Designed with TPSM84824

12V input,

0.95V, 15A output.

1.Output required for TPSM84824

	min		typ	max	
Input Voltage	-5.000 %	11.400 V	12.000 V	12.600 V	5.000 %
Output Voltage	-2.778 %	3.500 V	3.600 V	3.700 V	2.778 %
Output Current	-	-	-	5.000 A	-

2.Design plan for output accuracy

Rfbt=10kohm, ±0.1%

Rfbb=2kohm, ±0.1%

DC accuracy (Ta = 0 ~ 40 ℃)	±0.835 %	
Line Regulation	±0.028 %	;0.1mV/A*8A+α=0.2
Load Regulation	±0.910 %	;0.8mV/V*3.6+α,α=0.4
Output voltage ripple	±0.722 %	;16mV+α,α=10mV
Total accuracy	±2.495 %	

	min		typ	max	
Output Voltage	-2.495 %	3.510 V	3.600 V	3.690 V	2.495 %

I think it meets the required accuracy.

3.Designed files

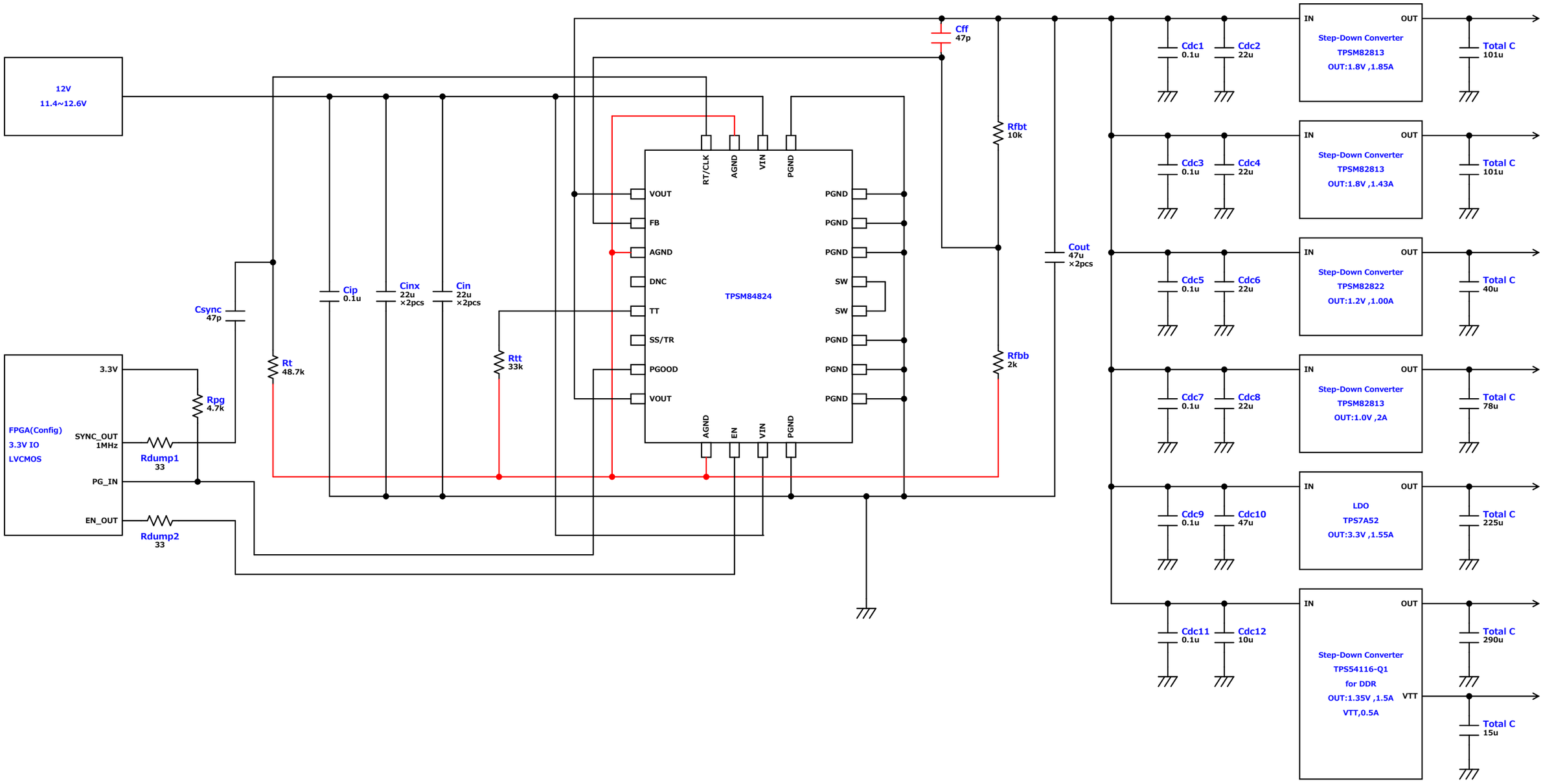
The following materials are available.

- Schematic
- Bills of materials
- WEBNCH Summary Report

4.Comment

This power supply drops 12V to 3.6V and supplies it to the IO power supply (6 power supplies) of the FPGA. Fill in the Schematic. Since LDO3.3V is used, it is set to 3.6V.

An external 1MHz clock is used to synchronize with TPSM82813 (2MHz) and TPS54116-Q1 (1MHz). This is to avoid beat noise.


12V
11.4~12.6V
Cff
47p
Rfbt
10k
Rfbb
2k
Cout
47u
×2pcs
Cip
0.1u
Cinx
22u
×2pcs
Cin
22u
×2pcs
Csync
47p
Rt
48.7k
Rtt
33k
Rpg
4.7k
Rdump1
33
Rdump2
33
FPGA(Config)
3.3V IO
LVCMOS
3.3V
SYNC_OUT
1MHz
PG_IN
EN_OUT
TPSM84824
RT/CLK
AGND
VIN
PGND
VOUT
FB
DNC
TT
SS/TR
PGOOD
EN
SW
Cdc1
0.1u
Cdc2
22u
Step-Down Converter
TPSM82813
OUT:1.8V ,1.85A
Total C
101u
Cdc3
0.1u
Cdc4
22u
Step-Down Converter
TPSM82813
OUT:1.8V ,1.43A
Total C
101u
Cdc5
0.1u
Cdc6
22u
Step-Down Converter
TPSM82822
OUT:1.2V ,1.00A
Total C
40u
Cdc7
0.1u
Cdc8
22u
Step-Down Converter
TPSM82813
OUT:1.0V ,2A
Total C
78u
Cdc9
0.1u
Cdc10
47u
LDO
TPS7A52
OUT:3.3V ,1.55A
Total C
225u
Cdc11
0.1u
Cdc12
10u
Step-Down Converter
TPS54116-Q1
for DDR
OUT:1.35V ,1.5A
VTT,0.5A
VTT
Total C
290u
Total C
15u
IN
OUT

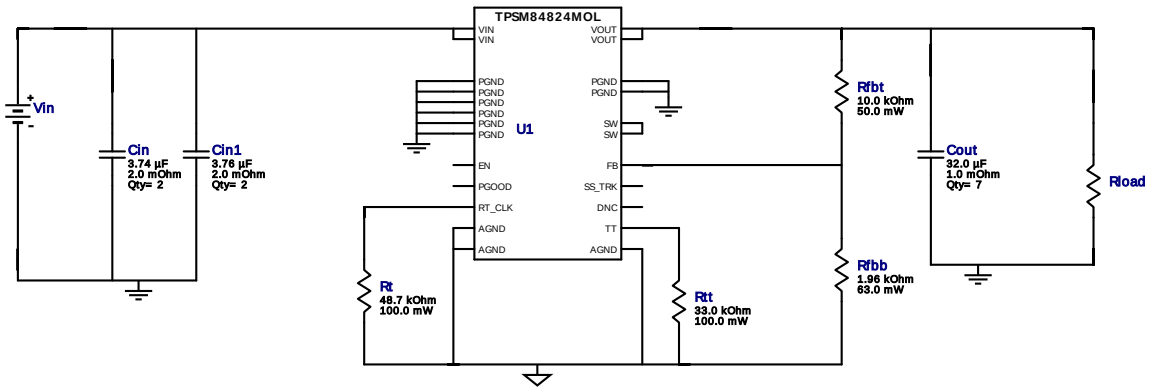
Part	Manufacturer	Part Number	Quantity	Description
Rt	KOA	RK73H1ETTP4872F	1	Resistance: 48.7 kΩ Tolerance: 1.0% Power: 100 mW Package: 0402
Rfbb	KOA	RN73R1ETTP2001B25	1	Resistance: 2 kΩ Tolerance: 1.0% Power: 63 mW Package: 0402
Rfbt	KOA	RN73H1ETTP1002B25	1	Resistance: 10 kΩ Tolerance: 0.1% Power: 63 mW Package: 0402
Rtt	KOA	RK73H1ETTP3302F	1	Resistance:33 kΩ Tolerance: 1.0% Power: 100 mW Package: 0402
Cff	MuRata	GRM0335C1H470JA01D	1	Cap: 47 pF Total Derated Cap: 47 pF VDC: 50 V ESR: 120 mΩ Package: 0201
U1	Texas Instruments	TPSM84824MOLR	1	
Cin	MuRata	GRM21BR61E226ME44L	2	Cap: 22 µF Total Derated Cap: 7.4 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cin1	MuRata	GRM21BR61E226ME44L	2	Cap: 22 µF Total Derated Cap: 7.4 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cout	MuRata	GRM31CR61C476ME44L	2	Cap: 47 µF Total Derated Cap: 32 µF VDC: 16 V ESR: 1 mΩ Package: 1206
Csync	MuRata	GRM0335C1H470JA01D	1	Cap: 47 pF Total Derated Cap: 47 pF VDC: 50 V ESR: 120 mΩ Package: 0201
Rdump1	KOA	RK73H1ETTP33R0F	1	Resistance:33 Ω Tolerance: 1.0% Power: 100 mW Package: 0402
Rdump2	KOA	RK73H1ETTP33R0F	1	Resistance:33 Ω Tolerance: 1.0% Power: 100 mW Package: 0402
Cip	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc1	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc2	MuRata	GRM21BR61E226ME44L	1	Cap: 22 µF Total Derated Cap: 13,6 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cdc3	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc4	MuRata	GRM21BR61E226ME44L	1	Cap: 22 µF Total Derated Cap: 13,6 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cdc5	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc6	MuRata	GRM21BR61E226ME44L	1	Cap: 22 µF Total Derated Cap: 13,6 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cdc7	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc8	MuRata	GRM21BR61E226ME44L	1	Cap: 22 µF Total Derated Cap: 13,6 µF VDC: 25 V ESR: 2 mΩ Package: 0805
Cdc9	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc10	MuRata	GRM31CR61C476ME44L	1	Cap: 47 µF Total Derated Cap: 32 µF VDC: 16 V ESR: 1 mΩ Package: 1206
Cdc11	MuRata	GRM033R61E104KE14D	1	Cap: 0.1 µF Total Derated Cap: 0..068 µF VDC: 25 V ESR: 30 mΩ Package: 0201
Cdc12	MuRata	GRM188R61E106KA73D	1	Cap: 10 µF Total Derated Cap: 5.58 µF VDC: 25 V ESR: 3 mΩ Package: 0603

WEBENCH® Design Report

VinMin = 11.4V
VinMax = 12.6V
Vout = 3.6V
Vout Sch = 3.6V
Iout = 8.0A

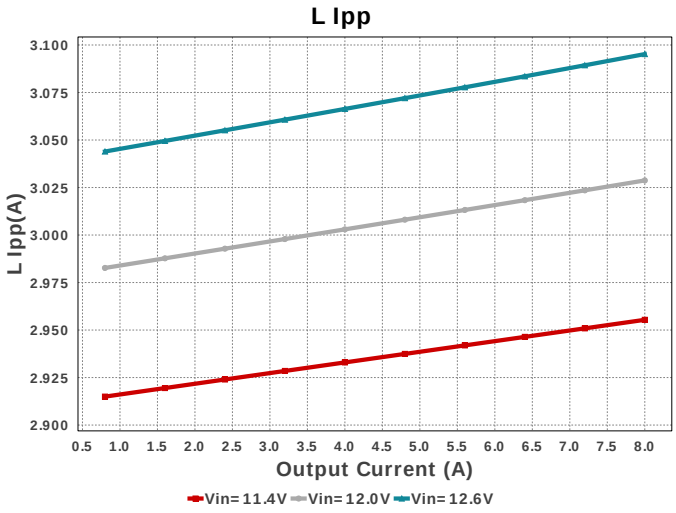
Device = TPSM84824MOLR
Topology = Buck
Created = 2020-09-17 22:25:28.553
BOM Cost = $6.32
BOM Count = 16
Total Pd = 2.58W

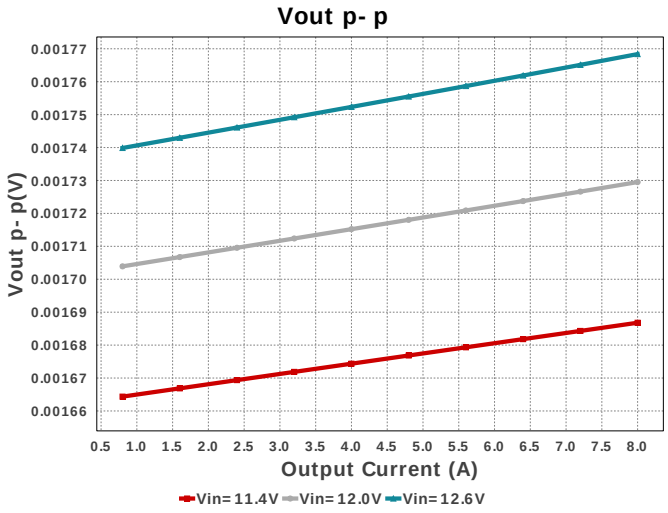
Design : 62 TPSM84824MOLR
TPSM84824MOLR 11.4V-12.6V to 3.60V @ 8A

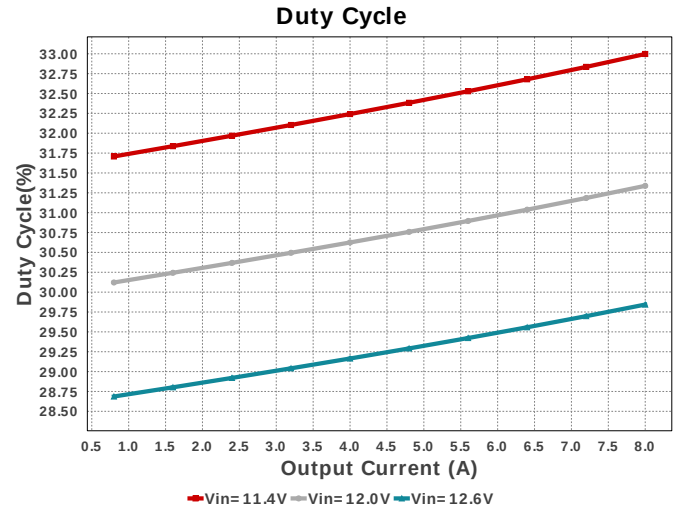


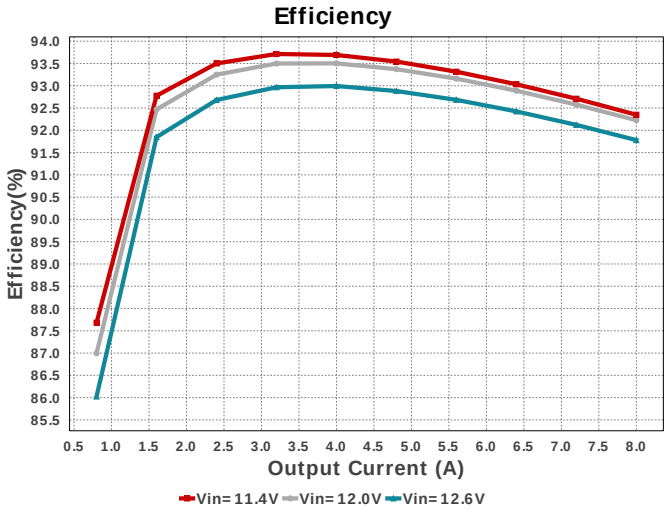
Electrical BOM

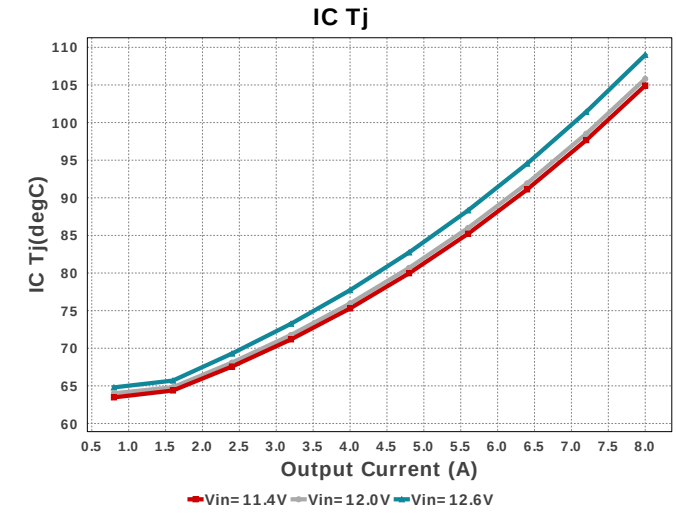
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	MuRata	GRM21BR61E226ME44L Series= X7R	Cap= 3.74 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.87 A	2	$0.10	0805 7 mm²
Cin1	MuRata	GRM21BR61E226ME44L Series= X7R	Cap= 3.76 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.87 A	2	$0.10	0805 7 mm²
Cout	MuRata	GRM31CR61C476ME44L Series= X7R	Cap= 32.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 3.2 A	7	$0.10	1210 11 mm²
Rfbb	Vishay-Dale	CRCW04021K96FKED Series= CRCW..e3	Res= 1.96 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rt	KOA	RK73H1ETTP4872F Series= CRCW..e3	Res= 48.7 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.10	0402 3 mm²
Rtt	MuRata	RK73H1ETTP3302F Series= CRCW..e3	Res= 33.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.10	0402 3 mm²
U1	Texas Instruments	TPSM84824MOLR	Switcher	1	$5.00	MOL0024A 90 mm²

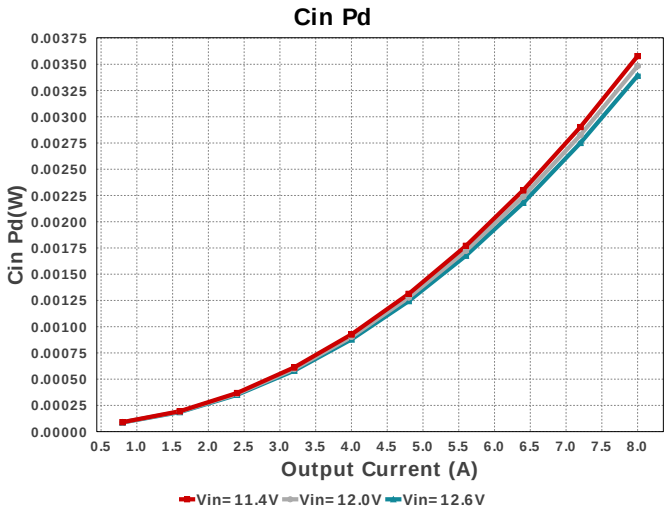




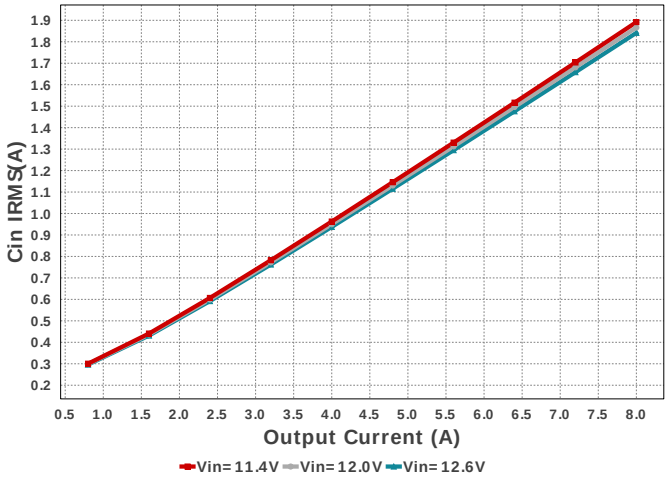




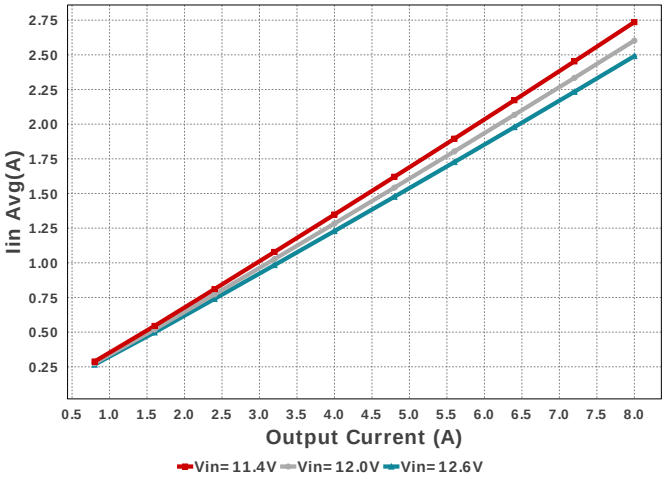




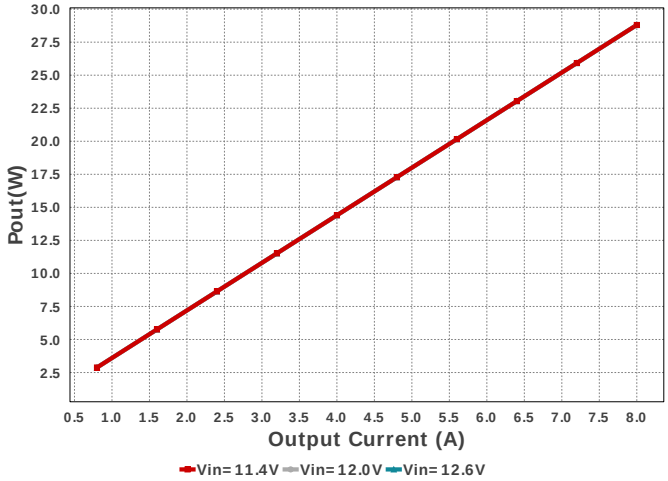
Cin IRMS



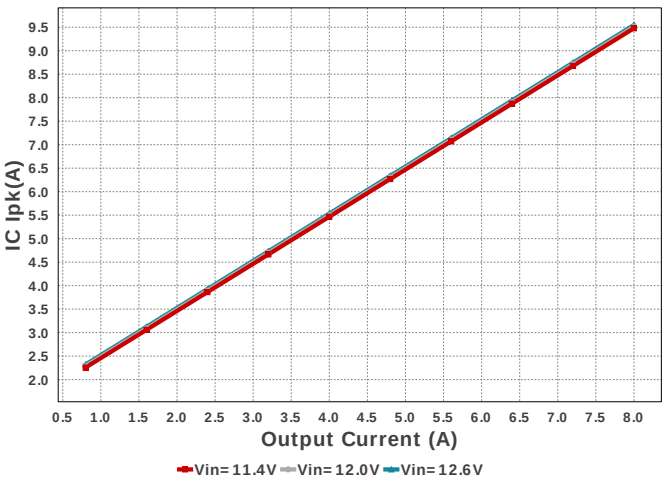
Iin Avg



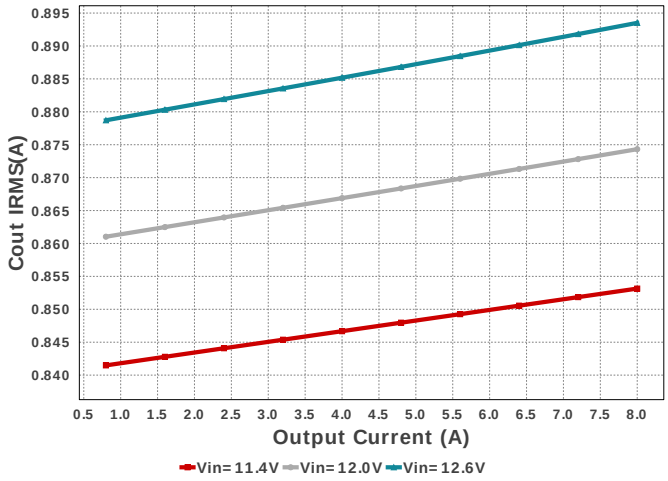
Pout



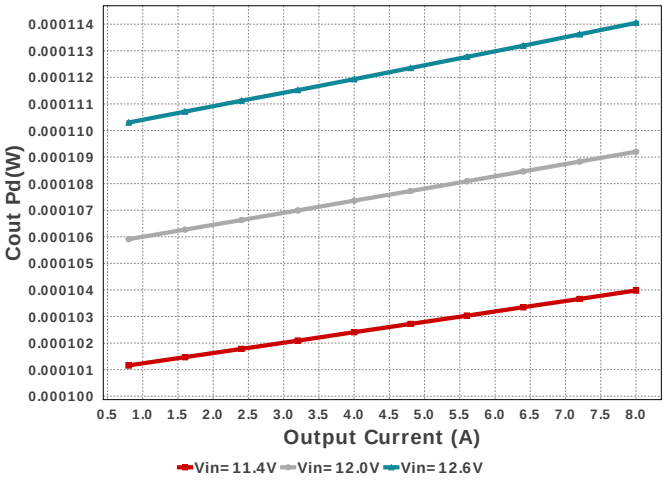
IC Ipk

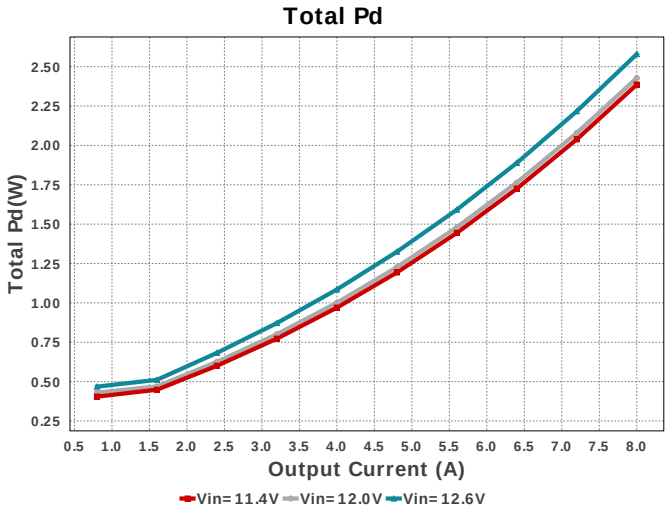


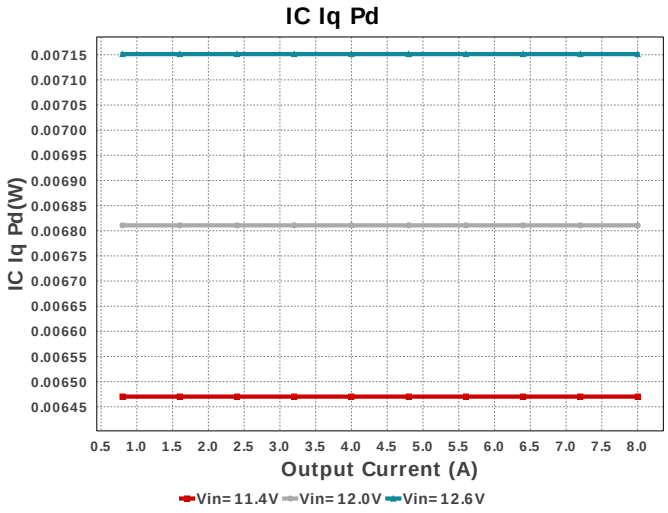
Cout IRMS

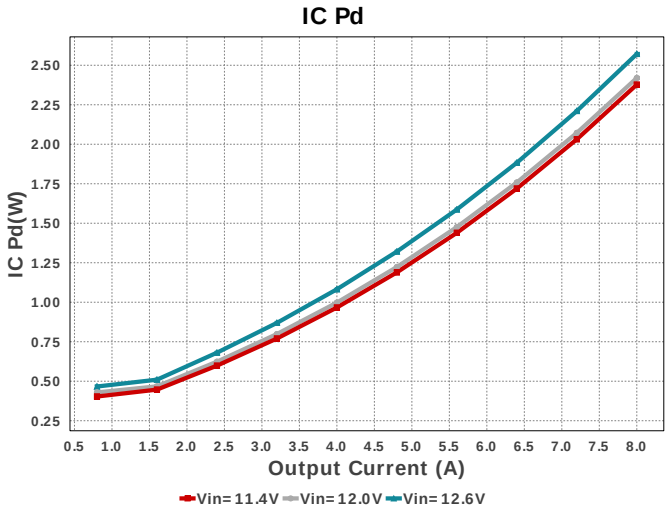


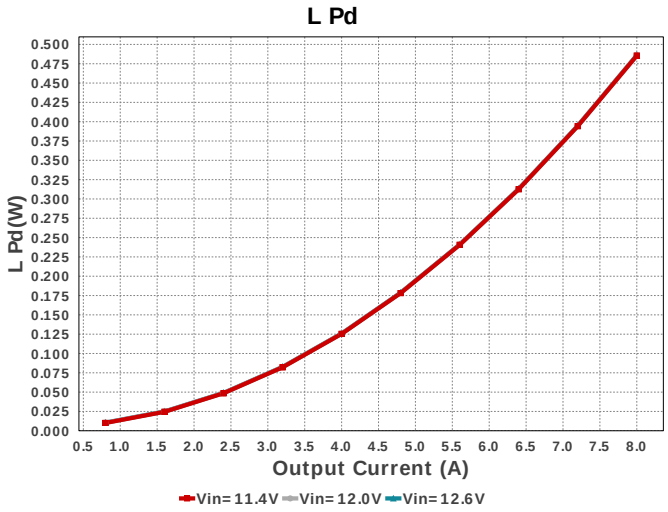
Cout Pd











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	16		Total Design BOM count
2.	Total BOM	$6.32		Total BOM Cost
3.	Cin IRMS	1.842 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	3.391 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	893.51 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	114.05 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	9.548 A	IC	Peak switch current in IC
8.	IC Iq Pd	7.151 mW	IC	IC Iq Pd
9.	IC Pd	2.571 W	IC	IC power dissipation
10.	IC Tj	109.0 degC	IC	IC junction temperature
11.	ICThetaJA Effective	21.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	2.491 A	IC	Average input current
13.	L Ipp	3.095 A	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	485.99 mW	Inductor	Inductor power dissipation
15.	Cin Pd	3.391 mW	Power	Input capacitor power dissipation
16.	Cout Pd	114.05 µW	Power	Output capacitor power dissipation
17.	IC Pd	2.571 W	Power	IC power dissipation
18.	L Pd	485.99 mW	Power	Inductor power dissipation
19.	Total Pd	2.58 W	Power	Total Power Dissipation
20.	Duty Cycle	29.844 %	System Information	Duty cycle
21.	Efficiency	91.78 %	System Information	Steady state efficiency
22.	FootPrint	231.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	995.676 kHz	System Information	Switching frequency
24.	Iout	8.0 A	System Information	Iout operating point
25.	Mode	CCM	System Information	Conduction Mode

#	Name	Value	Category	Description
26.	Pout	28.8 W	System Information	Total output power
27.	Vin	12.6 V	System Information	Vin operating point
28.	Vout	3.6 V	System Information	Operational Output Voltage
29.	Vout Actual	3.661 V	System Information	Vout Actual calculated based on selected voltage divider resistors
30.	Vout Tolerance	3.384 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
31.	Vout p-p	1.768 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

	Name	Value	Description
	Iout	8.0	Maximum Output Current
	SoftStart	1.2 ms	Soft Start Time (ms)
	VinMax	12.6	Maximum input voltage
	VinMin	11.4	Minimum input voltage
	Vout	3.6	Output Voltage
	base_pn	TPSM84824	Base Product Number
	source	DC	Input Source Type
	Ta	55.0	Ambient temperature
	UserFsw	1000.0 k	Customer Selected Frequency
1.	Vout Sch	3.6	Output voltage selected

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

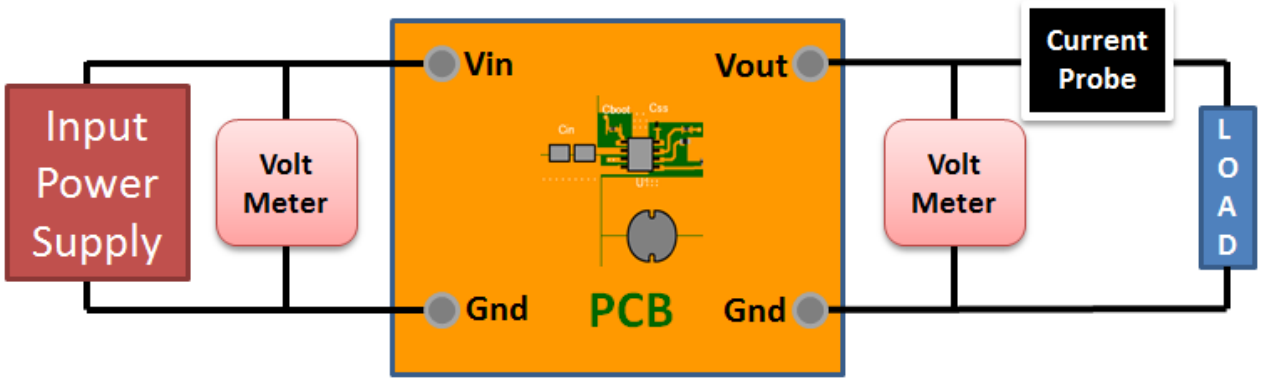
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 11.4V 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.

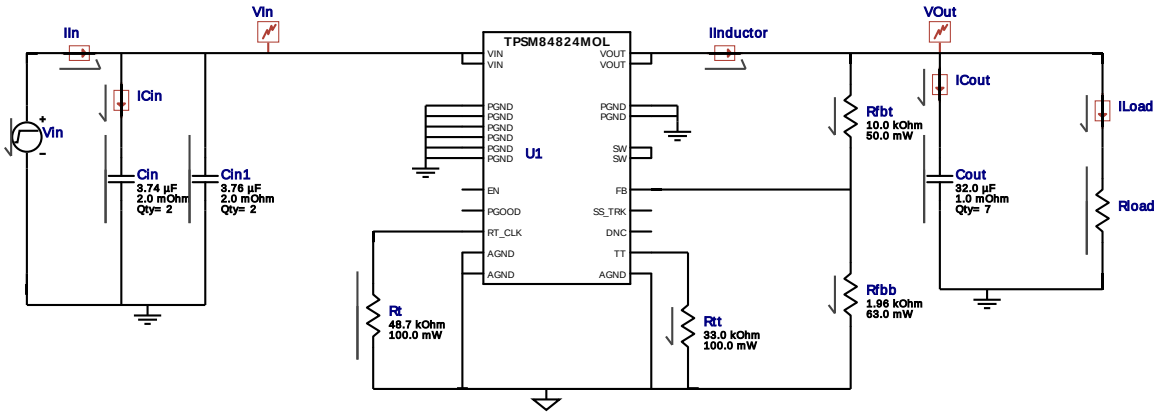


WEBENCH® Electrical Simulation Report

Design Id = 62

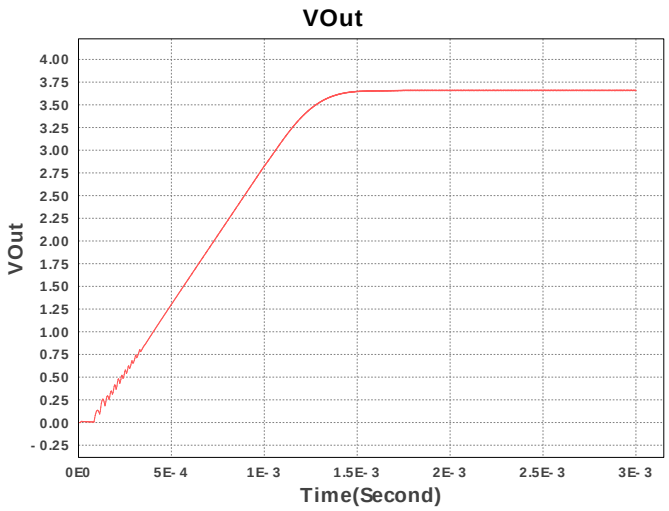
sim_id = 1

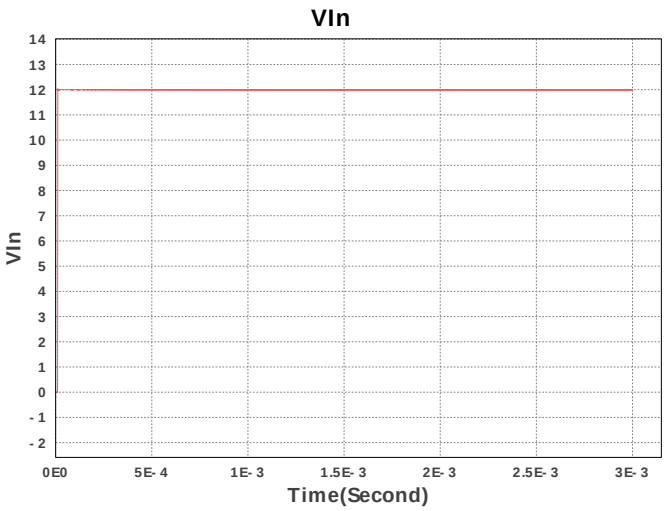
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	0.45 Ohm

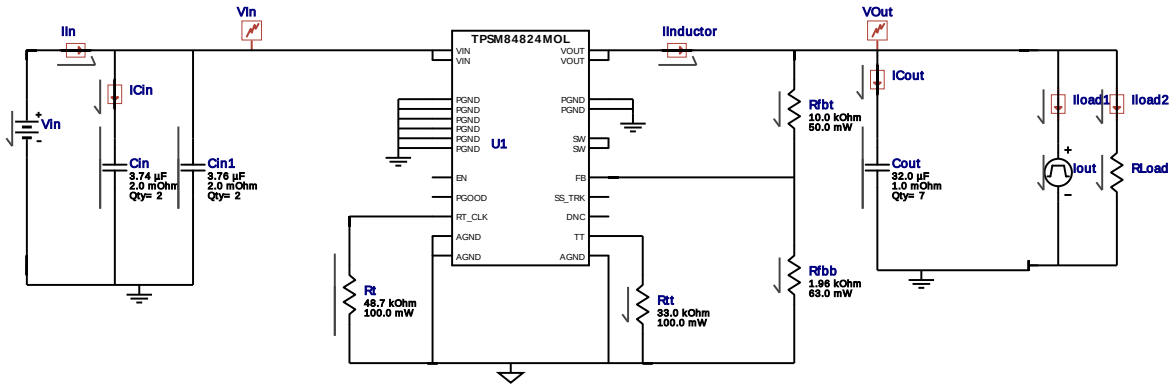




Design Id = 62

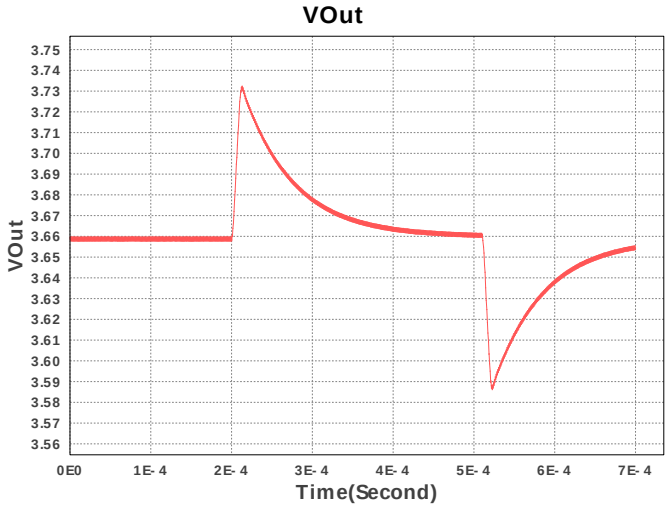
sim_id = 2

Simulation Type = Load Transient



Simulation Parameters

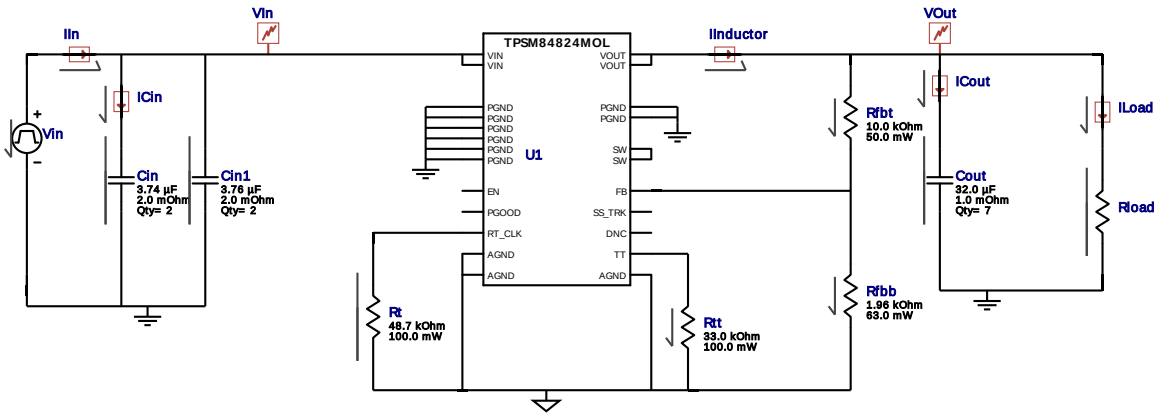
#	Name	Parameter Name	Description	Values
1.	Cin	IC	Initial Voltage	12.0 V
2.	Cout	IC	Initial Voltage	3.6 V
3.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	0 A
		I2	Minimum Load Current	-7.2 A
		Td	Initial Time Delay	0.2m s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	0.3m s
4.	RLoad	R	Load Resistance	0.45 Ohm



Design Id = 62

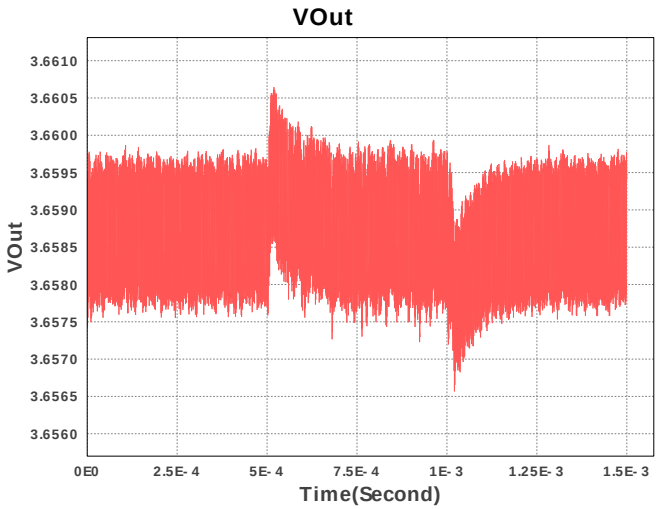
sim_id = 3

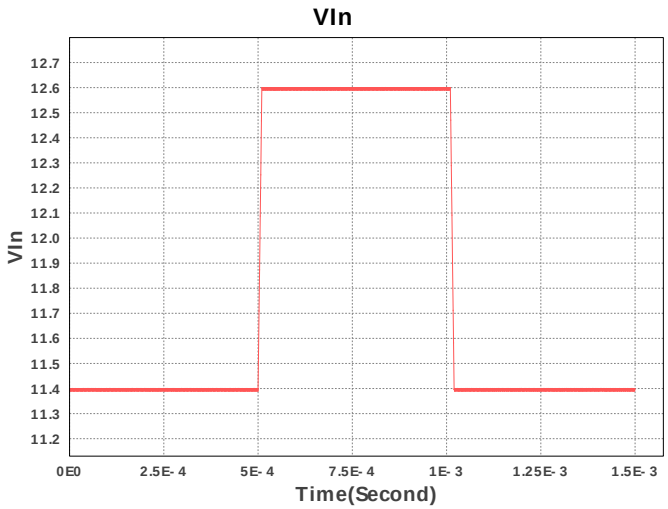
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cin	IC	Initial Voltage	12.0 V
2.	Cout	IC	Initial Voltage	3.6 V
3.	Rload	R	Load Resistance	0.45 Ohm

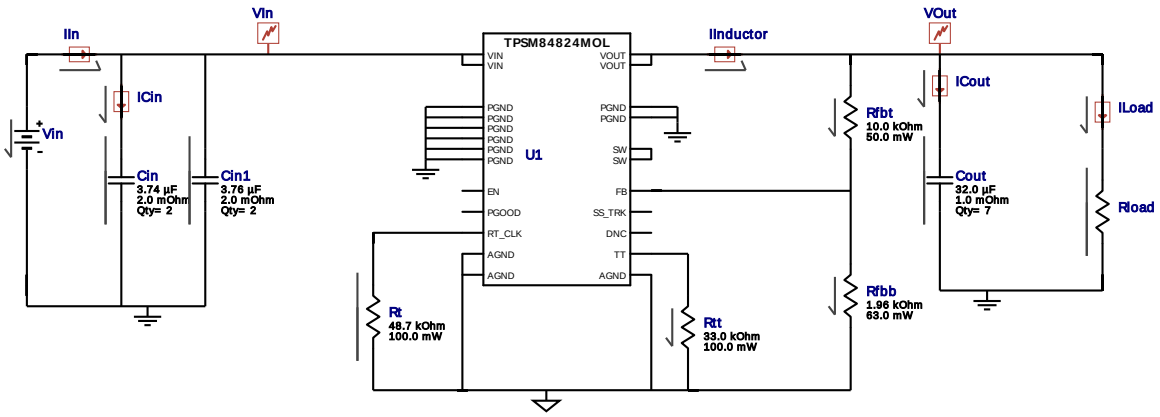




Design Id = 62

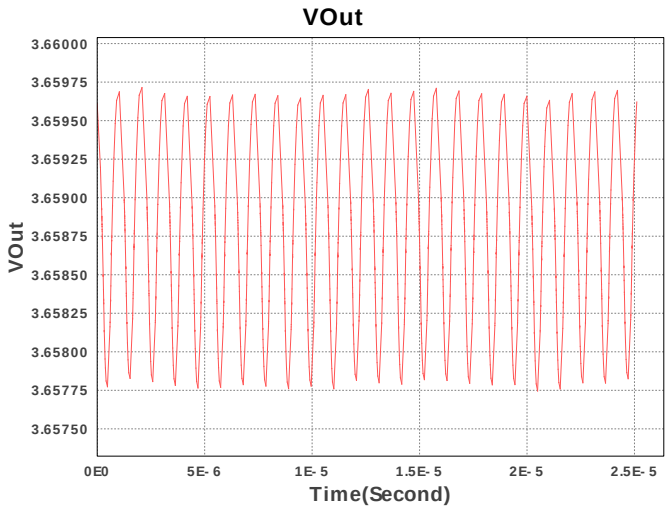
sim_id = 4

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cin	IC	Initial Voltage	12.0 V
2.	Cout	IC	Initial Voltage	3.6 V
3.	Rload	R	Load Resistance	0.45 Ohm



Design Assistance

1. Master key : 4B22EECAC03607DD[v1]
2. **TPSM84824** Product Folder : http://www.ti.com/product/TPSM84824 : contains the data sheet and other resources.