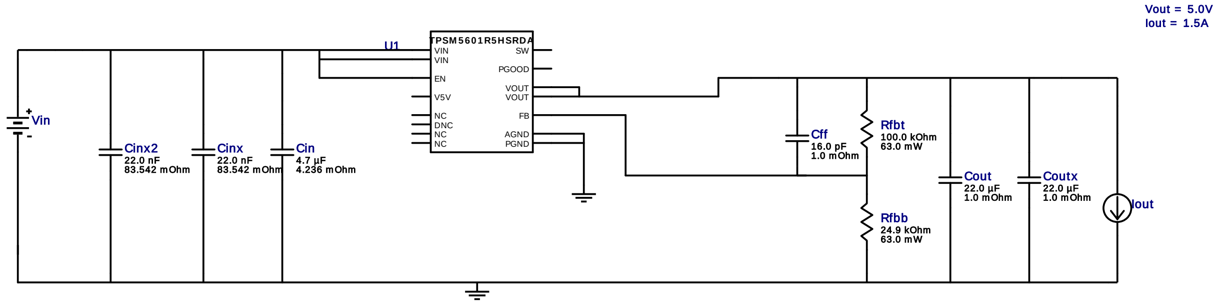
VinMin = 6.6V
VinMax = 60.0V
Vout = 5.0V
Iout = 1.5A

Device = TPSM5601R5HSRDAR
Topology = Buck
Created = 2022-02-09 04:30:12.978
BOM Cost = $3.68
BOM Count = 9
Total Pd = 2.41W

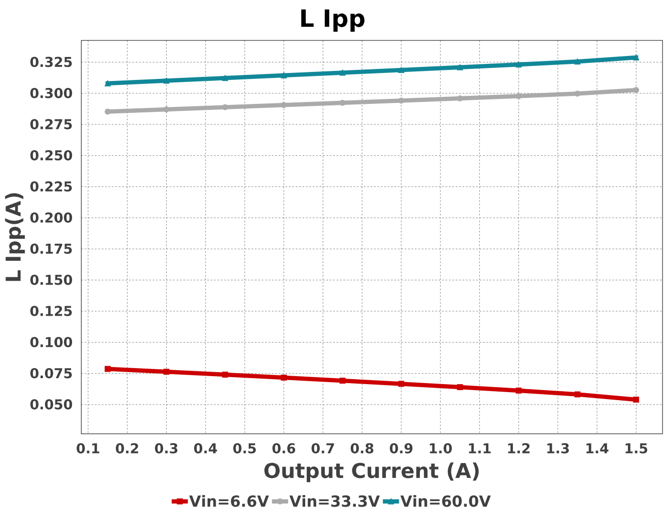
WEBENCH ® Design Report

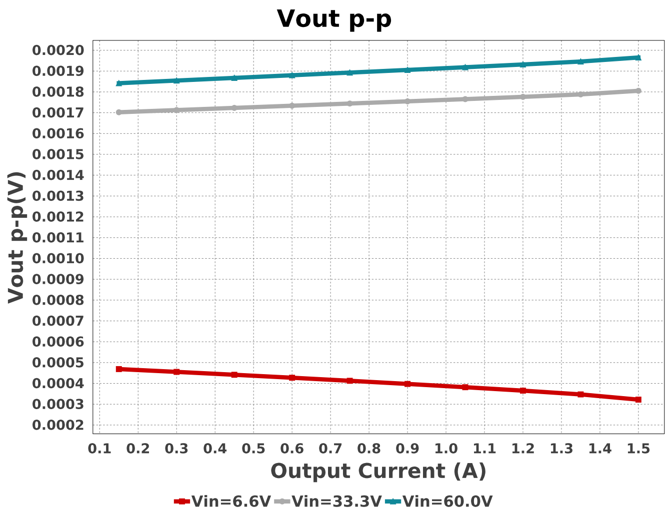
Design : 35 TPSM5601R5HSRDAR
TPSM5601R5HSRDAR 6.6V-60V to 5.00V @ 1.5A

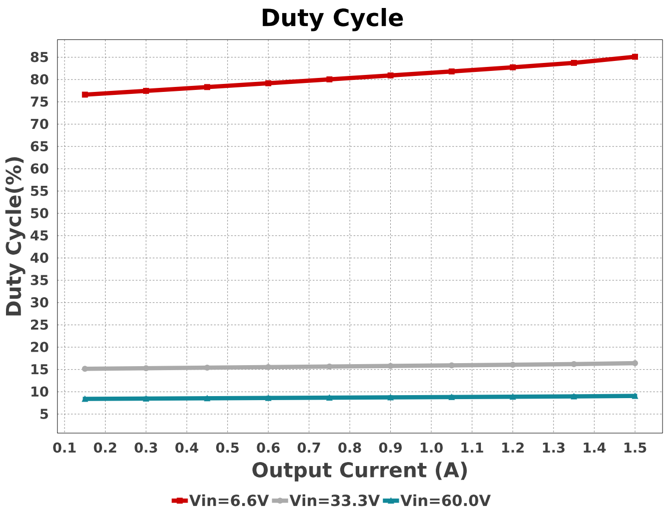


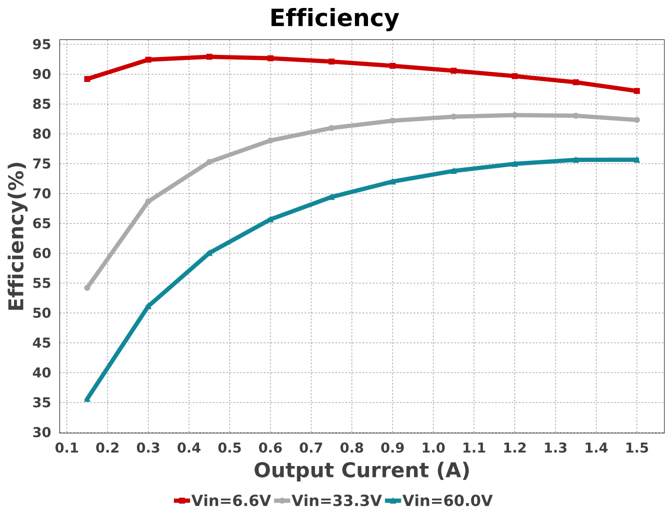
Electrical BOM

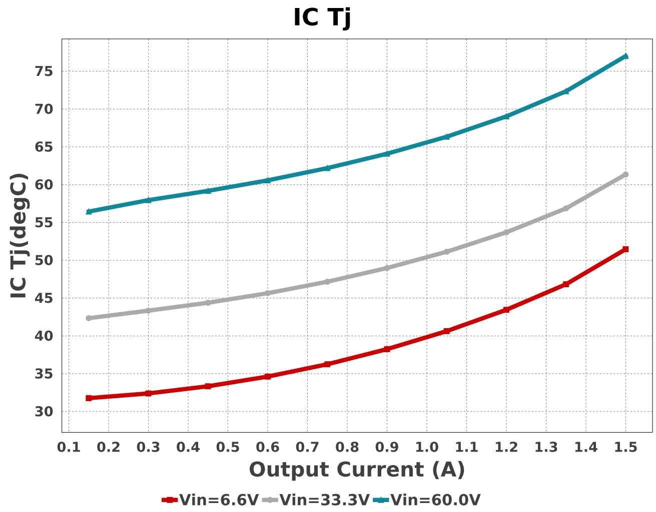
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cff	MuRata	GRM1555C1H160JA01D Series= C0G/NP0	Cap= 16.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	CGA6M3X7S2A475K200AB Series= X7S	Cap= 4.7 uF ESR= 4.236 mOhm VDC= 100.0 V IRMS= 3.57337 A	1	$0.47	1210_220 15 mm²
Cinx	TDK	CGA3E2X7R2A223K080AA Series= X7R	Cap= 22.0 nF ESR= 83.542 mOhm VDC= 100.0 V IRMS= 609.31 mA	1	$0.02	0603 5 mm²
Cinx2	TDK	CGA3E2X7R2A223K080AA Series= X7R	Cap= 22.0 nF ESR= 83.542 mOhm VDC= 100.0 V IRMS= 609.31 mA	1	$0.02	0603 5 mm²
Cout	MuRata	GRM21BD70J226ME44L Series= X7T	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.10	0805 7 mm²
Coutx	MuRata	GRM21BD70J226ME44L Series= X7T	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.10	0805 7 mm²
Rfbb	Vishay-Dale	CRCW040224K9FKED Series= CRCW..e3	Res= 24.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPSM5601R5HSRDAR	Switcher	1	$2.94	RDA0015A 52 mm²

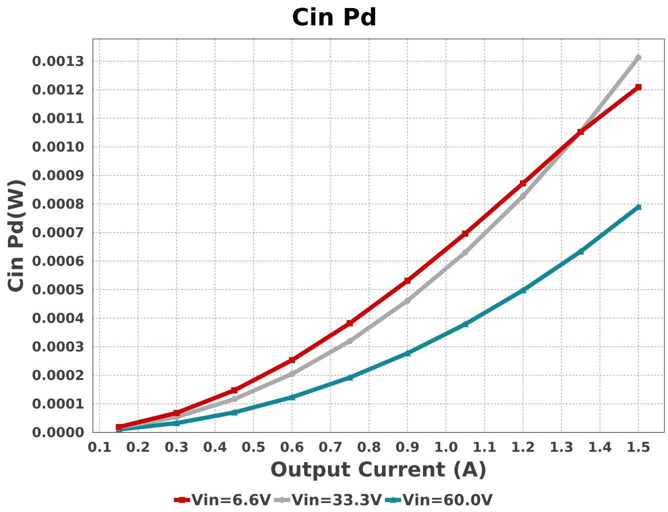

L Ipp
L Ipp(A)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

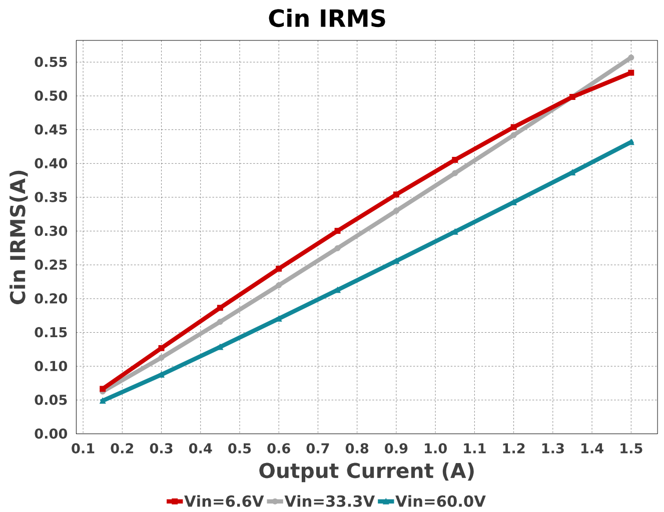

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

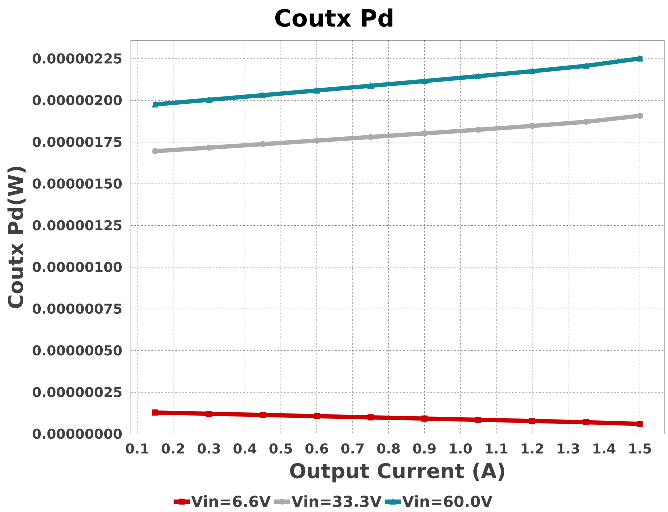

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

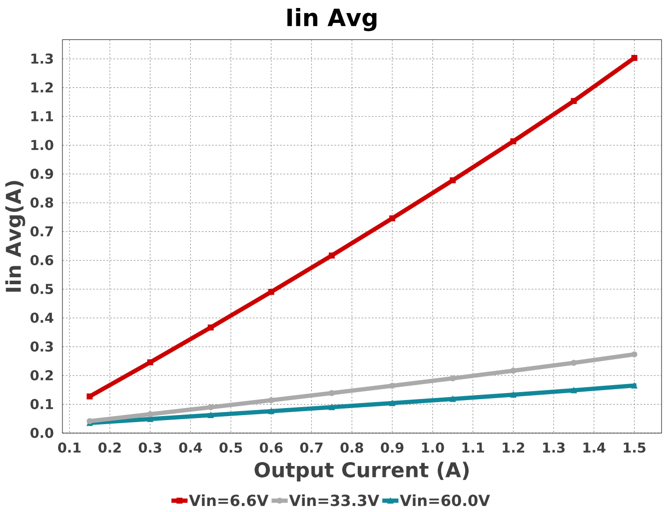

Efficiency
Efficiency(%)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

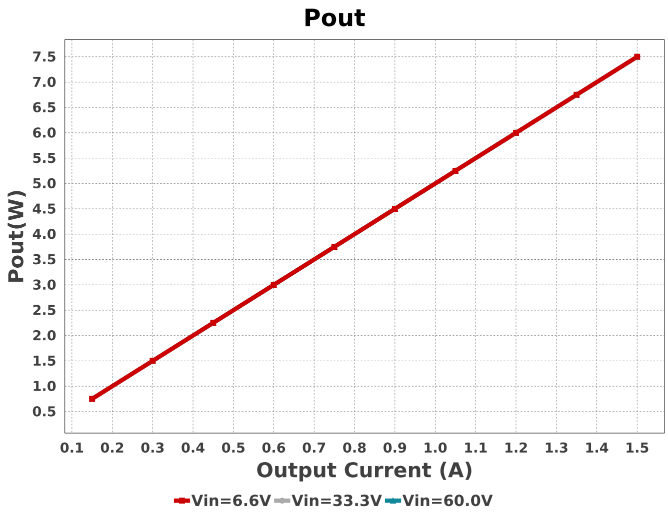

IC Tj
IC Tj(degC)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

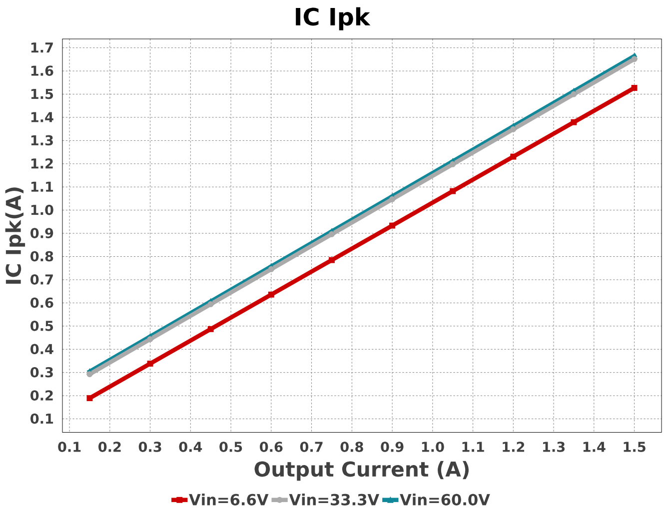

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

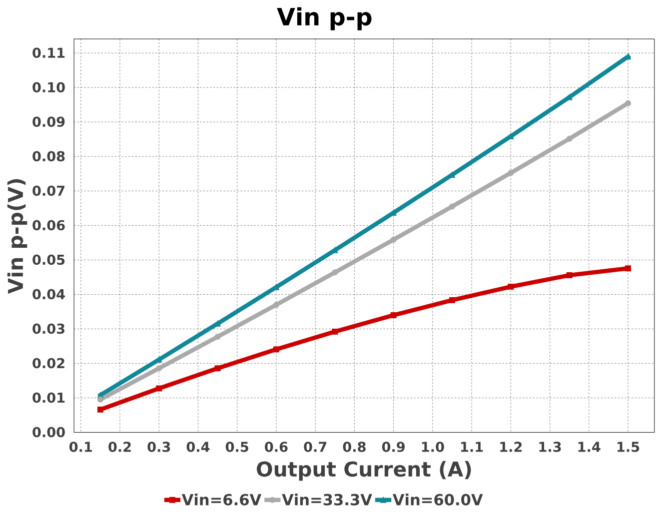

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V


Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

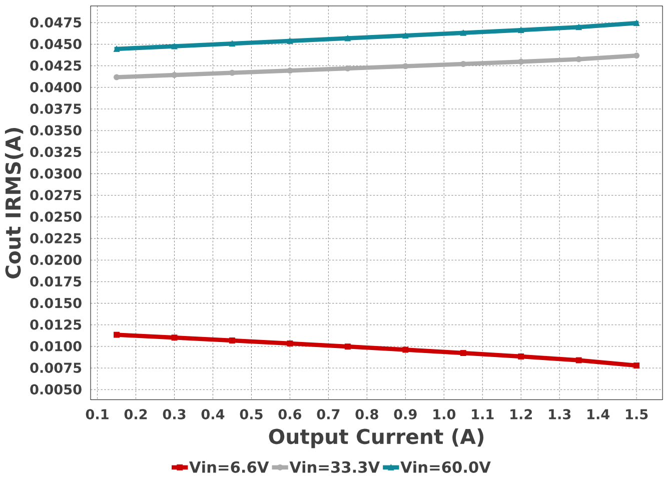

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V


Pout
Pout(W)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

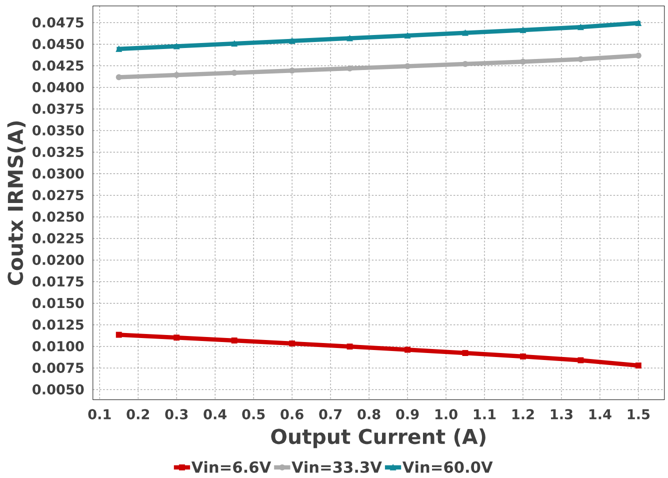

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V


Vin p-p
Vin p-p(V)
Output Current (A)
Vin=6.6V Vin=33.3V Vin=60.0V

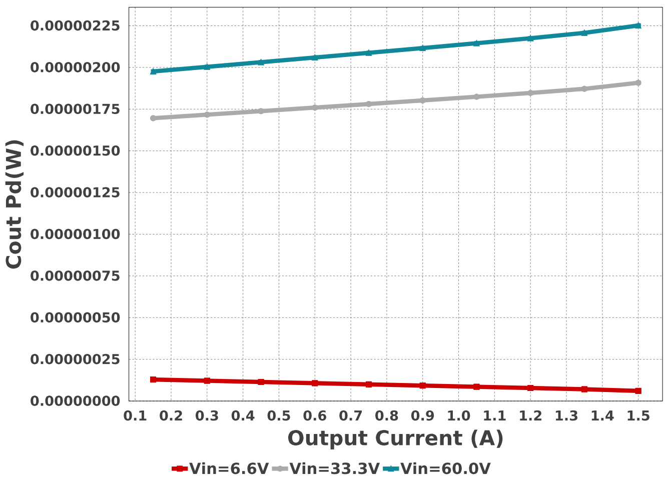
Cout IRMS



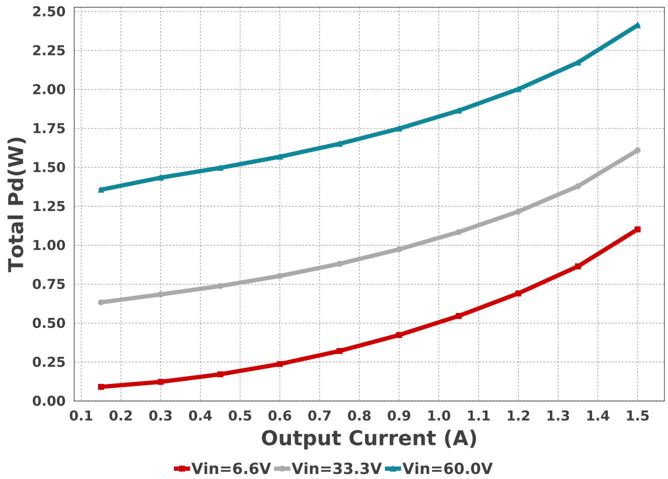
Coutx IRMS



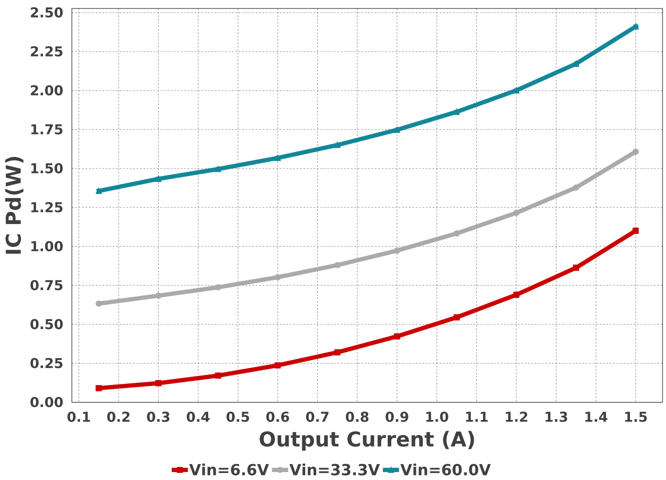
Cout Pd



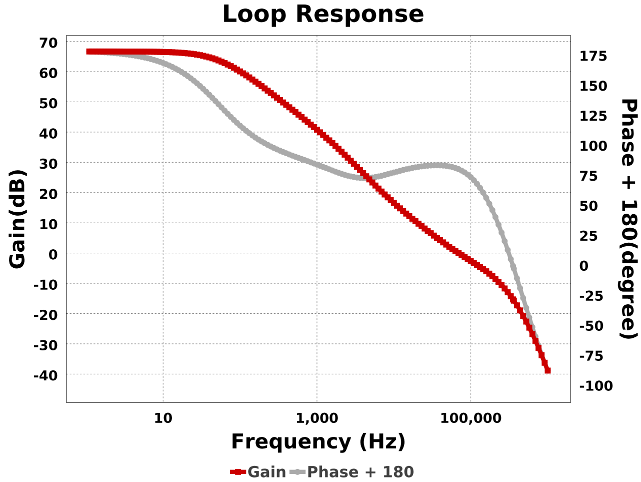
Total Pd



IC Pd



Loop Response



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	431.733 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	789.56 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	47.45 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	2.252 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	47.45 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	2.252 µW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	1.664 A	IC	Peak switch current in IC
8.	IC Pd	2.411 W	IC	IC power dissipation
9.	IC Tj	77.009 degC	IC	IC junction temperature
10.	IC Tolerance	15.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	19.5 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance

#	Name	Value	Category	Description
12.	Iin Avg	165.2 mA	IC	Average input current
13.	Cin Pd	789.56 µW	Power	Input capacitor power dissipation
14.	Cout Pd	2.252 µW	Power	Output capacitor power dissipation
15.	Coutx Pd	2.252 µW	Power	Output capacitor_x power loss
16.	IC Pd	2.411 W	Power	IC power dissipation
17.	Total Pd	2.412 W	Power	Total Power Dissipation
18.	BOM Count	9	System Information	Total Design BOM count
19.	Cross Freq	69.453 kHz	System Information	Bode plot crossover frequency
20.	Duty Cycle	9.071 %	System Information	Duty cycle
21.	Efficiency	75.668 %	System Information	Steady state efficiency
22.	FootPrint	99.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	1000.0 kHz	System Information	Switching frequency
24.	Gain Marg	-15.324 dB	System Information	Bode Plot Gain Margin
25.	Iout	1.5 A	System Information	Iout operating point
26.	L Ipp	328.74 mA	System Information	Peak-to-peak inductor ripple current
27.	Low Freq Gain	66.645 dB	System Information	Gain at 1Hz
28.	Mode	FCCM	System Information	Conduction Mode
29.	Phase Marg	80.66 deg	System Information	Bode Plot Phase Margin
30.	Pout	7.5 W	System Information	Total output power
31.	Total BOM	$3.68	System Information	Total BOM Cost
32.	Vin	60.0 V	System Information	Vin operating point
33.	Vin p-p	108.97 mV	System Information	Peak-to-peak input voltage
34.	Vout	5.0 V	System Information	Operational Output Voltage
35.	Vout Actual	5.016 V	System Information	Vout Actual calculated based on selected voltage divider resistors
36.	Vout Tolerance	3.142 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
37.	Vout p-p	1.965 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	60.0	Maximum input voltage
VinMin	6.6	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPSM5601R5HS	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

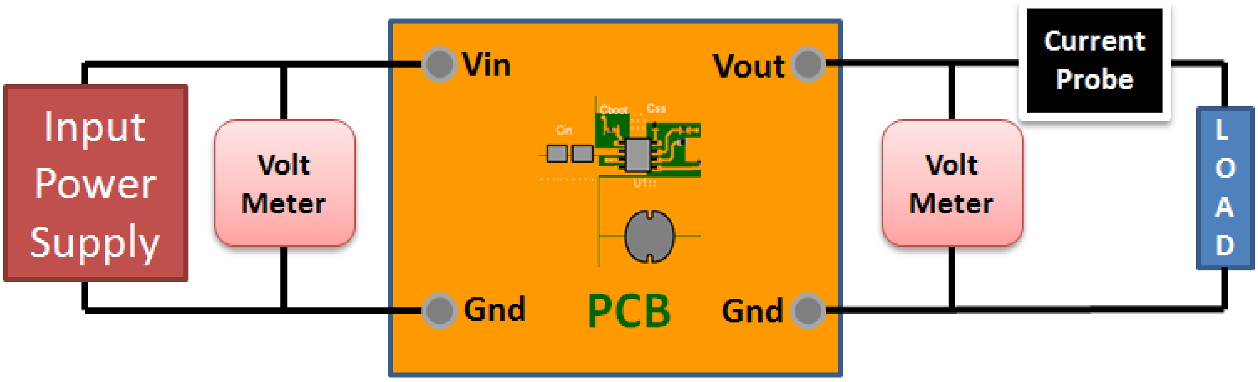
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.6V 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 : 472DCB3667881ABB[v1]

2. **TPSM5601R5HS** Product Folder : http://www.ti.com/product/TPSM5601R5H : contains the data sheet and other resources.

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