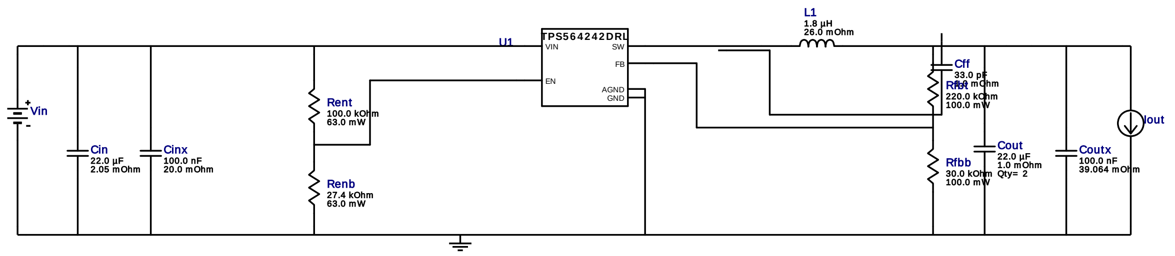
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 7.0V
VinMax = 7.2V
Vout = 5.0V
Iout = 2.0A

Device = TPS564242DRLR
Topology = Buck
Created = 2025-01-11 00:42:01.392
BOM Cost = $1.91
BOM Count = 12
Total Pd = 0.31W

Design : 1 TPS564242DRLR
TPS564242DRLR 7V-7.2V to 5.00V @ 2A



Design Alerts

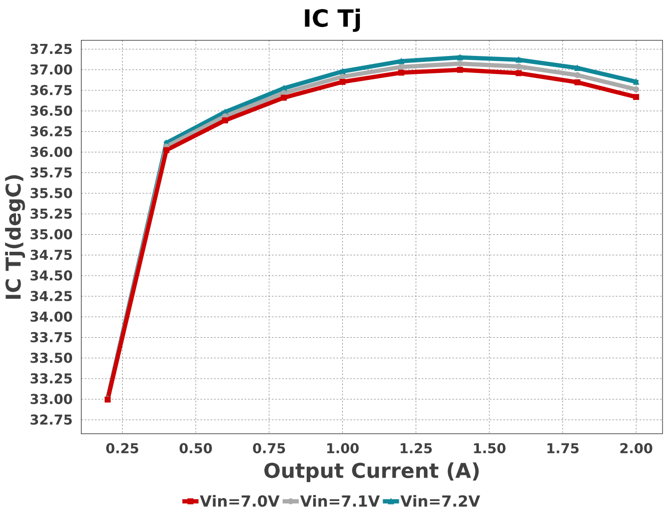
Design Information

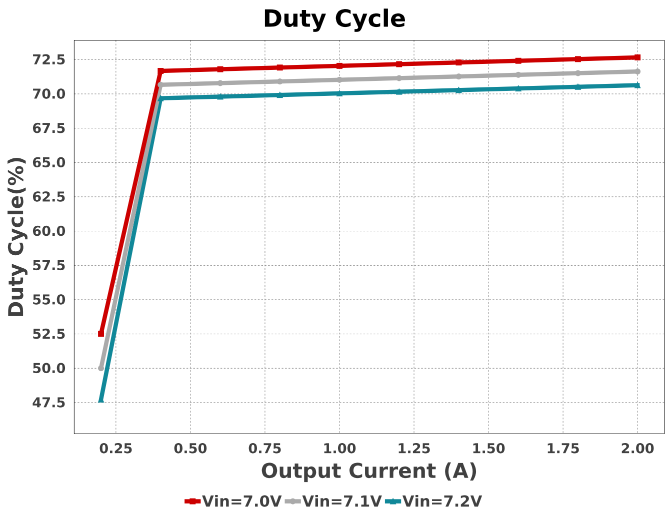
The TPS564242 can support the large duty operation, please contact https://e2e.ti.com/support/power-management/f/196 forum for application help.

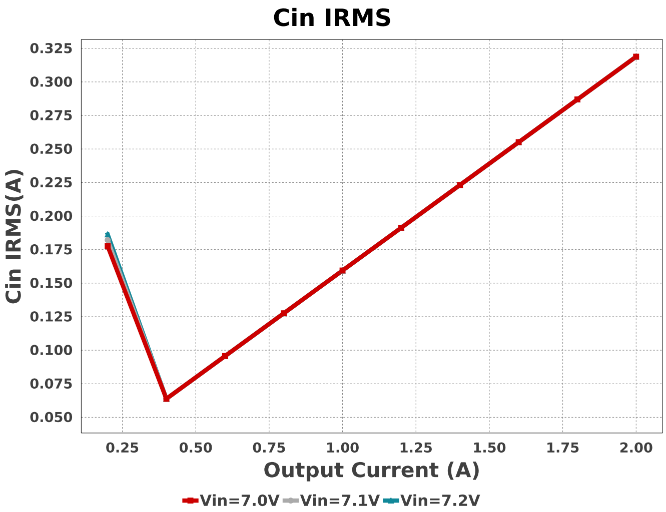
Electrical BOM

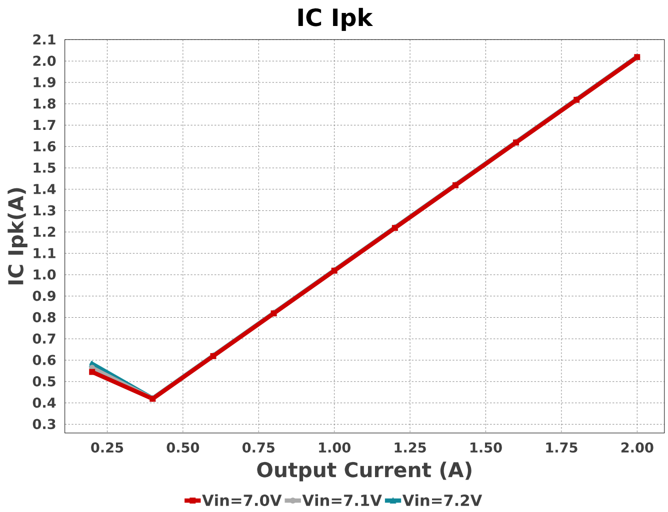
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cff	MuRata	GRM1555C1E330JA01D Series= C0G/NP0	Cap= 33.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.31	0805 7 mm^2
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm^2
Cout	Taiyo Yuden	LMK212BJ226MG-T Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 1.6 A	2	$0.09	0805 7 mm^2
Coutx	TDK	C1005X5R1H104K050BB Series= X5R	Cap= 100.0 nF ESR= 39.064 mOhm VDC= 50.0 V IRMS= 814.67 mA	1	$0.02	0402 3 mm^2
L1	Wurth Elektronik	74438356018HT	L= 1.8 µH 26.0 mOhm	1	$1.18	WE-MAPI_4020 26 mm^2
Renb	Vishay-Dale	CRCW040227K4FKED Series= CRCW..e3	Res= 27.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rent	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Yageo	RC0603FR-07220KL Series= ?	Res= 220.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2

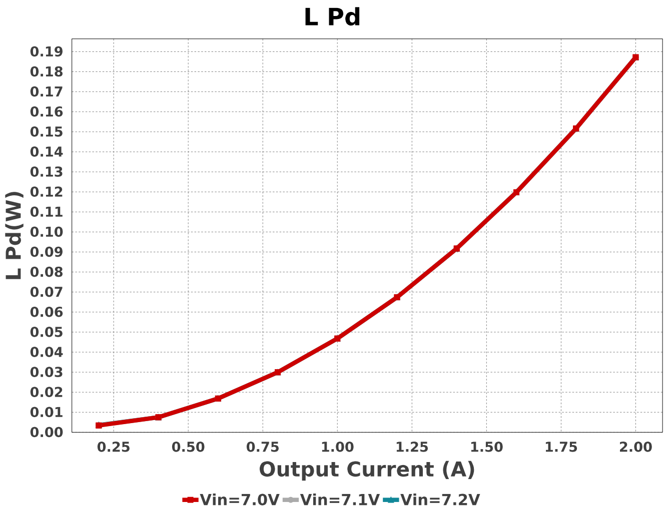
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	TPS564242DRLR	Switcher	1	$0.15	DRL0006A 7 mm²

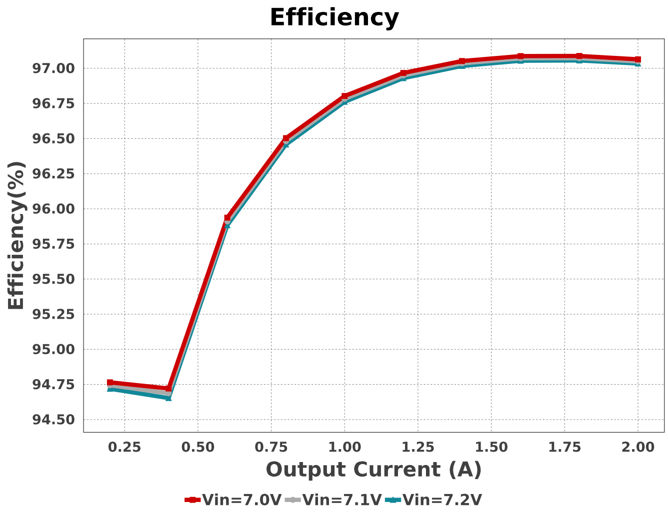


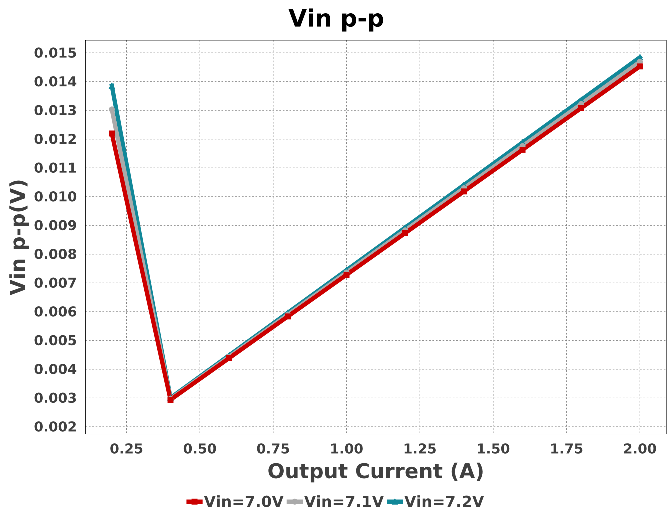


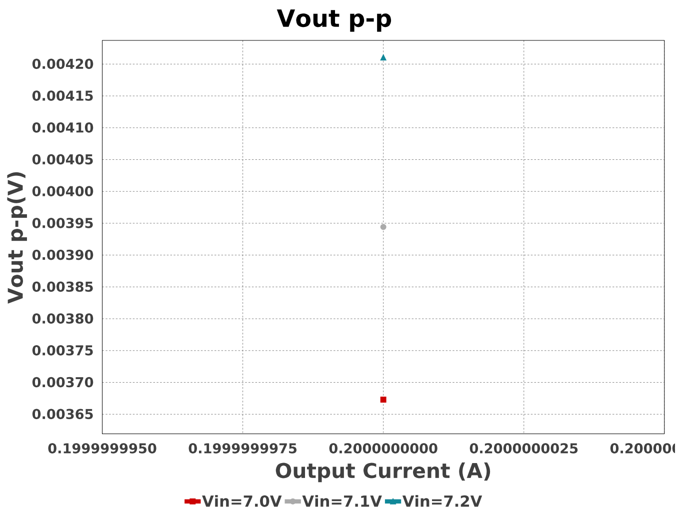


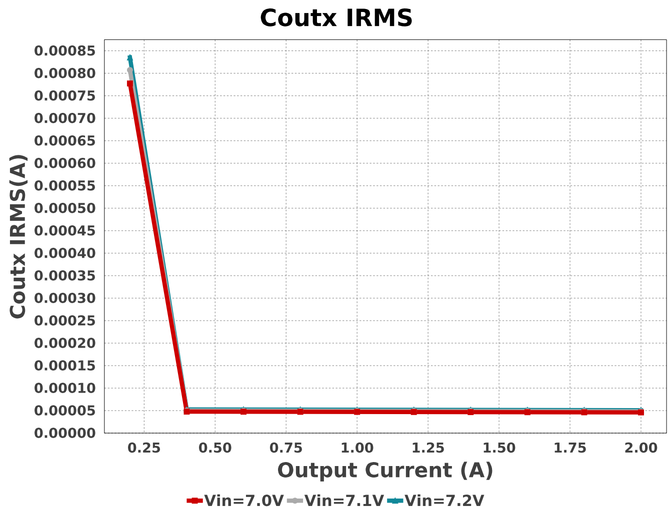


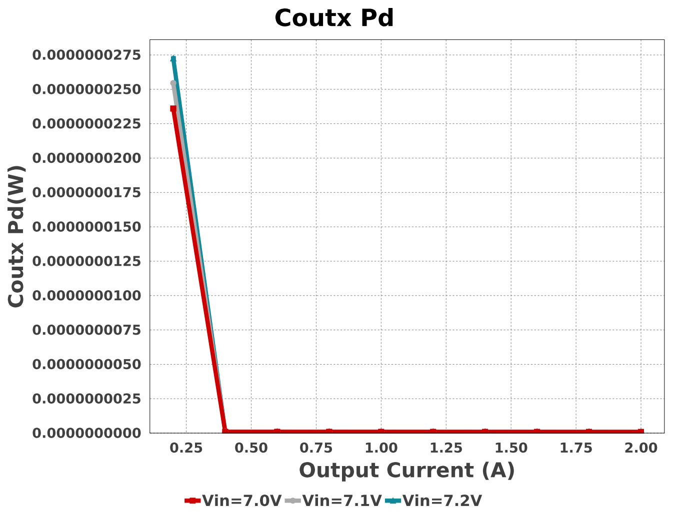


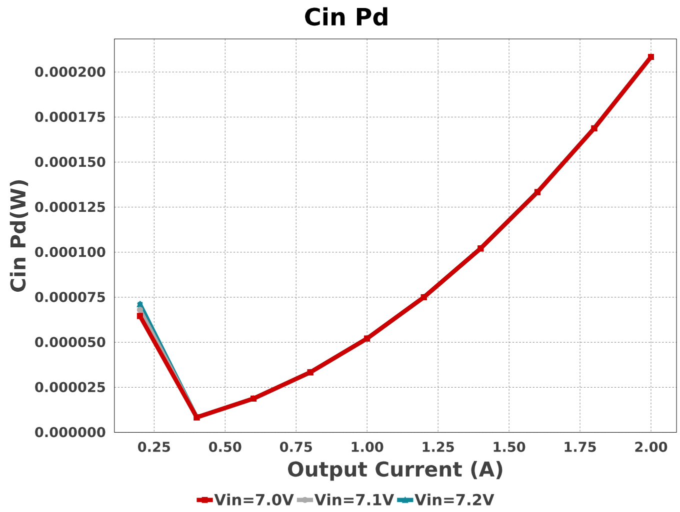


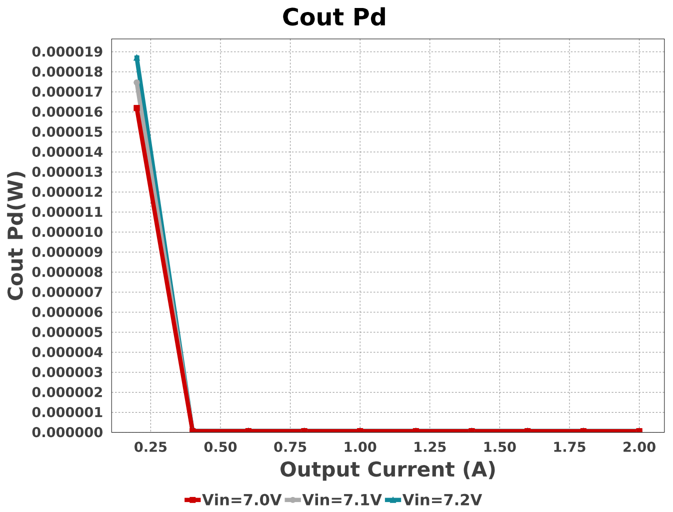

Vin p-p
Vin p-p(V)
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

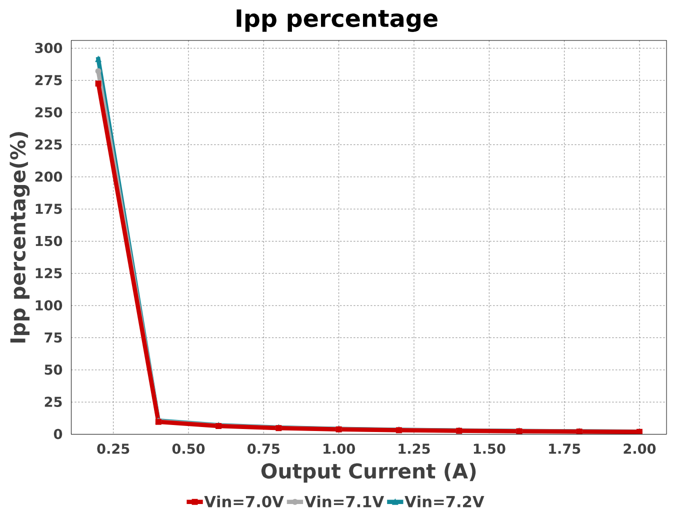

Vout p-p
Vout p-p(V)
0.00420
0.00415
0.00410
0.00405
0.00400
0.00395
0.00390
0.00385
0.00380
0.00375
0.00370
0.00365
0.1999999950 0.1999999975 0.2000000000 0.2000000025
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

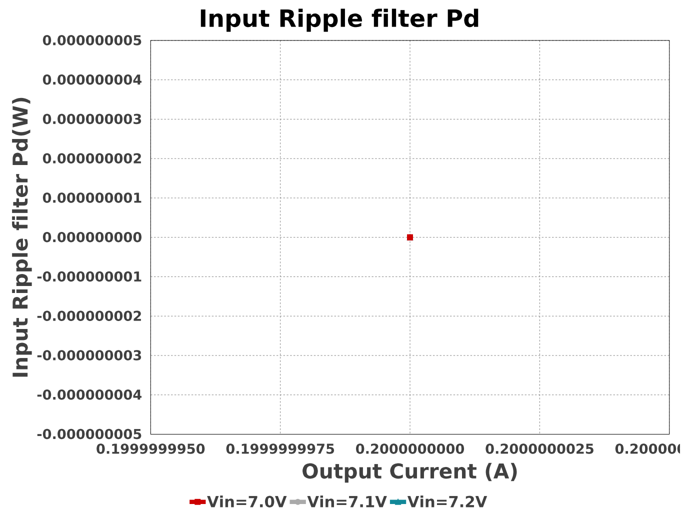

Coutx IRMS
Coutx IRMS(A)
0.00085
0.00080
0.00075
0.00070
0.00065
0.00060
0.00055
0.00050
0.00045
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

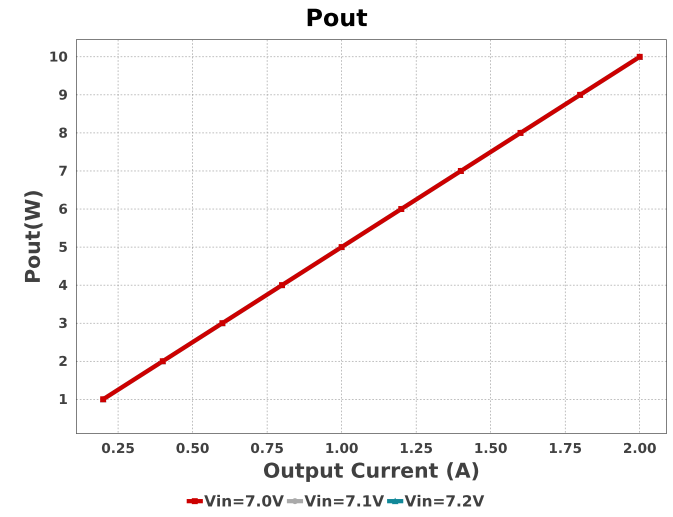

Coutx Pd
Coutx Pd(W)
0.0000000275
0.0000000250
0.0000000225
0.0000000200
0.0000000175
0.0000000150
0.0000000125
0.0000000100
0.0000000075
0.0000000050
0.0000000025
0.0000000000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

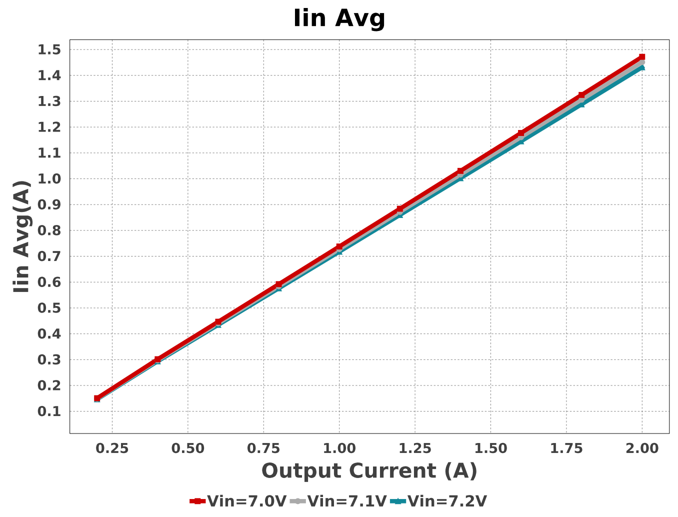

Cin Pd
Cin Pd(W)
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

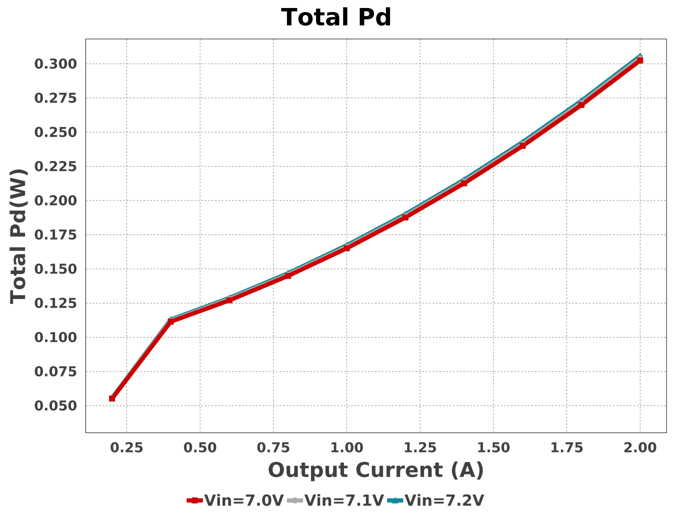

Cout Pd
Cout Pd(W)
0.000019
0.000018
0.000017
0.000016
0.000015
0.000014
0.000013
0.000012
0.000011
0.000010
0.000009
0.000008
0.000007
0.000006
0.000005
0.000004
0.000003
0.000002
0.000001
0.000000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

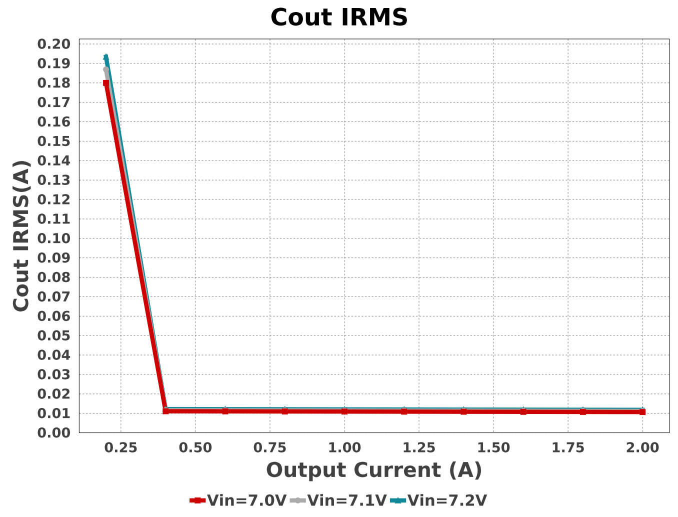

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V


Input Ripple filter Pd
Input Ripple filter Pd(W)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

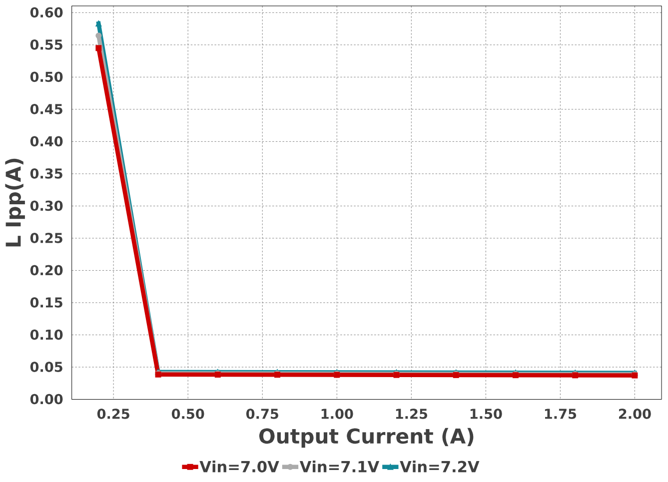

Pout
Pout(W)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

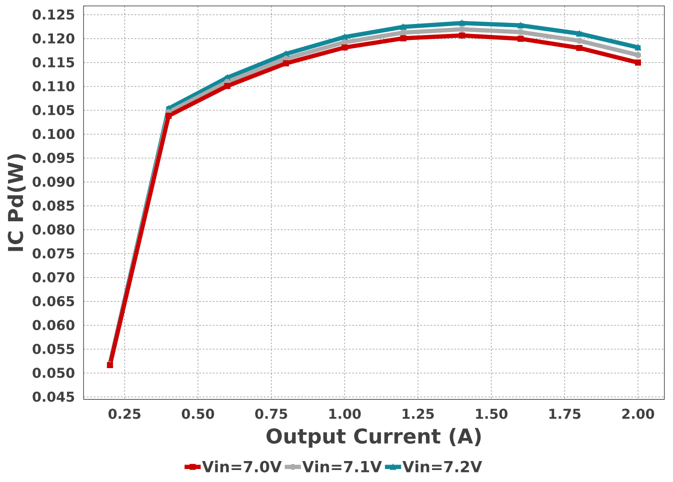

Total Pd
Total Pd(W)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=7.0V Vin=7.1V Vin=7.2V

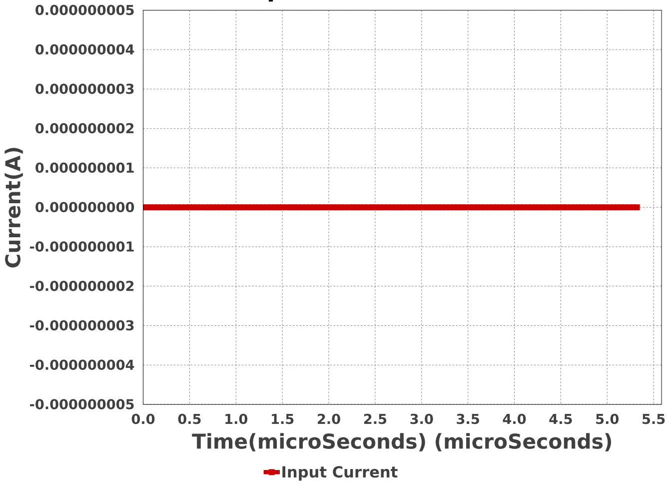
L Ipp



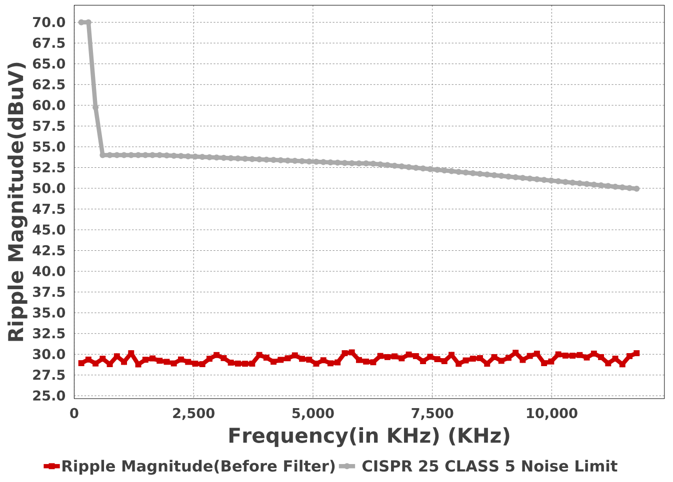
IC Pd



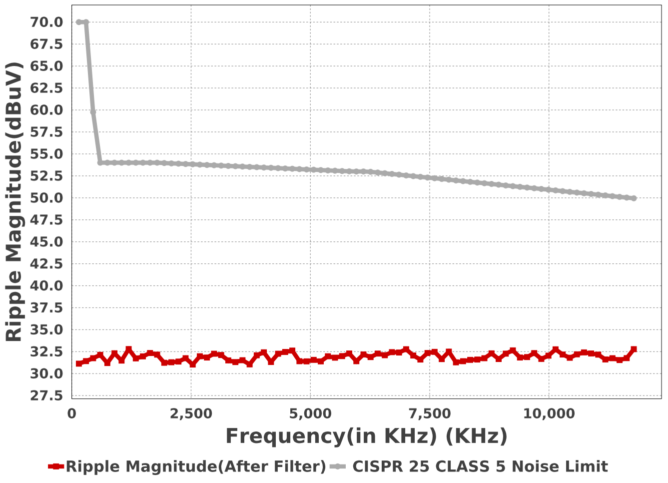
Input Current



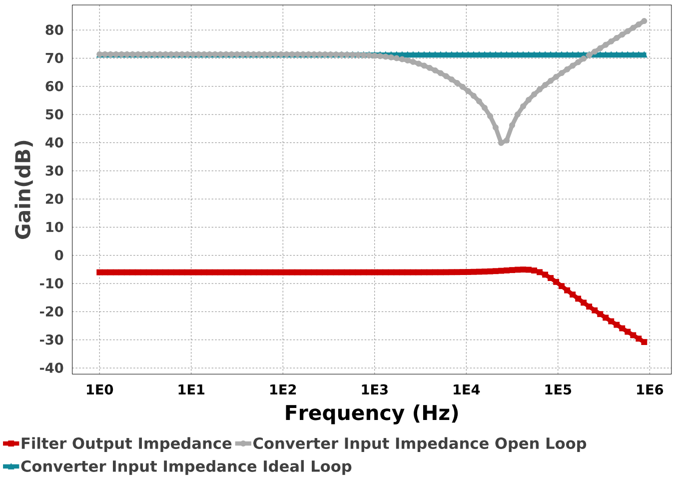
Ripple Freq Spectrum(Before Filter)

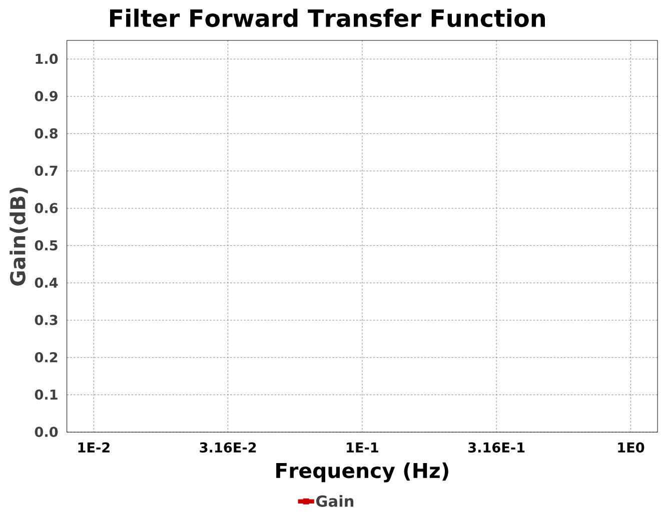


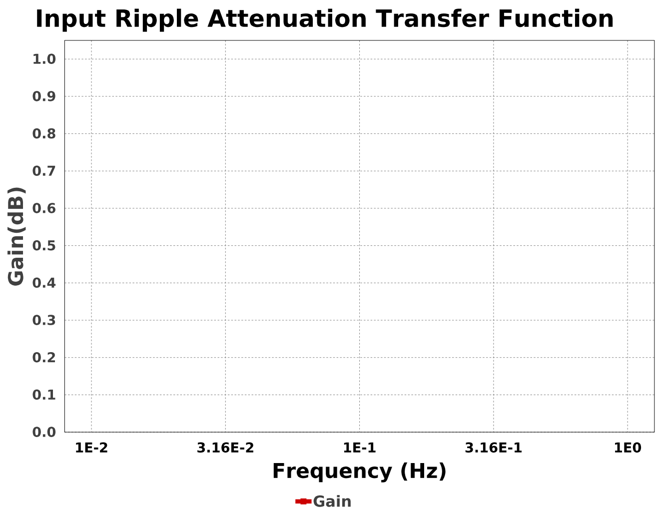
Ripple Freq Spectrum(After Filter)

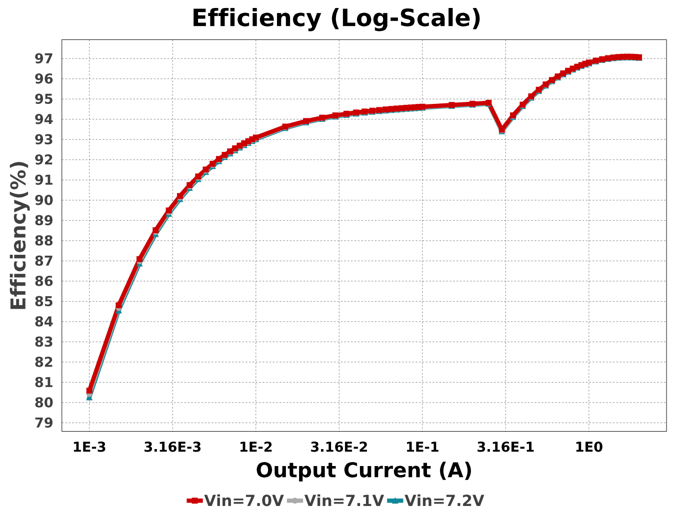


Filter vs Converter Impedance Comparison









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	318.811 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	208.36 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	11.783 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	69.42 nW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	50.829 µA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	100.93 pW	Capacitor	Output capacitor_x power loss
7.	Input Ripple Noise before input filter	30.19 dBuV	EMI Noise	Input Ripple Noise before filter at switching frequency
8.	Noise limits defined by CISPR Standards	54.0 dBuV	EMI Noise	Noise limits for CLASS 5 of CISPR 25 standard
9.	IC Ipk	2.02 A	IC	Peak switch current in IC
10.	IC Pd	118.17 mW	IC	IC power dissipation
11.	IC Tj	36.854 degC	IC	IC junction temperature
12.	IC Tolerance	11.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA Effective	58.0 degC/W	IC	IC junction-to-ambient thermal resistance with TI EVM
14.	Iin Avg	1.431 A	IC	Average input current
15.	Ipp percentage	2.05 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
16.	L Ipp	40.994 mA	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	187.21 mW	Inductor	Inductor power dissipation
18.	Cin Pd	208.36 µW	Power	Input capacitor power dissipation
19.	Cout Pd	69.42 nW	Power	Output capacitor power dissipation
20.	Coutx Pd	100.93 pW	Power	Output capacitor_x power loss
21.	IC Pd	118.17 mW	Power	IC power dissipation
22.	L Pd	187.21 mW	Power	Inductor power dissipation
23.	Total Pd	305.657 mW	Power	Total Power Dissipation
24.	BOM Count	12	System Information	Total Design BOM count
25.	Duty Cycle	70.635 %	System Information	Duty cycle
26.	Efficiency	97.034 %	System Information	Steady state efficiency

#	Name	Value	Category	Description
27.	FootPrint	79.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	745.427 kHz	System Information	Switching frequency
29.	Iout	2.0 A	System Information	Iout operating point
30.	Mode	CCM	System Information	Conduction Mode
31.	Pout	10.0 W	System Information	Total output power
32.	Total BOM	$1.91	System Information	Total BOM Cost
33.	Vin	7.2 V	System Information	Vin operating point
34.	Vin p-p	14.844 mV	System Information	Peak-to-peak input voltage
35.	Vout	5.0 V	System Information	Operational Output Voltage
36.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
37.	Vout Tolerance	3.644 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	7.2	Maximum input voltage
VinMin	7.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS564242	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

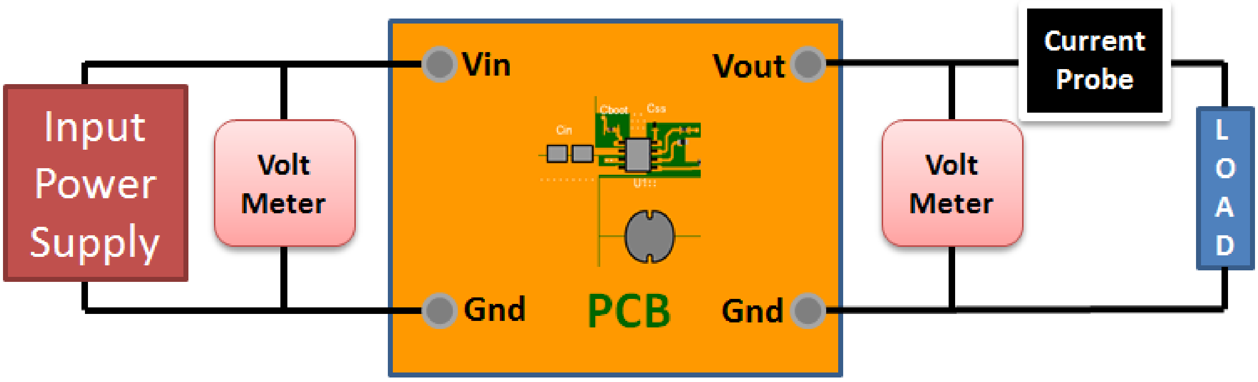
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 7.0V 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 : C21C59CAAB0A22F175A9C6A323C7143E[v1]

2. **TPS564242** Product Folder : http://www.ti.com/product/TPS564242 : contains the data sheet and other resources.

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