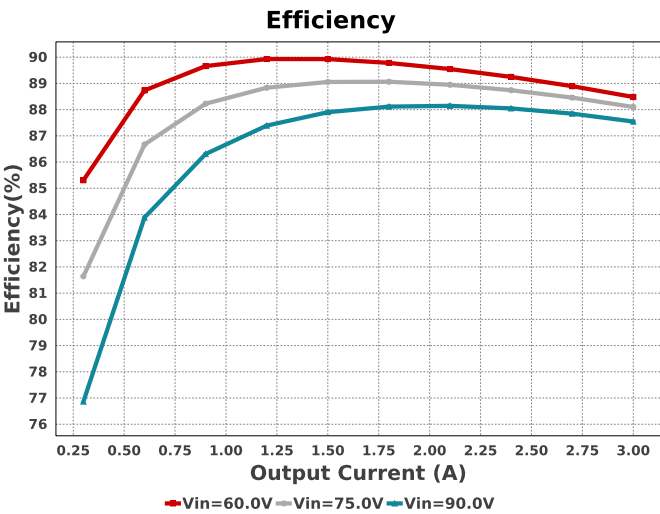
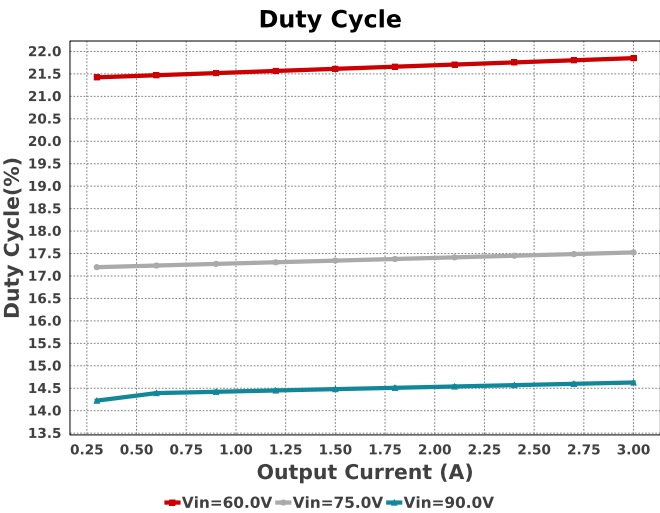
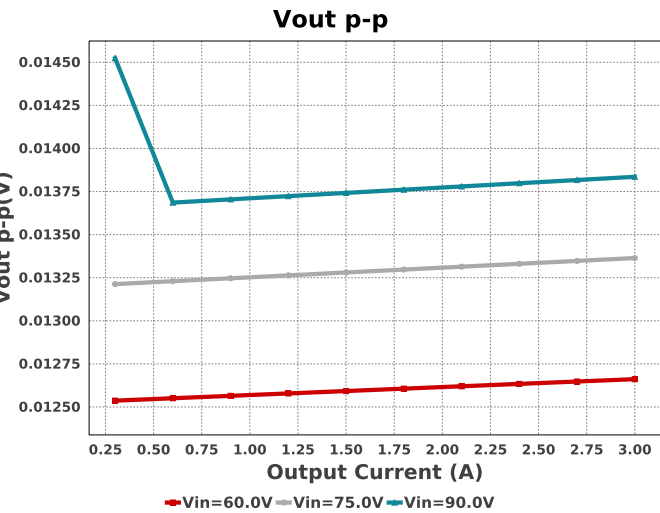
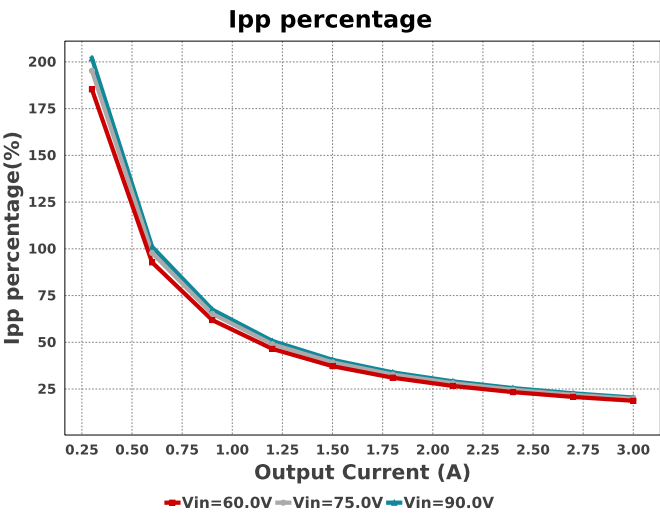
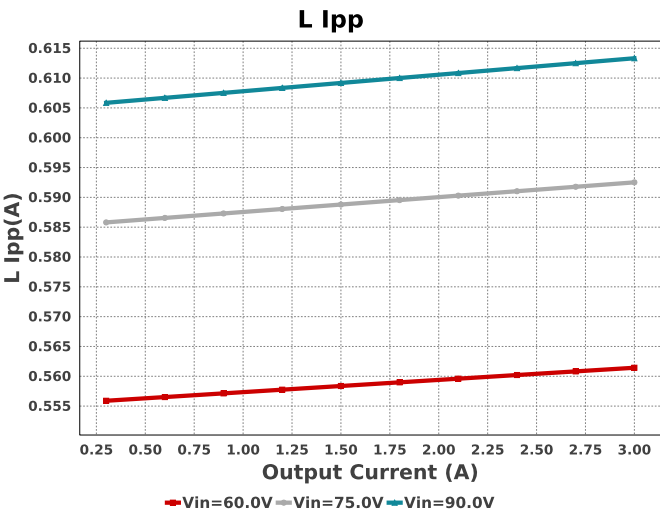
Design : 7 LM5013DDAR  
LM5013DDAR 60V-90V to 12.00V @ 3A

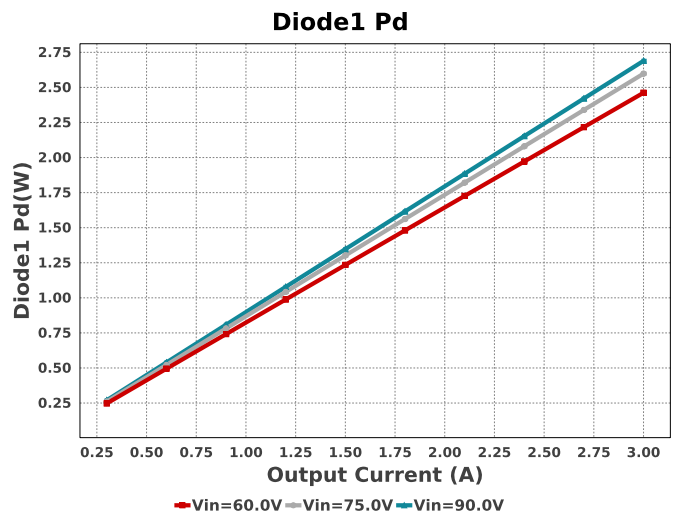
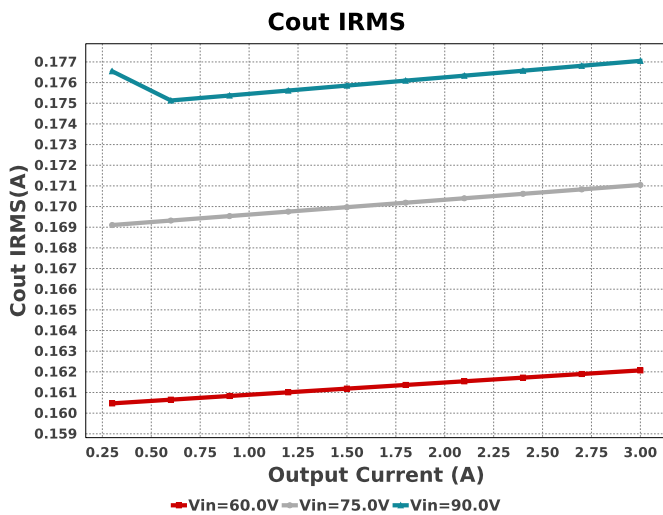
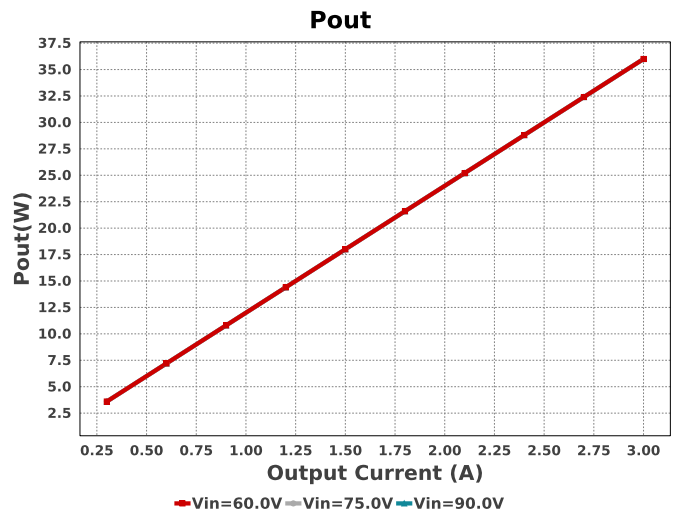
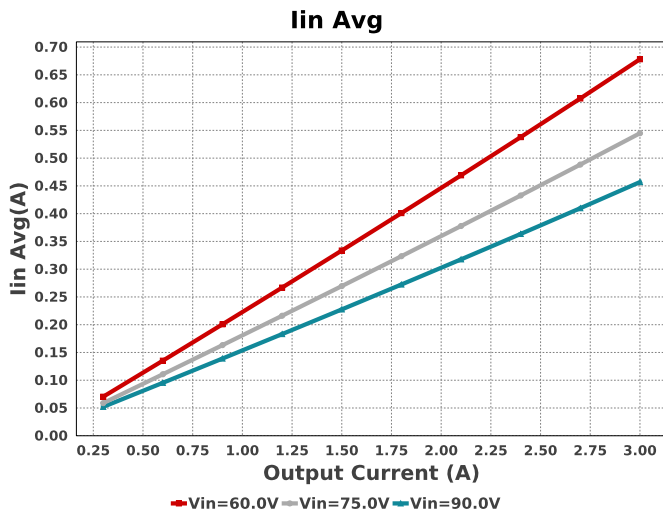
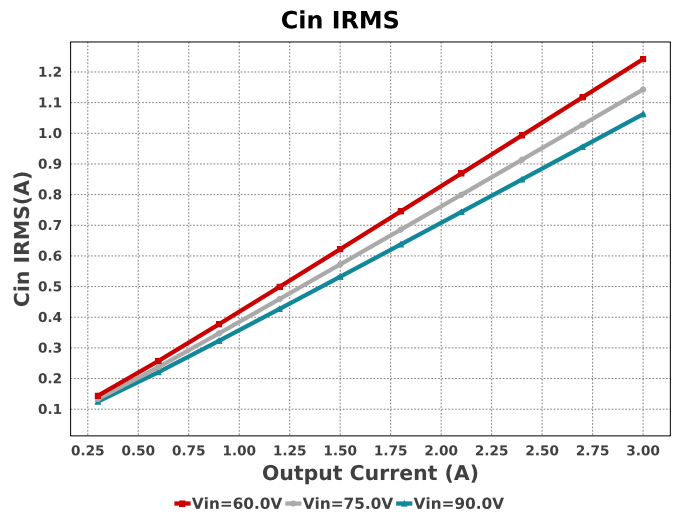
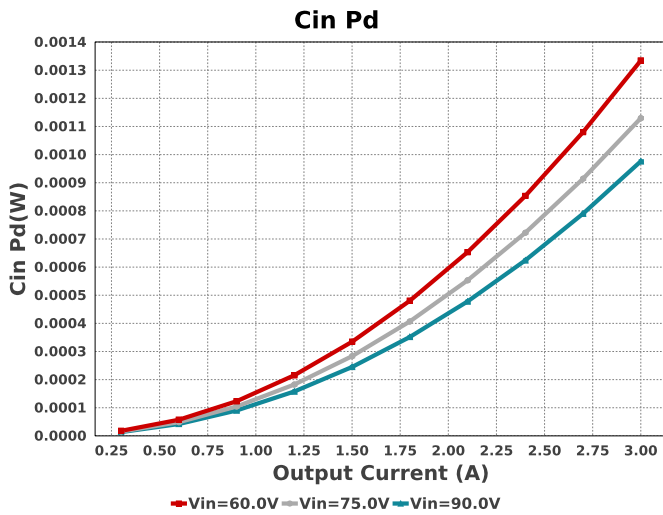


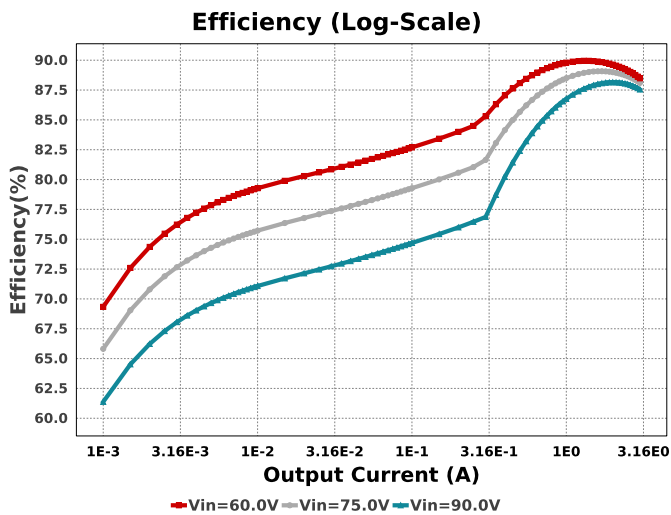
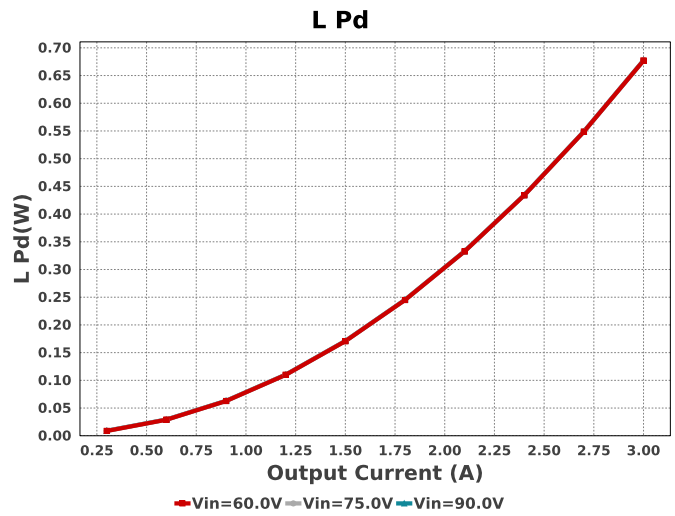
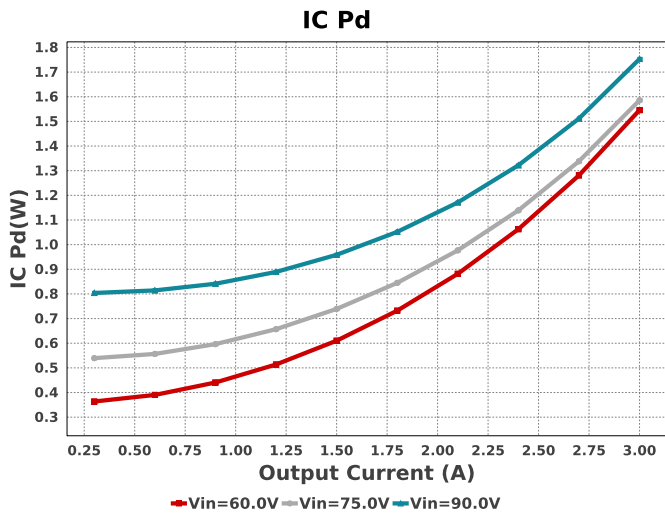
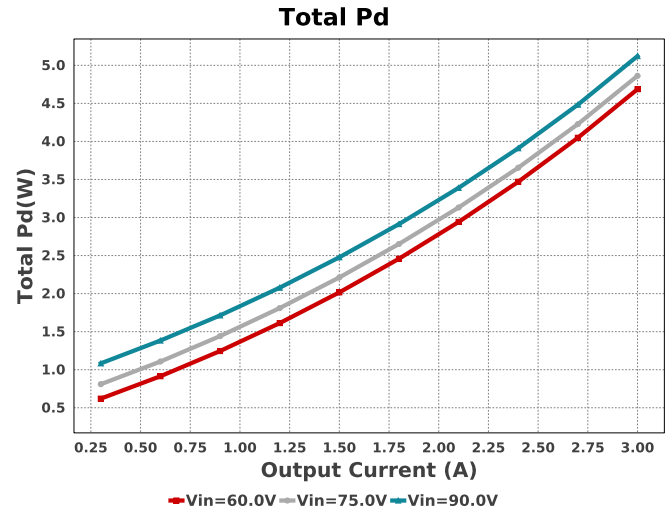
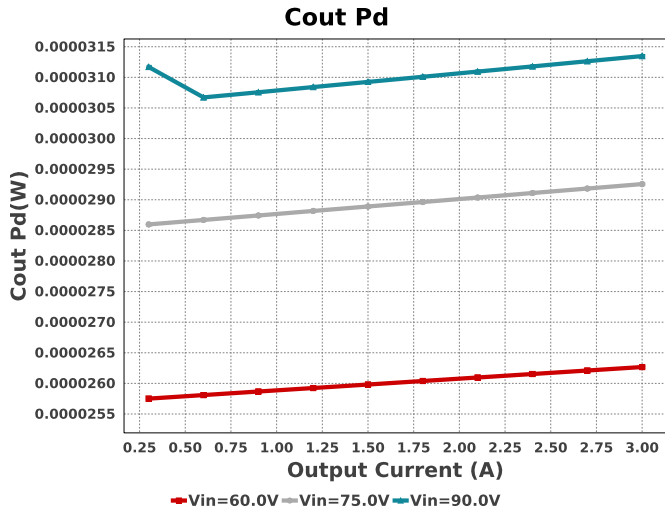
## Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	Kemet	C0805C470J5GACTU Series= C0G/NP0	Cap= 47.0 pF ESR= 115.0 mOhm VDC= 50.0 V IRMS= 505.0 mA	1	\$0.01	0805 7 mm <sup>2</sup>
Cbst	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	\$0.01	0805 7 mm <sup>2</sup>
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	2	\$0.21	1210_250 15 mm <sup>2</sup>
Cout	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	2	\$0.23	1210 15 mm <sup>2</sup>
Cr	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	\$0.01	0805 7 mm <sup>2</sup>
D1	SMC Diode Solutions	SB10150TA	VF@Io= 1.05 V VRRM= 150.0 V	1	\$0.26	DO-201AD 166 mm <sup>2</sup>
L1	Würth Elektronik	784373170680	L= 68.0 uH 75.0 mOhm	1	\$3.43	WE-LHCA_1770 0 mm <sup>2</sup>
Rfbb	Yageo	RC0603FR-0749K9L Series= ?	Res= 49.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm <sup>2</sup>
Rfbb	Yageo	RC0603FR-07453KL Series= ?	Res= 453.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm <sup>2</sup>
Ron	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rr	Vishay-Dale	CRCW08051M21FKEA Series= CRCW..e3	Res= 1.21 MOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	0805 7 mm²
U1	Texas Instruments	LM5013DDAR	Switcher	1	\$1.54	DDA0008E-MFG 55 mm²







## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.062 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	976.17 $\mu$ W	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	177.051 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	31.347 $\mu$ W	Capacitor	Output capacitor power dissipation
5.	Diode1 Pd	2.689 W	Diode	Diode1 power dissipation
6.	IC Pd	1.753 W	IC	IC power dissipation
7.	IC Tj	61.557 degC	IC	IC junction temperature
8.	IC Tolerance	19.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	18.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	456.9 mA	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	20.444 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	613.32 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	677.35 mW	Inductor	Inductor power dissipation
14.	Cin Pd	976.17 $\mu$ W	Power	Input capacitor power dissipation
15.	Cout Pd	31.347 $\mu$ W	Power	Output capacitor power dissipation
16.	Diode1 Pd	2.689 W	Power	Diode1 power dissipation
17.	IC Pd	1.753 W	Power	IC power dissipation
18.	L Pd	677.35 mW	Power	Inductor power dissipation
19.	Total Pd	5.121 W	Power	Total Power Dissipation
20.	BOM Count	14	System	Total Design BOM count
21.	Duty Cycle	14.628 %	Information	
			System	Duty cycle
22.	Efficiency	87.546 %	Information	
			System	Steady state efficiency
23.	FootPrint	720.0 mm <sup>2</sup>	Information	
			System	Total Foot Print Area of BOM components
24.	Frequency	271.739 kHz	Information	
			System	Switching frequency
25.	Iout	3.0 A	Information	
			System	Iout operating point
26.	Mode	CCM	Information	
			System	Conduction Mode
27.	Pout	36.0 W	Information	
			System	Total output power
28.	Total BOM	\$6.18	Information	
			System	Total BOM Cost
29.	Vin	90.0 V	Information	
			System	Vin operating point
30.	Vout	12.0 V	Information	
			System	Operational Output Voltage
31.	Vout Actual	12.094 V	Information	
			System	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	3.432 %	Information	
			System	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	13.835 mV	Information	
			System	Peak-to-peak output ripple voltage

## Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	90.0	Maximum input voltage
VinMin	60.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5013	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 60.0V 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 : DBB305F37318C4A42F1D3953713A2901[v1]
2. **LM5013** Product Folder : <http://www.ti.com/product/LM5013> : contains the data sheet and other resources.

**Important Notice and Disclaimer**

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with TI products.