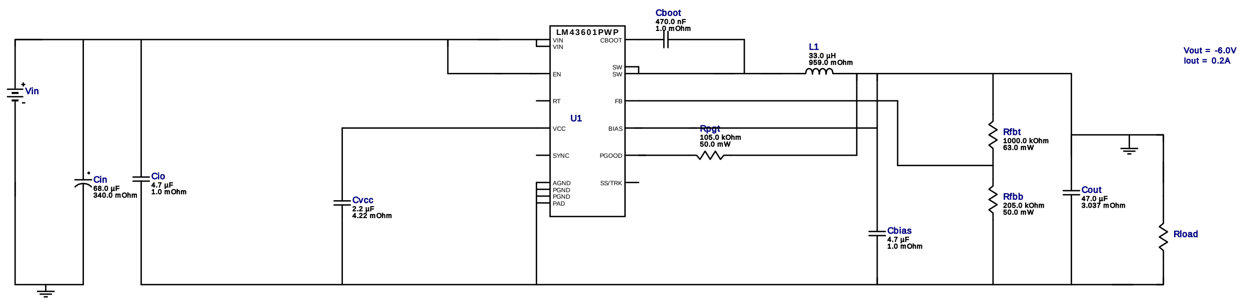
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 10.0V
VinMax = 22.0V
Vout = -6.0V
Iout = 0.2A

Device = LM43601PWPR
Topology = Inverting_Buck_Boost
Created = 2024-11-18 17:03:32.722
BOM Cost = $2.27
BOM Count = 11
Total Pd = 0.07W

Design : 6 LM43601PWPR
LM43601PWPR 10V-22V to -6.00V @ 0.2A

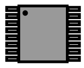


1. The input capacitor included in the BOM only contains a small filter capacitor that should be placed near the IC. Depending on where the power supply is laid out in the system additional bulk capacitance may need to be added to filter the line ripple.

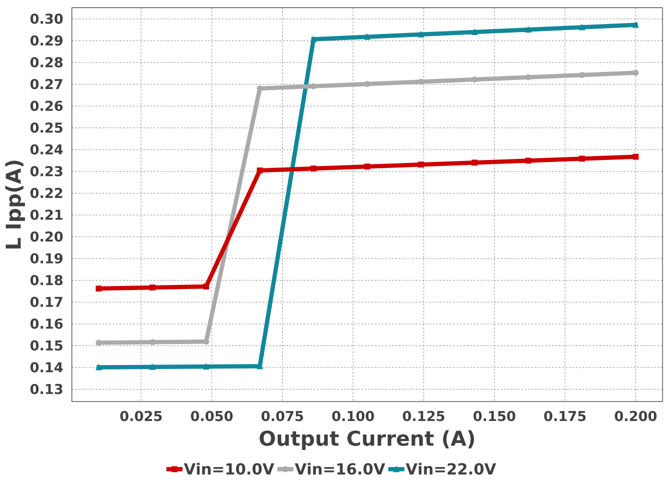
2. If there is no VinTyp specified, WEBENCH will use the VinMax value. To change the VinTyp value, click on the "Change Design Inputs" button under the Optimization Tuning knob. In some applications, while the design requires the input voltage to be a wide range, for a majority of the time, it is operating at a much lower voltage than the maximum input voltage. Sizing the inductor based on the maximum input voltage may yield an inductance much larger than typically needed, causing a larger footprint for the overall design. At the same time, components such as the input capacitor must be rated based on the maximum input voltage. WEBENCH now supports the use of this additional input voltage specification.

Electrical BOM

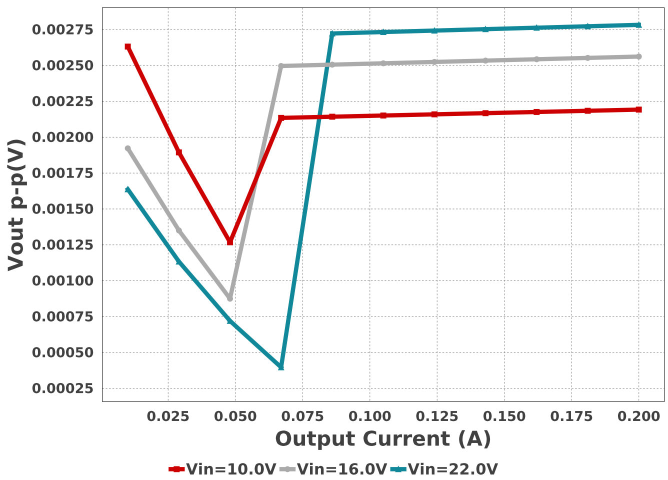
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Taiyo Yuden	LMK212B7475KG-T Series= X7R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Cboot	MuRata	GRM155R60J474KE19D Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	Nichicon	UUD1V680MCL1GS Series= uD	Cap= 68.0 uF ESR= 340.0 mOhm VDC= 35.0 V IRMS= 280.0 mA	1	$0.10	SM_RADIAL_6.3BMM 80 mm^2
Cio	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	1	$0.12	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	1	$0.17	1210_280 15 mm^2
Cvcc	MuRata	GRM21BR71A225KA01L Series= X7R	Cap= 2.2 uF ESR= 4.22 mOhm VDC= 10.0 V IRMS= 2.08454 A	1	$0.03	0805 7 mm^2
L1	Bourns	SRN3015-330M	L= 33.0 µH 959.0 mOhm	1	$0.22	SRN3015 16 mm^2
Rfbb	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpgt	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	LM43601PWPR	Switcher	1	$1.55	 PWP0016F 59 mm^2

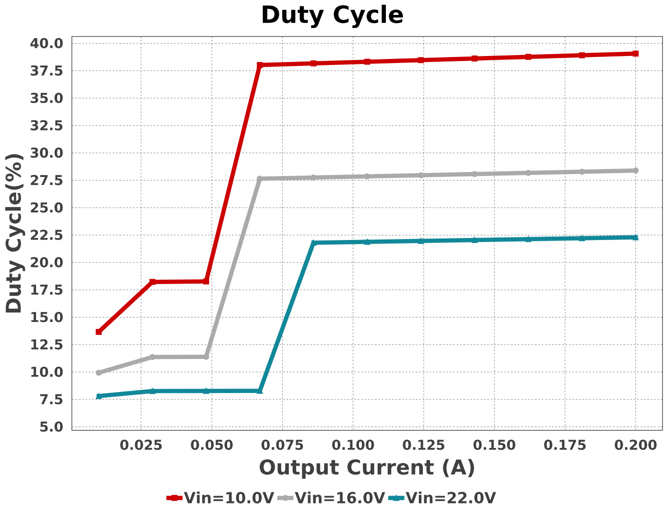
L Ipp



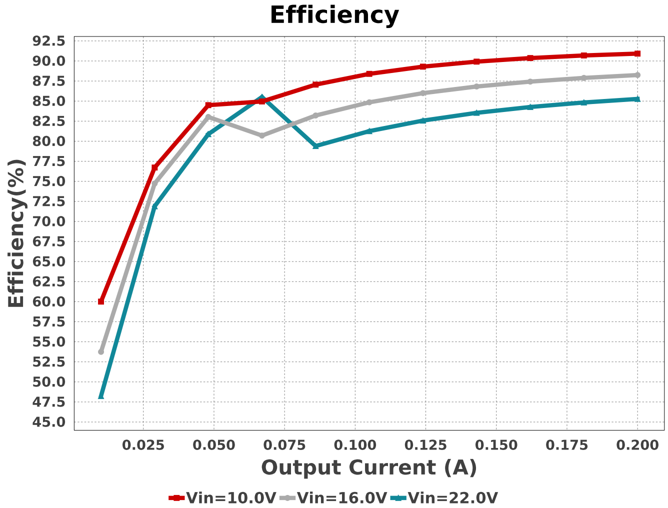
Vout p-p



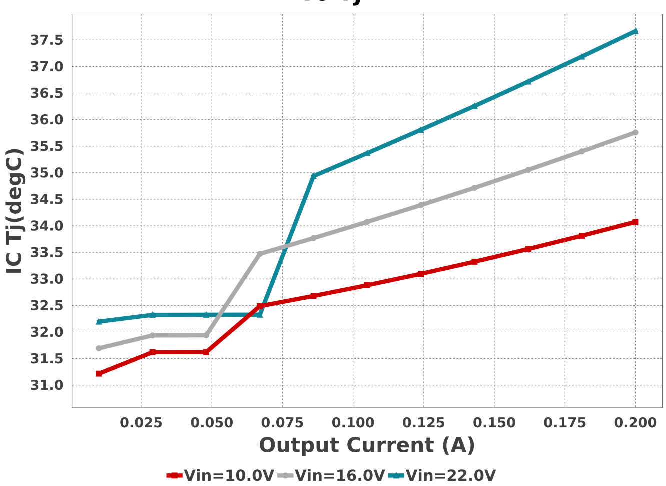
Duty Cycle



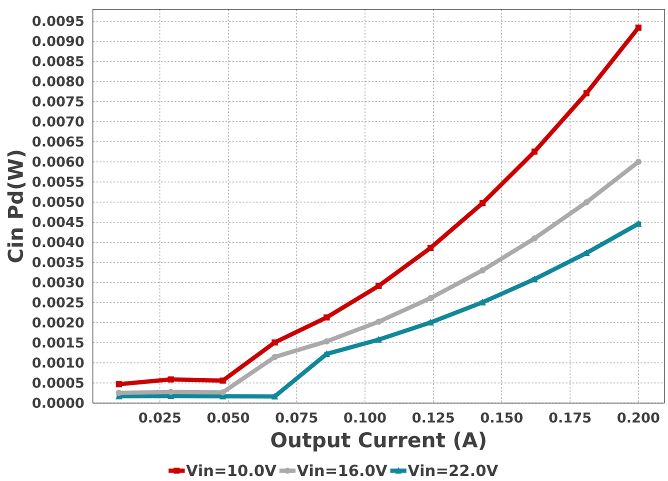
Efficiency

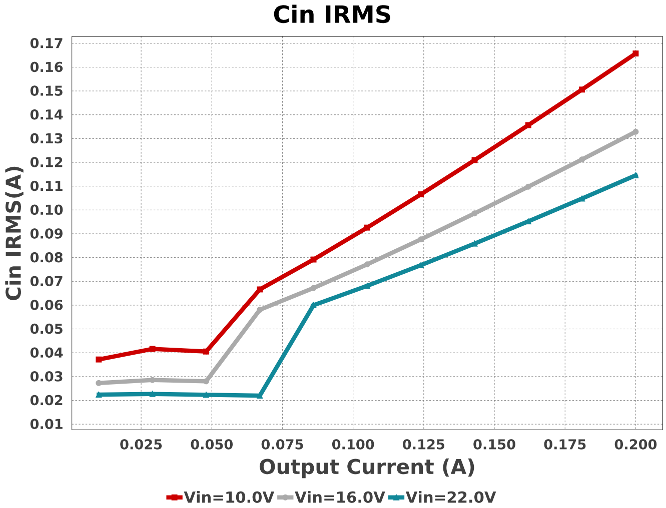


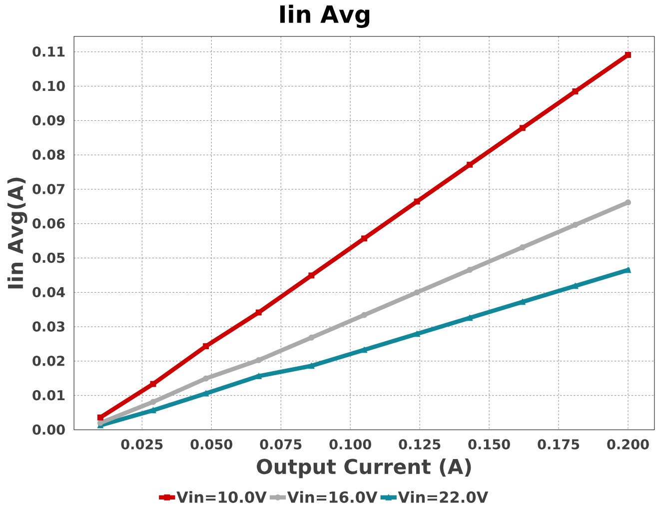
IC Tj

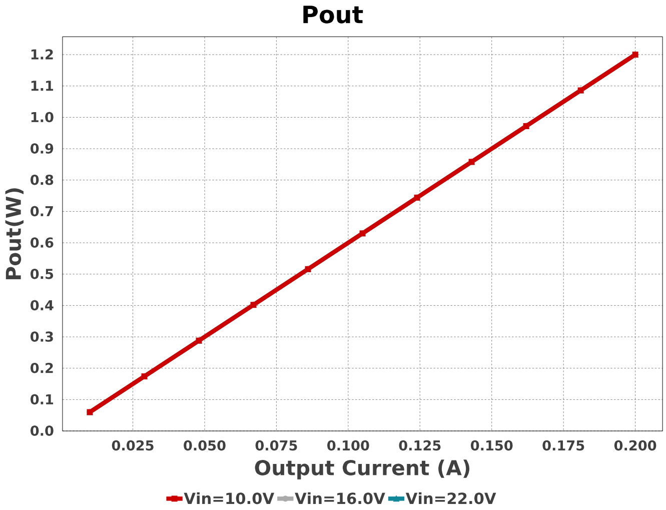


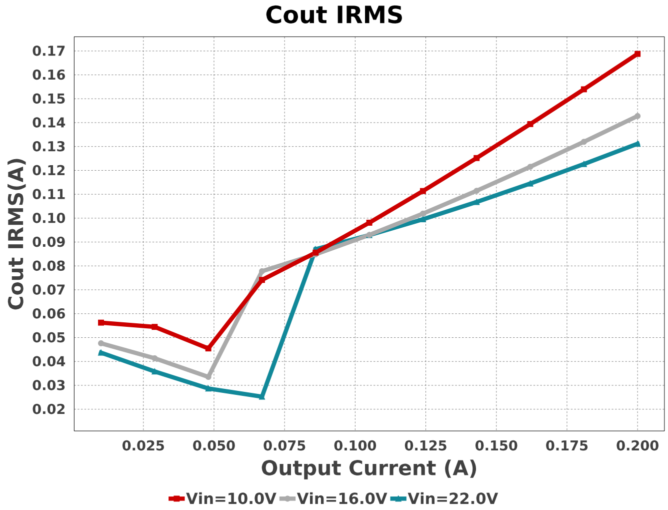
Cin Pd

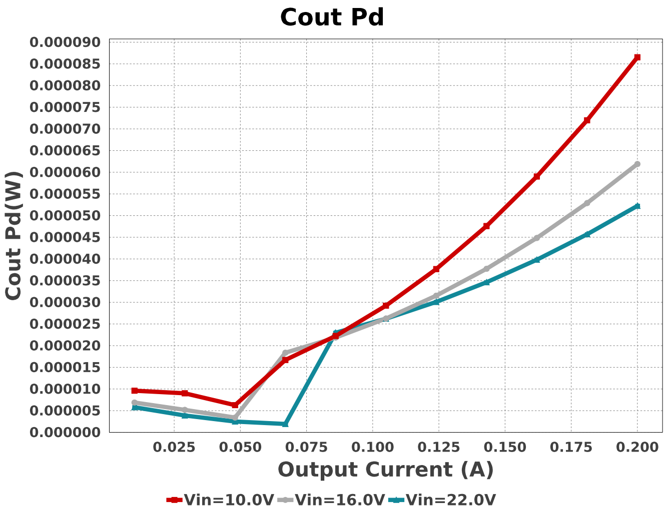


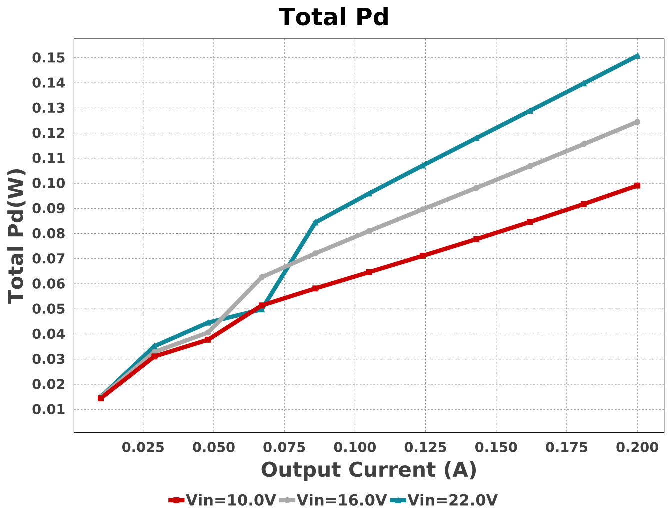

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

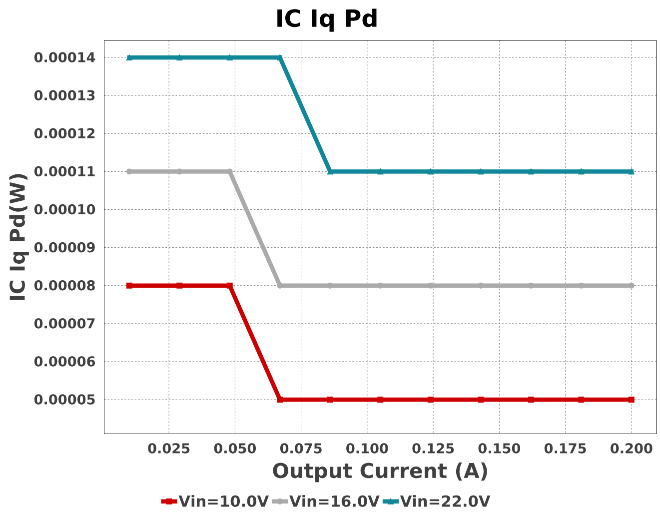

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

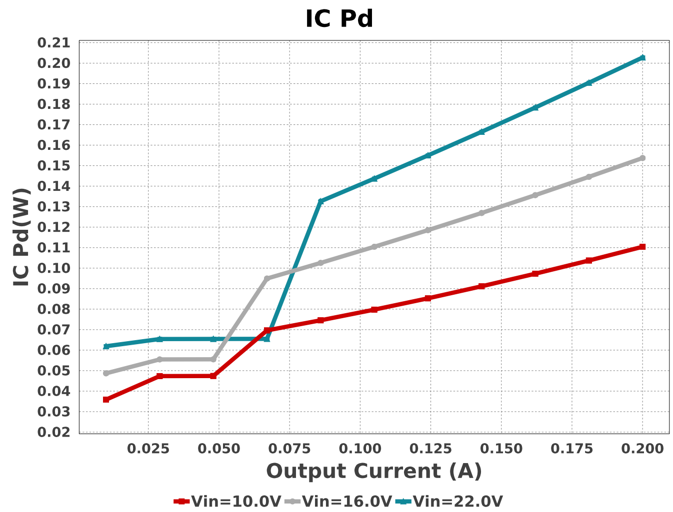

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

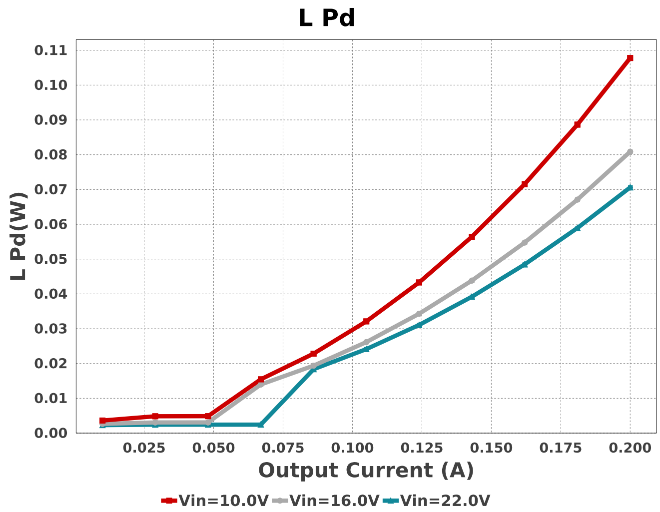

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

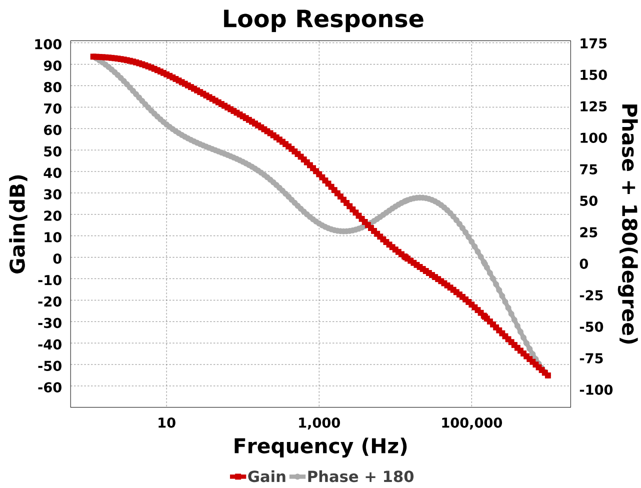

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V

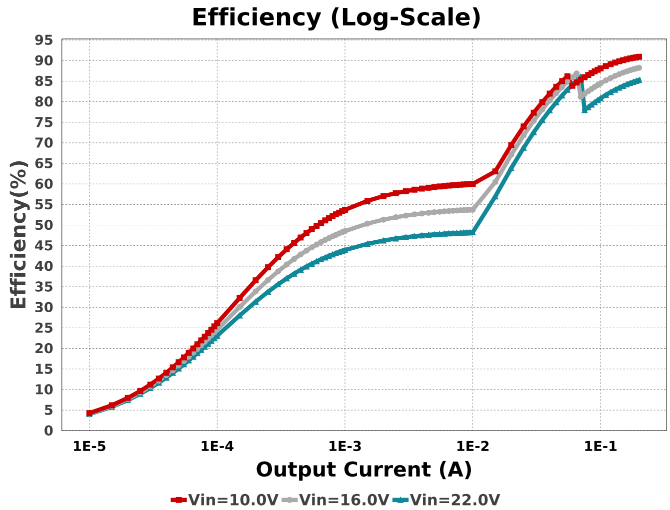

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=16.0V Vin=22.0V











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	11		Total Design BOM count
2.	Total BOM	$2.269		Total BOM Cost
3.	Cin IRMS	114.544 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	4.461 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	131.153 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	52.24 µW	Capacitor	Output capacitor power dissipation
7.	IC Iq Pd	110.0 µW	IC	IC Iq Pd
8.	IC Pd	202.76 mW	IC	IC power dissipation
9.	IC Tj	37.666 degC	IC	IC junction temperature
10.	ICThetaJA	38.9 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	46.511 mA	IC	Average input current

#	Name	Value	Category	Description
12.	L Ipp	297.293 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	70.597 mW	Inductor	Inductor power dissipation
14.	Cin Pd	4.461 mW	Power	Input capacitor power dissipation
15.	Cout Pd	52.24 µW	Power	Output capacitor power dissipation
16.	IC Pd	202.76 mW	Power	IC power dissipation
17.	L Pd	70.597 mW	Power	Inductor power dissipation
18.	Total Pd	68.515 mW	Power	Total Power Dissipation
19.	Cross Freq	13.664 kHz	System Information	Bode plot crossover frequency
20.	Duty Cycle	22.297 %	System Information	Duty cycle
21.	Efficiency	85.269 %	System Information	Steady state efficiency
22.	FootPrint	200.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	500.0 kHz	System Information	Switching frequency
24.	Gain Marg	-27.732 dB	System Information	Bode Plot Gain Margin
25.	Iout	200.0 mA	System Information	Iout operating point
26.	Low Freq Gain	93.543 dB	System Information	Gain at 1Hz
27.	Mode	CCM	System Information	Conduction Mode
28.	Phase Marg	50.083 deg	System Information	Bode Plot Phase Margin
29.	Pout	1.2 W	System Information	Total output power
30.	Vin	10.0 V	System Information	Vin operating point
31.	Vout	-6.0 V	System Information	Operational Output Voltage
32.	Vout Actual	5.972 V	System Information	Vout Actual calculated based on selected voltage divider resistors
33.	Vout Tolerance	3.978 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
34.	Vout p-p	2.783 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	22.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	-6.0	Output Voltage
base_pn	LM43601	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 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

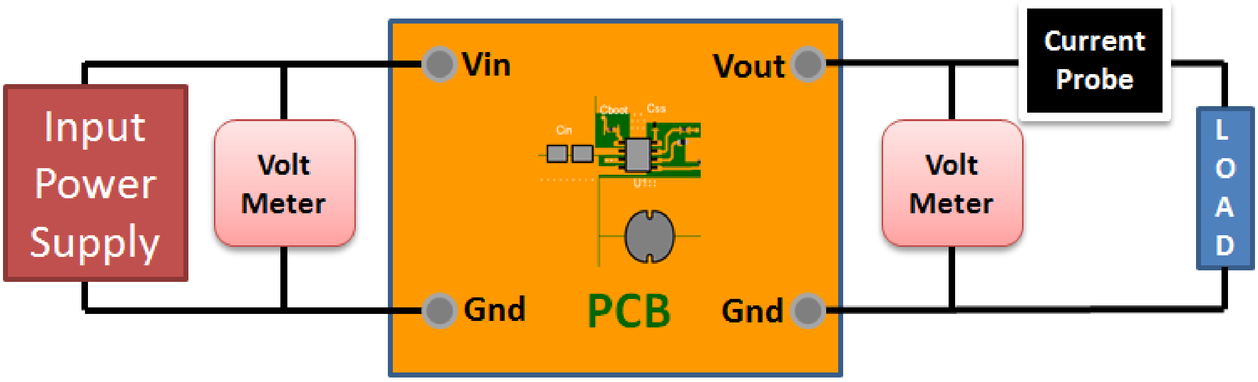
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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 : C6AE7176C9723757[v1]

2. **LM43601** Product Folder : http://www.ti.com/product/LM43601 : contains the data sheet and other resources.

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