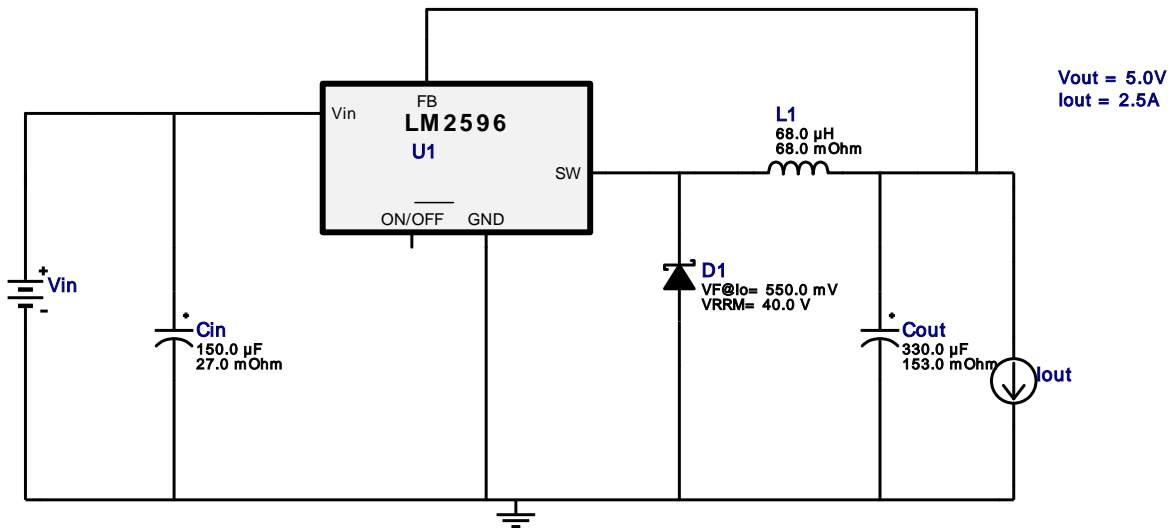


# WEBENCH® Design Report

Design : 3 LM2596SX-5.0/NOPB  
LM2596SX-5.0/NOPB 15V-20V to 5.00V @ 2.5A

VinMin = 15.0V  
VinMax = 20.0V  
Vout = 5.0V  
Iout = 2.5A

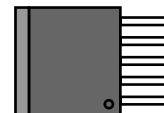
Device = LM2596SX-5.0/NOPB  
Topology = Buck  
Created = 2022-11-18 22:30:03.629  
BOM Cost = \$6.35  
BOM Count = 6  
Total Pd = 2.56W



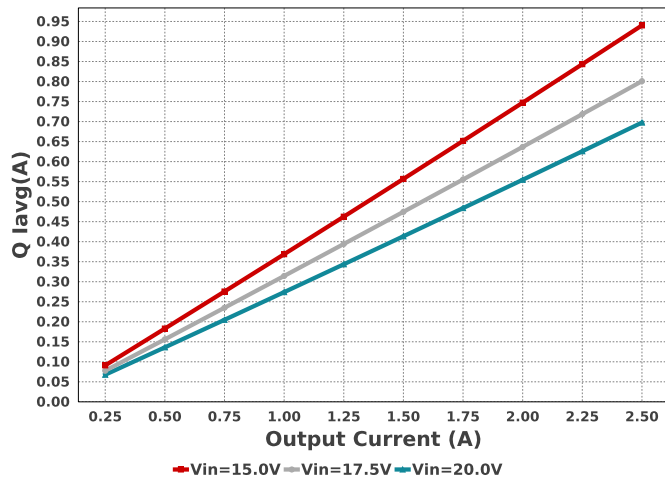
## Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cf	Samsung Electro-Mechanics	CL21C332JBFNNNE Series= C0G/NP0	Cap= 3.3 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.04	 0805 7 mm <sup>2</sup>
Cin	Panasonic	EEHZA1V151P Series= ZA	Cap= 150.0 µF ESR= 27.0 mOhm VDC= 35.0 V IRMS= 2.3 A	1	\$1.31	 SM_RADIAL_8MM 113 mm <sup>2</sup>
Cout	Panasonic	EEV-FK2A331M Series= FK	Cap= 330.0 µF ESR= 153.0 mOhm VDC= 100.0 V IRMS= 917.0 mA	1	\$1.60	 SM_RADIAL_K16 483 mm <sup>2</sup>
D1	Diodes Inc.	B540C-13-F	VF@Io= 550.0 mV VRRM= 40.0 V	1	\$0.19	 SMC 83 mm <sup>2</sup>
L1	Coilcraft	MSS1210-683MEB	L= 68.0 µH 68.0 mOhm	1	\$0.81	 MSS1210 204 mm <sup>2</sup>

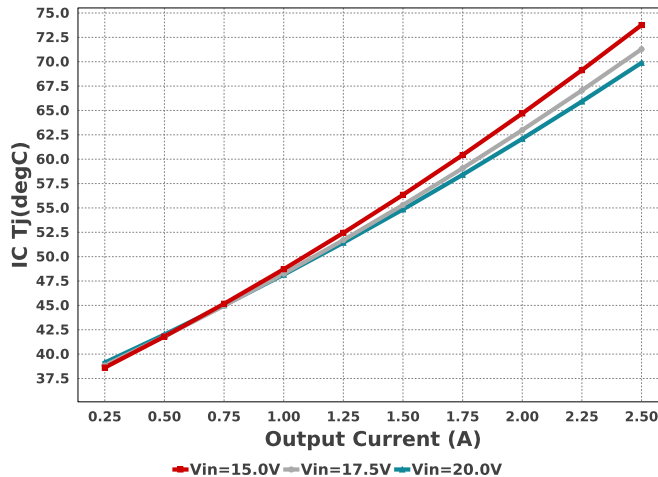
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LM2596SX-5.0/NOPB	Switcher	1	\$2.40	

TS5B 199 mm<sup>2</sup>

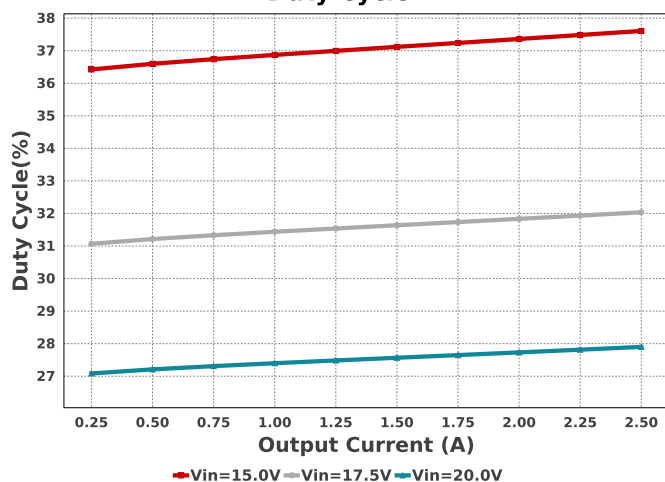
Q lavg



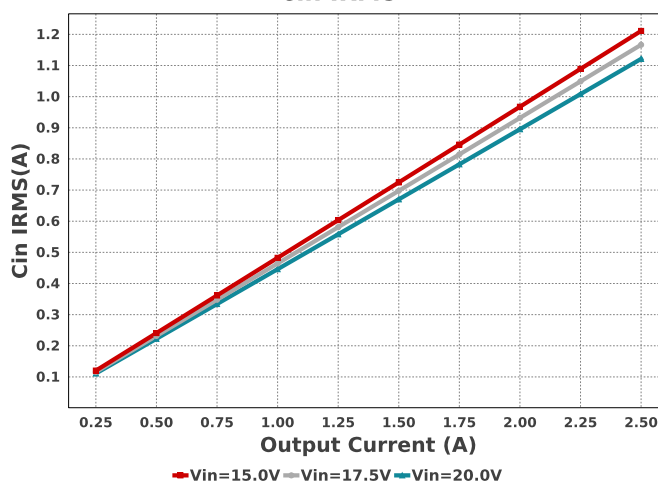
IC Tj



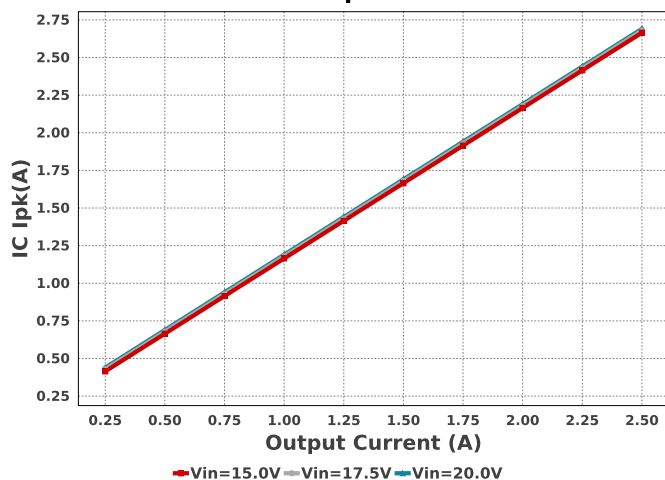
Duty Cycle



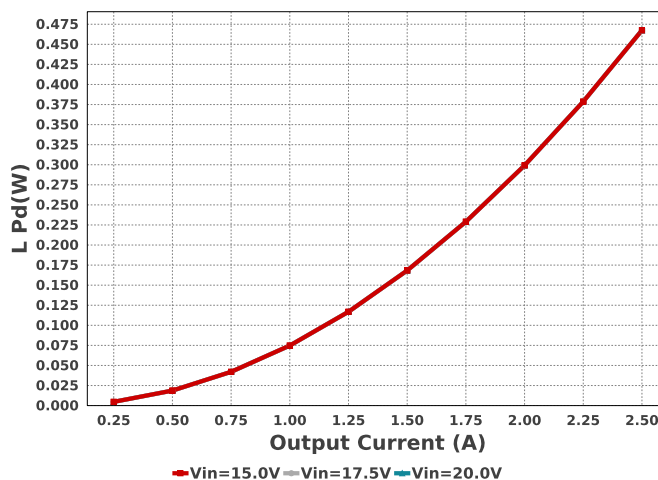
Cin IRMS

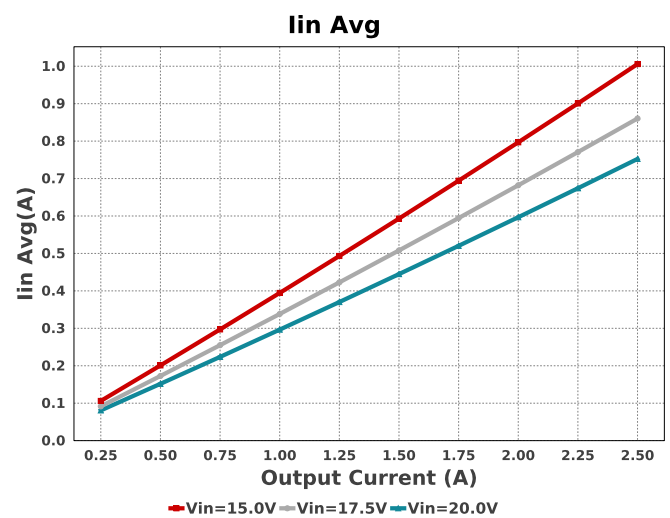
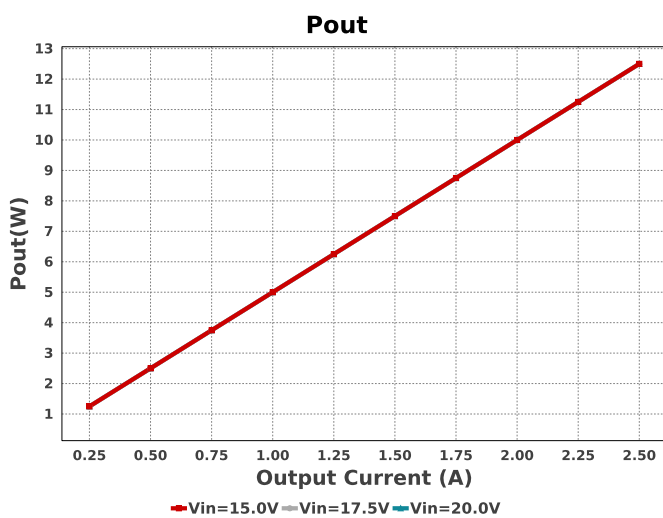
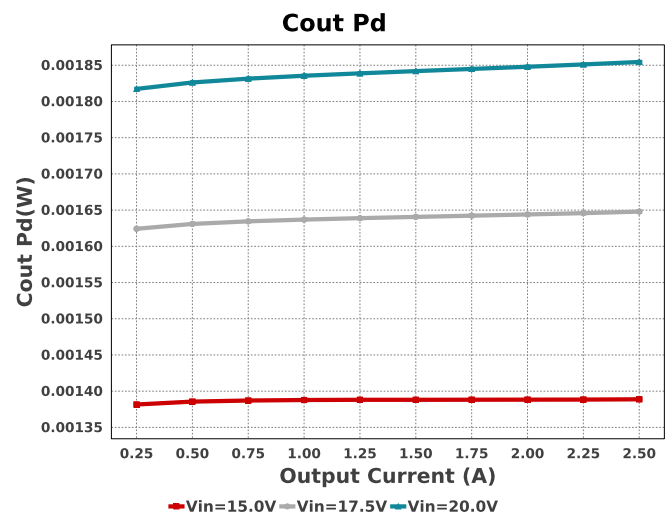
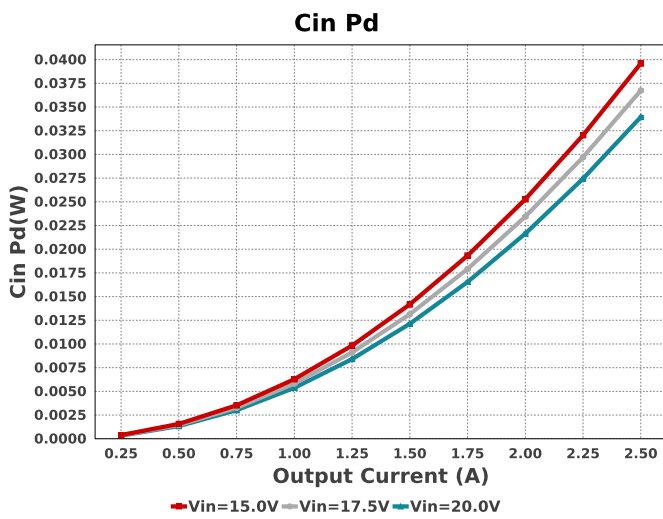
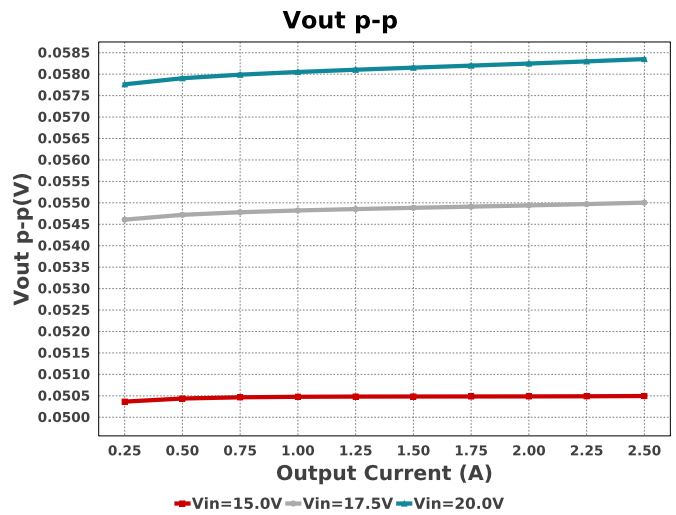
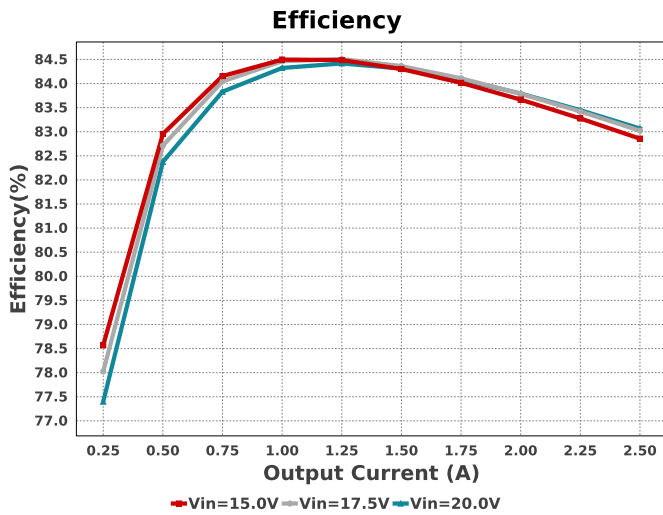


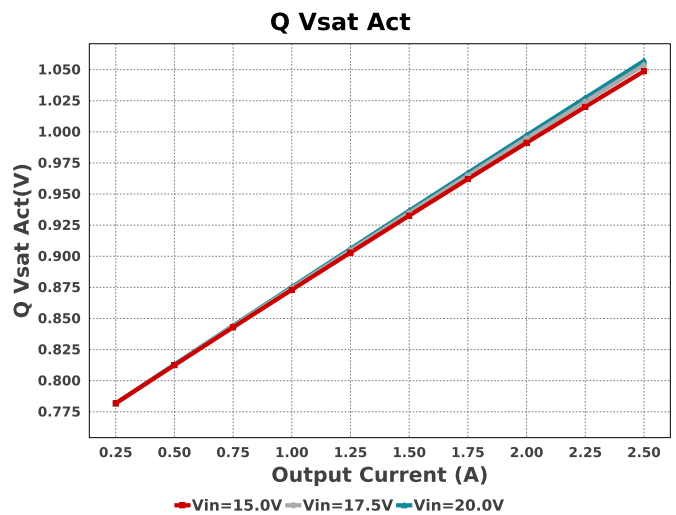
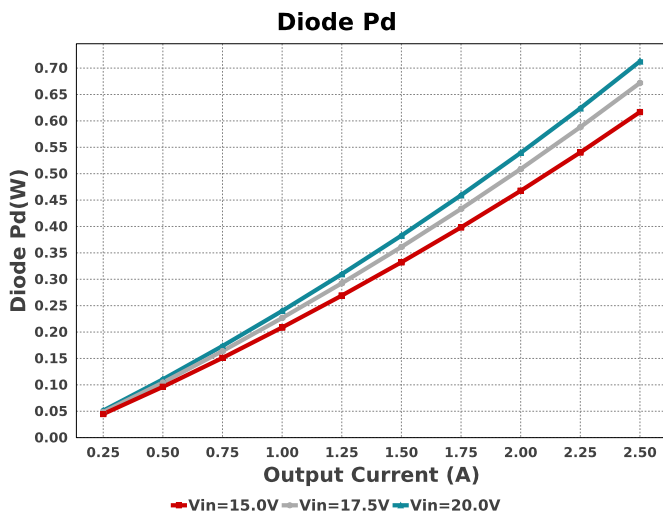
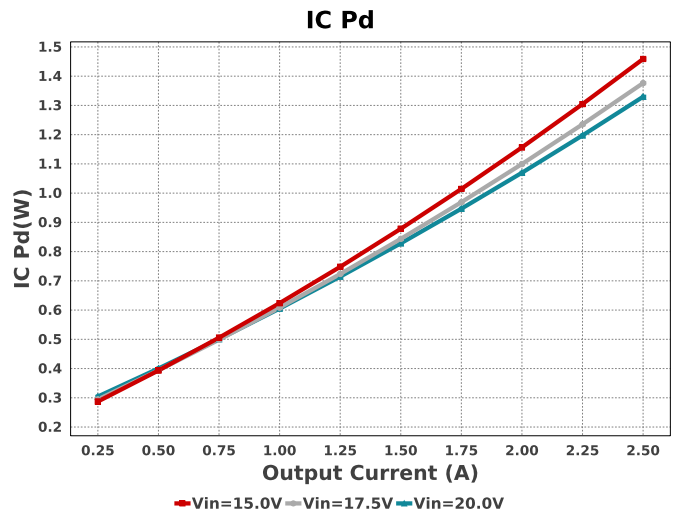
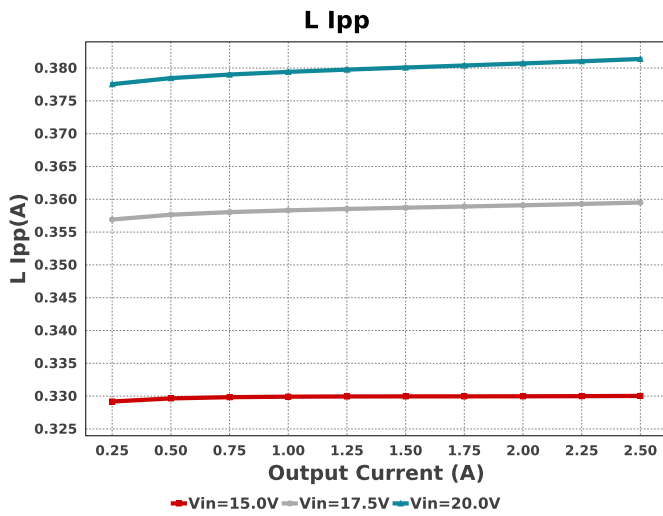
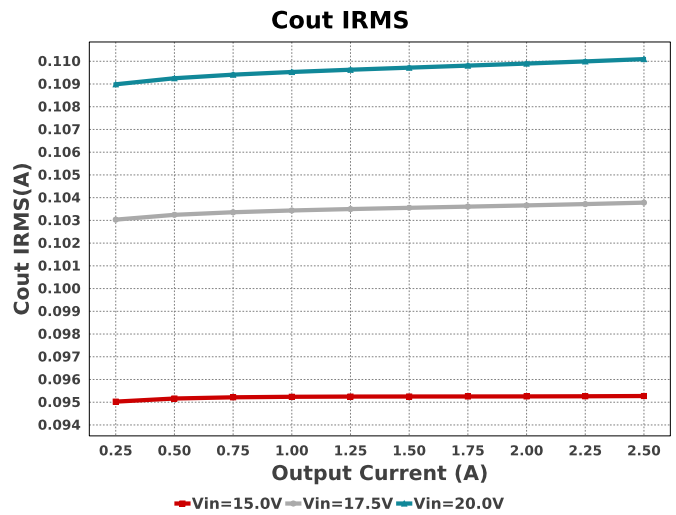
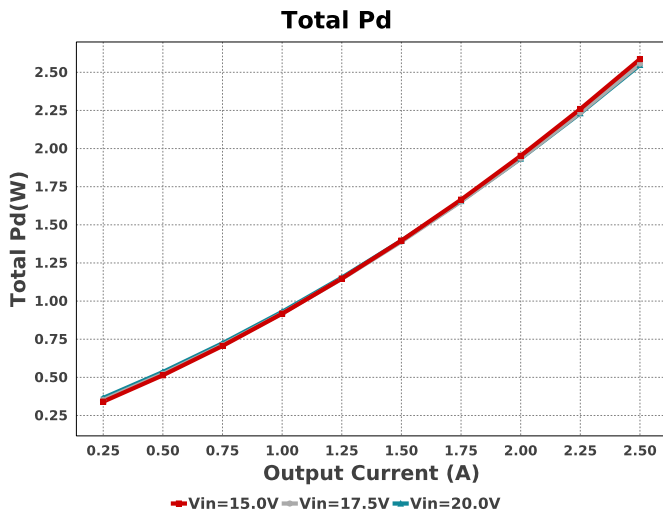
IC Ipk



L Pd







## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.121 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	33.946 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	110.095 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.854 mW	Capacitor	Output capacitor power dissipation
5.	Diode Pd	712.74 mW	Diode	Diode power dissipation
6.	IC Ipk	2.691 A	IC	Peak switch current in IC
7.	IC Pd	1.33 W	IC	IC power dissipation
8.	IC Tj	69.888 degC	IC	IC junction temperature
9.	IC Tolerance	0.0 V	IC	IC Feedback Tolerance
10.	ICThetaJA	30.0 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	752.78 mA	IC	Average input current

#	Name	Value	Category	Description
12.	L lpp	381.38 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	467.5 mW	Inductor	Inductor power dissipation
14.	Q lavg	697.501 mA	Mosfet	Q lavg
15.	Cin Pd	33.946 mW	Power	Input capacitor power dissipation
16.	Cout Pd	1.854 mW	Power	Output capacitor power dissipation
17.	Diode Pd	712.74 mW	Power	Diode power dissipation
18.	IC Pd	1.33 W	Power	IC power dissipation
19.	L Pd	467.5 mW	Power	Inductor power dissipation
20.	Total Pd	2.556 W	Power	Total Power Dissipation
21.	BOM Count	6	System	Total Design BOM count
Information				
22.	Duty Cycle	27.9 %	System	Duty cycle
Information				
23.	Efficiency	83.025 %	System	Steady state efficiency
Information				
24.	FootPrint	1.09 k mm <sup>2</sup>	System	Total Foot Print Area of BOM components
Information				
25.	Frequency	150.0 kHz	System	Switching frequency
Information				
26.	Iout	2.5 A	System	Iout operating point
Information				
27.	Mode	CCM	System	Conduction Mode
Information				
28.	Pout	12.5 W	System	Total output power
Information				
29.	Total BOM	\$6.35	System	Total BOM Cost
Information				
30.	Vin	20.0 V	System	Vin operating point
Information				
31.	Vout p-p	58.351 mV	System	Peak-to-peak output ripple voltage
Information				
32.	Q Vsat Act	1.057 V	Transistor	Q Vsat

## Design Inputs

Name	Value	Description
Iout	2.5	Maximum Output Current
VinMax	20.0	Maximum input voltage
VinMin	15.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM2596	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 : 554E87F380B10EF862A869D8392B4870[v1]
2. **LM2596** Product Folder : <http://www.ti.com/product/LM2596> : contains the data sheet and other resources.

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