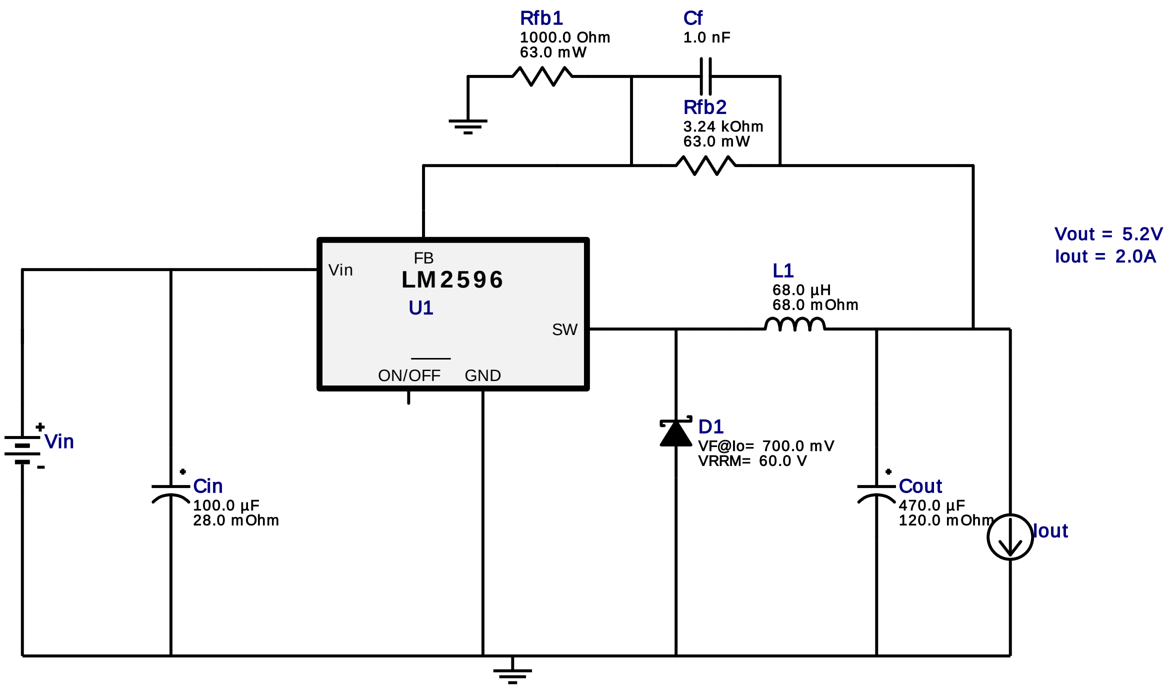
VinMin = 22.0V
VinMax = 32.0V
Vout = 5.2V
Iout = 2.0A

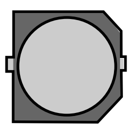
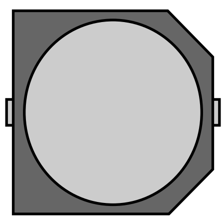
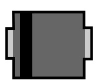
Device = LM2596T-ADJ/NOPB
Topology = Buck
Created = 2023-06-28 04:50:44.762
BOM Cost = $6.18
BOM Count = 8
Total Pd = 2.08W

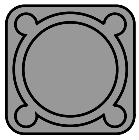
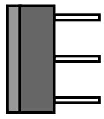
WEBENCH ® Design Report

Design : 12 LM2596T-ADJ/NOPB
LM2596T-ADJ/NOPB 22V-32V to 5.20V @ 2A

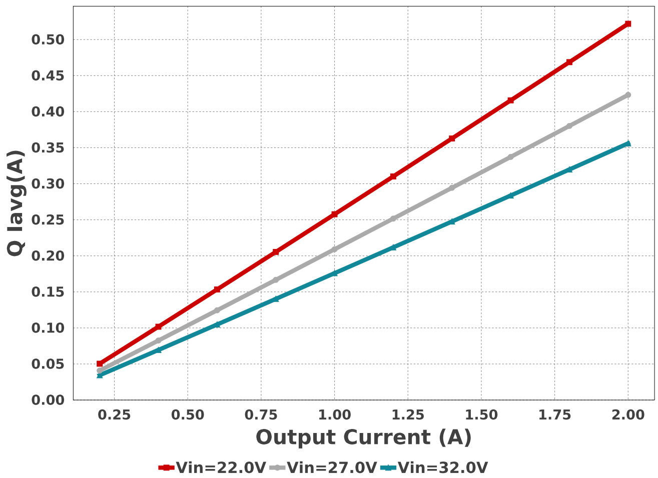


Electrical BOM

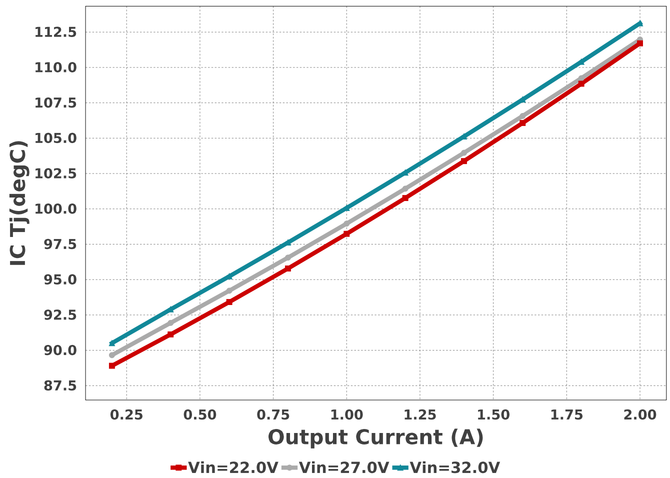
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cf	Samsung Electro-Mechanics	CL21C102JBCNNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	Panasonic	EEHZA1H101P Series= ZA	Cap= 100.0 uF ESR= 28.0 mOhm VDC= 50.0 V IRMS= 2.0 A	1	$1.43	 SM_RADIAL_10BMM 160 mm²
Cout	Chemi-Con	EMVY630GTR471MMH0S Series= MVY	Cap= 470.0 uF ESR= 120.0 mOhm VDC= 63.0 V IRMS= 905.0 mA	1	$1.54	 CAPSMT_62_MH0 441 mm²
D1	Diodes Inc.	B560C-13-F	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.19	 SMC 83 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	MSS1210-683MEB	L= 68.0 µH 68.0 mOhm	1	$0.81	 MSS1210 204 mm²
Rfb1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb2	Vishay-Dale	CRCW04023K24FKED Series= CRCW..e3	Res= 3.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM2596T-ADJ/NOPB	Switcher	1	$2.18	 TA05F 127 mm²

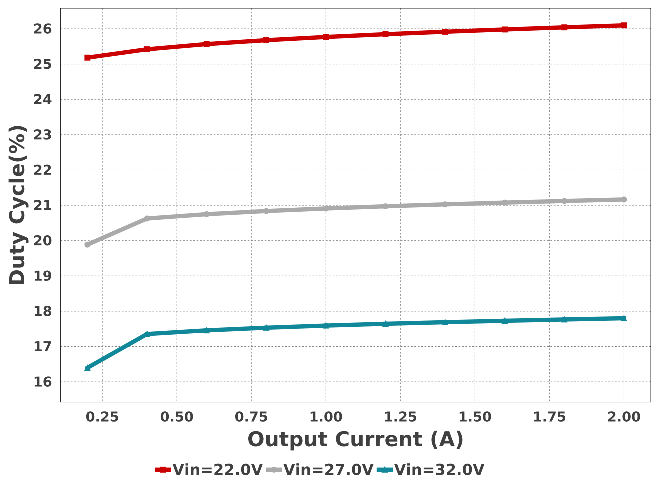
Q Iavg



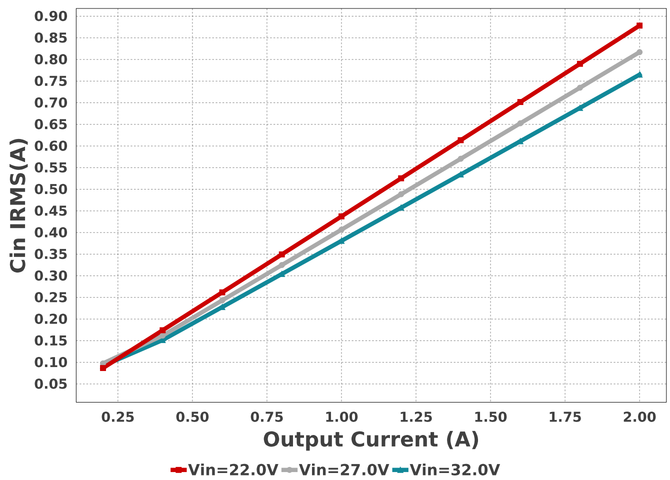
IC Tj

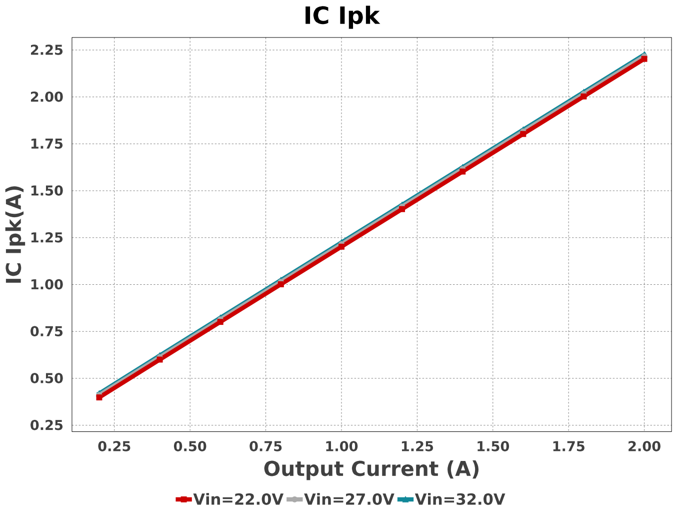


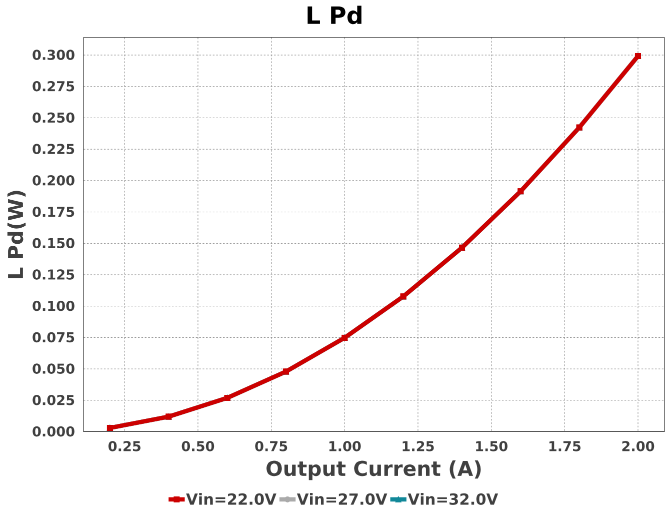
Duty Cycle

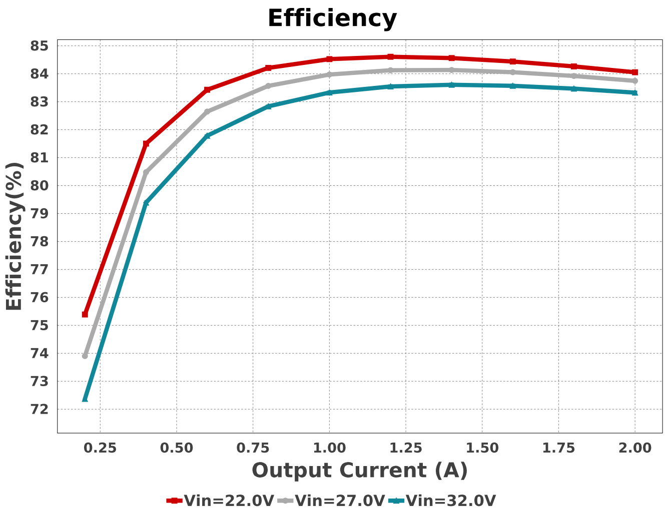


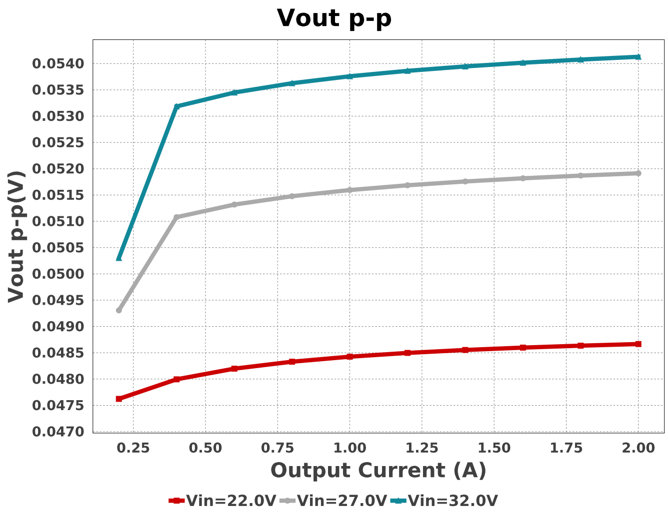
Cin IRMS

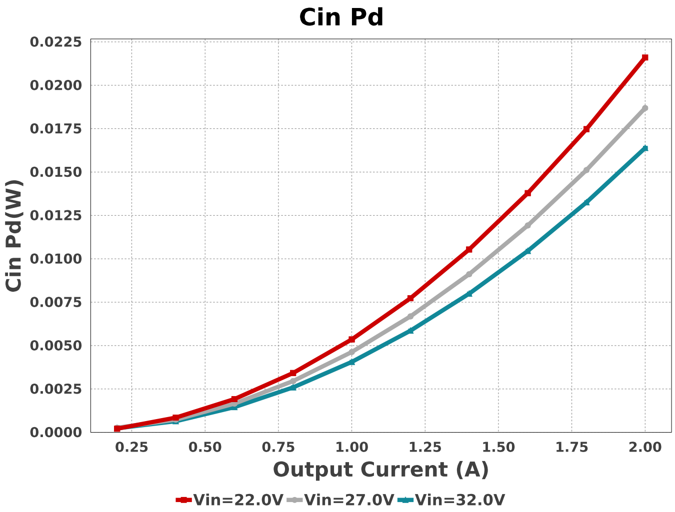


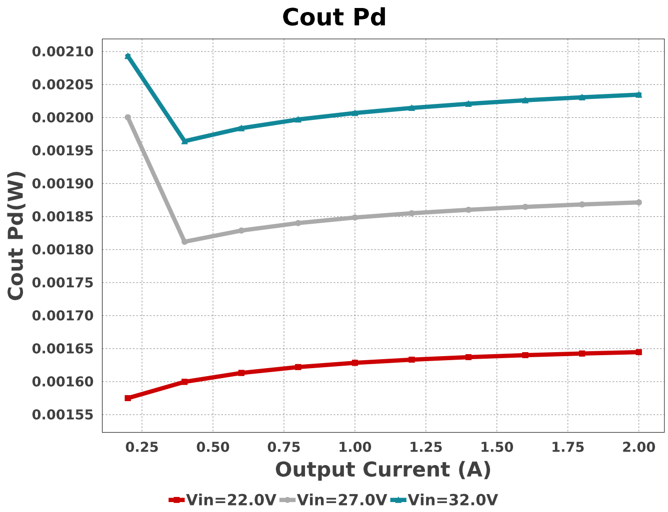

IC Ipk
IC Ipk(A)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

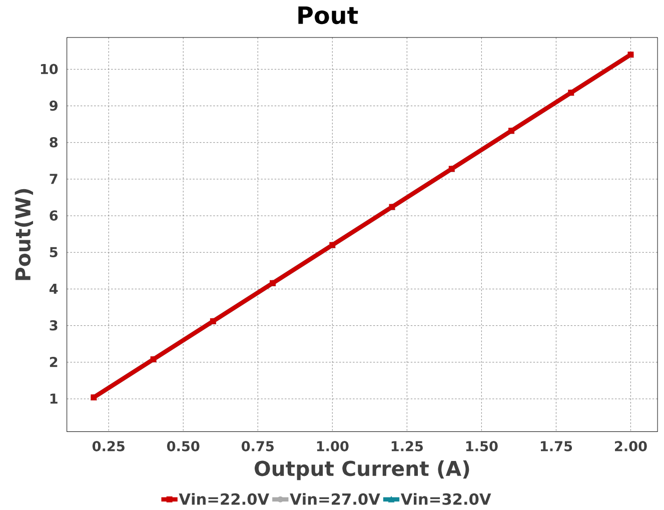

L Pd
L Pd(W)
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

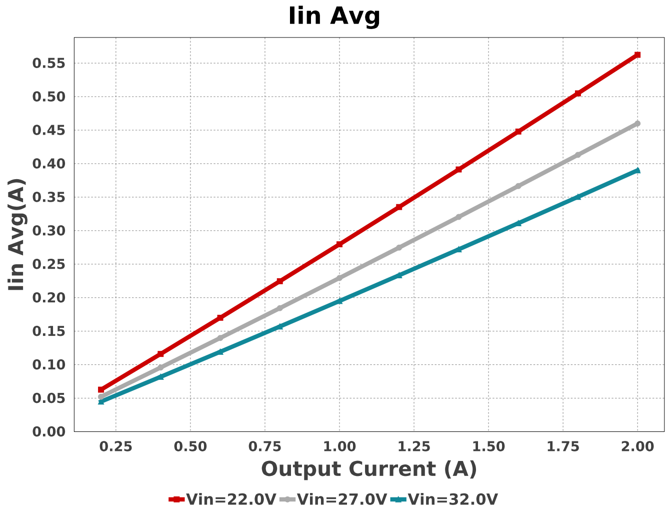

Efficiency
Efficiency(%)
85
84
83
82
81
80
79
78
77
76
75
74
73
72
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

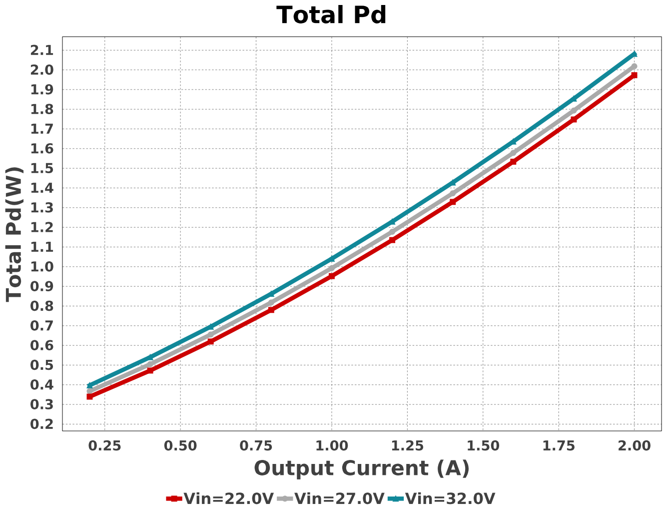

Vout p-p
Vout p-p(V)
0.0540
0.0535
0.0530
0.0525
0.0520
0.0515
0.0510
0.0505
0.0500
0.0495
0.0490
0.0485
0.0480
0.0475
0.0470
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

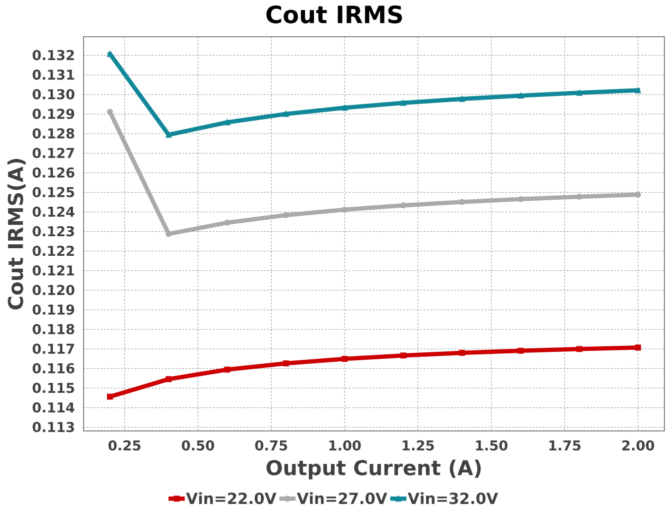

Cin Pd
Cin Pd(W)
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

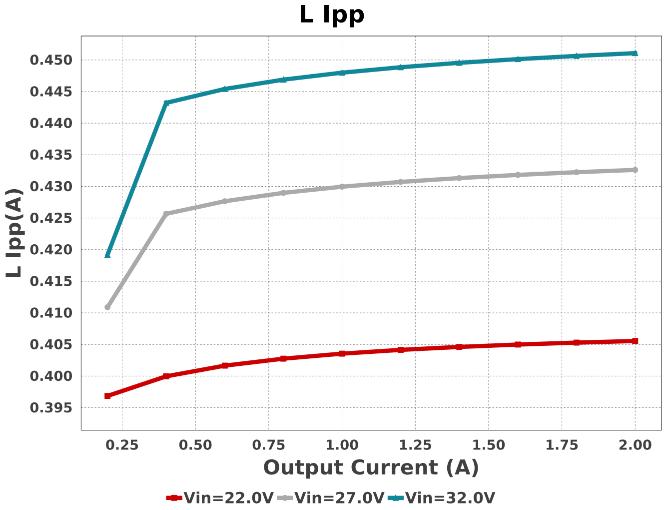

Cout Pd
Cout Pd(W)
0.00210
0.00205
0.00200
0.00195
0.00190
0.00185
0.00180
0.00175
0.00170
0.00165
0.00160
0.00155
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

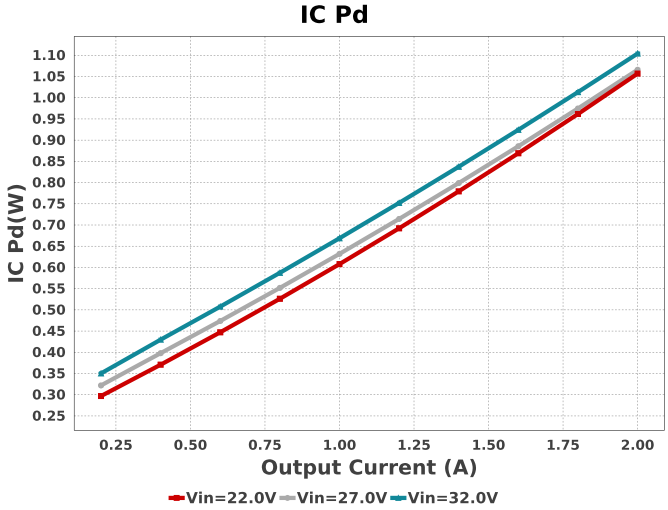

Pout
Pout(W)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

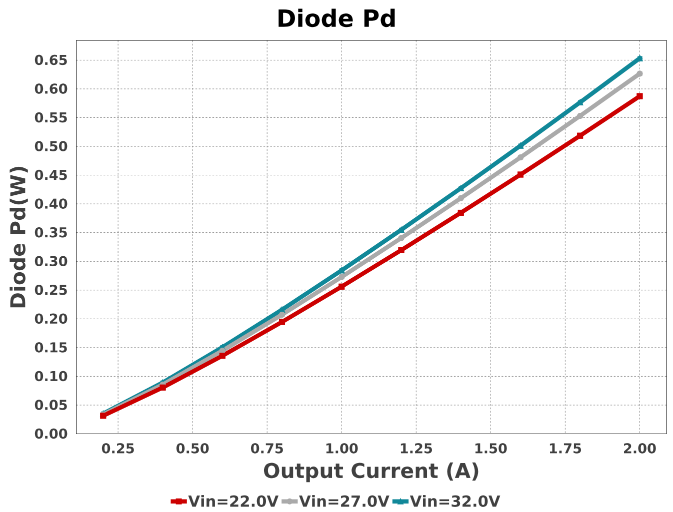

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V

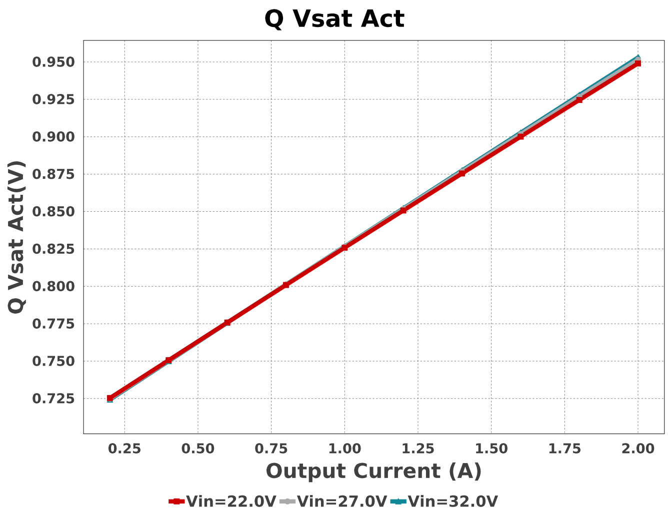

Total Pd
Total Pd(W)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=22.0V Vin=27.0V Vin=32.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	765.039 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	16.388 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	130.215 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	2.035 mW	Capacitor	Output capacitor power dissipation
5.	Diode Pd	653.26 mW	Diode	Diode power dissipation
6.	IC Ipk	2.226 A	IC	Peak switch current in IC
7.	IC Pd	1.104 W	IC	IC power dissipation
8.	IC Tj	113.121 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	390.04 mA	IC	Average input current
12.	L Ipp	451.08 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	299.2 mW	Inductor	Inductor power dissipation
14.	Q Iavg	356.017 mA	Mosfet	Q Iavg
15.	Cin Pd	16.388 mW	Power	Input capacitor power dissipation
16.	Cout Pd	2.035 mW	Power	Output capacitor power dissipation
17.	Diode Pd	653.26 mW	Power	Diode power dissipation
18.	IC Pd	1.104 W	Power	IC power dissipation
19.	L Pd	299.2 mW	Power	Inductor power dissipation
20.	Total Pd	2.081 W	Power	Total Power Dissipation
21.	BOM Count	8	System Information	Total Design BOM count
22.	Cross Freq	22.909 kHz	System Information	Bode plot crossover frequency
23.	Duty Cycle	17.801 %	System Information	Duty cycle
24.	Efficiency	83.325 %	System Information	Steady state efficiency
25.	FootPrint	1.029 k mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	150.0 kHz	System Information	Switching frequency
27.	Iout	2.0 A	System Information	Iout operating point
28.	Mode	CCM	System Information	Conduction Mode
29.	Phase Marg	99.696 deg	System Information	Bode Plot Phase Margin
30.	Pout	10.4 W	System Information	Total output power
31.	Total BOM	$6.18	System Information	Total BOM Cost
32.	Vin	32.0 V	System Information	Vin operating point
33.	Vout Actual	5.215 V	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	1.544 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	54.129 mV	System Information	Peak-to-peak output ripple voltage
36.	Q Vsat Act	952.976 mV	Transistor	Q Vsat

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	32.0	Maximum input voltage
VinMin	22.0	Minimum input voltage
Vout	5.2	Output Voltage
base_pn	LM2596	Base Product Number
source	DC	Input Source Type
Ta	80.0	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

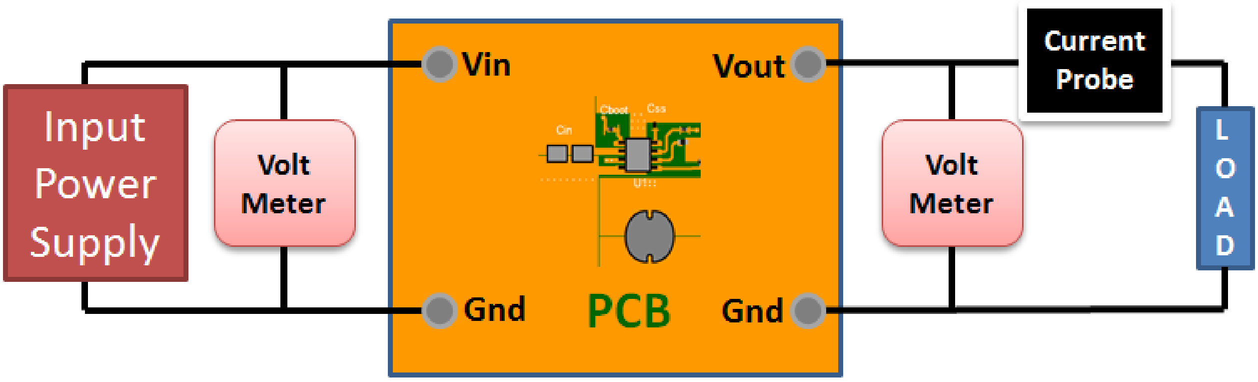
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 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. Master key : D329269B5F955765FD591E4DA19DD2A9[v1]

2. **LM2596** Product Folder : http://www.ti.com/product/LM2596 : contains the data sheet and other resources.