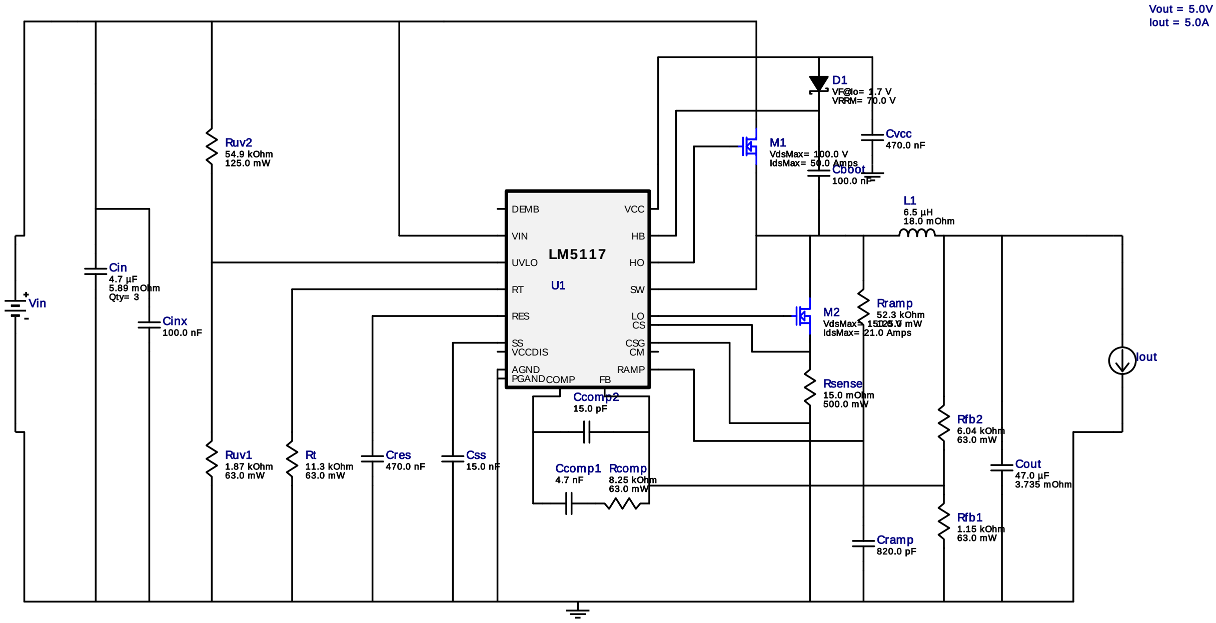
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 44.0V
VinMax = 56.0V
Vout = 5.0V
Iout = 5.0A

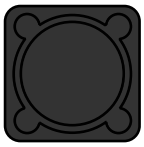
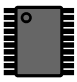
Device = LM5117PMHX/NOPB
Topology = Buck
Created = 8/12/16 5:44:39 PM
BOM Cost = $5.24
BOM Count = 25
Total Pd = 3.88W

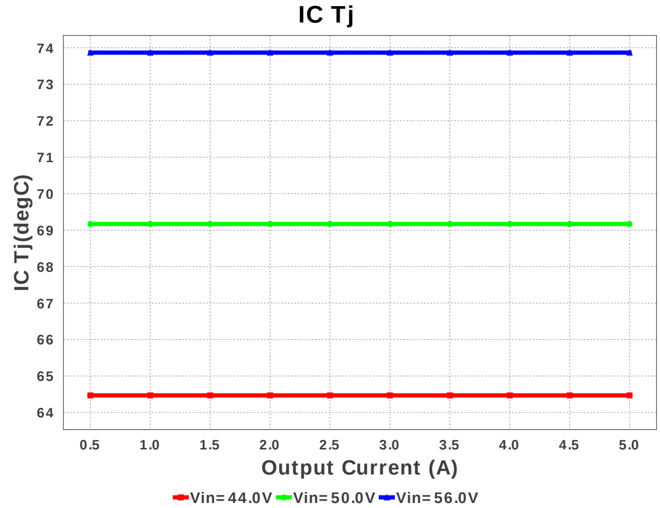
Design : 4766763/2 LM5117PMHX/NOPB
LM5117PMHX/NOPB 44.0V-56.0V to 5.00V @ 5.0A

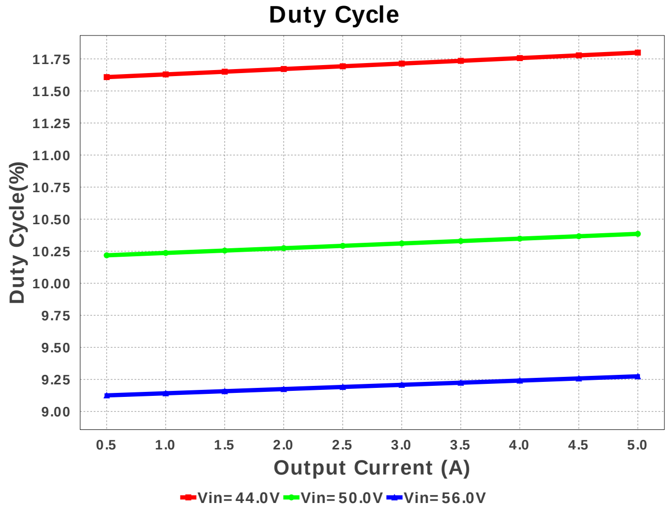


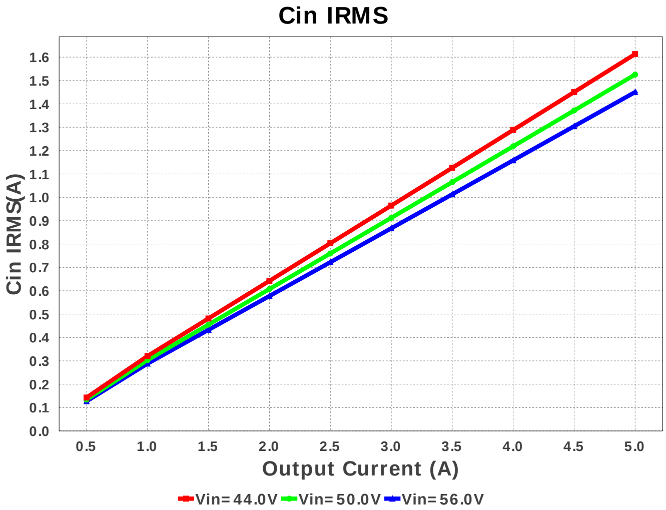
Electrical BOM

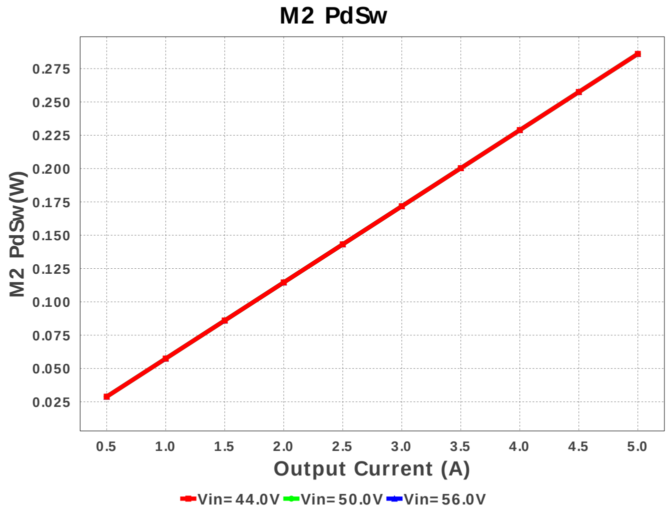
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot	MuRata	GRM155R61A104KA01D Series= X5R	Cap= 100.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
2.	Ccomp1	Yageo America	CC0805KRX7R9BB472 Series= X7R	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
3.	Ccomp2	Yageo America	CC0805JRNPO9BN150 Series= C0G/NP0	Cap= 15.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
4.	Cin	TDK	C3225X7S2A475M200AB Series= X7S	Cap= 4.7 uF ESR= 5.89 mOhm VDC= 100.0 V IRMS= 6.7739 A	3	$0.42	1210 15 mm²
5.	Cinx	Taiyo Yuden	HMK212B7104KG-T Series= X7R	Cap= 100.0 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
6.	Cout	MuRata	GRM31CC80J476KE18L Series= X6S	Cap= 47.0 uF ESR= 3.735 mOhm VDC= 6.3 V IRMS= 4.0522 A	1	$0.10	1206_190 11 mm²
7.	Cramp	Yageo America	CC0805KRX7R9BB821 Series= X7R	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
8.	Cres	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
9.	Css	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²

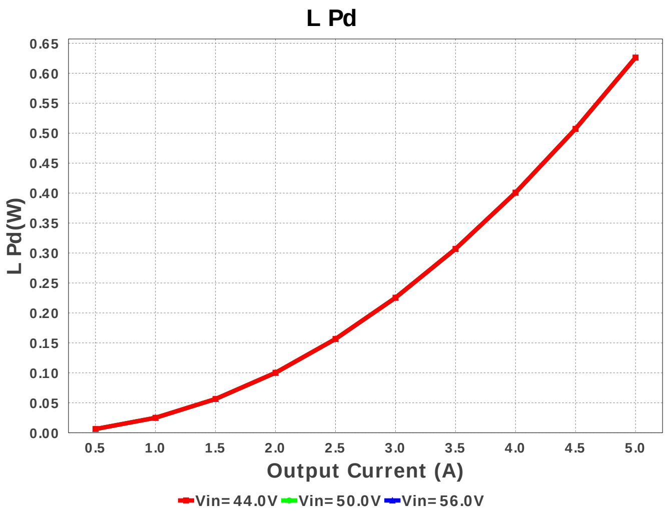
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Cvcc	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
11.	D1	Diodes Inc.	BAS70W-7-F	VF@Io= 1.7 V VRRM= 70.0 V	1	$0.08	 SOT-323 10 mm²
12.	L1	Bourns	SRR1208-6R5ML	L= 6.5 µH DCR= 18.0 mOhm	1	$0.37	 SRR1208 216 mm²
13.	M1	Texas Instruments	CSD19537Q3	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.50	 TRANS_NexFET_Q3 18 mm²
14.	M2	Infineon Technologies	BSZ520N15NS3 G	VdsMax= 150.0 V IdsMax= 21.0 Amps	1	$0.55	 PG-TSDSON-8 19 mm²
15.	Rcomp	Vishay-Dale	CRCW04028K25FKED Series= CRCW..e3	Res= 8.25 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
16.	Rfb1	Vishay-Dale	CRCW04021K15FKED Series= CRCW..e3	Res= 1.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
17.	Rfb2	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
18.	Rramp	Panasonic	ERJ-6ENF5232V Series= ERJ-6E	Res= 52.3 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
19.	Rsense	Stackpole Electronics Inc	CSR1206FK15L0 Series= ?	Res= 15.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	1206 11 mm²
20.	Rt	Vishay-Dale	CRCW040211K3FKED Series= CRCW..e3	Res= 11.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
21.	Ruv1	Vishay-Dale	CRCW04021K87FKED Series= CRCW..e3	Res= 1.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
22.	Ruv2	Panasonic	ERJ-6ENF5492V Series= ERJ-6E	Res= 54.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
23.	U1	Texas Instruments	LM5117PMHX/NOPB	Switcher	1	$2.10	 PWP0020A 71 mm²

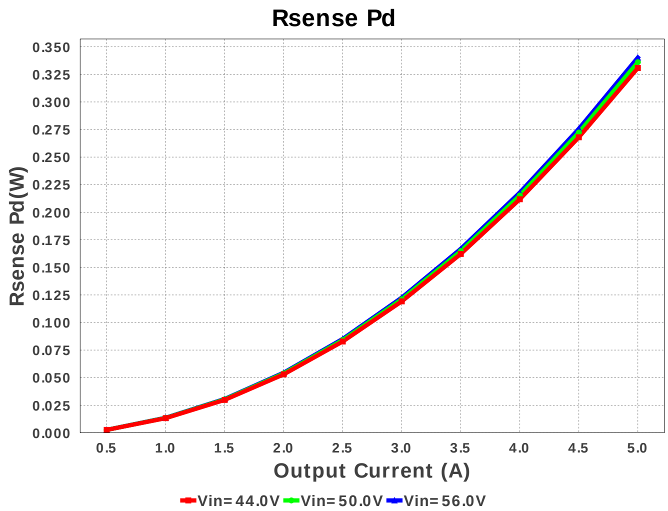

IC Tj
IC Tj(degC)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

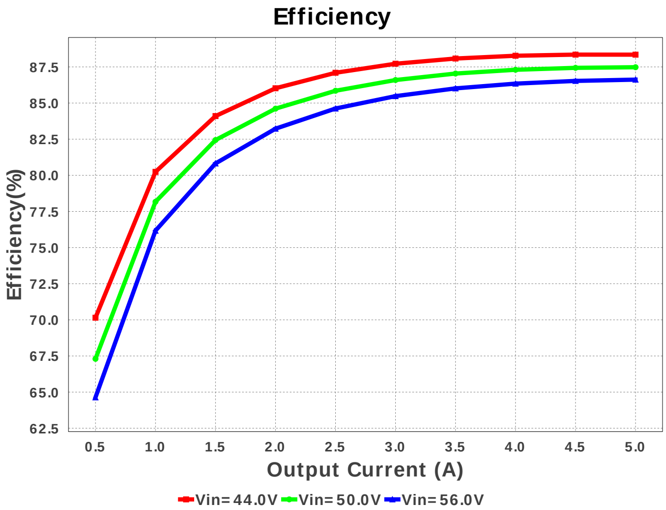

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

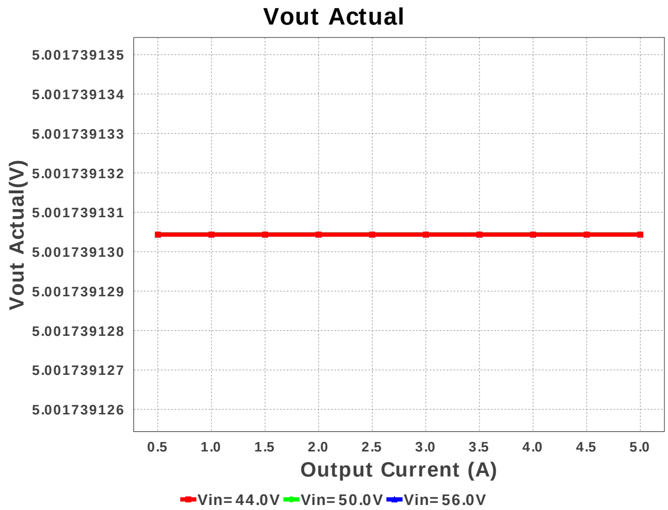

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

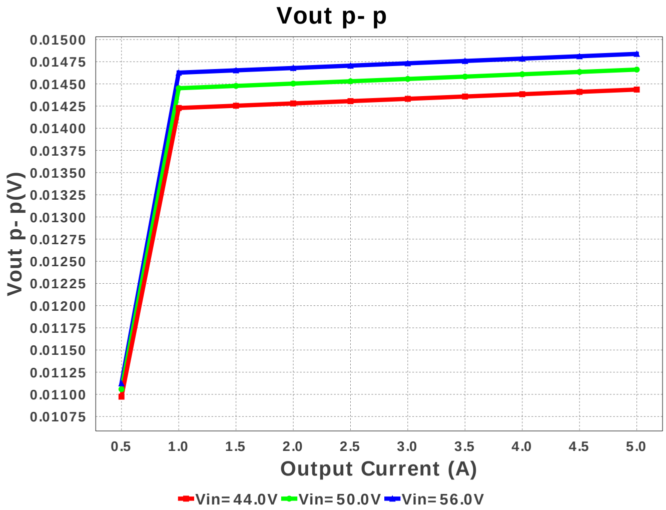

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

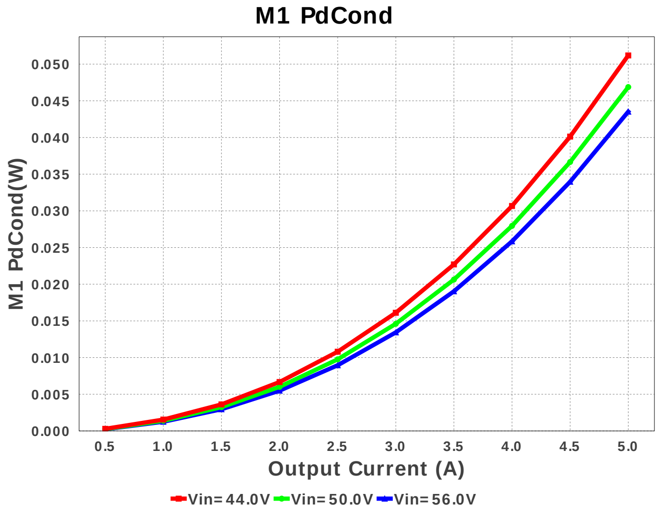

L Pd
L Pd(W)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

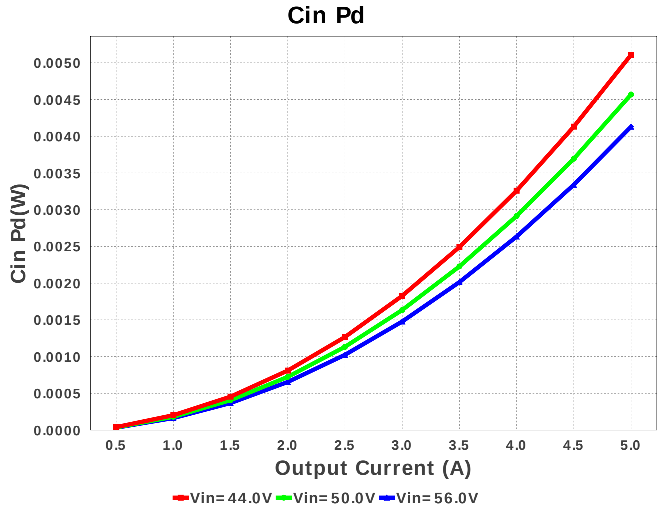

Rsense Pd
Rsense Pd(W)
Output Current (A)
Vin=44.0V Vin=50.0V Vin=56.0V

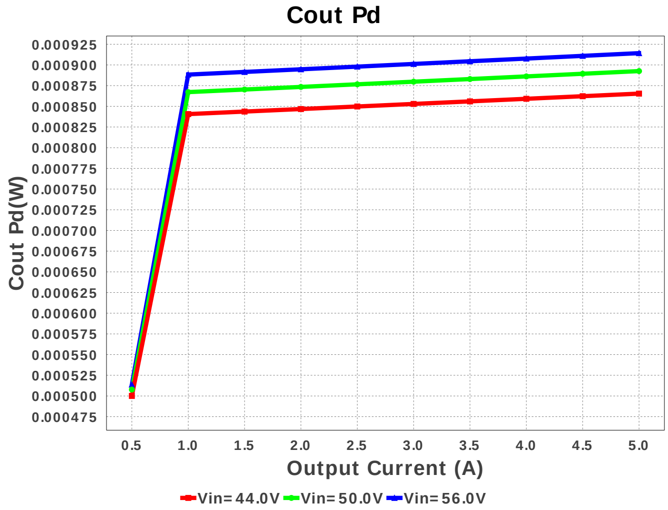

Efficiency
Efficiency(%)
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

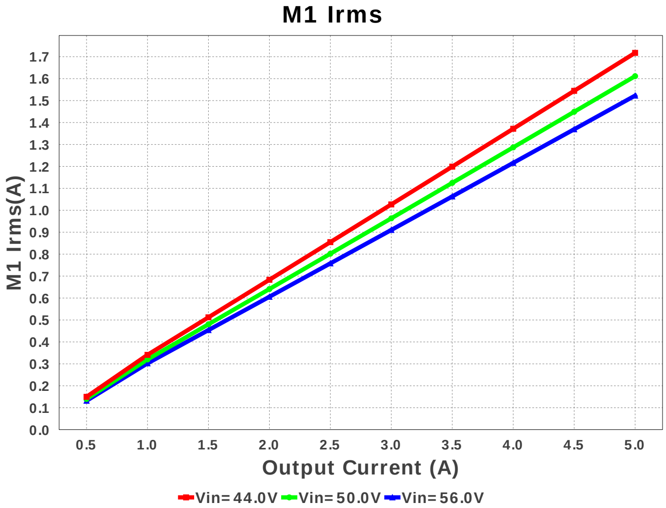

Vout Actual
Vout Actual(V)
5.001739135
5.001739134
5.001739133
5.001739132
5.001739131
5.001739130
5.001739129
5.001739128
5.001739127
5.001739126
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

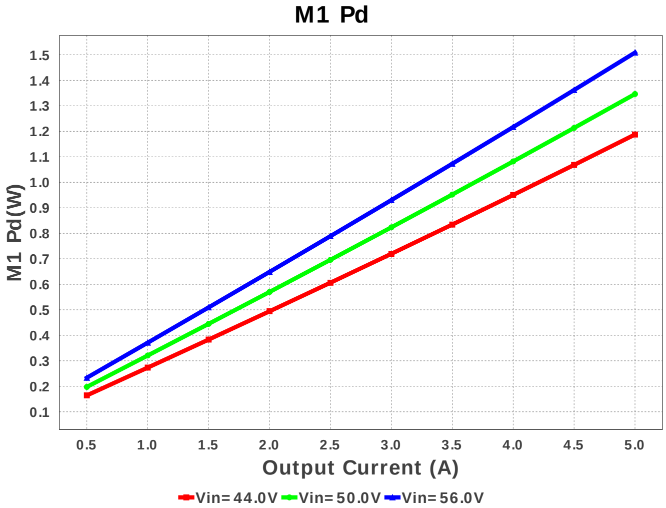

Vout p- p
Vout p- p(V)
0.01500
0.01475
0.01450
0.01425
0.01400
0.01375
0.01350
0.01325
0.01300
0.01275
0.01250
0.01225
0.01200
0.01175
0.01150
0.01125
0.01100
0.01075
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

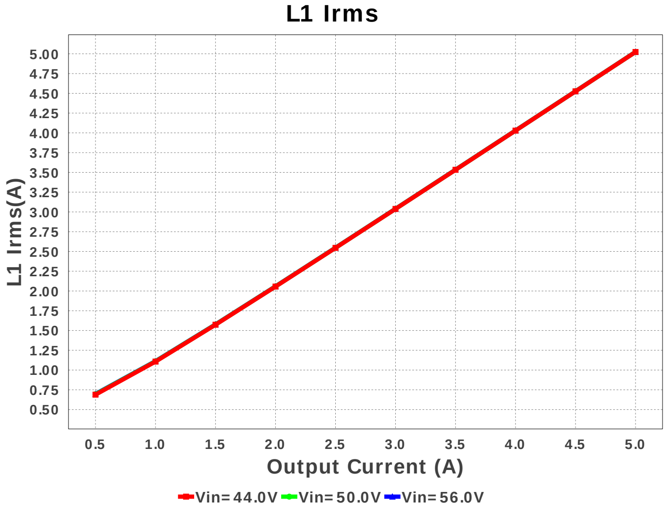

M1 PdCond
M1 PdCond(W)
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

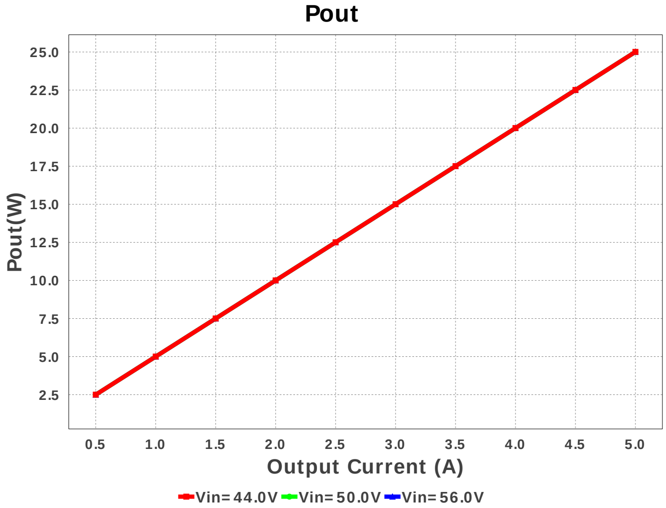

Cin Pd
Cin Pd(W)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

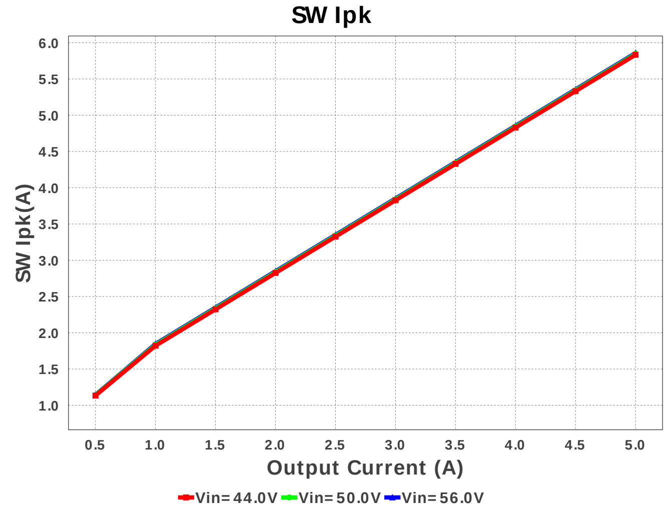

Cout Pd
Cout Pd(W)
0.000925
0.000900
0.000875
0.000850
0.000825
0.000800
0.000775
0.000750
0.000725
0.000700
0.000675
0.000650
0.000625
0.000600
0.000575
0.000550
0.000525
0.000500
0.000475
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

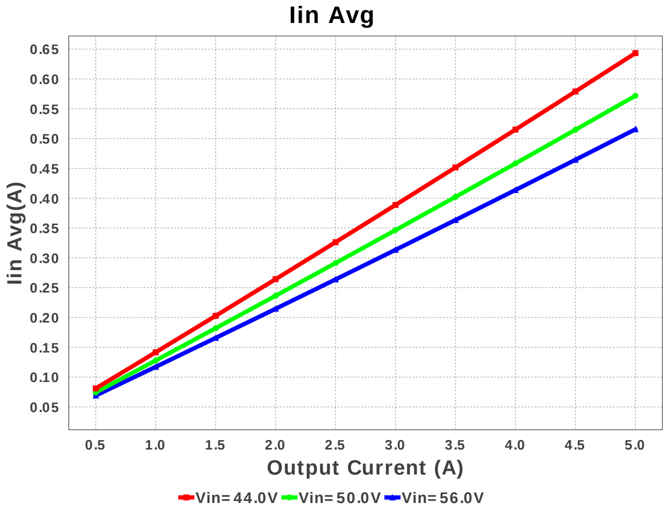

M1 Irms
M1 Irms(A)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V


M1 Pd
M1 Pd(W)
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
0.2
0.1
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

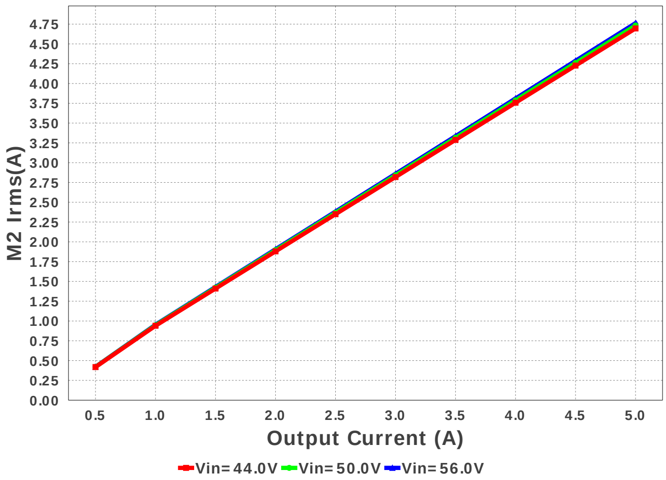

L1 Irms
L1 Irms(A)
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V


Pout
Pout(W)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

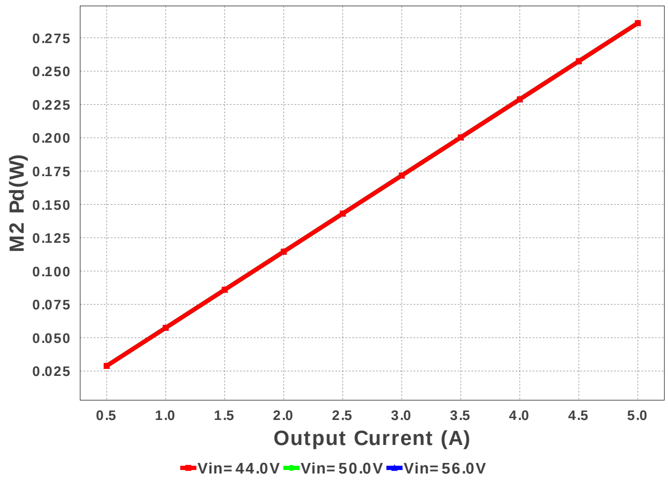

SW Ipk
SW Ipk(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V


Iin Avg
Iin Avg(A)
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
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Output Current (A)
Vin= 44.0V Vin= 50.0V Vin= 56.0V

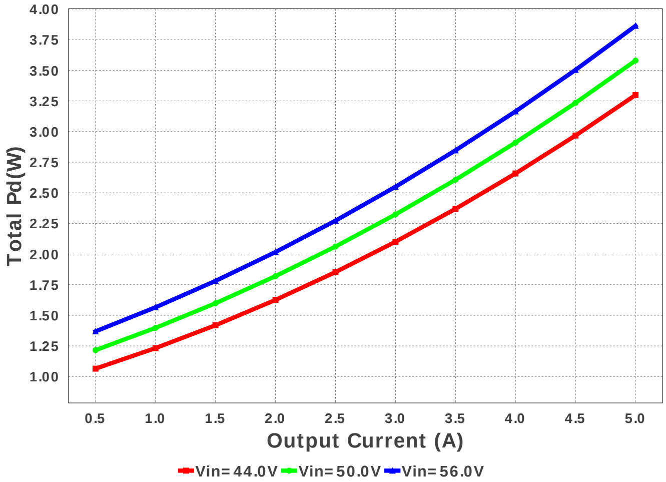
M2 Irms



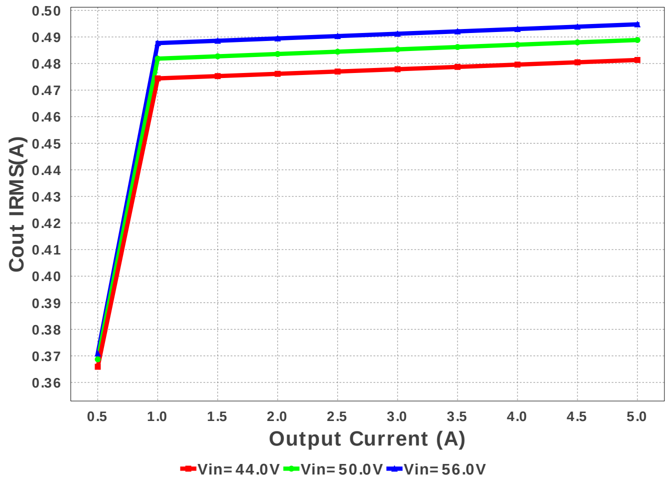
M2 Pd



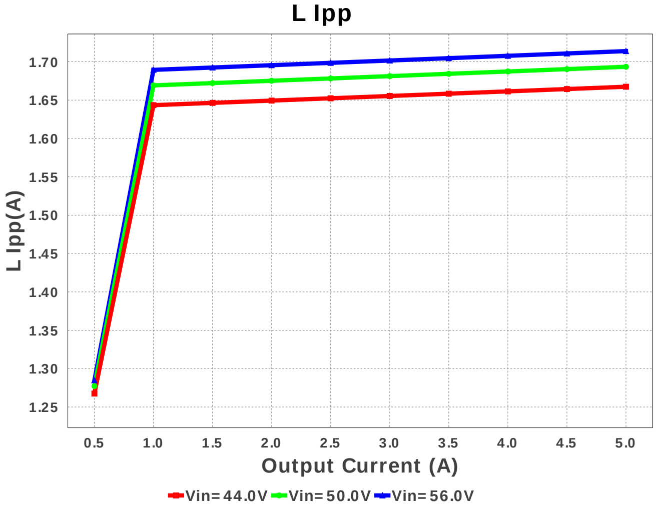
Total Pd



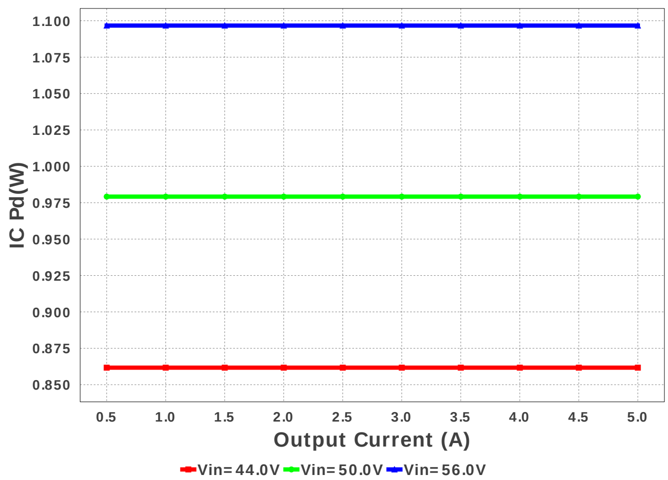
Cout IRMS

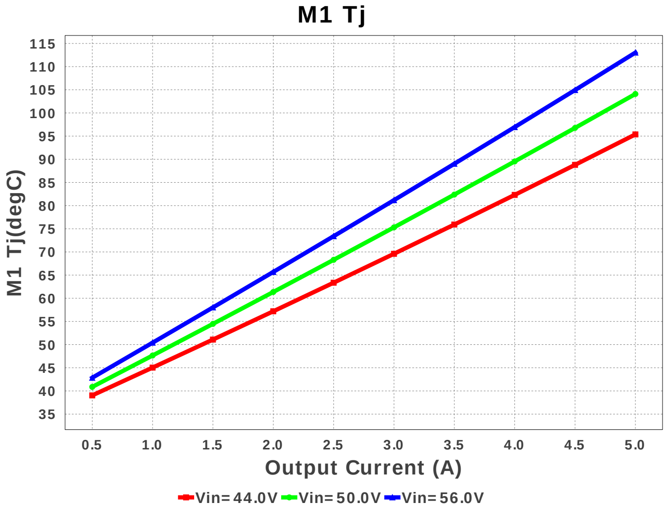


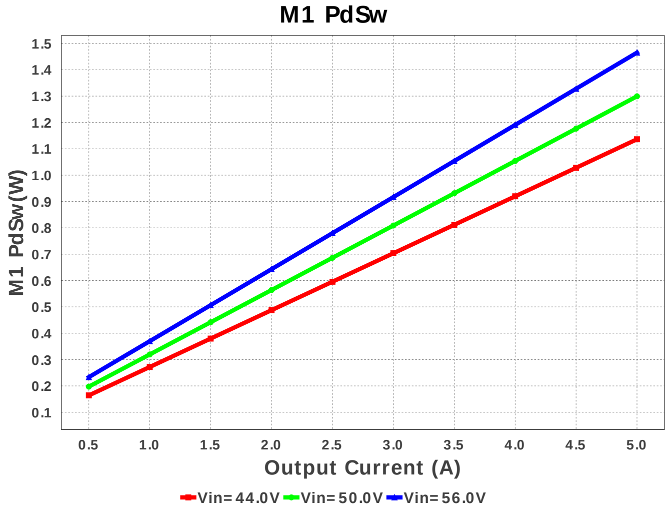
L Ipp

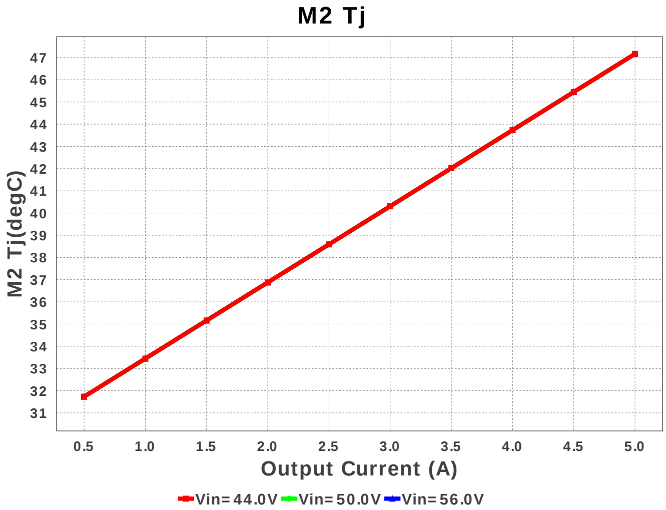


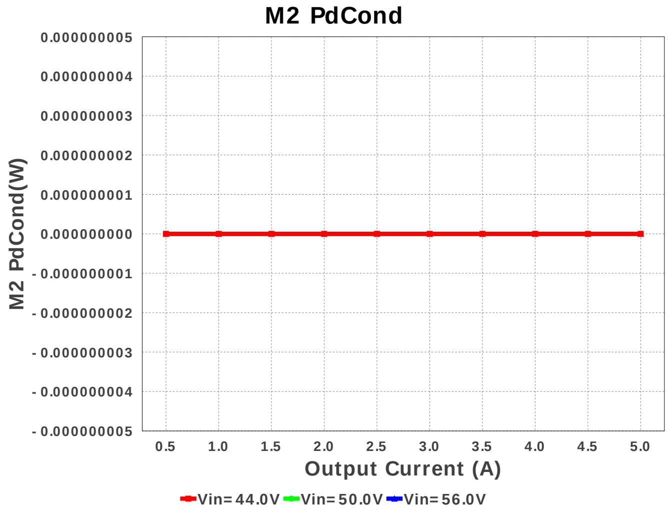
IC Pd

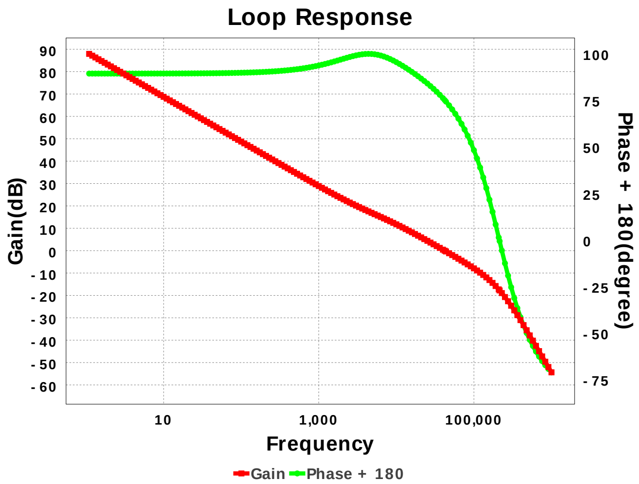












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.45 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	494.753 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	515.84 mA	Current	Average input current
4.	L Ipp	1.714 A	Current	Peak-to-peak inductor ripple current
5.	L1 Irms	5.024 A	Current	Inductor ripple current
6.	M1 Irms	1.523 A	Current	MOSFET RMS ripple current
7.	M2 Irms	4.763 A	Current	MOSFET RMS ripple current
8.	SW Ipk	5.857 A	Current	Peak switch current
9.	BOM Count	25	General	Total Design BOM count
10.	FootPrint	473.0 mm^2	General	Total Foot Print Area of BOM components
11.	Frequency	424.559 kHz	General	Switching frequency

#	Name	Value	Category	Description
12.	IC Tolerance	12.0 mV	General	IC Feedback Tolerance
13.	Mode	CCM	General	Conduction Mode
14.	Pout	25.009 W	General	Total output power
15.	Total BOM	$5.24	General	Total BOM Cost
16.	Low Freq Gain	87.939 dB	Op_Point	Gain at 10Hz
17.	Vout Actual	5.002 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
18.	Vout OP	5.002 V	Op_Point	Operational Output Voltage
19.	Cross Freq	42.005 kHz	Op_point	Bode plot crossover frequency
20.	Duty Cycle	9.274 %	Op_point	Duty cycle
21.	Efficiency	86.573 %	Op_point	Steady state efficiency
22.	Gain Marg	-17.761 dB	Op_point	Bode Plot Gain Margin
23.	IC Tj	74.116 degC	Op_point	IC junction temperature
24.	IOUT_OP	5.0 A	Op_point	Iout operating point
25.	M1 Tj	113.549 degC	Op_point	M1 MOSFET junction temperature
26.	M2 Tj	47.164 degC	Op_point	M2 MOSFET junction temperature
27.	Phase Marg	75.766 deg	Op_point	Bode Plot Phase Margin
28.	VIN_OP	56.0 V	Op_point	Vin operating point
29.	Vout p-p	14.841 mV	Op_point	Peak-to-peak output ripple voltage
30.	Cin Pd	4.13 mW	Power	Input capacitor power dissipation
31.	Cout Pd	914.257 µW	Power	Output capacitor power dissipation
32.	IC Pd	1.103 W	Power	IC power dissipation
33.	L Pd	626.184 mW	Power	Inductor power dissipation
34.	M1 Pd	1.518 W	Power	M1 MOSFET total power dissipation
35.	M1 PdCond	43.618 mW	Power	M1 MOSFET conduction losses
36.	M1 PdSw	1.475 W	Power	M1 MOSFET switching losses
37.	M2 Pd	286.073 mW	Power	M2 MOSFET total power dissipation
38.	M2 PdCond	0.0 W	Power	M2 MOSFET conduction losses
39.	M2 PdSw	286.073 mW	Power	M2 MOSFET switching losses
40.	Rsense Pd	340.222 mW	Power	LED Current Rsns Power Dissipation
41.	Total Pd	3.879 W	Power	Total Power Dissipation
42.	Vout Tolerance	3.222 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	5.0	Maximum Output Current
2.	VinMax	56.0	Maximum input voltage
3.	VinMin	44.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	base_pn	LM5117	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

Design Assistance

1. Outline The LM5117 is a synchronous buck controller intended for step-down regulator applications from a high voltage or widely varying input supply. The control method is based upon current mode control utilizing an emulated current ramp. Current mode control provides inherent line feed-forward, cycle-by-cycle current limiting and ease of loop compensation. The use of an emulated control ramp reduces noise sensitivity of the pulse-width modulation circuit, allowing reliable control of very small duty cycles necessary in high input voltage applications. External Vcc An output voltage derived bias supply can be applied to the VCC pin to reduce the controller power dissipation at higher input voltage. This can also relax constraints on the driver supply current if your external source can supply more than the LM5117 internal regulator. Please see Datasheet for more information. Diode Emulation A fully synchronous buck regulator implemented with a freewheel MOSFET rather than a diode has the capability to sink current from the output in certain conditions such as light load, over-voltage or pre-bias startup. The LM5117 provides a diode emulation feature that can be enabled to prevent reverse (drain to source) current flow in the low side free-wheel MOSFET.

2. **LM5117** Product Folder : http://www.ti.com/product/LM5117 : contains the data sheet and other resources.