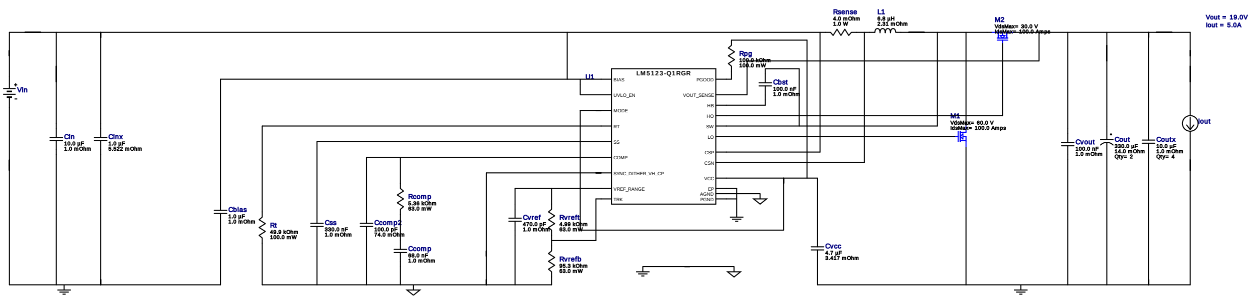
VinMin = 8.0V
VinMax = 18.0V
Vout = 19.0V
Iout = 5.0A

Device = LM5123QRGRRQ1
Topology = Boost
Created = 2023-03-04 16:47:01.818
BOM Cost = $12.39
BOM Count = 26
Total Pd = 2.21W

WEBENCH ® Design Report

Design : 5 LM5123QRGRRQ1
LM5123QRGRRQ1 10V-18V to 19V 5A



Design Alerts

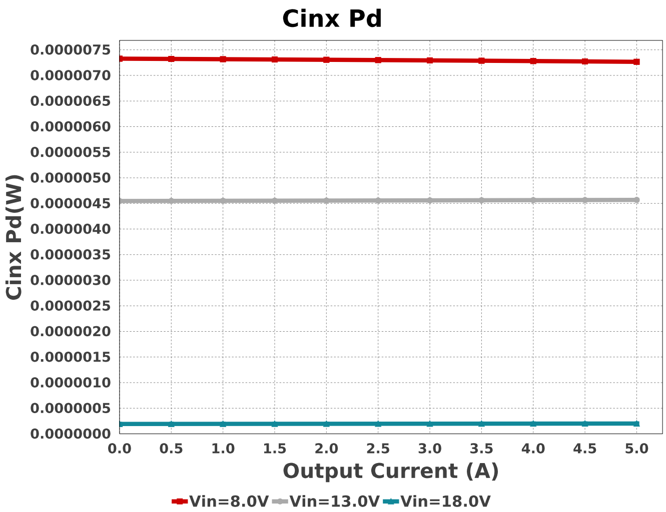
Component Selection Information

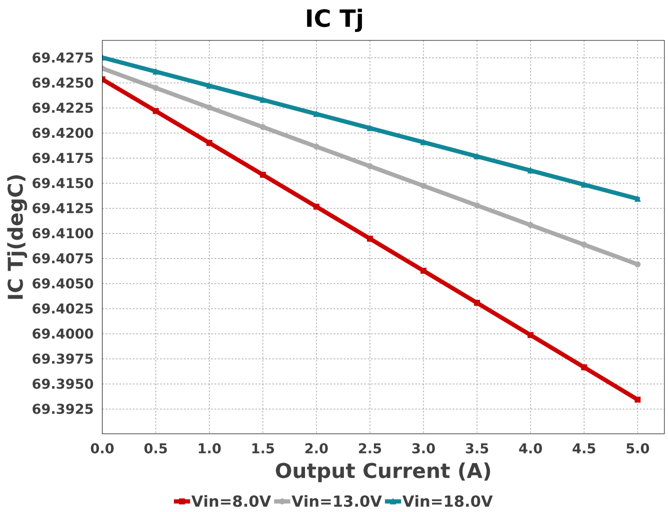
The LM5123-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

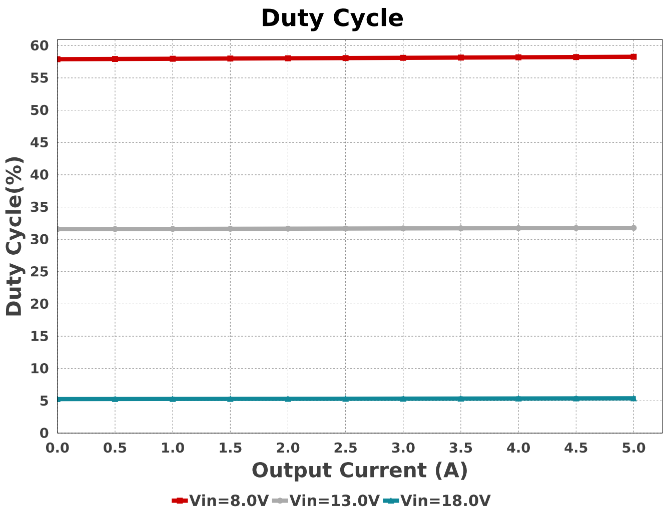
Electrical BOM

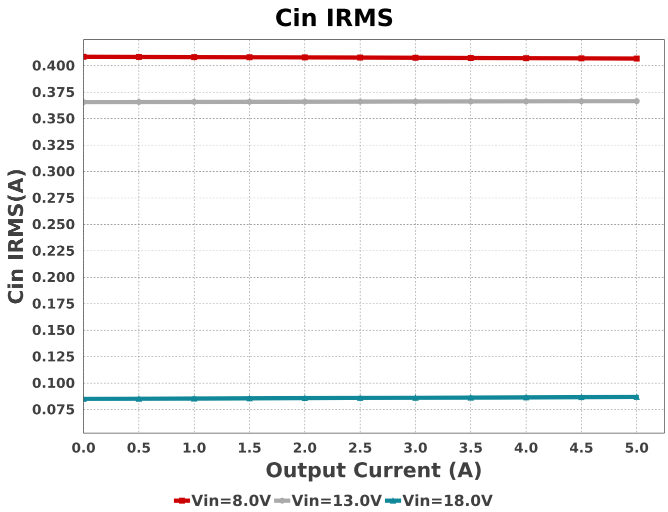
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Kemet	C0603C105K8PACTU Series= X5R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cbst	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM155R61A683KA01D Series= X5R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	Kemet	C0805C101K5GACTU Series= C0G/NP0	Cap= 100.0 pF ESR= 74.0 mOhm VDC= 50.0 V IRMS= 524.0 mA	1	$0.01	0805 7 mm^2
Cin	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	1	$0.27	1210 15 mm^2
Cinx	TDK	C1608X7R1V105K080AC Series= X7R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 35.0 V IRMS= 2.2162 A	1	$0.05	0603 5 mm^2
Cout	Panasonic	25SVPF330M Series= SVPF	Cap= 330.0 uF ESR= 14.0 mOhm VDC= 25.0 V IRMS= 5.0 A	2	$1.33	CAPSMT_62_F12 151 mm^2
Coutx	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	4	$0.27	1210 15 mm^2

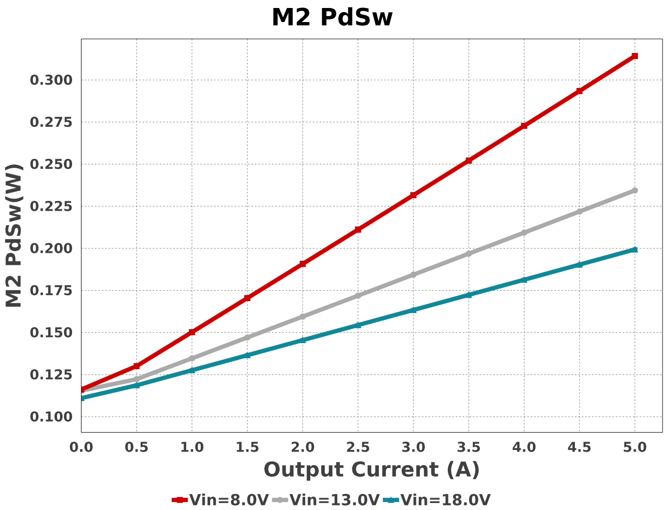
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Css	Kemet	C0603C334K8RACTU Series= X7R	Cap= 330.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cvcc	TDK	C1005X5R1A475K050BC Series= X5R	Cap= 4.7 uF ESR= 3.417 mOhm VDC= 10.0 V IRMS= 2.7063 A	1	$0.10	0402_065 3 mm^2
Cvout	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
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 mm^2
L1	Wurth Elektronik	74435580680	L= 6.8 µH 2.31 mOhm	1	$4.99	WE-HCI_2212 588 mm^2
M1	Texas Instruments	CSD18540Q5B	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.82	DNK0008A 56 mm^2
M2	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 100.0 Amps	1	$0.52	DNK0008A 56 mm^2
Rcomp	Vishay-Dale	CRCW04025K36FKED Series= CRCW..e3	Res= 5.36 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rsense	Panasonic	ERJ-M1WSF4M0U Series= ERJ	Res= 4.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.17	2512 43 mm^2
Rt	Vishay-Dale	CRCW060349K9FKEA Series= CRCW..e3	Res= 49.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rvrefb	Vishay-Dale	CRCW040295K3FKED Series= CRCW..e3	Res= 95.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvreft	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM5123QRGRRQ1	Switcher	1	$1.59	RTE0016C-IPC_A 16 mm^2

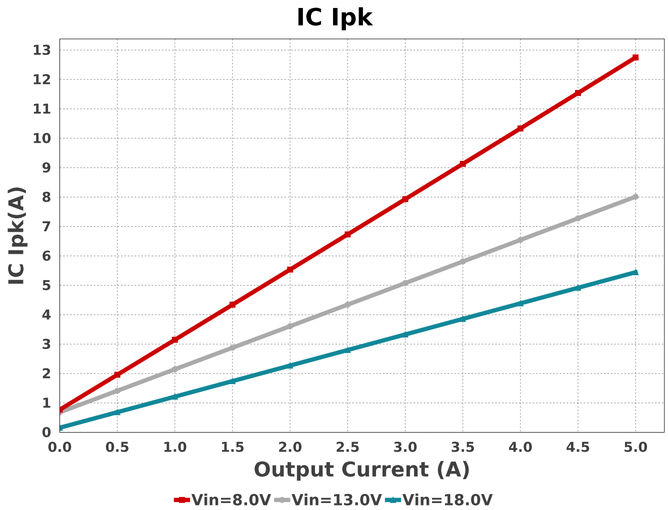

Cinx Pd
Cinx Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

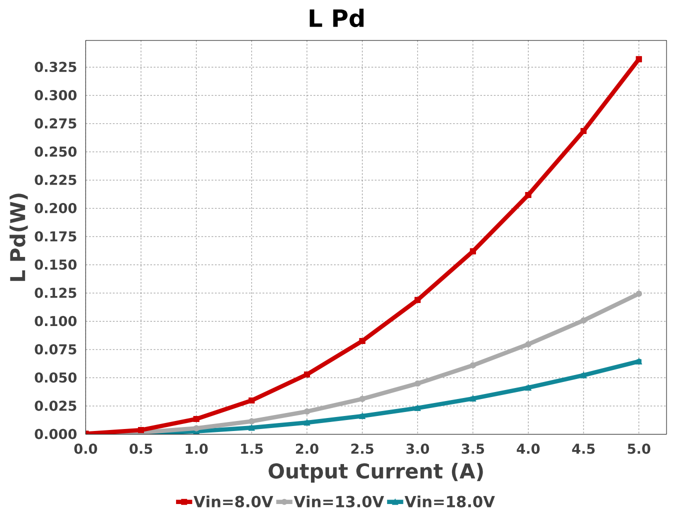

IC Tj
IC Tj(degC)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

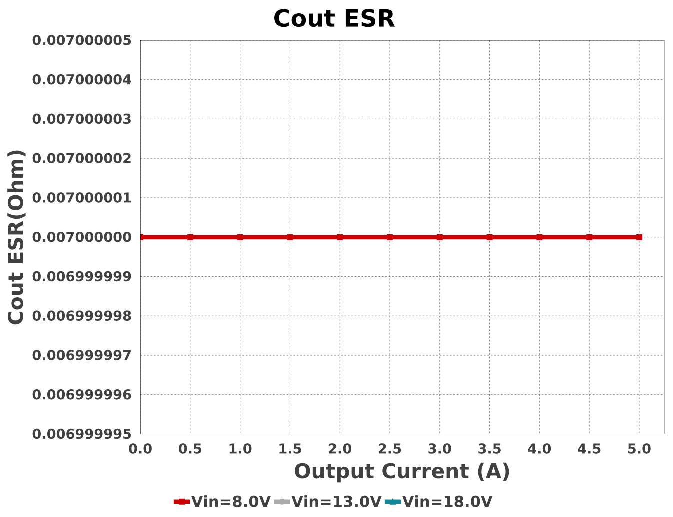

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

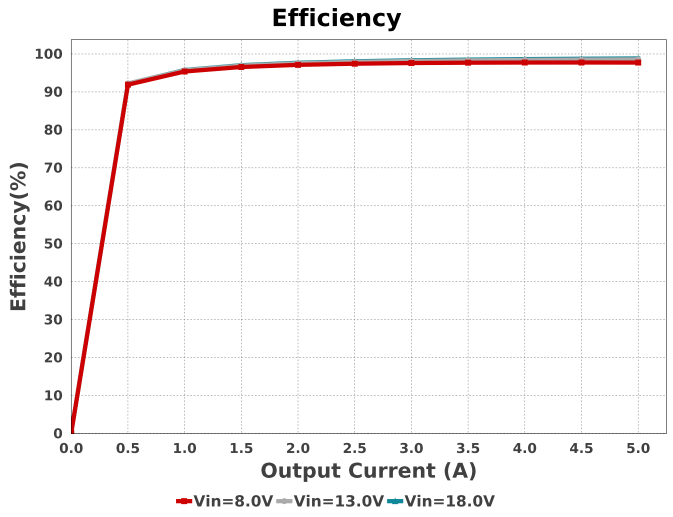

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

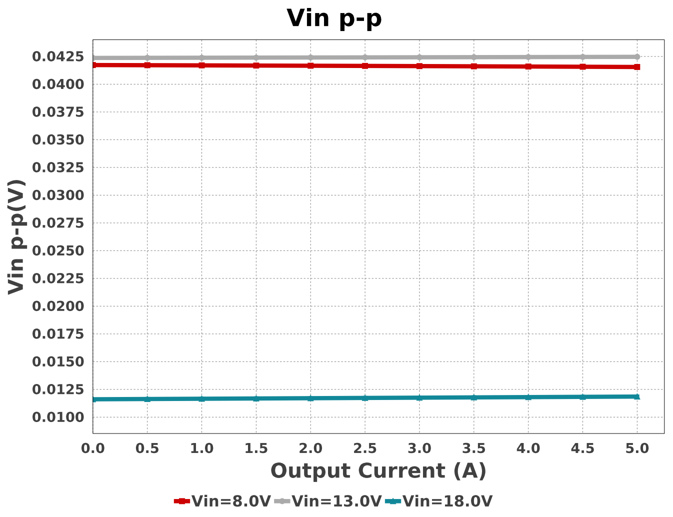

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

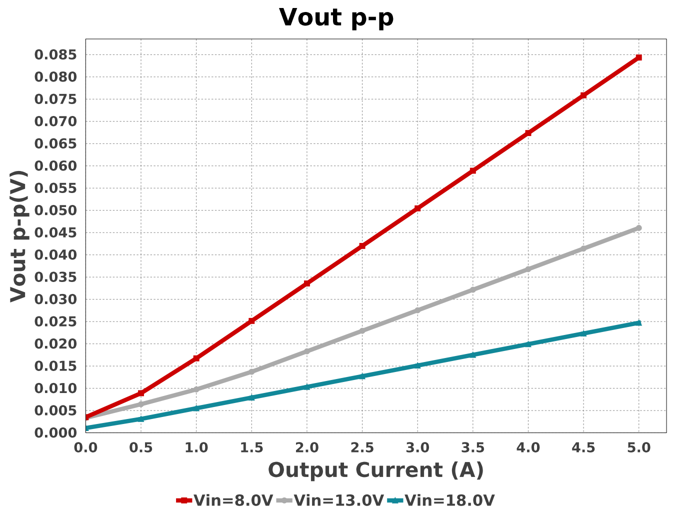

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

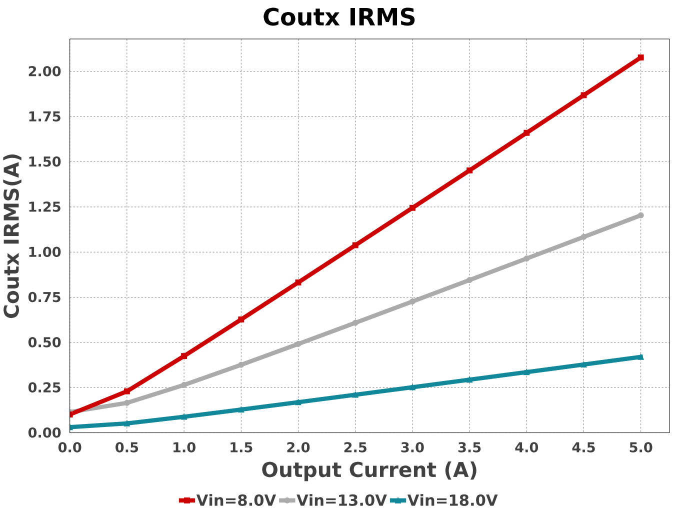

L Pd
L Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

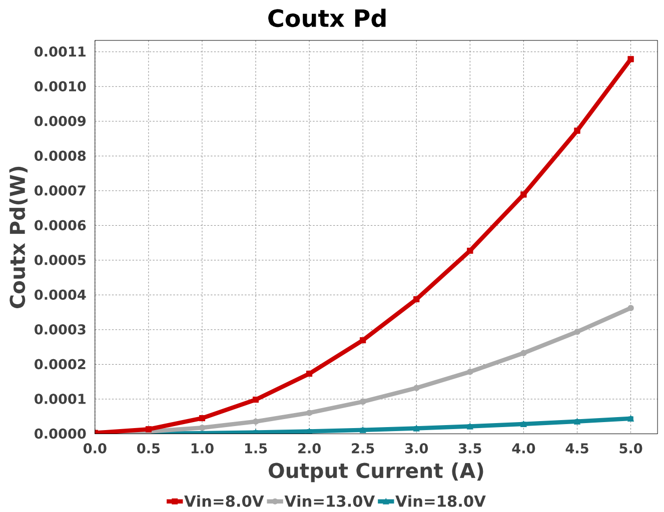

Cout ESR
Cout ESR(Ohm)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

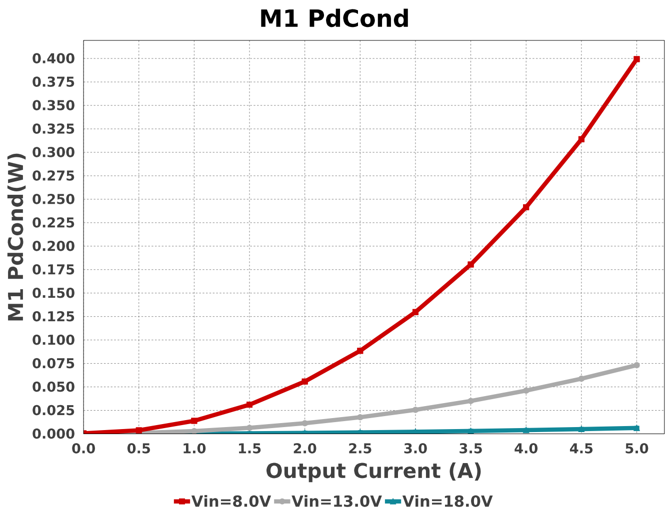

Efficiency
Efficiency(%)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

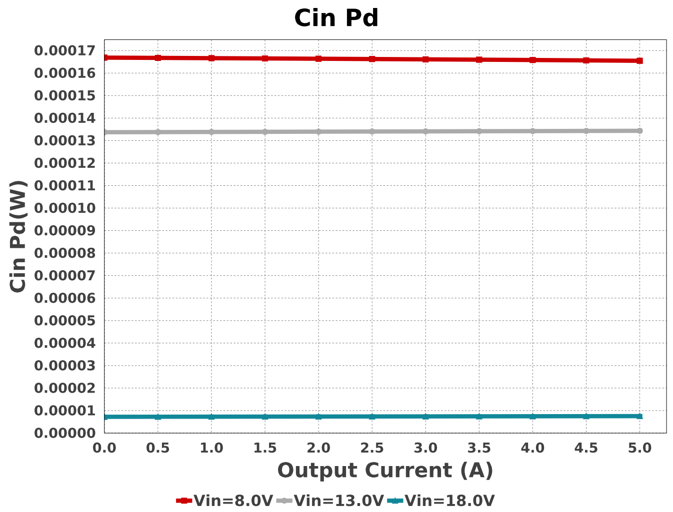

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

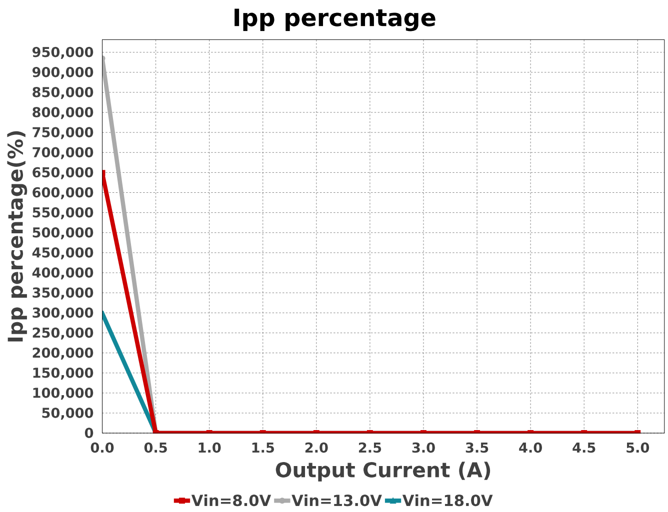

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

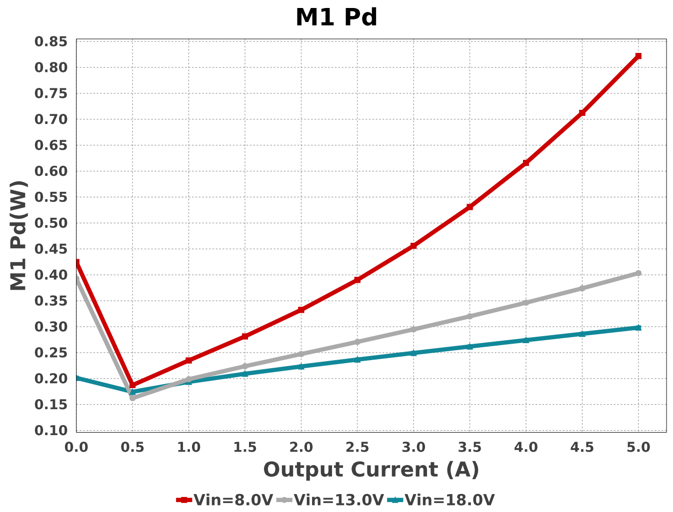

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

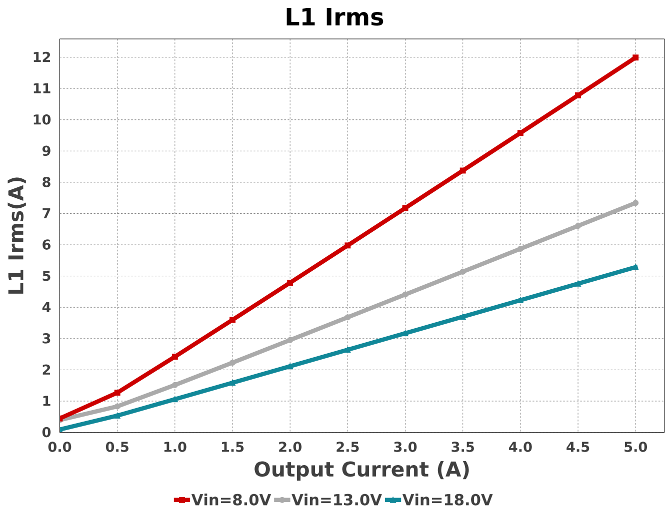

Coutx Pd
Coutx Pd(W)
0.0011
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

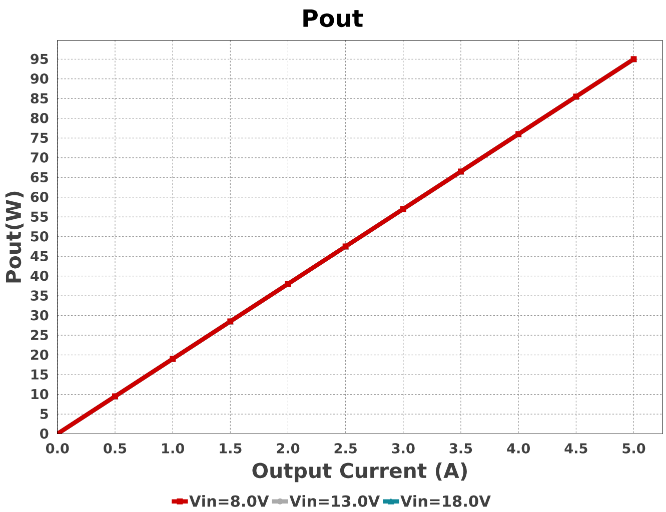

M1 PdCond
M1 PdCond(W)
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

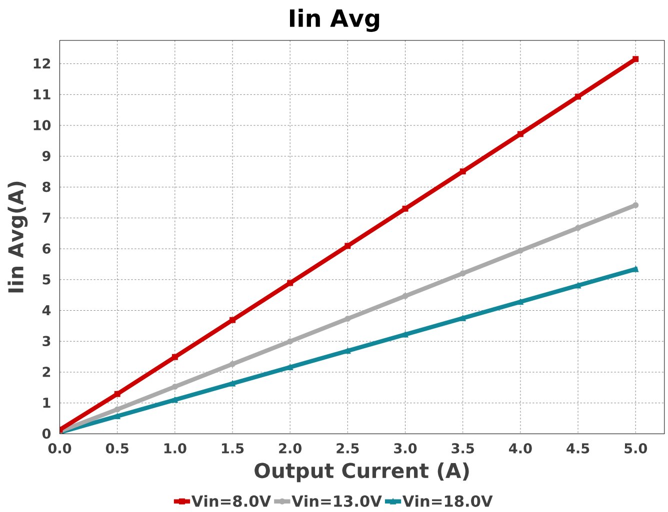

Cin Pd
Cin Pd(W)
0.00017
0.00016
0.00015
0.00014
0.00013
0.00012
0.00011
0.00010
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

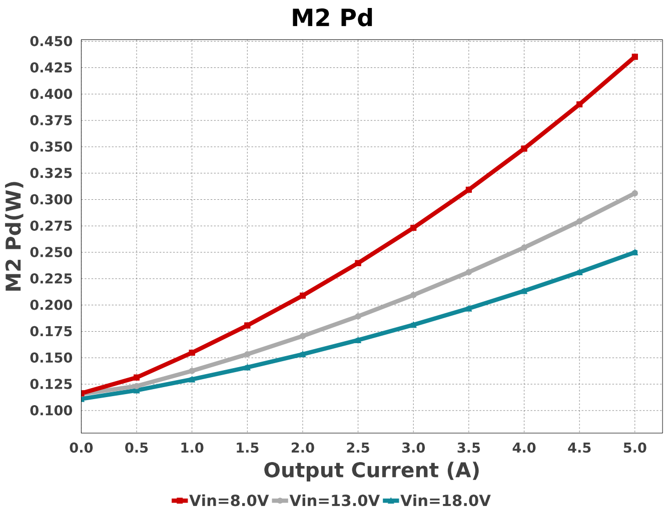

Ipp percentage
Ipp percentage(%)
950,000
900,000
850,000
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

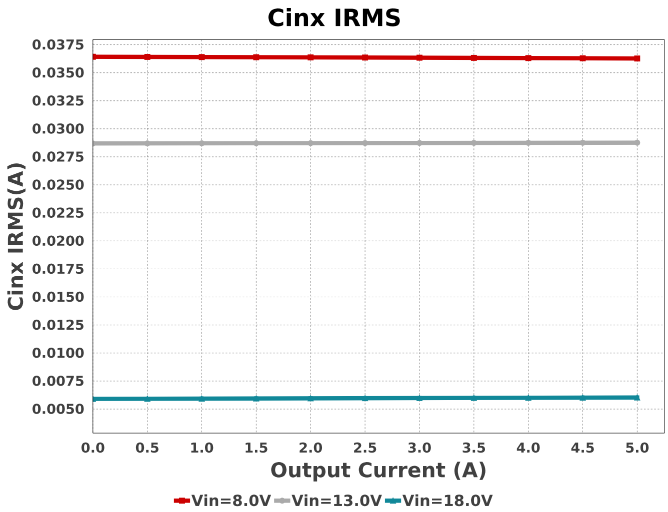

M1 Pd
M1 Pd(W)
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

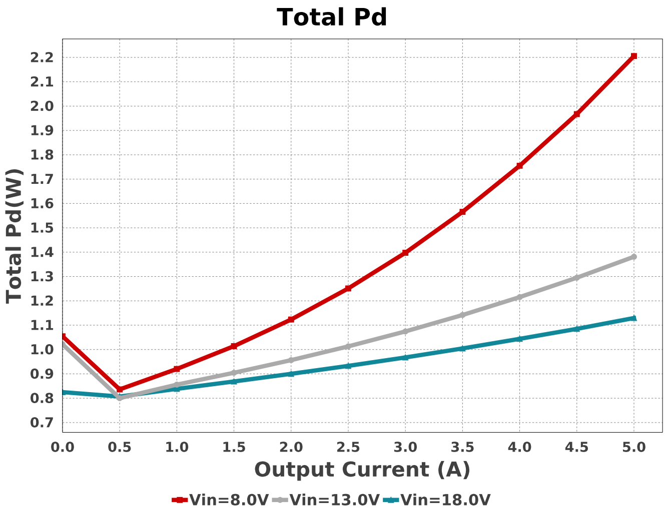

L1 Irms
L1 Irms(A)
12
11
10
9
8
7
6
5
4
3
2
1
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

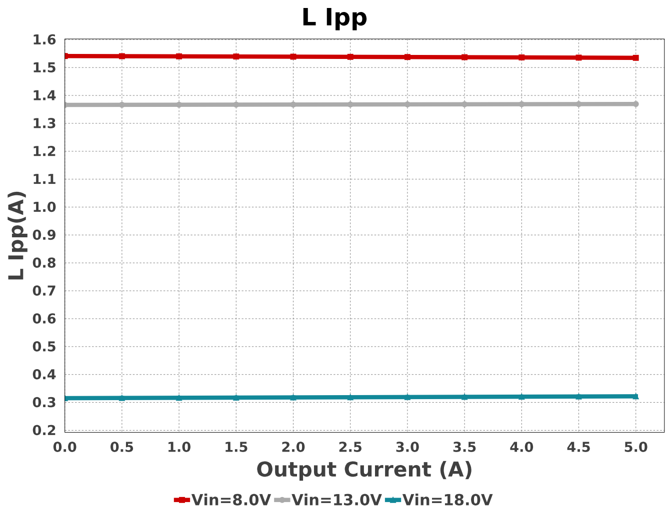

Pout
Pout(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

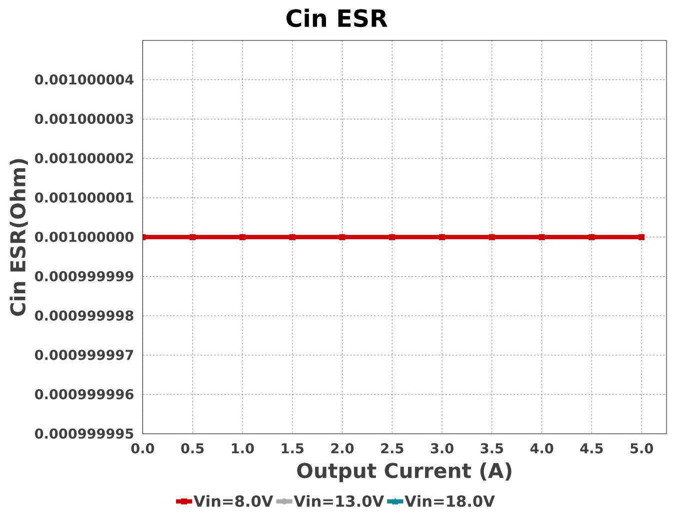

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

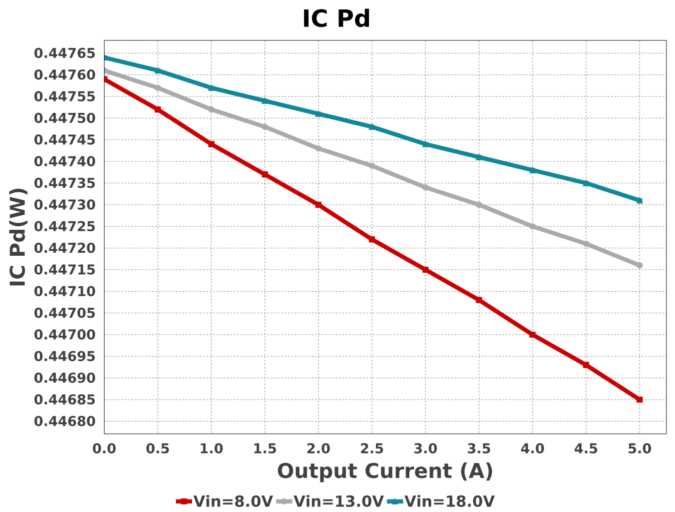

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

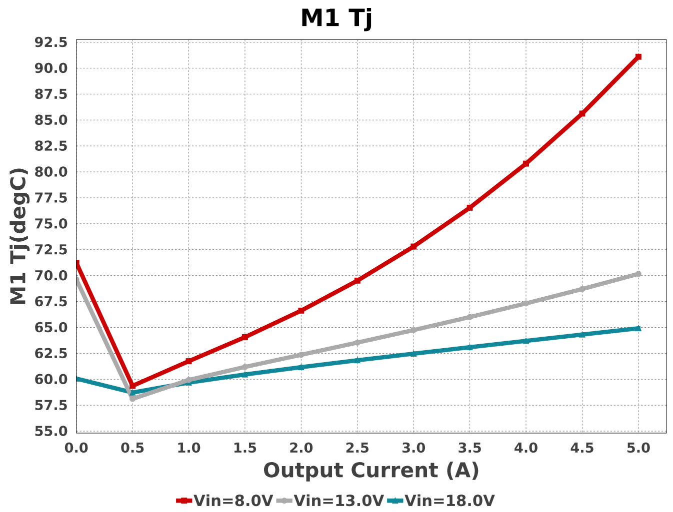

Cinx IRMS
Cinx IRMS(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

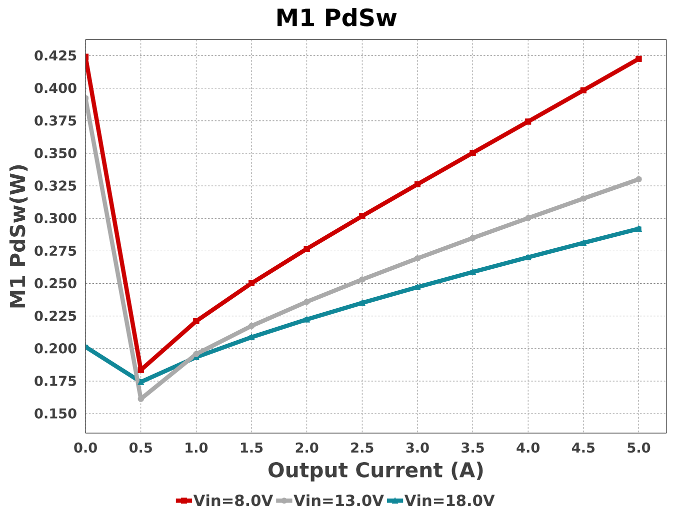

Total Pd
Total Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

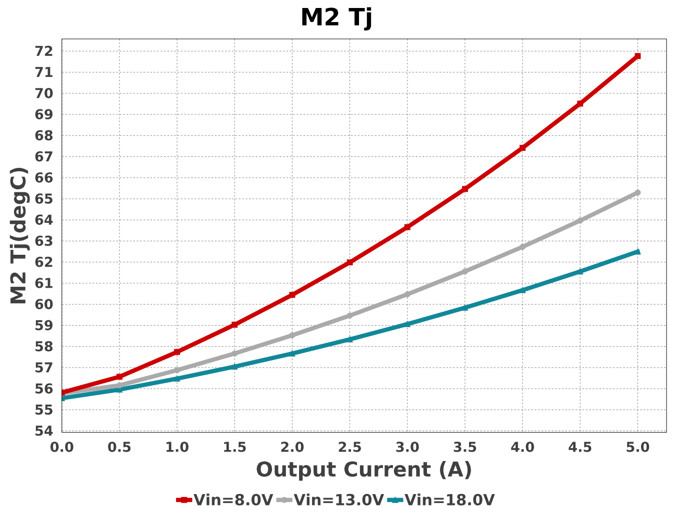

L Ipp
L Ipp(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

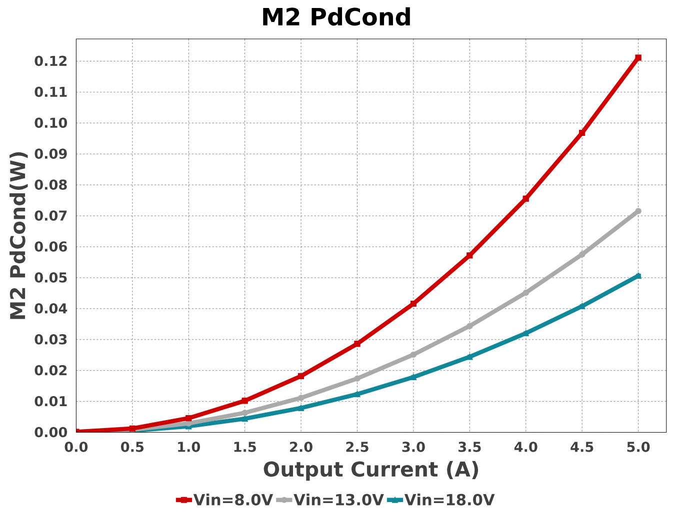

Cin ESR
Cin ESR(Ohm)
0.001000004
0.001000003
0.001000002
0.001000001
0.001000000
0.000999999
0.000999998
0.000999997
0.000999996
0.000999995
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

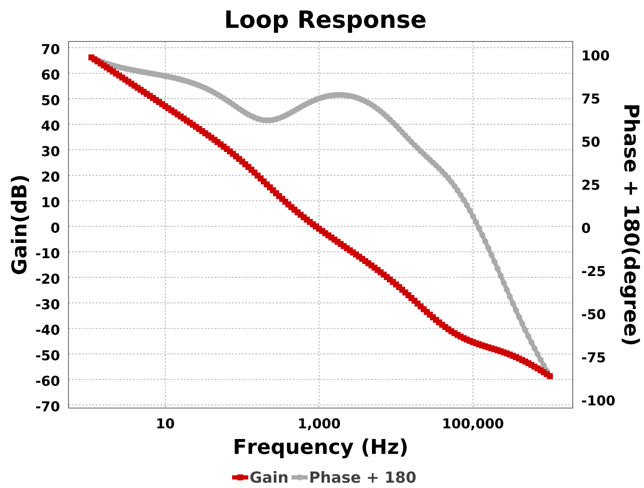

IC Pd
IC Pd(W)
0.44765
0.44760
0.44755
0.44750
0.44745
0.44740
0.44735
0.44730
0.44725
0.44720
0.44715
0.44710
0.44705
0.44700
0.44695
0.44690
0.44685
0.44680
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V


M1 Tj
M1 Tj(degC)
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V


M1 PdSw
M1 PdSw(W)
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V


M2 Tj
M2 Tj(degC)
72
71
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V


M2 PdCond
M2 PdCond(W)
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	26		Total Design BOM count
2.	Total BOM	$12.393		Total BOM Cost
3.	Cin ESR	1.0 mOhm	Capacitor	Cin Capacitor ESR
4.	Cin IRMS	406.768 mA	Capacitor	Input capacitor RMS ripple current
5.	Cin Pd	165.46 µW	Capacitor	Input capacitor power dissipation
6.	Cinx IRMS	36.273 mA	Capacitor	Bulk capacitor RMS ripple current
7.	Cinx Pd	7.266 µW	Capacitor	Bulk capacitor power dissipation
8.	Cout ESR	7.0 mOhm	Capacitor	Cout Capacitor ESR
9.	Coutx IRMS	2.077 A	Capacitor	Output capacitor_x RMS ripple current
10.	Coutx Pd	1.079 mW	Capacitor	Output capacitor_x power loss
11.	IC Ipk	12.749 A	IC	Peak switch current in IC
12.	IC Pd	446.85 mW	IC	IC power dissipation
13.	IC Tj	69.393 degC	IC	IC junction temperature
14.	IC Tolerance	5.0 mV	IC	IC Feedback Tolerance
15.	ICThetaJA Effective	43.4 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
16.	Iin Avg	12.151 A	IC	Average input current
17.	Ipp percentage	12.809 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
18.	L Ipp	1.535 A	Inductor	Peak-to-peak inductor ripple current
19.	L Pd	332.06 mW	Inductor	Inductor power dissipation
20.	L1 DCR	2.31 mOhm	Inductor	L1 DCR
21.	L1 Irms	11.99 A	Inductor	Inductor ripple current
22.	M1 Pd	821.91 mW	Mosfet	M1 MOSFET total power dissipation
23.	M1 PdCond	399.31 mW	Mosfet	M1 MOSFET conduction losses
24.	M1 PdSw	422.59 mW	Mosfet	M1 MOSFET switching losses
25.	M1 Tj	91.095 degC	Mosfet	M1 MOSFET junction temperature
26.	M2 Pd	435.34 mW	Mosfet	M2 MOSFET total power dissipation
27.	M2 PdCond	121.12 mW	Mosfet	M2 MOSFET conduction losses
28.	M2 PdSw	314.22 mW	Mosfet	M2 MOSFET switching losses
29.	M2 Tj	71.767 degC	Mosfet	M2 MOSFET junction temperature
30.	Cin Pd	165.46 µW	Power	Input capacitor power dissipation
31.	Cinx Pd	7.266 µW	Power	Bulk capacitor power dissipation
32.	Coutx Pd	1.079 mW	Power	Output capacitor_x power loss
33.	IC Pd	446.85 mW	Power	IC power dissipation
34.	L Pd	332.06 mW	Power	Inductor power dissipation
35.	M1 Pd	821.91 mW	Power	M1 MOSFET total power dissipation
36.	M1 PdCond	399.31 mW	Power	M1 MOSFET conduction losses
37.	M1 PdSw	422.59 mW	Power	M1 MOSFET switching losses
38.	M2 Pd	435.34 mW	Power	M2 MOSFET total power dissipation
39.	M2 PdCond	121.12 mW	Power	M2 MOSFET conduction losses
40.	M2 PdSw	314.22 mW	Power	M2 MOSFET switching losses
41.	Total Pd	2.206 W	Power	Total Power Dissipation
42.	Cross Freq	456.783 Hz	System Information	Bode plot crossover frequency
43.	Duty Cycle	58.269 %	System Information	Duty cycle
44.	Efficiency	97.731 %	System Information	Steady state efficiency
45.	FootPrint	1.189 k mm^2	System Information	Total Foot Print Area of BOM components
46.	Frequency	441.931 kHz	System Information	Switching frequency

#	Name	Value	Category	Description
47.	Gain Marg	-35.548 dB	System Information	Bode Plot Gain Margin
48.	Iout	5.0 A	System Information	Iout operating point
49.	Iout transient step used for Cout calculations	2.5 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
50.	Low Freq Gain	59.163 dB	System Information	Gain at 1Hz
51.	Mode	CCM	System Information	Conduction Mode
52.	Overshoot Value	1.473 mV	System Information	Theoretical Vout Overshoot Value
53.	Phase Marg	66.497 deg	System Information	Bode Plot Phase Margin
54.	Pout	95.0 W	System Information	Total output power
55.	Undershoot Value	865.804 µV	System Information	Theoretical Vout Undershoot Value
56.	Vin	8.0 V	System Information	Vin operating point
57.	Vin p-p	41.552 mV	System Information	Peak-to-peak input voltage
58.	Vout	19.0 V	System Information	Operational Output Voltage
59.	Vout Actual	19.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
60.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
61.	Vout Tolerance	26.316 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
62.	Vout p-p	84.359 mV	System Information	Peak-to-peak output ripple voltage
63.	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	5.0	Maximum Output Current
VinMax	18.0	Maximum input voltage
VinMin	8.0	Minimum input voltage
Vout	19.0	Output Voltage
base_pn	LM5123-Q1	Base Product Number
source	DC	Input Source Type
Ta	50.0	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

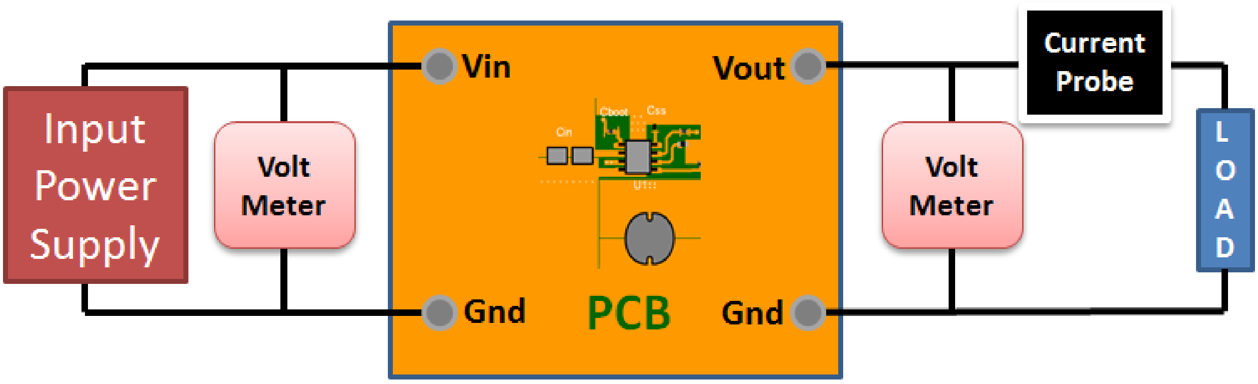
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 8.0V 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 : 1EF28B5469A4C9F4DB347D0B234F806D[v1]

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