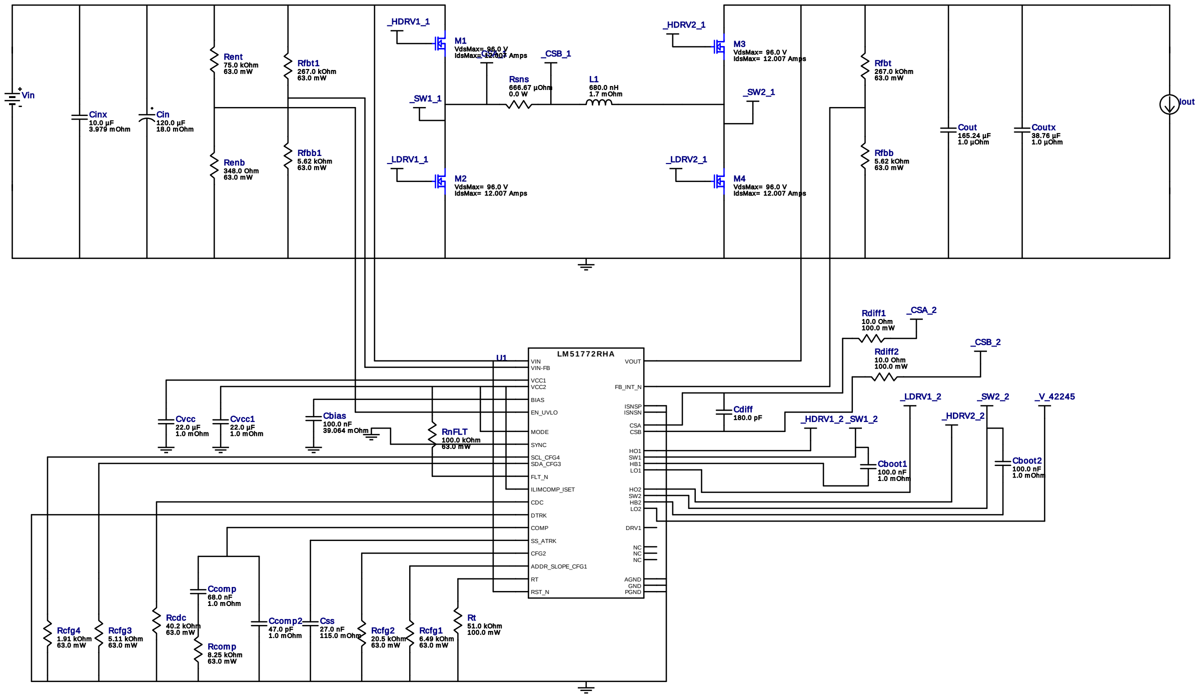
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 22.0V
VinMax = 27.0V
Vout = 48.0V
Iout = 12.0A

Device = LM51772RHAR
Topology = Buck_Boost
Created = 2025-08-13 18:18:10.977
BOM Cost = NA
BOM Count = 36
Total Pd =

Design : 234 LM51772RHAR
LM51772RHAR 22V-27V to 48.00V @ 12A



1. The LM51772 feature AutoMode for better light load efficiency. The operating point calculated in AutoMode configuration are estimate.

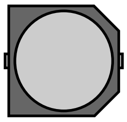
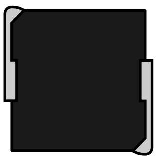
Design Alerts

LM51772 Design

With the design conditions, either the IC or the selected FET junction temperature is exceeded above the maximum rating. Hence, this design is created using an ideal FET. Please note that the resulting FET parameters are ideal, so the efficiency/loss opvals have been disabled. Also, the schematic/PCB export and Thermal simulations will not work with the ideal FET.

Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	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 mm²
Cboot1	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cboot2	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ccomp	MuRata	GRM155R71C683KA88D Series= X7R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp2	MuRata	GRM1555C1E470JA01D Series= C0G/NP0	Cap= 47.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cdiff	Kemet	C0805C181K5GACTU Series= C0G/NP0	Cap= 180.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	Panasonic	35SVPF120M Series= SVPF	Cap= 120.0 uF ESR= 18.0 mOhm VDC= 35.0 V IRMS= 4.4 A	1	$1.33	 CAPSMT_62_F12 151 mm^2
Cinx	Taiyo Yuden	MSASU32MSB5106KPNA01 Series= X5R	Cap= 10.0 uF ESR= 3.979 mOhm VDC= 50.0 V IRMS= 3.4821 A	1	$0.16	1210 15 mm^2
Cout	CUSTOM	CUSTOM Series= ?	Cap= 165.24 uF ESR= 1.0 uOhm VDC= 68.571 V IRMS= 2.96954 A	1	NA	CUSTOM 0 mm^2
Coutx	CUSTOM	CUSTOM Series= ?	Cap= 38.76 uF ESR= 1.0 uOhm VDC= 96.0 V IRMS= 696.56 mA	1	NA	CUSTOM 0 mm^2
Css	Kemet	C0805C273K5RACTU Series= X7R	Cap= 27.0 nF ESR= 115.0 mOhm VDC= 50.0 V IRMS= 728.0 mA	1	$0.02	0805 7 mm^2
Cvcc	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.04	0603 5 mm^2
Cvcc1	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.04	0603 5 mm^2
L1	Bourns	SRP1250-R68M	L= 680.0 nH 1.7 mOhm	1	$0.89	 SRP1250 253 mm^2
M1	NA	IdealFET	VdsMax= 96.0 V IdsMax= 12.007 Amps	1	NA	KCS0003B 80 mm^2
M2	NA	IdealFET	VdsMax= 96.0 V IdsMax= 12.007 Amps	1	NA	KCS0003B 80 mm^2
M3	NA	IdealFET	VdsMax= 96.0 V IdsMax= 12.007 Amps	1	NA	KCS0003B 80 mm^2
M4	NA	IdealFET	VdsMax= 96.0 V IdsMax= 12.007 Amps	1	NA	KCS0003B 80 mm^2
Rcdc	Vishay-Dale	CRCW040240K2FKED Series= CRCW..e3	Res= 40.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcfg1	Vishay-Dale	CRCW04026K49FKED Series= CRCW..e3	Res= 6.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcfg2	Vishay-Dale	CRCW040220K5FKED Series= CRCW..e3	Res= 20.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcfg3	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcfg4	Vishay-Dale	CRCW04021K91FKED Series= CRCW..e3	Res= 1.91 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

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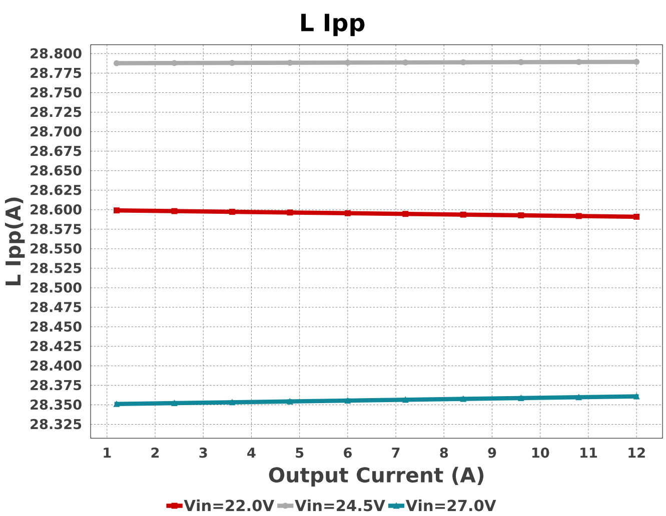
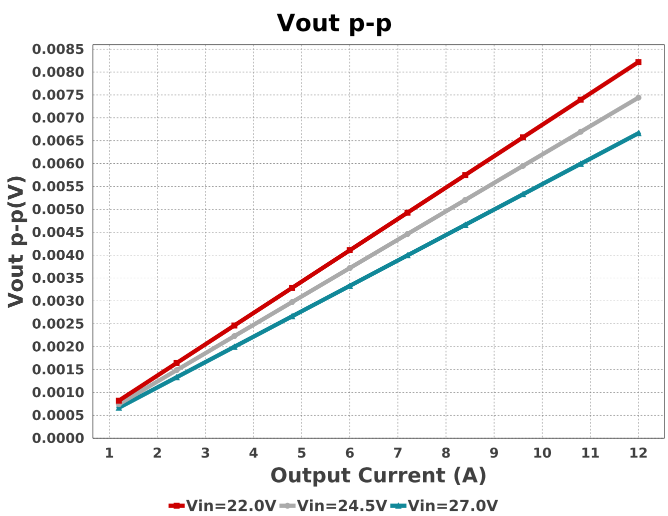
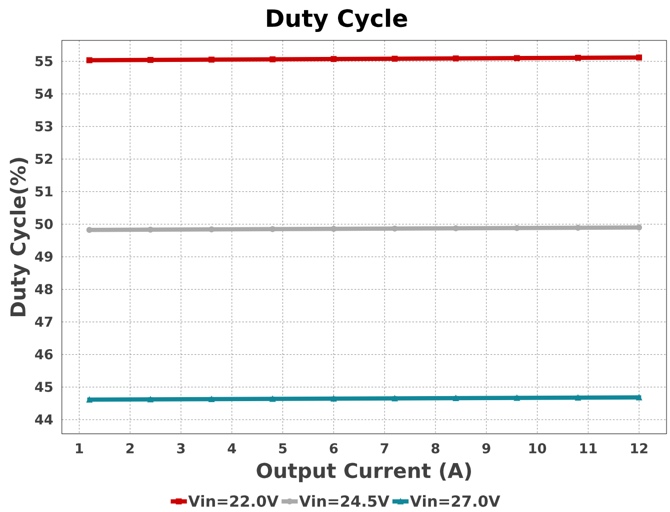
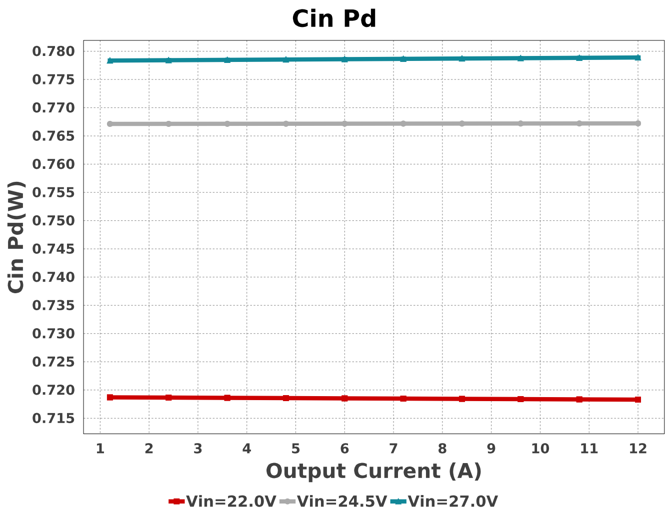
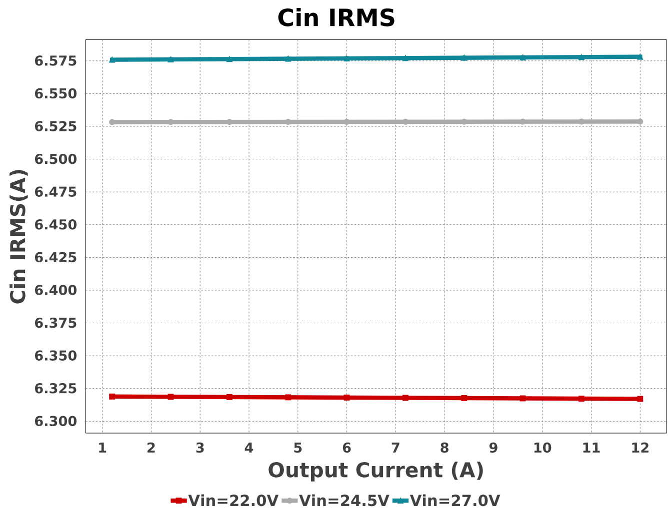
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rcomp	Vishay-Dale	CRCW04028K25FKED Series= CRCW..e3	Res= 8.25 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rdiff1	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rdiff2	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Renb	Vishay-Dale	CRCW0402348RFKED Series= CRCW..e3	Res= 348.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rent	Vishay-Dale	CRCW040275K0FKED Series= CRCW..e3	Res= 75.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04025K62FKED Series= CRCW..e3	Res= 5.62 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb1	Vishay-Dale	CRCW04025K62FKED Series= CRCW..e3	Res= 5.62 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW0402267KFKED Series= CRCW..e3	Res= 267.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt1	Vishay-Dale	CRCW0402267KFKED Series= CRCW..e3	Res= 267.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
RnFLT	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsns	CUSTOM	CUSTOM Series= ?	Res= 666.67 uOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rt	Yageo	RC0603FR-0751KL Series= ?	Res= 51.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LM51772RHAR	Switcher	1	$3.12	RHA0040P 64 mm^2

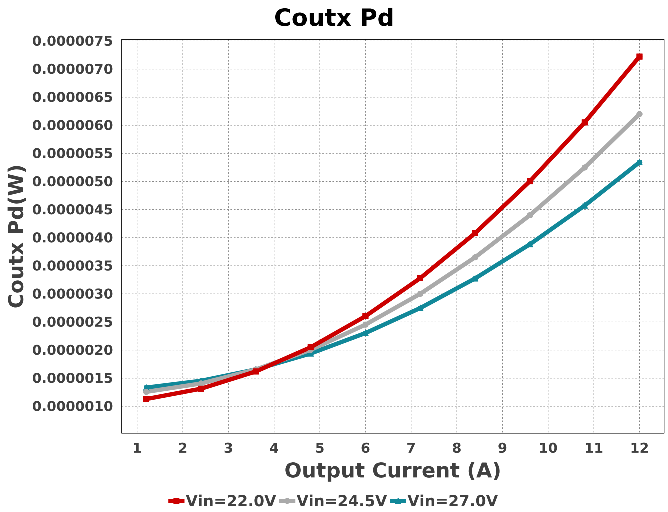


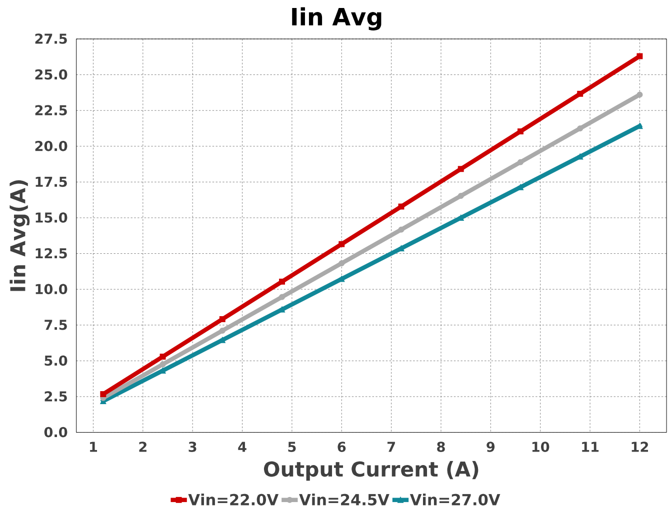


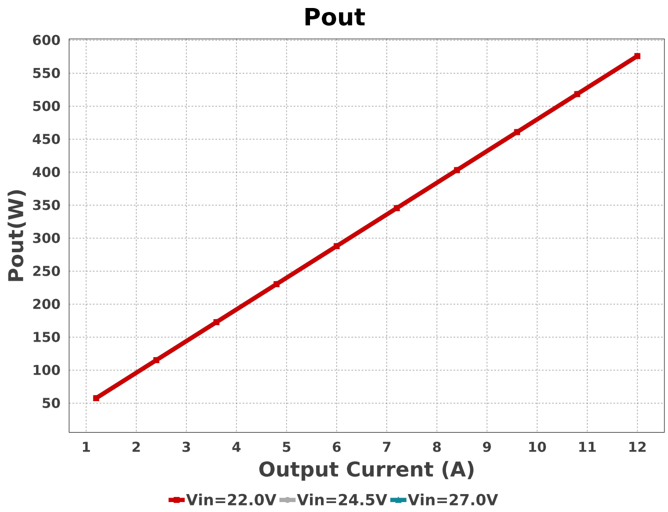

Duty Cycle
Duty Cycle(%)
55
54
53
52
51
50
49
48
47
46
45
44
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V


Cin Pd
Cin Pd(W)
0.780
0.775
0.770
0.765
0.760
0.755
0.750
0.745
0.740
0.735
0.730
0.725
0.720
0.715
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V

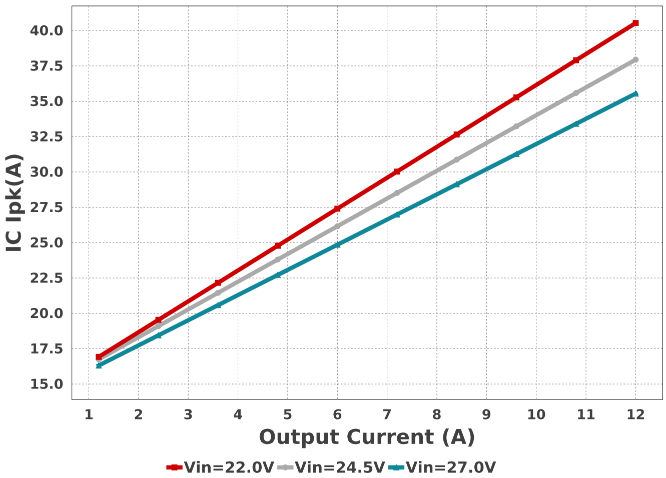

Cin IRMS
Cin IRMS(A)
6.575
6.550
6.525
6.500
6.475
6.450
6.425
6.400
6.375
6.350
6.325
6.300
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V


Coutx Pd
Coutx Pd(W)
0.0000075
0.0000070
0.0000065
0.0000060
0.0000055
0.0000050
0.0000045
0.0000040
0.0000035
0.0000030
0.0000025
0.0000020
0.0000015
0.0000010
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V

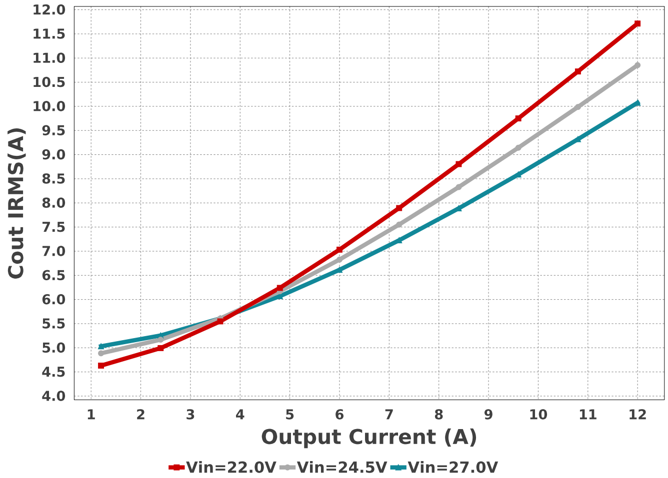

Iin Avg
Iin Avg(A)
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V


Pout
Pout(W)
600
550
500
450
400
350
300
250
200
150
100
50
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=22.0V Vin=24.5V Vin=27.0V

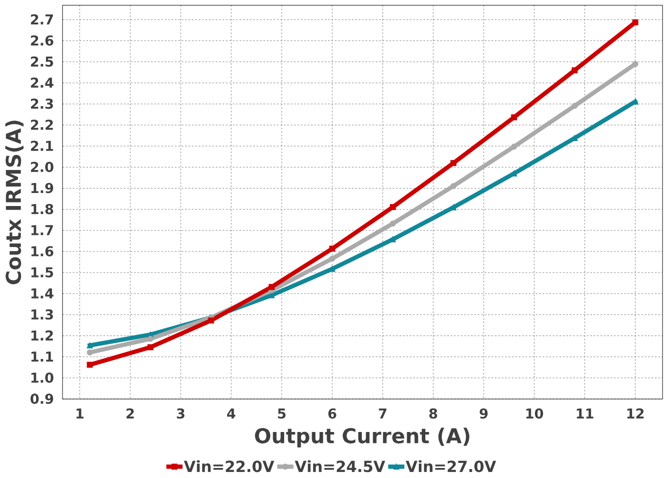
IC Ipk



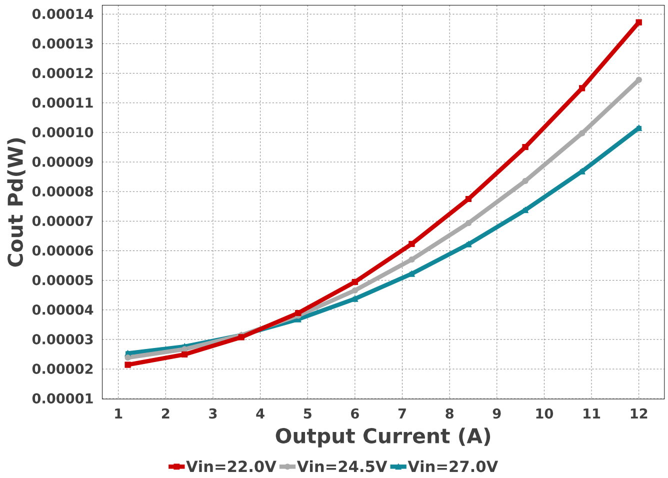
Cout IRMS



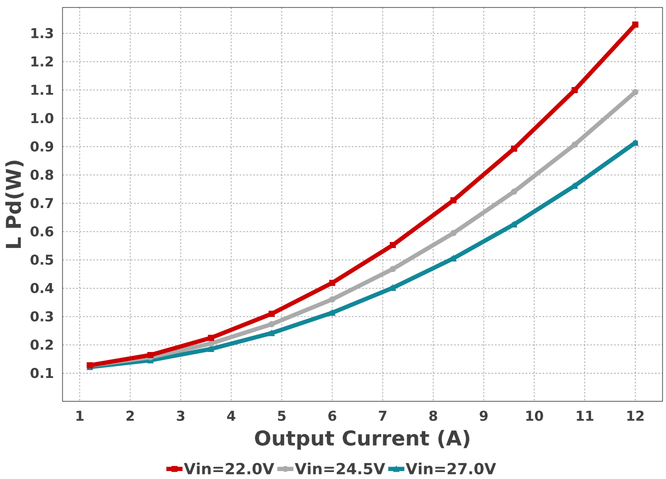
Coutx IRMS



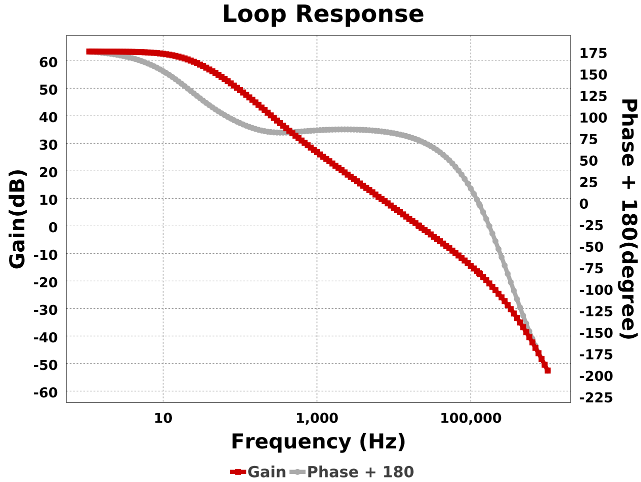
Cout Pd



L Pd



Loop Response



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	6.317 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	718.3 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	11.665 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	136.08 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	2.736 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	7.488 µW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	40.53 A	IC	Peak switch current in IC
8.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
9.	Iin Avg	26.295 A	IC	Average input current
10.	L Ipp	28.591 A	Inductor	Peak-to-peak inductor ripple current
11.	L Pd	1.331 W	Inductor	Inductor power dissipation

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#	Name	Value	Category	Description
12.	Cin Pd	718.3 mW	Power	Input capacitor power dissipation
13.	Cout Pd	136.08 µW	Power	Output capacitor power dissipation
14.	Coutx Pd	7.488 µW	Power	Output capacitor_x power loss
15.	L Pd	1.331 W	Power	Inductor power dissipation
16.	BOM Count	36	System Information	Total Design BOM count
17.	Cross Freq	17.791 kHz	System Information	Bode plot crossover frequency
18.	Duty Cycle	55.117 %	System Information	Duty cycle
19.	FootPrint	981.0 mm^2	System Information	Total Foot Print Area of BOM components
20.	Frequency	612.745 kHz	System Information	Switching frequency
21.	Gain Marg	-16.811 dB	System Information	Bode Plot Gain Margin
22.	Iout	12.0 A	System Information	Iout operating point
23.	Low Freq Gain	61.573 dB	System Information	Gain at 1Hz
24.	Mode	CCM	System Information	Conduction Mode
25.	Phase Marg	74.0 deg	System Information	Bode Plot Phase Margin
26.	Pout	576.0 W	System Information	Total output power
27.	Total BOM	NA	System Information	Total BOM Cost
28.	Vin	22.0 V	System Information	Vin operating point
29.	Vout	48.0 V	System Information	Operational Output Voltage
30.	Vout Actual	48.509 V	System Information	Vout Actual calculated based on selected voltage divider resistors
31.	Vout Tolerance	2.998 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	8.42 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	12.0	Maximum Output Current
VinMax	27.0	Maximum input voltage
VinMin	22.0	Minimum input voltage
Vout	48.0	Output Voltage
base_pn	LM51772	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

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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

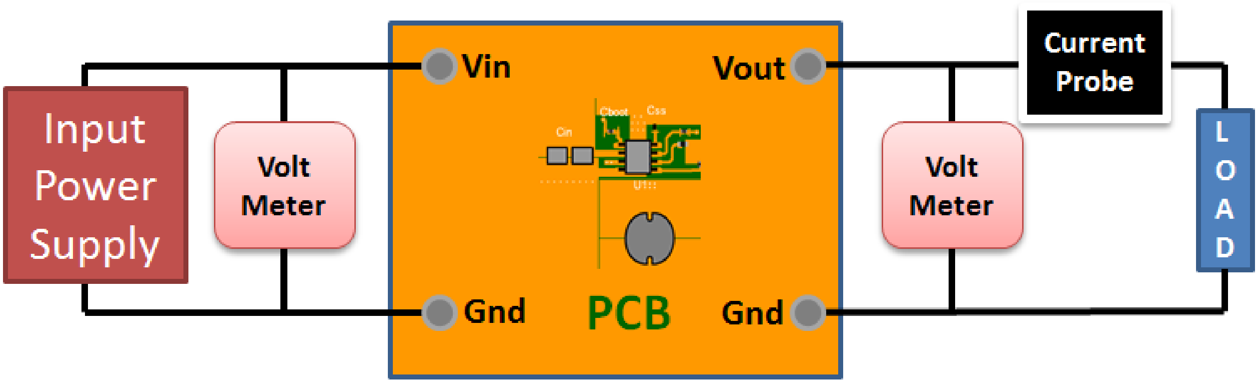
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 22.0V 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 : A540F5FC52A5D074[v1]

2. **LM51772** Product Folder : http://www.ti.com/product/LM51772 : contains the data sheet and other resources.

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