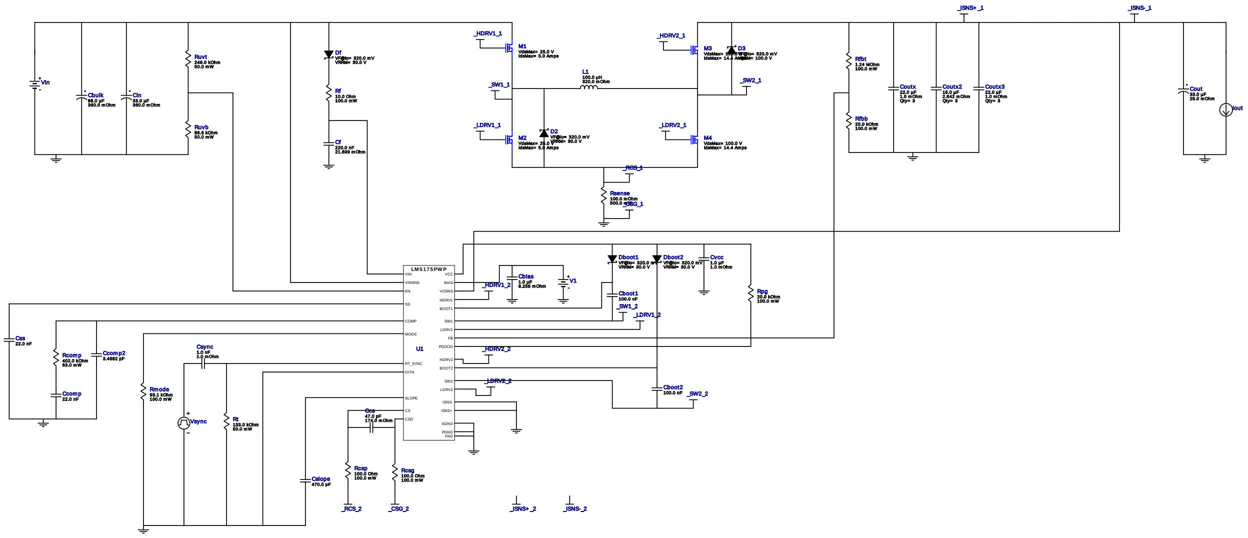
VinMin = 5.0V
VinMax = 15.0V
Vout = 50.0V
Iout = 0.1A

Device = LM5175PWPR
Topology = Buck_Boost
Created = 2021-11-04 11:38:17.372
BOM Cost = NA
BOM Count = 46
Total Pd = 0.9W

WEBENCH ® Design Report

Design : 2 LM5175PWPR
LM5175PWPR 5V-15V to 50.00V @ 0.1A



Design Alerts

Component Selection Information

Embedded simulation models do not currently support the Sync frequency behavior. The simulation feature has been turned off for this designTo enable simulation please uncheck 'User Sync Frequency' option and 'Update' this design from 'Advanced Options'

Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	TDK	CGA4J3X7S2A105K125AB Series= X7S	Cap= 1.0 uF ESR= 8.255 mOhm VDC= 100.0 V IRMS= 2.27442 A	1	$0.12	0805 7 mm^2
Cboot1	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
Cboot2	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.06	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	TDK	CGA4J2C0G1H223J125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm^2
Ccomp2	CUSTOM	CUSTOM Series= ?	Cap= 3.4882 pF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 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	CGA3E3X7R1H224K080AB Series= X7R	Cap= 220.0 nF ESR= 21.699 mOhm VDC= 50.0 V IRMS= 1.125 A	1	$0.03	0603 5 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	Panasonic	EEE-FK1E330P Series= FK	Cap= 33.0 uF ESR= 360.0 mOhm VDC= 25.0 V IRMS= 240.0 mA	1	$0.11	SM_RADIAL_D 84 mm^2
Cout	Panasonic	63SXV33M Series= SXV	Cap= 33.0 uF ESR= 25.0 mOhm VDC= 63.0 V IRMS= 2.95 A	1	$1.18	CAPSMT_62_E12 106 mm^2
Coutx	TDK	CKG57NX7S2A226M500JH Series= X7S	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	3	$2.36	CKG57N 56 mm^2
Coutx2	TDK	C5750X7S2A156M250KB Series= X7S	Cap= 15.0 uF ESR= 2.642 mOhm VDC= 100.0 V IRMS= 5.6162 A	3	$1.23	2220_280 54 mm^2
Coutx3	TDK	CKG57NX7S2A226M500JH Series= X7S	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	3	$2.36	CKG57N 56 mm^2
Cslope	Samsung Electro-Mechanics	CL10C471JB8NNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Css	TDK	CGA4J2C0G1H223J125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm^2
Csync	MuRata	GRM216R71E102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	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	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.19	M-FLAT 19 mm^2
D3	Vishay-Semiconductor	SS2PH10-M3	VF@Io= 620.0 mV VRRM= 100.0 V	1	$0.15	DO-220AA 14 mm^2
Dboot1	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.19	M-FLAT 19 mm^2
Dboot2	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.19	M-FLAT 19 mm^2
Df	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.19	M-FLAT 19 mm^2
L1	Bourns	SDR1105-101KL	L= 100.0 µH 320.0 mOhm	1	$0.36	SDR1105 157 mm^2
M1	Texas Instruments	CSD16301Q2	VdsMax= 25.0 V IdsMax= 5.0 Amps	1	$0.13	DQK0006C 9 mm^2
M2	Texas Instruments	CSD16301Q2	VdsMax= 25.0 V IdsMax= 5.0 Amps	1	$0.13	DQK0006C 9 mm^2
M3	Texas Instruments	CSD19538Q2	VdsMax= 100.0 V IdsMax= 14.4 Amps	1	$0.16	DQK0006C 9 mm^2
M4	Texas Instruments	CSD19538Q2	VdsMax= 100.0 V IdsMax= 14.4 Amps	1	$0.16	DQK0006C 9 mm^2

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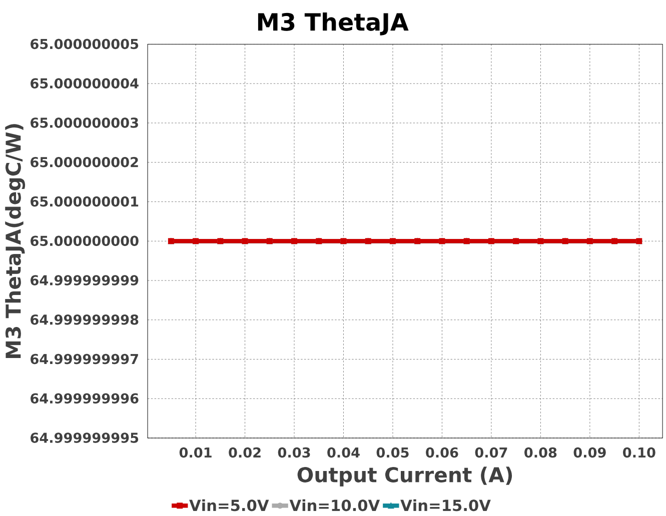
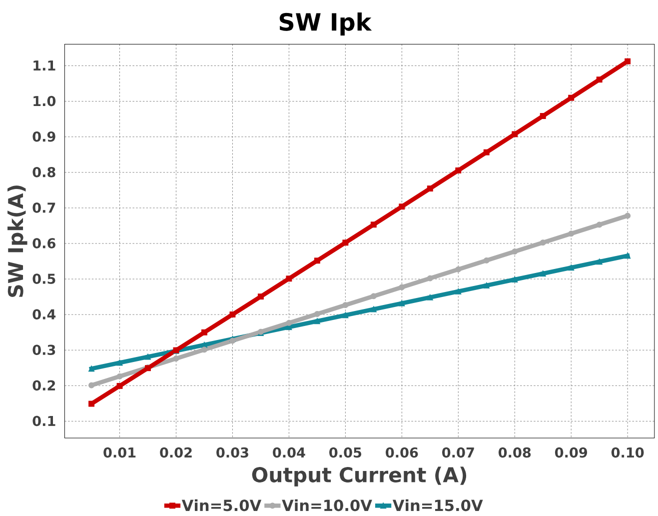
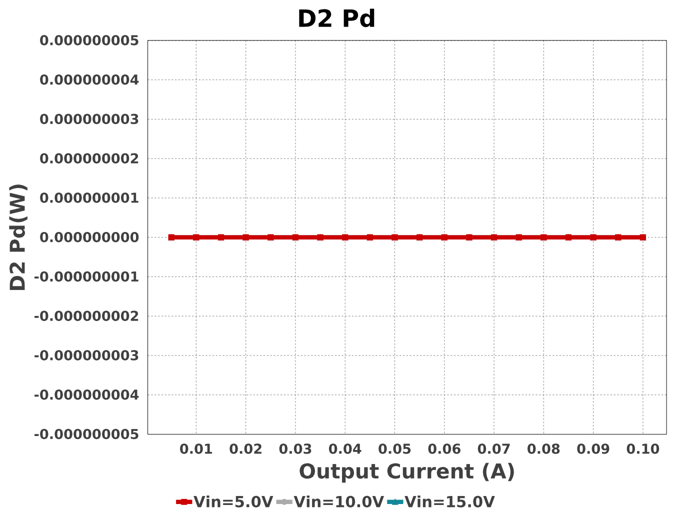
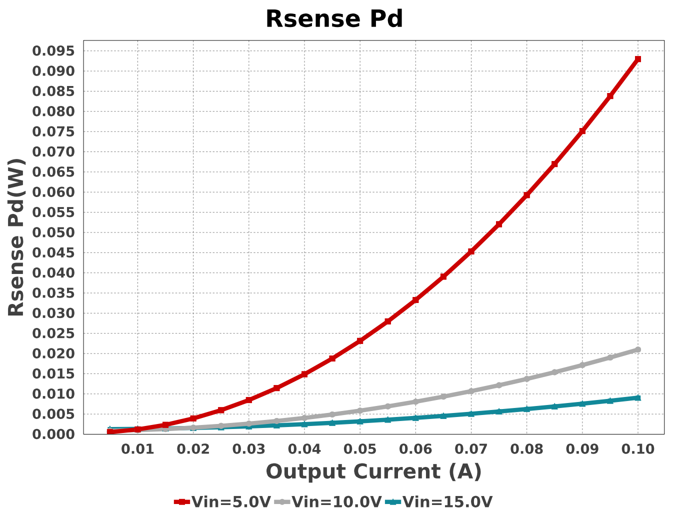
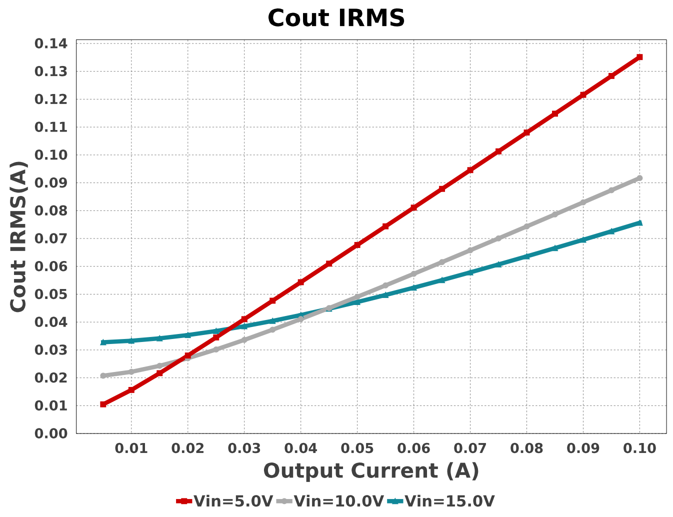
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rcomp	Vishay-Dale	CRCW0402402KFKED Series= CRCW..e3	Res= 402.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcsg	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rcsp	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rf	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbb	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Vishay-Dale	CRCW06031M24FKEA Series= CRCW..e3	Res= 1.24 MOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rmode	Vishay-Dale	CRCW060393K1FKEA Series= CRCW..e3	Res= 93.1 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rpg	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rsense	Rohm	MCR25JZHFLR100 Series= MCR25	Res= 100.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	1210 15 mm²
Rt	Yageo	RC0201FR-07133KL Series= ?	Res= 133.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Ruvb	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Ruvt	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
U1	Texas Instruments	LM5175PWPR	Switcher	1	$3.00	PWP0028F_N 98 mm²

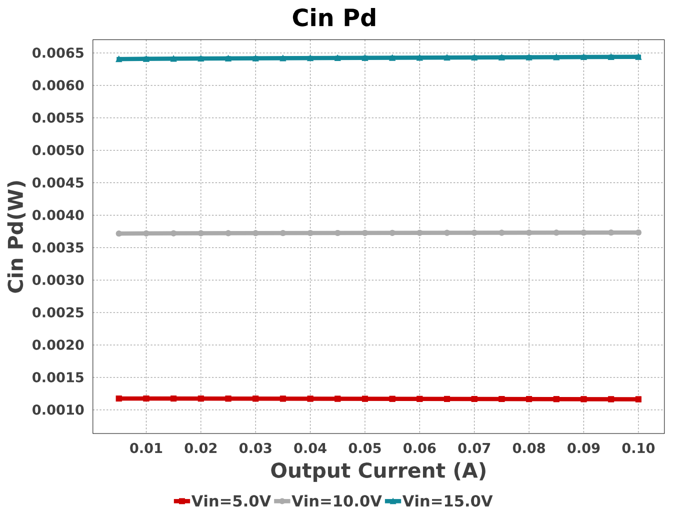


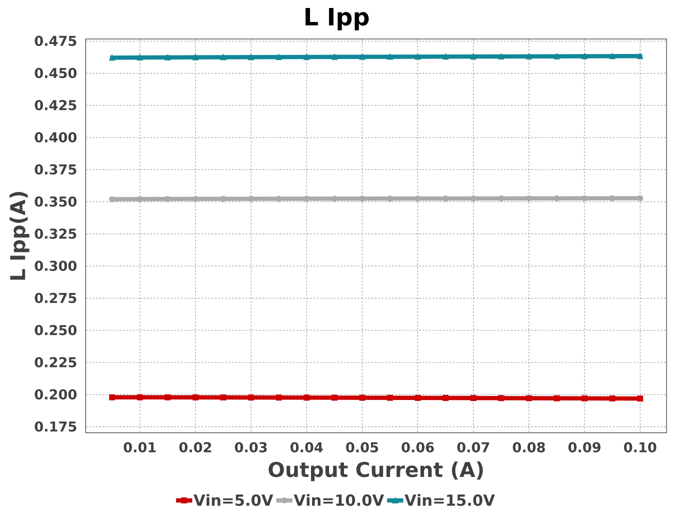


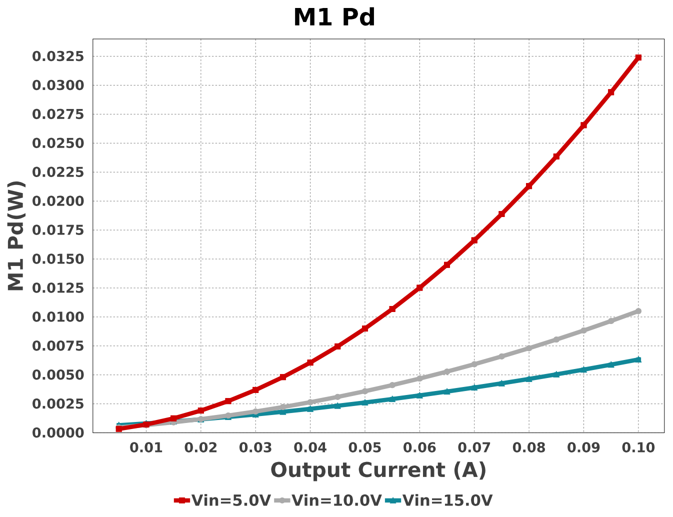












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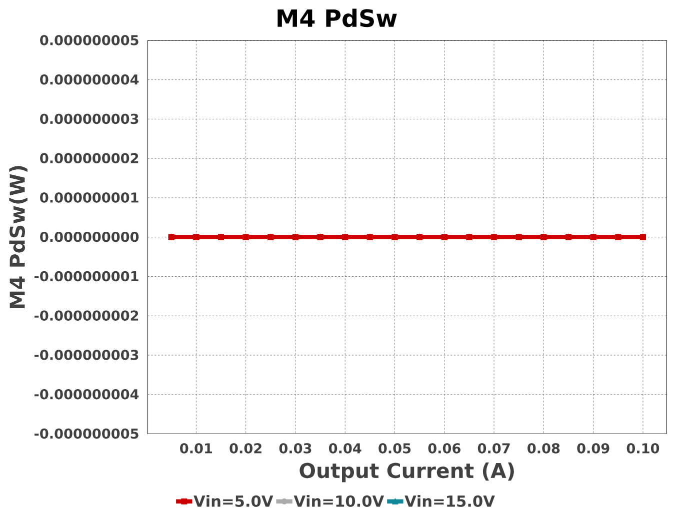
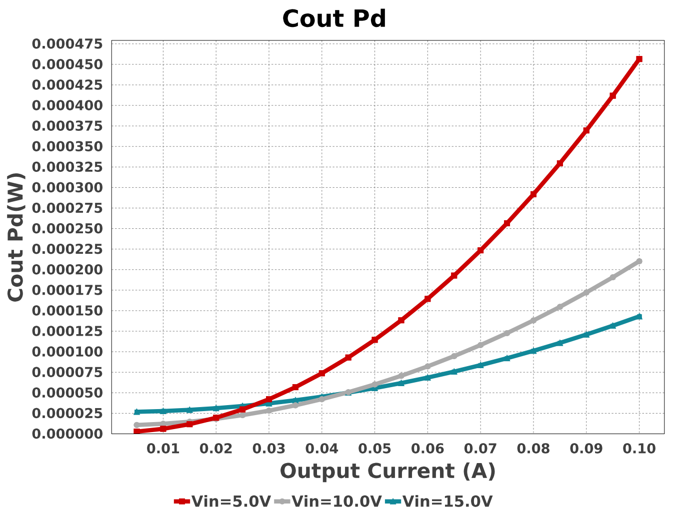
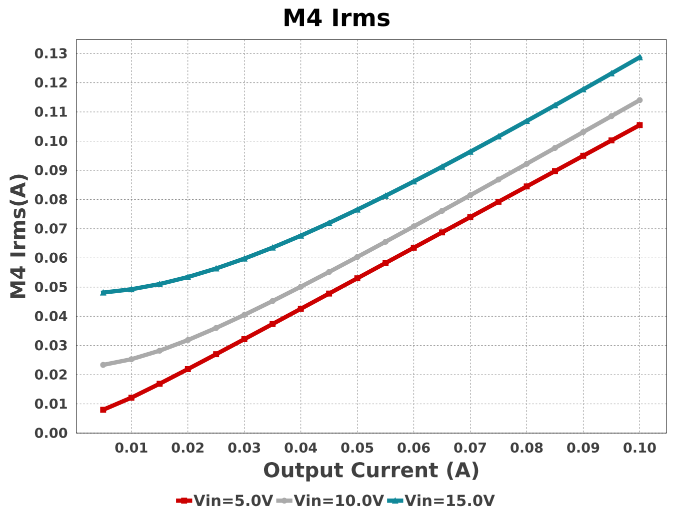
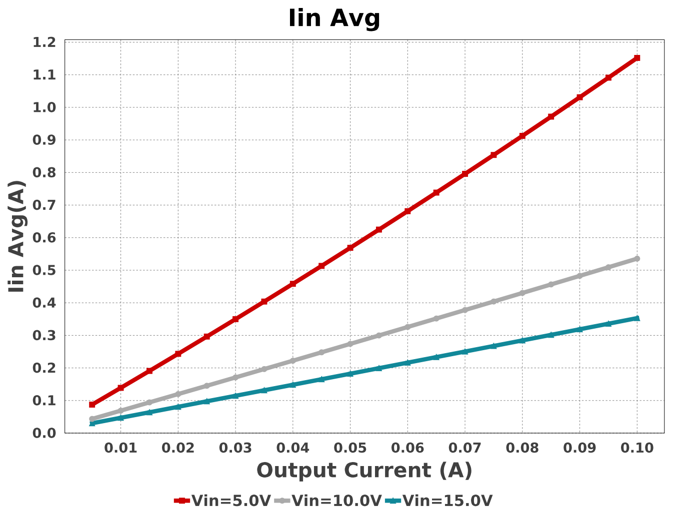
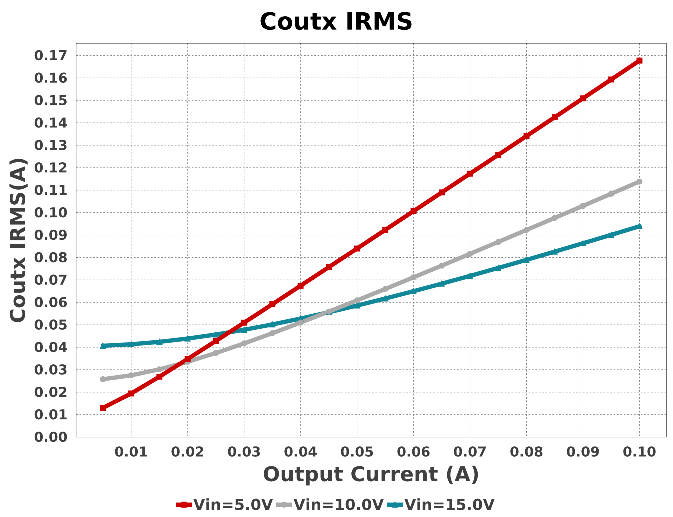
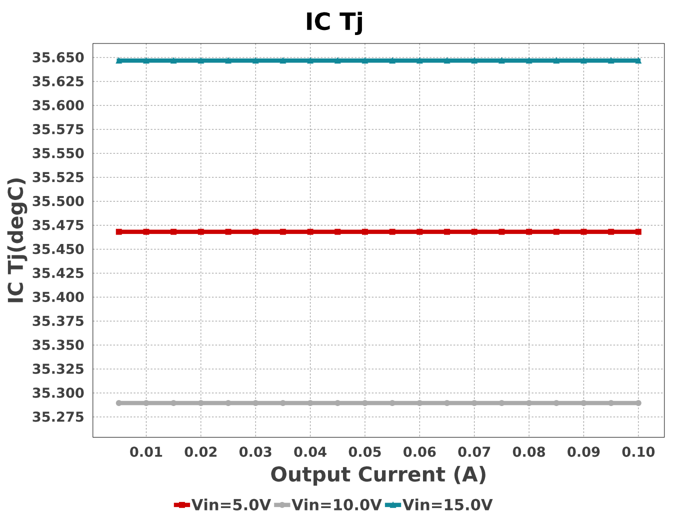

M4 PdSw
M4 PdSw(W)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

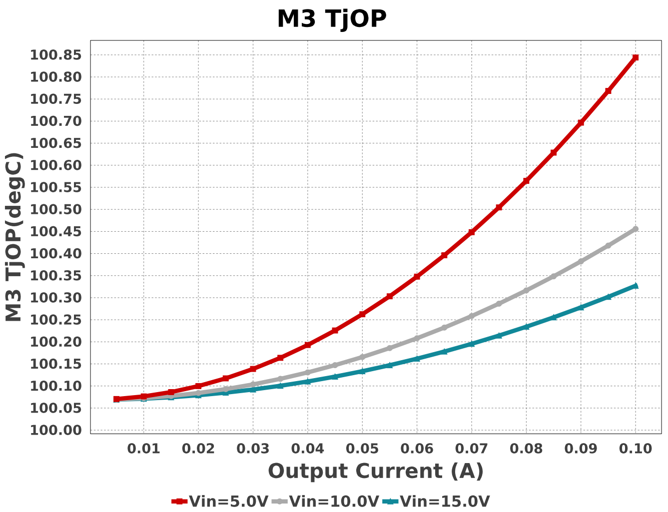

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

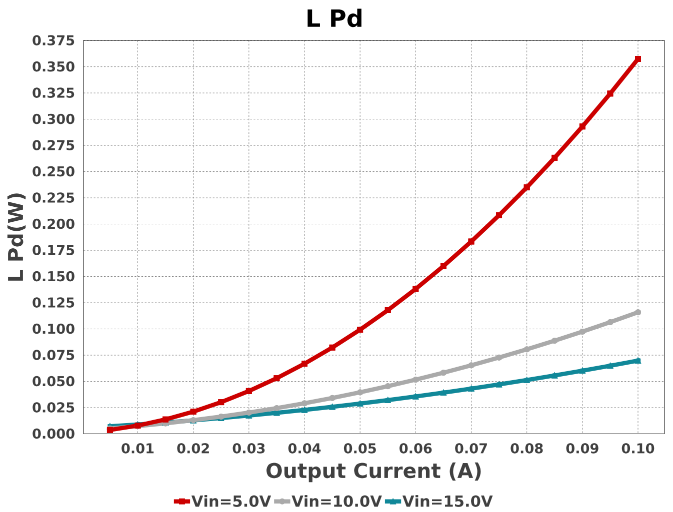

M4 Irms
M4 Irms(A)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

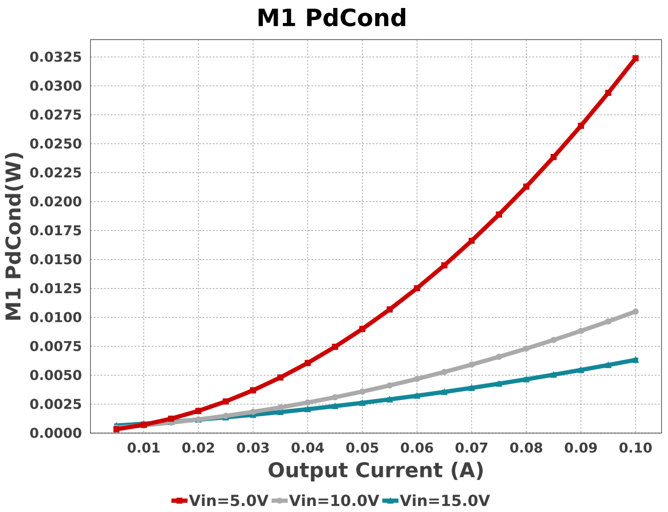

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

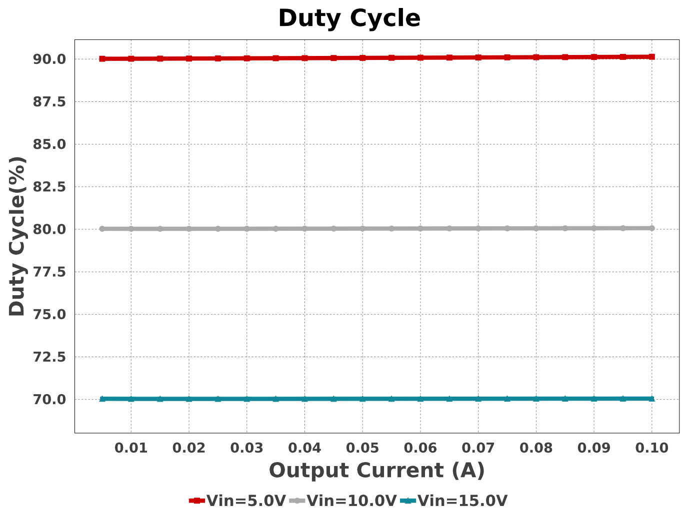

Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

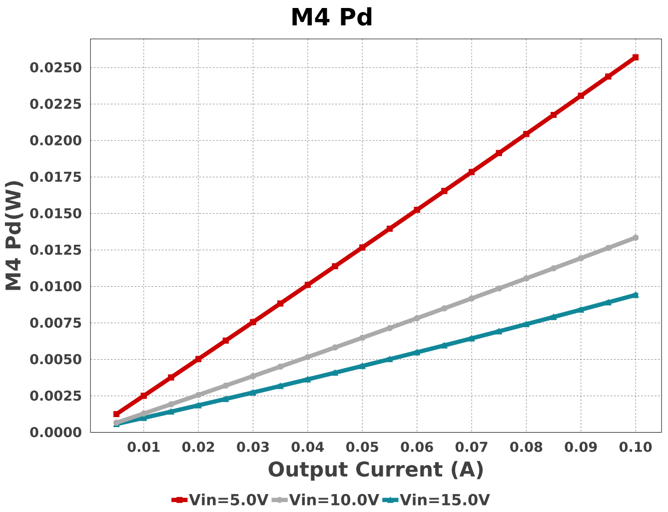

IC Tj
IC Tj(degC)
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

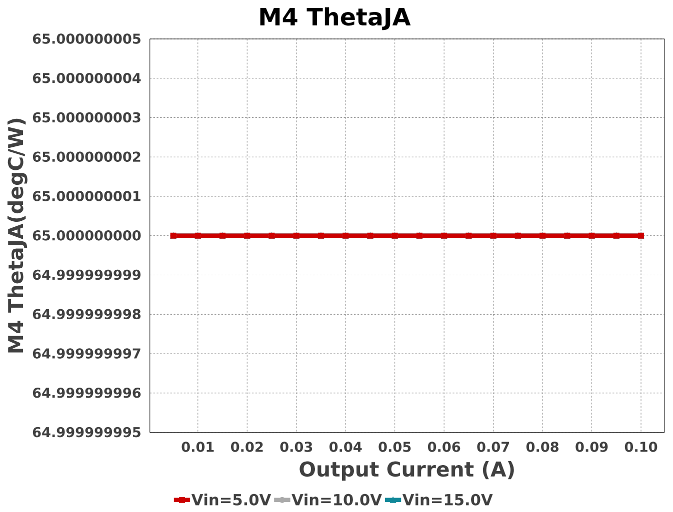

M3 TjOP
M3 TjOP(degC)
100.85
100.80
100.75
100.70
100.65
100.60
100.55
100.50
100.45
100.40
100.35
100.30
100.25
100.20
100.15
100.10
100.05
100.00
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

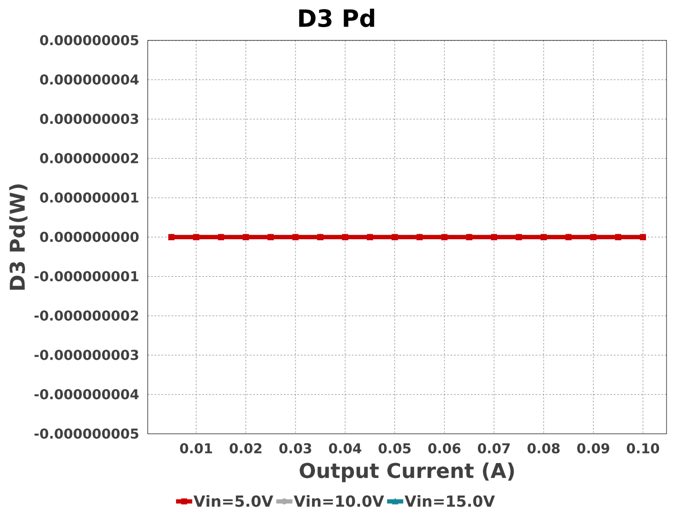

L Pd
L Pd(W)
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

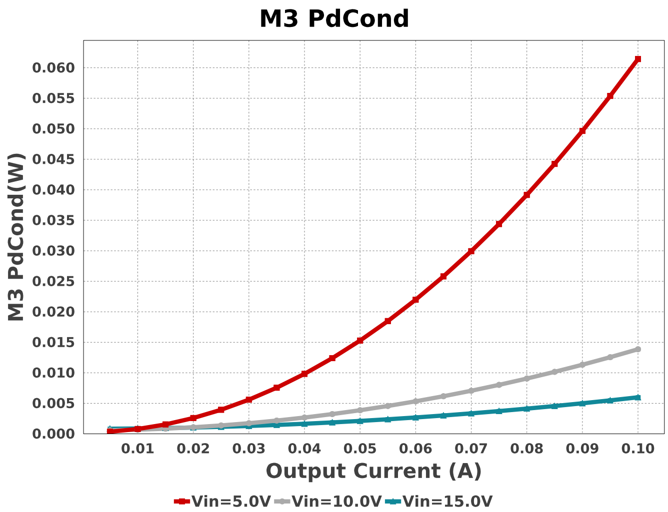

M1 PdCond
M1 PdCond(W)
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

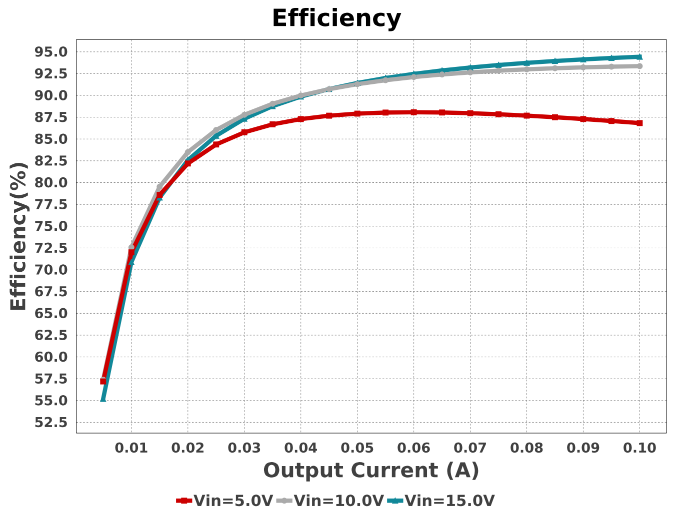

Duty Cycle
Duty Cycle(%)
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

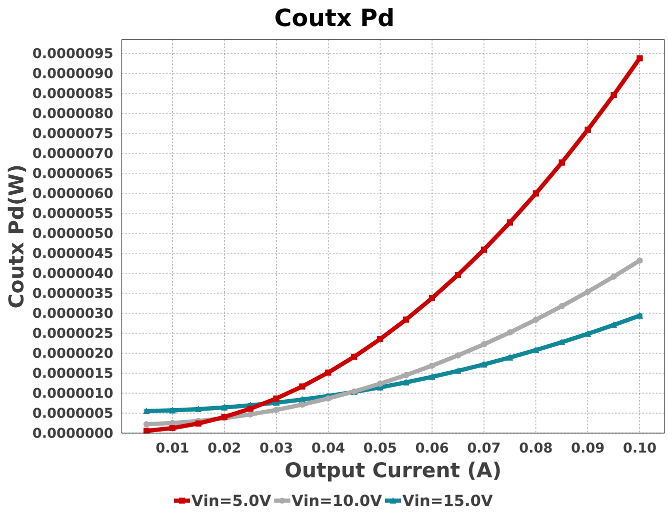

M4 Pd
M4 Pd(W)
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

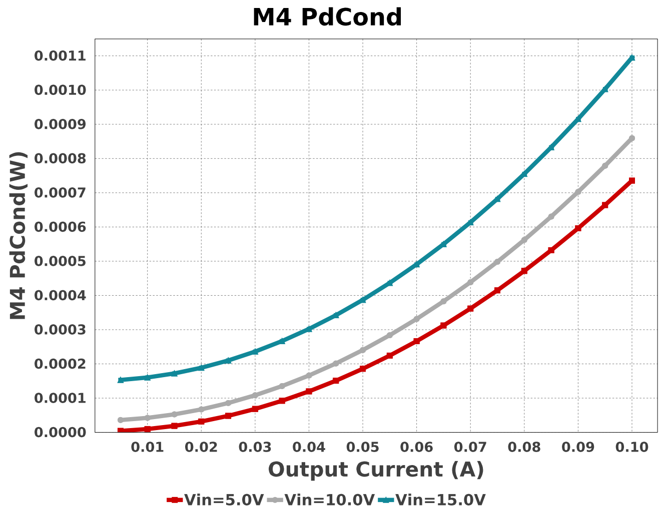

M4 ThetaJA
M4 ThetaJA(degC/W)
65.000000005
65.000000004
65.000000003
65.000000002
65.000000001
65.000000000
64.999999999
64.999999998
64.999999997
64.999999996
64.999999995
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

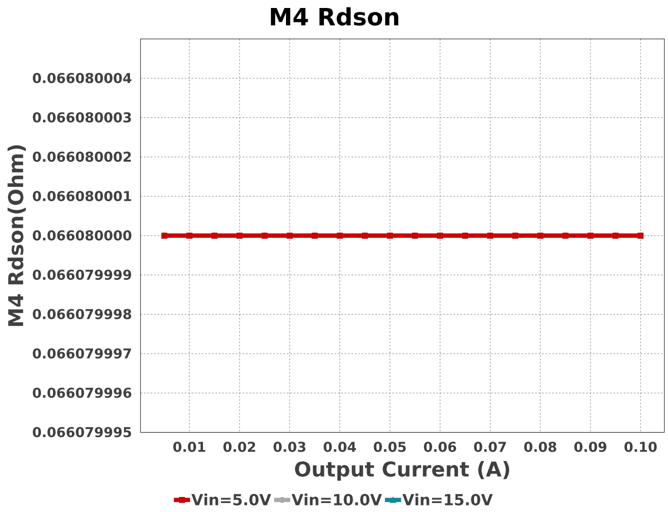

D3 Pd
D3 Pd(W)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

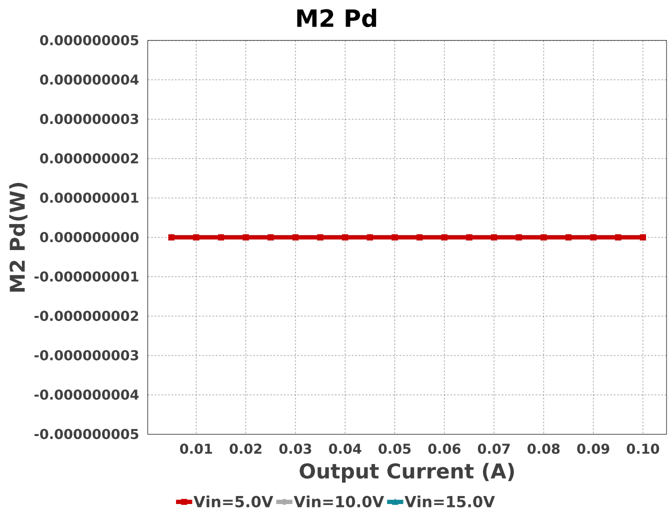

M3 PdCond
M3 PdCond(W)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

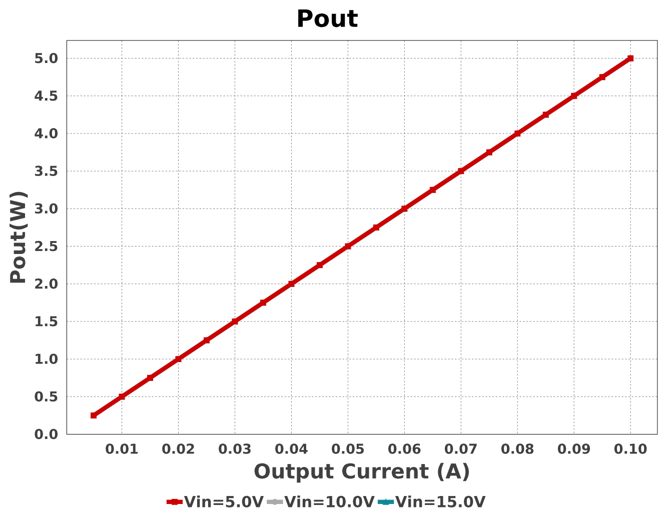

Efficiency
Efficiency(%)
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

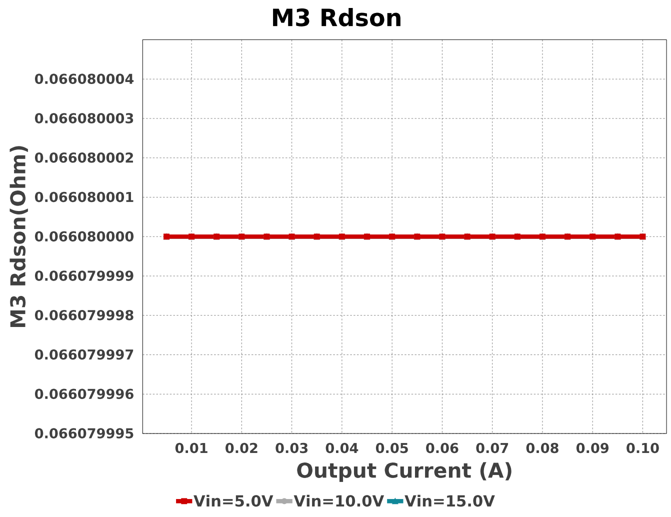

Coutx Pd
Coutx Pd(W)
0.0000095
0.0000090
0.0000085
0.0000080
0.0000075
0.0000070
0.0000065
0.0000060
0.0000055
0.0000050
0.0000045
0.0000040
0.0000035
0.0000030
0.0000025
0.0000020
0.0000015
0.0000010
0.0000005
0.0000000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

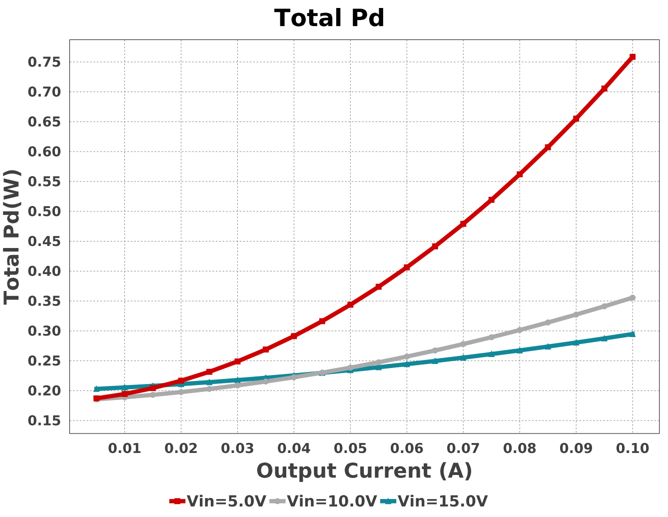

M4 PdCond
M4 PdCond(W)
0.0011
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

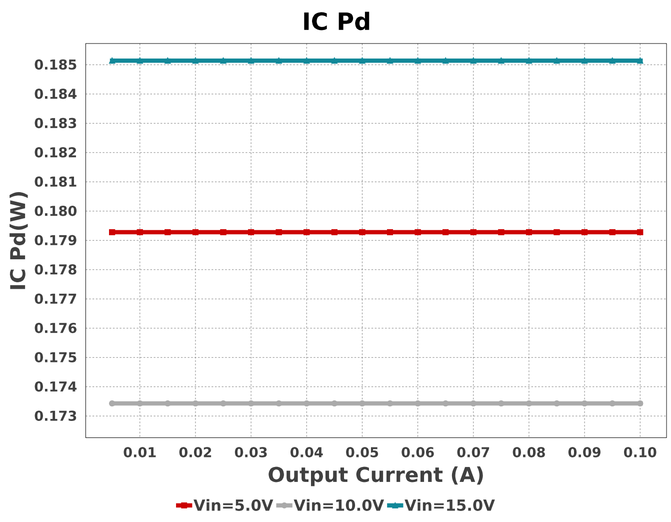

M4 Rdson
M4 Rdson(Ohm)
0.066080004
0.066080003
0.066080002
0.066080001
0.066080000
0.066079999
0.066079998
0.066079997
0.066079996
0.066079995
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
Output Current (A)
Vin=5.0V Vin=10.0V Vin=15.0V

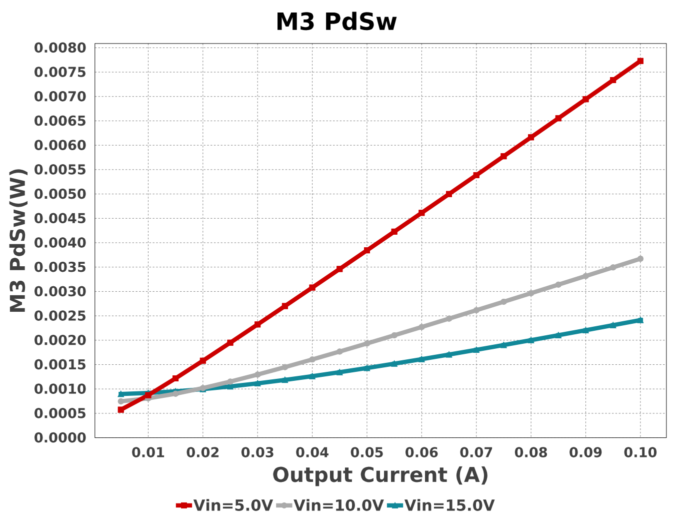












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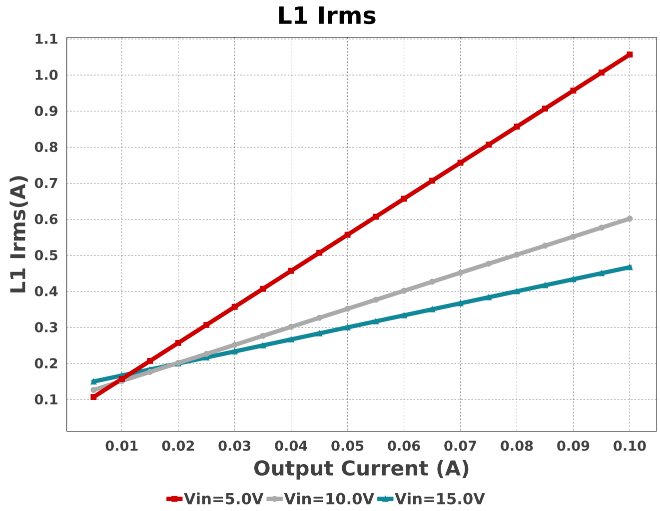

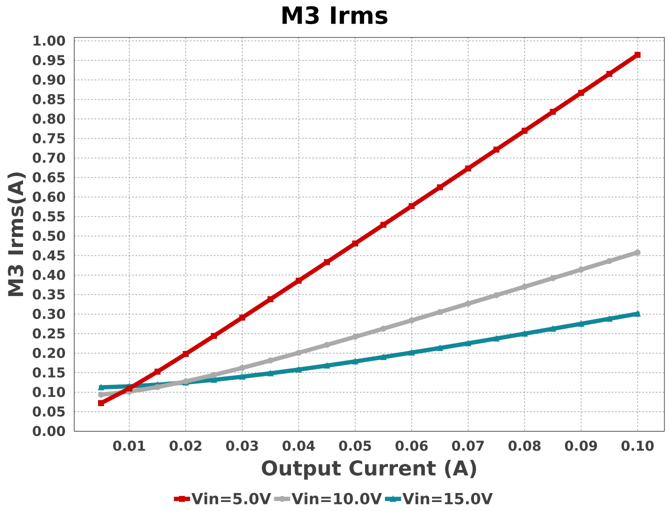

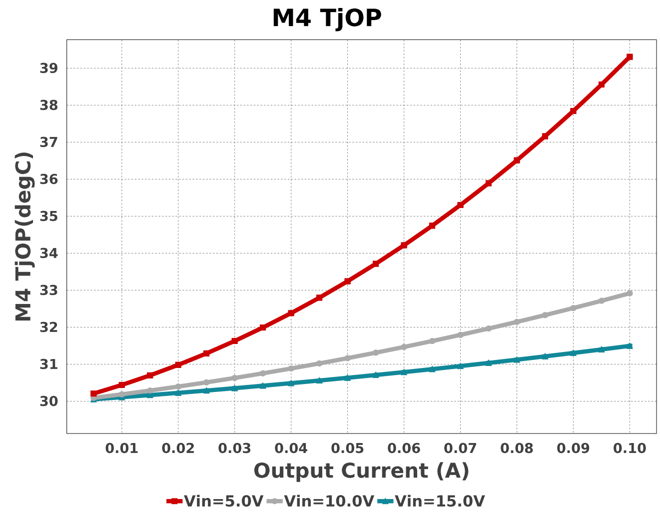

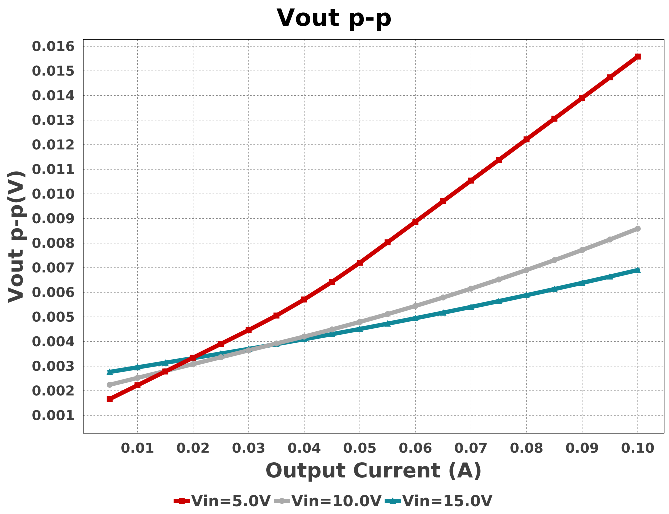

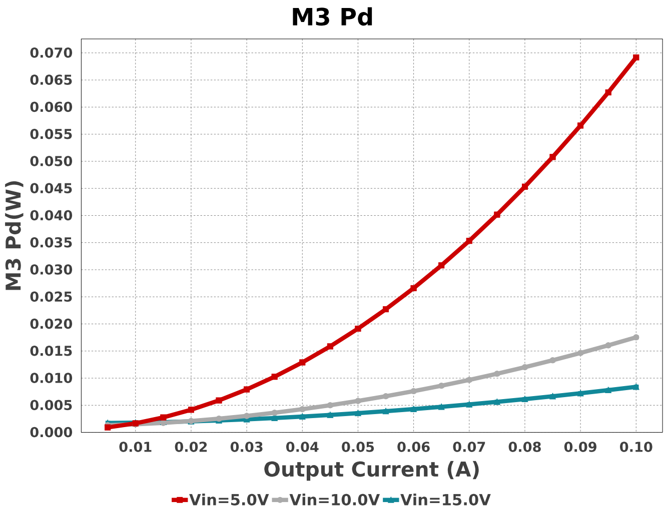

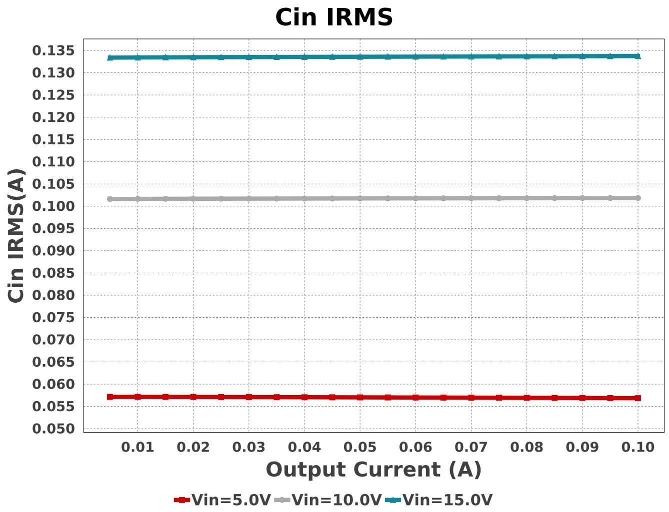

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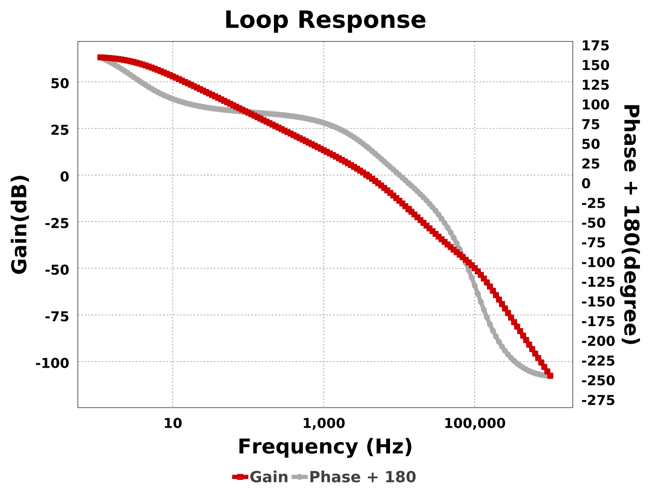

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	171.33 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	10.567 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	80.133 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	160.53 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	99.457 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	3.297 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	185.14 mW	IC	IC power dissipation
10.	IC Tj	35.647 degC	IC	IC junction temperature
11.	IC Tolerance	12.0 mV	IC	IC Feedback Tolerance
12.	ICThetaJA	30.5 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	1.181 A	IC	Average input current
14.	L Ipp	593.51 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	439.04 mW	Inductor	Inductor power dissipation
16.	L1 Irms	1.171 A	Inductor	Inductor ripple current
17.	M1 Pd	39.788 mW	Mosfet	M1 MOSFET total power dissipation
18.	M1 PdCond	39.788 mW	Mosfet	M1 MOSFET conduction losses
19.	M2 Pd	0.0 W	Mosfet	M2 MOSFET total power dissipation
20.	M3 Irms	1.084 A	Mosfet	MOSFET RMS ripple current
21.	M3 Pd	86.287 mW	Mosfet	MOSFET power dissipation
22.	M3 PdCond	77.6 mW	Mosfet	M1 MOSFET conduction losses
23.	M3 PdSw	8.687 mW	Mosfet	M1 MOSFET switching losses
24.	M3 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
25.	M3 TjOP	100.84 degC	Mosfet	MOSFET junction temperature
26.	M4 Irms	118.301 mA	Mosfet	MOSFET RMS ripple current
27.	M4 Pd	25.895 mW	Mosfet	MOSFET power dissipation
28.	M4 PdCond	924.8 µW	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	39.307 degC	Mosfet	MOSFET junction temperature
32.	M4 TjOP	39.307 degC	Mosfet	M4 MOSFET junction temperature
33.	Cin Pd	10.567 mW	Power	Input capacitor power dissipation
34.	Cout Pd	160.53 µW	Power	Output capacitor power dissipation
35.	Coutx Pd	3.297 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	185.14 mW	Power	IC power dissipation
39.	L Pd	439.04 mW	Power	Inductor power dissipation
40.	M1 Pd	39.788 mW	Power	M1 MOSFET total power dissipation
41.	M1 PdCond	39.788 mW	Power	M1 MOSFET conduction losses
42.	M2 Pd	0.0 W	Power	M2 MOSFET total power dissipation
43.	M3 Pd	86.287 mW	Power	MOSFET power dissipation
44.	M3 PdCond	77.6 mW	Power	M1 MOSFET conduction losses
45.	M3 PdSw	8.687 mW	Power	M1 MOSFET switching losses
46.	M3 Rdson	66.08 mOhm	Power	Drain-Source On-resistance
47.	M4 Pd	25.895 mW	Power	MOSFET power dissipation
48.	M4 PdCond	924.8 µW	Power	M2 MOSFET conduction losses
49.	M4 PdSw	0.0 W	Power	M2 MOSFET switching losses
50.	M4 Rdson	66.08 mOhm	Power	Drain-Source On-resistance
51.	Rsense Pd	117.43 mW	Power	LED Current Rsns Power Dissipation
52.	Total Pd	904.333 mW	Power	Total Power Dissipation

#	Name	Value	Category	Description
53.	Rsense Pd	117.43 mW	Resistor	LED Current Rsns Power Dissipation
54.	BOM Count	46	System Information	Total Design BOM count
55.	Cross Freq	3.721 kHz	System Information	Bode plot crossover frequency
56.	Duty Cycle	70.137 %	System Information	Duty cycle
57.	Efficiency	84.684 %	System Information	Steady state efficiency
58.	FootPrint	1.277 k mm^2	System Information	Total Foot Print Area of BOM components
59.	Frequency	227.0 kHz	System Information	Switching frequency
60.	Gain Marg	-18.42 dB	System Information	Bode Plot Gain Margin
61.	Iout	100.0 mA	System Information	Iout operating point
62.	Low Freq Gain	63.117 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	46.602 deg	System Information	Bode Plot Phase Margin
66.	Pout	5.0 W	System Information	Total output power
67.	SW Ipk	631.618 mA	System Information	Peak switch current
68.	Total BOM	NA	System Information	Total BOM Cost
69.	Vin	5.0 V	System Information	Vin operating point
70.	Vout	50.0 V	System Information	Operational Output Voltage
71.	Vout Actual	50.4 V	System Information	Vout Actual calculated based on selected voltage divider resistors
72.	Vout Tolerance	3.518 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
73.	Vout p-p	7.427 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	100.0 m	Maximum Output Current
SoftStart	3.0 ms	Soft Start Time (ms)
VinMax	15.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	50.0	Output Voltage
base_pn	LM5175	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	161.447 k	Customer Selected Frequency

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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

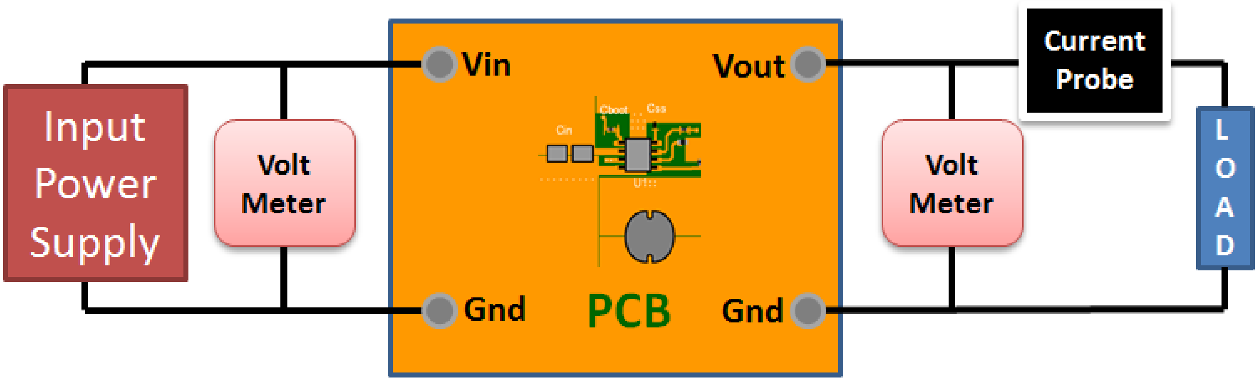
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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 : 197FC7C18B979790[v1]
4. **LM5175** Product Folder : http://www.ti.com/product/LM5175 : contains the data sheet and other resources.

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