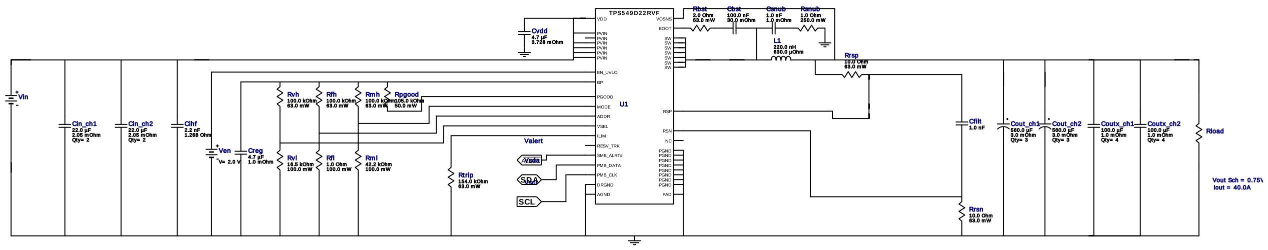
VinMin = 10.8V
VinMax = 13.2V
Vout = 0.75V
Vout Sch = 0.75V
Iout = 40.0A

Device = TPS549D22RVFR
Topology = Buck
Created = 2023-01-26 01:39:14.913
BOM Cost = $14.82
BOM Count = 38
Total Pd = 6.89W

WEBENCH ® Design Report

Design : 216 TPS549D22RVFR
TPS549D22RVFR 10.8V-13.2V to .75V @ 40A



Design Alerts

Component Selection Information

TPS549D22 is a PMBus(TM) device with key features listed below. PMBus(TM) features marked with * are included in WEBENCH(R) Power Designer. - On-the-fly output programming (VOUT_COMMAND) * - Output voltage margining (VOUT_MARGIN) - Programmable switching frequency * - Programmable soft-start rate * - Selectable conduction mode * - Fault reporting (OV, OC, Temperature)Use the Advanced Options on the left side to set the PMBus(TM) commands.Please refer to the TPS549D22 datasheet and visit http://www.ti.com/pmbus for more information.

Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	MuRata	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 A	1	$0.01	0603 5 mm^2
Cfilt	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihf	TDK	CGA1A2X7R1E222K030BA Series= X7R	Cap= 2.2 nF ESR= 1.26834 Ohm VDC= 25.0 V IRMS= 201.468 mA	1	$0.01	0201_033 2 mm^2
Cin_ch1	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	2	$0.31	0805 7 mm^2
Cin_ch2	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	2	$0.31	0805 7 mm^2
Cout_ch1	Panasonic	EEFGX0D561R Series= GX	Cap= 560.0 uF ESR= 3.0 mOhm VDC= 2.0 V IRMS= 10.2 A	3	$0.86	7343-20 59 mm^2
Cout_ch2	Panasonic	EEFGX0D561R Series= GX	Cap= 560.0 uF ESR= 3.0 mOhm VDC= 2.0 V IRMS= 10.2 A	3	$0.86	7343-20 59 mm^2
Coutx_ch1	MuRata	GRM32EC80J107ME20L Series= X6S	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	4	$0.17	1210_270 15 mm^2
Coutx_ch2	MuRata	GRM32EC80J107ME20L Series= X6S	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	4	$0.17	1210_270 15 mm^2

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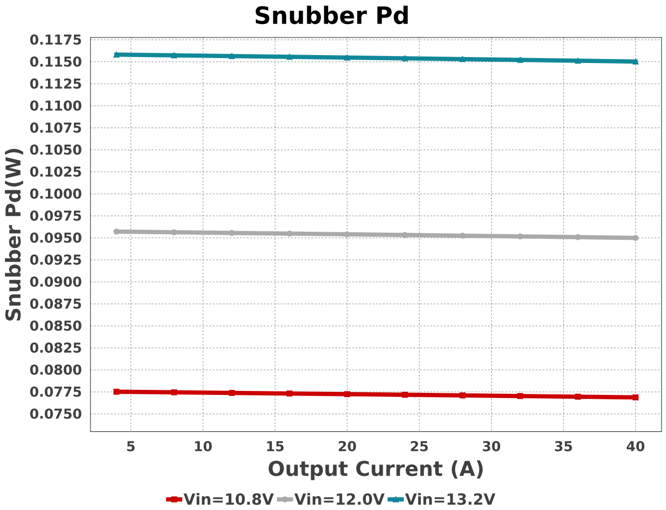
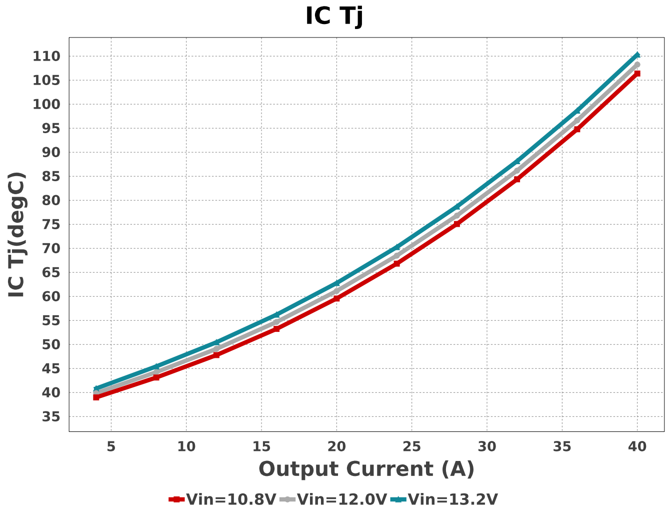
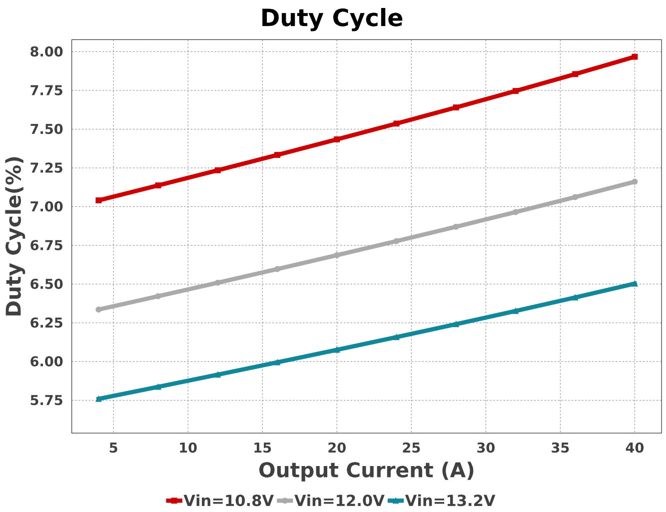
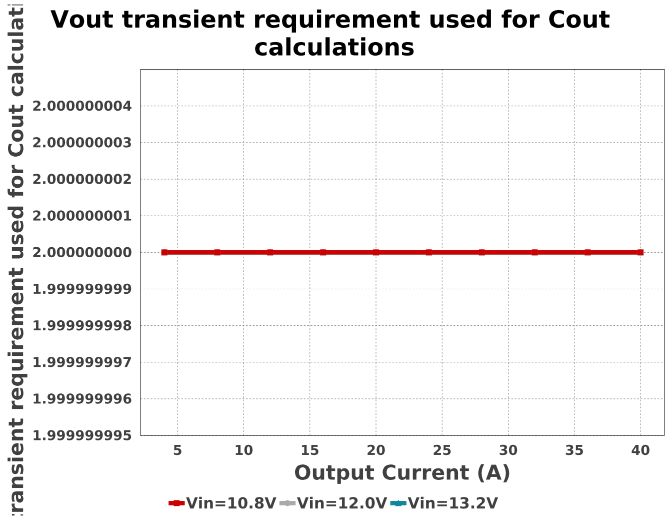
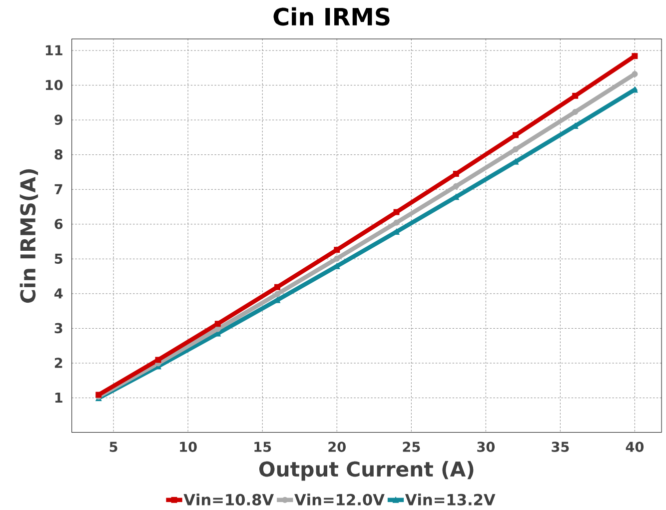
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Creg	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
Csnub	MuRata	GRM1885C1H102JA01D Series= C0G/NP0	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cvdd	TDK	C1608X5R1V475K080AC Series= X5R	Cap= 4.7 uF ESR= 3.728 mOhm VDC= 35.0 V IRMS= 2.69359 A	1	$0.10	0603 5 mm^2
L1	Vishay-Dale	IHLP6767GZERR22M01	L= 220.0 nH 630.0 µOhm	1	$2.32	IHLP-6767GZ 367 mm^2
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfl	Yageo	RC0603FR-071RL Series= ?	Res= 1.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rmh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rml	Vishay-Dale	CRCW060342K2FKEA Series= CRCW..e3	Res= 42.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rpgood	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rrsn	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rrsp	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsnub	Vishay-Dale	CRCW12061R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rtrip	Vishay-Dale	CRCW0402154KFKED Series= CRCW..e3	Res= 154.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvl	Yageo	RC0603FR-0716K5L Series= ?	Res= 16.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	TPS549D22RVFR	Switcher	1	$4.42	RVF0040A 63 mm^2

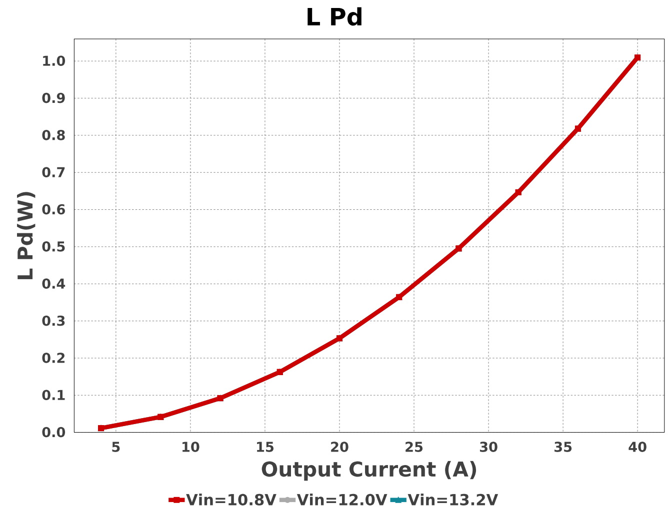

Snubber Pd
Snubber Pd(W)
0.1175
0.1150
0.1125
0.1100
0.1075
0.1050
0.1025
0.1000
0.0975
0.0950
0.0925
0.0900
0.0875
0.0850
0.0825
0.0800
0.0775
0.0750
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


IC Tj
IC Tj(degC)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

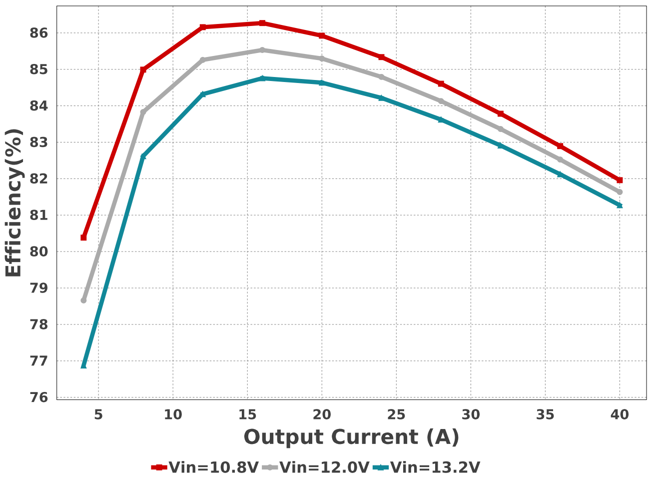

Duty Cycle
Duty Cycle(%)
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
5.75
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


Vout transient requirement used for Cout calculations
ransient requirement used for Cout calculati
2.000000004
2.000000003
2.000000002
2.000000001
2.000000000
1.999999999
1.999999998
1.999999997
1.999999996
1.999999995
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

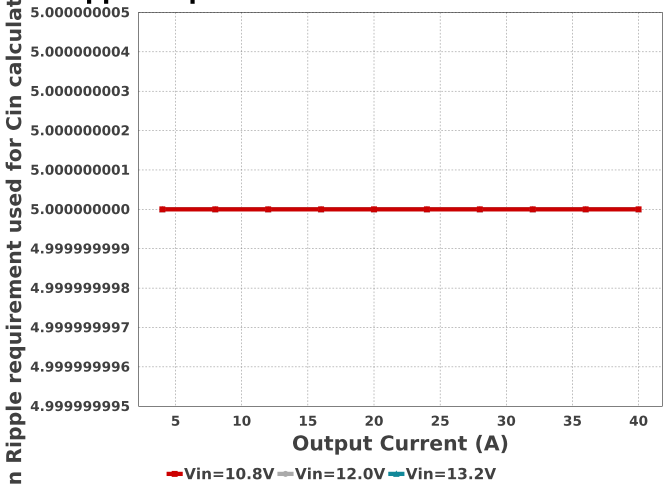

Cin IRMS
Cin IRMS(A)
11
10
9
8
7
6
5
4
3
2
1
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


L Pd
L Pd(W)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5 10 15 20 25 30 35 40
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

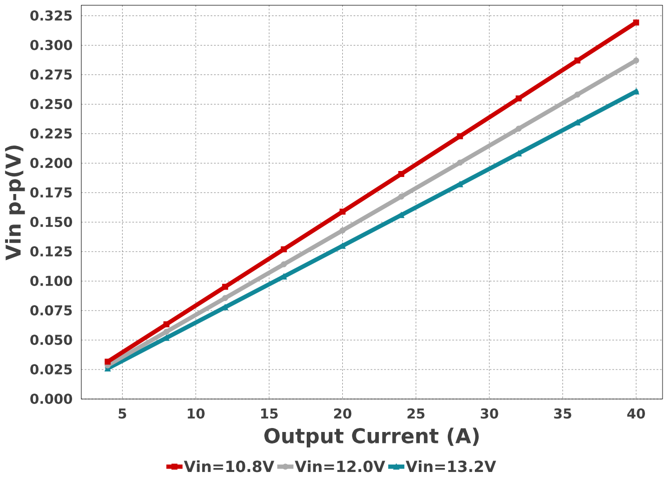
Efficiency



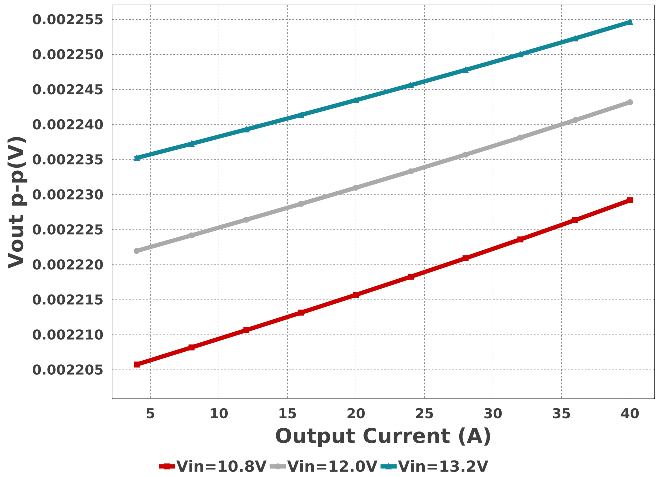
Vin Ripple requirement used for Cin calculations



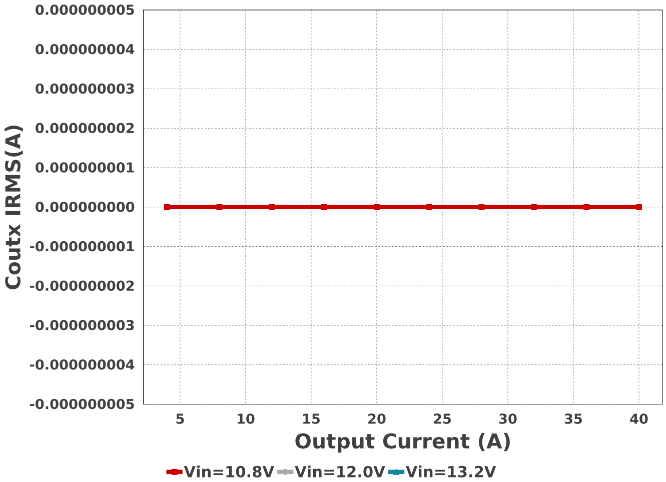
Vin p-p



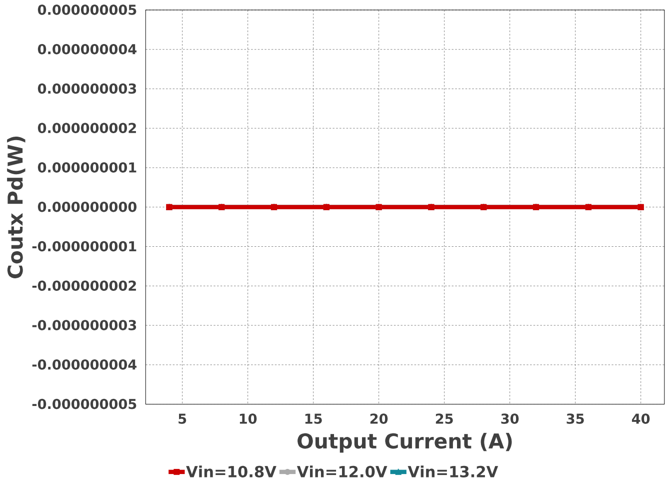
Vout p-p



Coutx IRMS



Coutx Pd



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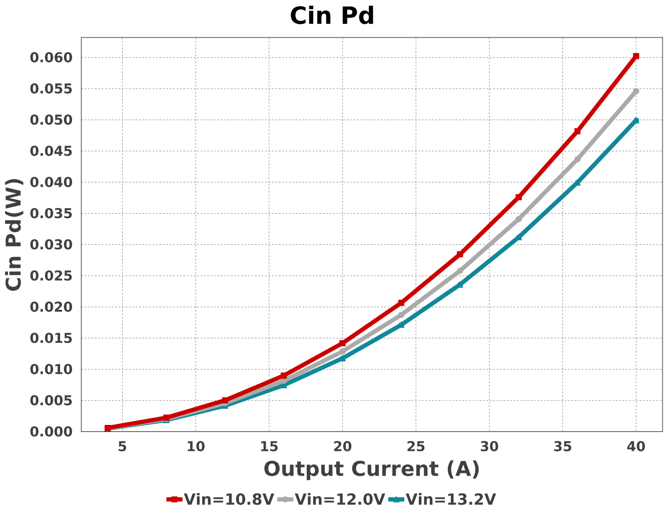

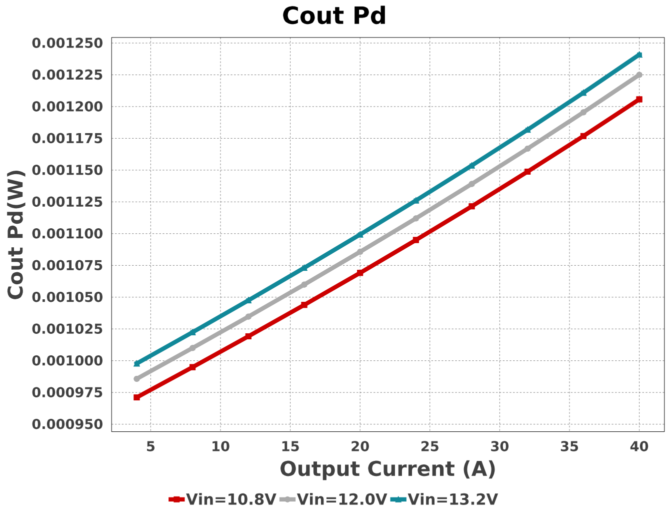

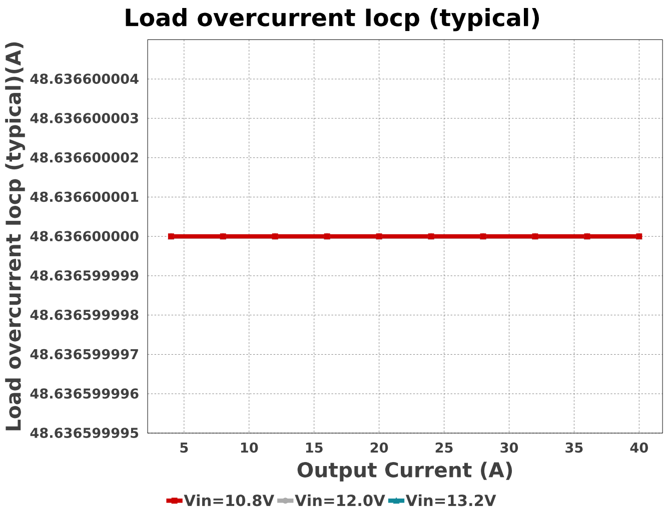

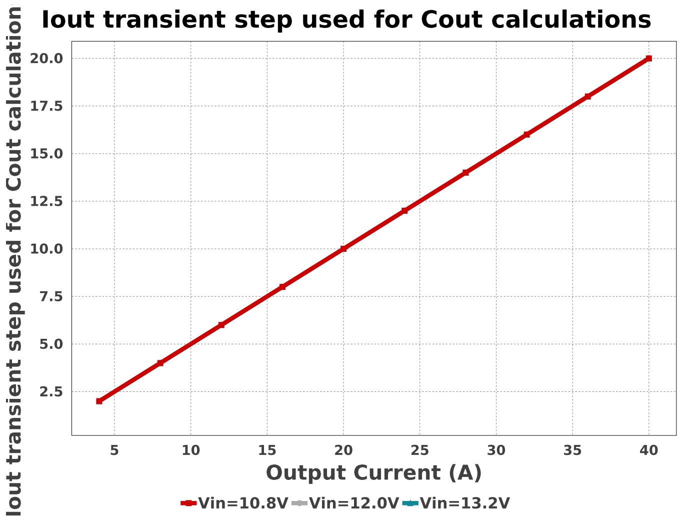

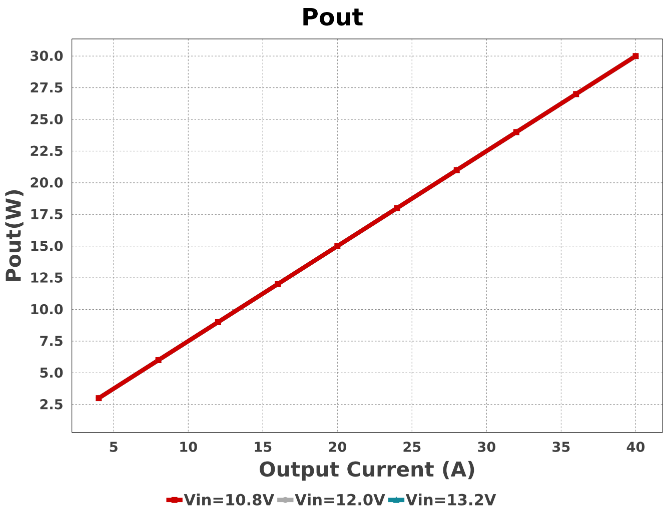

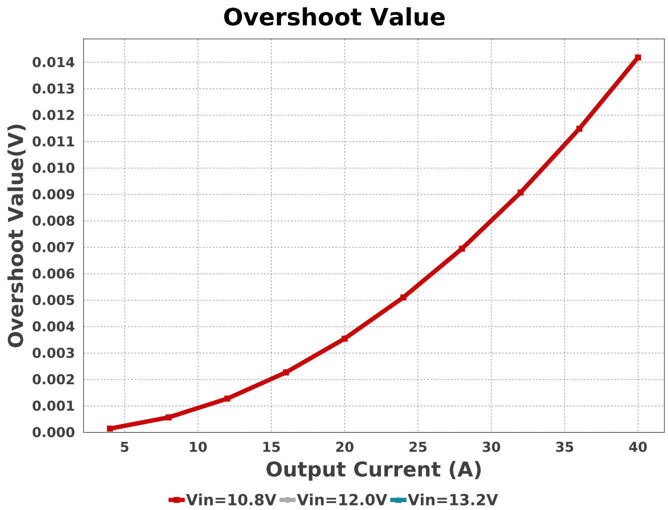

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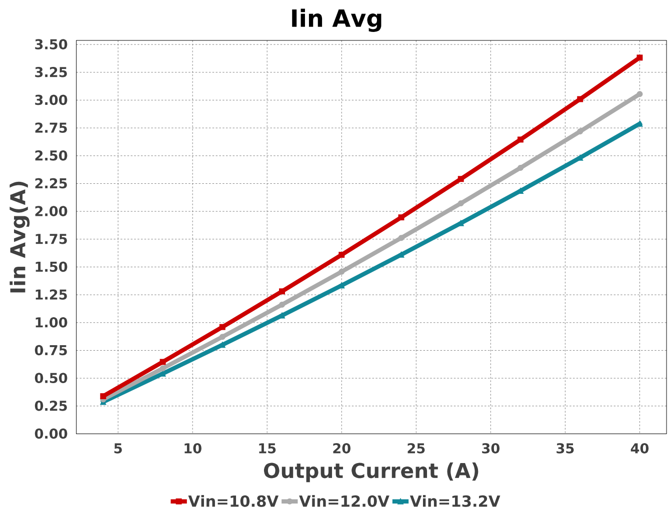
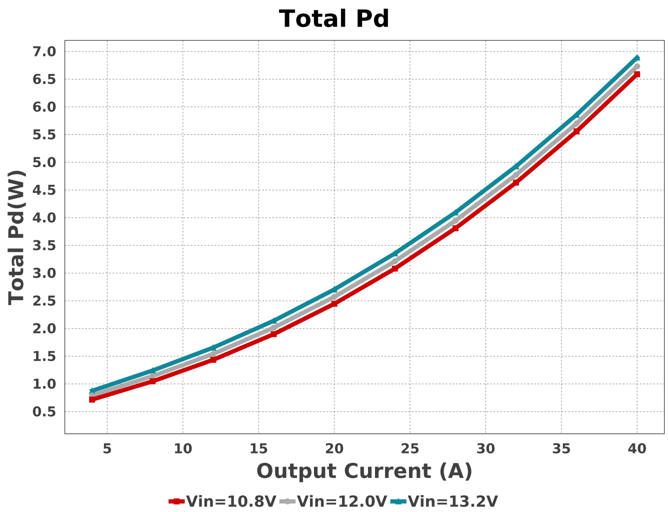
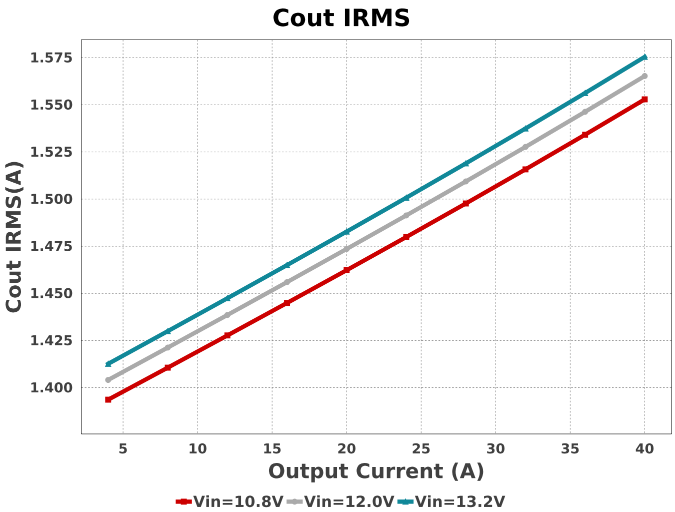
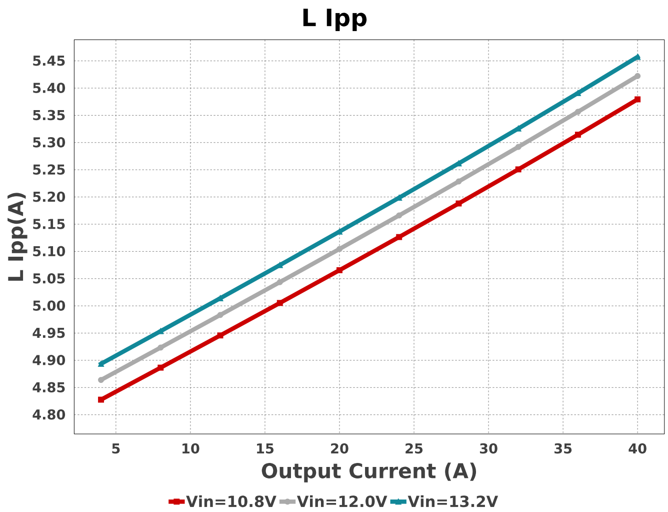
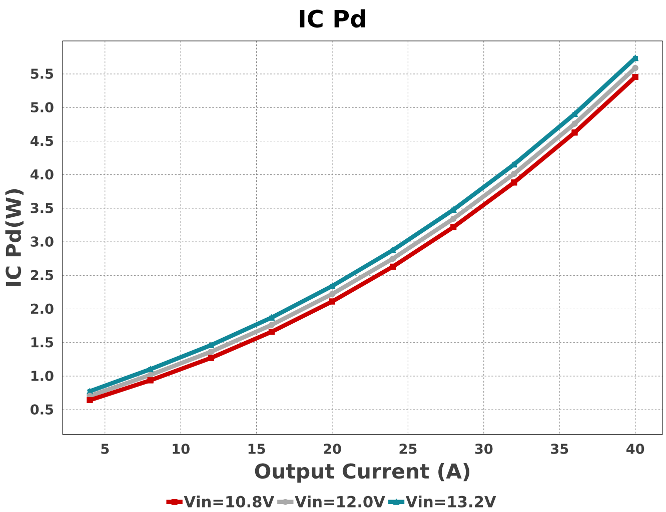
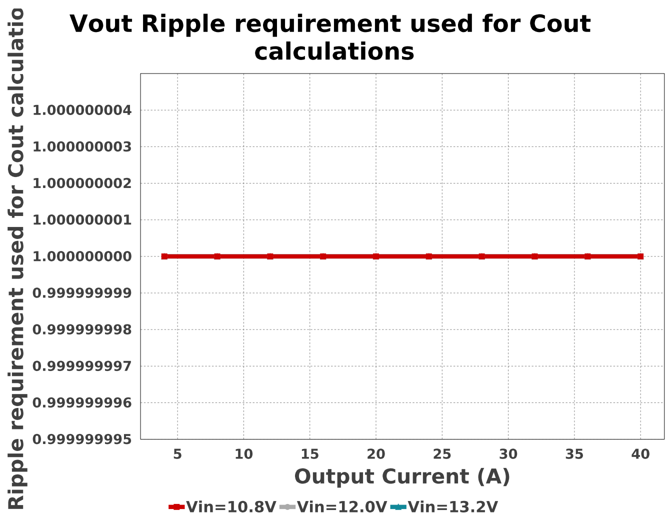

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

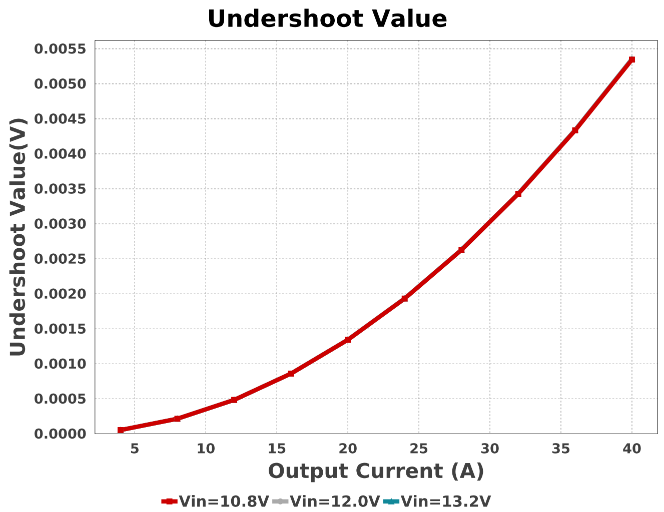

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V

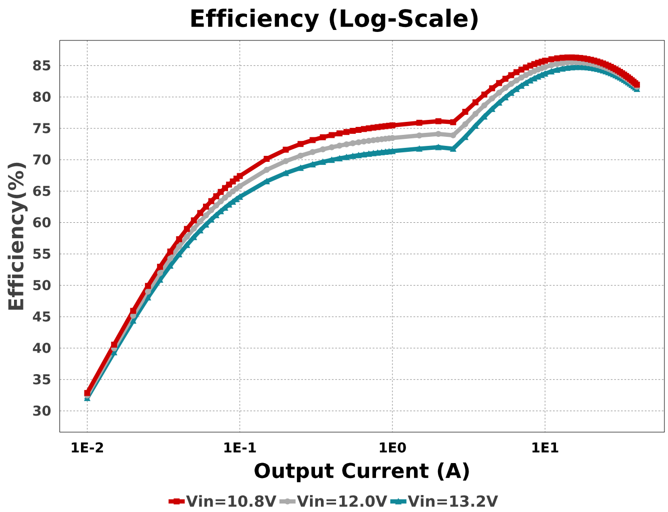

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


L Ipp
L Ipp(A)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V


Vout Ripple requirement used for Cout calculations
Ripple requirement used for Cout calculatio
Output Current (A)
Vin=10.8V Vin=12.0V Vin=13.2V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	38		Total Design BOM count
2.	Ramp Height	R/2		Ramp height
3.	Total BOM	$14.824		Total BOM Cost
4.	Cin IRMS	9.871 A	Capacitor	Input capacitor RMS ripple current
5.	Cin Pd	49.94 mW	Capacitor	Input capacitor power dissipation
6.	Cout IRMS	1.575 A	Capacitor	Output capacitor RMS ripple current
7.	Cout Pd	1.241 mW	Capacitor	Output capacitor power dissipation
8.	Coutx IRMS	0.0 A	Capacitor	Output capacitor_x RMS ripple current
9.	Coutx Pd	0.0 W	Capacitor	Output capacitor_x power loss
10.	IC Pd	5.737 W	IC	IC power dissipation
11.	IC Tj	110.319 degC	IC	IC junction temperature
12.	ICThetaJA Effective	14.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
13.	Iin Avg	2.788 A	IC	Average input current
14.	L Ipp	5.457 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	1.01 W	Inductor	Inductor power dissipation
16.	PMBus Vout Command	384.0	PMBus	PMBus Vout Command
17.	Cin Pd	49.94 mW	Power	Input capacitor power dissipation
18.	Cout Pd	1.241 mW	Power	Output capacitor power dissipation
19.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
20.	IC Pd	5.737 W	Power	IC power dissipation
21.	L Pd	1.01 W	Power	Inductor power dissipation
22.	Snubber Pd	115.031 mW	Power	Snubber Power Dissipation
23.	Total Pd	6.891 W	Power	Total Power Dissipation
24.	Duty Cycle	6.503 %	System Information	Duty cycle
25.	Efficiency	81.272 %	System Information	Steady state efficiency
26.	FootPrint	1,000.0 mm^2	System Information	Total Foot Print Area of BOM components
27.	Frequency	660.19 kHz	System Information	Switching frequency
28.	Iout	40.0 A	System Information	Iout operating point
29.	Iout transient step used for Cout calculations	20.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
30.	Load overcurrent Iocp (typical)	48.637 A	System Information	Over current protection threshold
31.	Mode	CCM	System Information	Conduction Mode
32.	Overshoot Value	14.183 mV	System Information	Theoretical Vout Overshoot Value
33.	Pout	30.0 W	System Information	Total output power
34.	Undershoot Value	5.356 mV	System Information	Theoretical Vout Undershoot Value
35.	Vin	13.2 V	System Information	Vin operating point
36.	Vin Ripple requirement used for Cin calculations	5.0 %	System Information	Custom maximum input ripple requirement that was used for Cin selection(% of Minimum Vin).
37.	Vin p-p	260.798 mV	System Information	Peak-to-peak input voltage

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#	Name	Value	Category	Description
38.	Vout	750.0 mV	System Information	Operational Output Voltage
39.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
40.	Vout Tolerance	600.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	2.255 mV	System Information	Peak-to-peak output ripple voltage
42.	Vout transient requirement used for Cout calculations	2.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

	Name	Value	Description
	Iout	40.0	Maximum Output Current
	VinMax	13.2	Maximum input voltage
	VinMin	10.8	Minimum input voltage
	Vout	750.0 m	Output Voltage
	base_pn	TPS549D22	Base Product Number
	source	DC	Input Source Type
	Ta	30.0	Ambient temperature
1.	Vout Sch	750.0 m	Output voltage selected

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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

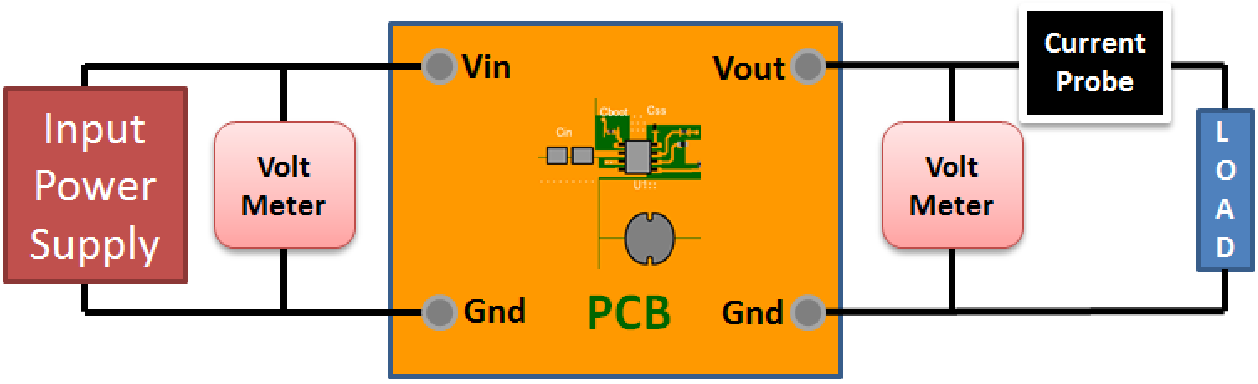
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.8V 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.



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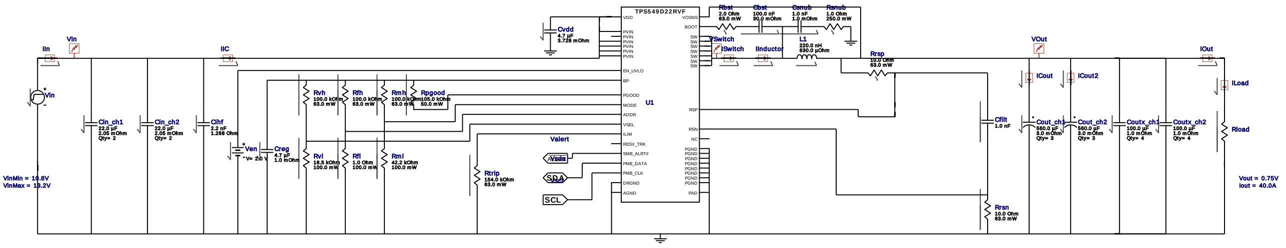
WEBENCH® Electrical Simulation Report

Design Id = 216

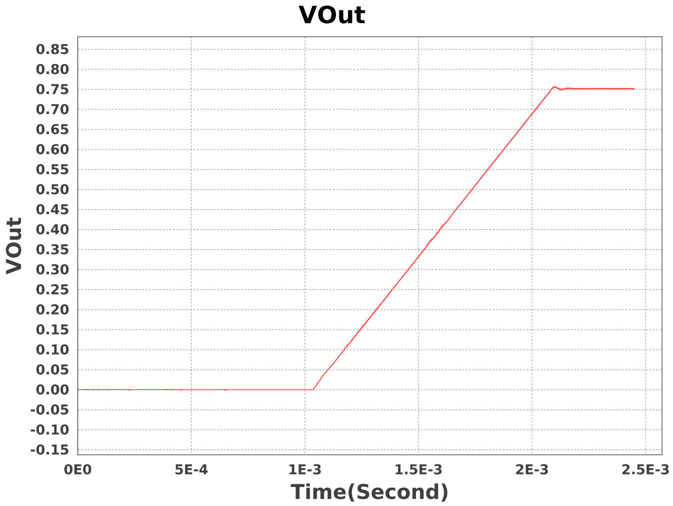
sim_id = 1

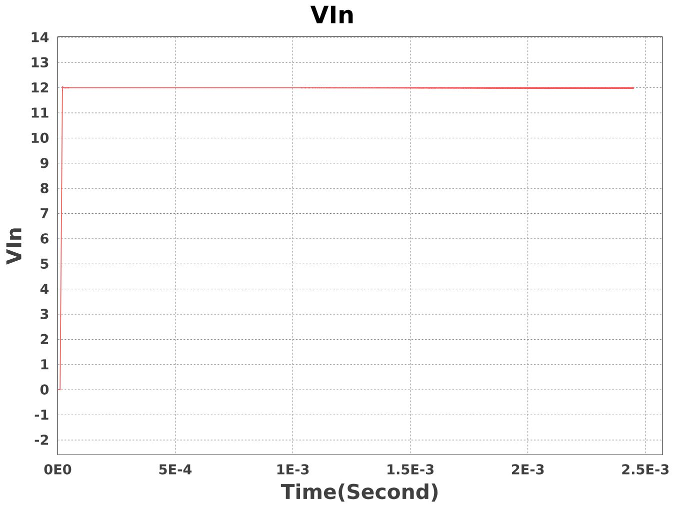
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Ven	signal_type	Signal Type	PULSE
		V1	Initial Input Voltage	0 V
		V2	Peak Input Voltage	5 V
		Td	Initial Time Delay	10u s
		Tr	Rise Time	10u s
2.	Vscl	V	no description	0 V
3.	Vsda	V	no description	0 V
4.	Valert	V	no description	0 V
5.	Rload	R	Load Resistance	0.01875 ohm





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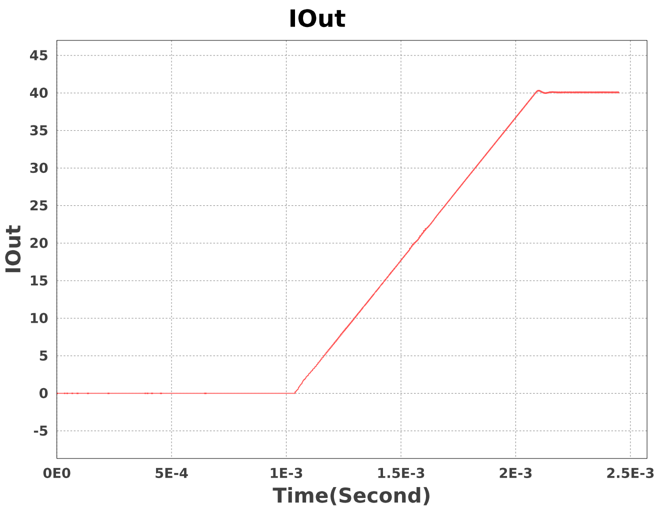
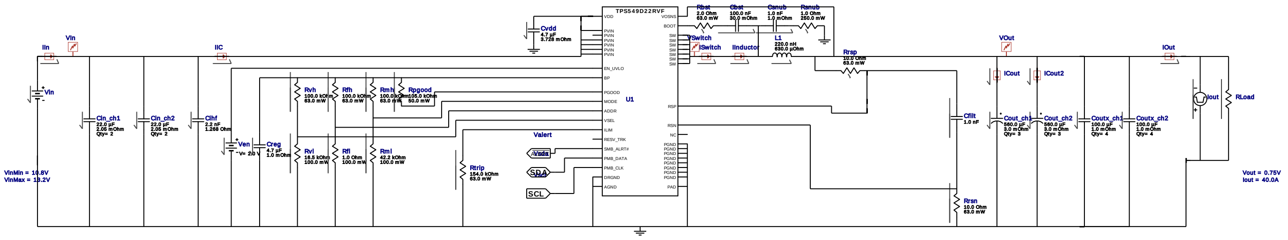

IOut
45
40
35
30
25
20
15
10
5
0
-5
IOut
0E0
5E-4
1E-3
1.5E-3
2E-3
2.5E-3
Time(Second)

Design Id = 216

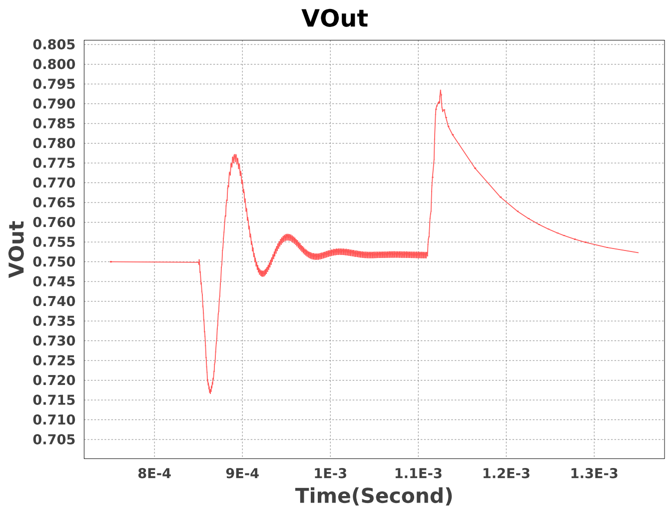
sim_id = 2

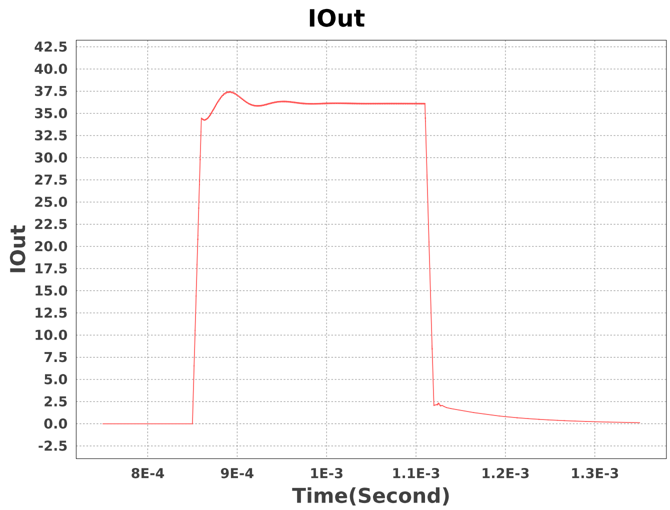
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Current	40.0 A
2.	Coutx_ch1	IC	Initial Voltage	0.7725 V
3.	Coutx_ch2	IC	Initial Voltage	0.7725 V
4.	Ven	V	Input Voltage	2 V
5.	Cout_ch2	IC	Initial Voltage	0.7725 V
6.	Cbst	IC	no description	5
7.	Vscl	V	Input Voltage	0 V
8.	Vsda	V	Input Voltage	0 V
9.	Valert	V	no description	0
10.	Cout_ch1	IC	Initial Voltage	0.7725 V
11.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	40.0 A
		I2	Minimum Load Current	4.0 A
		Td	Initial Time Delay	8.500000000000001E-4 s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse width	2.5E-4
12.	RLoad	R	Load Resistance	0.01875 Ohm





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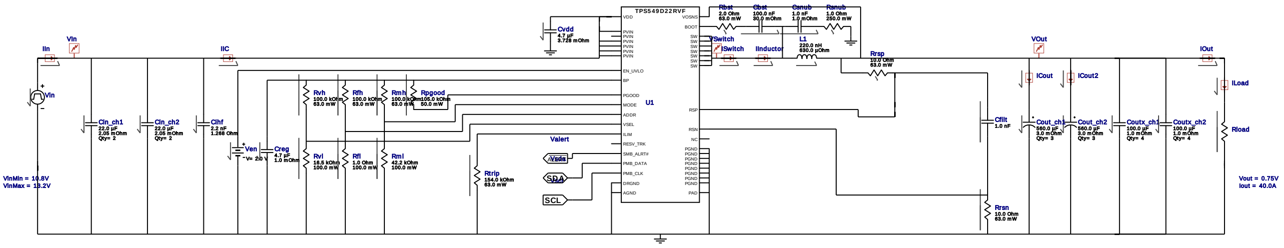
Design Id = 216

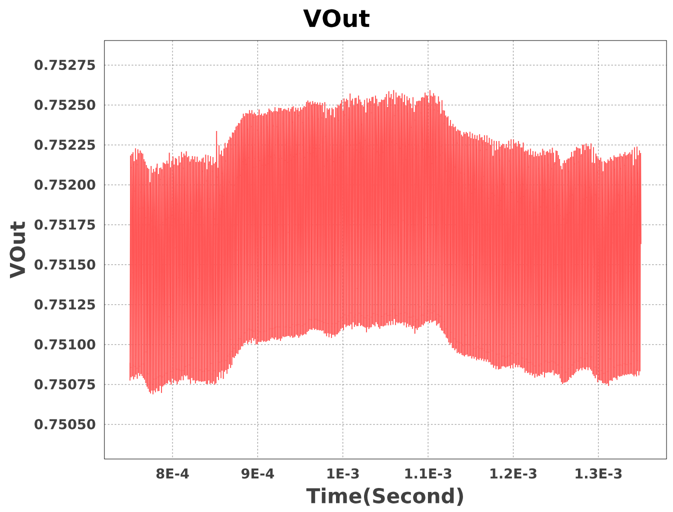
sim_id = 3

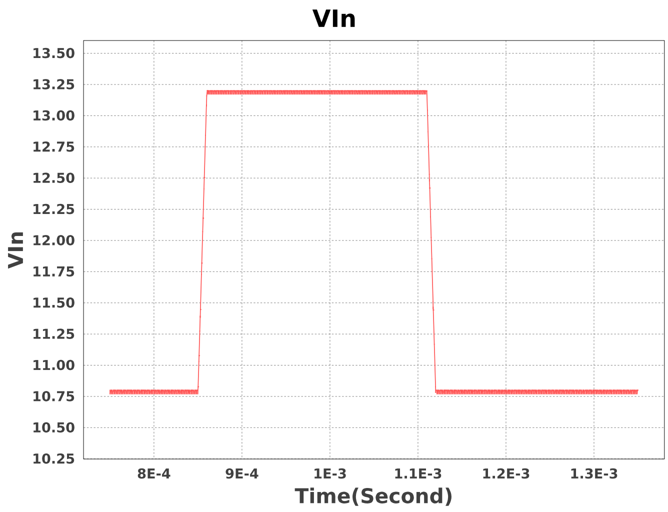
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Current	40.0 A
2.	Coutx_ch1	IC	Initial Voltage	0.7725 V
3.	Coutx_ch2	IC	Initial Voltage	0.7725 V
4.	Ven	V	Input Voltage	2 V
5.	Cout_ch2	IC	Initial Voltage	0.7725 V
6.	Cbst	IC	no description	5
7.	Vscl	V	Input Voltage	0 V
8.	Vsda	V	Input Voltage	0 V
9.	Valert	V	Input Voltage	0 V
10.	Cout_ch1	IC	Initial Voltage	0.7725 V
11.	Rload	R	Load Resistance	0.01875 ohm





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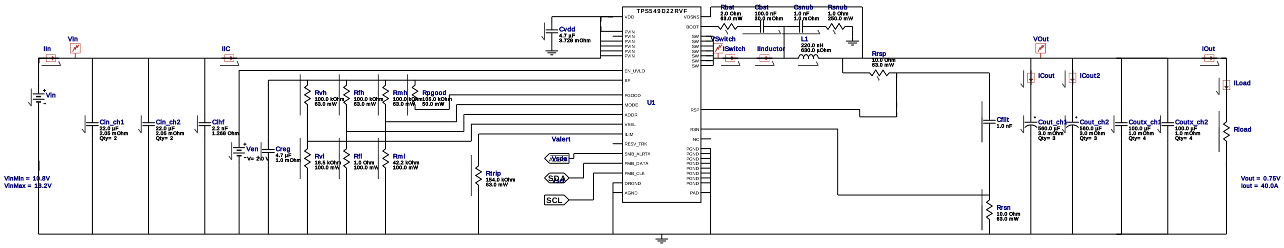
Design Id = 216

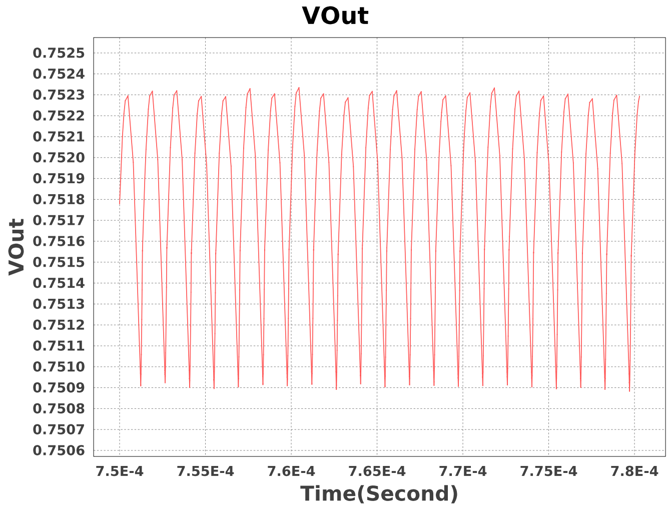
sim_id = 4

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Condition	40.0 A
2.	Coutx_ch1	IC	no description	0.7725
3.	Coutx_ch2	IC	no description	0.7725
4.	Ven	V	Enable Voltage	2 V
5.	Cout_ch2	IC	no description	0.7725
6.	Cbst	IC	no description	5
7.	Vscl	V	no description	0 V
8.	Vsda	V	no description	0 V
9.	Valert	V	no description	0 V
10.	Cout_ch1	IC	no description	0.7725
11.	Rload	R	Load Resistance	0.01875



Design Assistance

1. Master key : 9AF9817288869DC1[v1]

2. **TPS549D22** Product Folder : http://www.ti.com/product/TPS549D22 : contains the data sheet and other resources.

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