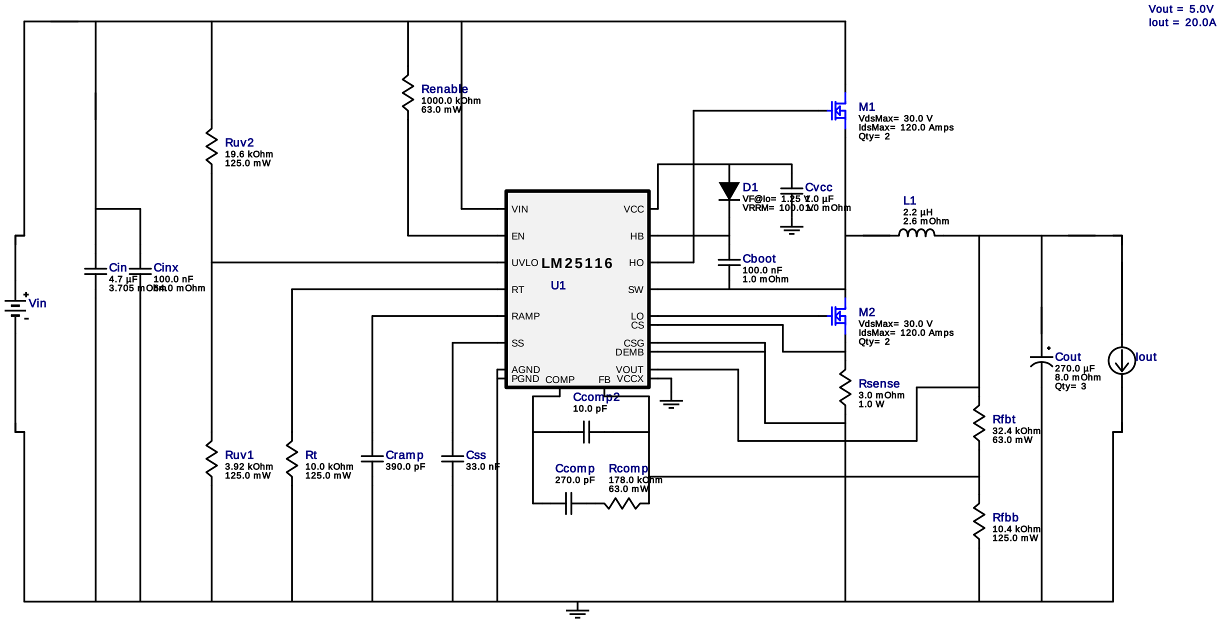
VinMin = 9.0V
VinMax = 18.0V
Vout = 5.0V
Iout = 20.0A

Device = LM25116MHX/NOPB
Topology = Buck
Created = 2022-08-26 12:23:39.437
BOM Cost = $6.99
BOM Count = 27
Total Pd = 5.47W

WEBENCH ® Design Report

Design : 6 LM25116MHX/NOPB
LM25116MHX/NOPB 9V-18V to 5.00V @ 20A

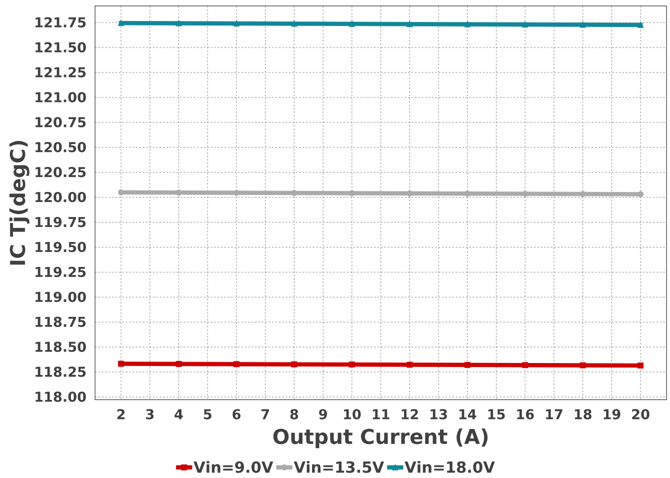


Electrical BOM

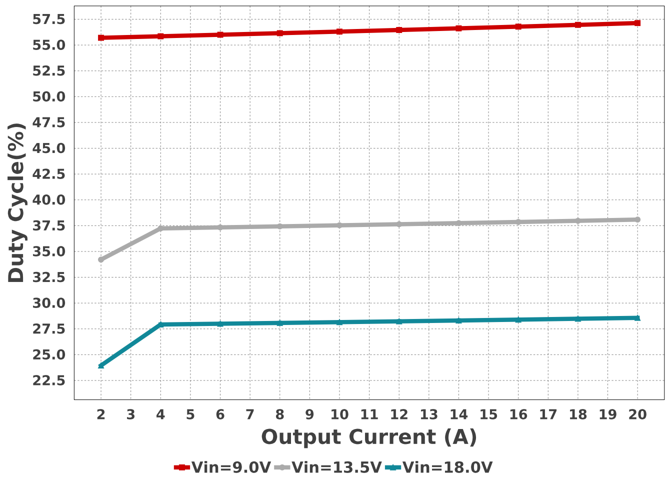
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	Taiyo Yuden	UMK105CG271JV-F Series= C0G/NP0	Cap= 270.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp2	Kemet	C0805C100M4GACTU Series= C0G/NP0	Cap= 10.0 pF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	MuRata	GRM31CR71E475KA88L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 25.0 V IRMS= 2.8649 A	1	$0.08	1206_190 11 mm²
Cinx	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Cout	Panasonic	16SVPG270M Series= SVPG	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	3	$0.67	CAPSMT_62_C10 74 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	$0.09	0805 7 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	Taiyo Yuden	TMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
D1	Nexperia	BAS516,115	VF@Io= 1.25 V VRRM= 100.0 V	1	$0.21	SOD-523 5 mm^2
L1	Coilcraft	XAL1010-222MEB	L= 2.2 µH 2.6 mOhm	1	$1.71	XAL1010 160 mm^2
M1	Texas Instruments	CSD17577Q5A	VdsMax= 30.0 V IdsMax= 120.0 Amps	2	$0.21	TRANS_NexFET_Q5A 55 mm^2
M2	Texas Instruments	CSD17577Q5A	VdsMax= 30.0 V IdsMax= 120.0 Amps	2	$0.21	TRANS_NexFET_Q5A 55 mm^2
Rcomp	Vishay-Dale	CRCW0402178KFKED Series= CRCW..e3	Res= 178.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Renable	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RT0805BRD0710K4L Series= RT0805	Res= 10.4 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.06	0805 7 mm^2
Rfbt	Vishay-Dale	CRCW040232K4FKED Series= CRCW..e3	Res= 32.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rramp	Vishay-Dale	CRCW040210M0FKED Series= CRCW..e3	Res= 10.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Stackpole Electronics Inc	CSNL1206FT3L00 Series= CSNL	Res= 3.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	1206 11 mm^2
Rt	Panasonic	ERJ-6ENF1002V Series= ERJ-6E	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Ruv1	Vishay-Dale	CRCW08053K92FKEA Series= CRCW..e3	Res= 3.92 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Ruv2	Vishay-Dale	CRCW080519K6FKEA Series= CRCW..e3	Res= 19.6 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	LM25116MHX/NOPB	Switcher	1	$1.65	MXA20A 71 mm^2

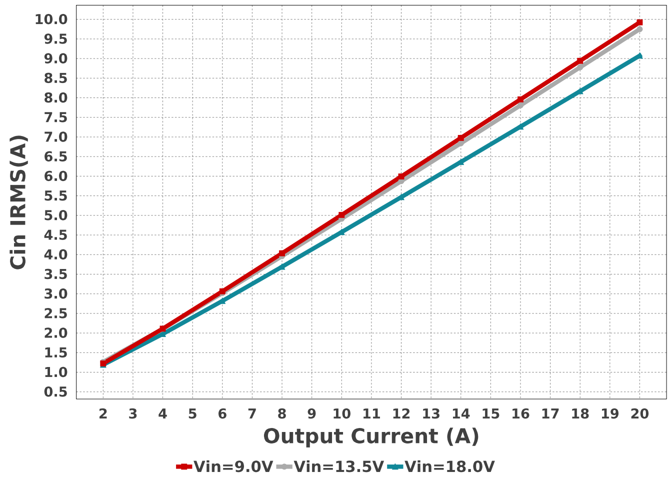
IC Tj



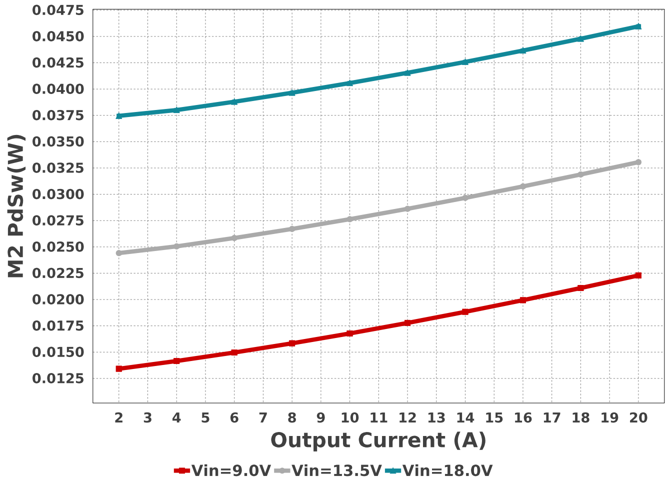
Duty Cycle



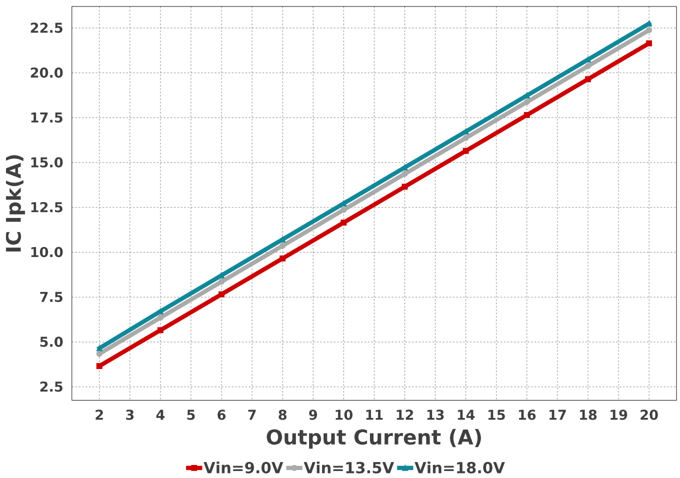
Cin IRMS



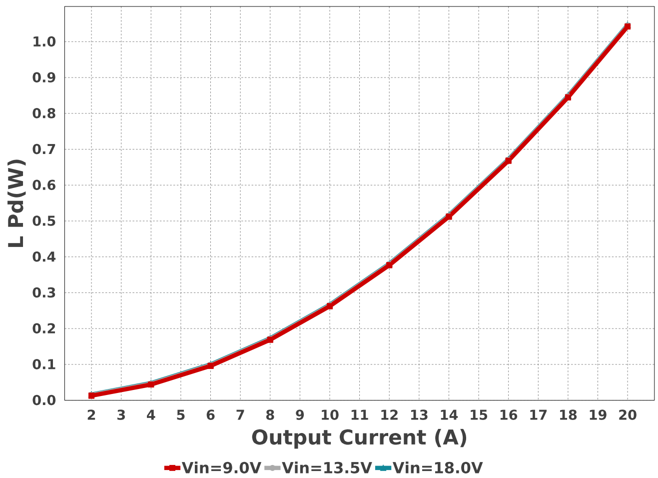
M2 PdSw

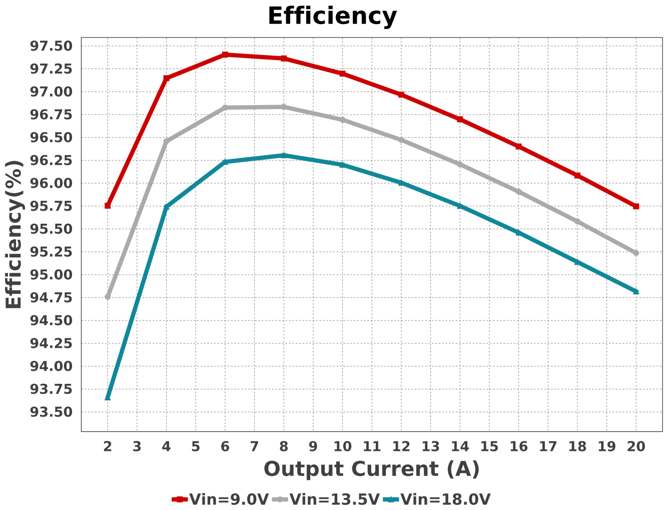


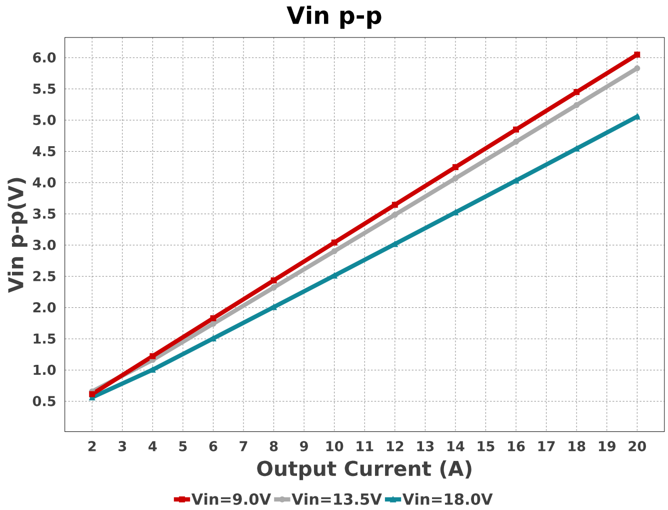
IC Ipk

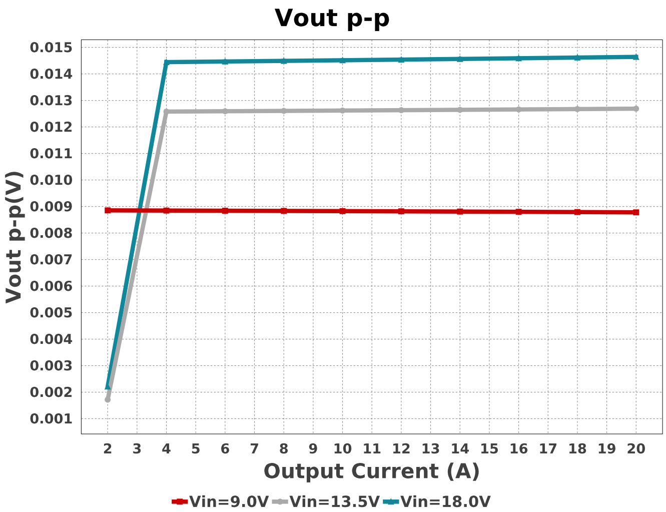


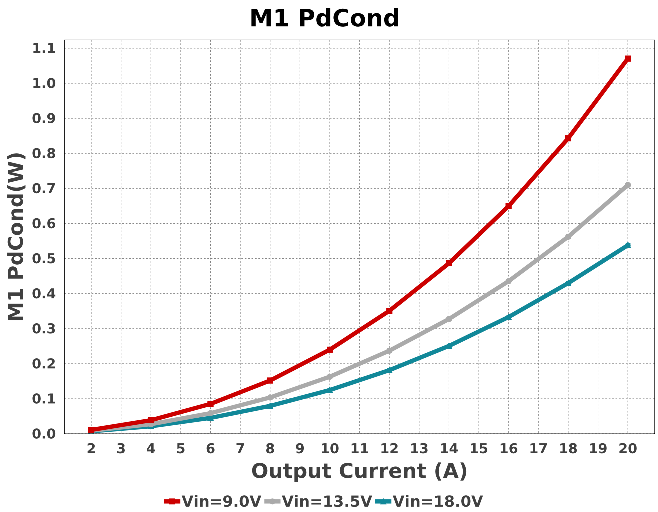
L Pd

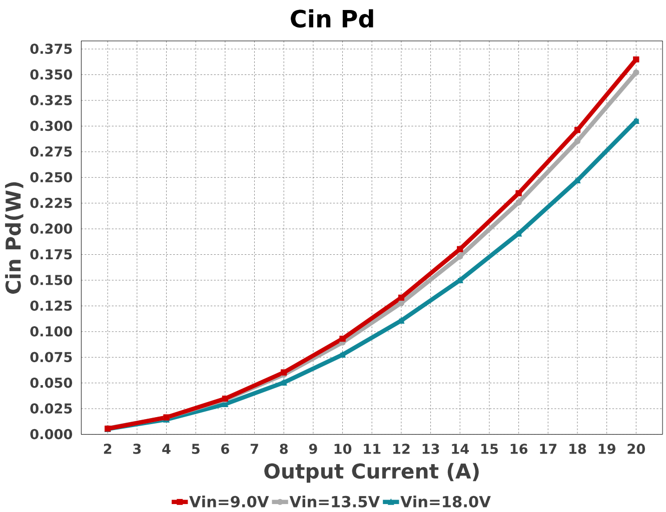


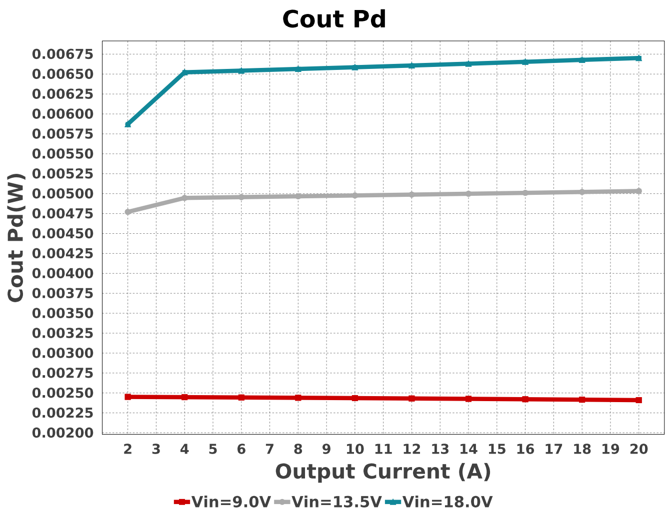

Efficiency
97.50
97.25
97.00
96.75
96.50
96.25
96.00
95.75
95.50
95.25
95.00
94.75
94.50
94.25
94.00
93.75
93.50
Efficiency(%)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


Vin p-p
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Vin p-p(V)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

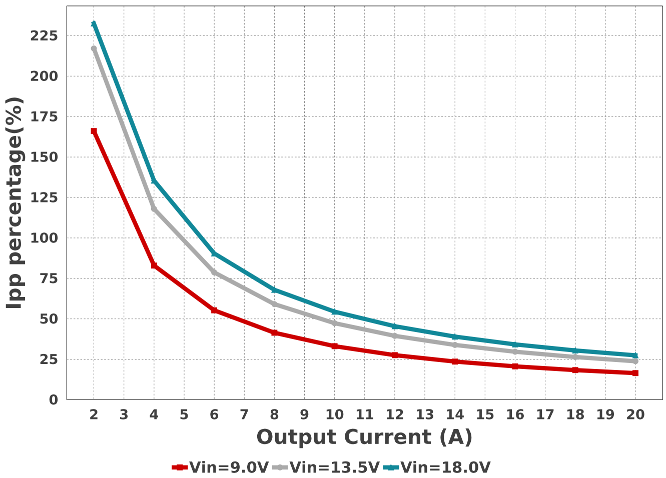

Vout p-p
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
Vout p-p(V)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


M1 PdCond
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
M1 PdCond(W)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

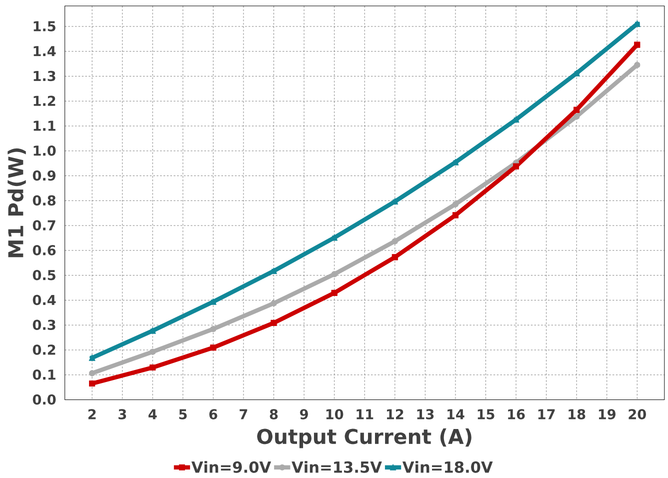

Cin Pd
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
Cin Pd(W)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


Cout Pd
0.00675
0.00650
0.00625
0.00600
0.00575
0.00550
0.00525
0.00500
0.00475
0.00450
0.00425
0.00400
0.00375
0.00350
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
Cout Pd(W)
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

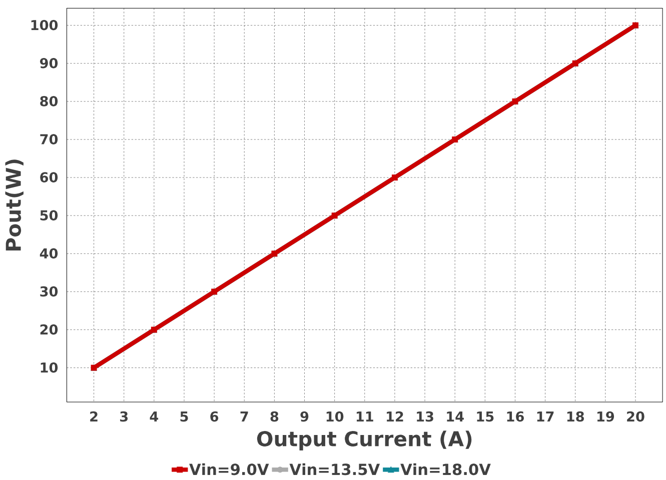
Ipp percentage



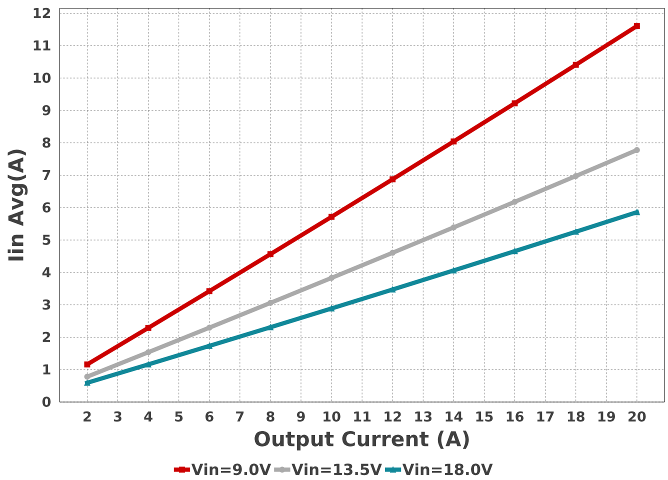
M1 Pd



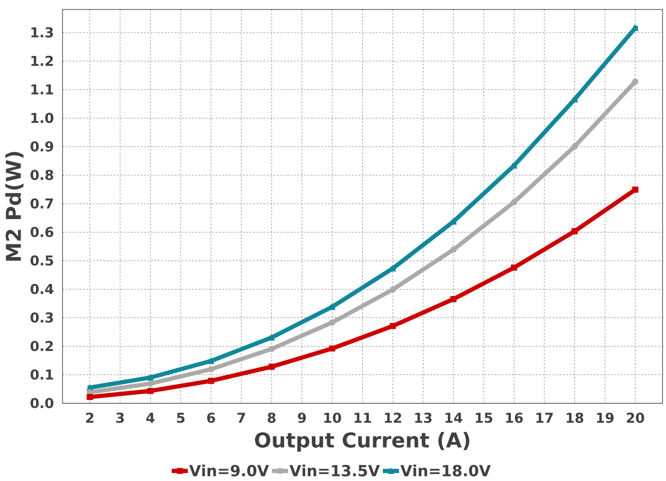
Pout



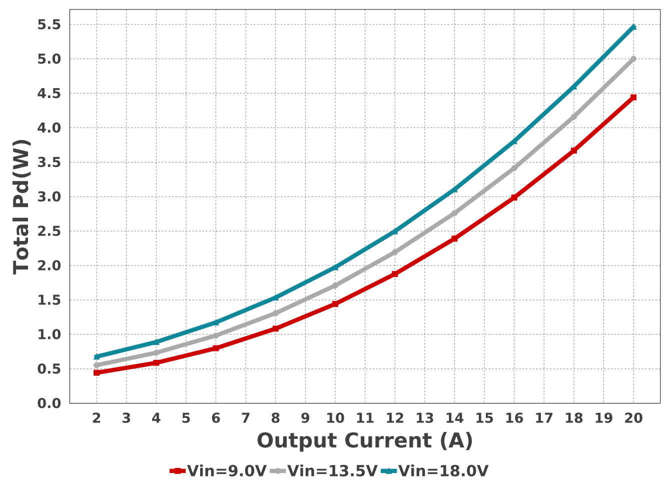
Iin Avg

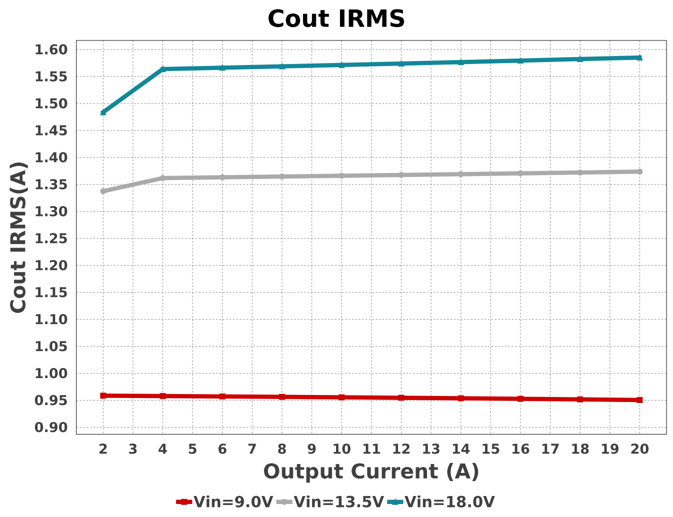


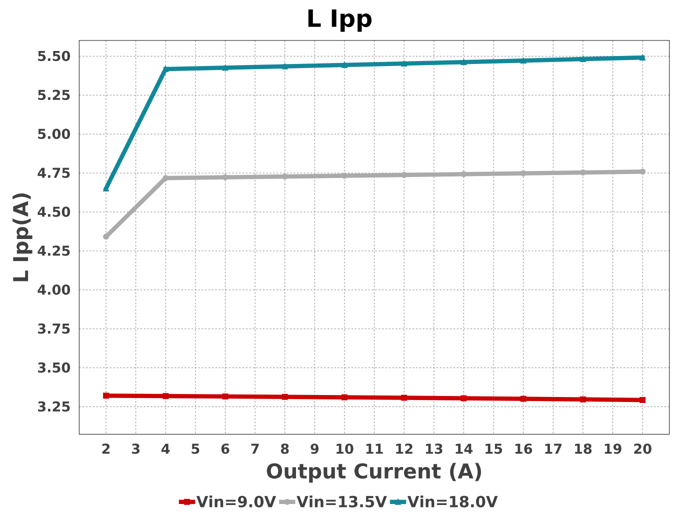
M2 Pd

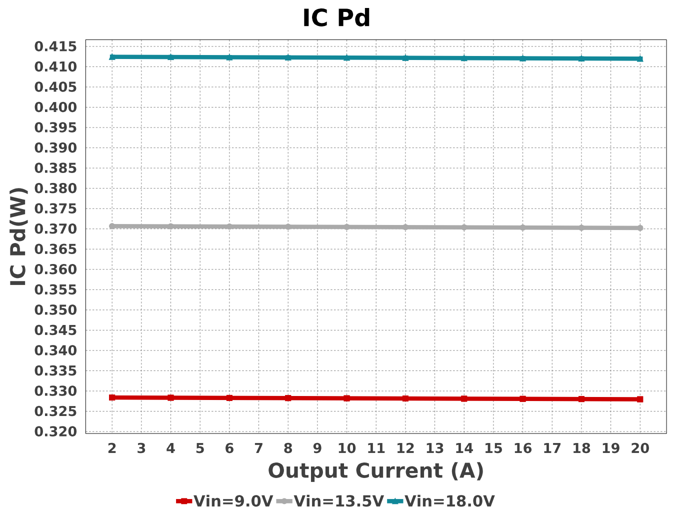


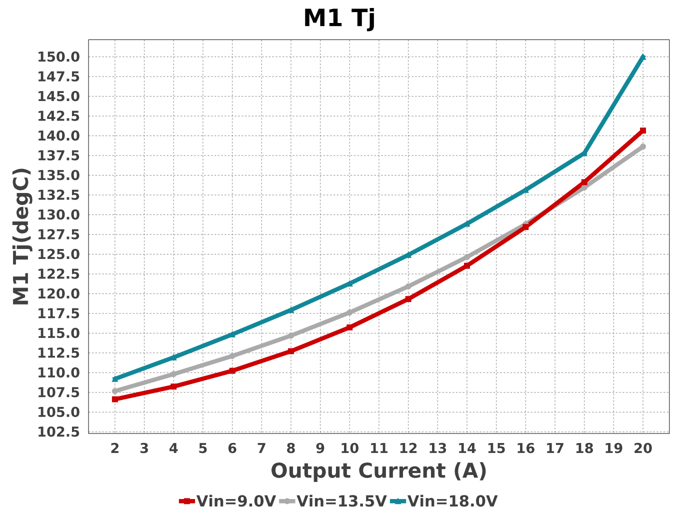
Total Pd

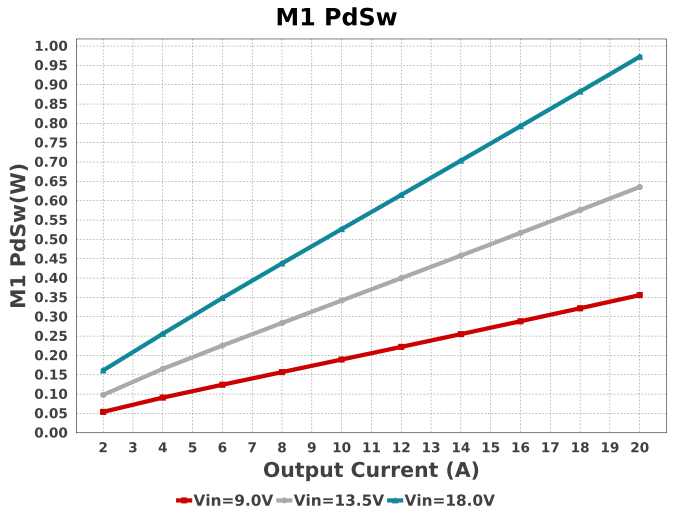


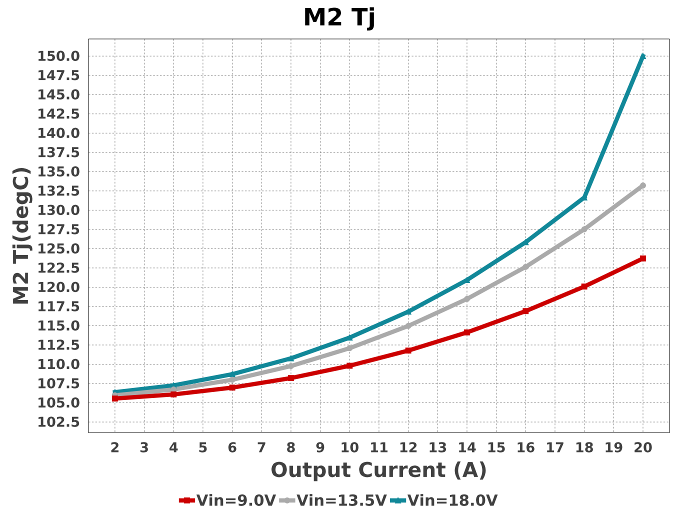

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V

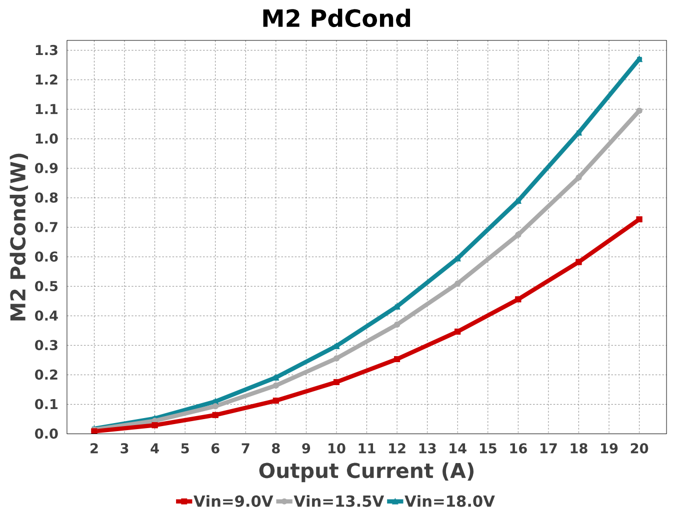

L Ipp
L Ipp(A)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V

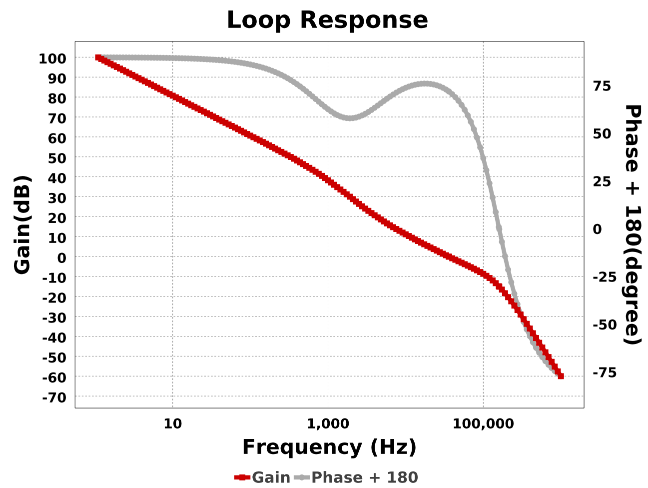

IC Pd
IC Pd(W)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V


M1 Tj
M1 Tj(degC)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V


M1 PdSw
M1 PdSw(W)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V


M2 Tj
M2 Tj(degC)
Output Current (A)
Vin=9.0V
Vin=13.5V
Vin=18.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	27		Total Design BOM count
2.	Total BOM	$6.986		Total BOM Cost
3.	Cin IRMS	9.074 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	305.07 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	1.585 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	6.701 mW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	22.746 A	IC	Peak switch current in IC
8.	IC Pd	411.98 mW	IC	IC power dissipation
9.	IC Tj	121.726 degC	IC	IC junction temperature
10.	IC Tolerance	16.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	40.6 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	5.859 A	IC	Average input current
13.	Ipp percentage	27.456 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	5.491 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	1.046 W	Inductor	Inductor power dissipation
16.	M1 Pd	1.51 W	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	537.85 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	972.34 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	150.0 degC	Mosfet	M1 MOSFET junction temperature
20.	M2 Pd	1.316 W	Mosfet	M2 MOSFET total power dissipation
21.	M2 PdCond	1.27 W	Mosfet	M2 MOSFET conduction losses
22.	M2 PdSw	45.962 mW	Mosfet	M2 MOSFET switching losses
23.	M2 Tj	150.0 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	305.07 mW	Power	Input capacitor power dissipation
25.	Cout Pd	6.701 mW	Power	Output capacitor power dissipation
26.	IC Pd	411.98 mW	Power	IC power dissipation
27.	L Pd	1.046 W	Power	Inductor power dissipation
28.	M1 Pd	1.51 W	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	537.85 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	972.34 mW	Power	M1 MOSFET switching losses
31.	M2 Pd	1.316 W	Power	M2 MOSFET total power dissipation
32.	M2 PdCond	1.27 W	Power	M2 MOSFET conduction losses
33.	M2 PdSw	45.962 mW	Power	M2 MOSFET switching losses
34.	Total Pd	5.466 W	Power	Total Power Dissipation
35.	Cross Freq	35.758 kHz	System Information	Bode plot crossover frequency
36.	Duty Cycle	28.566 %	System Information	Duty cycle
37.	Efficiency	94.817 %	System Information	Steady state efficiency
38.	FootPrint	776.0 mm^2	System Information	Total Foot Print Area of BOM components
39.	Frequency	303.951 kHz	System Information	Switching frequency
40.	Gain Marg	-15.15 dB	System Information	Bode Plot Gain Margin
41.	Iout	20.0 A	System Information	Iout operating point
42.	Low Freq Gain	99.882 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	72.23 deg	System Information	Bode Plot Phase Margin
45.	Pout	100.0 W	System Information	Total output power
46.	Vin	18.0 V	System Information	Vin operating point
47.	Vin p-p	5.057 V	System Information	Peak-to-peak input voltage
48.	Vout	5.0 V	System Information	Operational Output Voltage
49.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	2.161 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	14.643 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	20.0	Maximum Output Current
VinMax	18.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM25116	Base Product Number
source	DC	Input Source Type
Ta	105.0	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

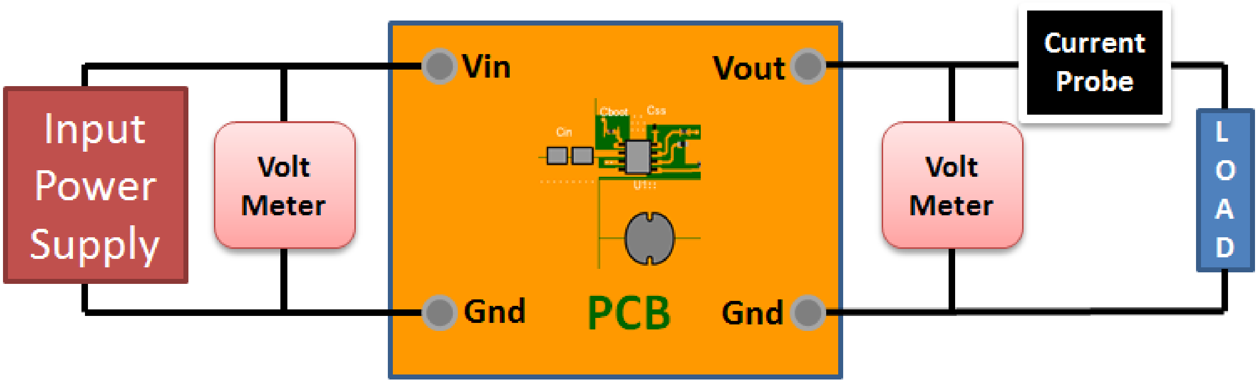
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 9.0V 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.

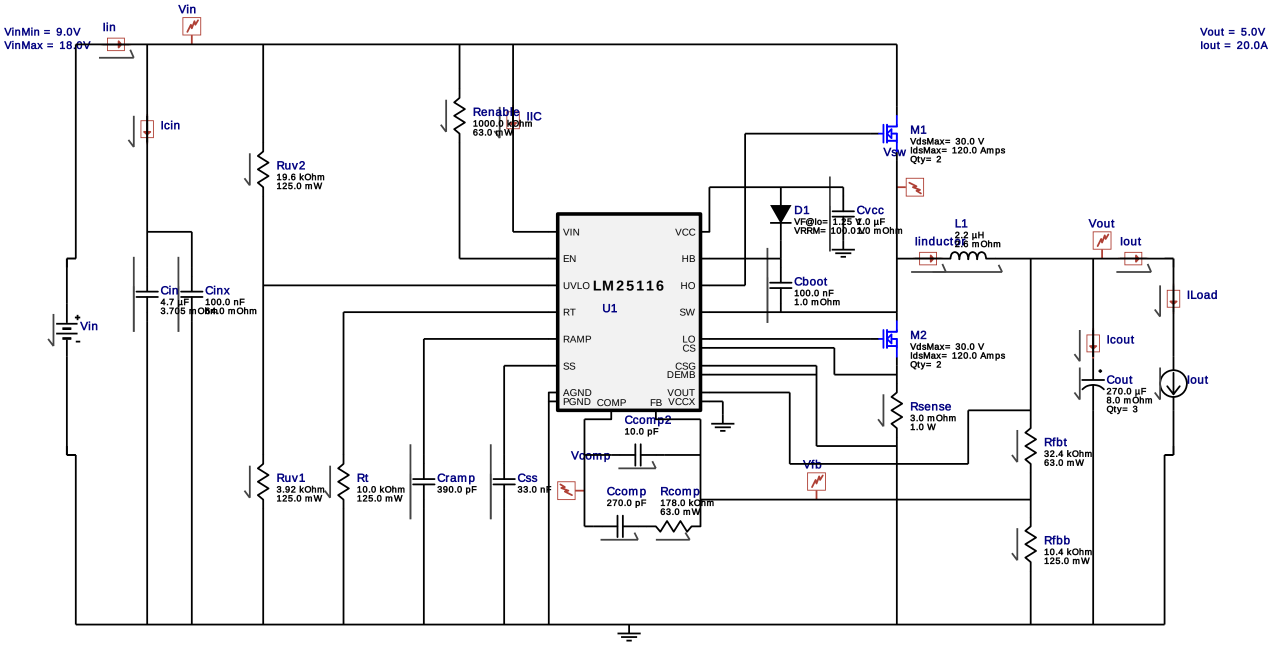


WEBENCH® Electrical Simulation Report

Design Id = 6

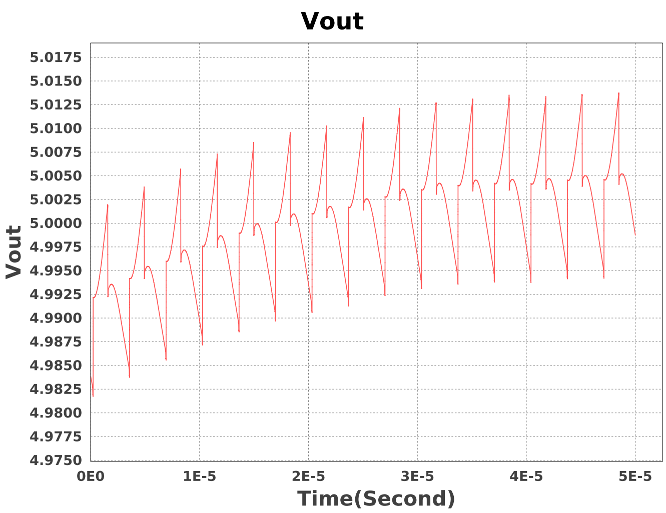
sim_id = 3

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	I	Load Current	20.0 A



Design Assistance

1. Master key : E0FD6E39E6D81B756E440F1D816F98FA[v1]

2. **LM25116** Product Folder : http://www.ti.com/product/LM25116 : contains the data sheet and other resources.