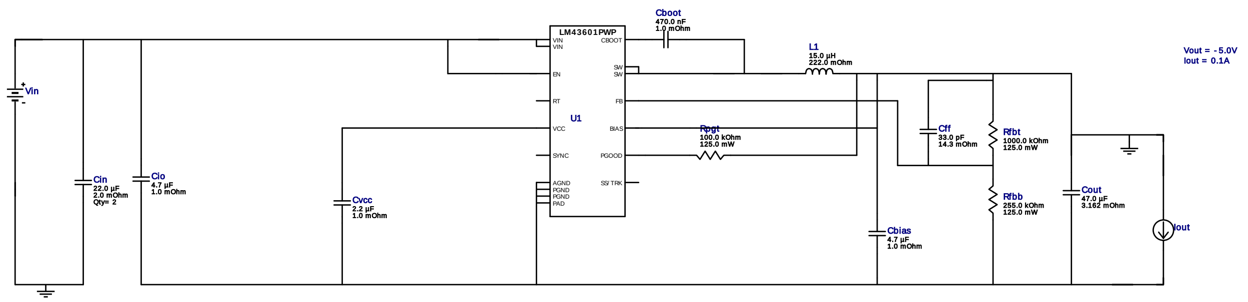
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 4.0V
VinMax = 12.0V
Vout = -5.0V
Iout = 0.1A

Device = LM43601PWPR
Topology = Inverting_Buck_Boost
Created = 2019-11-08 12:55:11.601
BOM Cost = $3.80
BOM Count = 13
Total Pd = 0.01W

Design : 8 LM43601PWPR
LM43601PWPR 4V-12V to -5.00V @ 0.1A



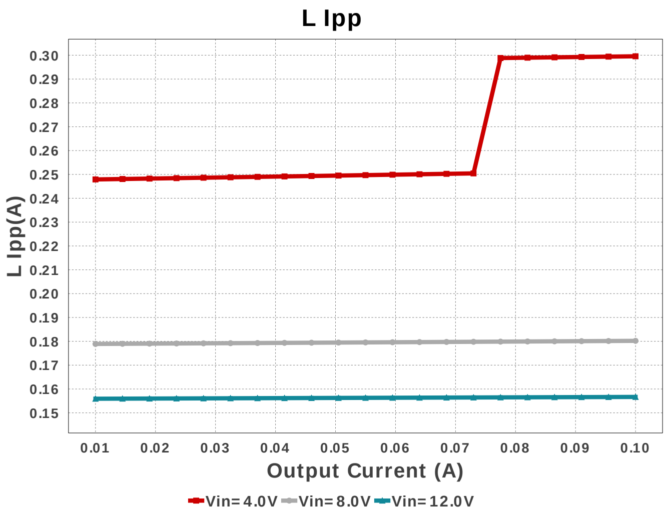
1. The input capacitor included in the BOM only contains a small filter capacitor that should be placed near the IC. Depending on where the power supply is laid out in the system additional bulk capacitance may need to be added to filter the line ripple.

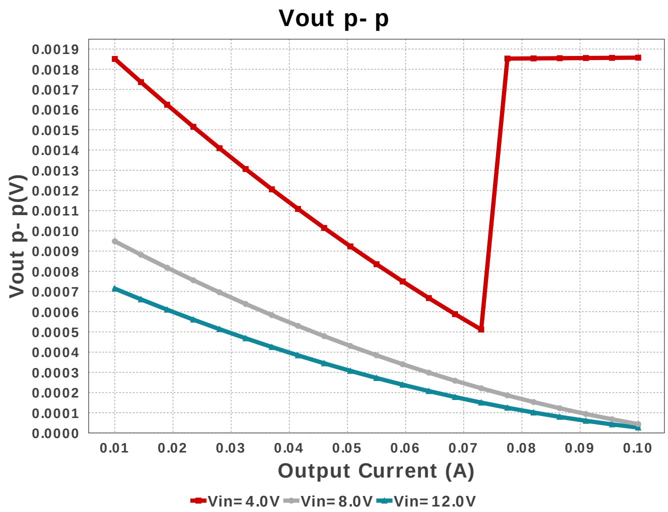
2. If there is no VinTyp specified, WEBENCH will use the VinMax value. To change the VinTyp value, click on the "Change Design Inputs" button under the Optimization Tuning knob. In some applications, while the design requires the input voltage to be a wide range, for a majority of the time, it is operating 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.

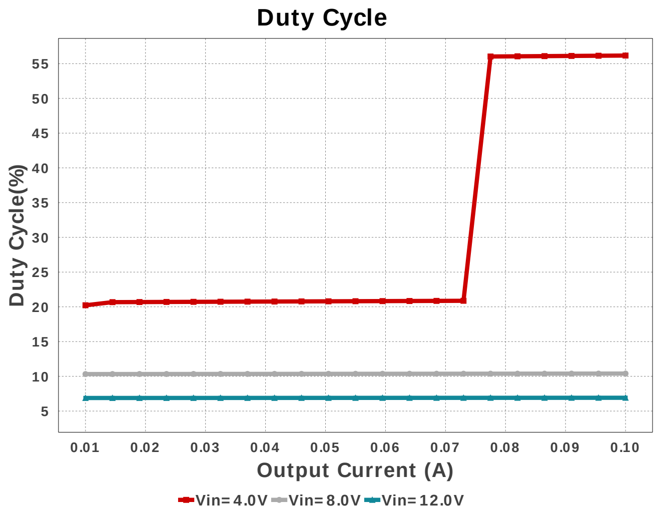
Electrical BOM

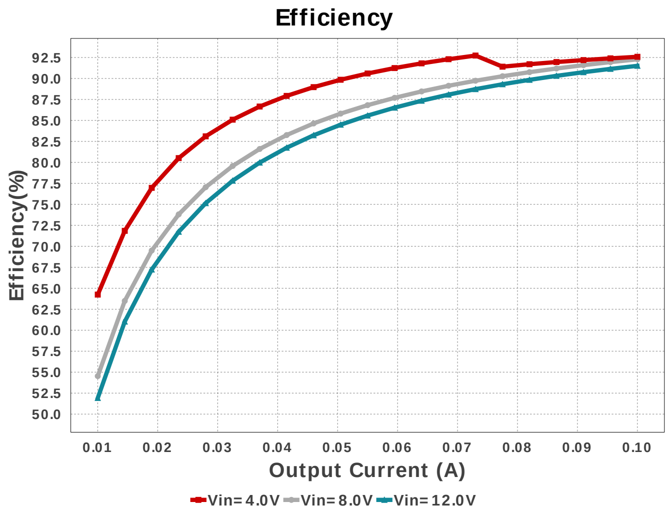
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Taiyo Yuden	LMK212BJ475KD-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cboot	Taiyo Yuden	TMK212BJ474KD-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 20.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
Cff	Kemet	C0805C330J5GACTU Series= C0G/NP0	Cap= 33.0 pF ESR= 14.3 mOhm VDC= 50.0 V IRMS= 656.0 mA	1	$0.01	0805 7 mm^2
Cin	MuRata	GRM32ER61C226ME20L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 16.0 V IRMS= 3.68 A	2	$0.55	1210 15 mm^2
Cio	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
Cout	TDK	CGA9N3X7R1C476M230KB Series= X7R	Cap= 47.0 uF ESR= 3.162 mOhm VDC= 16.0 V IRMS= 5.1344 A	1	$0.74	2220_250 54 mm^2
Cvcc	Taiyo Yuden	EMK212BJ225KG-T Series= X5R	Cap= 2.2 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
L1	Vishay-Dale	IFSC1515AHER150M01	L= 15.0 µH 222.0 mOhm	1	$0.19	ELL6RH 67 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Panasonic	ERJ-6ENF2553V Series= ERJ-6E	Res= 255.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbt	Vishay-Dale	CRCW08051M00FKEA Series= CRCW..e3	Res= 1000.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rpgt	Vishay-Dale	CRCW0805100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	LM43601PWPR	Switcher	1	$1.60	PWP0016F 59 mm^2

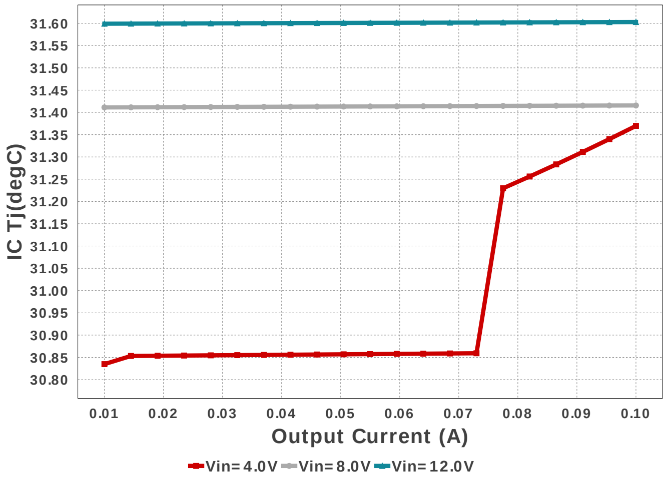




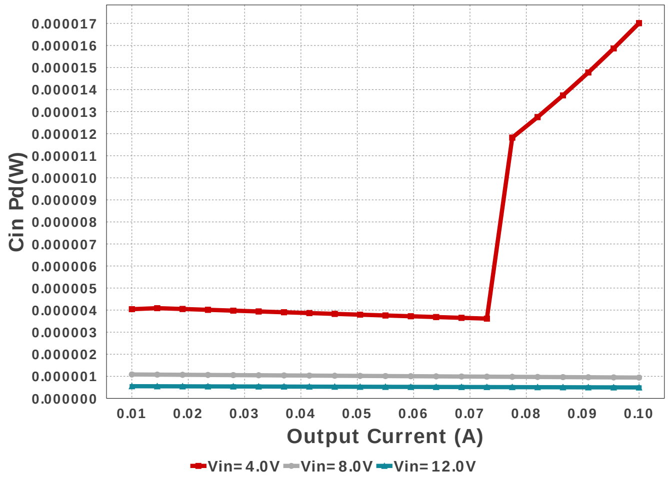




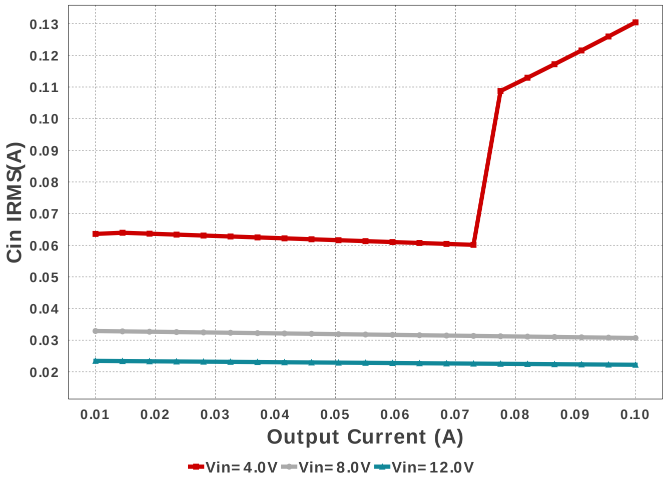
IC Tj



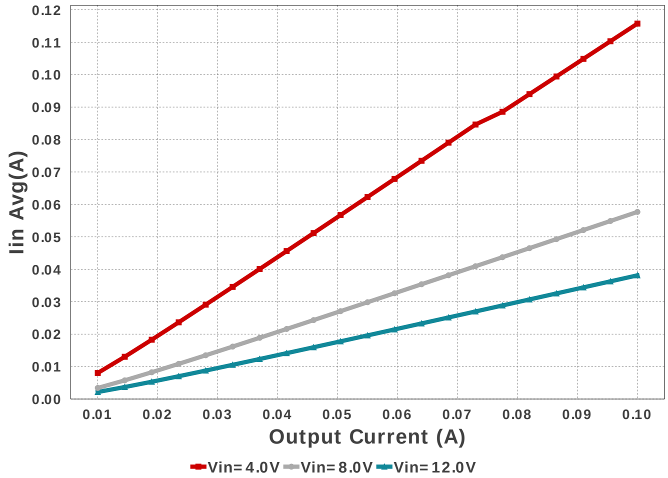
Cin Pd



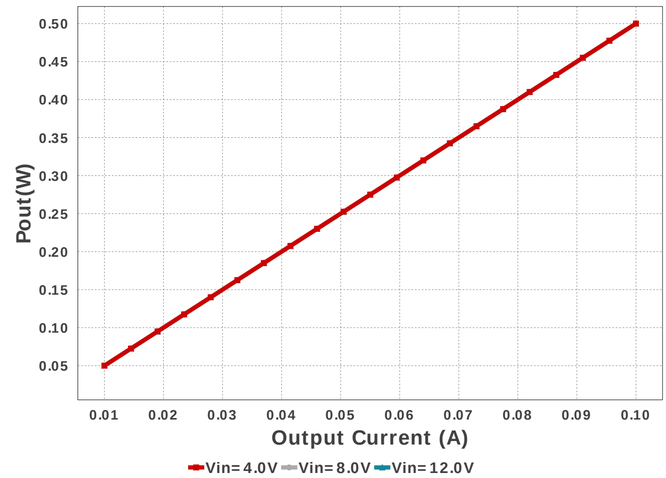
Cin IRMS



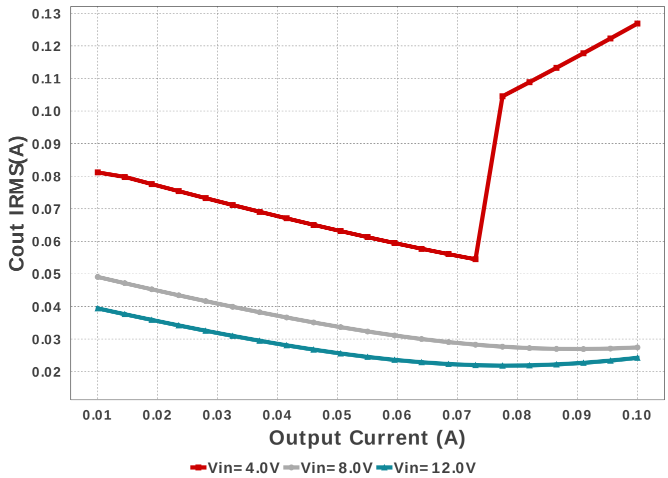
Iin Avg

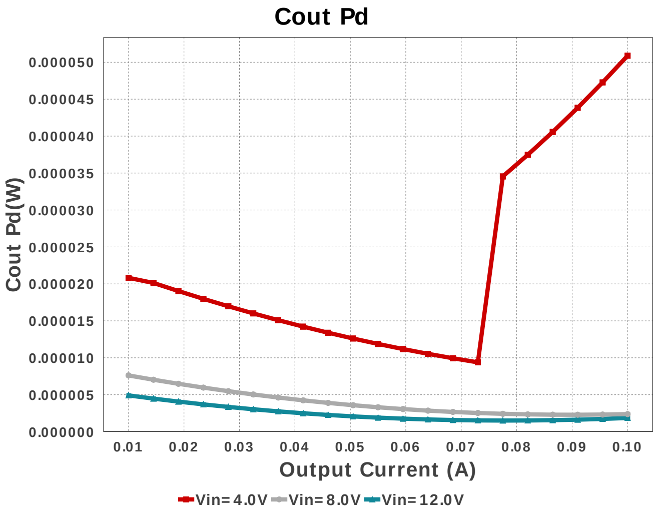


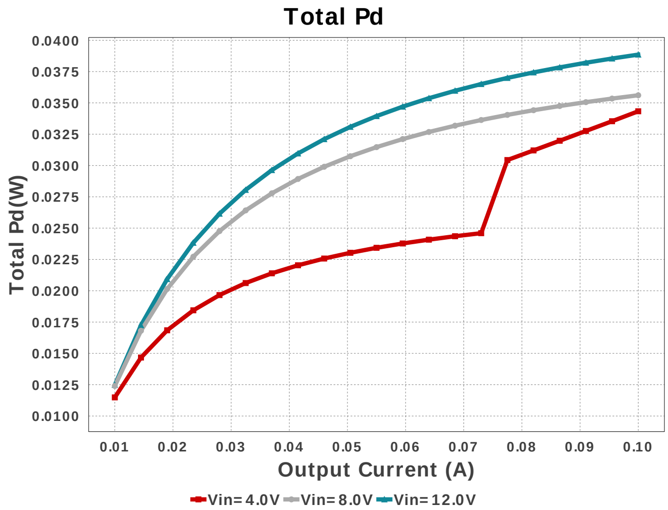
Pout

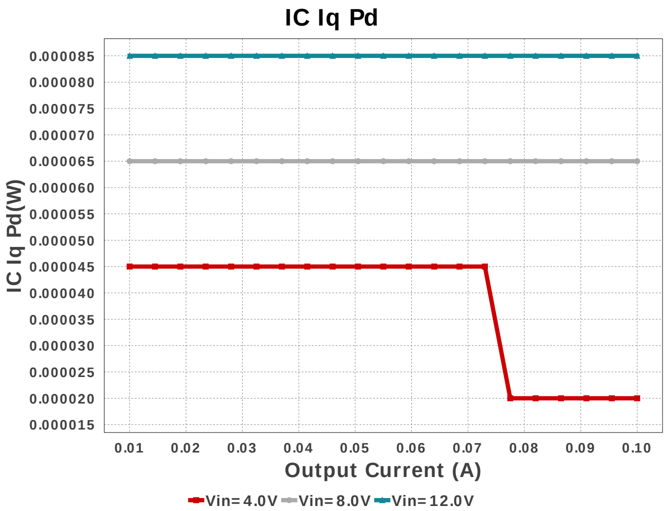


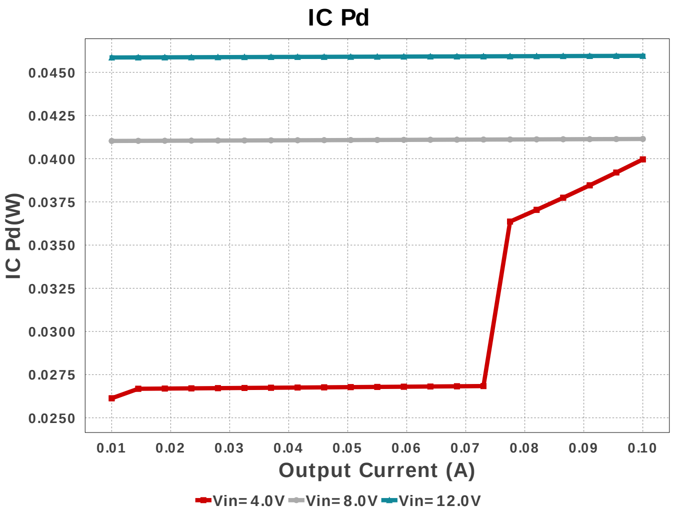
Cout IRMS

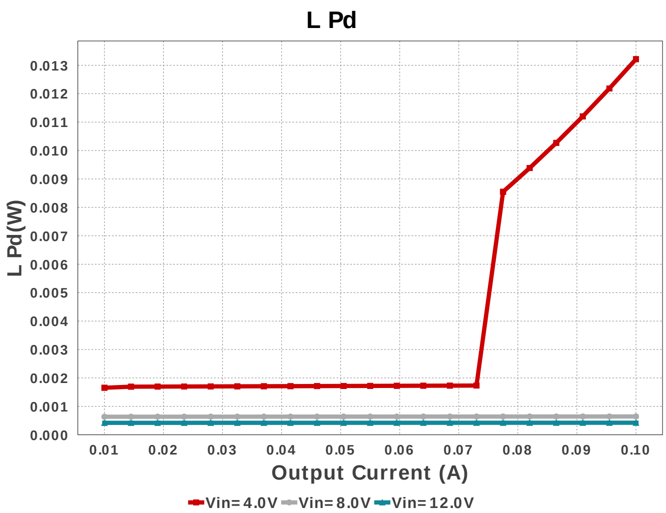


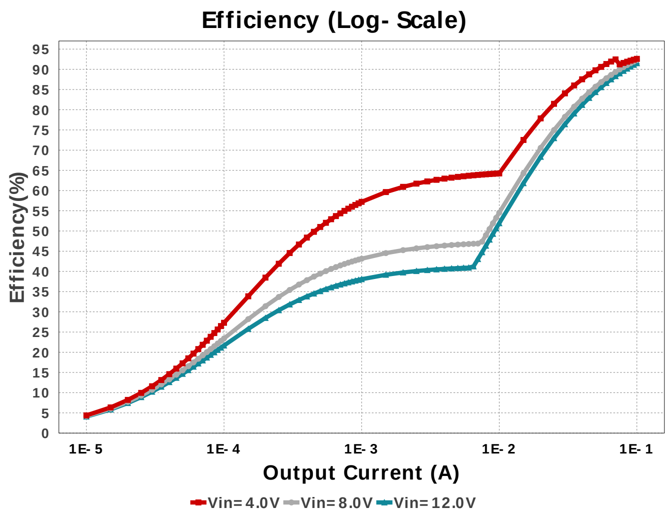












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	13		Total Design BOM count
2.	Total BOM	$3.8		Total BOM Cost
3.	Cin IRMS	22.226 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	493.98 nW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	24.229 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	1.856 µW	Capacitor	Output capacitor power dissipation
7.	IC Iq Pd	85.0 µW	IC	IC Iq Pd
8.	IC Pd	45.955 mW	IC	IC power dissipation
9.	IC Tj	31.603 degC	IC	IC junction temperature
10.	ICThetaJA	38.9 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	38.128 mA	IC	Average input current

#	Name	Value	Category	Description
12.	L Ipp	156.67 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	423.99 µW	Inductor	Inductor power dissipation
14.	Cin Pd	493.98 nW	Power	Input capacitor power dissipation
15.	Cout Pd	1.856 µW	Power	Output capacitor power dissipation
16.	IC Pd	45.955 mW	Power	IC power dissipation
17.	L Pd	423.99 µW	Power	Inductor power dissipation
18.	Total Pd	12.951 mW	Power	Total Power Dissipation
19.	Duty Cycle	6.912 %	System Information	Duty cycle
20.	Efficiency	91.508 %	System Information	Steady state efficiency
21.	FootPrint	263.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	500.0 kHz	System Information	Switching frequency
23.	Iout	100.0 mA	System Information	Iout operating point
24.	Mode	PFM	System Information	Conduction Mode
25.	Pout	500.0 mW	System Information	Total output power
26.	Vin	4.0 V	System Information	Vin operating point
27.	Vout	-5.0 V	System Information	Operational Output Voltage
28.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
29.	Vout Tolerance	3.91 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
30.	Vout p-p	26.884 µV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	100.0 m	Maximum Output Current
VinMax	12.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
VinTyp	5.0	Typical input voltage
Vout	-5.0	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

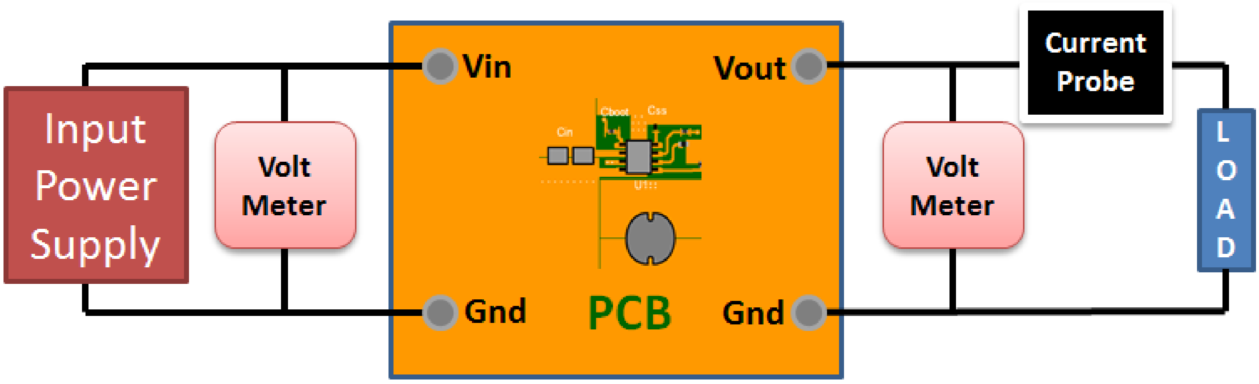
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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 : 2128C7AEB785B442[v1]

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

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