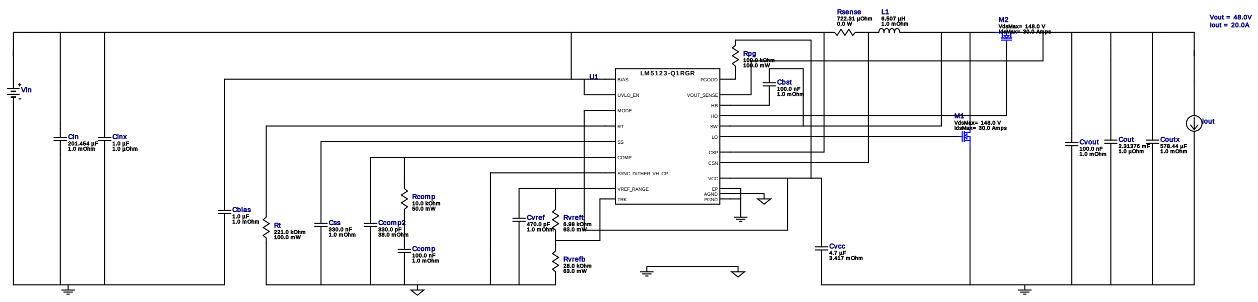
VinMin = 15.0V
VinMax = 28.0V
Vout = 48.0V
Iout = 20.0A

Device = LM5123QRGRRQ1
Topology = Boost
Created = 2024-06-13 13:09:00.752
BOM Cost = NA
BOM Count = 22
Total Pd =

WEBENCH ® Design Report

Design : 1 LM5123QRGRRQ1
LM5123QRGRRQ1 15V-28V to 48.00V @ 20A



Design Alerts

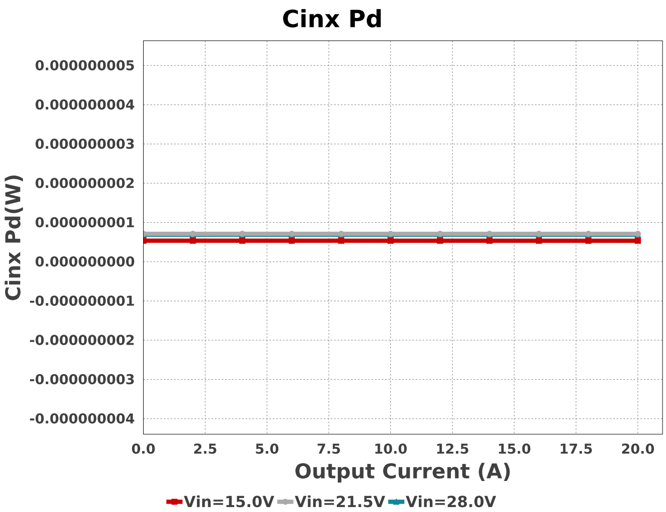
Component Selection Information

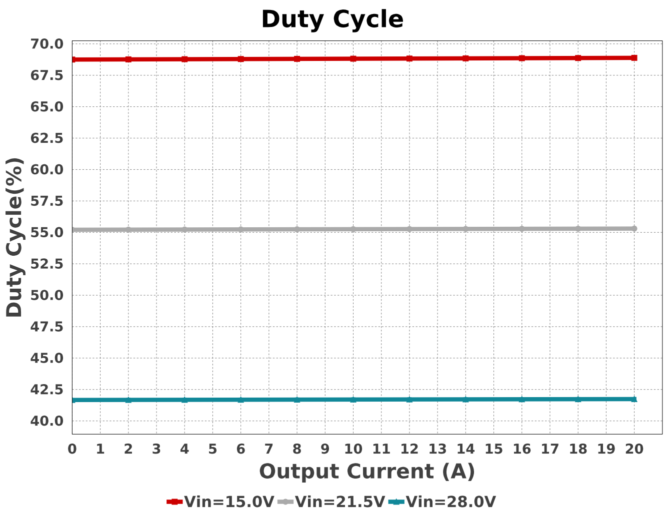
The LM5123-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

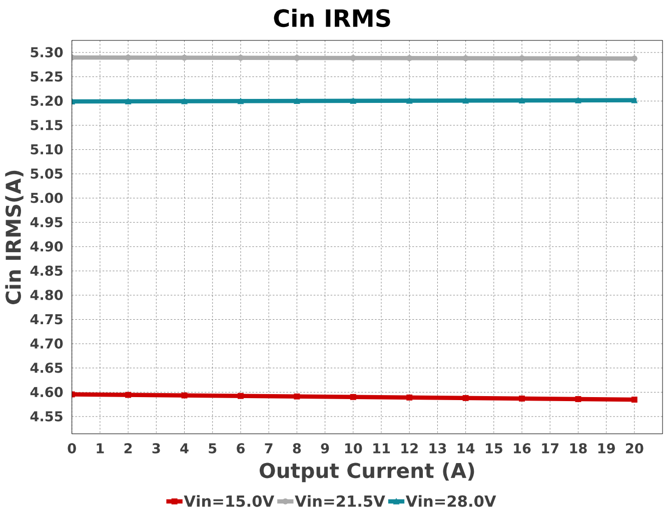
Electrical BOM

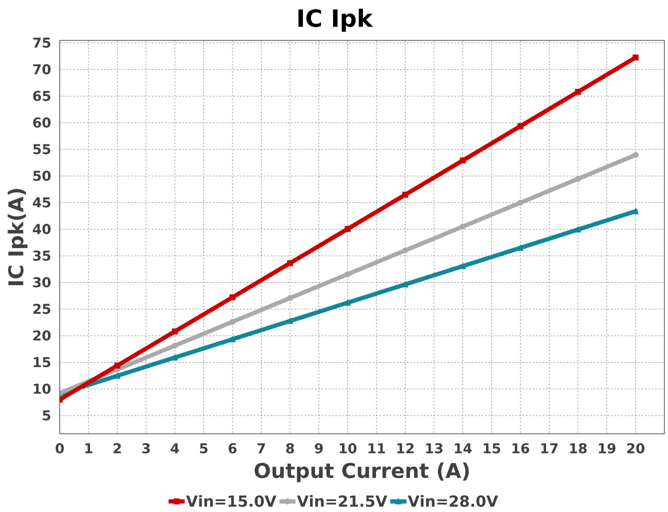
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Kemet	C0603C105K8PACTU Series= X5R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cbst	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM155R70J104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	Kemet	C0805C331J5GACTU Series= C0G/NP0	Cap= 330.0 pF ESR= 38.0 mOhm VDC= 50.0 V IRMS= 1.04 A	1	$0.01	0805 7 mm^2
Cin	CUSTOM	CUSTOM Series= ?	Cap= 201.454 uF ESR= 1.0 mOhm VDC= 33.6 V IRMS= 6.5828 A	1	NA	CUSTOM 0 mm^2
Cinx	CUSTOM	CUSTOM Series= ?	Cap= 1.0 uF ESR= 1.0 uOhm VDC= 33.6 V IRMS= 6.5828 A	1	NA	CUSTOM 0 mm^2
Cout	CUSTOM	CUSTOM Series= ?	Cap= 2.31376 mF ESR= 1.0 uOhm VDC= 62.4 V IRMS= 19.4653 A	1	NA	CUSTOM 0 mm^2
Coutx	CUSTOM	CUSTOM Series= ?	Cap= 578.44 uF ESR= 1.0 mOhm VDC= 72.0 V IRMS= 3.31 A	1	NA	CUSTOM 0 mm^2
Css	Kemet	C0603C334K8RACTU Series= X7R	Cap= 330.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2

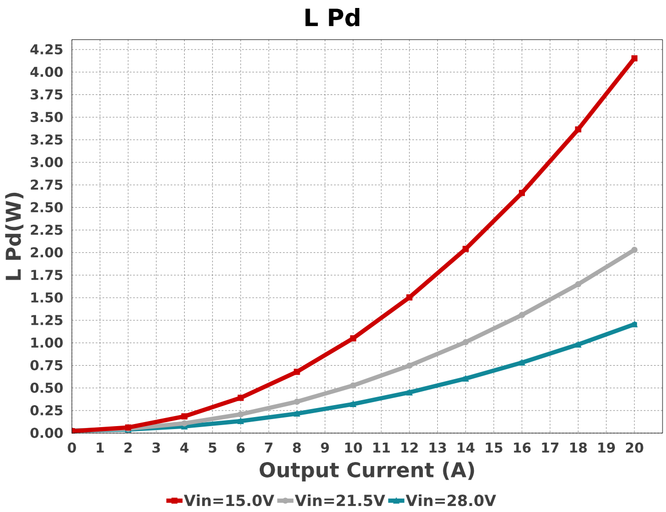
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	TDK	C1005X5R1A475K050BC Series= X5R	Cap= 4.7 uF ESR= 3.417 mOhm VDC= 10.0 V IRMS= 2.7063 A	1	$0.10	0402_065 3 mm²
Cvout	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvref	MuRata	GRM1555C1E471JA01D Series= C0G/NP0	Cap= 470.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
L1	CUSTOM	CUSTOM	L= 6.507 µH 1.0 mOhm	1	NA	CUSTOM 0 mm²
M1	NA	IdealFET	VdsMax= 148.0 V IdsMax= 30.0 Amps	1	NA	KCS0003B 80 mm²
M2	NA	IdealFET	VdsMax= 148.0 V IdsMax= 30.0 Amps	1	NA	KCS0003B 80 mm²
Rcomp	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rsense	CUSTOM	CUSTOM Series= ?	Res= 722.31 uOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rt	Vishay-Dale	CRCW0603221KFKEA Series= CRCW..e3	Res= 221.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rvrefb	Vishay-Dale	CRCW040228K0FKED Series= CRCW..e3	Res= 28.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rvreft	Vishay-Dale	CRCW04026K98FKED Series= CRCW..e3	Res= 6.98 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM5123QRGRRQ1	Switcher	1	$1.59	RTE0016C-IPC_A 16 mm²

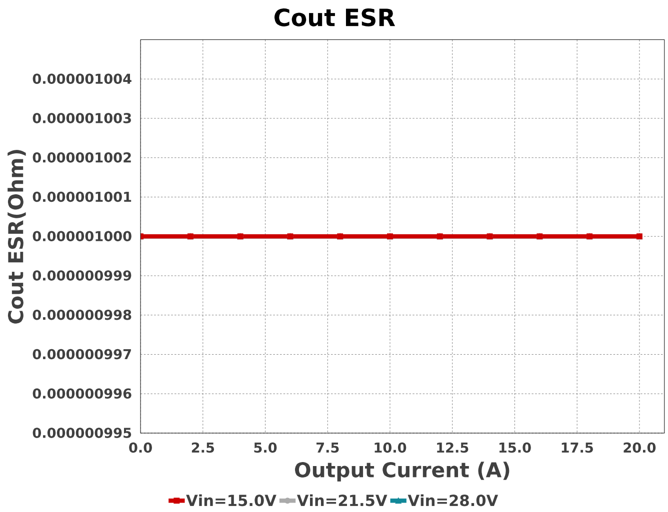


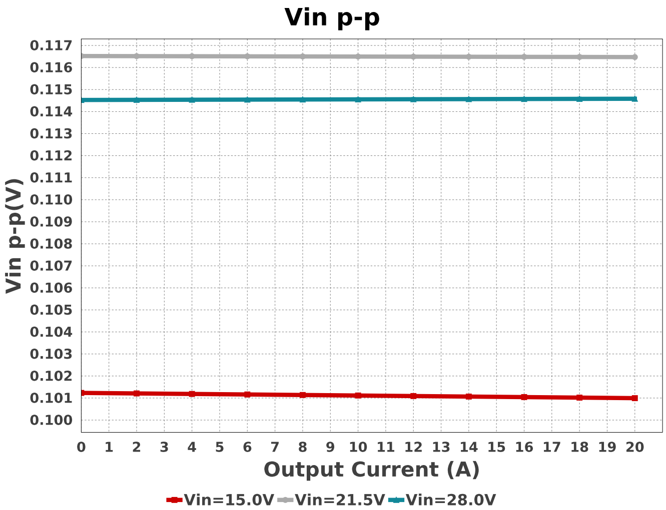


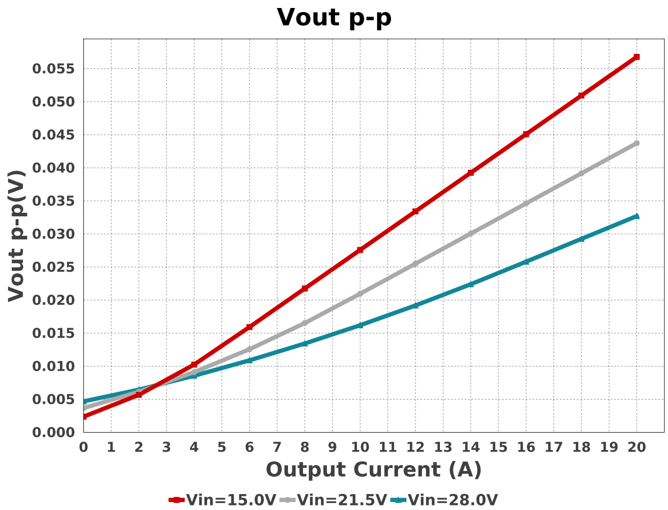

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V


IC Ipk
IC Ipk(A)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V

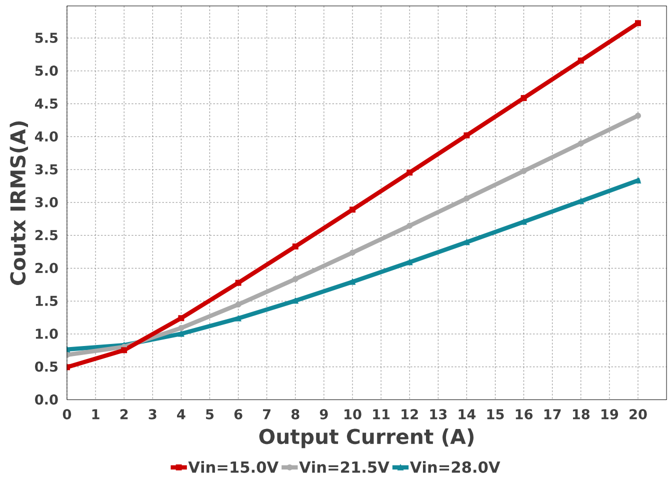

L Pd
L Pd(W)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V


Cout ESR
Cout ESR(Ohm)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V

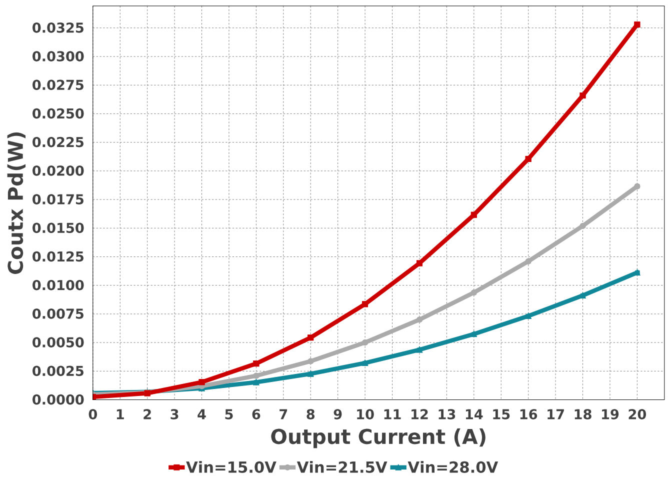

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V


Vout p-p
Vout p-p(V)
Output Current (A)
Vin=15.0V Vin=21.5V Vin=28.0V

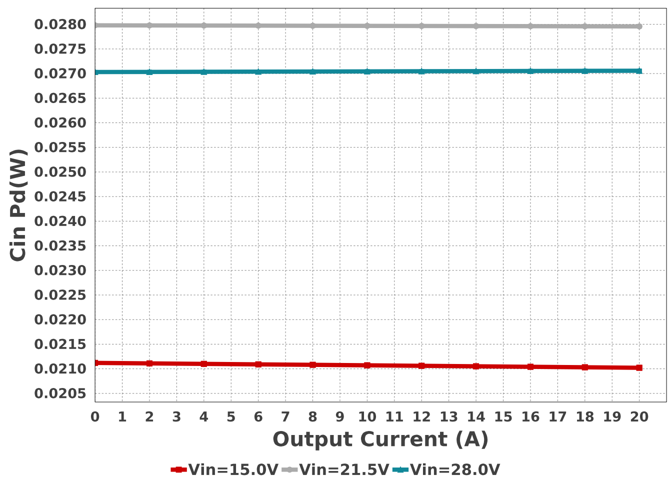
Coutx IRMS



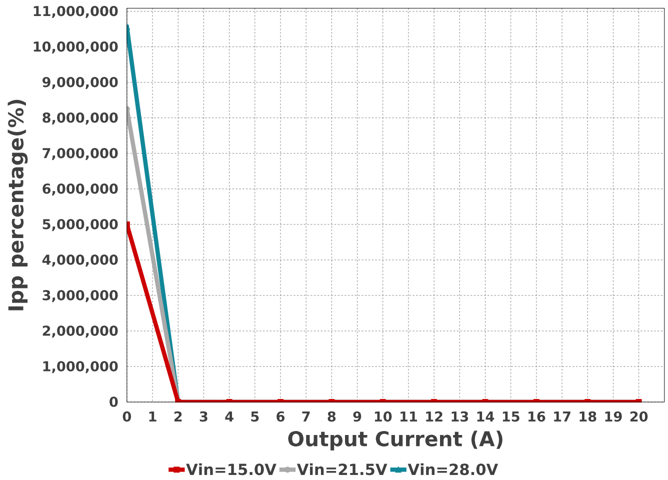
Coutx Pd



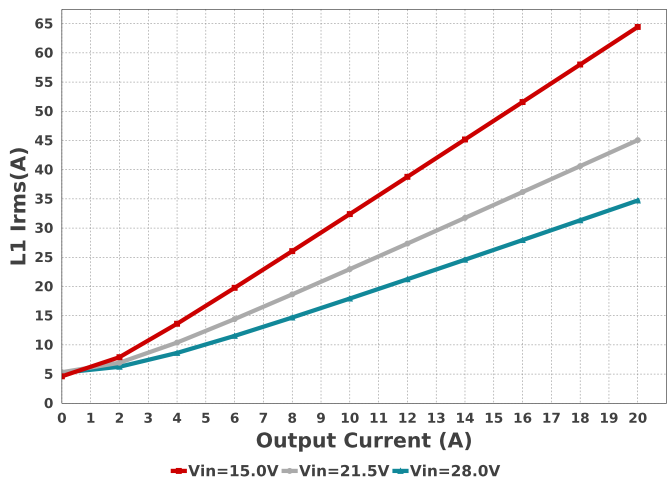
Cin Pd



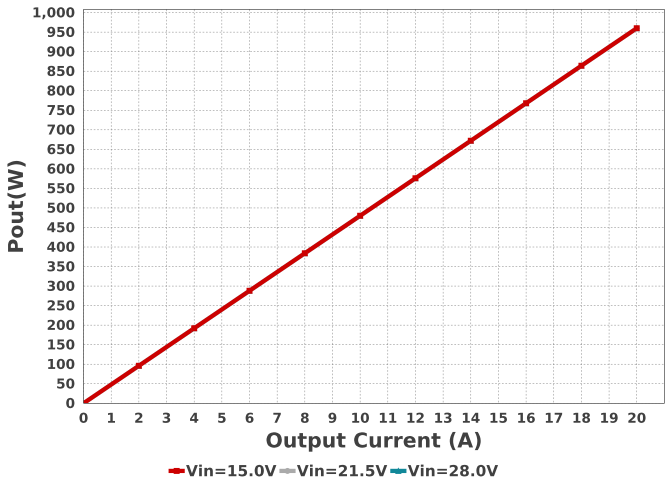
Ipp percentage

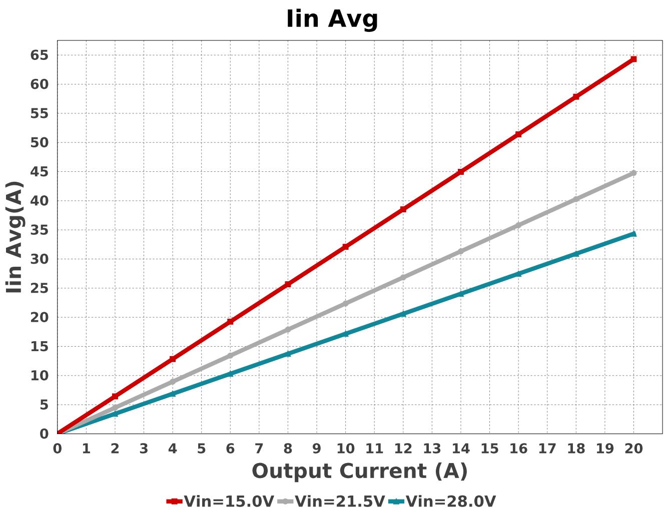


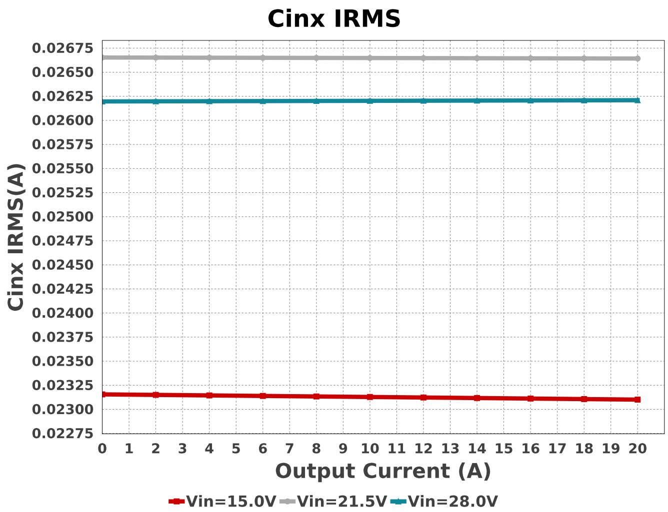
L1 Irms

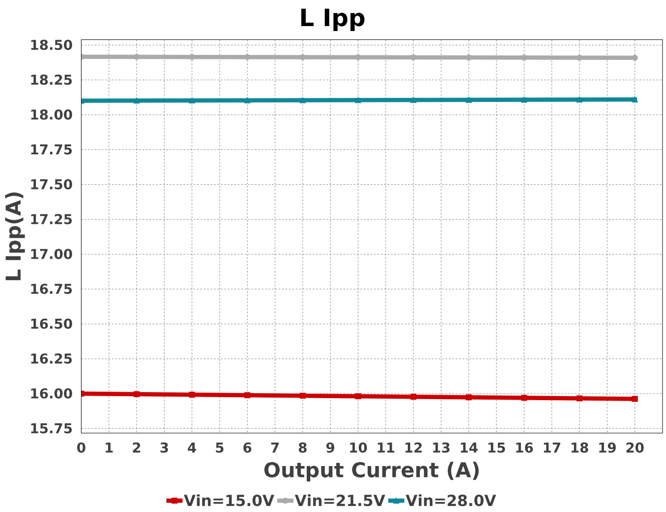


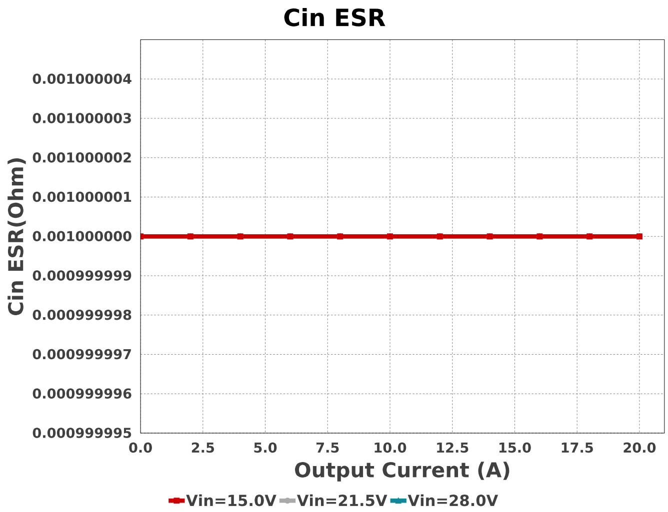
Pout

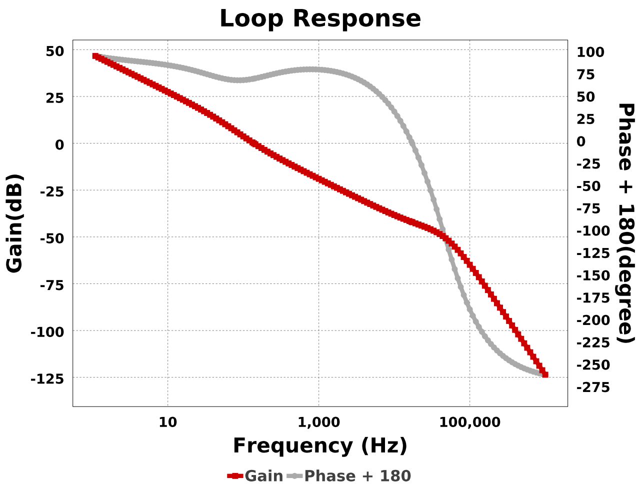












Operating Values

#	Name	Value	Category	Description
1.	Cin ESR	1.0 mOhm	Capacitor	Cin Capacitor ESR
2.	Cin IRMS	4.585 A	Capacitor	Input capacitor RMS ripple current
3.	Cin Pd	21.022 mW	Capacitor	Input capacitor power dissipation
4.	Cinx IRMS	22.938 mA	Capacitor	Bulk capacitor RMS ripple current
5.	Cinx Pd	526.14 pW	Capacitor	Bulk capacitor power dissipation
6.	Cout ESR	1.0 µOhm	Capacitor	Cout Capacitor ESR
7.	Coutx IRMS	5.688 A	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	32.352 mW	Capacitor	Output capacitor_x power loss
9.	IC Ipk	72.257 A	IC	Peak switch current in IC
10.	IC Tolerance	5.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	43.4 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance

#	Name	Value	Category	Description
12.	Iin Avg	64.302 A	IC	Average input current
13.	Ipp percentage	24.834 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	15.962 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	4.153 W	Inductor	Inductor power dissipation
16.	L1 DCR	1.0 mOhm	Inductor	L1 DCR
17.	L1 Irms	64.441 A	Inductor	Inductor ripple current
18.	Cin Pd	21.022 mW	Power	Input capacitor power dissipation
19.	Cinx Pd	526.14 pW	Power	Bulk capacitor power dissipation
20.	Coutx Pd	32.352 mW	Power	Output capacitor_x power loss
21.	L Pd	4.153 W	Power	Inductor power dissipation
22.	BOM Count	22	System Information	Total Design BOM count
23.	Cross Freq	86.191 Hz	System Information	Bode plot crossover frequency
24.	Duty Cycle	68.884 %	System Information	Duty cycle
25.	FootPrint	1.177 k mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	99.045 kHz	System Information	Switching frequency
27.	Gain Marg	-38.687 dB	System Information	Bode Plot Gain Margin
28.	Iout	20.0 A	System Information	Iout operating point
29.	Iout transient step used for Cout calculations	10.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
30.	Low Freq Gain	41.227 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Overshoot Value	1.512 mV	System Information	Theoretical Vout Overshoot Value
33.	Phase Marg	67.822 deg	System Information	Bode Plot Phase Margin
34.	Pout	960.0 W	System Information	Total output power
35.	Total BOM	NA	System Information	Total BOM Cost
36.	Undershoot Value	1.455 mV	System Information	Theoretical Vout Undershoot Value
37.	Vin	15.0 V	System Information	Vin operating point
38.	Vin p-p	100.281 mV	System Information	Peak-to-peak input voltage
39.	Vout	48.0 V	System Information	Operational Output Voltage
40.	Vout Actual	48.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
42.	Vout Tolerance	18.286 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	Vout p-p	56.513 mV	System Information	Peak-to-peak output ripple voltage
44.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	20.0	Maximum Output Current
SoftStart	10.0 ms	Soft Start Time (ms)
VinMax	28.0	Maximum input voltage
VinMin	15.0	Minimum input voltage
Vout	48.0	Output Voltage
base_pn	LM5123-Q1	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	100.0 k	Customer Selected Frequency

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

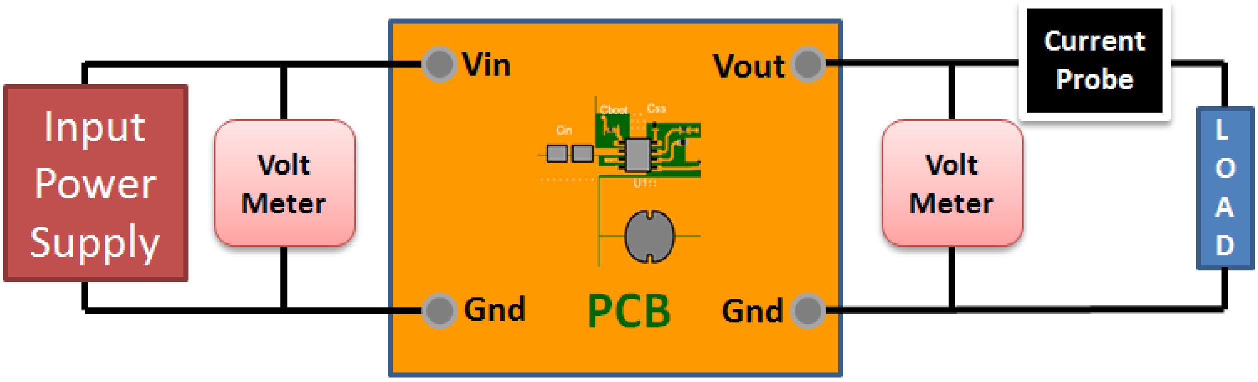
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 15.0V 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 : B09A30C71D1B3D0ED38ABFDAA1D91EC8[v1]

2. **LM5123-Q1** Product Folder : http://www.ti.com/product/LM5123%2DQ1 : contains the data sheet and other resources.