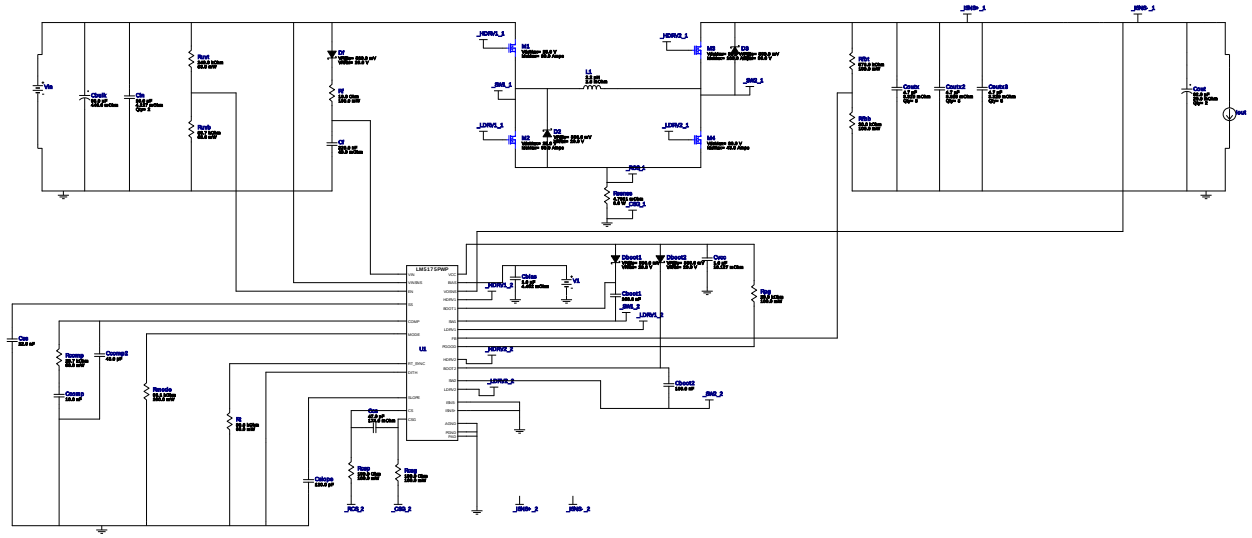
WEBENCH® Design Report

VinMin = 5.0V
VinMax = 12.0V
Vout = 24.0V
Iout = 4.0A

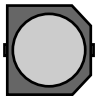
Device = LM5175PWPR
Topology = Buck_Boost
Created = 7/19/16 4:11:32 AM
BOM Cost = $0.00
BOM Count = 53
Total Pd = 8.33W

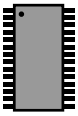
Design : 4077713/20 LM5175PWPR
LM5175PWPR 5.0V-12.0V to 24.00V @ 4.0A

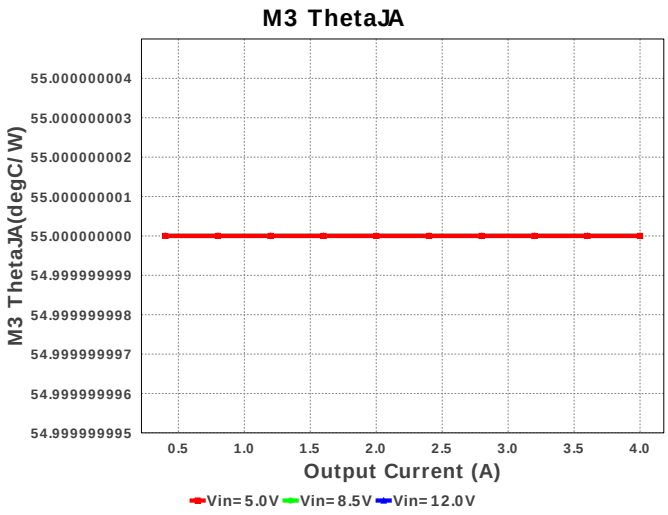


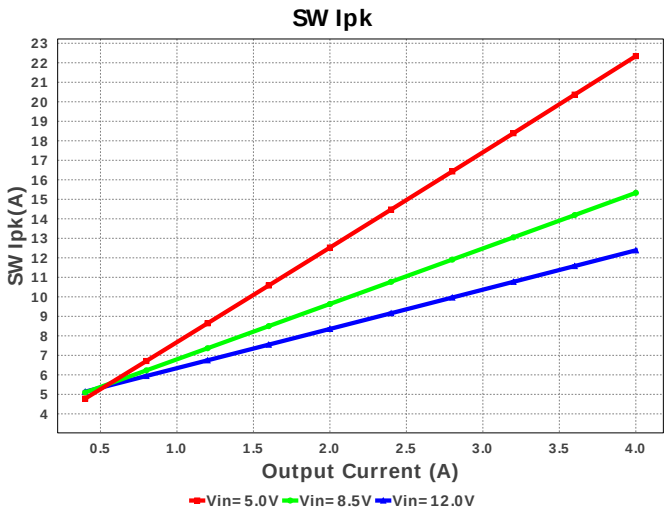
Electrical BOM

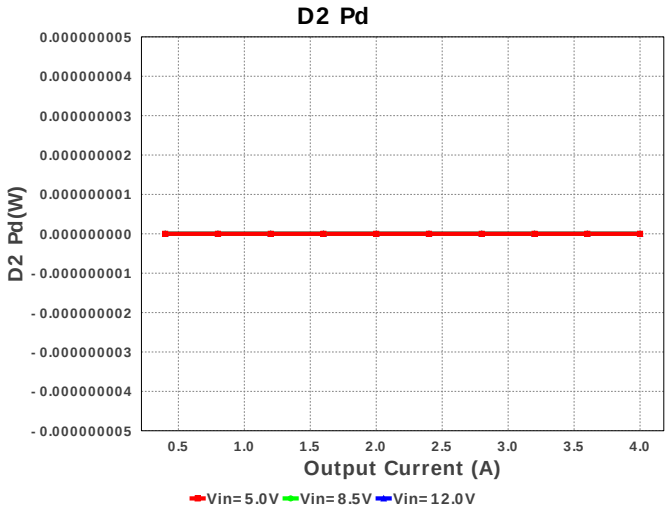
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbias	MuRata	GRM21BR71H105KA12L Series= X7R	Cap= 1.0 uF ESR= 4.402 mOhm VDC= 50.0 V IRMS= 1.677 A	1	$0.05	0805 7 mm²
2.	Cboot1	Kemet	C0603C104K3RACTU Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
3.	Cboot2	Kemet	C0603C104K3RACTU Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
4.	Cbulk	Nichicon	UUD1C680MCL1GS Series= uD	Cap= 68.0 uF ESR= 440.0 mOhm VDC= 16.0 V IRMS= 230.0 mA	1	$0.11	SM_RADIAL_6.3AMM 80 mm²
5.	Ccomp	MuRata	GRM216R71H103KA01D Series= X7R	Cap= 10.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
6.	Ccomp2	Samsung Electro-Mechanics	CL21C430JBANNNC Series= C0G/NP0	Cap= 43.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
7.	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 mm²
8.	Cf	Kemet	C0805C224K5RACTU Series= X7R	Cap= 220.0 nF ESR= 46.0 mOhm VDC= 50.0 V IRMS= 2.65 A	1	$0.02	0805 7 mm²
9.	Cin	MuRata	GRM21BR61C106KE15L Series= X5R	Cap= 10.0 uF ESR= 4.127 mOhm VDC= 16.0 V IRMS= 2.46634 A	2	$0.03	0805 7 mm²

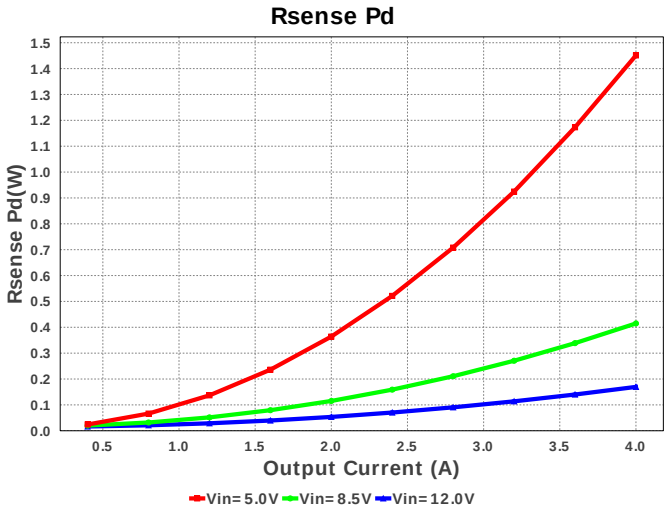
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Cout	Panasonic	35SVPF82M Series= ?	Cap= 82.0 uF ESR= 20.0 mOhm VDC= 35.0 V IRMS= 4.0 A	2	$0.61	 CAPSMT_62_E12 106 mm^2
11.	Coutx	TDK	C3225X6S1H475K Series= X6S	Cap= 4.7 uF ESR= 3.329 mOhm VDC= 50.0 V IRMS= 0.0 A	5	$0.19	 1210 15 mm^2
12.	Coutx2	TDK	C3225X6S1H475K Series= X6S	Cap= 4.7 uF ESR= 3.329 mOhm VDC= 50.0 V IRMS= 0.0 A	5	$0.19	 1210 15 mm^2
13.	Coutx3	TDK	C3225X6S1H475K Series= X6S	Cap= 4.7 uF ESR= 3.329 mOhm VDC= 50.0 V IRMS= 0.0 A	5	$0.19	 1210 15 mm^2
14.	Cslope	Yageo America	CC0603JRNPO9BN121 Series= C0G/NP0	Cap= 120.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0603 5 mm^2
15.	Css	Kemet	C0603C223K3RACTU Series= X7R	Cap= 22.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0603 5 mm^2
16.	Cvcc	MuRata	GRM188R61C105KA93D Series= X5R	Cap= 1.0 uF ESR= 10.127 mOhm VDC= 16.0 V IRMS= 994.63 mA	1	$0.01	 0603 5 mm^2
17.	D2	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMB 44 mm^2
18.	D3	Diodes Inc.	B230A-13-F	VF@Io= 500.0 mV VRRM= 30.0 V	1	$0.09	 SMA 37 mm^2
19.	Dboot1	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMB 44 mm^2
20.	Dboot2	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMB 44 mm^2
21.	Df	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMB 44 mm^2
22.	L1	Coilcraft	XAL1010-222MEB	L= 2.2 µH DCR= 2.6 mOhm	1	$1.71	 XAL1010 160 mm^2
23.	M1	Texas Instruments	CSD16323Q3	VdsMax= 25.0 V IdsMax= 60.0 Amps	1	$0.44	 TRANS_NexFET_Q3 18 mm^2
24.	M2	Texas Instruments	CSD16409Q3	VdsMax= 25.0 V IdsMax= 60.0 Amps	1	$0.37	 TRANS_NexFET_Q3 18 mm^2
25.	M3	Texas Instruments	CSD17303Q5	VdsMax= 30.0 V IdsMax= 100.0 Amps	1	$0.73	 TRANS_NexFET_Q5 55 mm^2

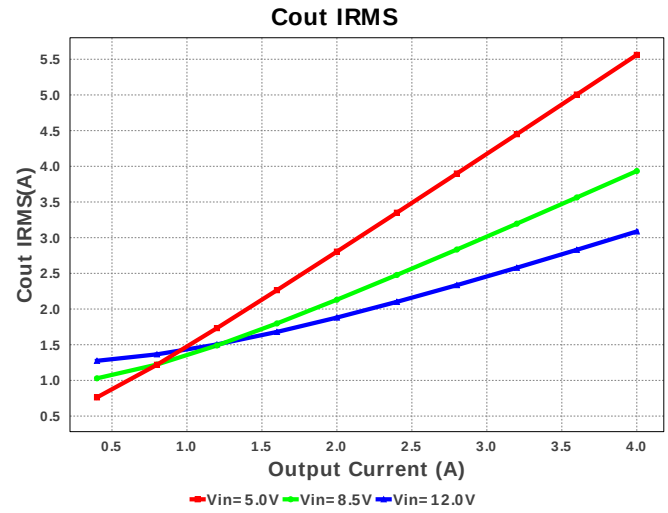
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	M4	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 43.0 Amps	1	$0.75	 TRANS_NexFET_Q5B 58 mm²
27.	Rcomp	Vishay-Dale	CRCW040223K7FKED Series= CRCW..e3	Res= 23.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
28.	Rcsg	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
29.	Rcsp	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
30.	Rf	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
31.	Rfbb	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
32.	Rfbt	Vishay-Dale	CRCW0603576KFKEA Series= CRCW..e3	Res= 576.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
33.	Rmode	Vishay-Dale	CRCW060393K1FKEA Series= CRCW..e3	Res= 93.1 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
34.	Rpg	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
35.	Rsense	CUSTOM	CUSTOM Series= ?	Res= 4.7611 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
36.	Rt	Vishay-Dale	CRCW040280K6FKED Series= CRCW..e3	Res= 80.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
37.	Ruvb	Vishay-Dale	CRCW040288K7FKED Series= CRCW..e3	Res= 88.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
38.	Ruvt	Vishay-Dale	CRCW0402249KFKED Series= CRCW..e3	Res= 249.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
39.	U1	Texas Instruments	LM5175PWPR	Switcher	1	$3.10	 PWP0028F_N 98 mm²

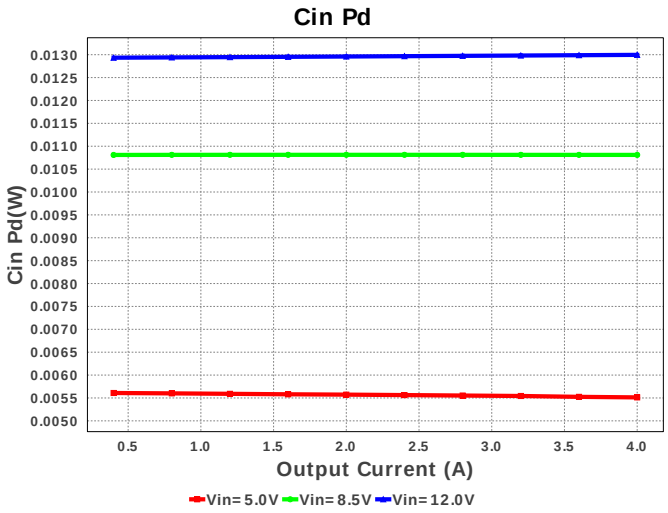


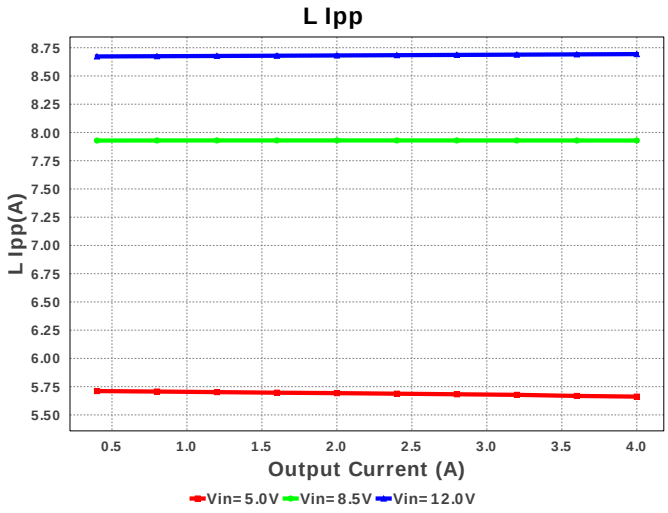


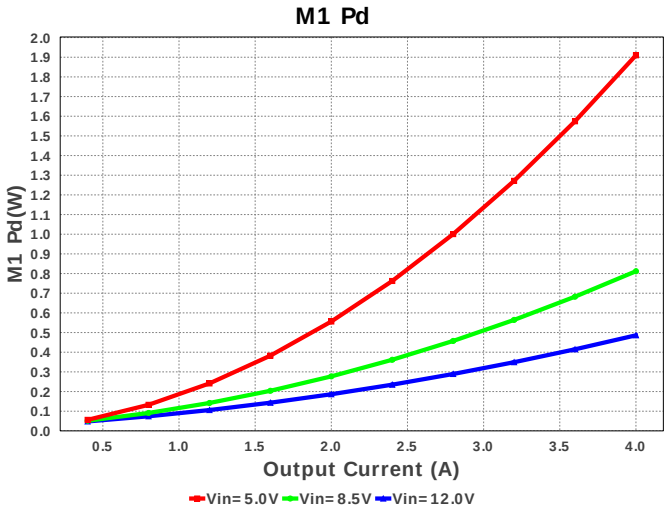


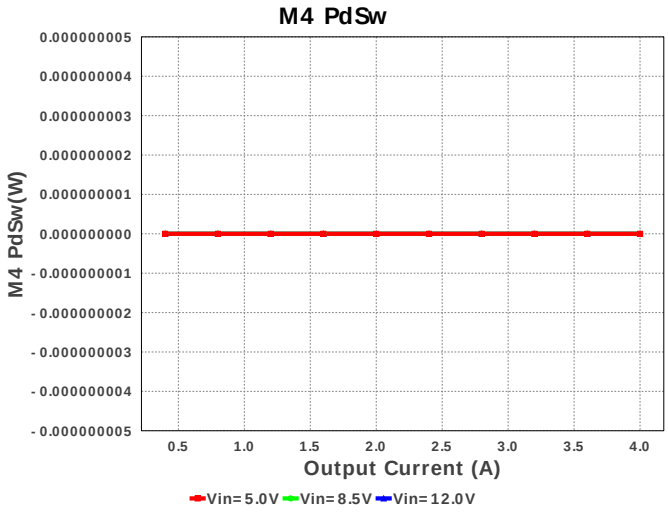


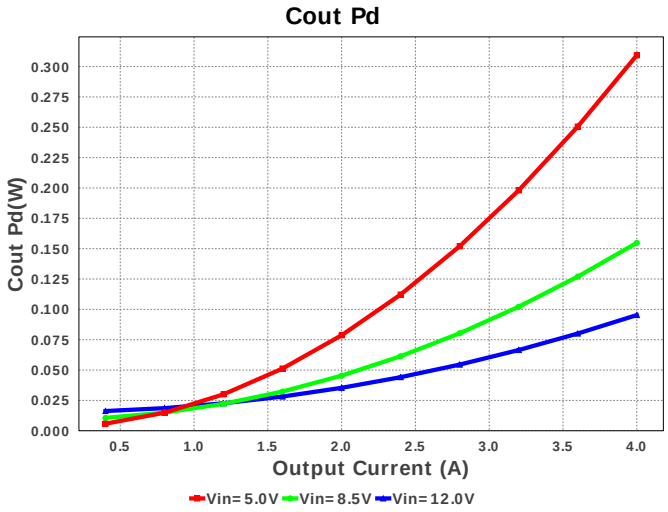


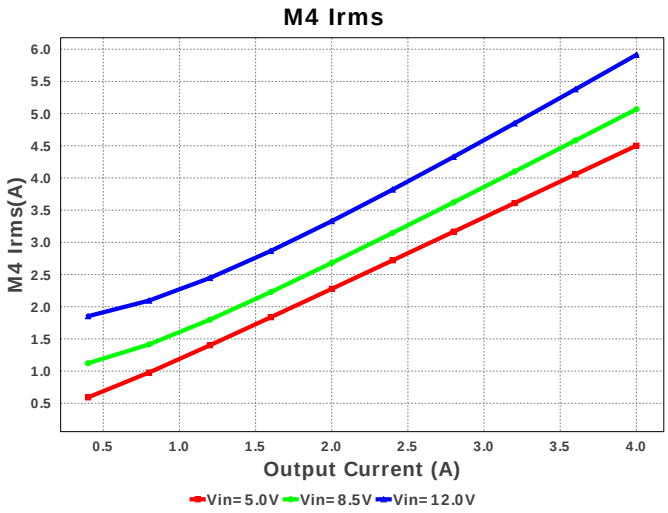


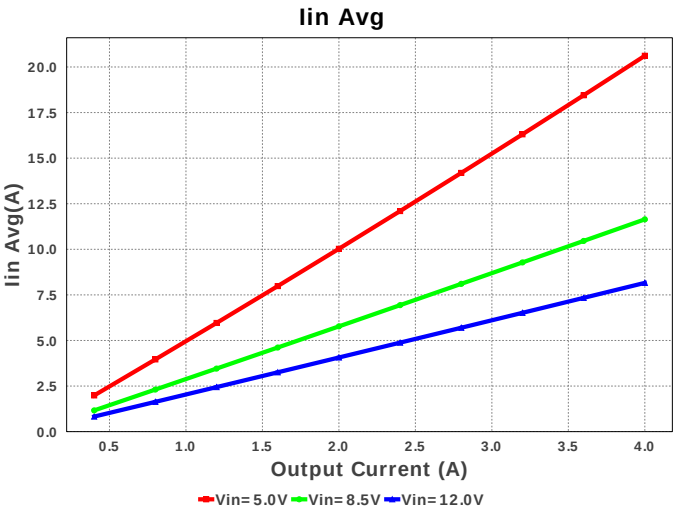


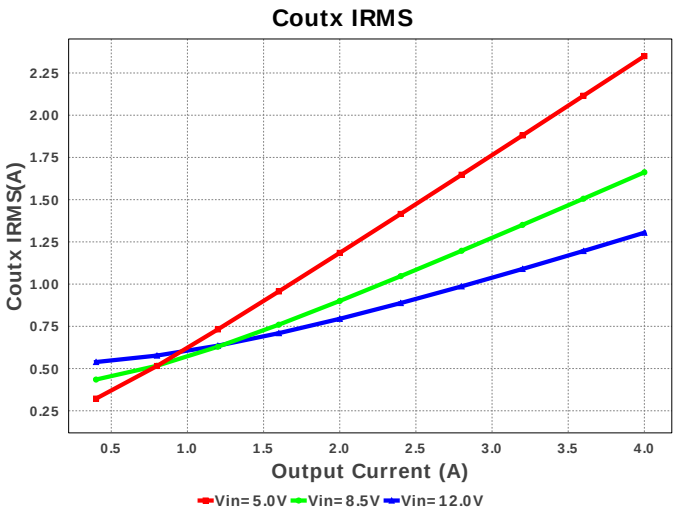


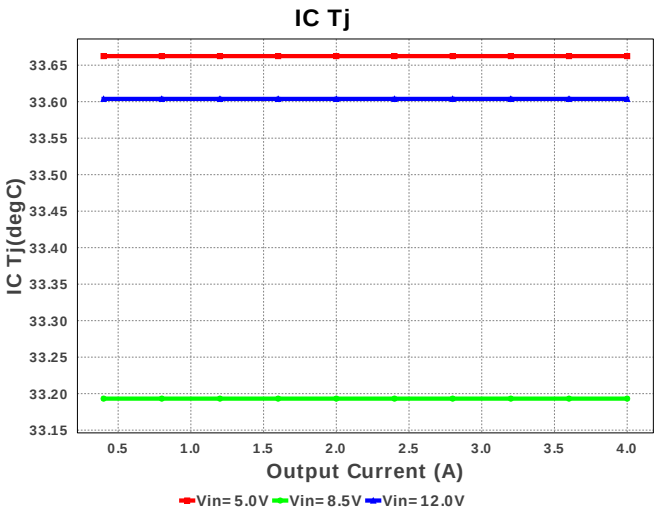


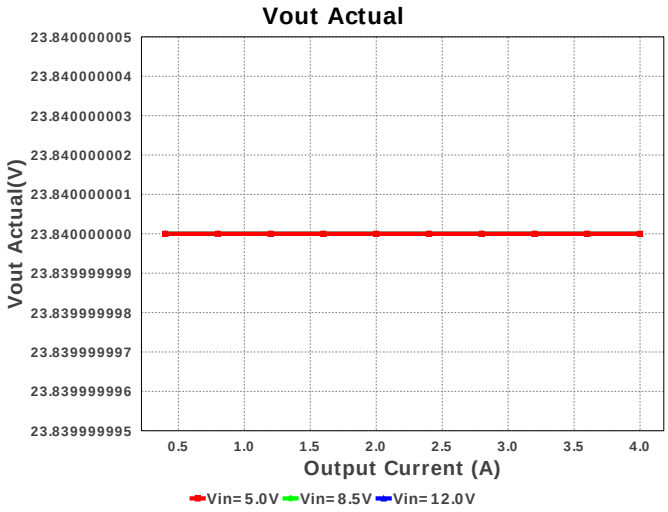


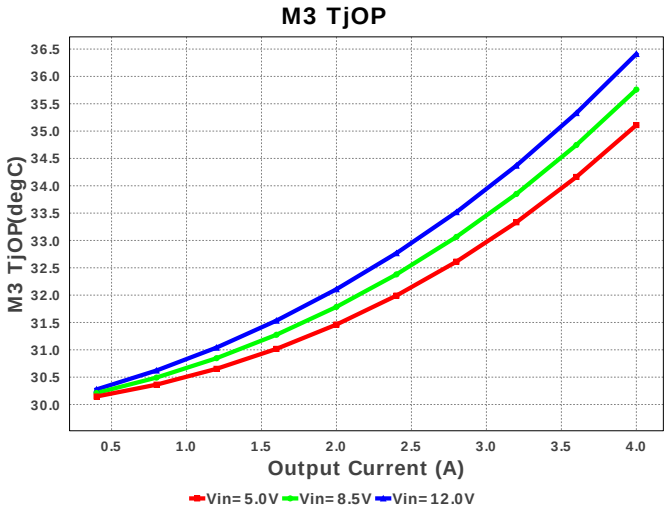


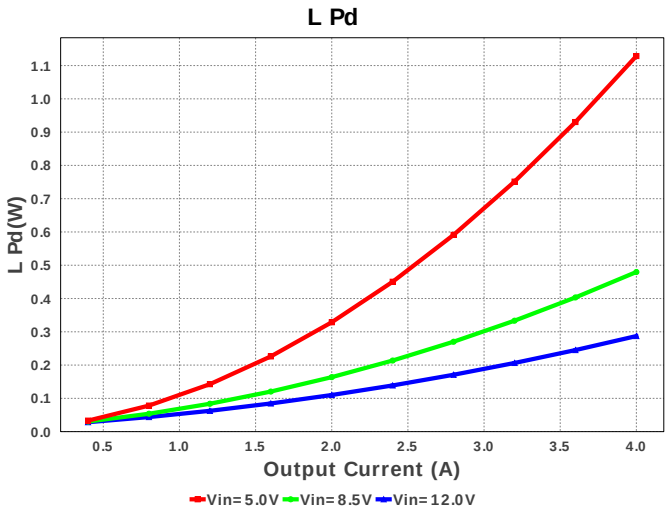


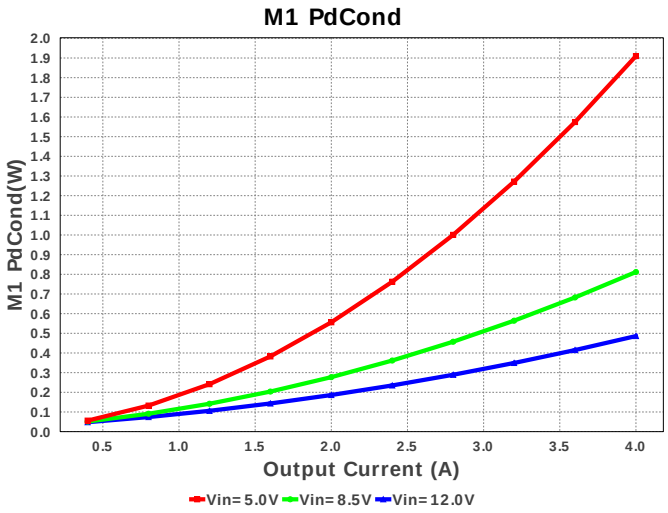


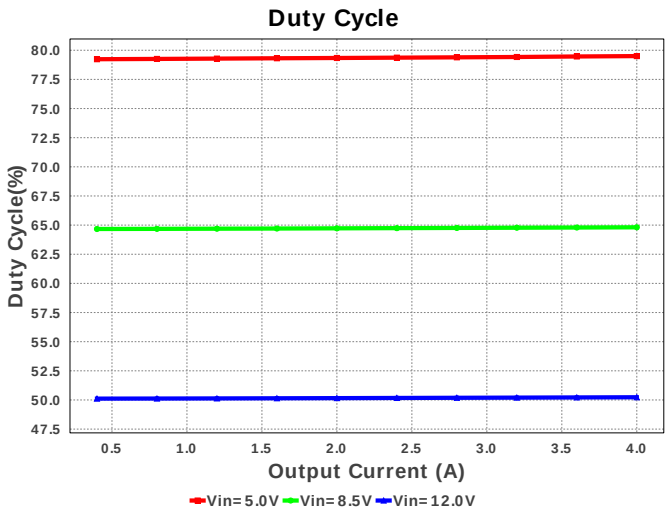


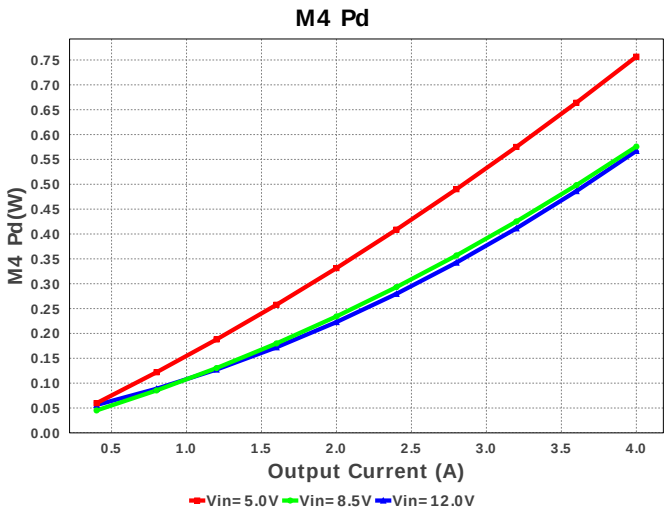


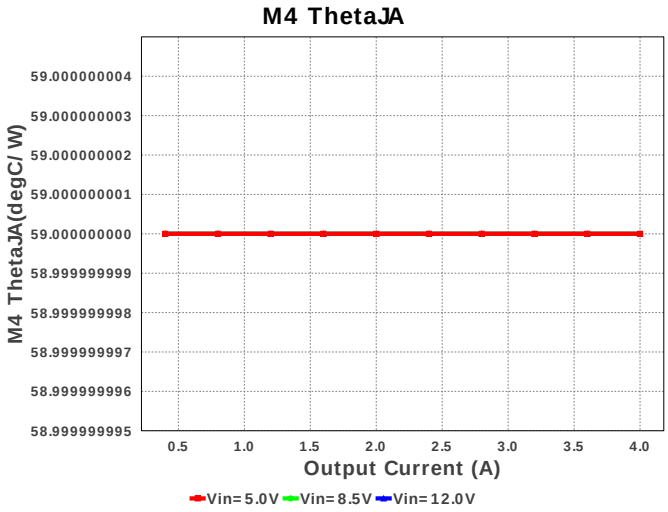


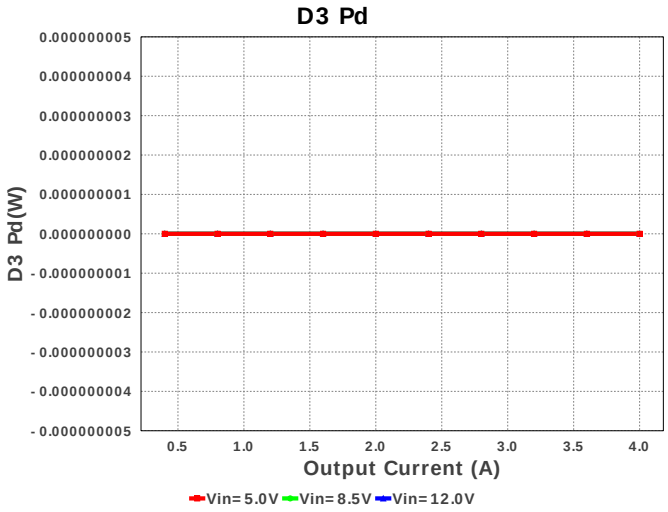


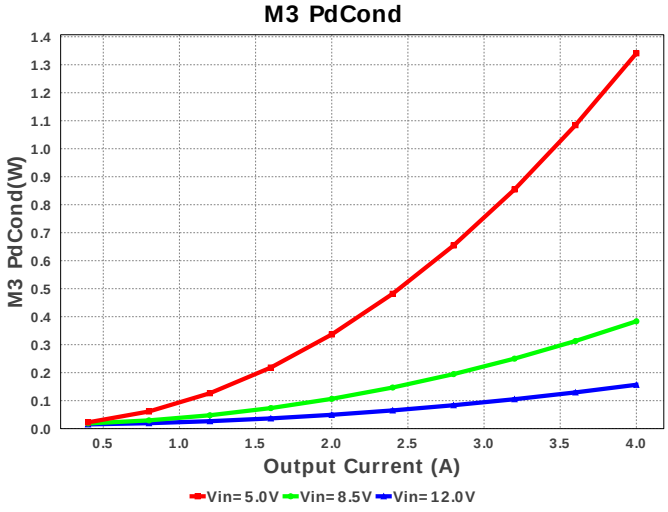


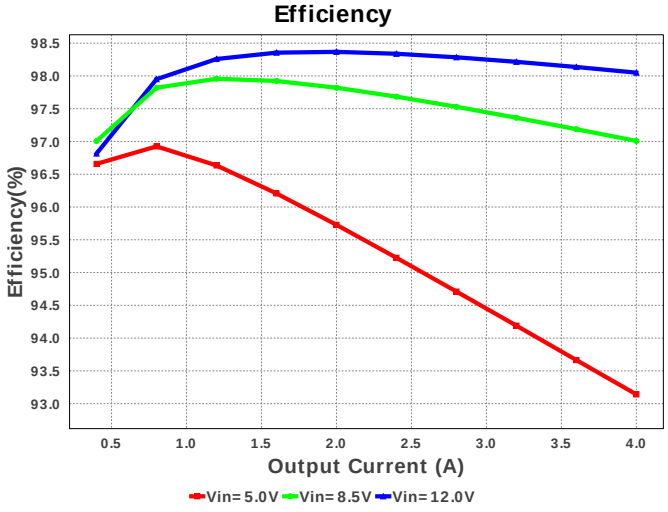


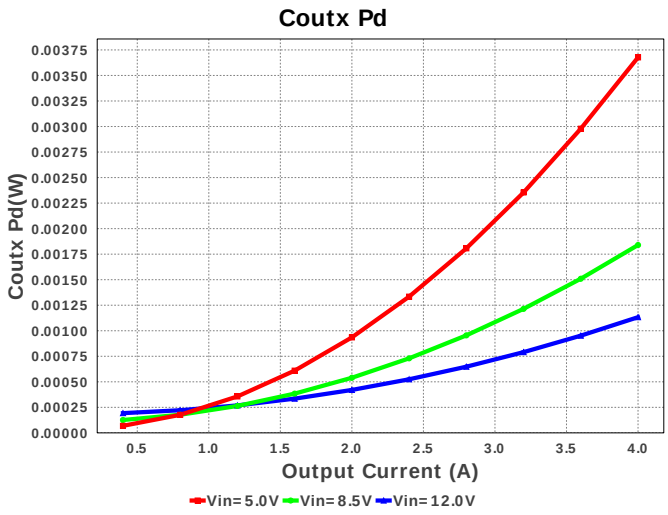


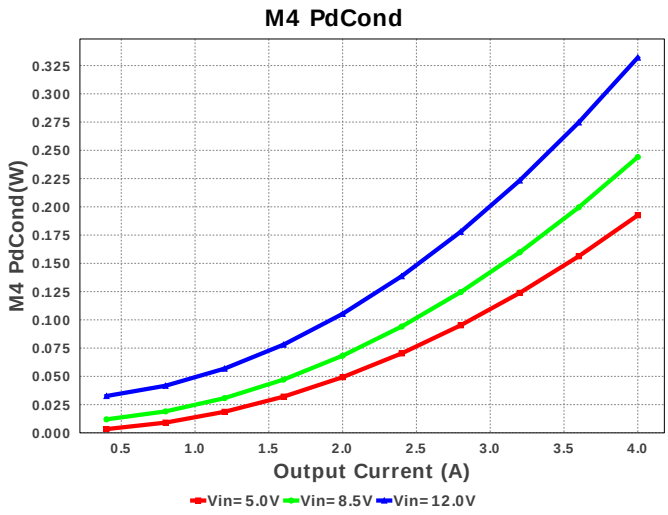


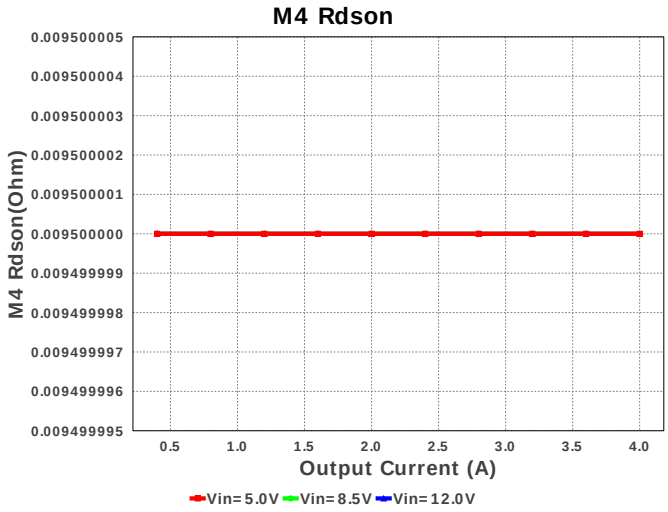


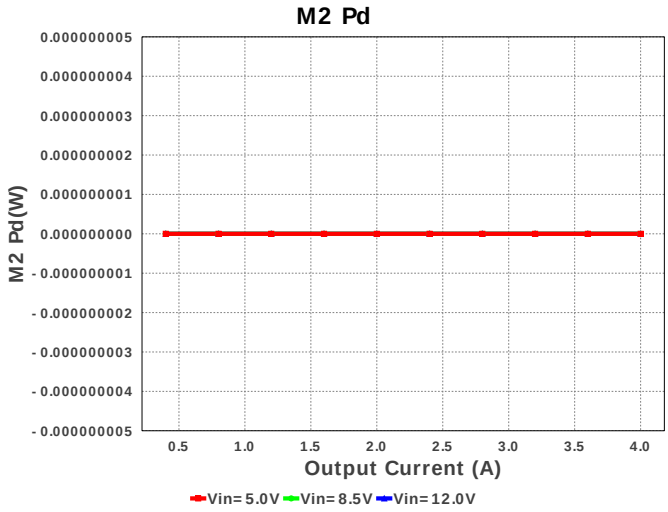


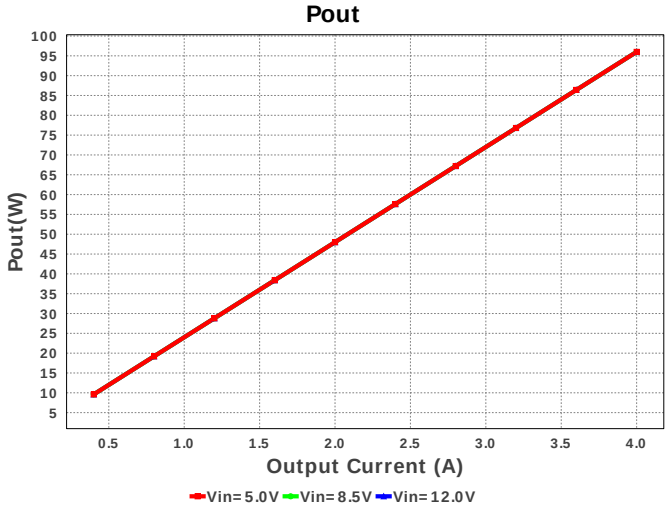


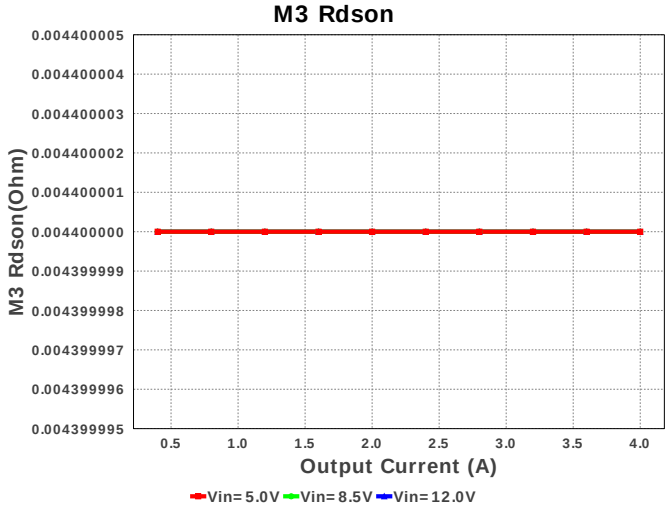


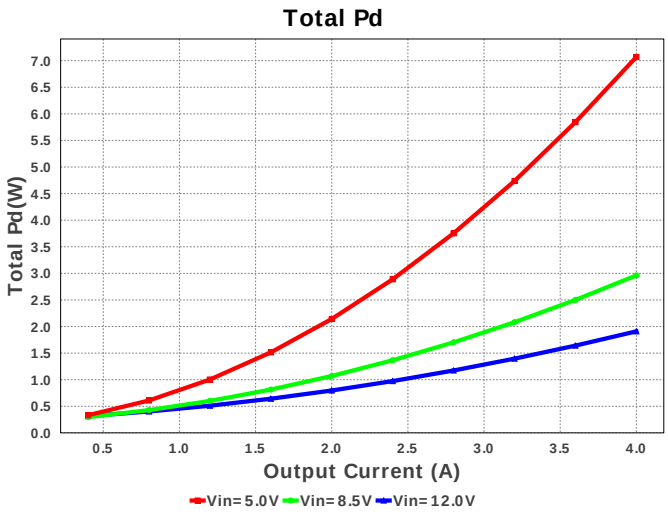


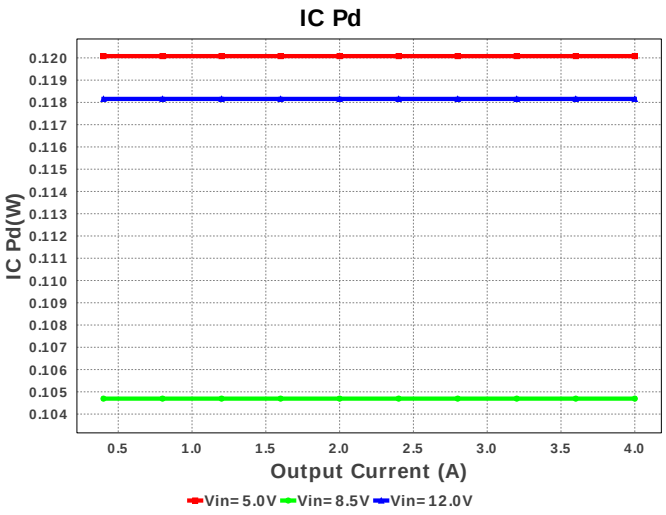


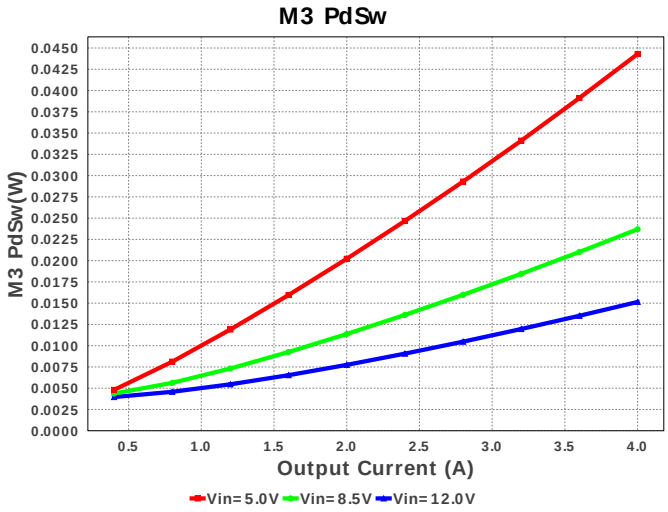


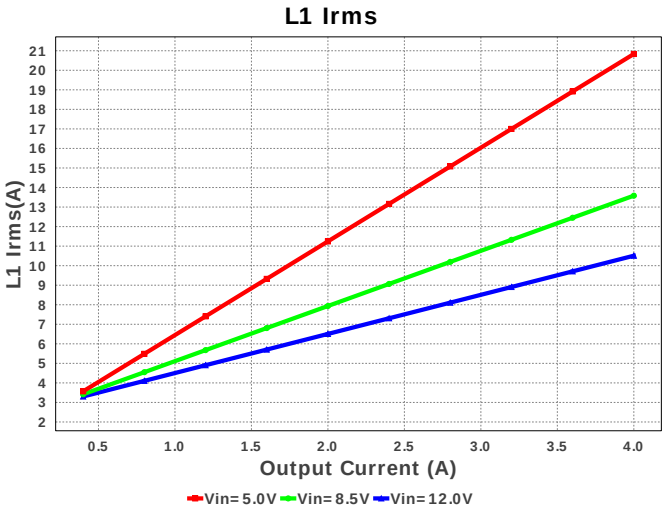


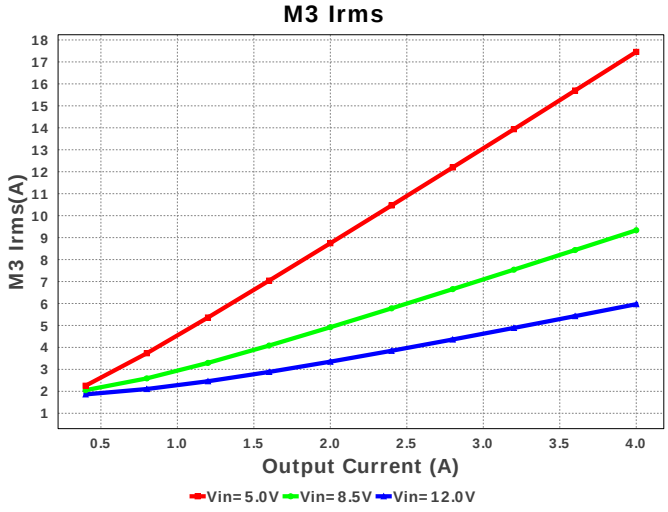


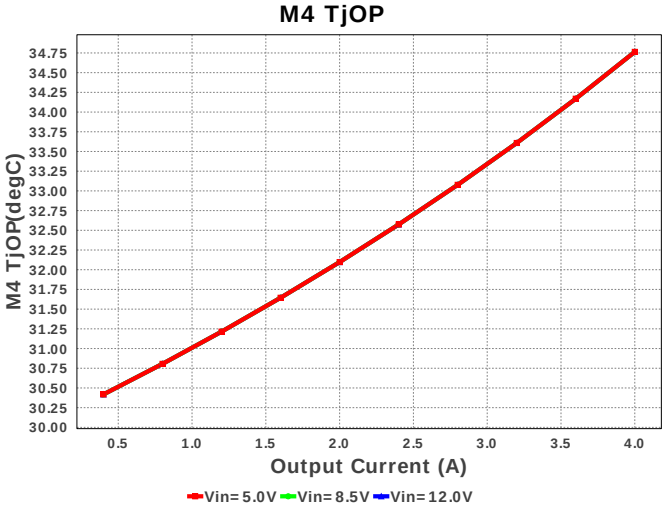


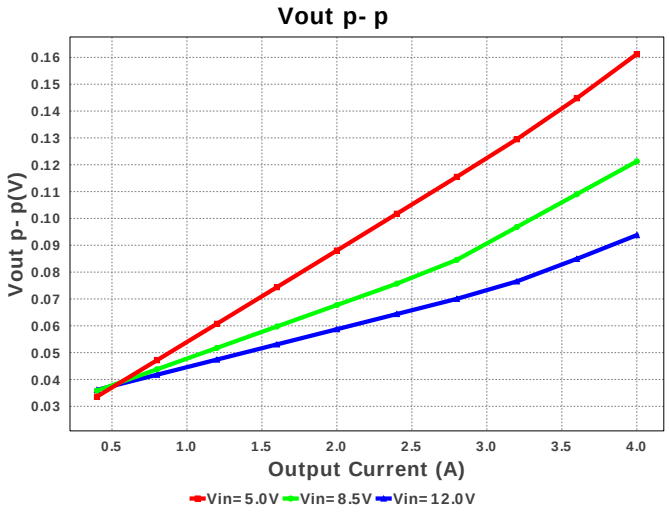


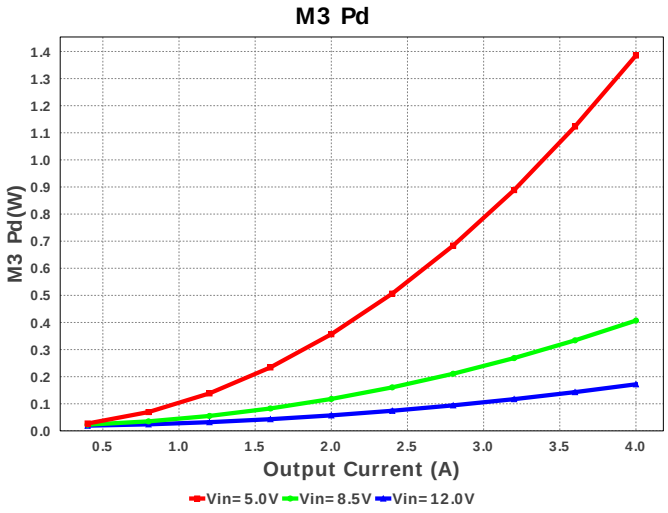


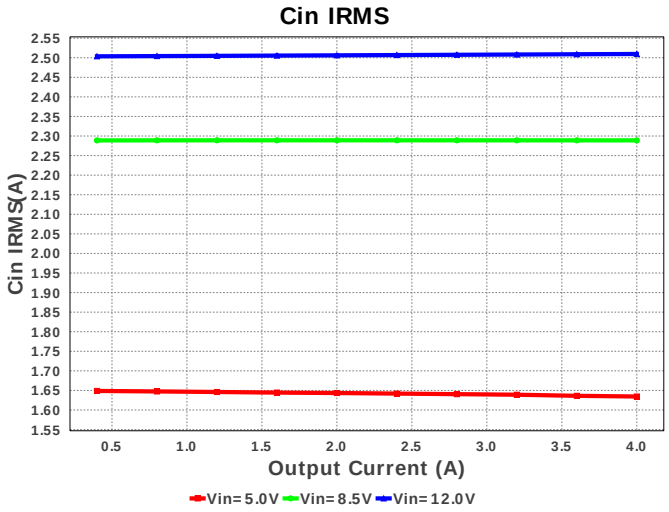


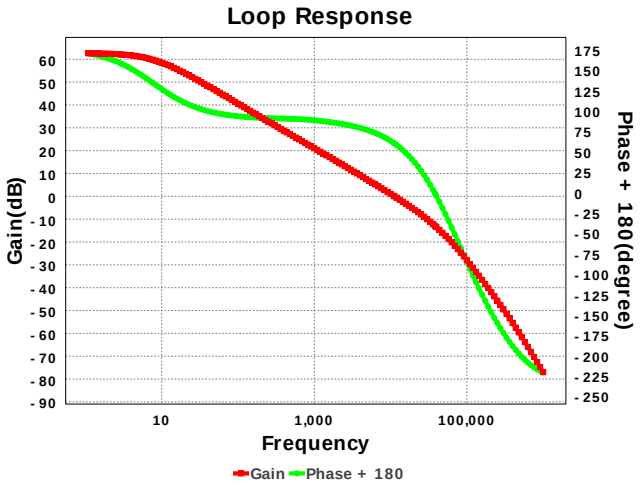












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.953 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	3.443 A	Current	Output capacitor RMS ripple current
3.	Coutx IRMS	1.455 A	Current	Output capacitor_x RMS ripple current
4.	Iin Avg	20.866 A	Current	Average input current
5.	L Ipp	13.694 A	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	23.153 A	Current	Inductor ripple current
7.	M3 Irms	19.418 A	Current	MOSFET RMS ripple current
8.	M4 Irms	4.996 A	Current	MOSFET RMS ripple current
9.	SW Ipk	14.903 A	Current	Peak switch current
10.	BOM Count	53	General	Total Design BOM count
11.	FootPrint	1.252 k mm^2	General	Total Foot Print Area of BOM components
12.	Frequency	314.248 kHz	General	Switching frequency
13.	IC Tolerance	0.0 V	General	IC Feedback Tolerance
14.	Pout	96.0 W	General	Total output power
15.	Total BOM	$0.0	General	Total BOM Cost
16.	Low Freq Gain	62.608 dB	Op_Point	Gain at 10Hz
17.	M3 TjOP	36.413 degC	Op_Point	MOSFET junction temperature
18.	M4 TjOP	35.588 degC	Op_Point	MOSFET junction temperature
19.	Vout Actual	23.84 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
20.	Vout OP	24.0 V	Op_Point	Operational Output Voltage
21.	Cross Freq	11.24 kHz	Op_point	Bode plot crossover frequency
22.	Duty Cycle	50.351 %	Op_point	Duty cycle
23.	Efficiency	92.018 %	Op_point	Steady state efficiency
24.	Gain Marg	-12.974 dB	Op_point	Bode Plot Gain Margin
25.	IC Tj	33.604 degC	Op_point	IC junction temperature
26.	ICThetaJA	30.5 degC/W	Op_point	IC junction-to-ambient thermal resistance
27.	IOUT_OP	4.0 A	Op_point	Iout operating point
28.	Phase Marg	61.528 deg	Op_point	Bode Plot Phase Margin
29.	VIN_OP	5.0 V	Op_point	Vin operating point
30.	Vout p-p	104.766 mV	Op_point	Peak-to-peak output ripple voltage
31.	Cin Pd	32.245 mW	Power	Input capacitor power dissipation

#	Name	Value	Category	Description
32.	Cout Pd	118.522 mW	Power	Output capacitor power dissipation
33.	Coutx Pd	1.409 mW	Power	Output capacitor_x power loss
34.	D2 Pd	0.0 W	Power	Diode power dissipation
35.	D3 Pd	0.0 W	Power	Diode power dissipation
36.	IC Pd	118.157 mW	Power	IC power dissipation
37.	L Pd	1.394 W	Power	Inductor power dissipation
38.	M1 Pd	2.359 W	Power	M1 MOSFET total power dissipation
39.	M1 PdCond	2.359 W	Power	M1 MOSFET conduction losses
40.	M2 Pd	0.0 W	Power	M2 MOSFET total power dissipation
41.	M3 Pd	1.708 W	Power	MOSFET power dissipation
42.	M3 PdCond	1.659 W	Power	M1 MOSFET conduction losses
43.	M3 PdSw	49.27 mW	Power	M1 MOSFET switching losses
44.	M3 Rdson	4.4 mOhm	Power	Drain-Source On-resistance
45.	M4 Pd	801.253 mW	Power	MOSFET power dissipation
46.	M4 PdCond	237.115 mW	Power	M2 MOSFET conduction losses
47.	M4 PdSw	0.0 W	Power	M2 MOSFET switching losses
48.	M4 Rdson	9.5 mOhm	Power	Drain-Source On-resistance
49.	Rsense Pd	1.795 W	Power	LED Current Rsns Power Dissipation
50.	Total Pd	8.328 W	Power	Total Power Dissipation
51.	M3 ThetaJA	55.0 degC/W		MOSFET junction-to-ambient thermal resistance
52.	M4 ThetaJA	59.0 degC/W		MOSFET junction-to-ambient thermal resistance
53.	Vout Tolerance	1.952 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	4.0	Maximum Output Current
2.	VinMax	12.0	Maximum input voltage
3.	VinMin	5.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	base_pn	LM5175	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

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