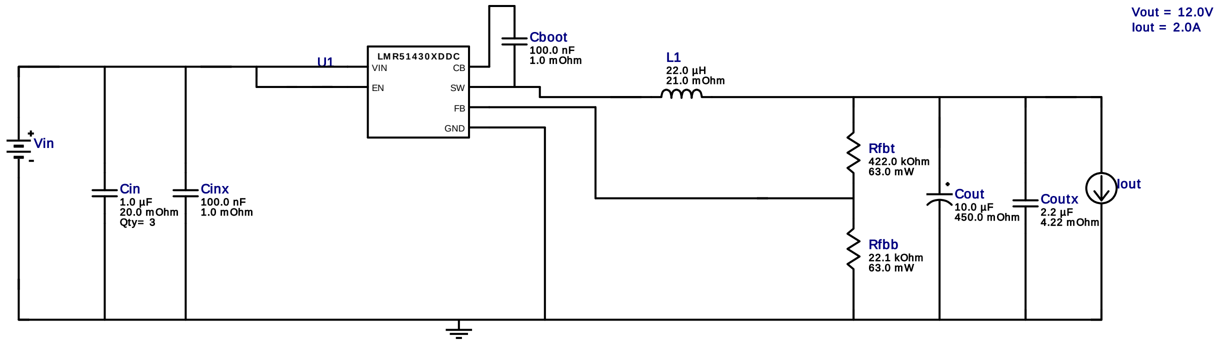
VinMin = 13.2V
VinMax = 16.8V
Vout = 12.0V
Iout = 2.0A

Device = LMR51430XDDCR
Topology = Buck
Created = 2025-05-21 00:50:33.534
BOM Cost = $3.36
BOM Count = 11
Total Pd = 0.74W

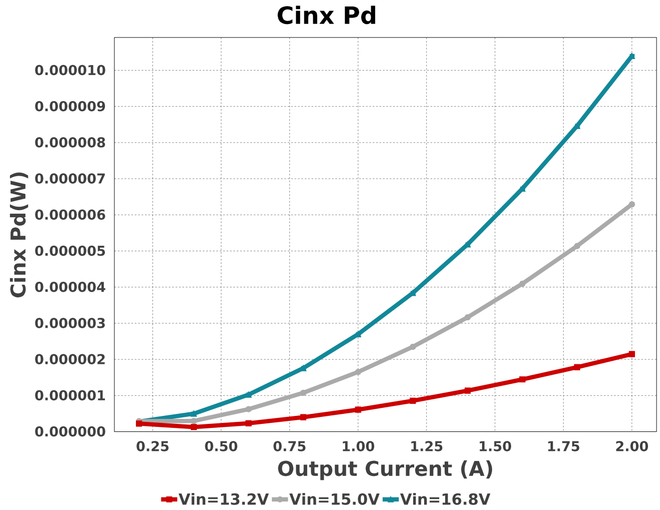
WEBENCH ® Design Report

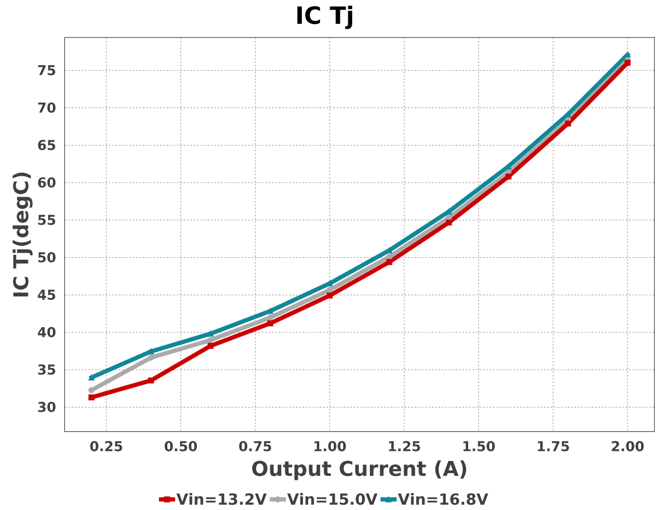
Design : 9 LMR51430XDDCR
LMR51430XDDCR 13.2V-16.8V to 12.00V @ 2A

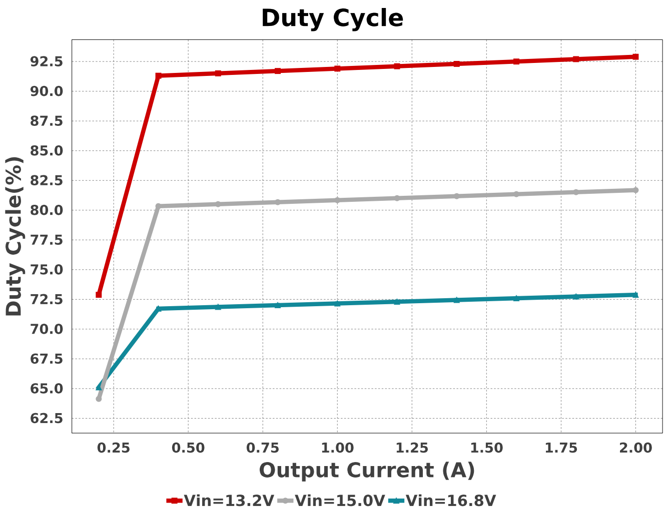


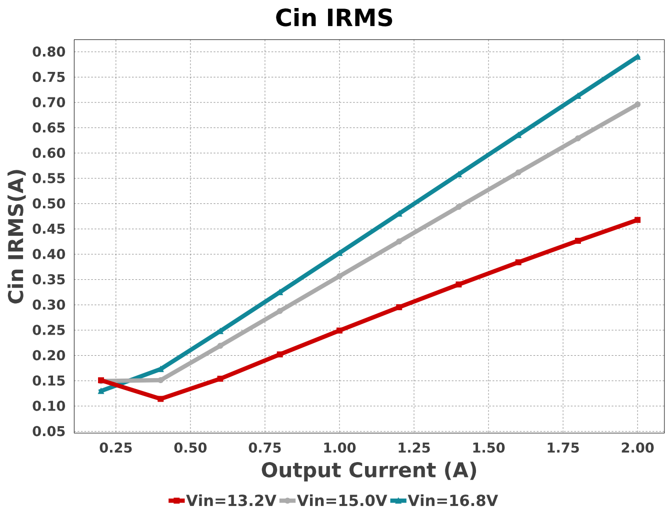
Electrical BOM

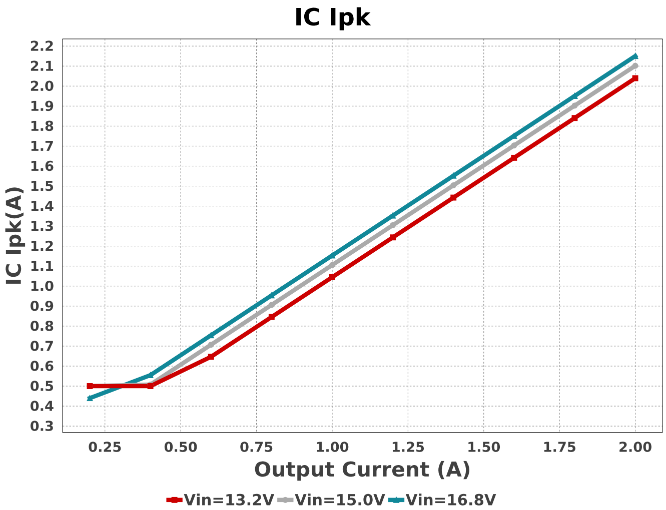
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM188R71E105KA12D Series= X7R	Cap= 1.0 uF ESR= 20.0 mOhm VDC= 25.0 V IRMS= 2.7 A	3	$0.08	0603 5 mm²
Cinx	MuRata	GRM21BR71H104KA01L Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 3.85 A	1	$0.03	0805 7 mm²
Cout	Vishay-Sprague	593D106X9025C2TE3 Series= 593D	Cap= 10.0 uF ESR= 450.0 mOhm VDC= 25.0 V IRMS= 490.0 mA	1	$0.20	6032-28 42 mm²
Coutx	MuRata	GRM21BR71C225KA12L Series= X7R	Cap= 2.2 uF ESR= 4.22 mOhm VDC= 16.0 V IRMS= 1.94677 A	1	$0.09	0805 7 mm²
L1	Vishay-Dale	IHLP6767GZER220M11	L= 22.0 µH 21.0 mOhm	1	$2.32	IHLP-6767GZ 367 mm²
Rfbb	Vishay-Dale	CRCW040222K1FKED Series= CRCW..e3	Res= 22.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402422KFKED Series= CRCW..e3	Res= 422.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LMR51430XDDCR	Switcher	1	$0.45	DBV0006A 15 mm²

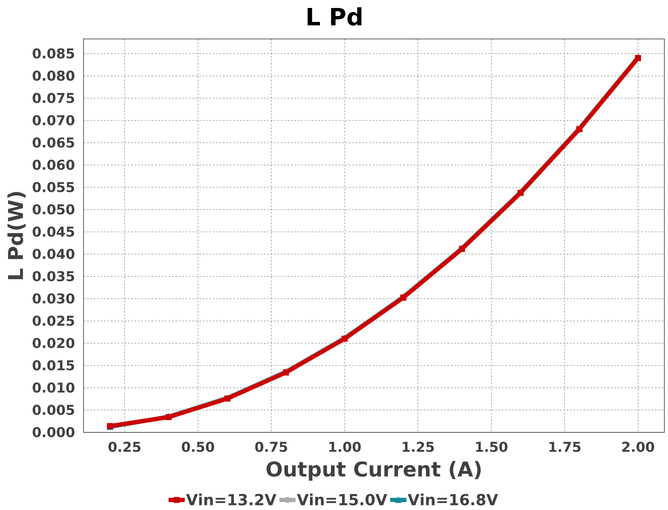

Cinx Pd
Cinx Pd(W)
0.000010
0.000009
0.000008
0.000007
0.000006
0.000005
0.000004
0.000003
0.000002
0.000001
0.000000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

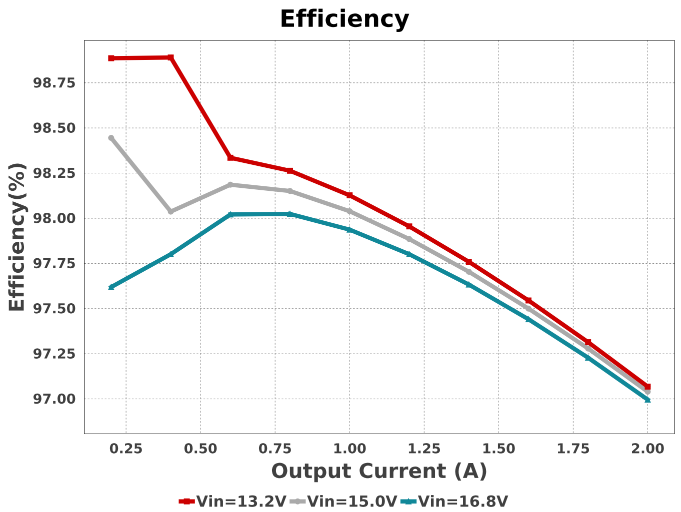

IC Tj
IC Tj(degC)
75
70
65
60
55
50
45
40
35
30
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

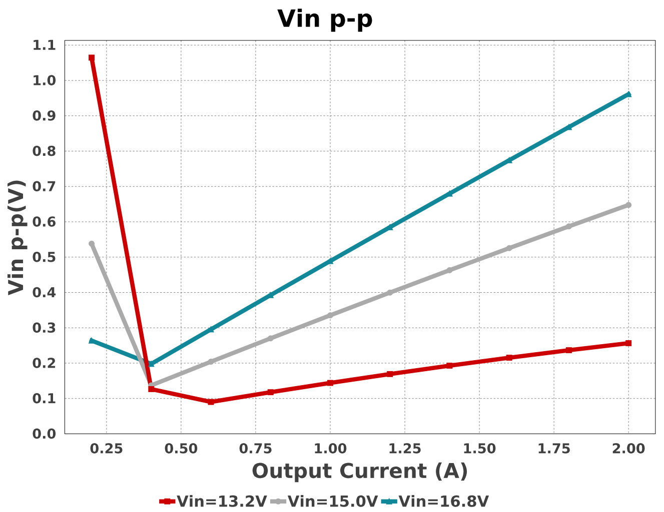

Duty Cycle
Duty Cycle(%)
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

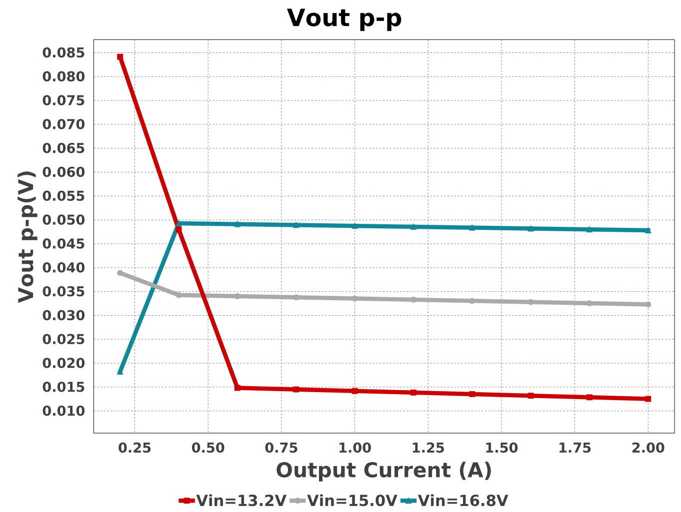

Cin IRMS
Cin IRMS(A)
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

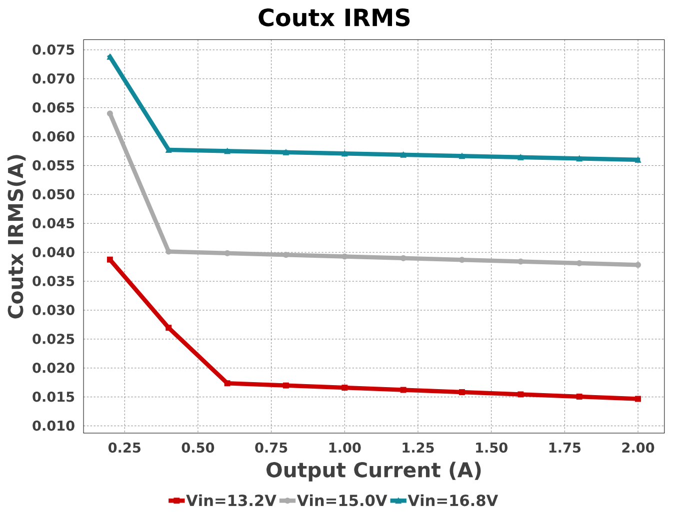

IC Ipk
IC Ipk(A)
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

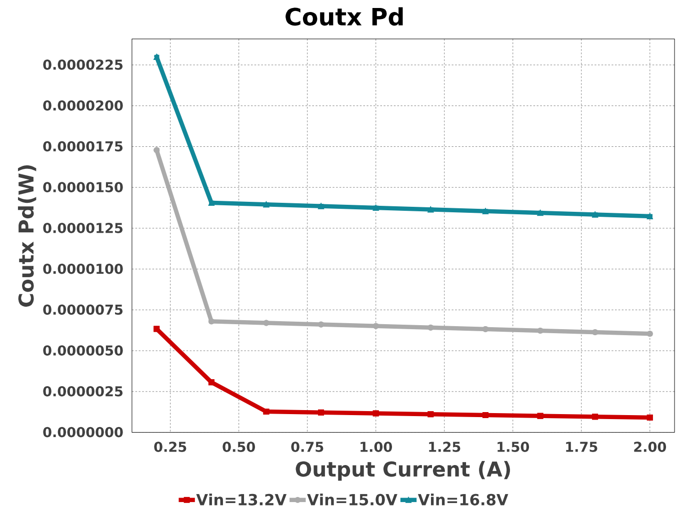

L Pd
L Pd(W)
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

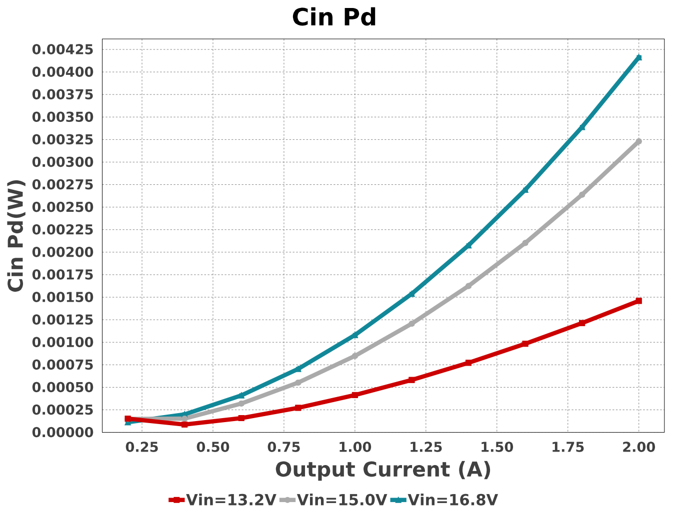

Efficiency
Efficiency(%)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

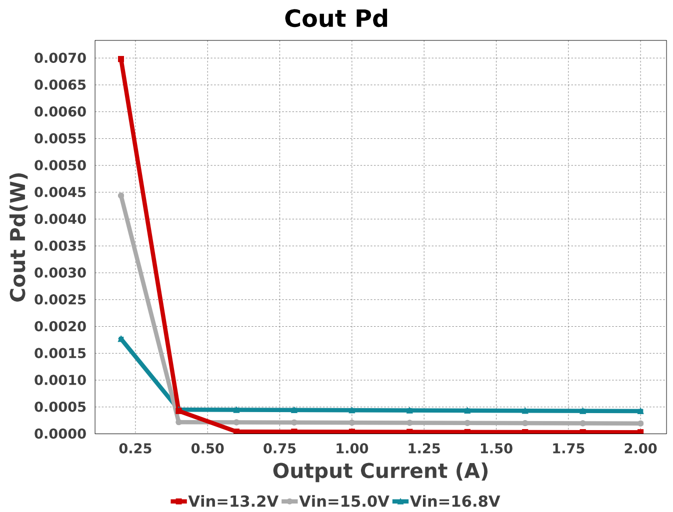

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

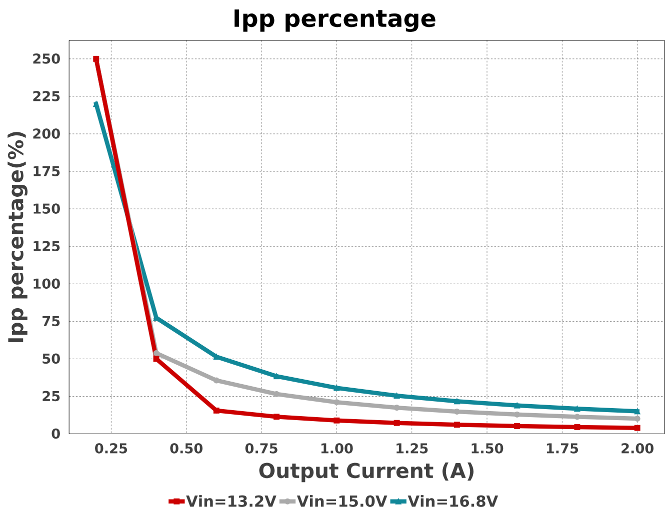

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

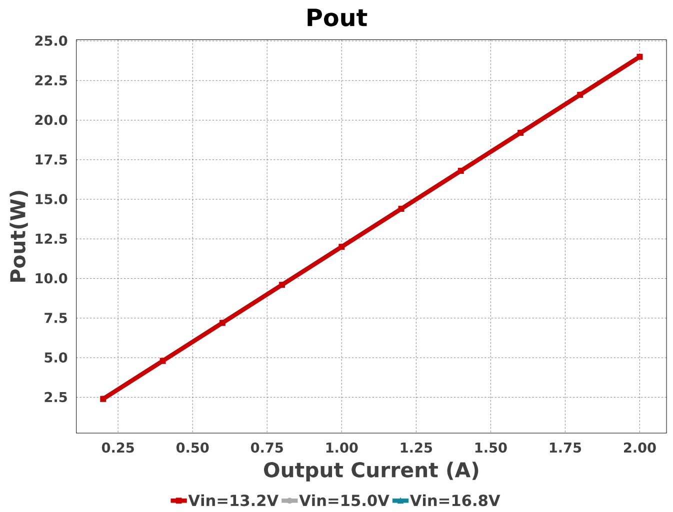

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

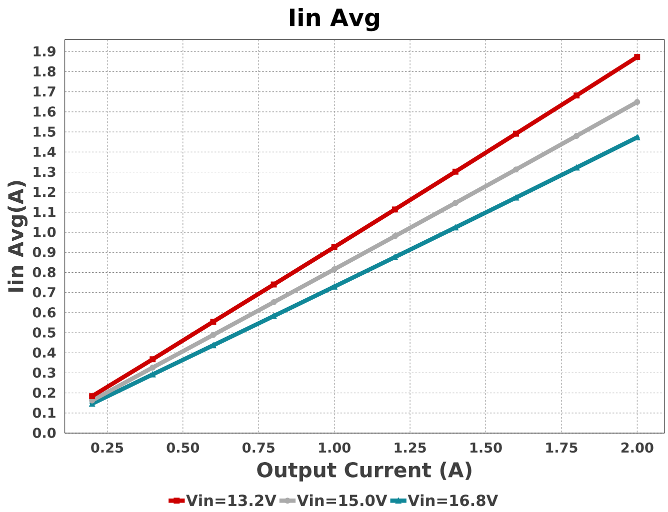

Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

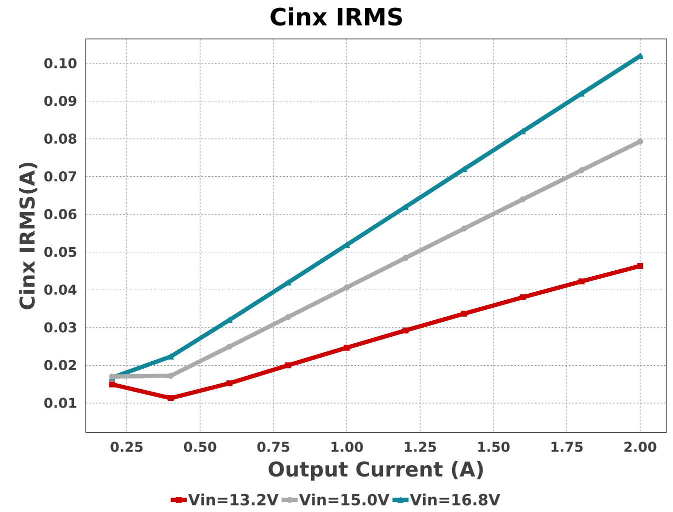

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

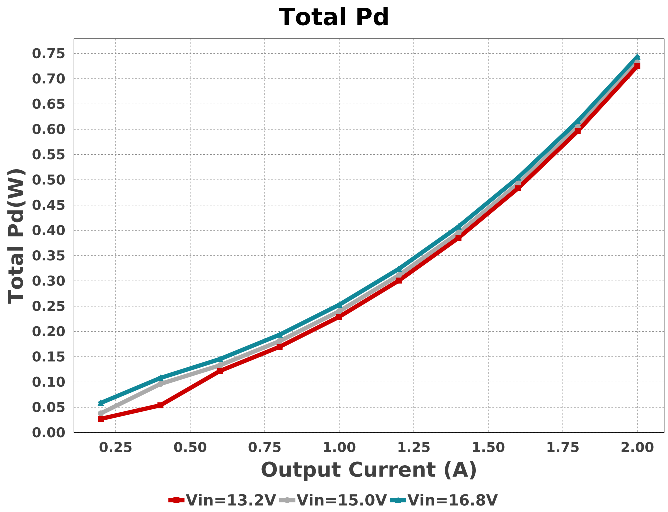

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

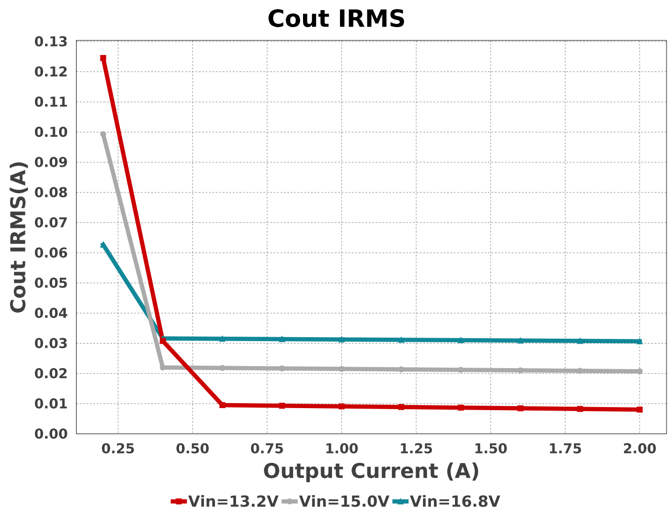

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

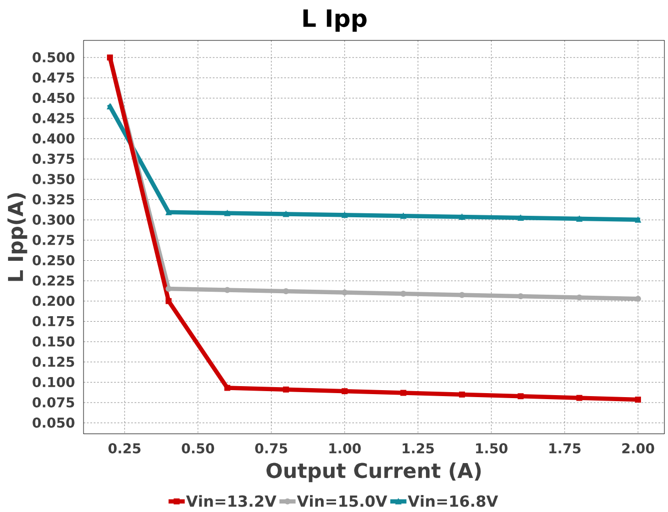

Pout
Pout(W)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

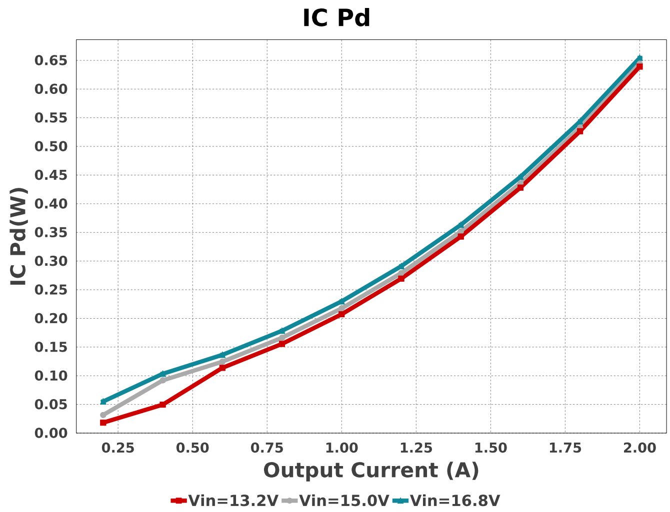

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

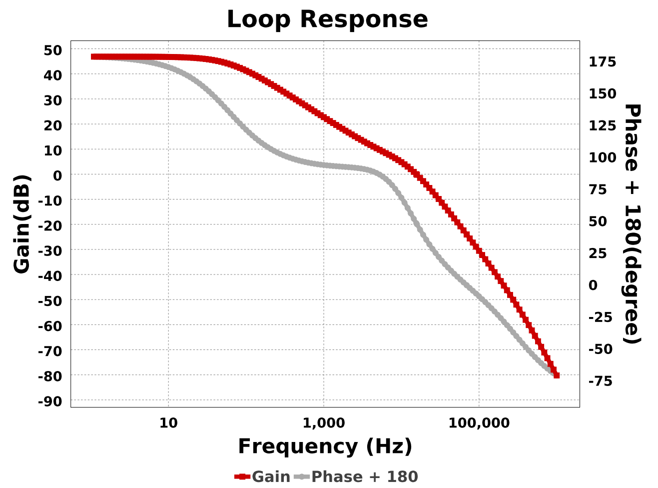

Cinx IRMS
Cinx IRMS(A)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V

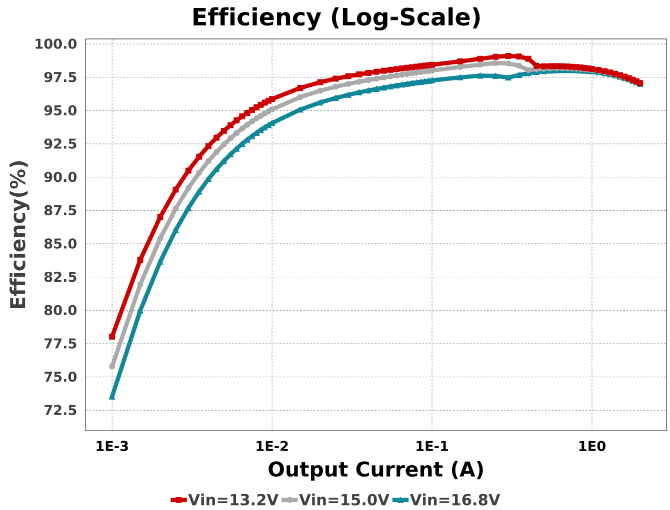

Total Pd
Total Pd(W)
Output Current (A)
Vin=13.2V Vin=15.0V Vin=16.8V











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	11		Total Design BOM count
2.	Total BOM	$3.36		Total BOM Cost
3.	Cin IRMS	790.214 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	4.163 mW	Capacitor	Input capacitor power dissipation
5.	Cinx IRMS	101.957 mA	Capacitor	Bulk capacitor RMS ripple current
6.	Cinx Pd	10.395 µW	Capacitor	Bulk capacitor power dissipation
7.	Cout IRMS	30.673 mA	Capacitor	Output capacitor RMS ripple current
8.	Cout Pd	423.37 µW	Capacitor	Output capacitor power dissipation
9.	Coutx IRMS	55.999 mA	Capacitor	Output capacitor_x RMS ripple current
10.	Coutx Pd	13.234 µW	Capacitor	Output capacitor_x power loss
11.	IC Ipk	2.15 A	IC	Peak switch current in IC

#	Name	Value	Category	Description
12.	IC Pd	654.32 mW	IC	IC power dissipation
13.	IC Tj	77.111 degC	IC	IC junction temperature
14.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
15.	ICThetaJA Effective	72.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
16.	Iin Avg	1.473 A	IC	Average input current
17.	Ipp percentage	15.012 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
18.	L Ipp	300.241 mA	Inductor	Peak-to-peak inductor ripple current
19.	L Pd	84.158 mW	Inductor	Inductor power dissipation
20.	Cin Pd	4.163 mW	Power	Input capacitor power dissipation
21.	Cinx Pd	10.395 µW	Power	Bulk capacitor power dissipation
22.	Cout Pd	423.37 µW	Power	Output capacitor power dissipation
23.	Coutx Pd	13.234 µW	Power	Output capacitor_x power loss
24.	IC Pd	654.32 mW	Power	IC power dissipation
25.	L Pd	84.158 mW	Power	Inductor power dissipation
26.	Total Pd	743.281 mW	Power	Total Power Dissipation
27.	Cross Freq	15.553 kHz	System Information	Bode plot crossover frequency
28.	Duty Cycle	72.886 %	System Information	Duty cycle
29.	Efficiency	96.996 %	System Information	Steady state efficiency
30.	FootPrint	460.0 mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	500.0 kHz	System Information	Switching frequency
32.	Gain Marg	-24.066 dB	System Information	Bode Plot Gain Margin
33.	Iout	2.0 A	System Information	Iout operating point
34.	Low Freq Gain	46.855 dB	System Information	Gain at 1Hz
35.	Mode	CCM	System Information	Conduction Mode
36.	Phase Marg	48.623 deg	System Information	Bode Plot Phase Margin
37.	Pout	24.0 W	System Information	Total output power
38.	Vin	16.8 V	System Information	Vin operating point
39.	Vin p-p	961.15 mV	System Information	Peak-to-peak input voltage
40.	Vout	12.0 V	System Information	Operational Output Voltage
41.	Vout Actual	12.057 V	System Information	Vout Actual calculated based on selected voltage divider resistors
42.	Vout Tolerance	3.618 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	Vout p-p	47.814 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	16.8	Maximum input voltage
VinMin	13.2	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LMR51430X	Base Product Number
source	DC	Input Source Type
Ta	30.0	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

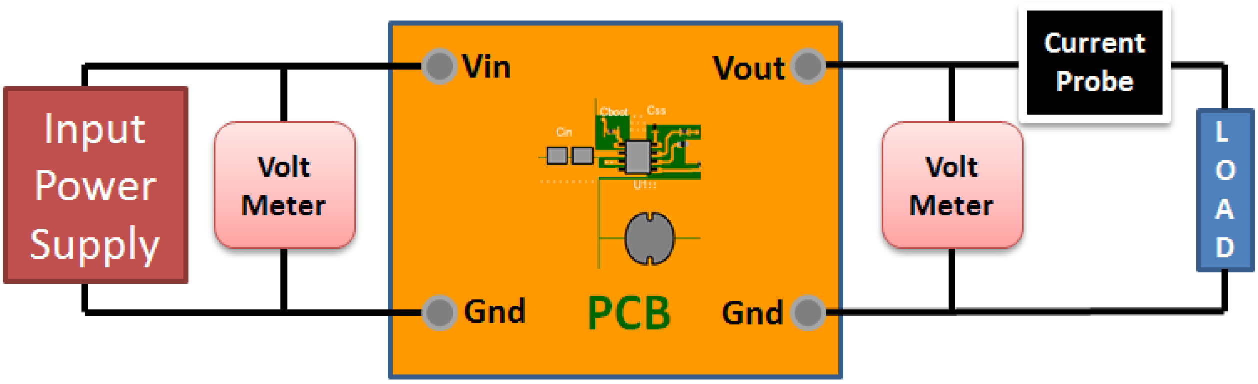
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 13.2V 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 : DF1643A7B06630C289ACDF7D614263E5[v1]

2. **LMR51430X** Product Folder : http://www.ti.com/product/LMR51430 : contains the data sheet and other resources.

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