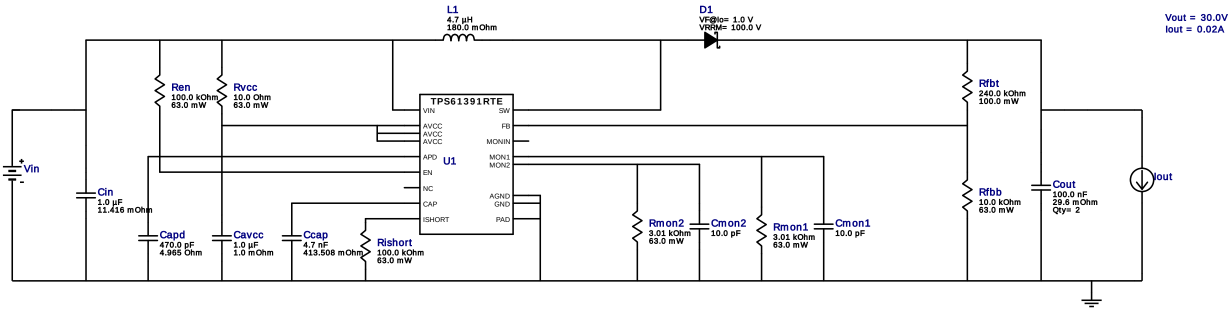
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 2.5V
VinMax = 5.5V
Vout = 30.0V
Iout = 0.02A

Device = TPS61391RTER
Topology = Boost
Created = 2024-09-06 11:51:36.550
BOM Cost = $1.66
BOM Count = 18
Total Pd = 0.23W

Design : 1 TPS61391RTER
TPS61391RTER 2.5V-5.5V to 30.00V @ 0.02A



Design Alerts

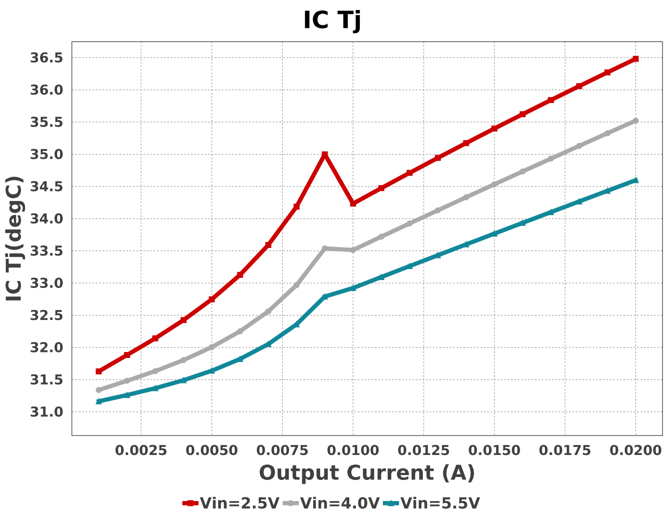
Efficiency Information

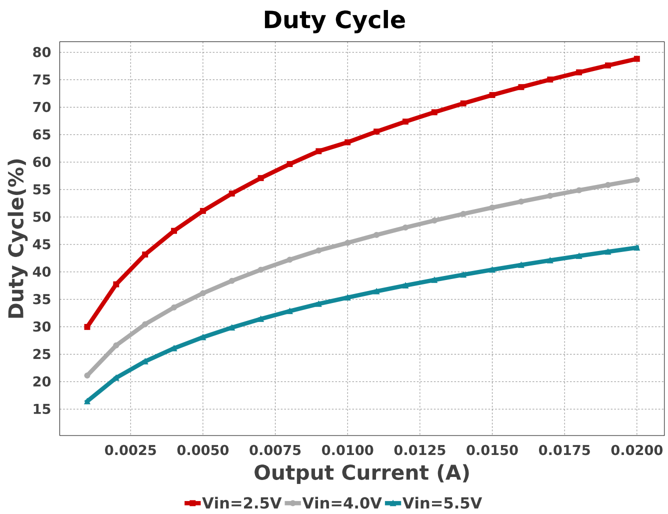
The TPS61391 efficiency validation is prone to ~ 5% ~ 10% mismatch from the bench data The switching frequency of TPS61391 is modelled at fixed 700kHz. However, it may vary over higher load

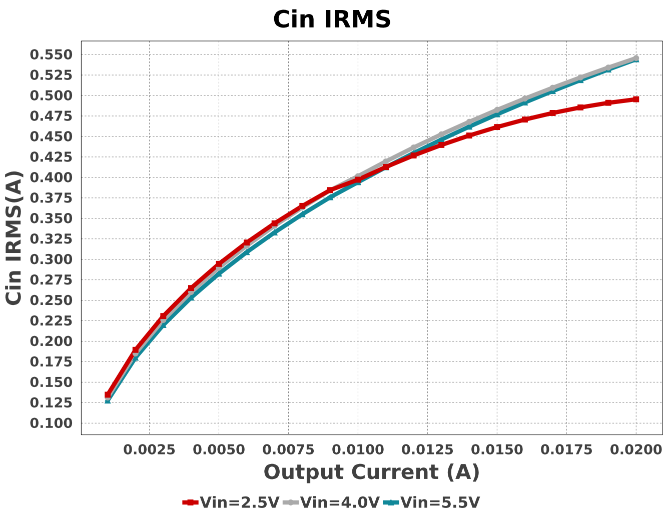
Electrical BOM

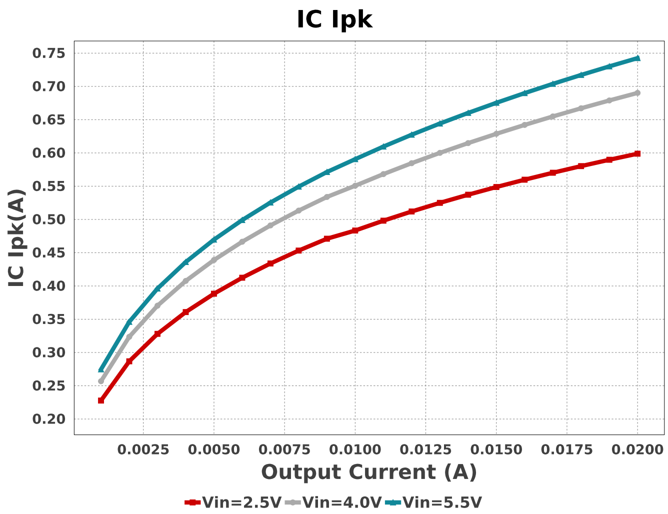
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Capd	TDK	CGA2B2X7R1H471K050BA Series= X7R	Cap= 470.0 pF ESR= 4.9649 Ohm VDC= 50.0 V IRMS= 228.41 mA	1	$0.01	0402 3 mm²
Cavcc	Kemet	C0603C105Z8VACTU Series= Y5V	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ccap	TDK	CGA2B2X7R1H472K050BA Series= X7R	Cap= 4.7 nF ESR= 413.51 mOhm VDC= 50.0 V IRMS= 330.88 mA	1	$0.01	0402 3 mm²
Cin	TDK	C1005X6S1C105K050BC Series= X6S	Cap= 1.0 uF ESR= 11.416 mOhm VDC= 16.0 V IRMS= 1.483 A	1	$0.02	0402 3 mm²
Cmon1	MuRata	GRM0335C1H100JA01D Series= C0G/NP0	Cap= 10.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cmon2	MuRata	GRM0335C1H100JA01D Series= C0G/NP0	Cap= 10.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cout	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	2	$0.01	0603 5 mm²
D1	Comchip Technology	CDBW46-G	VF@Io= 1.0 V VRRM= 100.0 V	1	$0.04	SOD-123 13 mm²
L1	MuRata	LQM2HPN4R7MGCL	L= 4.7 µH 180.0 mOhm	1	$0.09	1008 10 mm²
Ren	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

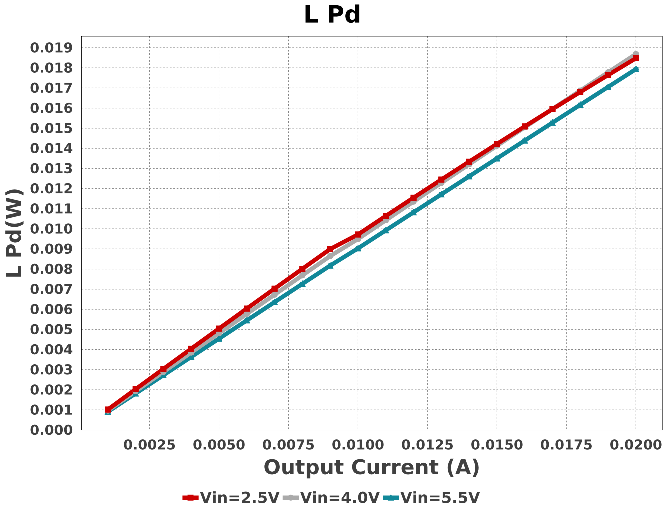
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Susumu Co Ltd	RG1608P-244-B-T5 Series= RG1608	Res= 240.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rishort	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rmon1	Vishay-Dale	CRCW04023K01FKED Series= CRCW..e3	Res= 3.01 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rmon2	Vishay-Dale	CRCW04023K01FKED Series= CRCW..e3	Res= 3.01 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rvcc	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS61391RTER	Switcher	1	$1.32	RGT0016C 16 mm²

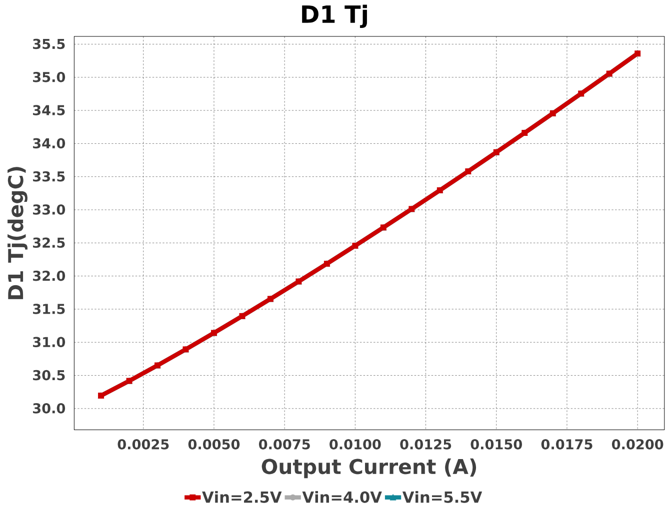


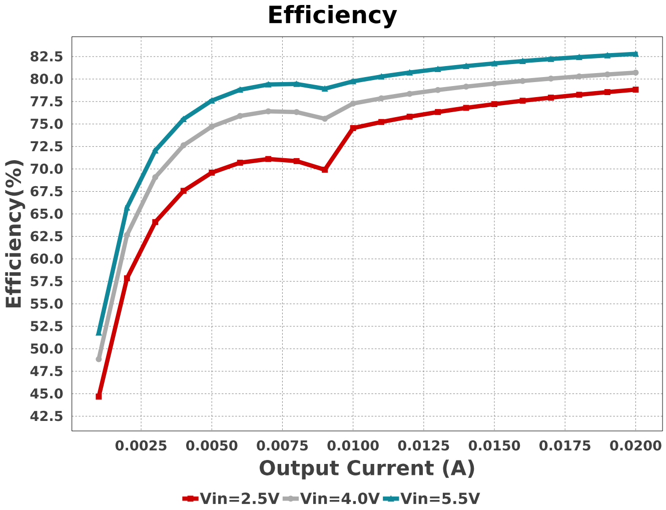


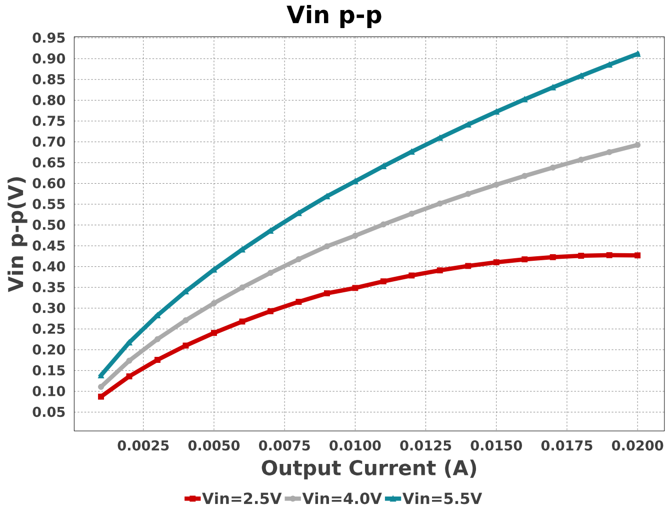


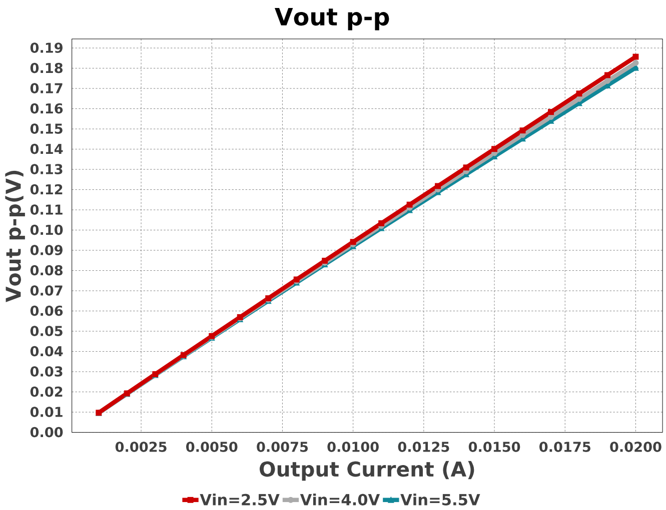


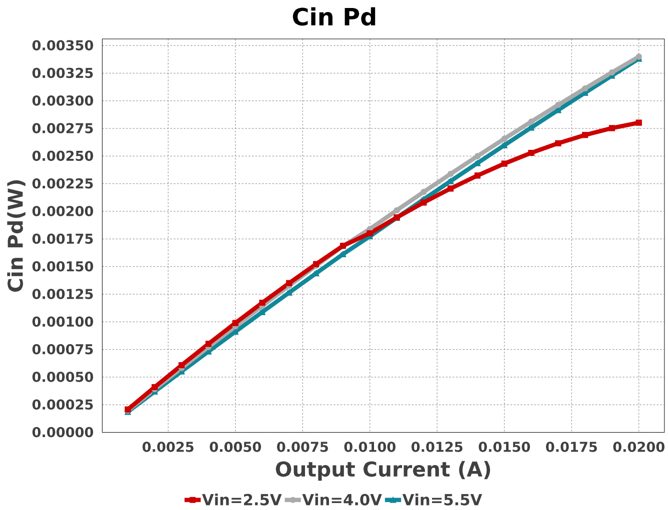

L Pd
L Pd(W)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

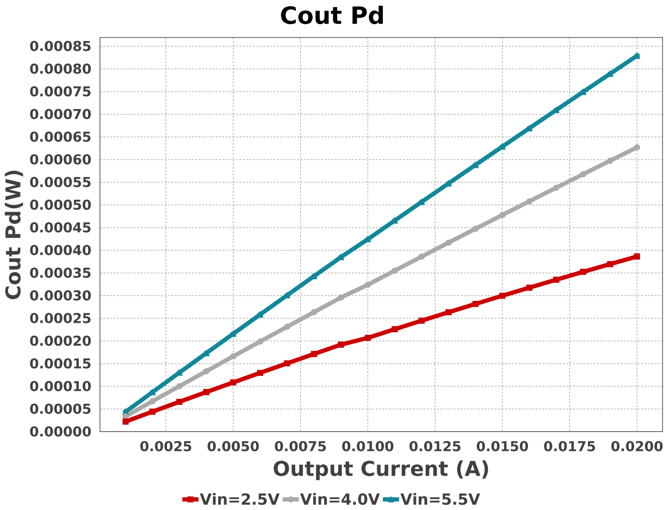

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

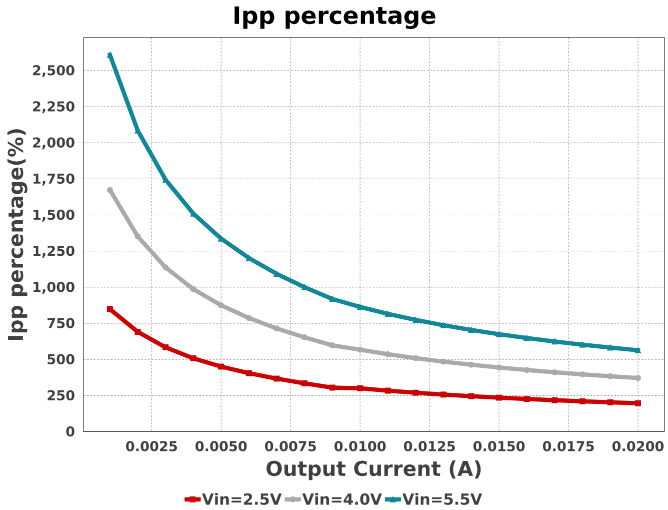

Efficiency
Efficiency(%)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

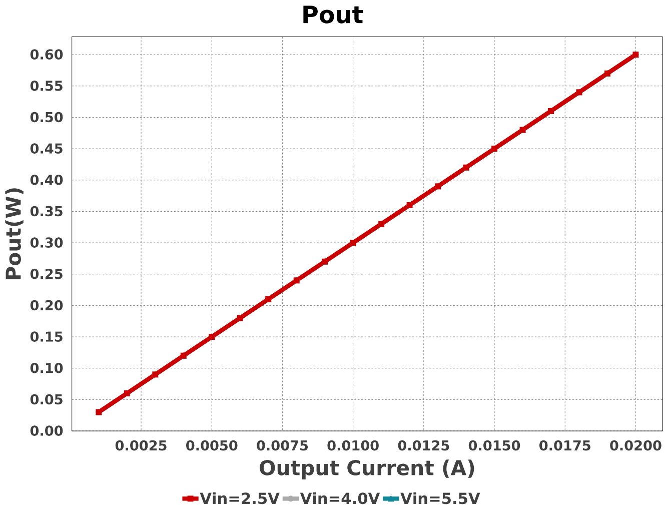

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

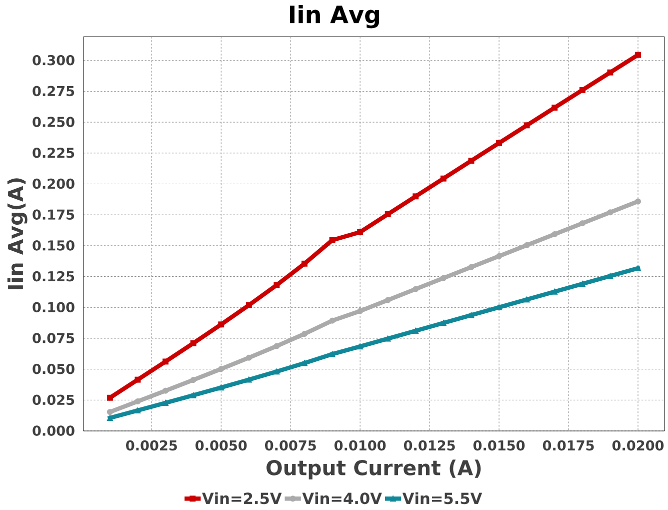

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

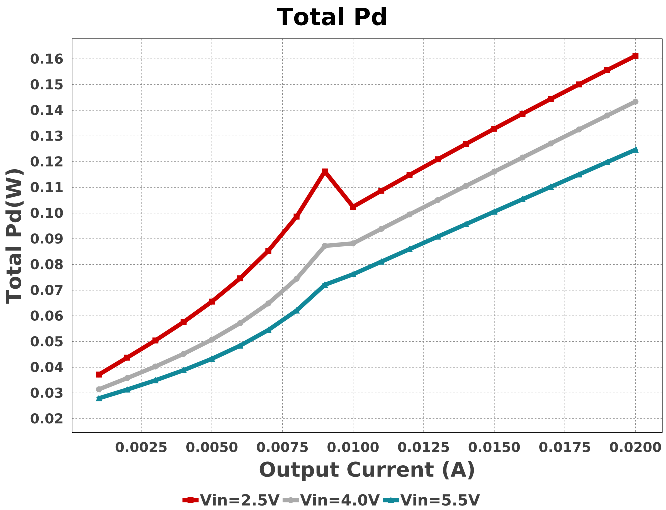

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=2.5V Vin=4.0V Vin=5.5V

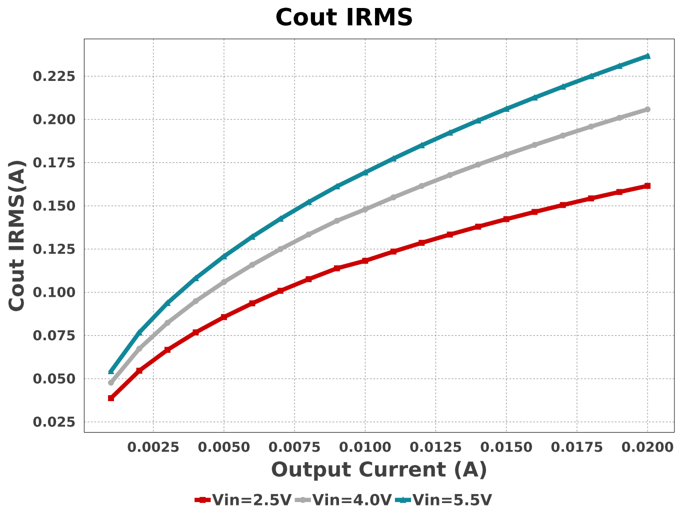

Cout Pd
0.00085
0.00080
0.00075
0.00070
0.00065
0.00060
0.00055
0.00050
0.00045
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Cout Pd(W)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V

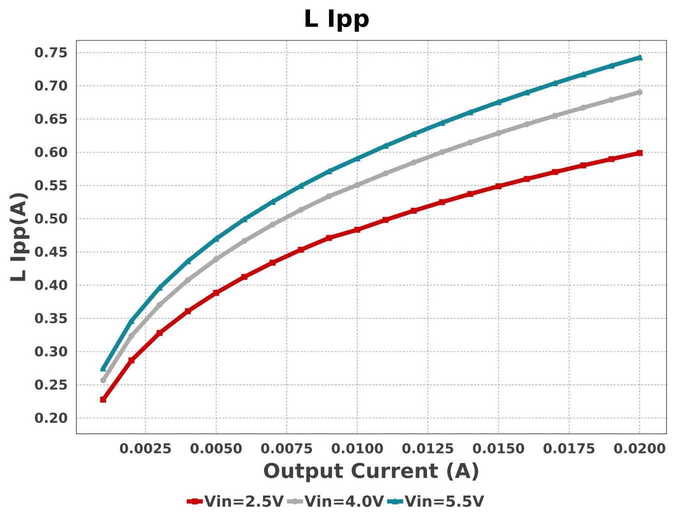

Ipp percentage
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
Ipp percentage(%)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V

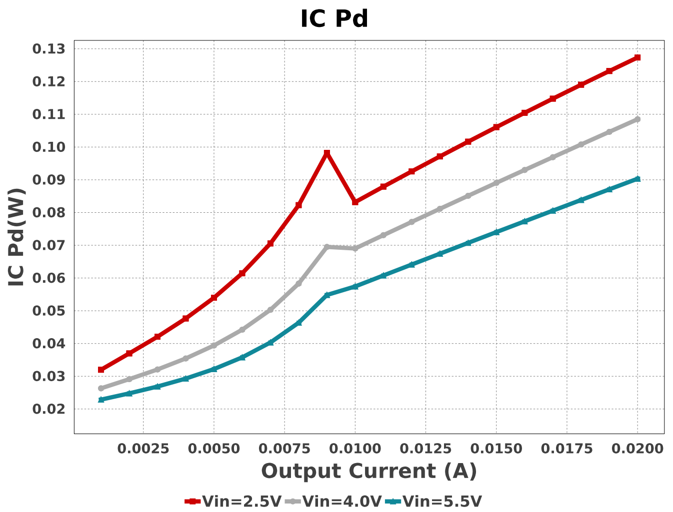

Pout
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Pout(W)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V

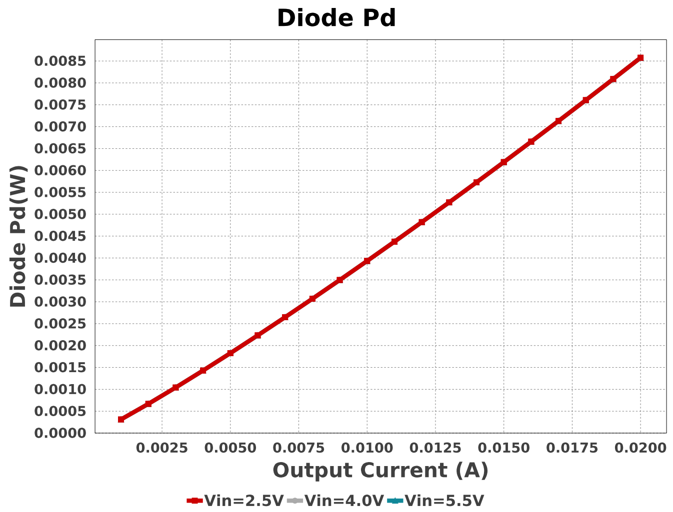

Iin Avg
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
Iin Avg(A)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V

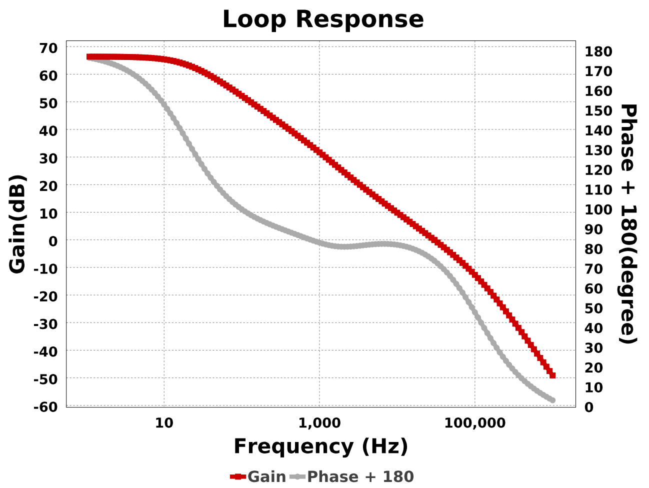

Total Pd
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
Total Pd(W)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V


Cout IRMS
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
Cout IRMS(A)
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Output Current (A)
Vin=2.5V
Vin=4.0V
Vin=5.5V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	495.413 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.802 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	161.565 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	386.33 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	35.359 degC	Diode	D1 junction temperature
6.	Diode Pd	8.574 mW	Diode	Diode power dissipation
7.	IC Ipk	598.864 mA	IC	Peak switch current in IC
8.	IC Pd	127.34 mW	IC	IC power dissipation
9.	IC Tj	36.482 degC	IC	IC junction temperature
10.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	50.9 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	330.22 mA	IC	Average input current
13.	Ipp percentage	181.356 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	598.86 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	82.833 mW	Inductor	Inductor power dissipation
16.	Cin Pd	2.802 mW	Power	Input capacitor power dissipation
17.	Cout Pd	386.33 µW	Power	Output capacitor power dissipation
18.	Diode Pd	8.574 mW	Power	Diode power dissipation
19.	IC Pd	127.34 mW	Power	IC power dissipation
20.	L Pd	82.833 mW	Power	Inductor power dissipation
21.	Total Pd	225.54 mW	Power	Total Power Dissipation
22.	BOM Count	18	System Information	Total Design BOM count
23.	Cross Freq	11.793 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	78.81 %	System Information	Duty cycle
25.	Efficiency	72.68 %	System Information	Steady state efficiency
26.	FootPrint	89.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
27.	Frequency	700.0 kHz	System Information	Switching frequency
28.	Gain Marg	-45.983 dB	System Information	Bode Plot Gain Margin
29.	Iout	20.0 mA	System Information	Iout operating point
30.	Low Freq Gain	57.99 dB	System Information	Gain at 1Hz
31.	Mode	DCM	System Information	Conduction Mode
32.	Phase Marg	81.469 deg	System Information	Bode Plot Phase Margin
33.	Pout	600.0 mW	System Information	Total output power
34.	Total BOM	$1.66	System Information	Total BOM Cost
35.	Vin	2.5 V	System Information	Vin operating point
36.	Vin p-p	426.913 mV	System Information	Input Source ripple voltage
37.	Vout	30.0 V	System Information	Operational Output Voltage
38.	Vout Actual	30.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	2.583 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	185.676 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	20.0 m	Maximum Output Current
VinMax	5.5	Maximum input voltage
VinMin	2.5	Minimum input voltage
Vout	30.0	Output Voltage
base_pn	TPS61391	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

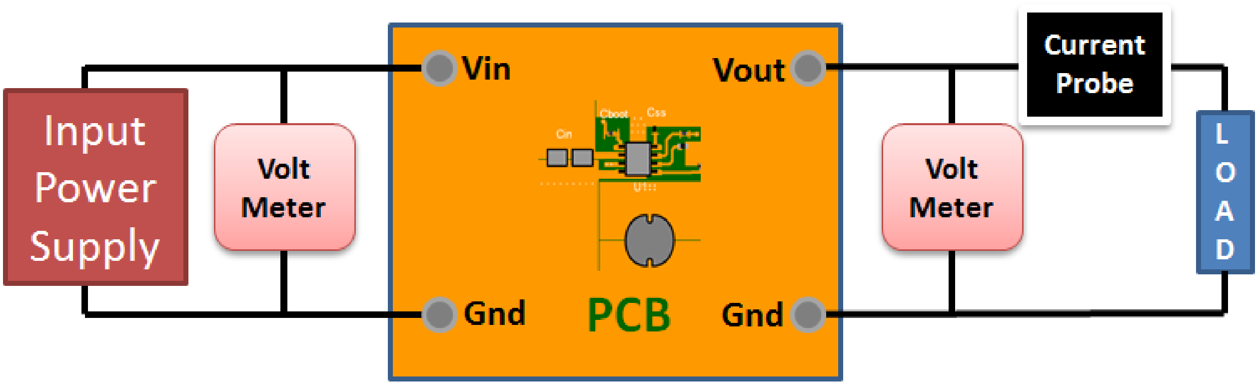
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 2.5V 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 : BC5209B3293B6F833461C515FCD314A8[v1]

2. **TPS61391** Product Folder : http://www.ti.com/product/TPS61391 : contains the data sheet and other resources.