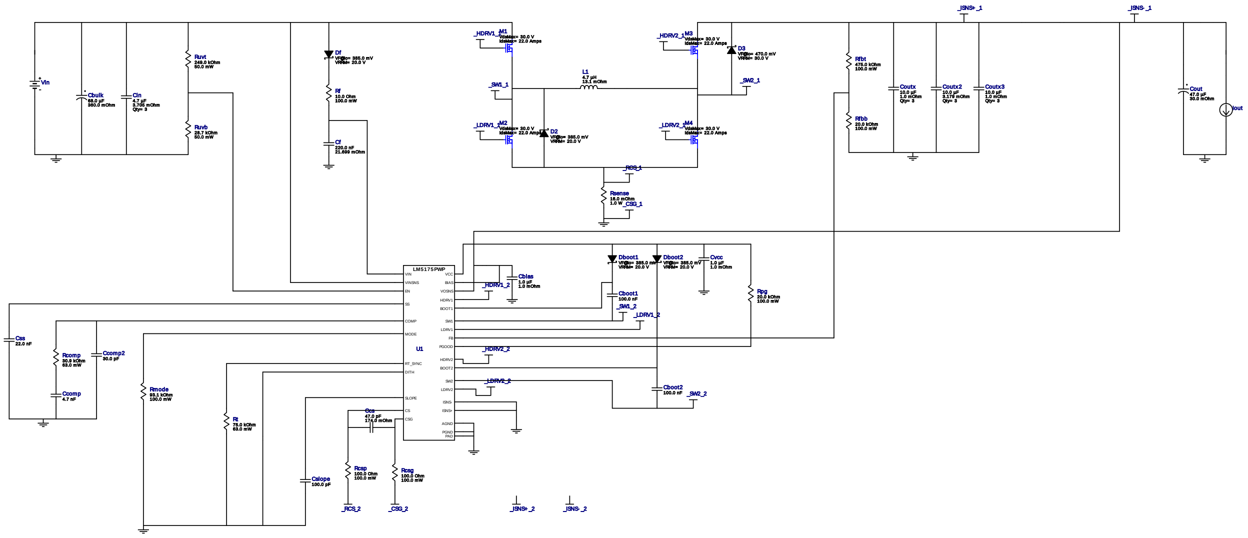
VinMin = 12.0V
VinMax = 14.0V
Vout = 20.0V
Iout = 3.0A

Device = LM5175PWPR
Topology = Buck_Boost
Created = 2019-06-28 08:27:52.855
BOM Cost = $11.12
BOM Count = 47
Total Pd = 3.01W

WEBENCH ® Design Report

Design : 319 LM5175PWPR
LM5175PWPR 12V-14V to 20.00V @ 3A

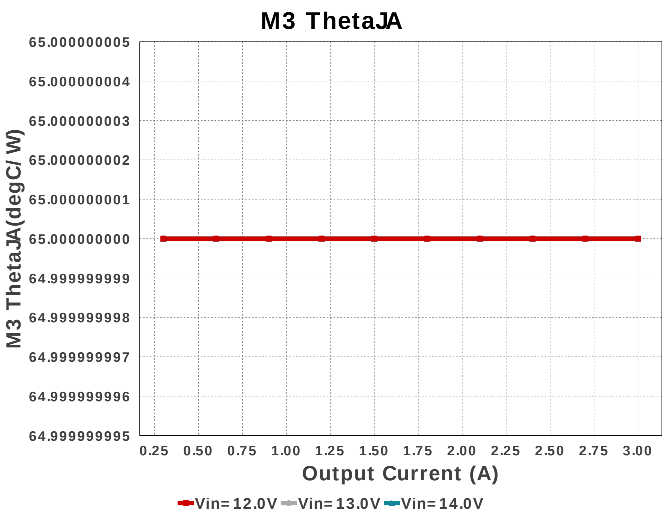


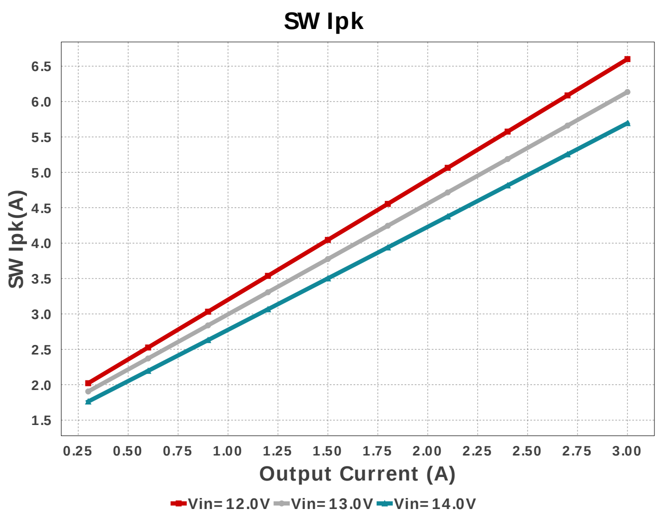
Electrical BOM

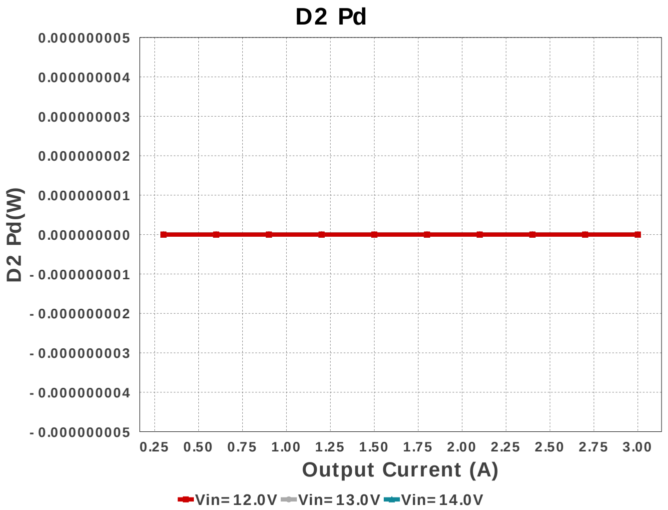
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Taiyo Yuden	GMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm^2
Cboot1	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm^2
Cboot2	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm^2
Cbulk	Panasonic	EEE-FK1E680P Series= FK	Cap= 68.0 uF ESR= 360.0 mOhm VDC= 25.0 V IRMS= 240.0 mA	1	$0.11	SM_RADIAL_D 84 mm^2
Ccomp	Samsung Electro-Mechanics	CL21C472JAFNNNE Series= C0G/NP0	Cap= 4.7 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Ccomp2	Samsung Electro-Mechanics	CL21C300JBANNNC Series= C0G/NP0	Cap= 30.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccs	AVX	06035A470JAT2A Series= C0G/NP0	Cap= 47.0 pF ESR= 174.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cf	TDK	C1608X6S1H224K080AB Series= X6S	Cap= 220.0 nF ESR= 21.699 mOhm VDC= 50.0 V IRMS= 1.125 A	1	$0.04	0603 5 mm^2
Cin	MuRata	GRM31CR71E475KA88L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 25.0 V IRMS= 2.8649 A	3	$0.08	1206_190 11 mm^2

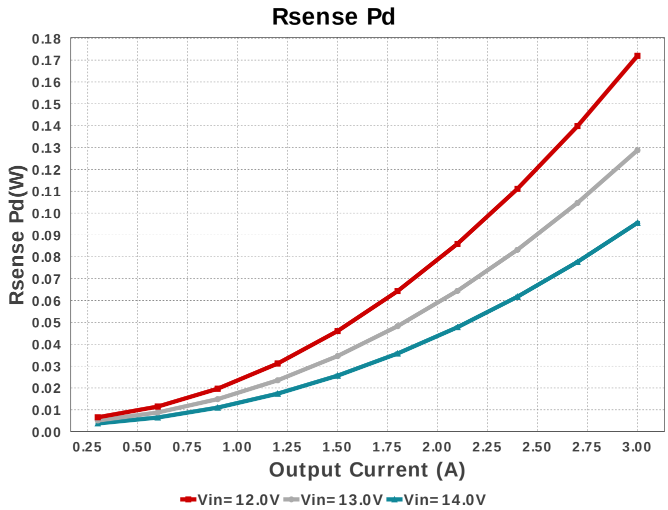
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cout	Panasonic	25SVPF47M Series= SVPF	Cap= 47.0 uF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 2.8 A	1	$0.44	CAPSMT_62_F61 74 mm^2
Coutx	MuRata	GRM32ER71H106MA12 Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	3	$0.33	1210_270 15 mm^2
Coutx2	TDK	C5750X7S2A106K230KB Series= X7S	Cap= 10.0 uF ESR= 3.179 mOhm VDC= 100.0 V IRMS= 5.1199 A	3	$0.92	2220_250 54 mm^2
Coutx3	MuRata	GRM32ER71H106MA12 Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	3	$0.33	1210_270 15 mm^2
Cslope	Samsung Electro-Mechanics	CL10C101JB8NNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Css	MuRata	GCM21B5C1H223JA16L Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.12	0805 7 mm^2
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
D2	Comchip Technology	CDBK0520L-HF	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.07	SOD-123F 12 mm^2
D3	Torex USA Corporation	XBS053V15R-G	VF@Io= 470.0 mV VRRM= 30.0 V	1	$0.12	SOD-523 5 mm^2
Dboot1	Comchip Technology	CDBK0520L-HF	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.07	SOD-123F 12 mm^2
Dboot2	Comchip Technology	CDBK0520L-HF	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.07	SOD-123F 12 mm^2
Df	Comchip Technology	CDBK0520L-HF	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.07	SOD-123F 12 mm^2
L1	Coilcraft	XAL6060-472MEB	L= 4.7 µH 13.1 mOhm	1	$0.82	XAL6060 72 mm^2
M1	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm^2
M2	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm^2
M3	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm^2
M4	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm^2
Rcomp	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcsg	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rcsp	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rf	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2

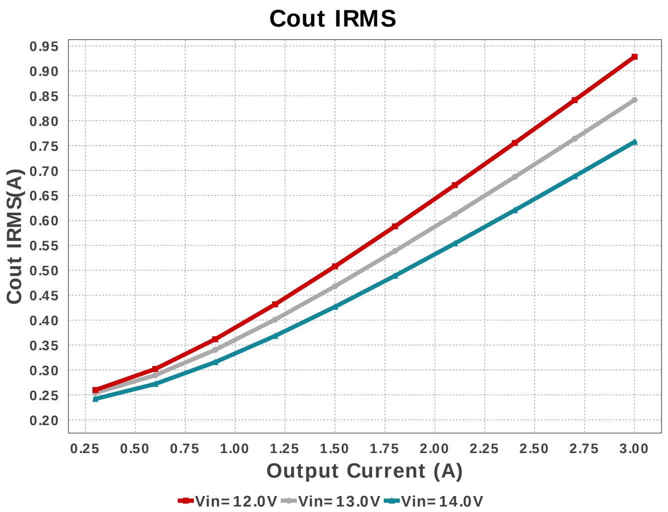
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Yageo	RC0603FR-07475KL Series= ?	Res= 475.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rmode	Vishay-Dale	CRCW060393K1FKEA Series= CRCW..e3	Res= 93.1 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rpg	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rsense	Susumu Co Ltd	PRL1632-R016-F-T1 Series= PRL1632	Res= 16.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	0612 11 mm^2
Rt	Vishay-Dale	CRCW040275K0FKED Series= CRCW..e3	Res= 75.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruvb	Yageo	RC0201FR-0728K7L Series= ?	Res= 28.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Ruvt	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	LM5175PWPR	Switcher	1	$3.10	PWP0028F_N 98 mm^2

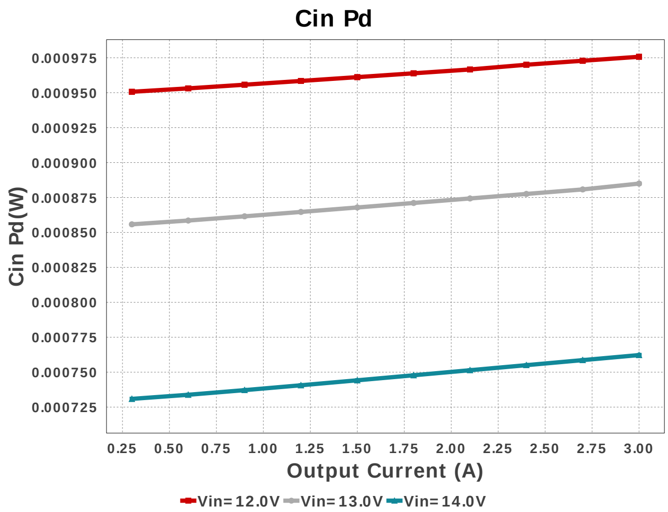


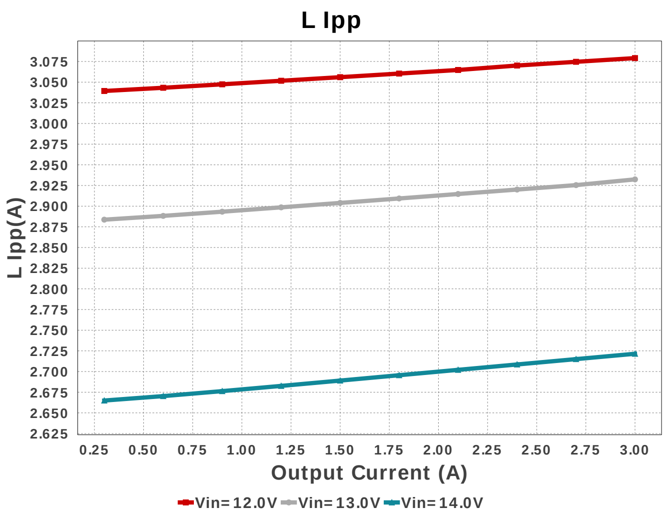


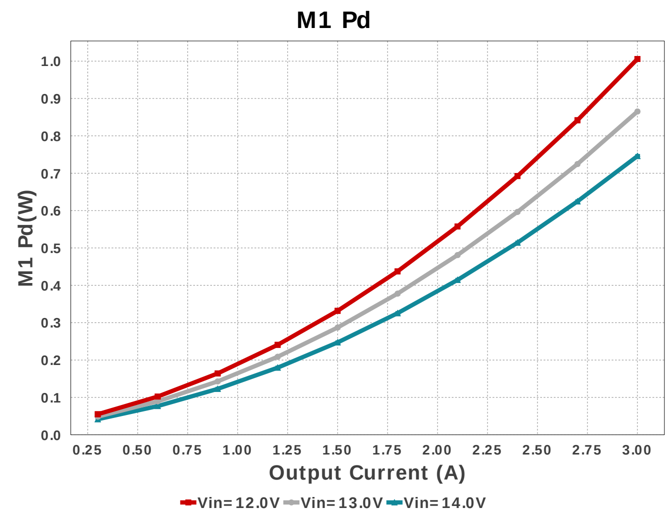

D2 Pd
D2 Pd(W)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

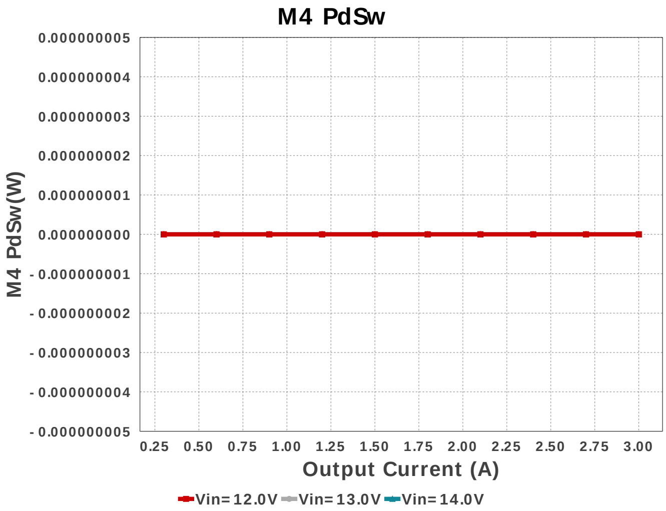

Rsense Pd
Rsense Pd(W)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

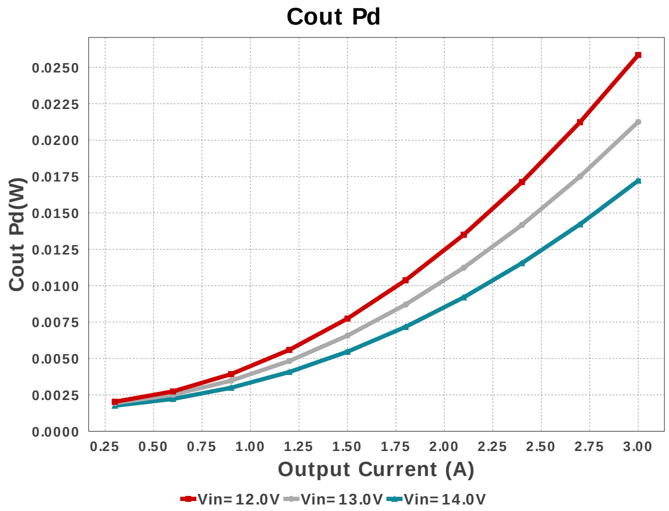

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

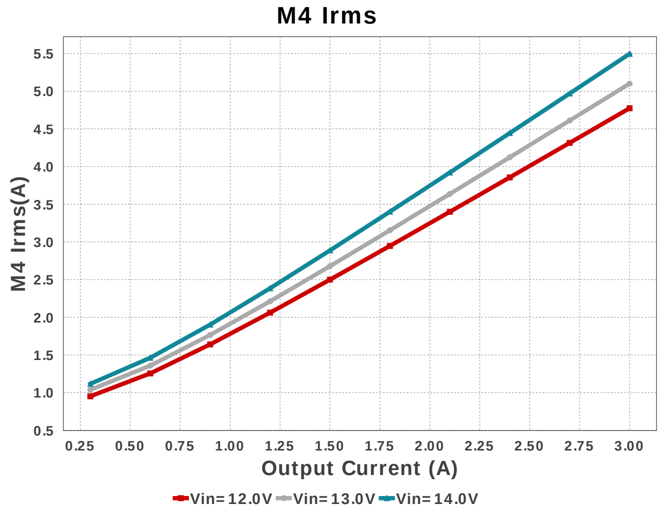

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

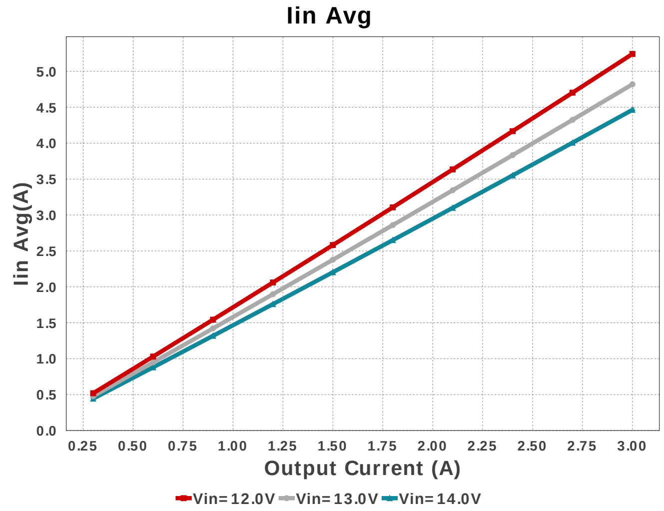

L Ipp
L Ipp(A)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

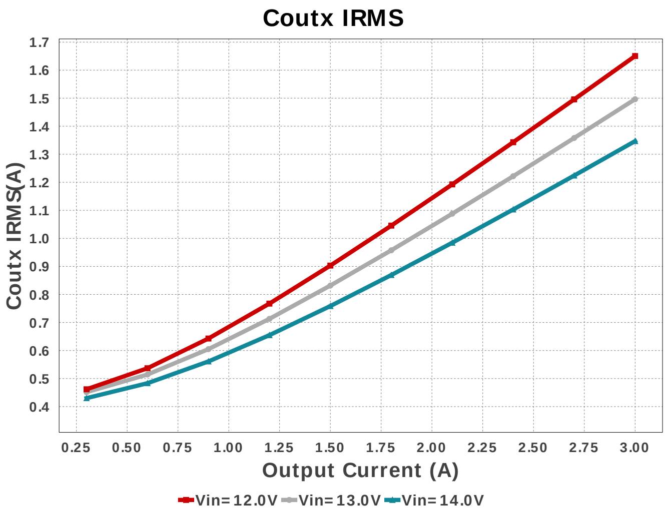

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=12.0V
Vin=13.0V
Vin=14.0V

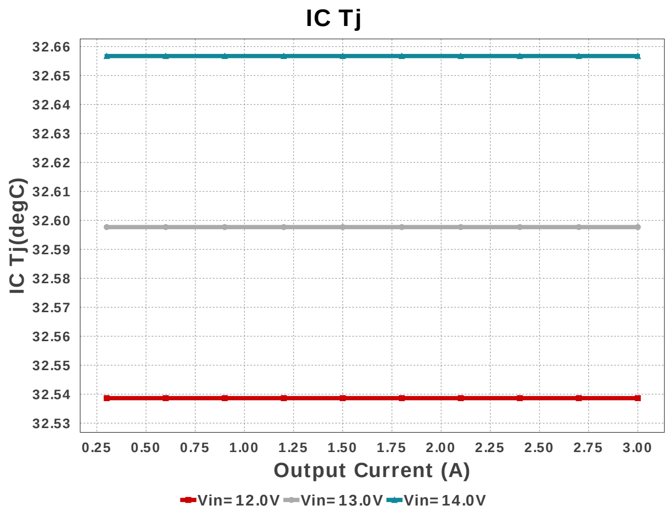

M4 PdSw
M4 PdSw(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

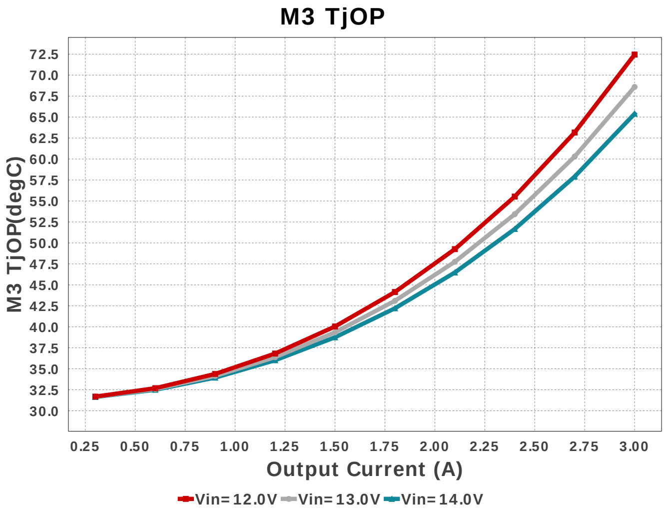

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

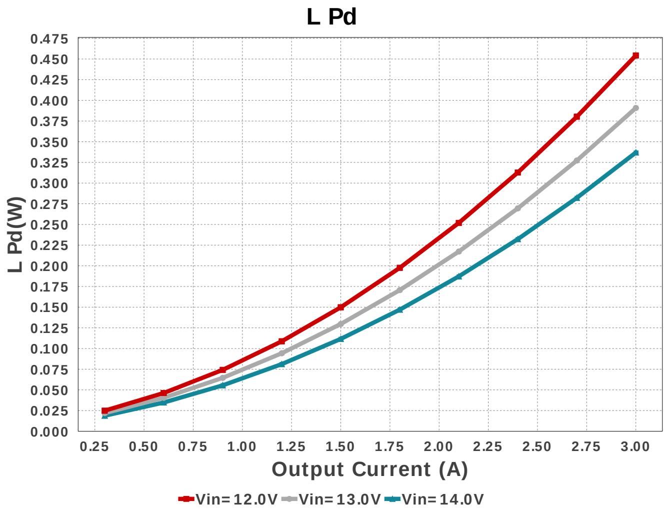

M4 Irms
M4 Irms(A)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

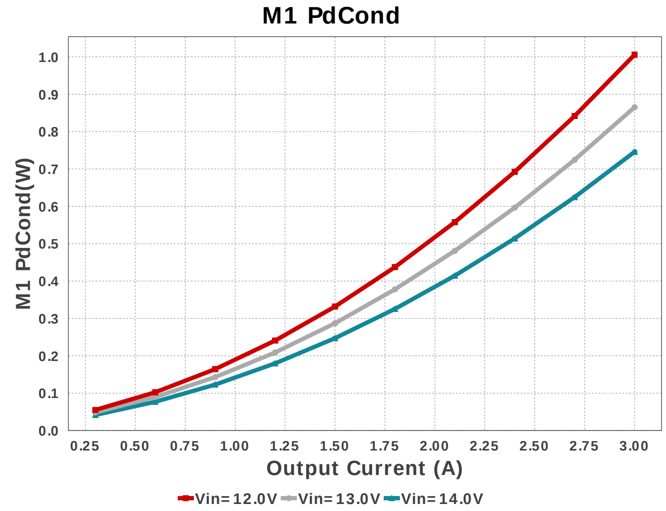

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

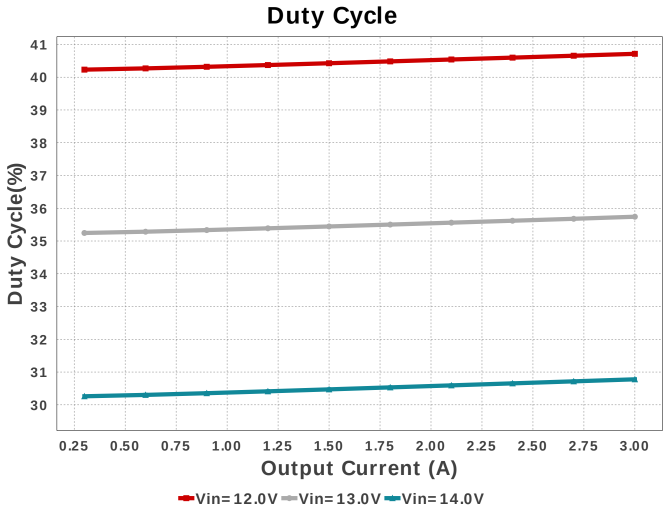

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

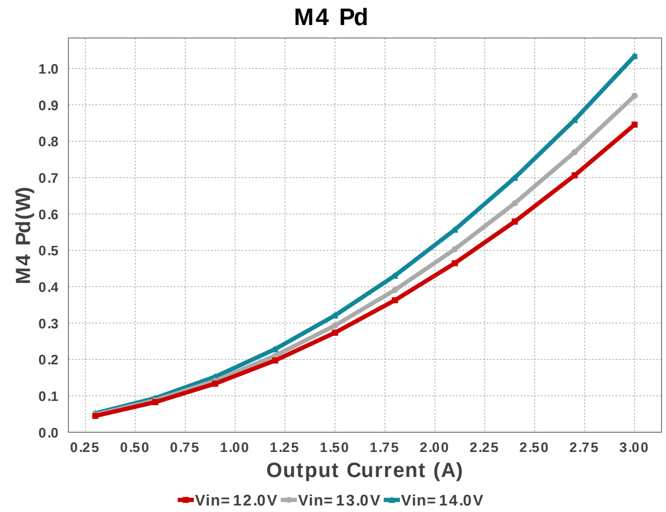

IC Tj
IC Tj(degC)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

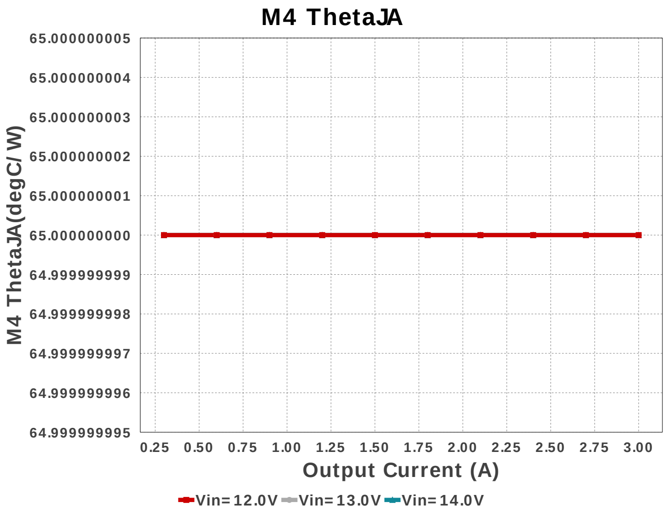

M3 TjOP
M3 TjOP(degC)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

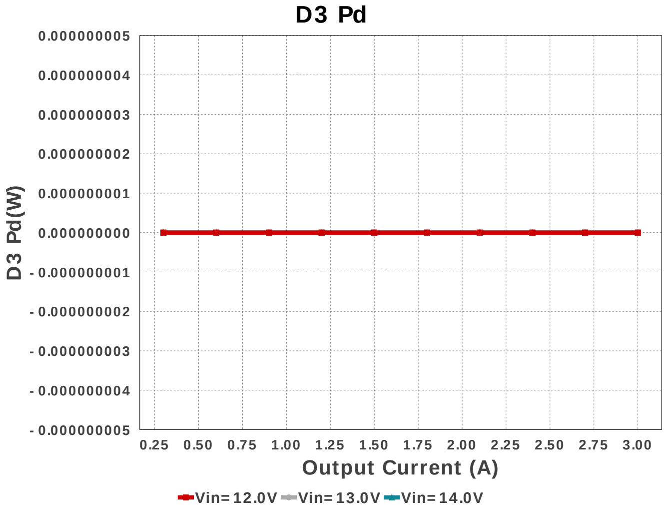

L Pd
L Pd(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

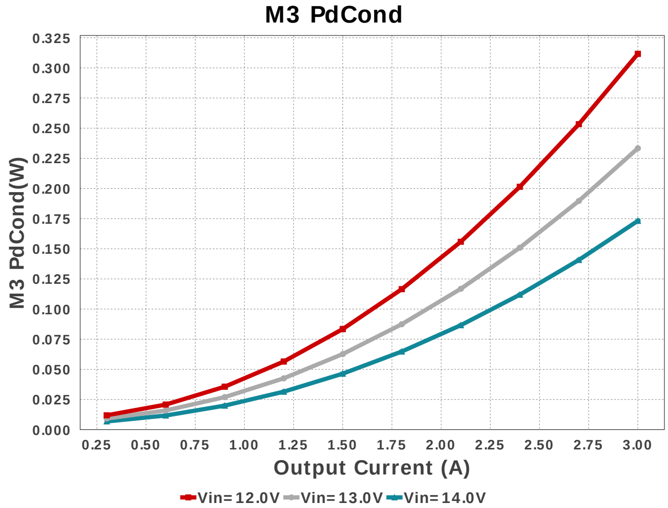

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

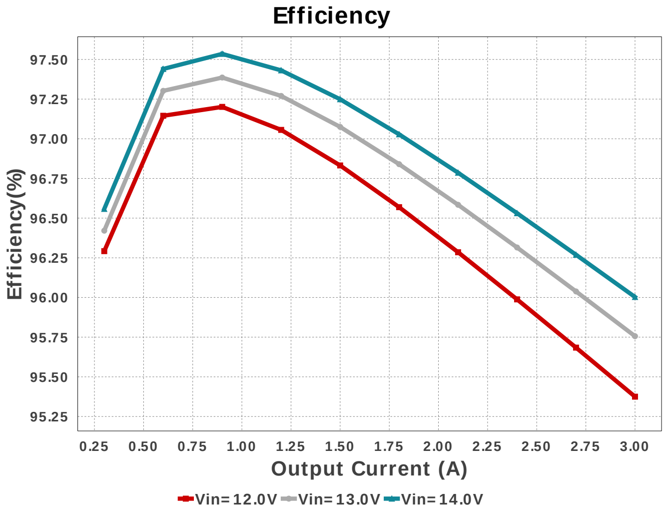

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

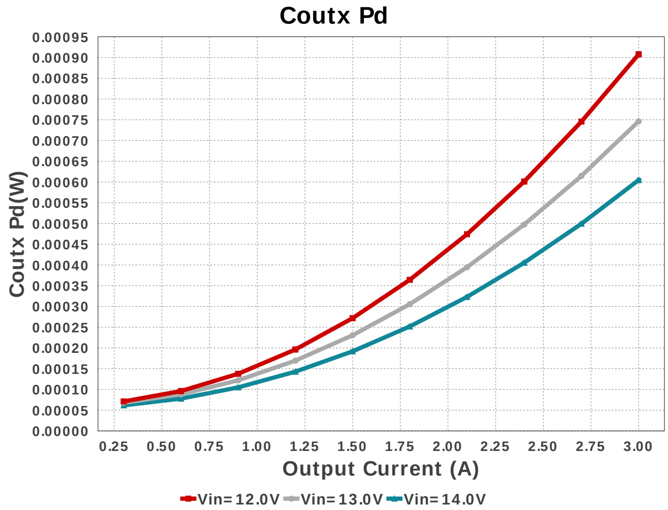

M4 Pd
M4 Pd(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

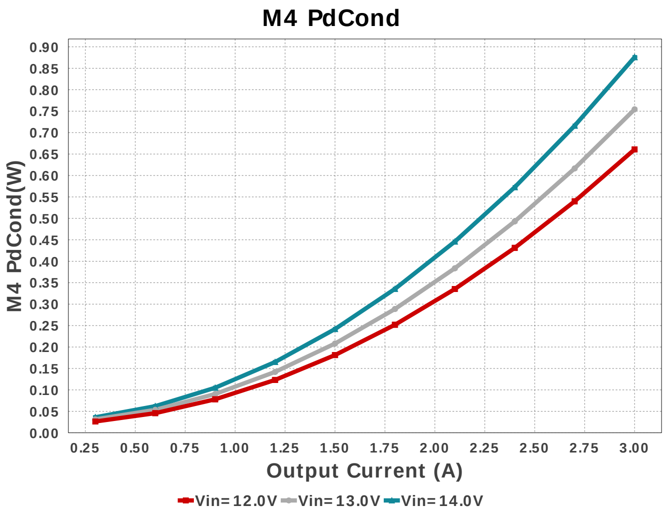

M4 ThetaJA
M4 ThetaJA(degC/W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

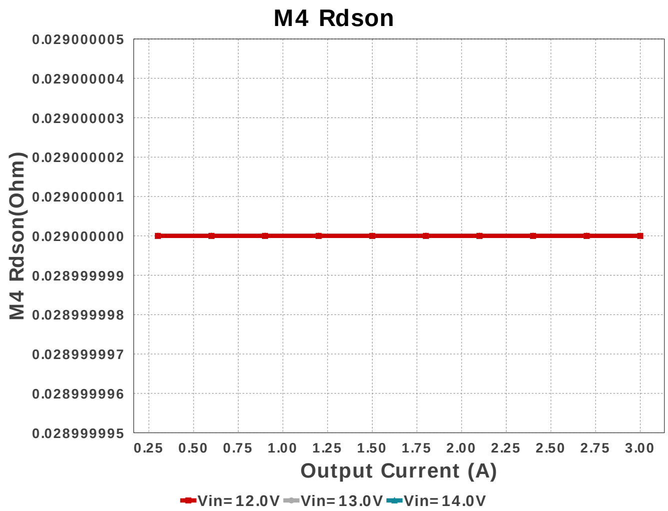

D3 Pd
D3 Pd(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

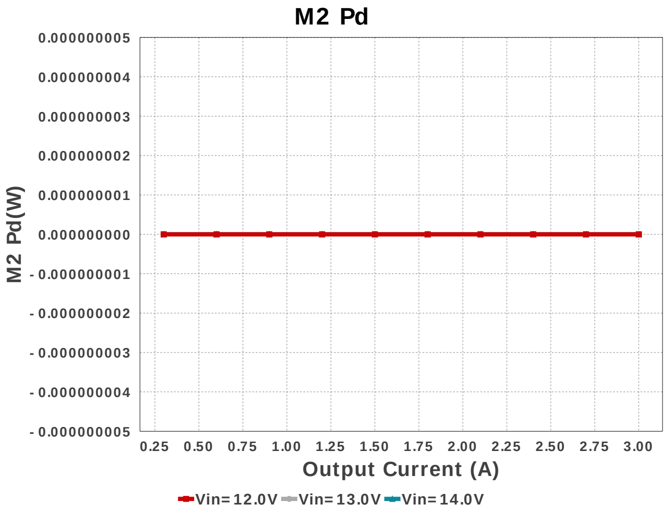

M3 PdCond
M3 PdCond(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

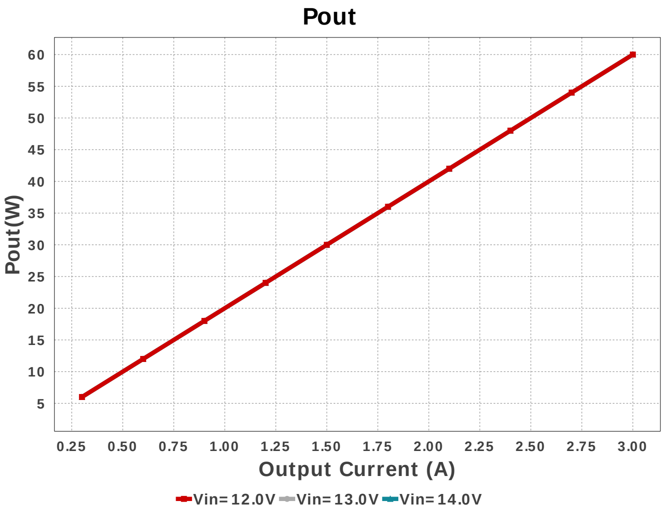

Efficiency
Efficiency(%)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

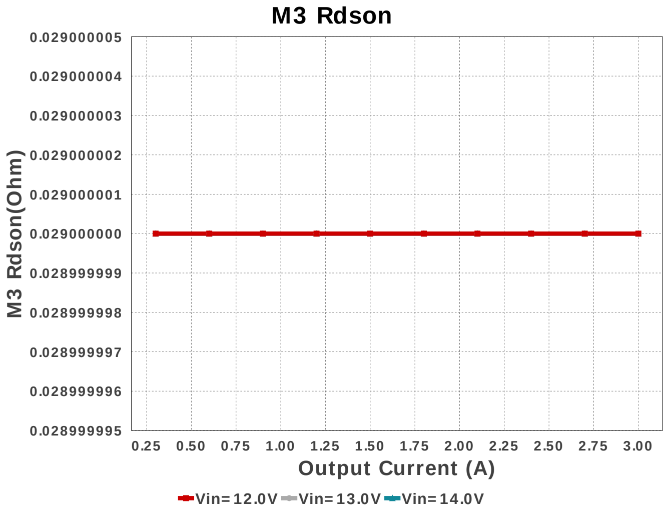

Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

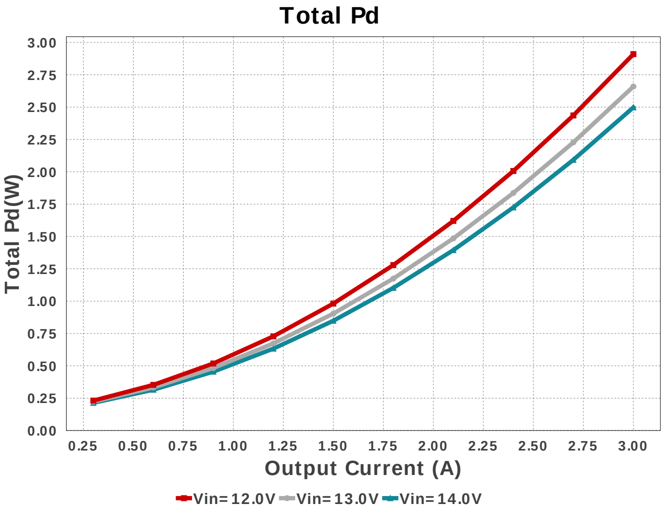

M4 PdCond
M4 PdCond(W)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

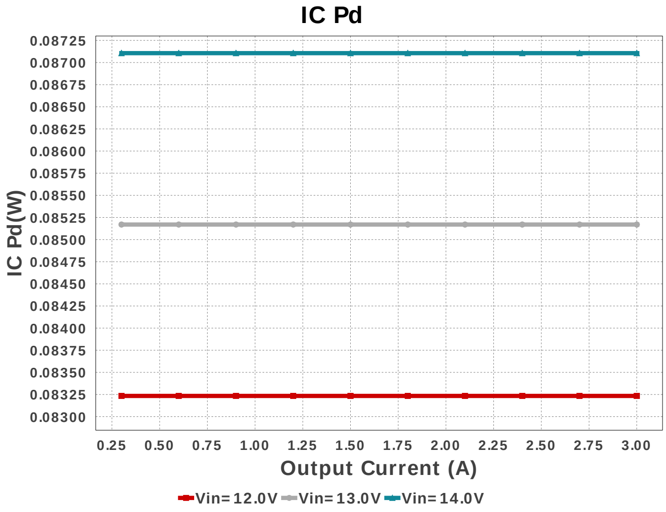

M4 Rdson
M4 Rdson(Ohm)
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

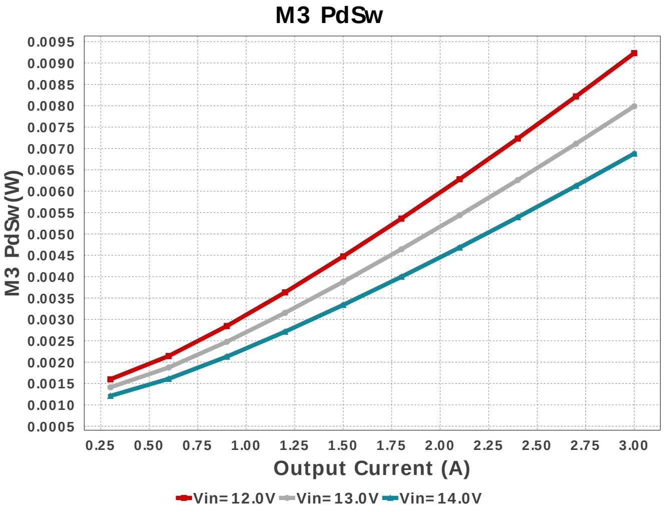

M2 Pd
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
- 0.000000001
- 0.000000002
- 0.000000003
- 0.000000004
- 0.000000005
M2 Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

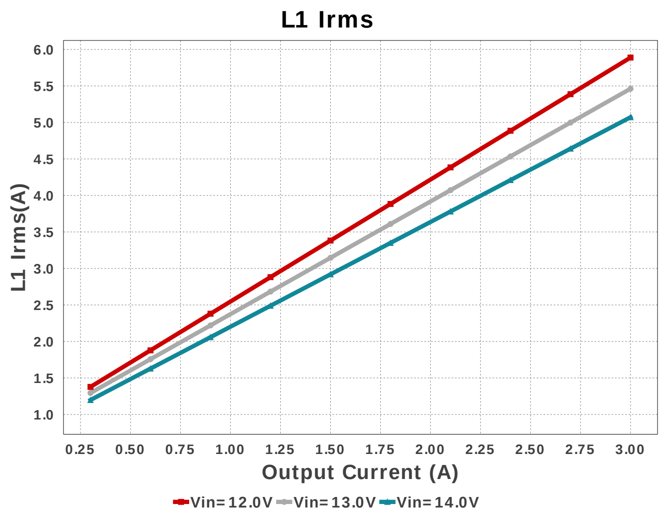

Pout
60
55
50
45
40
35
30
25
20
15
10
5
Pout(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

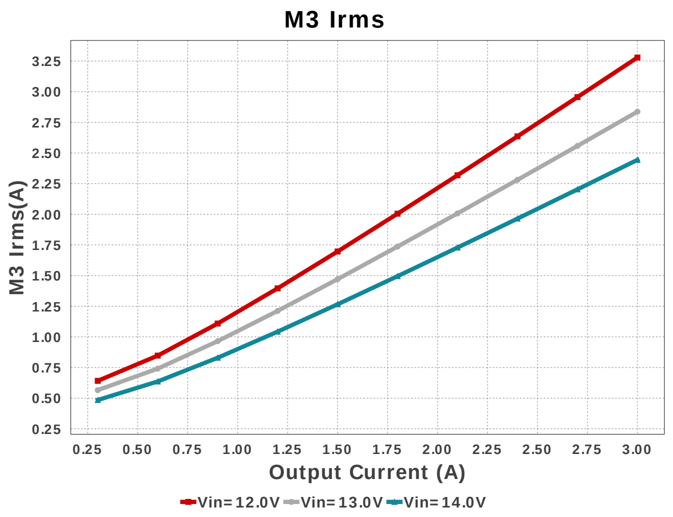

M3 Rdson
0.029000005
0.029000004
0.029000003
0.029000002
0.029000001
0.029000000
0.028999999
0.028999998
0.028999997
0.028999996
0.028999995
M3 Rdson(Ohm)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

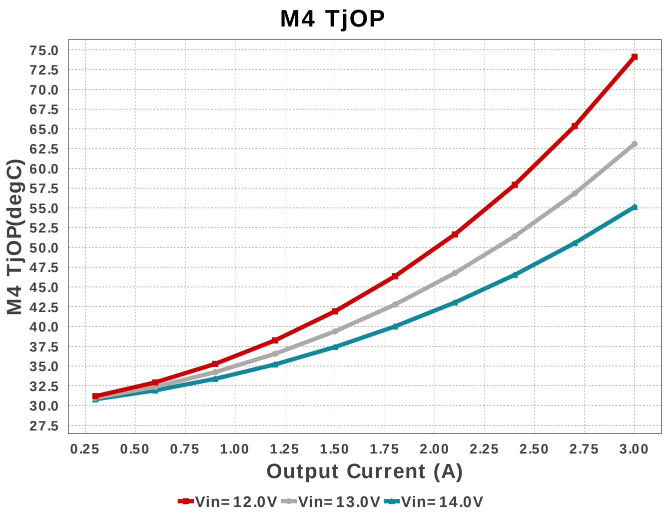

Total Pd
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Total Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

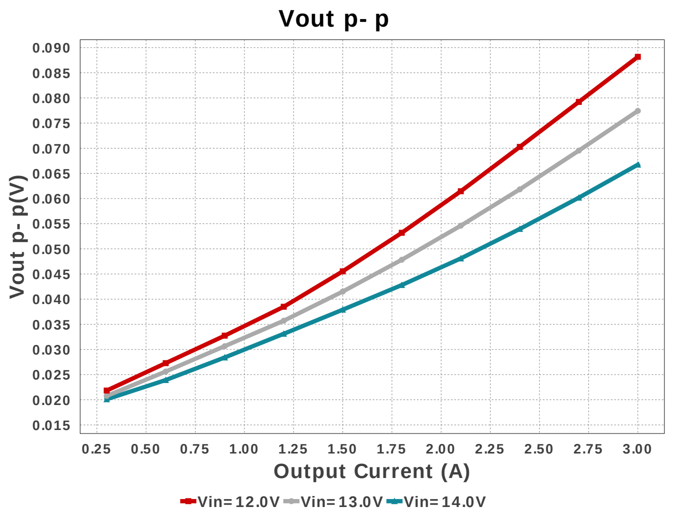

IC Pd
0.08725
0.08700
0.08675
0.08650
0.08625
0.08600
0.08575
0.08550
0.08525
0.08500
0.08475
0.08450
0.08425
0.08400
0.08375
0.08350
0.08325
0.08300
IC Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

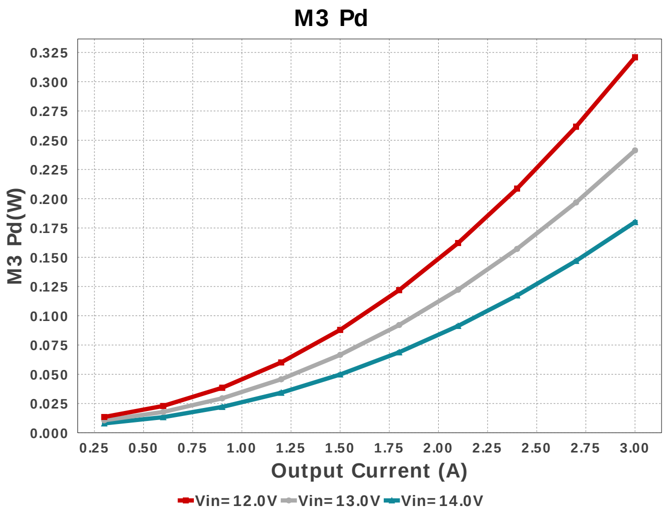

M3 PdSw
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
M3 PdSw(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=12.0V Vin=13.0V Vin=14.0V

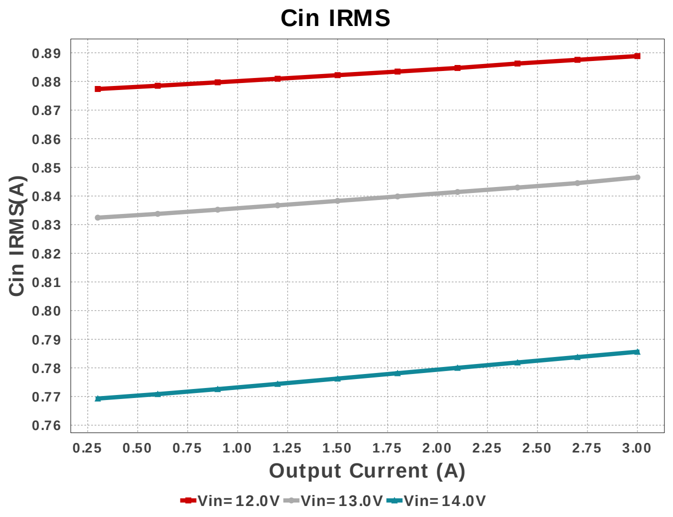












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.037 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	1.328 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	783.949 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	18.437 mW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	1.394 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	647.36 µW	Capacitor	Output capacitor_x power loss
7.	D2 Pd	0.0 W	Diode	Diode power dissipation
8.	D3 Pd	0.0 W	Diode	Diode power dissipation
9.	IC Pd	87.106 mW	IC	IC power dissipation
10.	IC Tj	32.657 degC	IC	IC junction temperature
11.	IC Tolerance	0.0 V	IC	IC Feedback Tolerance

#	Name	Value	Category	Description
12.	ICThetaJA	30.5 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	5.251 A	IC	Average input current
14.	L Ipp	3.592 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	477.43 mW	Inductor	Inductor power dissipation
16.	L1 Irms	6.037 A	Inductor	Inductor ripple current
17.	M1 Pd	1.057 W	Mosfet	M1 MOSFET total power dissipation
18.	M1 PdCond	1.057 W	Mosfet	M1 MOSFET conduction losses
19.	M2 Pd	0.0 W	Mosfet	M2 MOSFET total power dissipation
20.	M3 Irms	3.32 A	Mosfet	MOSFET RMS ripple current
21.	M3 Pd	328.99 mW	Mosfet	MOSFET power dissipation
22.	M3 PdCond	319.64 mW	Mosfet	M1 MOSFET conduction losses
23.	M3 PdSw	9.348 mW	Mosfet	M1 MOSFET switching losses
24.	M3 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
25.	M3 TjOP	72.449 degC	Mosfet	MOSFET junction temperature
26.	M4 Irms	4.834 A	Mosfet	MOSFET RMS ripple current
27.	M4 Pd	862.67 mW	Mosfet	MOSFET power dissipation
28.	M4 PdCond	677.8 mW	Mosfet	M2 MOSFET conduction losses
29.	M4 PdSw	0.0 W	Mosfet	M2 MOSFET switching losses
30.	M4 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
31.	M4 TjOP	74.113 degC	Mosfet	MOSFET junction temperature
32.	M4 TjOP	74.113 degC	Mosfet	M4 MOSFET junction temperature
33.	Cin Pd	1.328 mW	Power	Input capacitor power dissipation
34.	Cout Pd	18.437 mW	Power	Output capacitor power dissipation
35.	Coutx Pd	647.36 µW	Power	Output capacitor_x power loss
36.	D2 Pd	0.0 W	Power	Diode power dissipation
37.	D3 Pd	0.0 W	Power	Diode power dissipation
38.	IC Pd	87.106 mW	Power	IC power dissipation
39.	L Pd	477.43 mW	Power	Inductor power dissipation
40.	M1 Pd	1.057 W	Power	M1 MOSFET total power dissipation
41.	M1 PdCond	1.057 W	Power	M1 MOSFET conduction losses
42.	M2 Pd	0.0 W	Power	M2 MOSFET total power dissipation
43.	M3 Pd	328.99 mW	Power	MOSFET power dissipation
44.	M3 PdCond	319.64 mW	Power	M1 MOSFET conduction losses
45.	M3 PdSw	9.348 mW	Power	M1 MOSFET switching losses
46.	M3 Rdson	29.0 mOhm	Power	Drain-Source On-resistance
47.	M4 Pd	862.67 mW	Power	MOSFET power dissipation
48.	M4 PdCond	677.8 mW	Power	M2 MOSFET conduction losses
49.	M4 PdSw	0.0 W	Power	M2 MOSFET switching losses
50.	M4 Rdson	29.0 mOhm	Power	Drain-Source On-resistance
51.	Rsense Pd	176.35 mW	Power	LED Current Rsns Power Dissipation
52.	Total Pd	3.01 W	Power	Total Power Dissipation
53.	Rsense Pd	176.35 mW	Resistor	LED Current Rsns Power Dissipation
54.	BOM Count	47	System Information	Total Design BOM count
55.	Cross Freq	13.091 kHz	System Information	Bode plot crossover frequency
56.	Duty Cycle	30.754 %	System Information	Duty cycle
57.	Efficiency	95.223 %	System Information	Steady state efficiency
58.	FootPrint	812.0 mm^2	System Information	Total Foot Print Area of BOM components
59.	Frequency	336.134 kHz	System Information	Switching frequency
60.	Gain Marg	-12.127 dB	System Information	Bode Plot Gain Margin
61.	Iout	3.0 A	System Information	Iout operating point
62.	Low Freq Gain	61.303 dB	System Information	Gain at 1Hz
63.	Mode	CCM	System Information	Conduction Mode
64.	Operating Topology	Boost	System Information	The current operating topology of the device
65.	Phase Marg	57.151 deg	System Information	Bode Plot Phase Margin
66.	Pout	60.0 W	System Information	Total output power
67.	SW Ipk	6.128 A	System Information	Peak switch current
68.	Total BOM	$11.12	System Information	Total BOM Cost
69.	Vin	12.0 V	System Information	Vin operating point
70.	Vout	20.0 V	System Information	Operational Output Voltage

#	Name	Value	Category	Description
71.	Vout Actual	19.8 V	System Information	Vout Actual calculated based on selected voltage divider resistors
72.	Vout Tolerance	1.939 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
73.	Vout p-p	68.159 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	14.0	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	20.0	Output Voltage
base_pn	LM5175	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

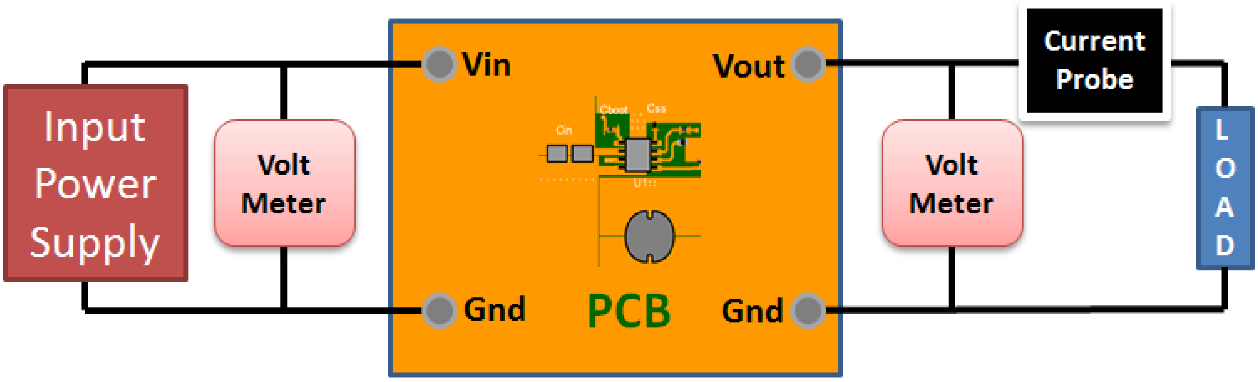
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.0V 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.



Design Assistance

1. Tip: Snubbers and/or gate resistors may be required to limit the SW1,2 node switching spikes below the IC and FET abs max ratings.

2. Tip: Slope Capacitor: smaller slope capacitors provide better transition region behavior.

3. Master key : E96045539EEBA2FE[v1]

4. **LM5175** Product Folder : http://www.ti.com/product/LM5175 : contains the data sheet and other resources.