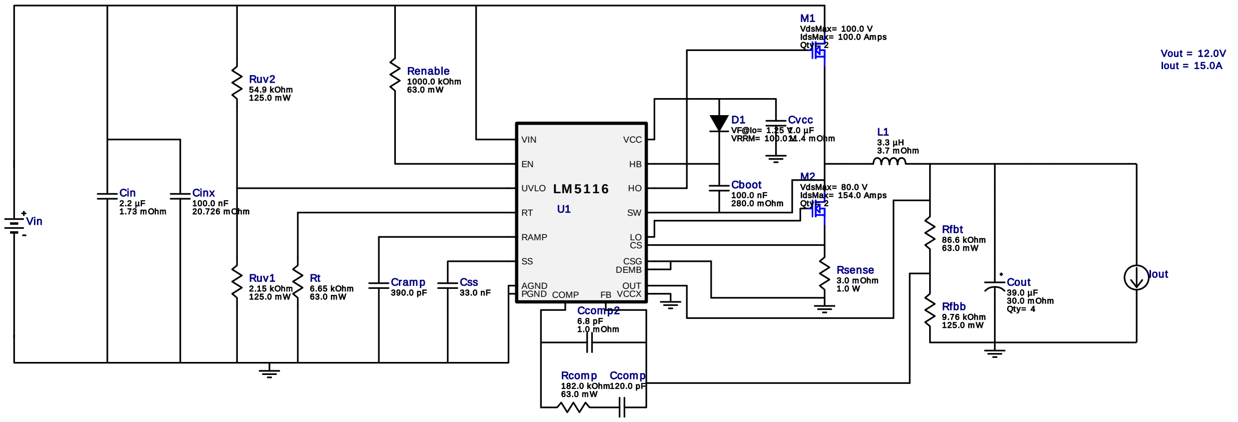
Texas Instruments

WEBENCH ® Design Report

VinMin = 40.0V
VinMax = 50.0V
Vout = 12.0V
Iout = 15.0A

Device = LM5116MH/NOPB
Topology = Buck
Created = 2025-11-30 17:37:10.070
BOM Cost = $9.92
BOM Count = 28
Total Pd = 6.82W

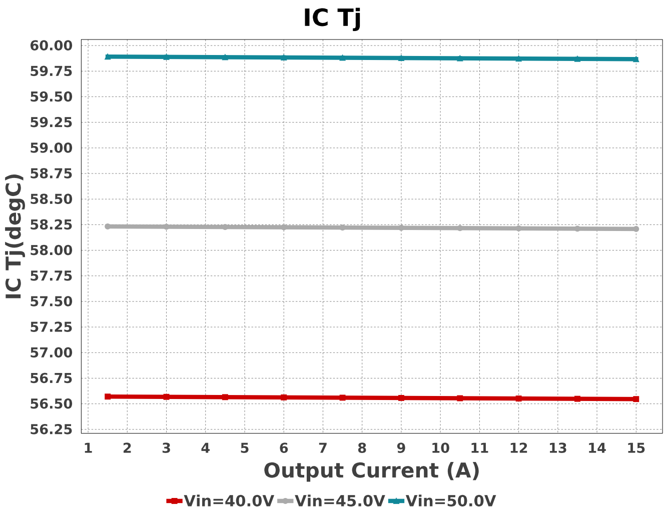
Design : 13 LM5116MH/NOPB
LM5116MH/NOPB 40V-50V to 12.00V @ 15A

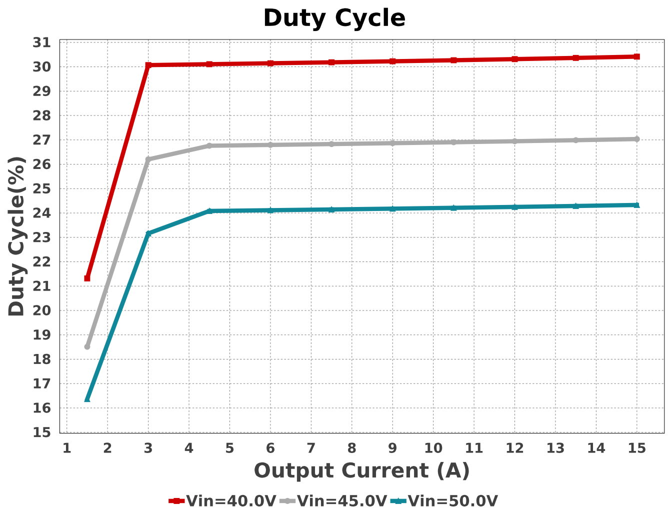


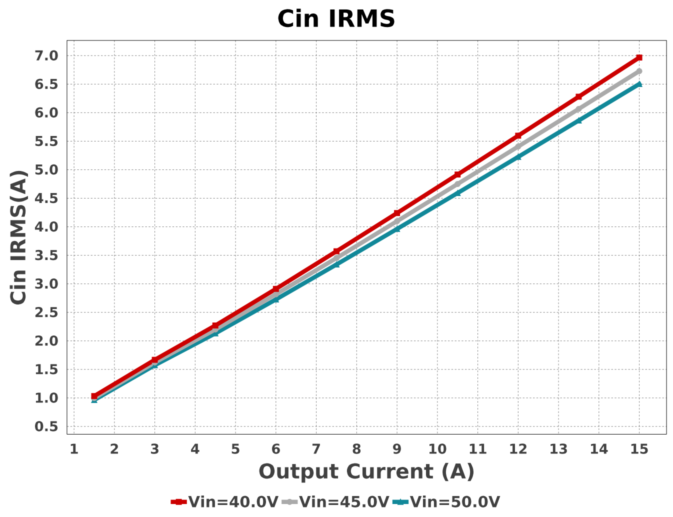
Electrical BOM

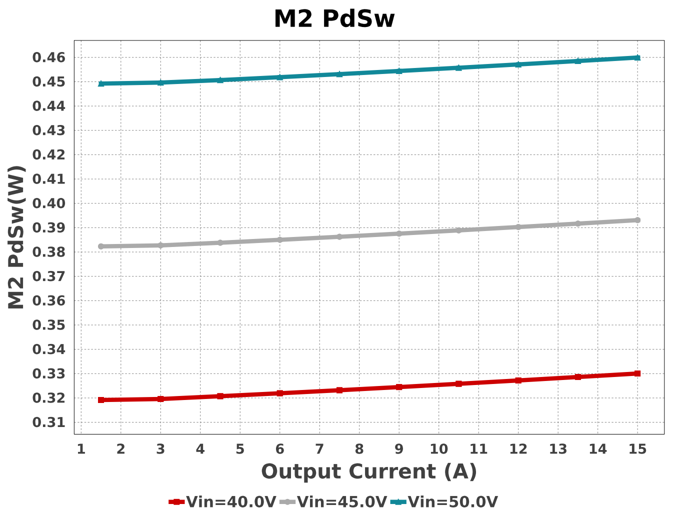
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Ccomp	Taiyo Yuden	UMK105CG121JV-F Series= C0G/NP0	Cap= 120.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp2	MuRata	GRM1555C1E6R8CA01D Series= C0G/NP0	Cap= 6.8 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	1	$0.21	1210_250 15 mm²
Cinx	TDK	C2012X7R2A104K125AA Series= X7R	Cap= 100.0 nF ESR= 20.726 mOhm VDC= 100.0 V IRMS= 1.456 A	1	$0.03	0805 7 mm²
Cout	Panasonic	35SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 30.0 mOhm VDC= 35.0 V IRMS= 2.8 A	4	$0.67	CAPSMT_62_E7 106 mm²
Cramp	MuRata	GRM1555C1H391JA01J Series= C0G/NP0	Cap= 390.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Css	TDK	CGA4J2C0G1H333J125AA Series= C0G/NP0	Cap= 33.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm²
Cvcc	TDK	C1005X5R1E105K050BC Series= X5R	Cap= 1.0 uF ESR= 11.4 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
D1	Nexperia	BAS516,115	VF@Io= 1.25 V VRRM= 100.0 V	1	$0.22	SOD-523 5 mm²

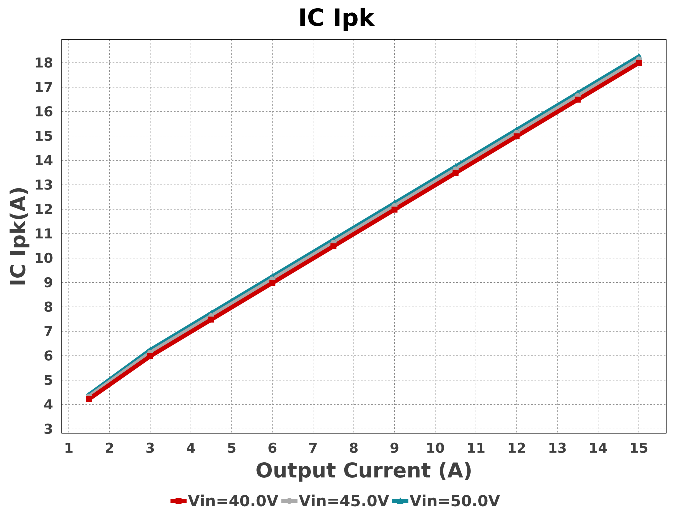
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	XAL1010-332MEB	L= 3.3 µH 3.7 mOhm	1	$1.71	XAL1010 160 mm²
M1	Texas Instruments	CSD19534Q5A	VdsMax= 100.0 V IdsMax= 100.0 Amps	2	$0.28	TRANS_NexFET_Q5A 55 mm²
M2	ON Semiconductor	NVMFS6H836NLT1G	VdsMax= 80.0 V IdsMax= 154.0 Amps	2	$0.64	DFNW5 55 mm²
Rcomp	Vishay-Dale	CRCW0402182KFKED Series= CRCW..e3	Res= 182.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Renable	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Panasonic	ERJ-6ENF9761V Series= ERJ-6E	Res= 9.76 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rfbt	Yageo	AC0402FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rramp	Vishay-Dale	CRCW0402475KFKED Series= CRCW..e3	Res= 475.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsense	Stackpole Electronics Inc	CSNL1206FT3L00 Series= CSNL	Res= 3.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.19	1206 11 mm²
Rt	Vishay-Dale	CRCW04026K65FKED Series= CRCW..e3	Res= 6.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ruv1	Vishay-Dale	CRCW08052K15FKEA Series= CRCW..e3	Res= 2.15 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Ruv2	Panasonic	ERJ-6ENF5492V Series= ERJ-6E	Res= 54.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
U1	Texas Instruments	LM5116MH/NOPB	Switcher	1	$2.82	MXA20A 71 mm²

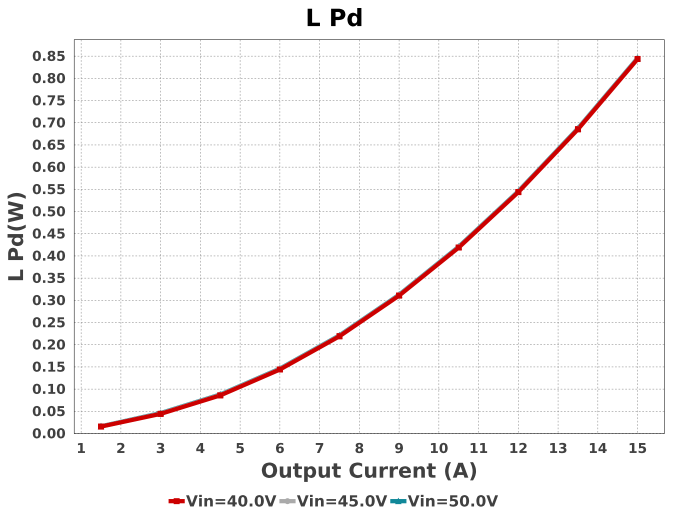


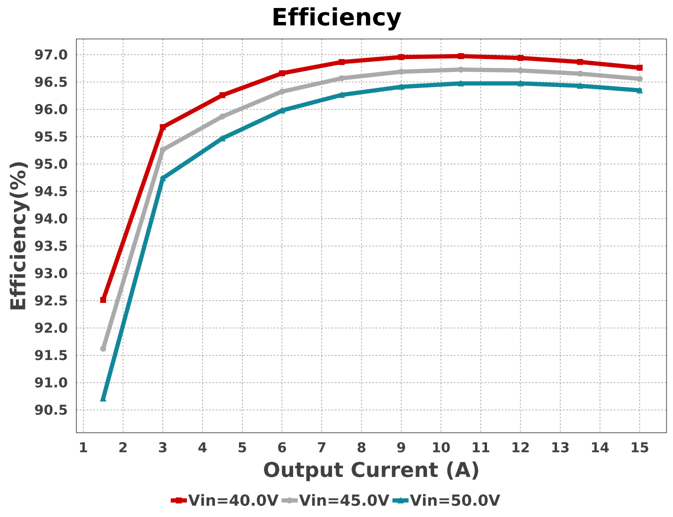


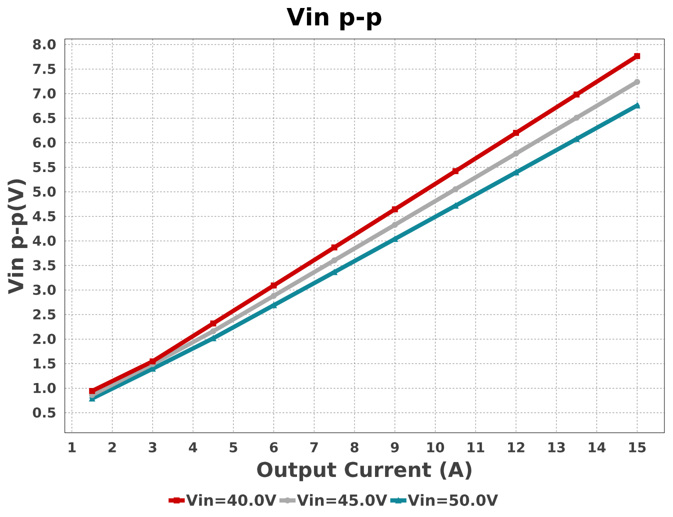

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V


M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

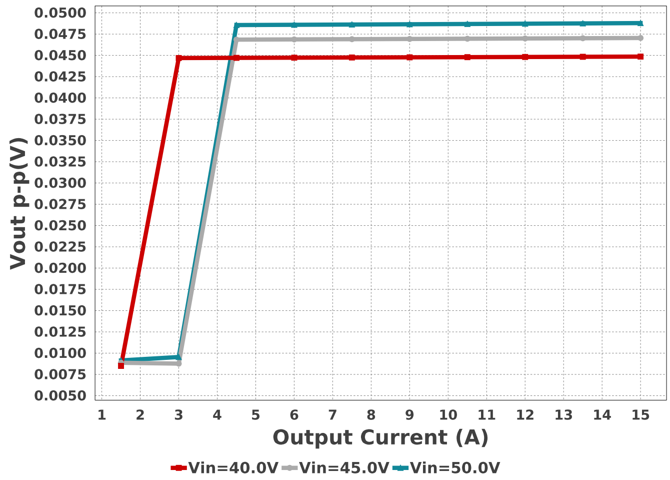

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V


L Pd
L Pd(W)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

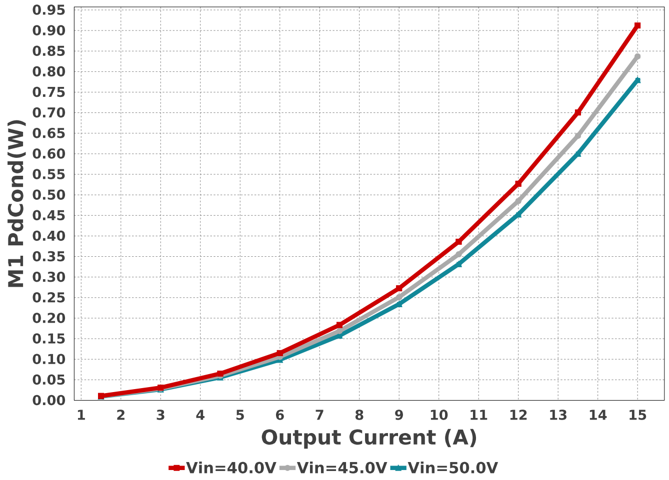

Efficiency
Efficiency(%)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V


Vin p-p
Vin p-p(V)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

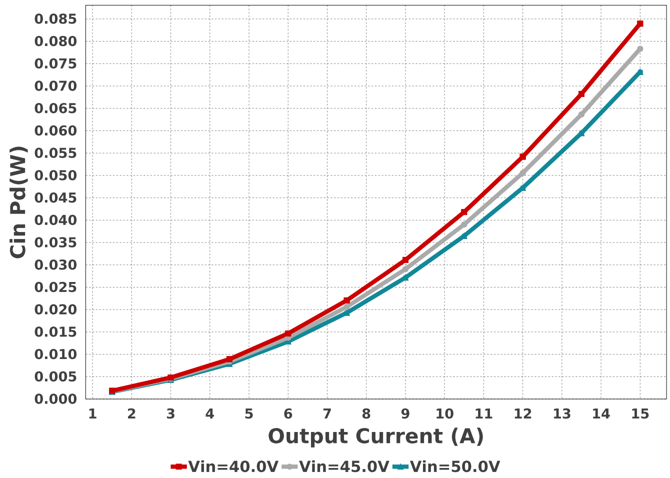
Vout p-p



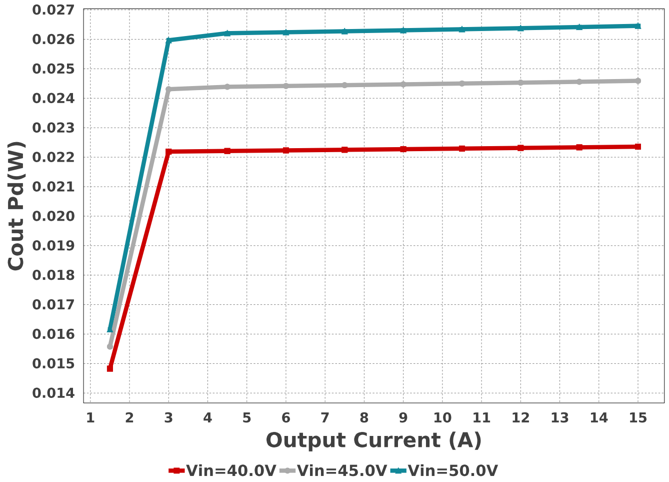
M1 PdCond



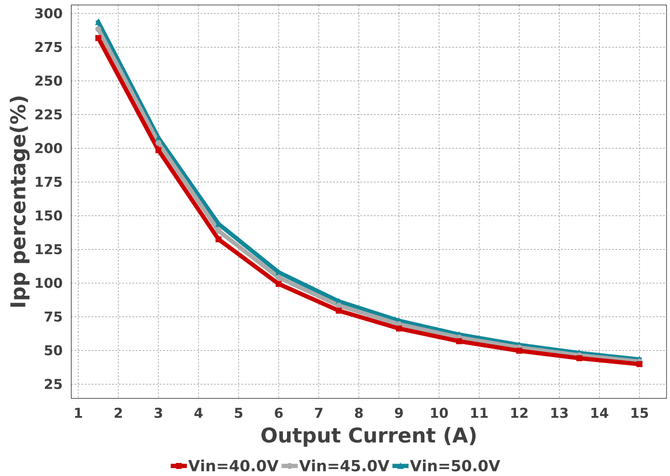
Cin Pd



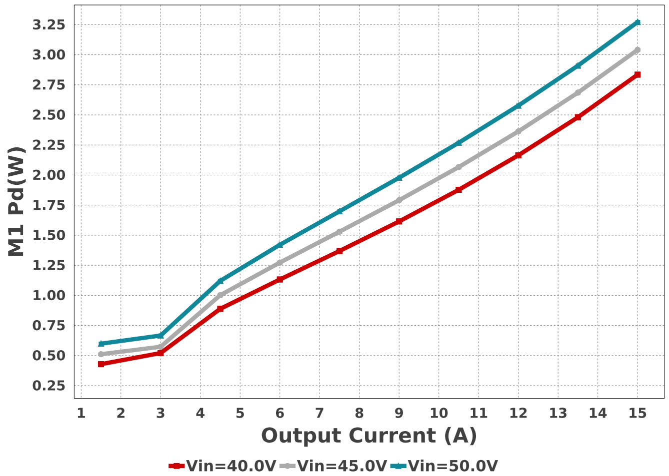
Cout Pd

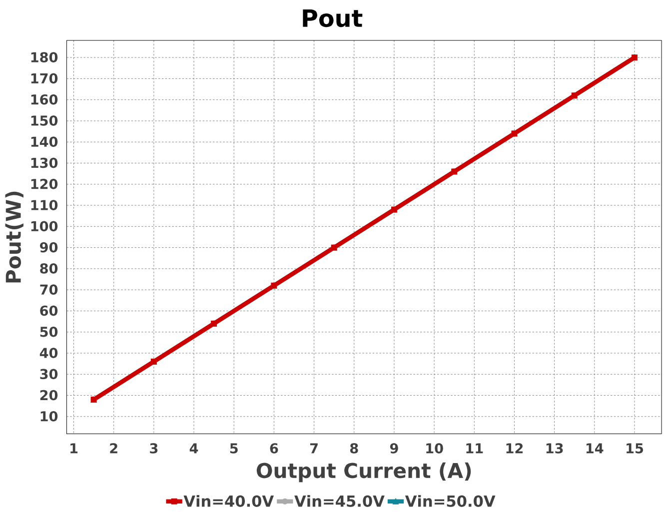


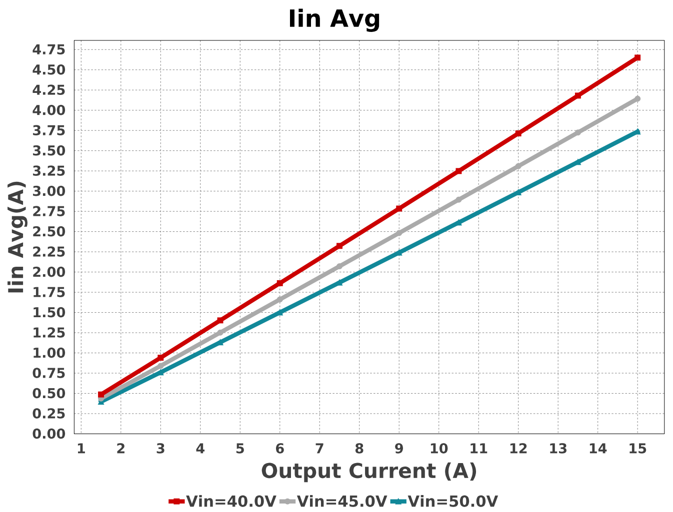
Ipp percentage

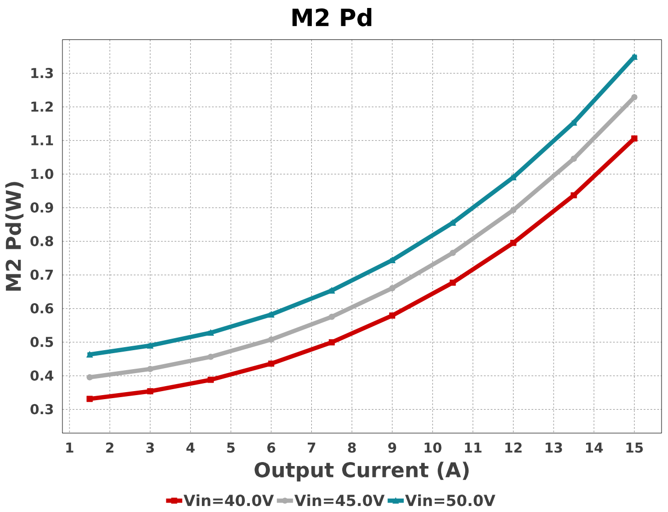


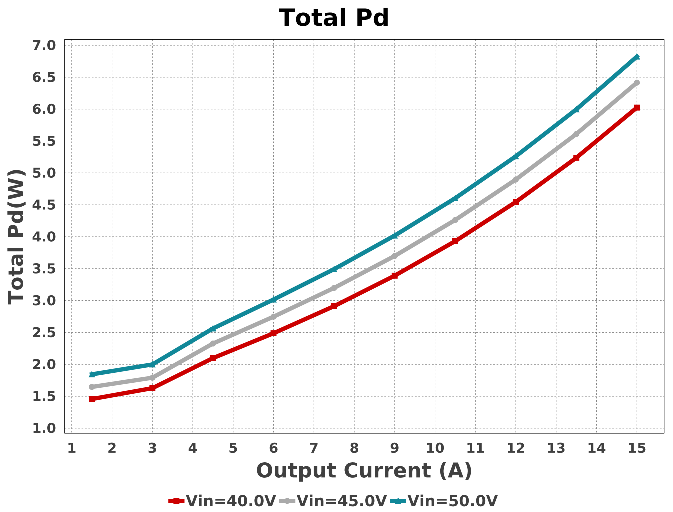
M1 Pd

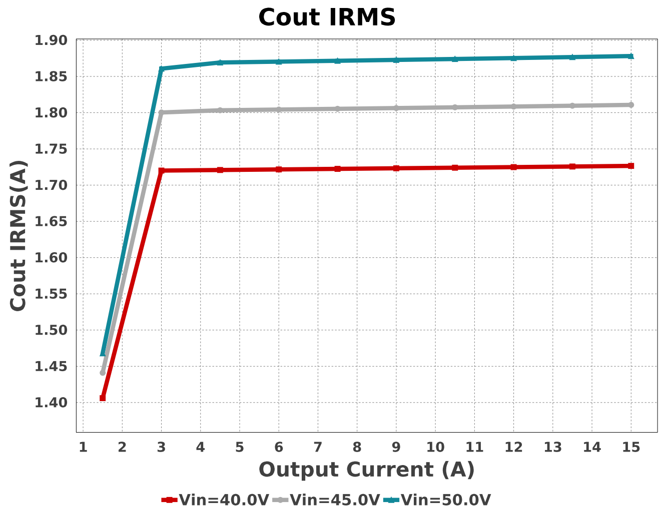


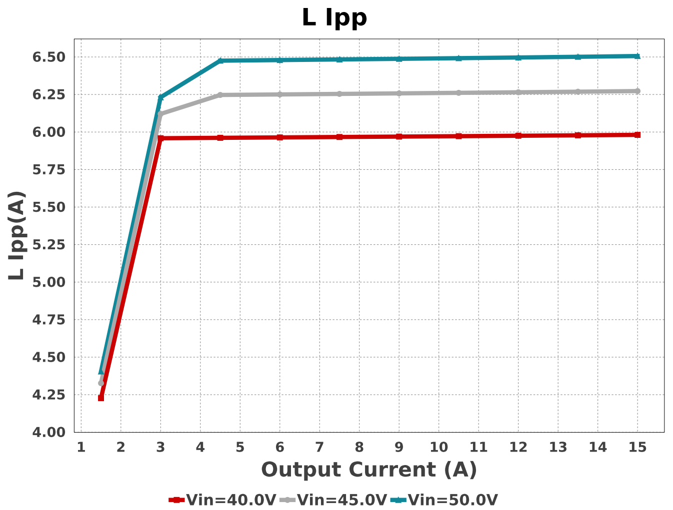

Pout
Pout(W)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

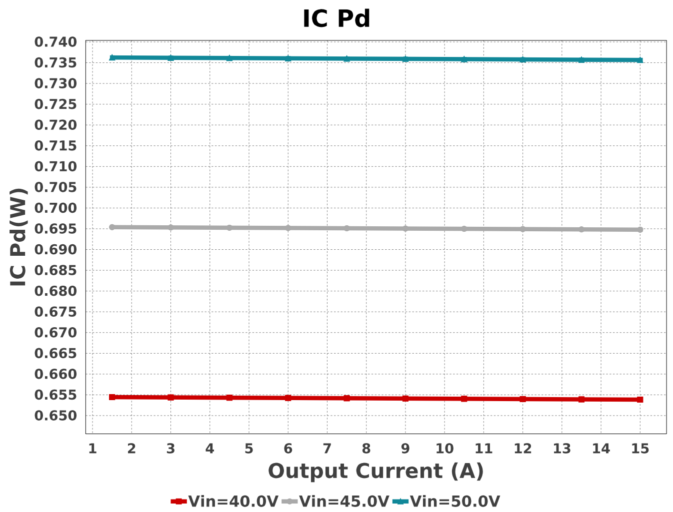

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

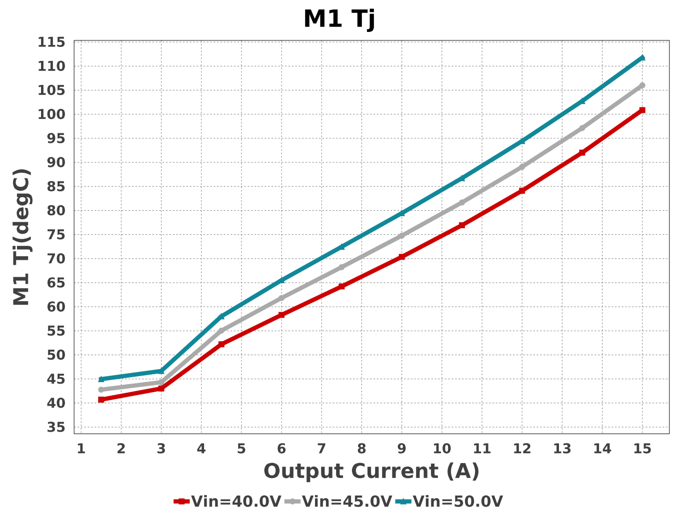

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

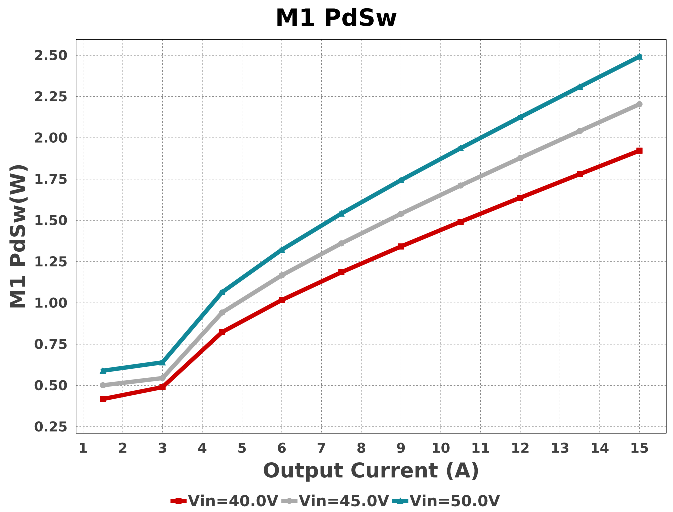

Total Pd
Total Pd(W)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

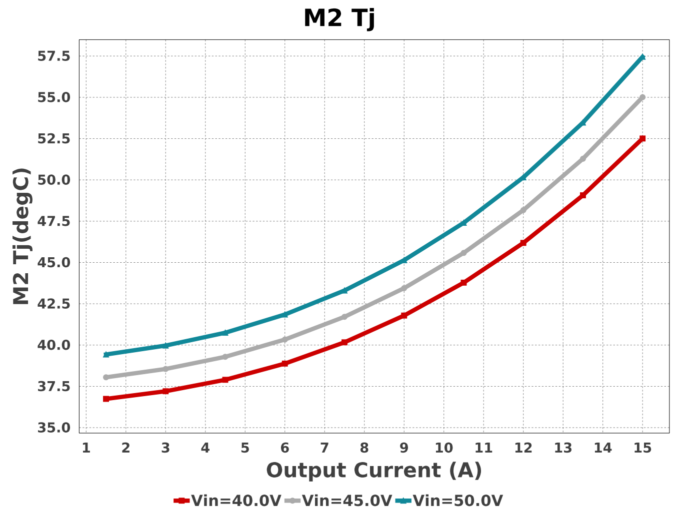

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

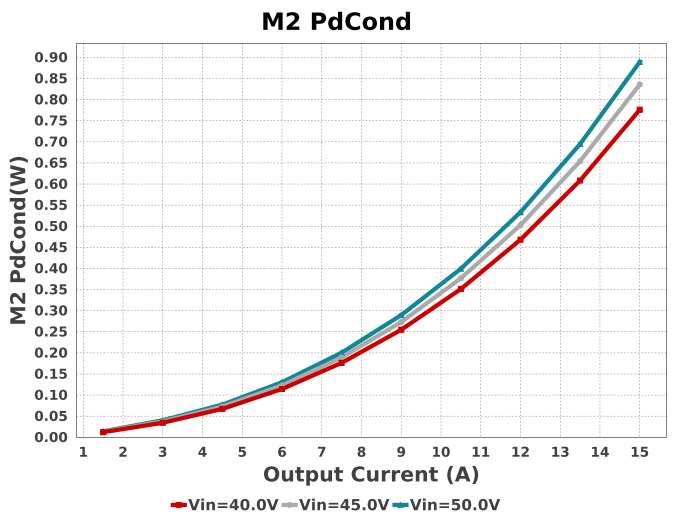

L Ipp
L Ipp(A)
Output Current (A)
Vin=40.0V Vin=45.0V Vin=50.0V

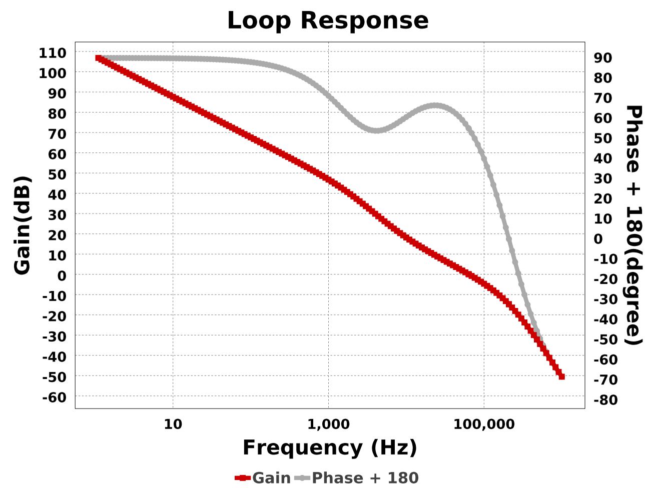












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	6.502 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	73.129 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.878 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	26.443 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	18.252 A	IC	Peak switch current in IC
6.	IC Pd	735.65 mW	IC	IC power dissipation
7.	IC Tj	59.426 degC	IC	IC junction temperature
8.	IC Tolerance	16.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	3.735 A	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	43.363 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	6.504 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	845.55 mW	Inductor	Inductor power dissipation
14.	M1 Pd	3.271 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	779.12 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	2.492 W	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	111.78 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	1.349 W	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	889.29 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	459.93 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	57.457 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	73.129 mW	Power	Input capacitor power dissipation
23.	Cout Pd	26.443 mW	Power	Output capacitor power dissipation
24.	IC Pd	735.65 mW	Power	IC power dissipation
25.	L Pd	845.55 mW	Power	Inductor power dissipation
26.	M1 Pd	3.271 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	779.12 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	2.492 W	Power	M1 MOSFET switching losses
29.	M2 Pd	1.349 W	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	889.29 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	459.93 mW	Power	M2 MOSFET switching losses
32.	Total Pd	6.82 W	Power	Total Power Dissipation
33.	BOM Count	28	System Information	Total Design BOM count
34.	Cross Freq	63.857 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	24.321 %	System Information	Duty cycle
36.	Efficiency	96.348 %	System Information	Steady state efficiency
37.	FootPrint	973.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	427.606 kHz	System Information	Switching frequency
39.	Gain Marg	-14.748 dB	System Information	Bode Plot Gain Margin
40.	Iout	15.0 A	System Information	Iout operating point
41.	Low Freq Gain	106.817 dB	System Information	Gain at 1Hz
42.	Mode	CCM	System Information	Conduction Mode
43.	Phase Marg	54.813 deg	System Information	Bode Plot Phase Margin
44.	Pout	179.935 W	System Information	Total output power
45.	Total BOM	$9.92	System Information	Total BOM Cost
46.	Vin	50.0 V	System Information	Vin operating point
47.	Vin p-p	6.76 V	System Information	Peak-to-peak input voltage
48.	Vout	11.996 V	System Information	Operational Output Voltage
49.	Vout Actual	11.996 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	3.156 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	48.784 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	15.0	Maximum Output Current
VinMax	50.0	Maximum input voltage
VinMin	40.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5116	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

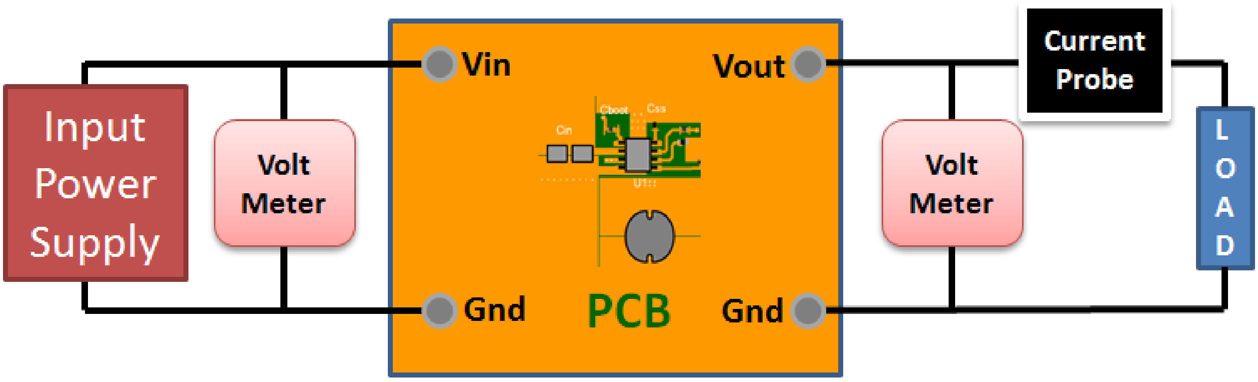
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 40.0V 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.

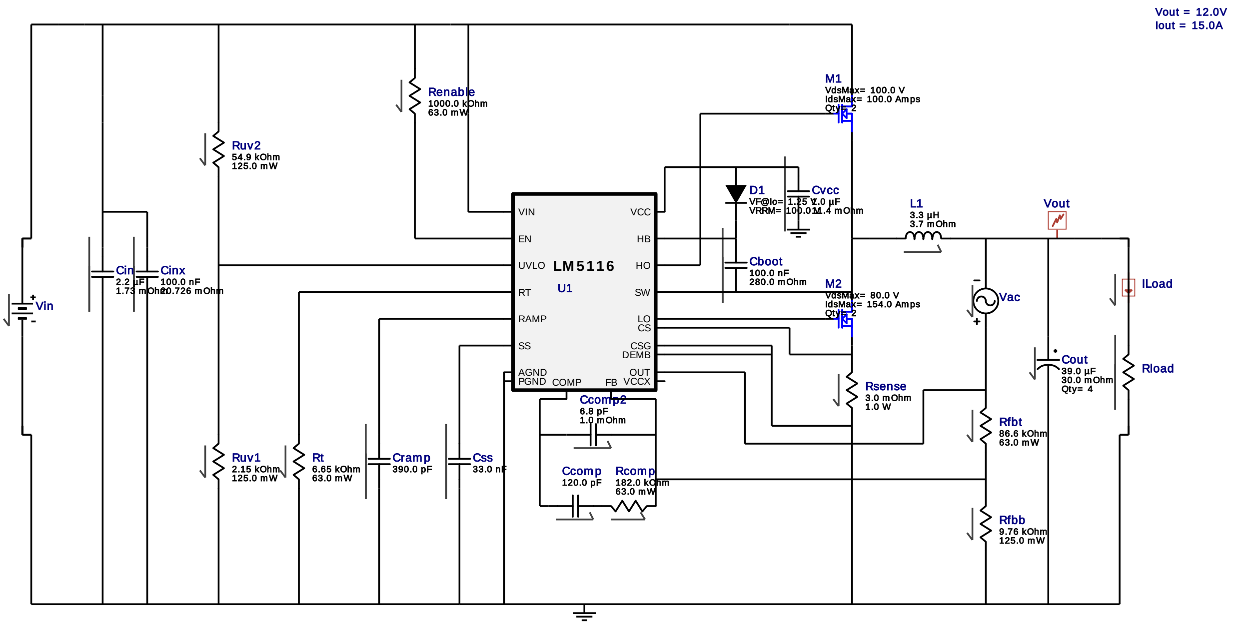


WEBENCH® Electrical Simulation Report

Design Id = 13

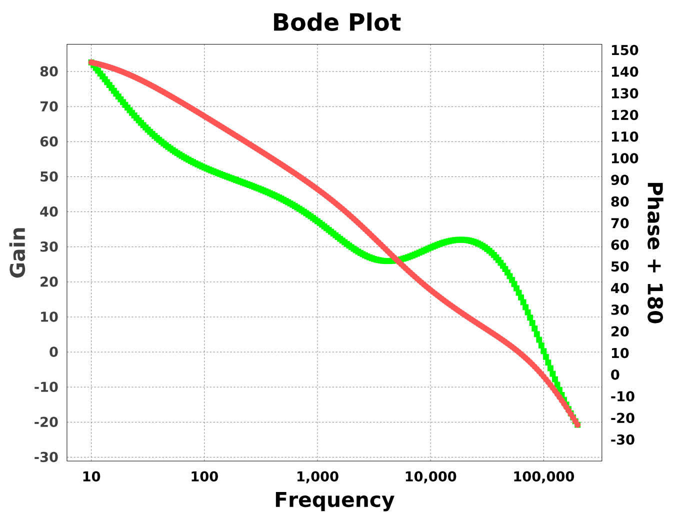
sim_id = 1

Simulation Type = Bode Plot



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cinj	C	Injection Isolation Capacitance	1000 F
2.	Linj	L	Injection Isolation Inductance	1000 H
3.	Vinj	AC	AC Voltage Source Amplitude	1 V
4.	Rload	R	Load Resistance	0.8 Ohm



Design Assistance

1. Master key : 7A4459C6FA4FE0216C1B3129042AFC47[v1]

2. **LM5116** Product Folder : http://www.ti.com/product/LM5116 : contains the data sheet and other resources.

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