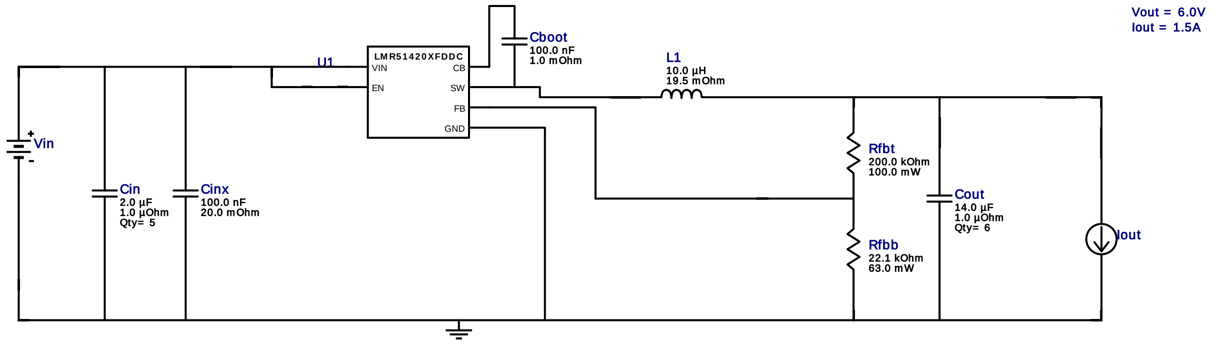
VinMin = 10.0V
VinMax = 14.0V
Vout = 6.0V
Iout = 1.5A

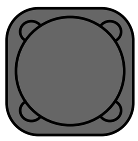
Device = LMR51420XFDDCR
Topology = Buck
Created = 2023-11-14 03:38:04.800
BOM Cost = NA
BOM Count = 17
Total Pd = 0.45W

WEBENCH ® Design Report

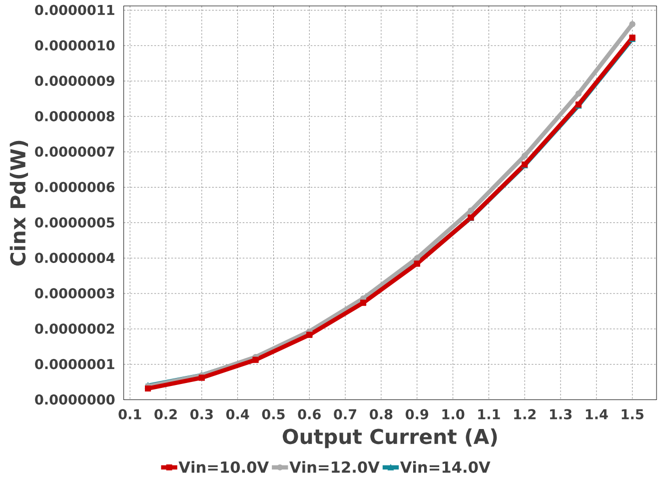
Design : 167 LMR51420XFDDCR
LMR51420XFDDCR 10V-14V to 6.00V @ 1.5A



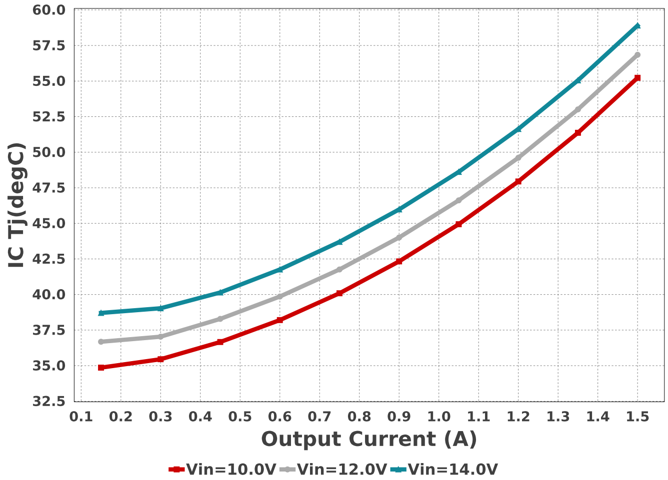
Electrical BOM

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 mm^2
Cin	CUSTOM	CUSTOM Series= X5R	Cap= 2.0 uF ESR= 1.0 uOhm VDC= 35.0 V IRMS= 2.3752 A	5	NA	0603 0 mm^2
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm^2
Cout	CUSTOM	CUSTOM Series= X7R	Cap= 14.0 uF ESR= 1.0 uOhm VDC= 16.0 V IRMS= 4.5756 A	6	NA	1210_280 0 mm^2
L1	Sumida	CDRH127/LDNP-100MC	L= 10.0 µH 19.5 mOhm	1	$0.73	 CDRH127 196 mm^2
Rfbb	Vishay-Dale	CRCW040222K1FKED Series= CRCW..e3	Res= 22.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RC0603FR-07200KL Series= ?	Res= 200.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LMR51420XFDDCR	Switcher	1	$0.34	DBV0006A 15 mm^2

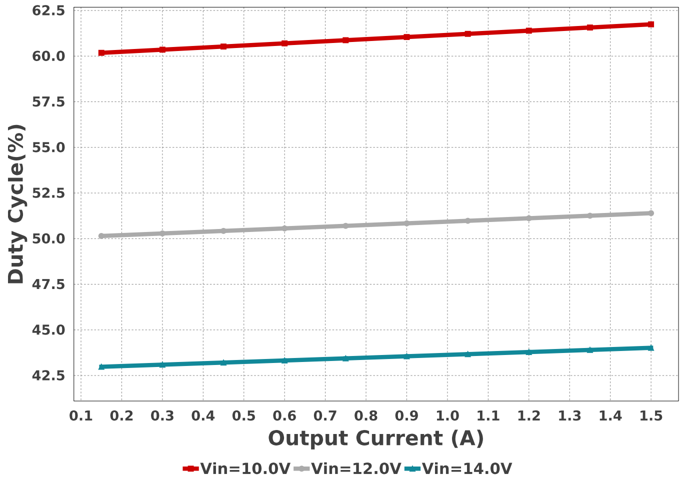
Cinx Pd



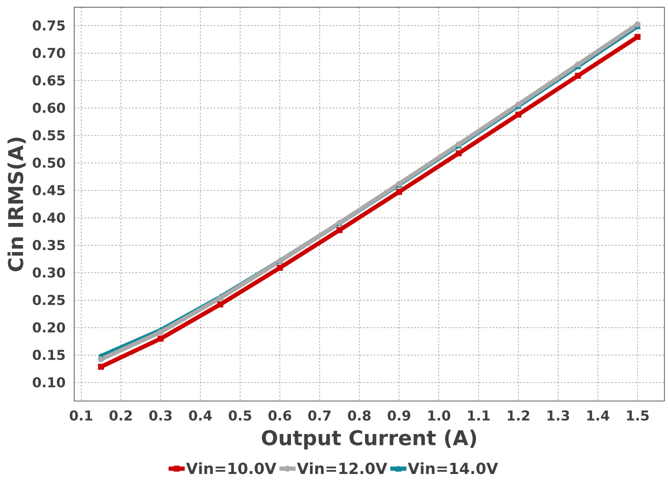
IC Tj



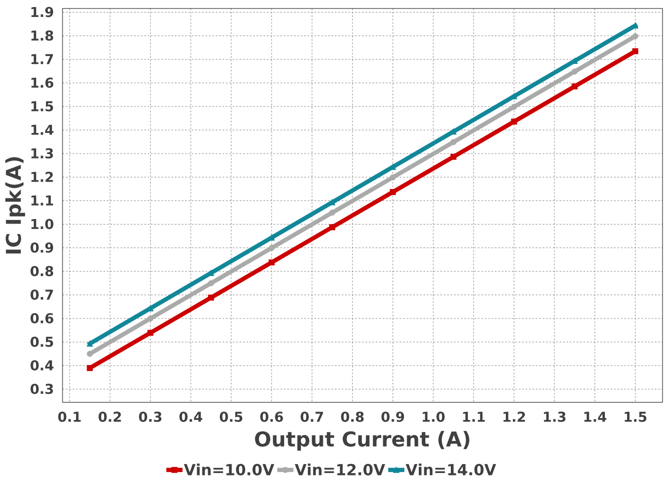
Duty Cycle



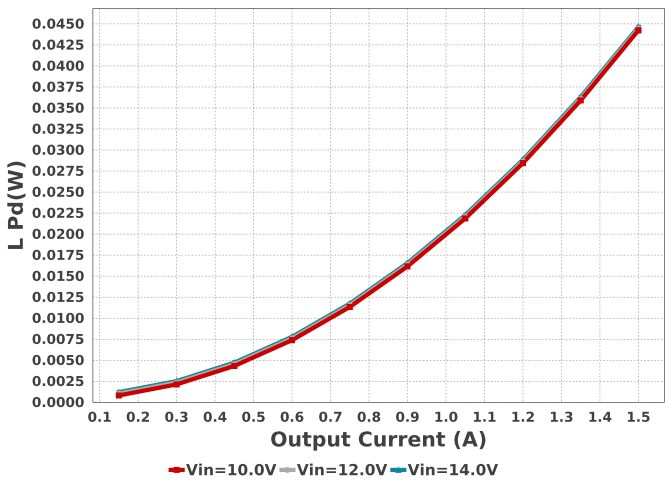
Cin IRMS



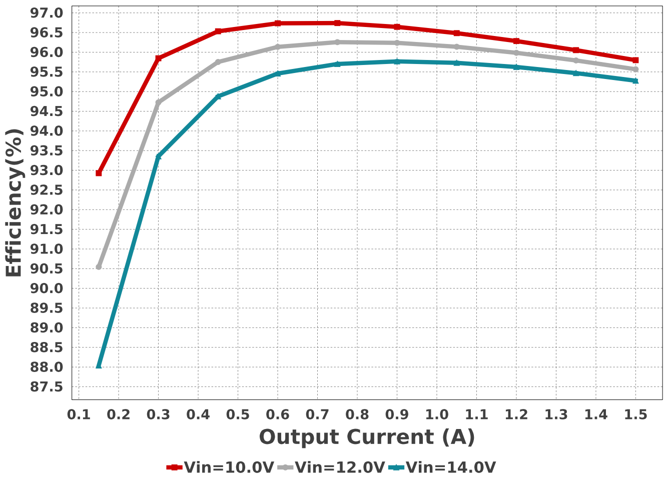
IC Ipk



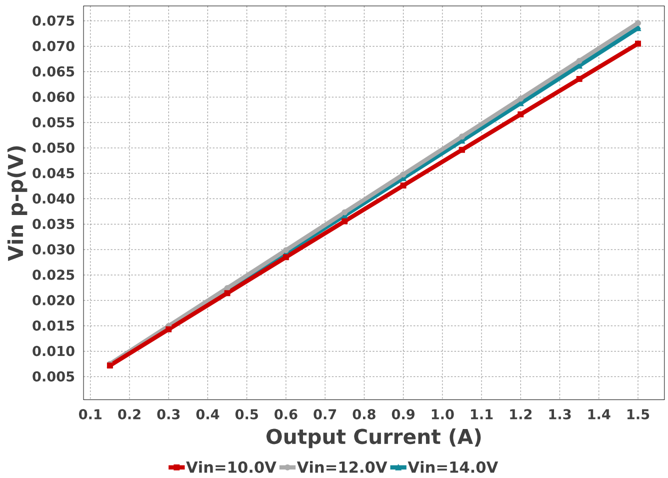
L Pd



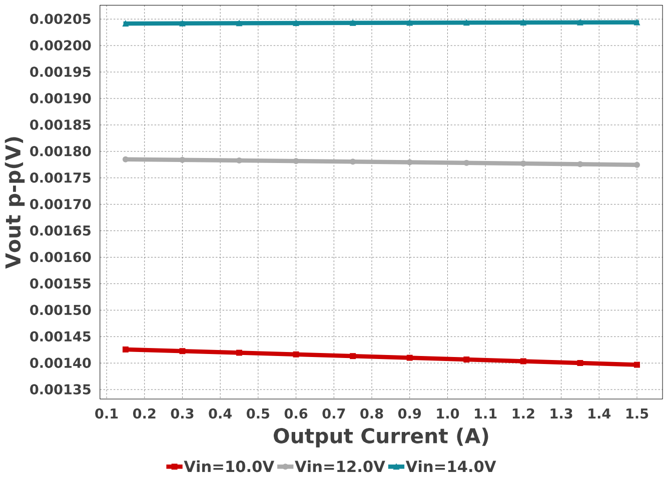
Efficiency



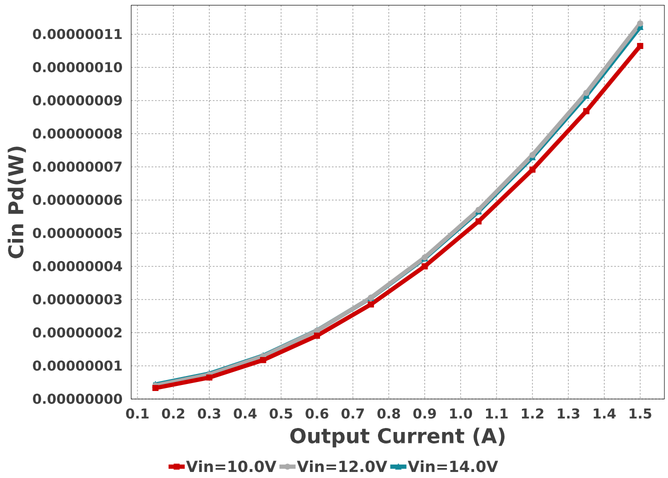
Vin p-p



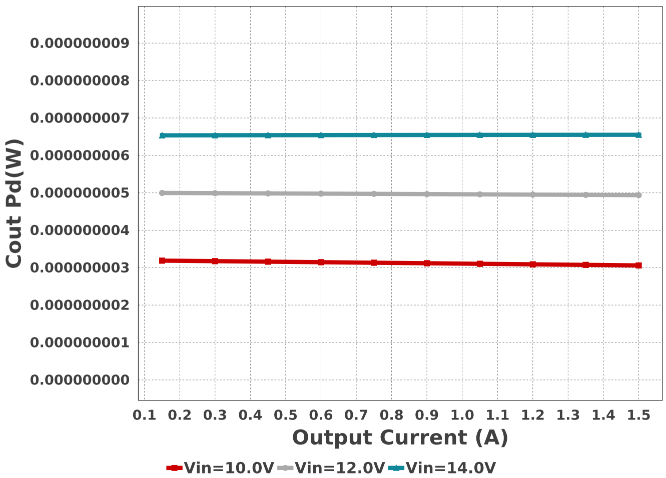
Vout p-p



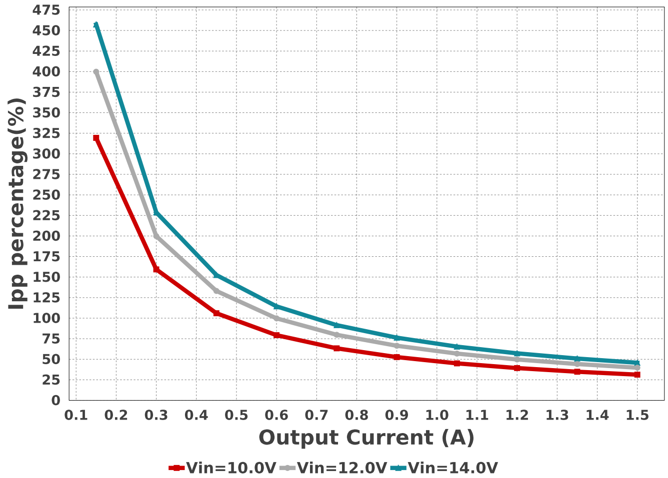
Cin Pd



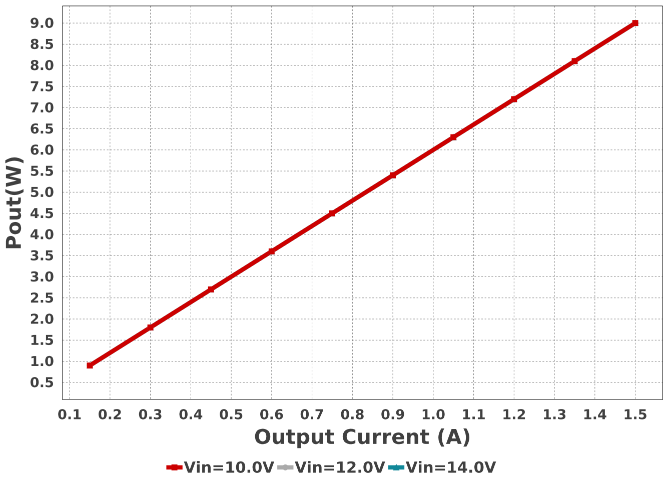
Cout Pd



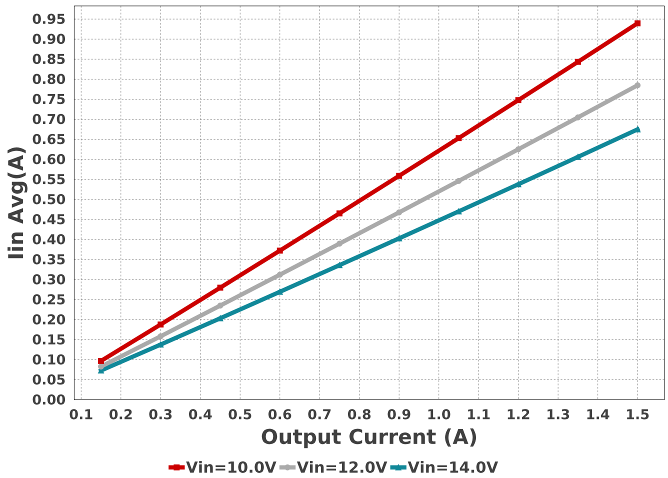
Ipp percentage



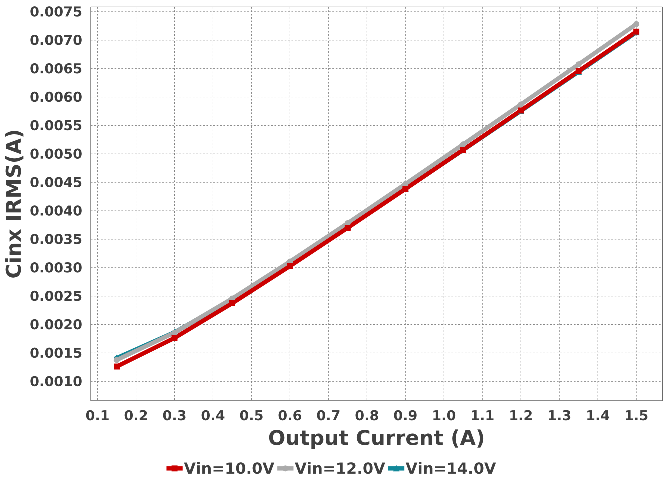
Pout



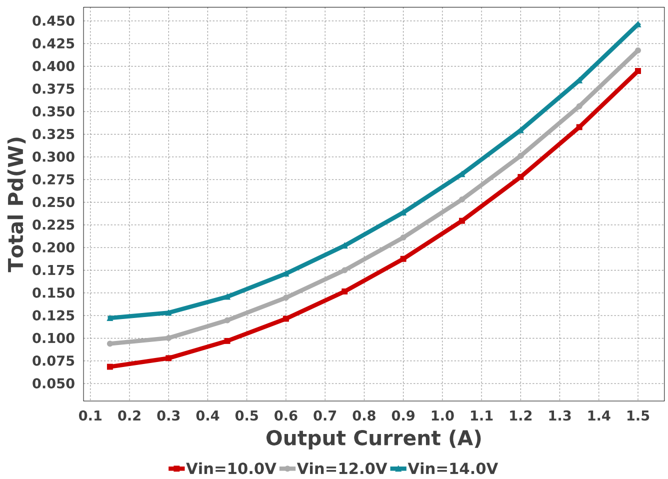
Iin Avg



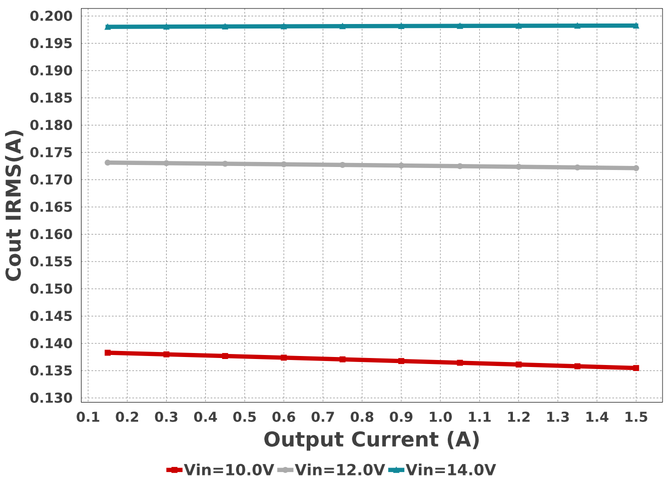
Cinx IRMS



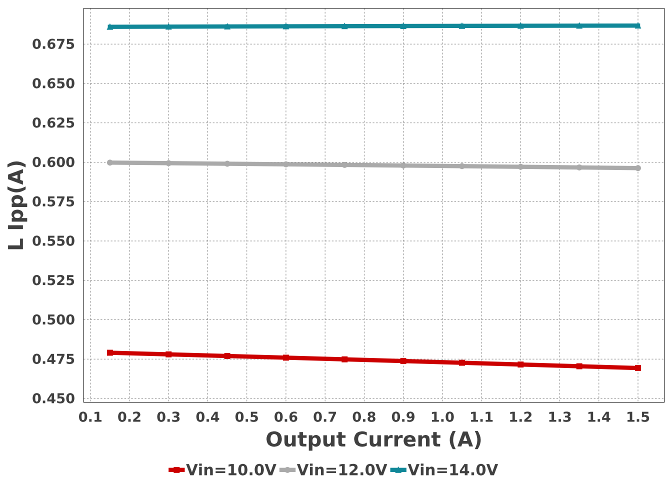
Total Pd

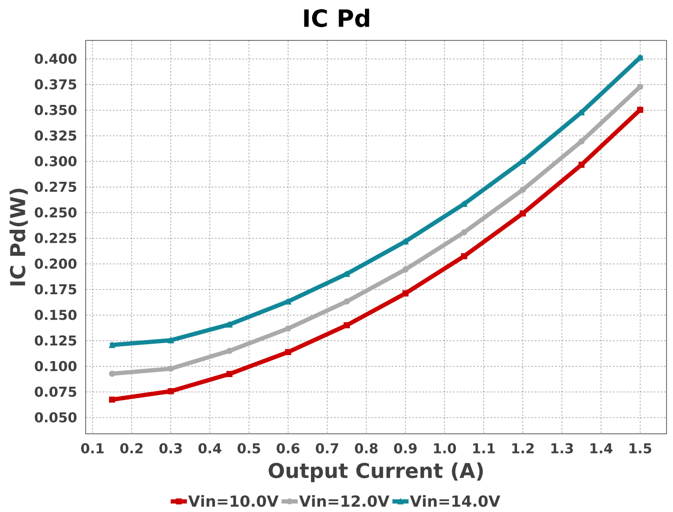


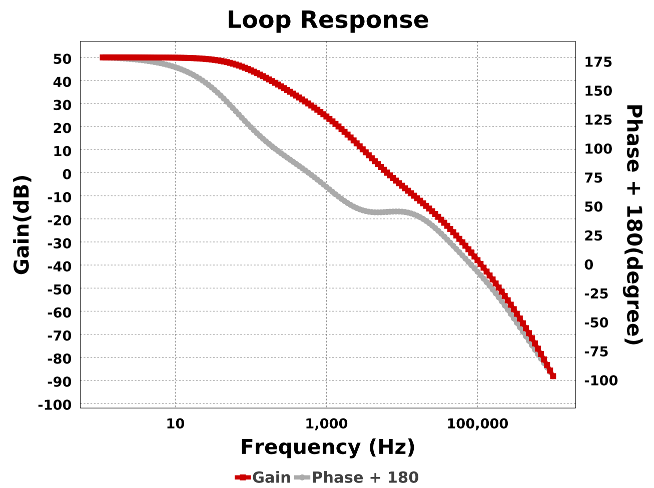
Cout IRMS



L Ipp







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	17		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	749.003 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	112.2 nW	Capacitor	Input capacitor power dissipation
5.	Cinx IRMS	7.138 mA	Capacitor	Bulk capacitor RMS ripple current
6.	Cinx Pd	1.019 µW	Capacitor	Bulk capacitor power dissipation
7.	Cout IRMS	198.247 mA	Capacitor	Output capacitor RMS ripple current
8.	Cout Pd	6.55 nW	Capacitor	Output capacitor power dissipation
9.	IC Ipk	1.843 A	IC	Peak switch current in IC
10.	IC Pd	401.42 mW	IC	IC power dissipation
11.	IC Tj	58.902 degC	IC	IC junction temperature
12.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA Effective	72.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
14.	Iin Avg	674.73 mA	IC	Average input current
15.	Ipp percentage	45.783 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
16.	L Ipp	686.748 mA	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	44.641 mW	Inductor	Inductor power dissipation
18.	Cin Pd	112.2 nW	Power	Input capacitor power dissipation
19.	Cinx Pd	1.019 µW	Power	Bulk capacitor power dissipation
20.	Cout Pd	6.55 nW	Power	Output capacitor power dissipation
21.	IC Pd	401.42 mW	Power	IC power dissipation
22.	L Pd	44.641 mW	Power	Inductor power dissipation
23.	Total Pd	446.239 mW	Power	Total Power Dissipation
24.	Cross Freq	6.35 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	44.018 %	System Information	Duty cycle
26.	Efficiency	95.276 %	System Information	Steady state efficiency
27.	FootPrint	338.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	500.0 kHz	System Information	Switching frequency
29.	Gain Marg	-34.537 dB	System Information	Bode Plot Gain Margin
30.	Iout	1.5 A	System Information	Iout operating point
31.	Low Freq Gain	50.027 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	45.576 deg	System Information	Bode Plot Phase Margin
34.	Pout	9.0 W	System Information	Total output power
35.	Vin	14.0 V	System Information	Vin operating point
36.	Vin p-p	73.575 mV	System Information	Peak-to-peak input voltage
37.	Vout	6.0 V	System Information	Operational Output Voltage

#	Name	Value	Category	Description
38.	Vout Actual	6.03 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	3.516 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	2.044 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	14.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	6.0	Output Voltage
base_pn	LMR51420XF	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

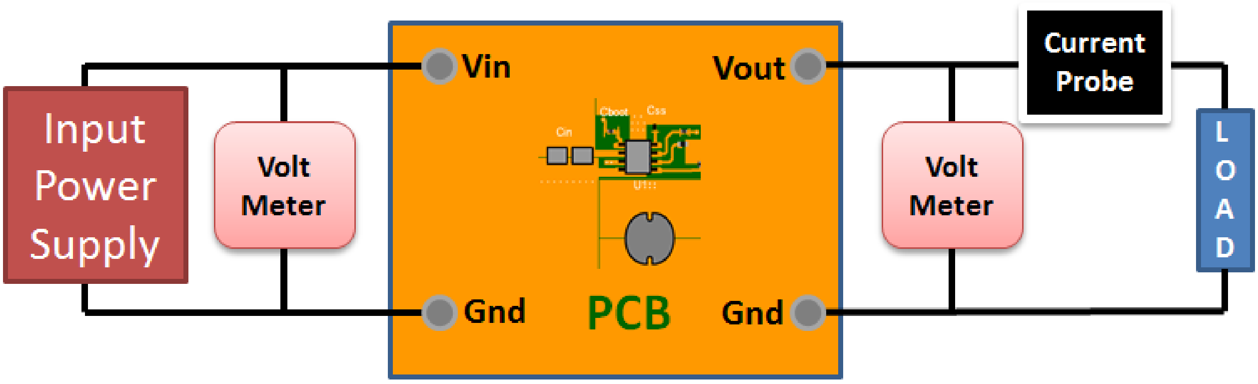
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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.

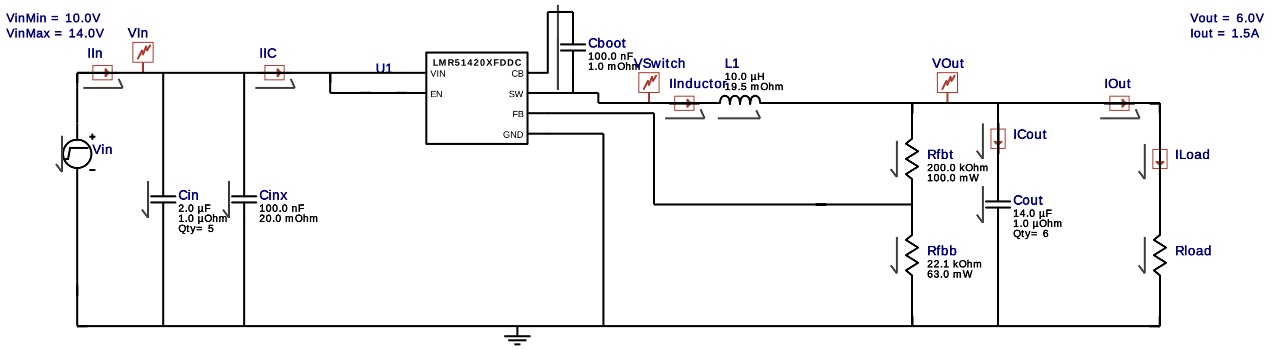


WEBENCH® Electrical Simulation Report

Design Id = 167

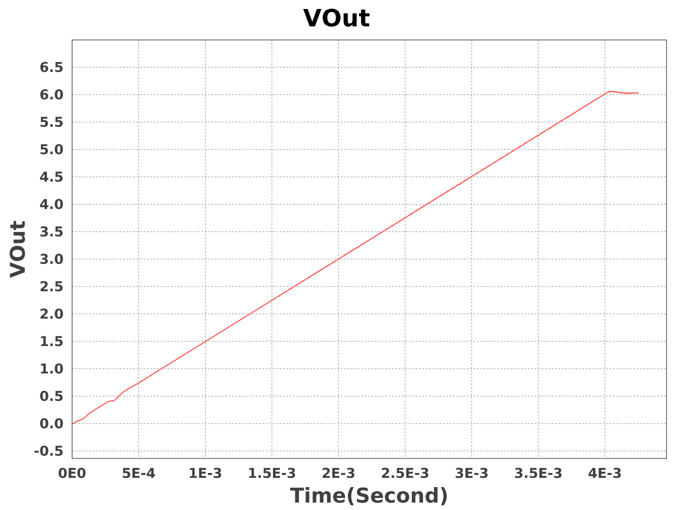
sim_id = 27

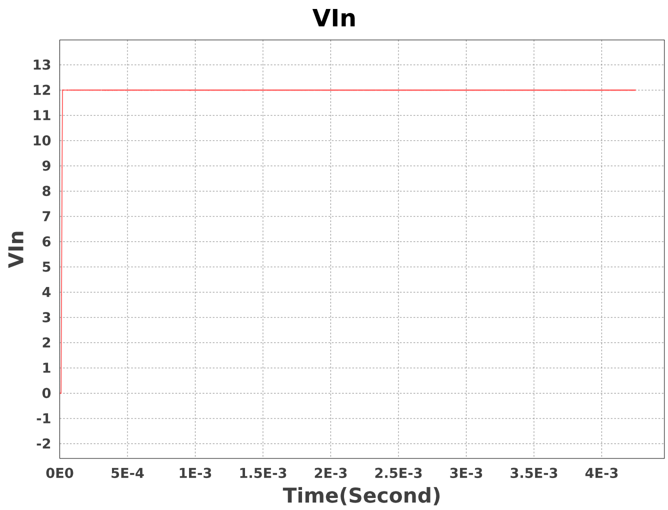
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	4.0 Ohm

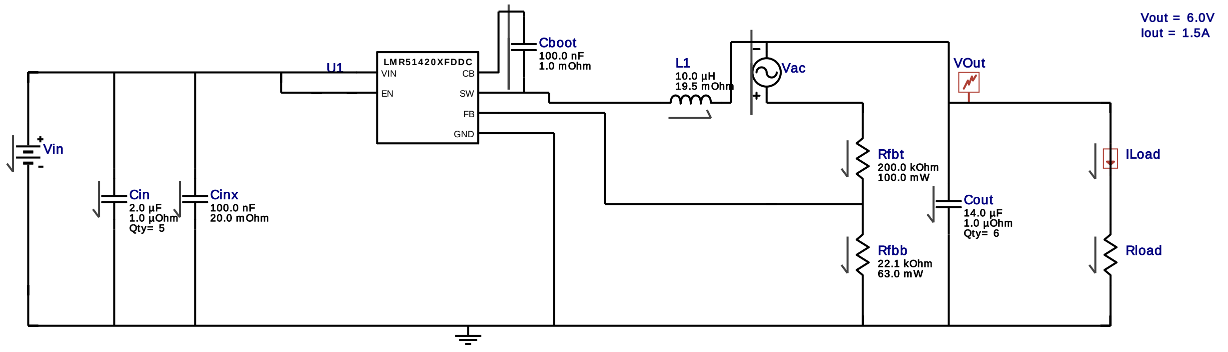




Design Id = 167

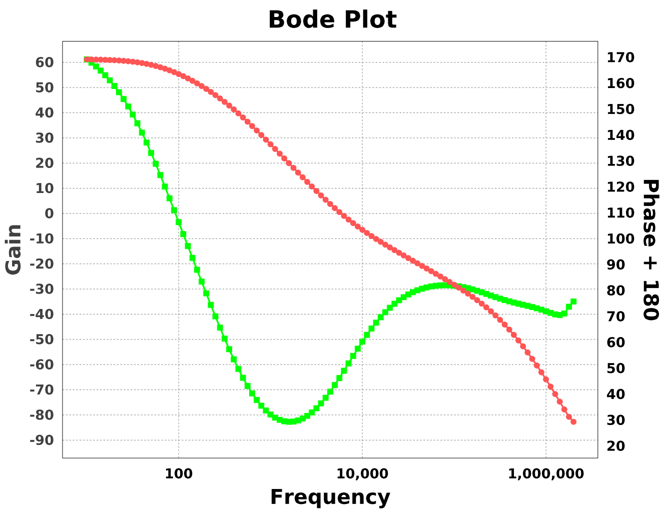
sim_id = 28

Simulation Type = Bode Plot



Simulation Parameters

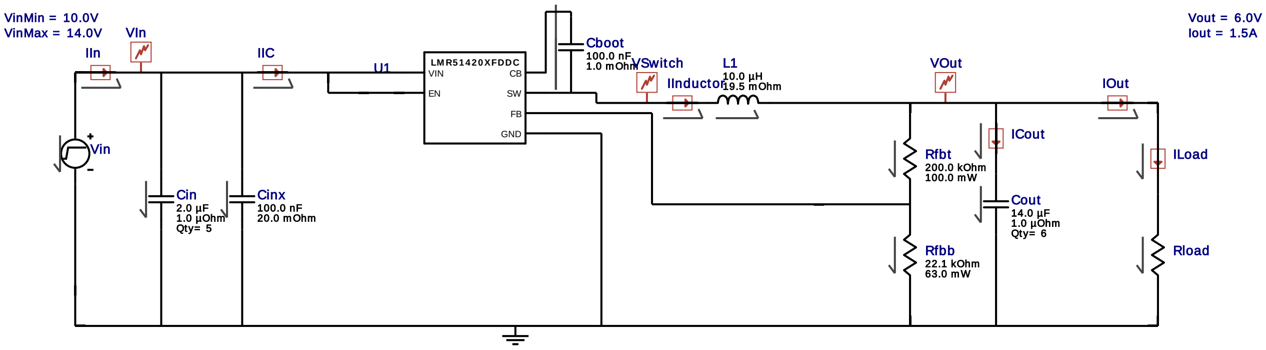
#	Name	Parameter Name	Description	Values
1.	Cinj	C	Ac Injection Source	10000000 F
2.	Linj	L	Injection Inductance	10000000 H
3.	Vinj	AC	Ac Injection Source	1 V
4.	Rload	R	no description	4.0 ohm



Design Id = 167

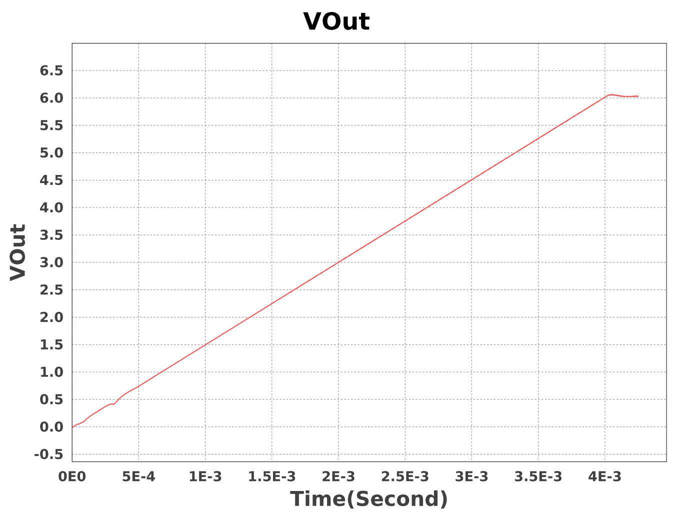
sim_id = 29

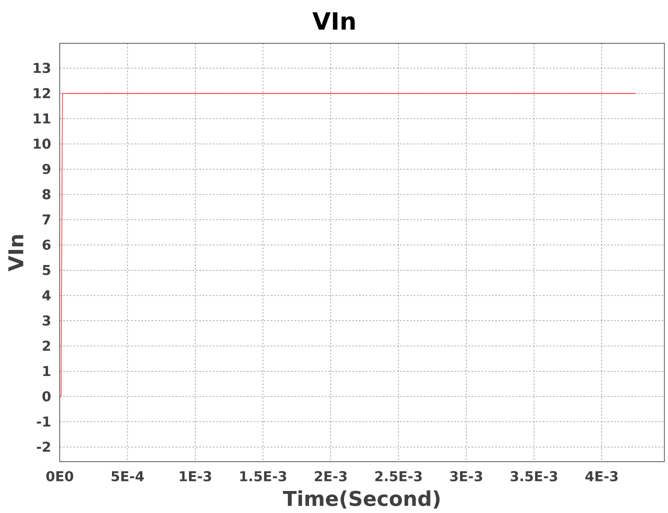
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	4.0 Ohm

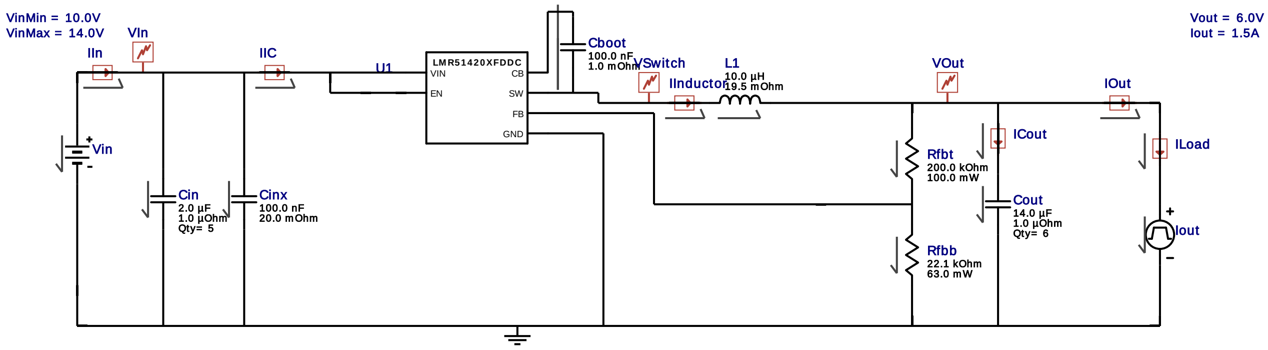




Design Id = 167

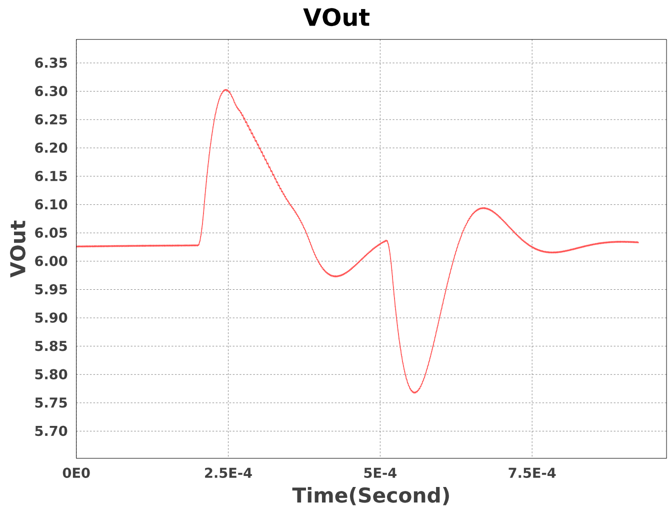
sim_id = 30

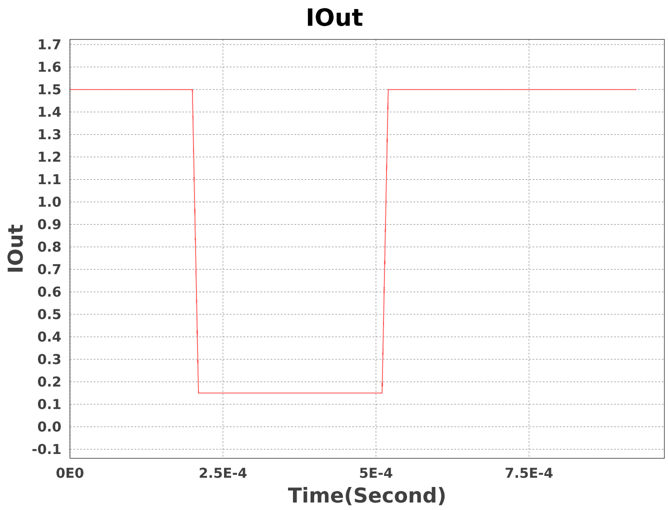
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	1.5 A
		I2	Minimum Load Current	0.15 A
		Td	Initial Time Delay	200u s
		Tf	Fall Time	10u a
		Tr	Rise Time	10u s
		Pw	Pulse Width	300u s





Design Assistance

1. Master key : 5AA238EE4536C64A[v1]

2. **LMR51420XF** Product Folder : http://www.ti.com/product/LMR51420 : contains the data sheet and other resources.