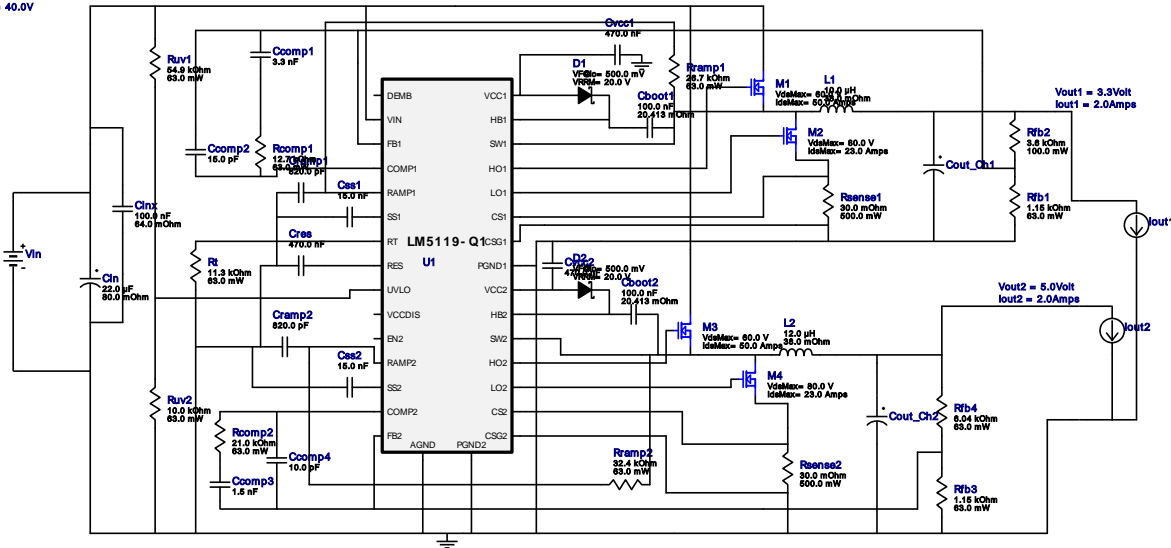


WEBENCH[®] Design Report

Design : 4387389/1 LM5119QPSQ/NOPB
 LM5119QPSQ/NOPB 10.0V-40.0V to 5.00V @ 2.0A














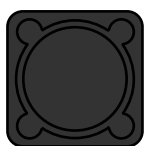



VinMin = 10.0V
 VinMax = 40.0V



1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer.

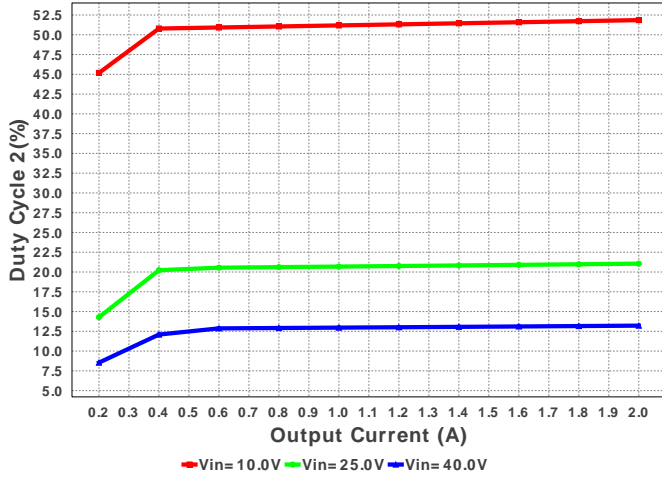
Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot1	TDK	C1005X5R1A104K Series= X5R	Cap= 100.0 nF ESR= 20.413 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
2.	Cboot2	TDK	C1005X5R1A104K Series= X5R	Cap= 100.0 nF ESR= 20.413 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
3.	Ccomp1	Yageo America	CC0805KRX7R9BB332 Series= X7R	Cap= 3.3 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
4.	Ccomp2	Yageo America	CC0805JRNPO9BN150 Series= C0G/NP0	Cap= 15.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
5.	Ccomp3	Yageo America	CC0805KRX7R9BB152 Series= X7R	Cap= 1.5 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
6.	Ccomp4	Kemet	C0805C100K5GACTU Series= C0G/NP0	Cap= 10.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
7.	Cin	Panasonic	EEHZA1J220XP Series= 1267	Cap= 22.0 uF ESR= 80.0 mOhm VDC= 63.0 V IRMS= 1.5 A	1	\$0.70	 SM_RADIAL_6.3BMM 80 mm ²

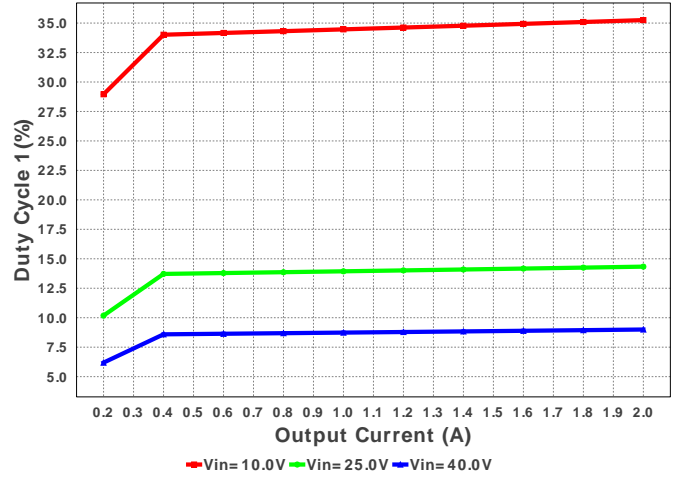
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Cinx	Kemet	C0805C104K5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	\$0.01	 0805 7 mm ²
9.	Cout1	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	2	\$0.05	 0805 7 mm ²
10.	Coutx2	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	2	\$0.05	 0805 7 mm ²
11.	Cramp1	Yageo America	CC0805KRX7R9BB821 Series= X7R	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
12.	Cramp2	Yageo America	CC0805KRX7R9BB821 Series= X7R	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
13.	Cres	MuRata	GRM155C80G474KE01D Series= 379	Cap= 470.0 nF VDC= 4.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
14.	Css1	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
15.	Css2	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
16.	Cvcc1	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
17.	Cvcc2	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
18.	D1	Vishay-Semiconductor	SS12-E3/61T	VF@Io= 500.0 mV VRRM= 20.0 V	1	\$0.08	 SMA 37 mm ²
19.	D2	Vishay-Semiconductor	SS12-E3/61T	VF@Io= 500.0 mV VRRM= 20.0 V	1	\$0.08	 SMA 37 mm ²
20.	L1	TDK	VLP8040T-100M	L= 10.0 uH DCR= 38.0 mOhm	1	\$0.22	 VLP8040 113 mm ²
21.	L2	Bourns	SRR1206-120ML	L= 12.0 uH DCR= 38.0 mOhm	1	\$0.37	 SRR1206 216 mm ²
22.	M1	Texas Instruments	CSD18537NQ5A	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	\$0.46	 TRANS_NexFET_Q5A 55 mm ²
23.	M2	Infineon Technologies	BSC340N08NS3 G	VdsMax= 80.0 V IdsMax= 23.0 Amps	1	\$0.26	 PG-TDSON-8 55 mm ²
24.	M3	Texas Instruments	CSD18537NQ5A	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	\$0.46	 TRANS_NexFET_Q5A 55 mm ²

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	M4	Infineon Technologies	BSC340N08NS3 G	VdsMax= 80.0 V IdsMax= 23.0 Amps	1	\$0.26	 PG-TDSON-8 55 mm ²
26.	Rcomp1	Vishay-Dale	CRCW040212K7FKED Series= CRCW..e3	Res= 12.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
27.	Rcomp2	Vishay-Dale	CRCW040221K0FKED Series= CRCW..e3	Res= 21.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
28.	Rfb1	Vishay-Dale	CRCW04021K15FKED Series= CRCW..e3	Res= 1.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
29.	Rfb2	Susumu Co Ltd	RR1220P-362-D Series= 264	Res= 3.6 kOhm Power= 100.0 mW Tolerance= 0.5%	1	\$0.01	 0805 7 mm ²
30.	Rfb3	Vishay-Dale	CRCW04021K15FKED Series= CRCW..e3	Res= 1.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
31.	Rfb4	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
32.	Rramp1	Vishay-Dale	CRCW040226K7FKED Series= CRCW..e3	Res= 26.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
33.	Rramp2	Vishay-Dale	CRCW040232K4FKED Series= CRCW..e3	Res= 32.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
34.	Rsense1	Stackpole Electronics Inc	CSR1206FK30L0 Series= ?	Res= 30.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	\$0.10	 1206 11 mm ²
35.	Rsense2	Stackpole Electronics Inc	CSR1206FK30L0 Series= ?	Res= 30.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	\$0.10	 1206 11 mm ²
36.	Rt	Vishay-Dale	CRCW040211K3FKED Series= CRCW..e3	Res= 11.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
37.	Ruv1	Vishay-Dale	CRCW040254K9FKED Series= CRCW..e3	Res= 54.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
38.	Ruv2	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
39.	U1	Texas Instruments	LM5119QPSQ/NOPB	Switcher	1	\$3.74	 SQA32A 49 mm ²

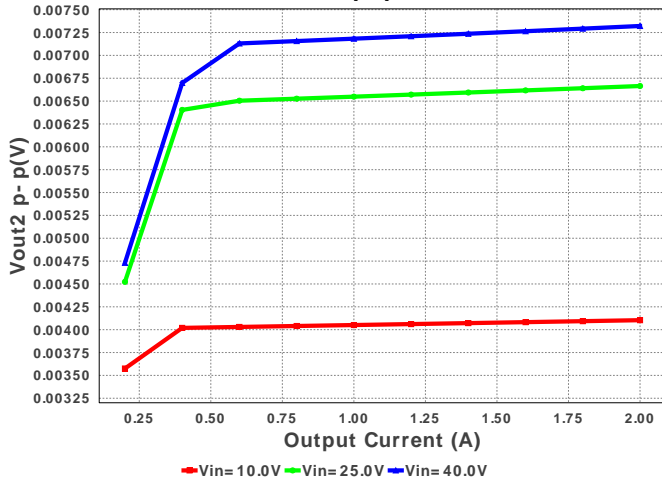
Duty Cycle 2



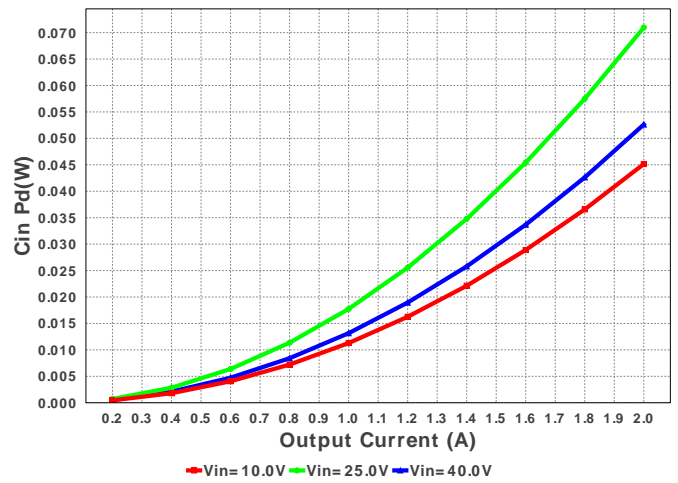
Duty Cycle 1



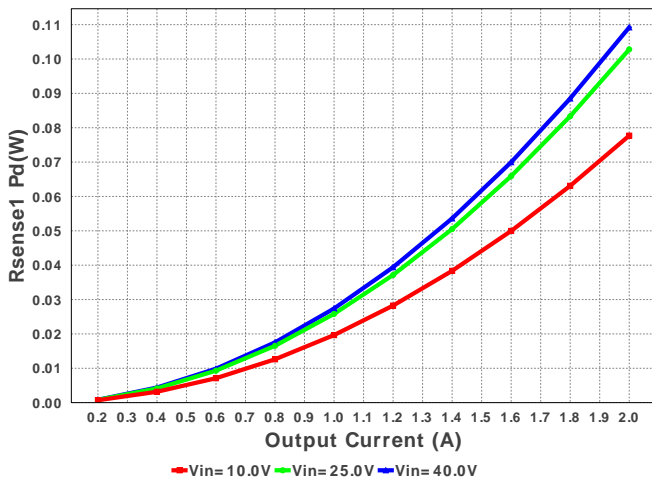
Vout2 p- p



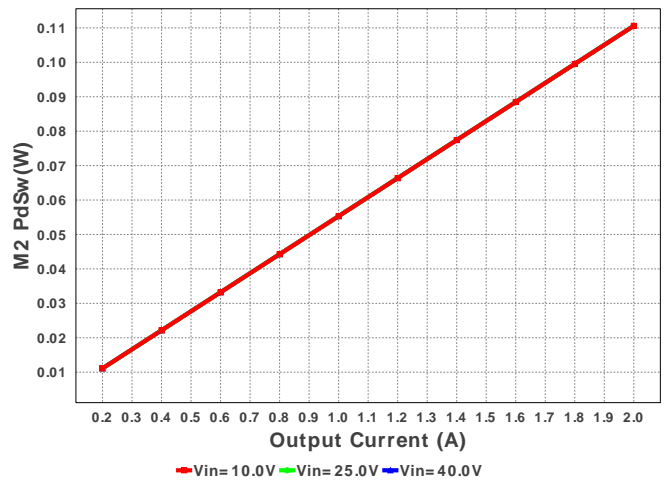
Cin Pd



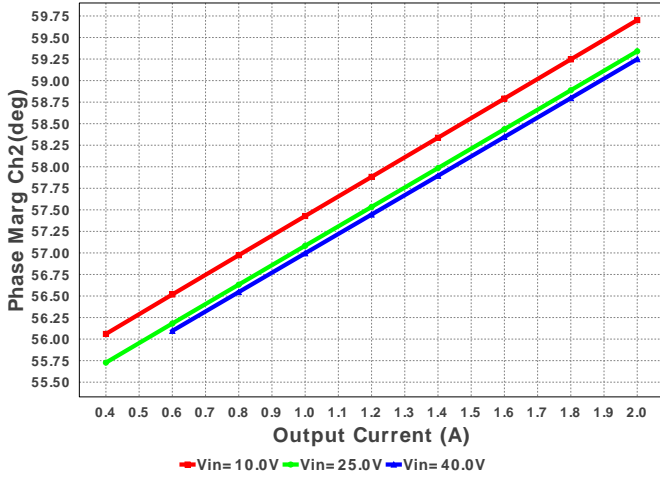
Rsense1 Pd



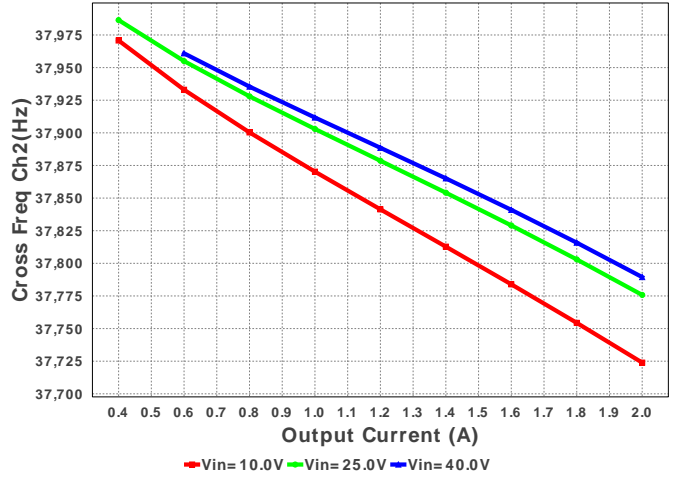
M2 PdSw



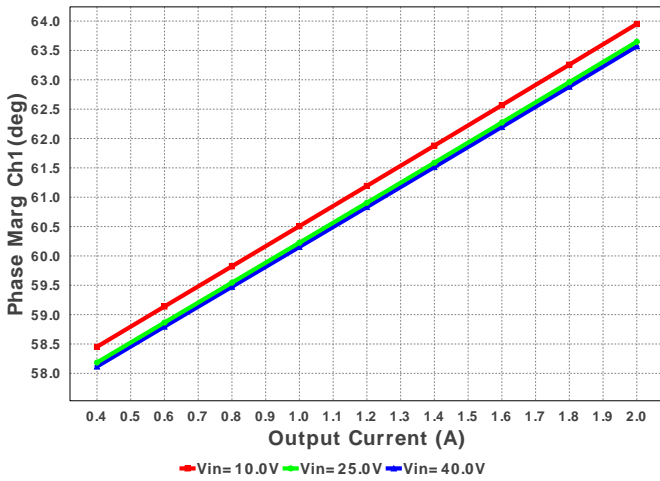
Phase Marg Ch2



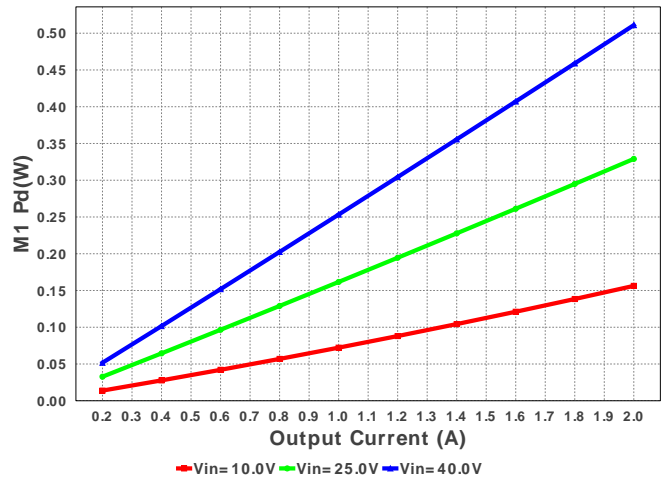
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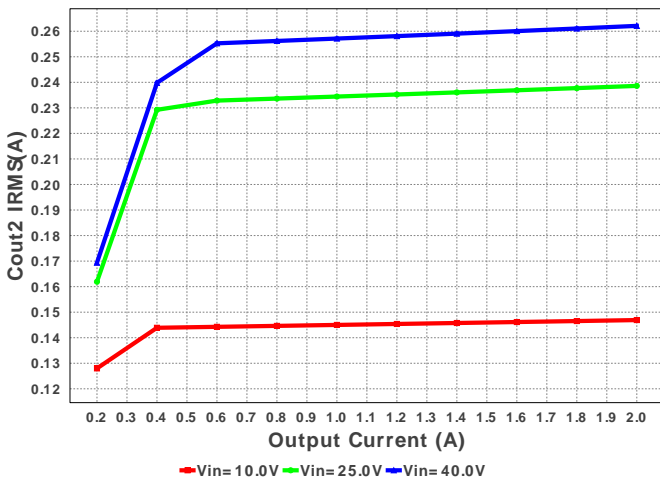
Phase Marg Ch1



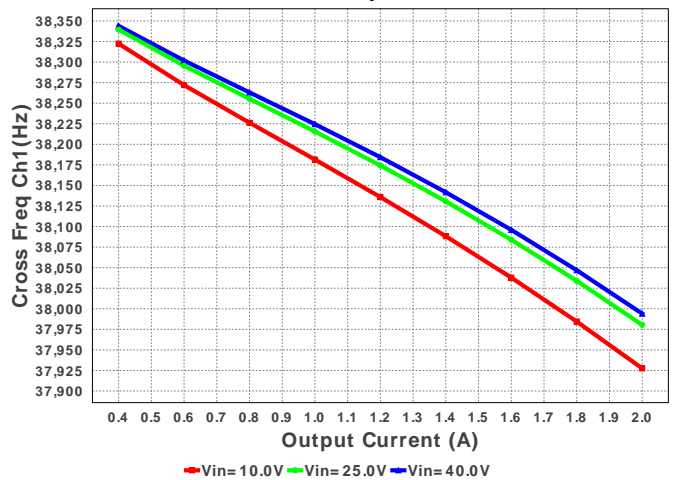
M1 Pd

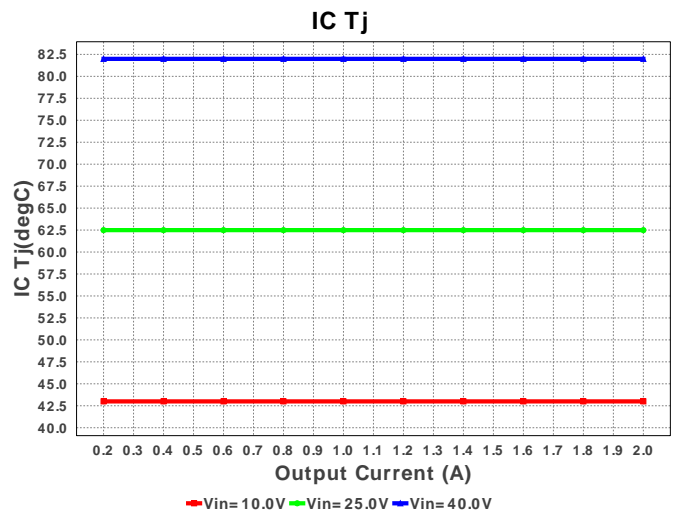
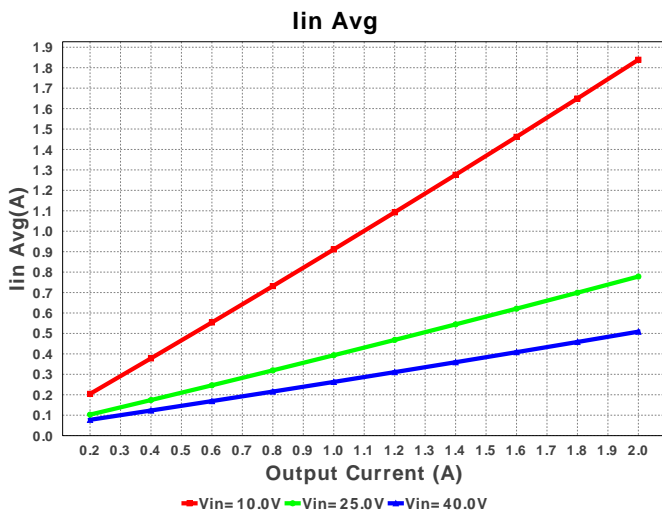
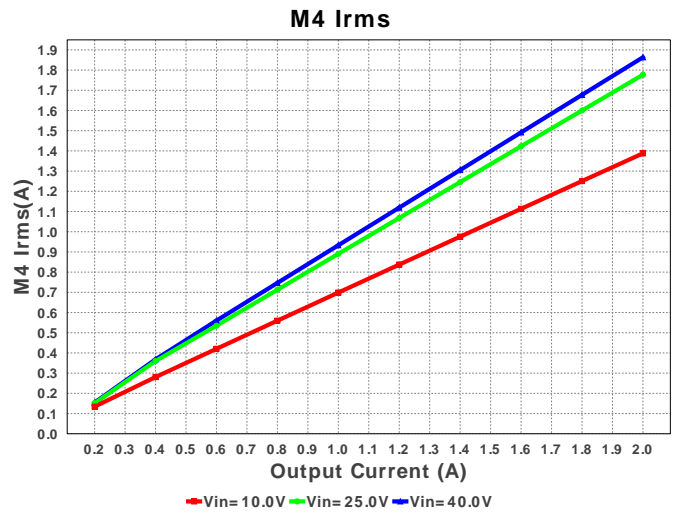
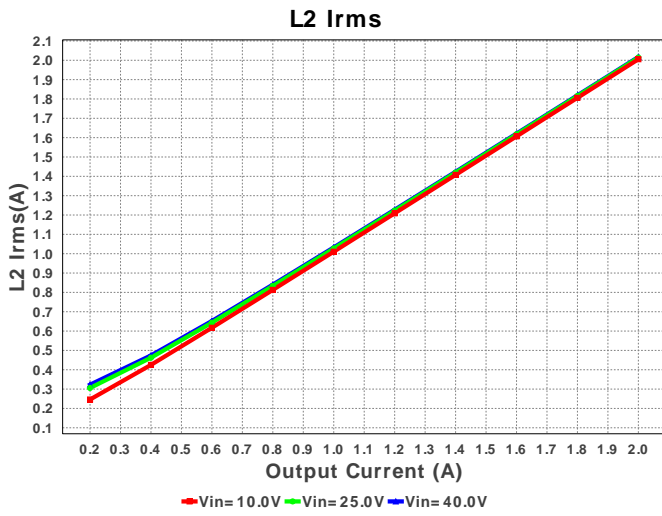
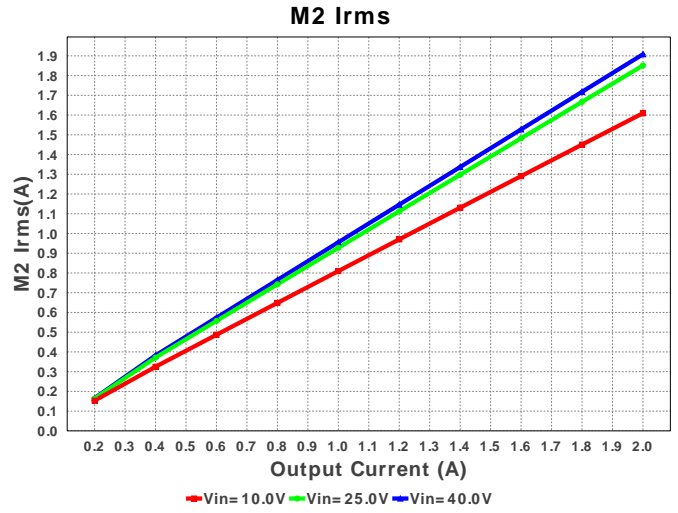
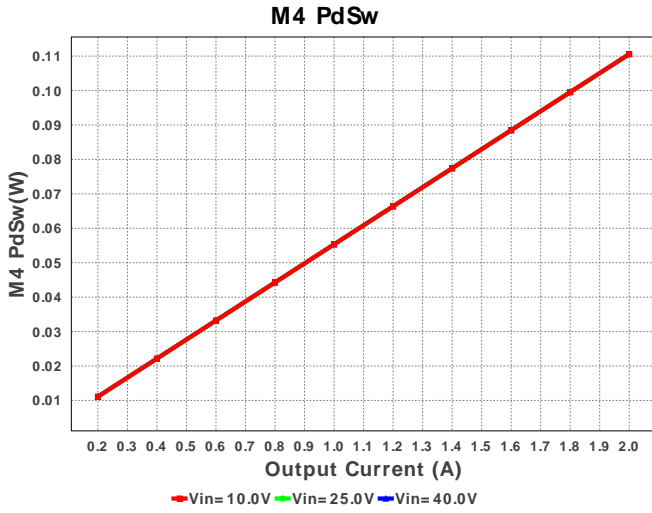


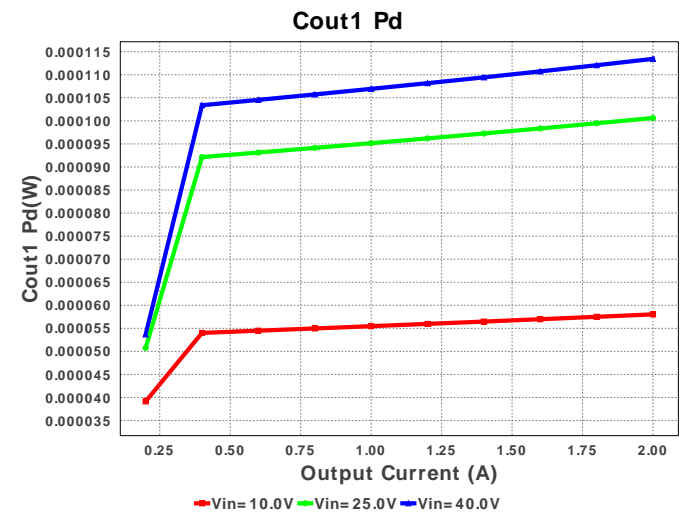
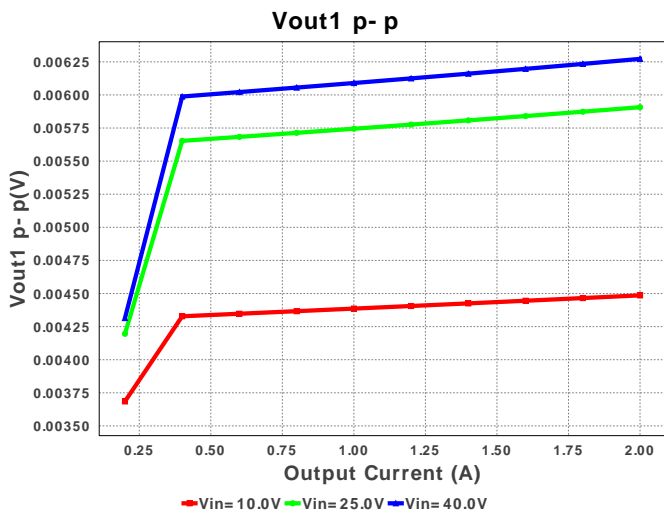
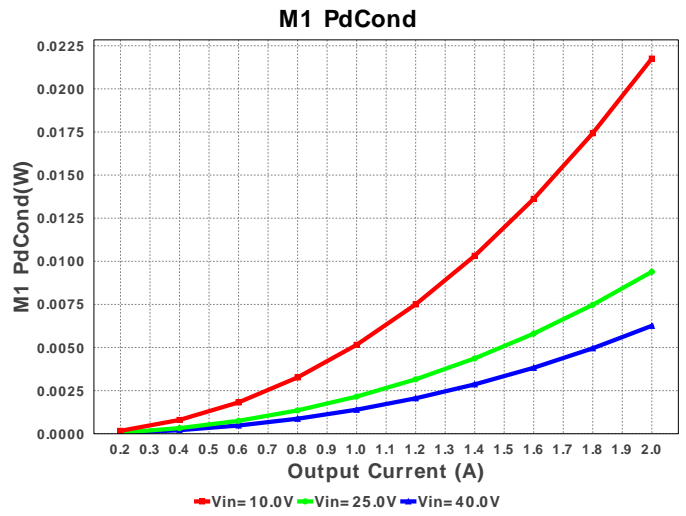
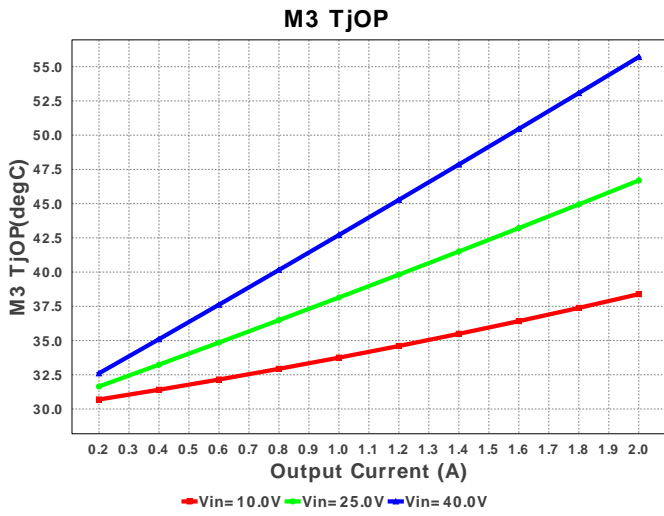
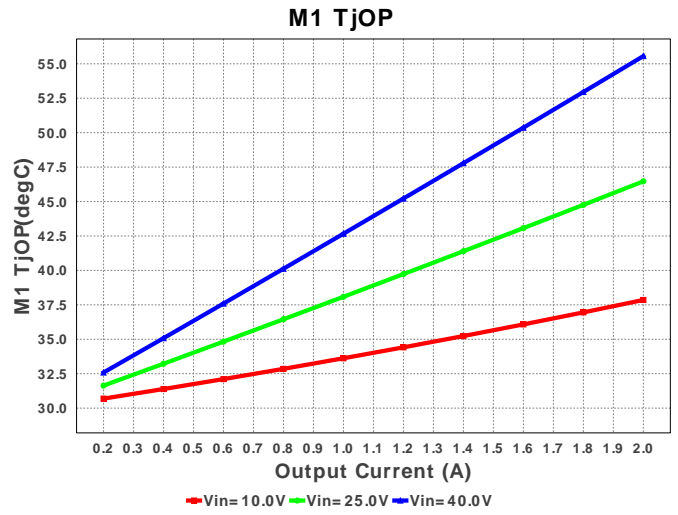
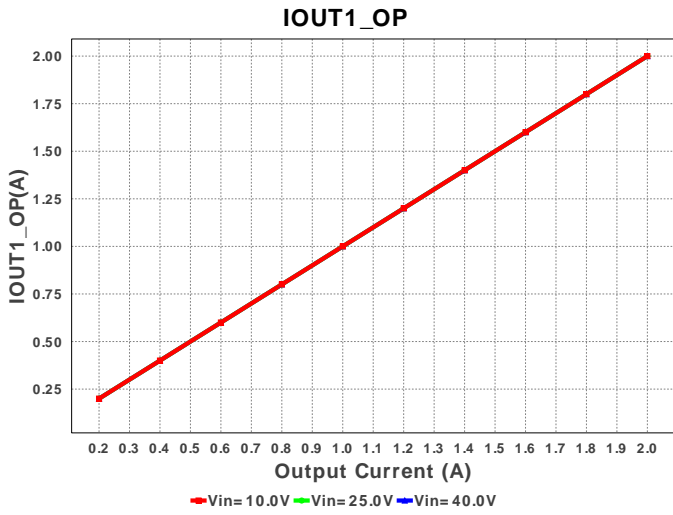
Cout2 IRMS

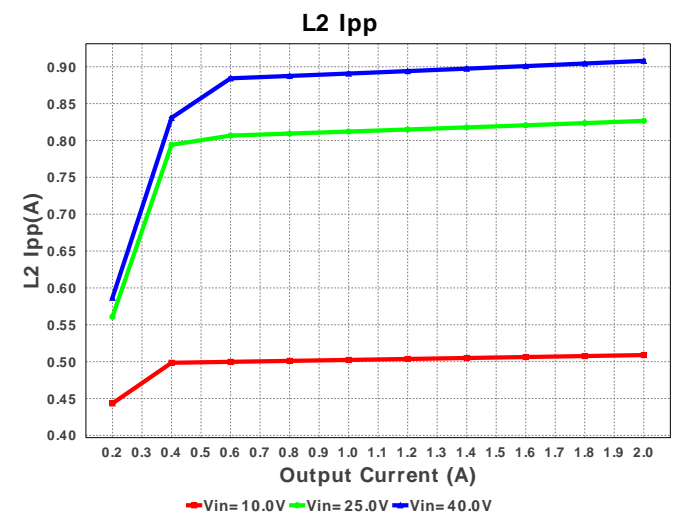
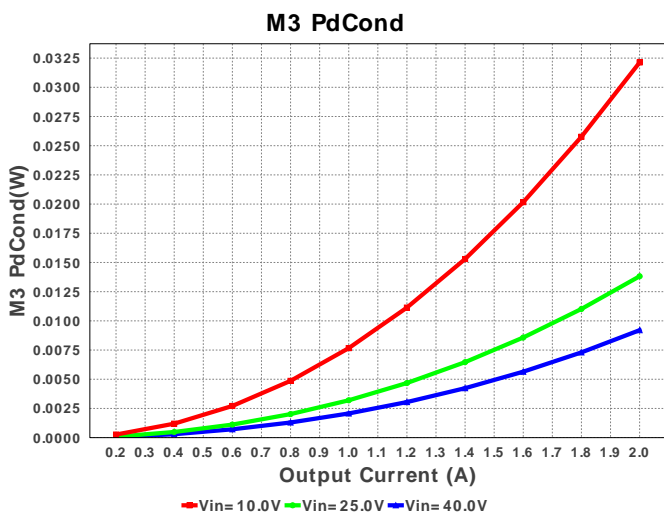
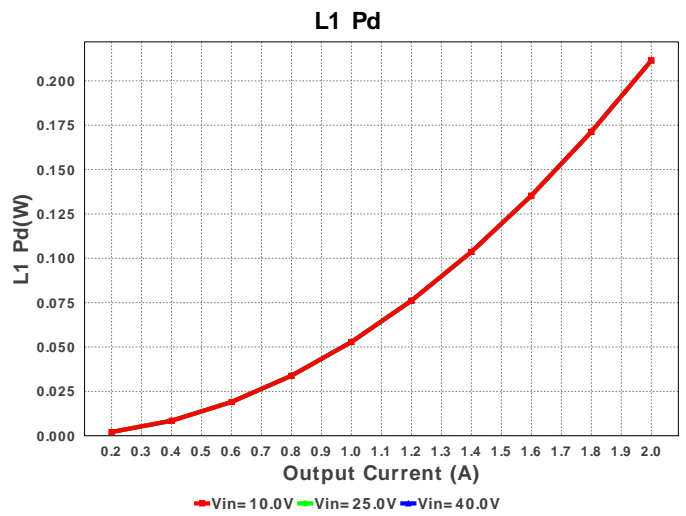
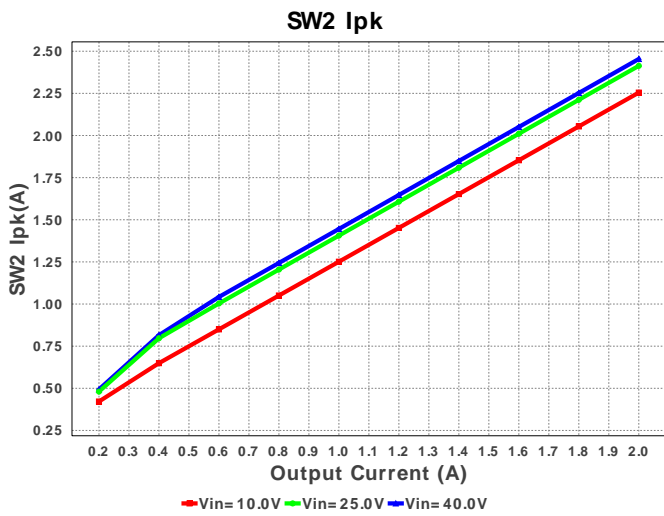
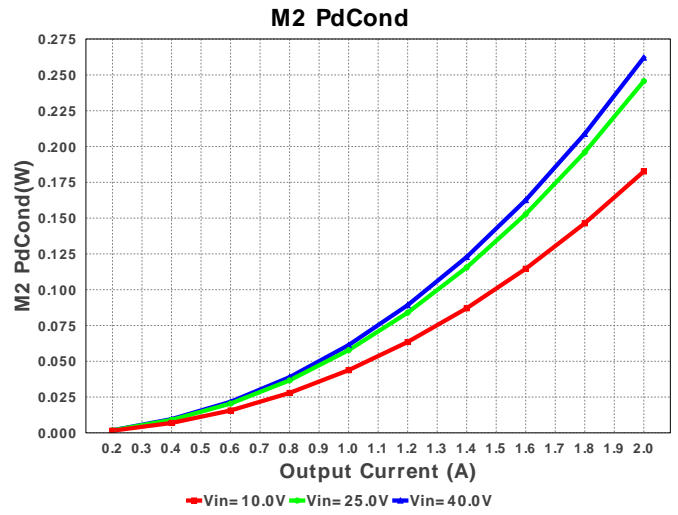
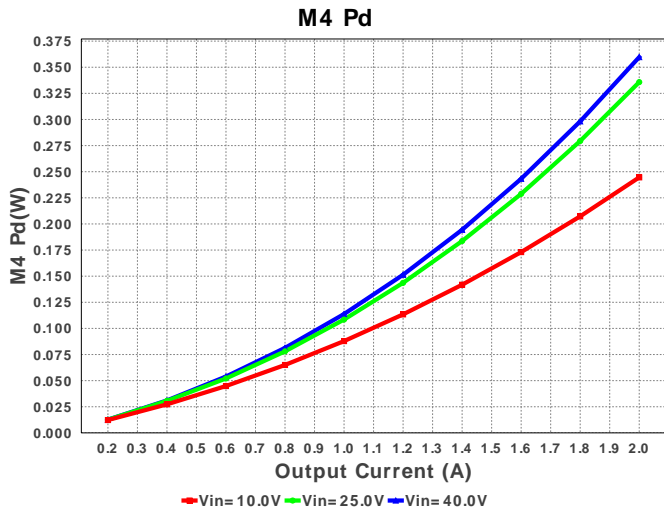


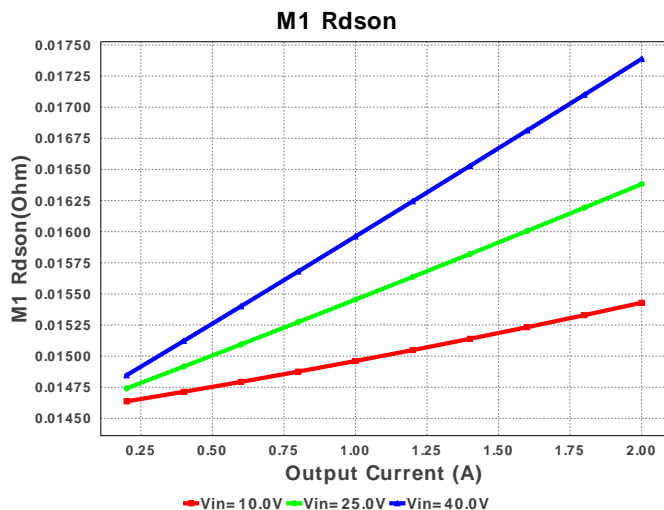
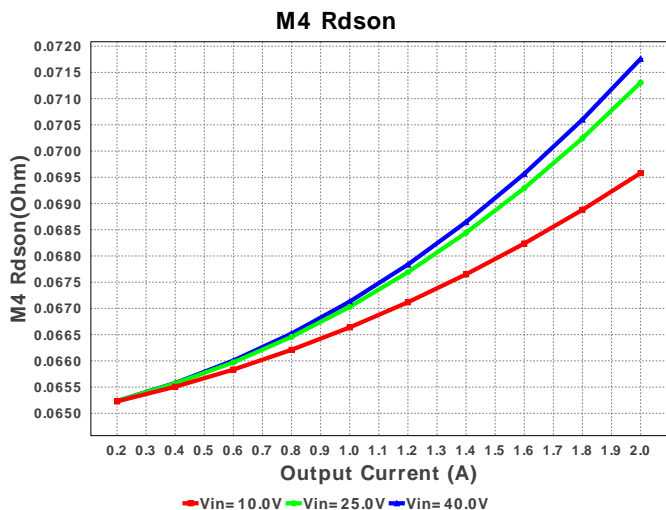
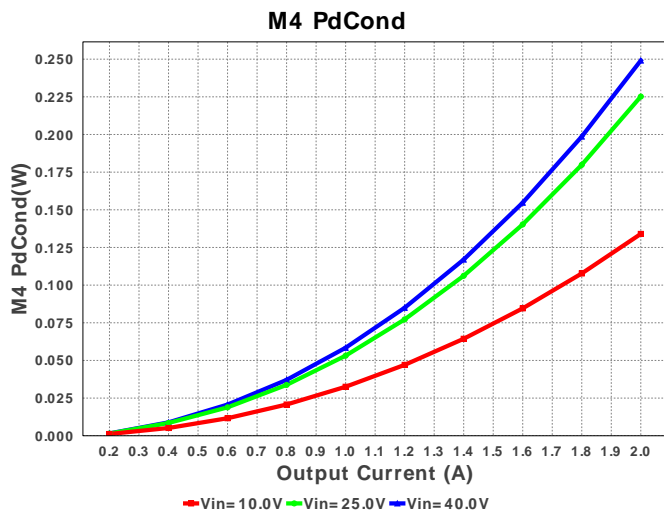
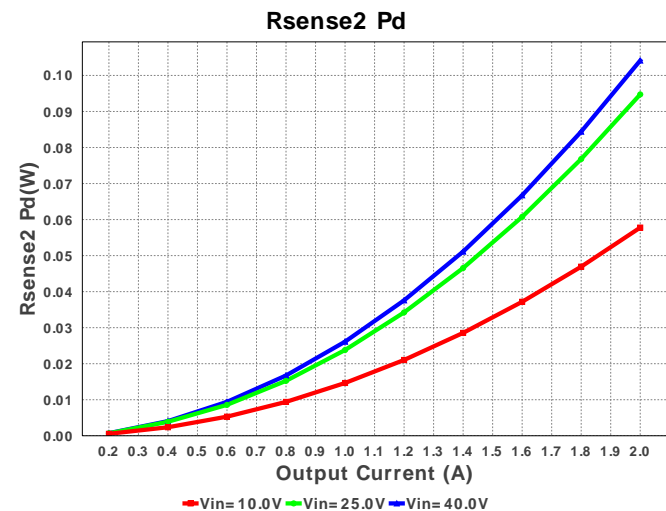
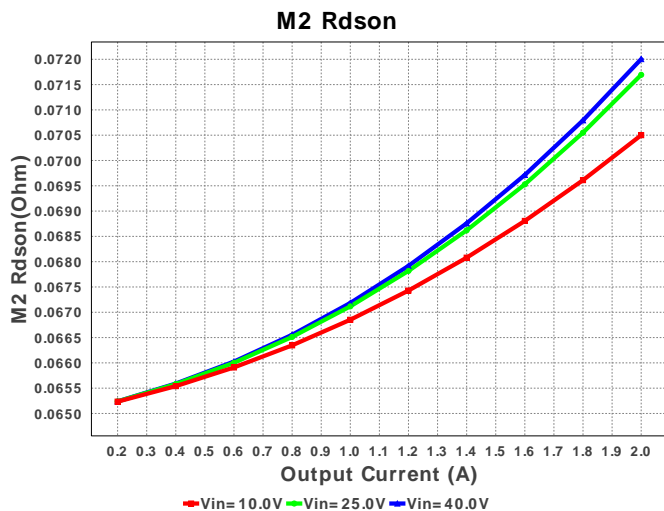
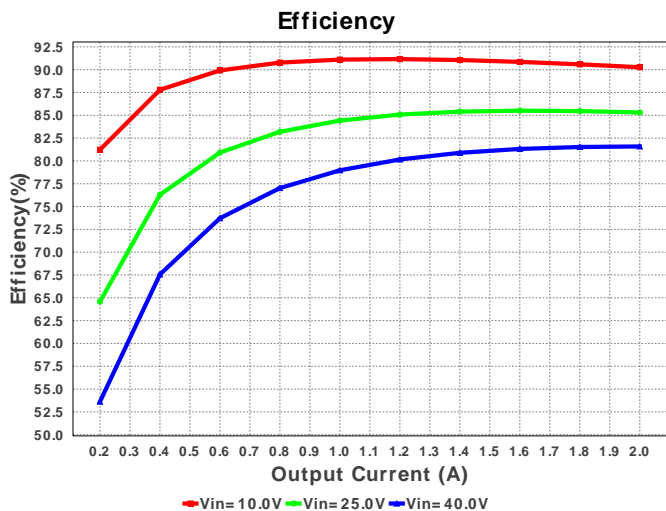
Cross Freq Ch1

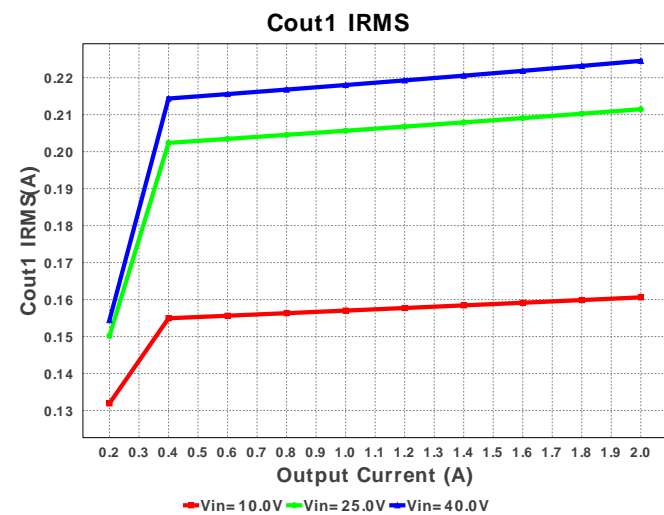
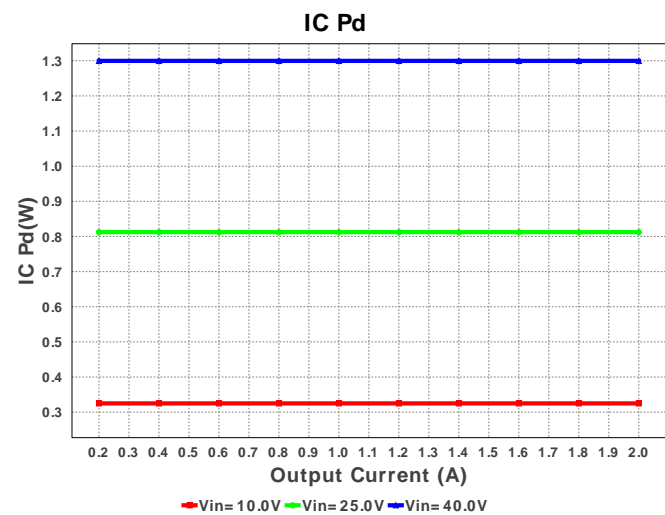
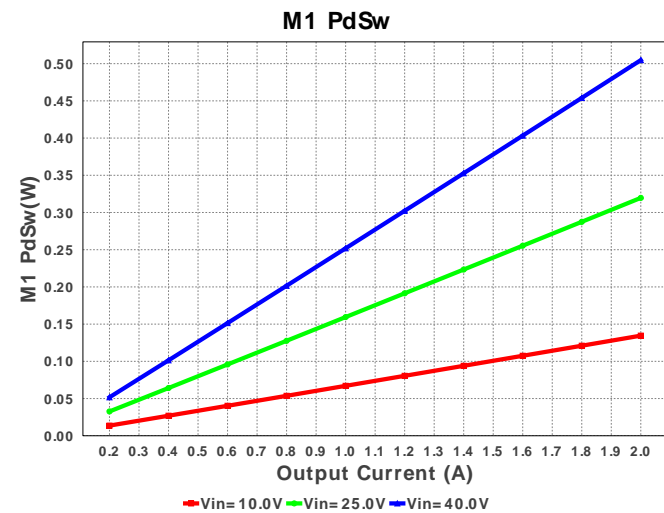
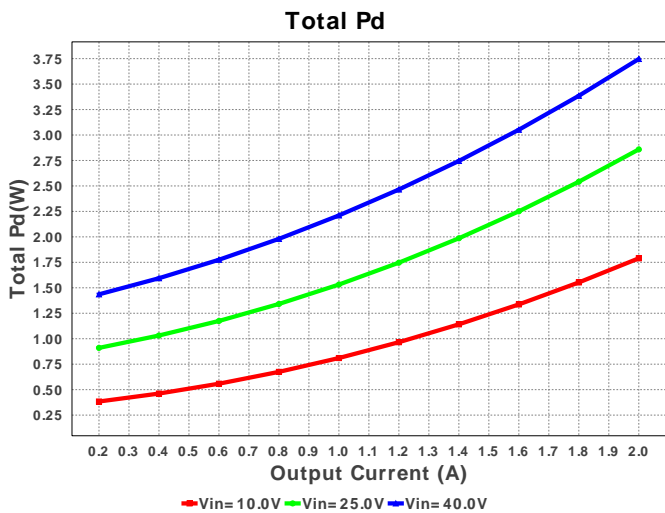
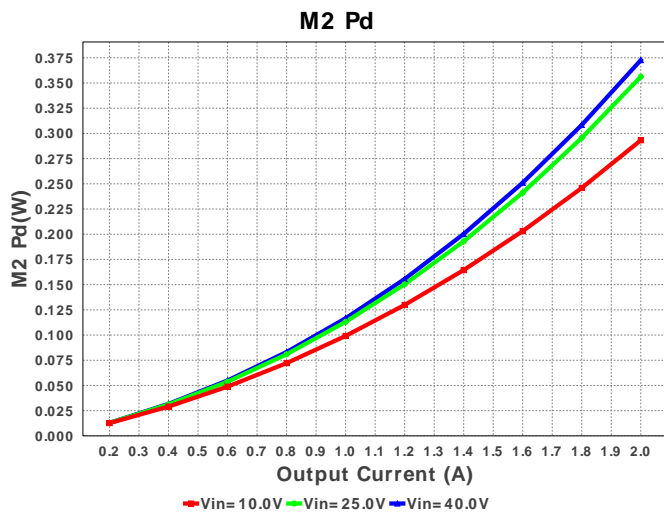
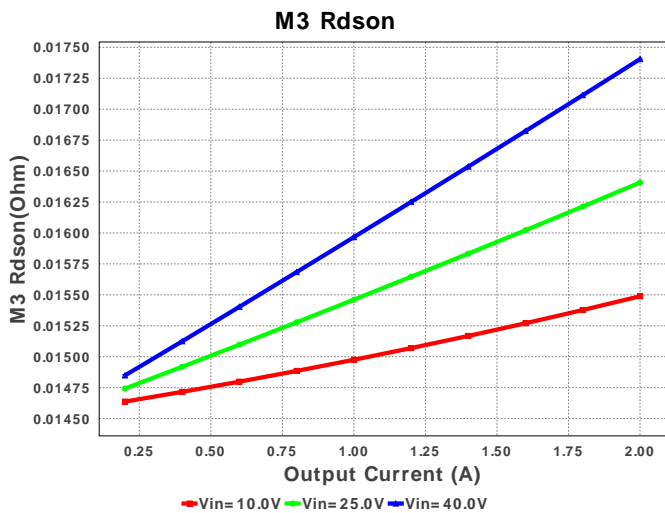




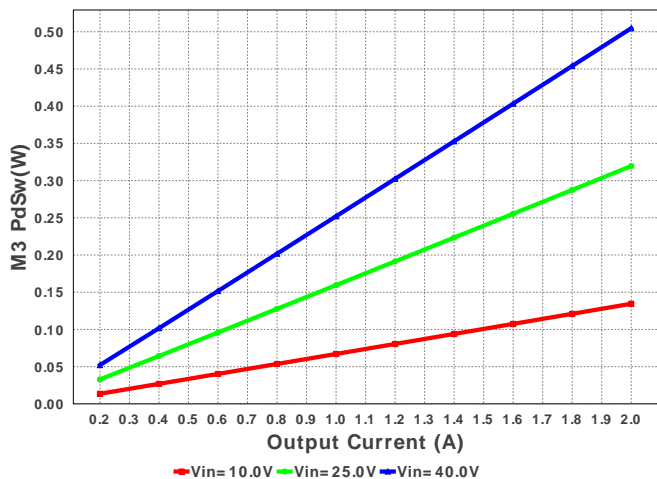




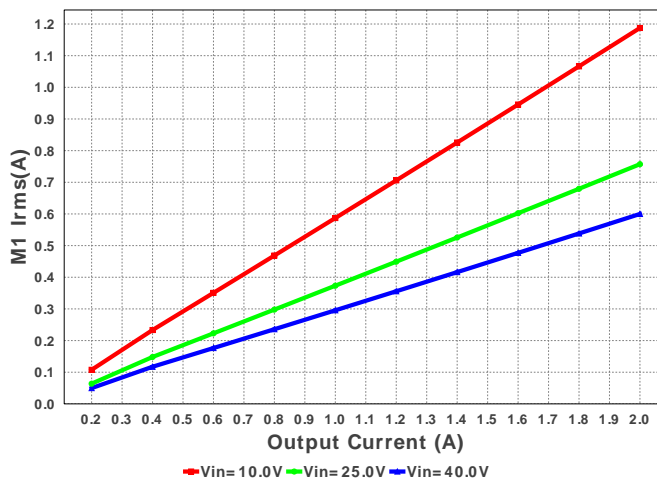




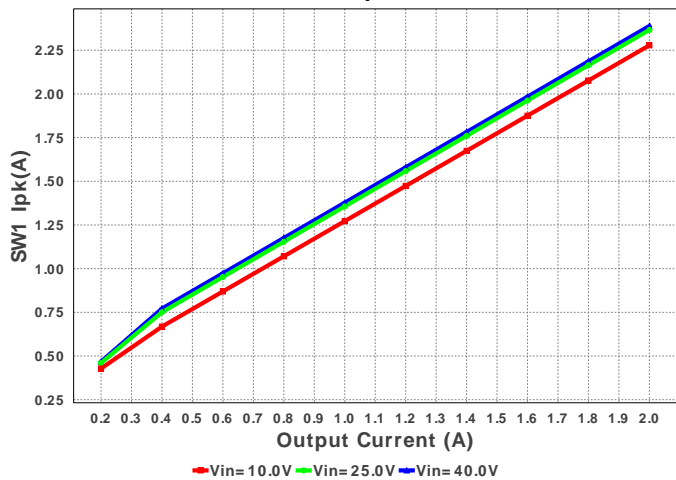
M3 PdSw



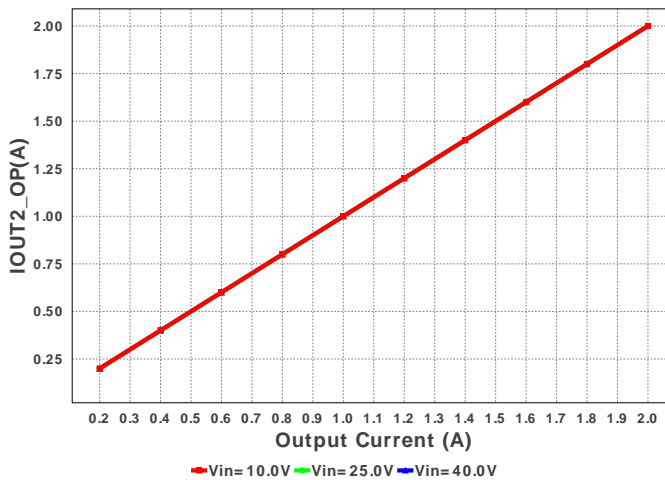
M1 Irms



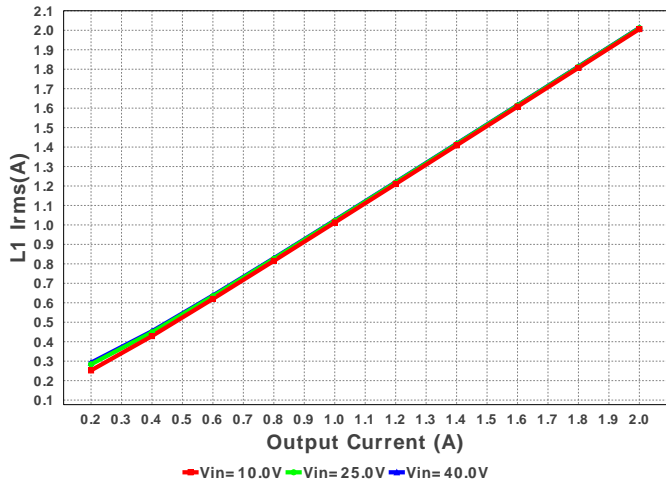
SW1 Ipk



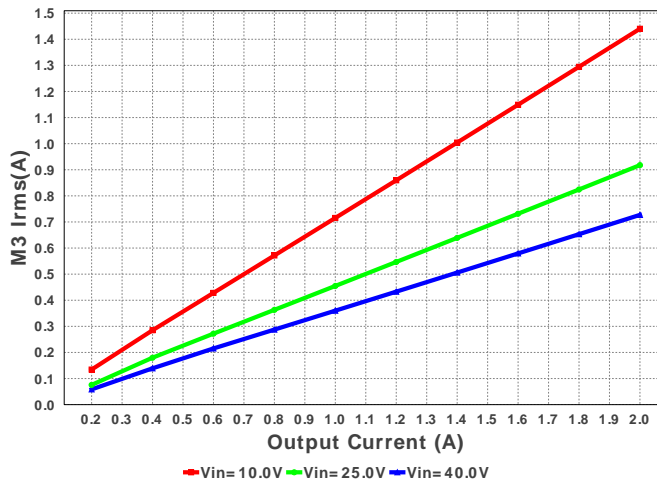
IOUT2_OP

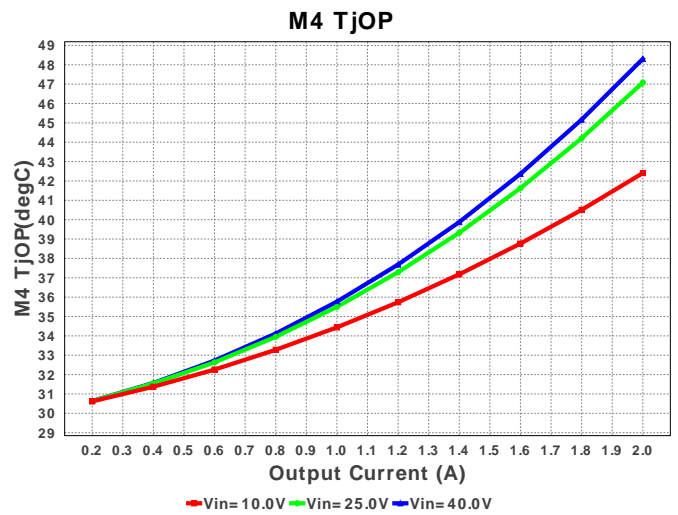
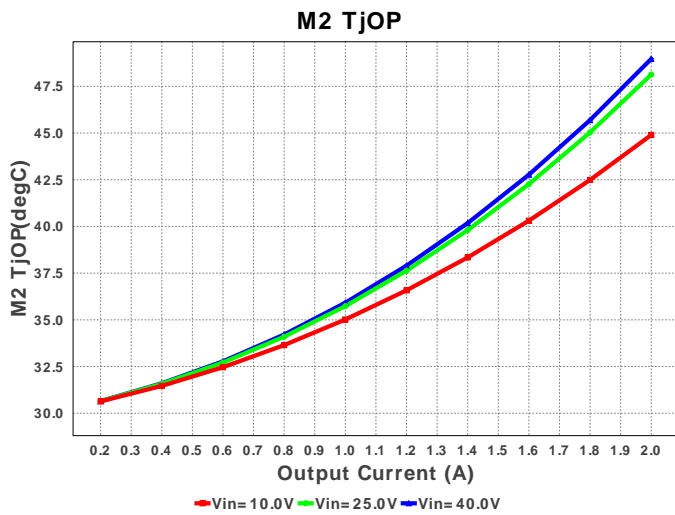
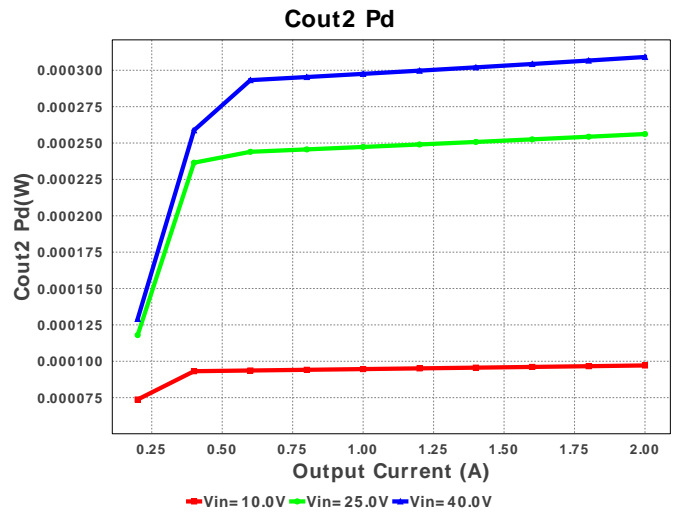
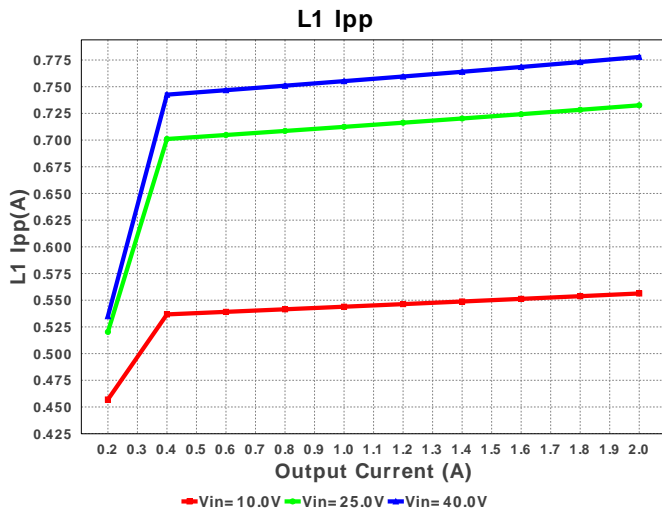
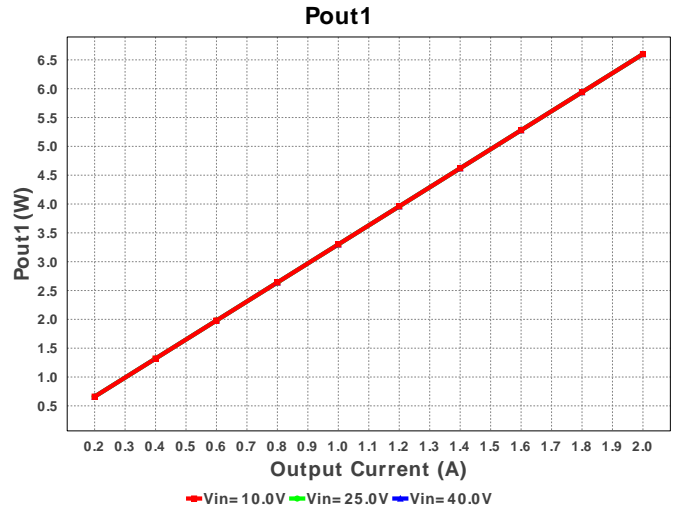
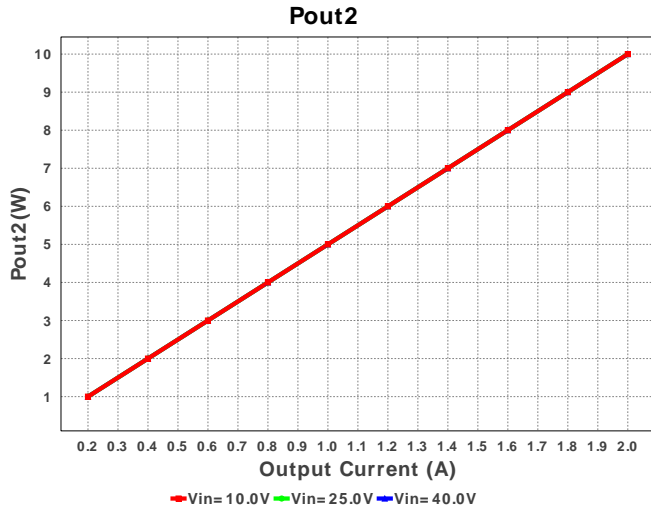


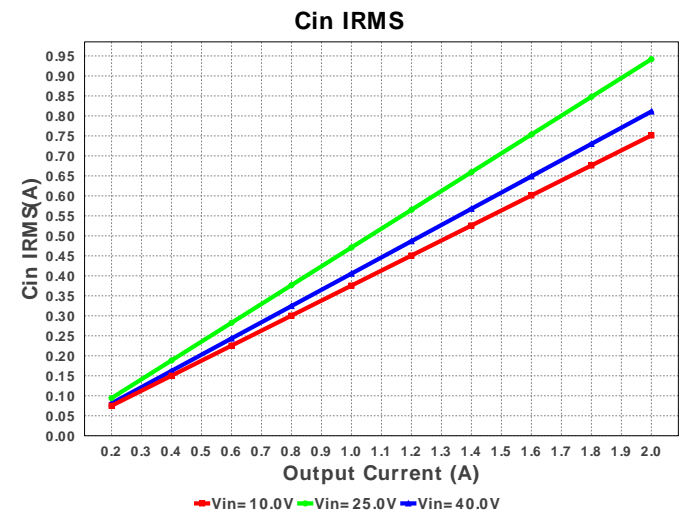
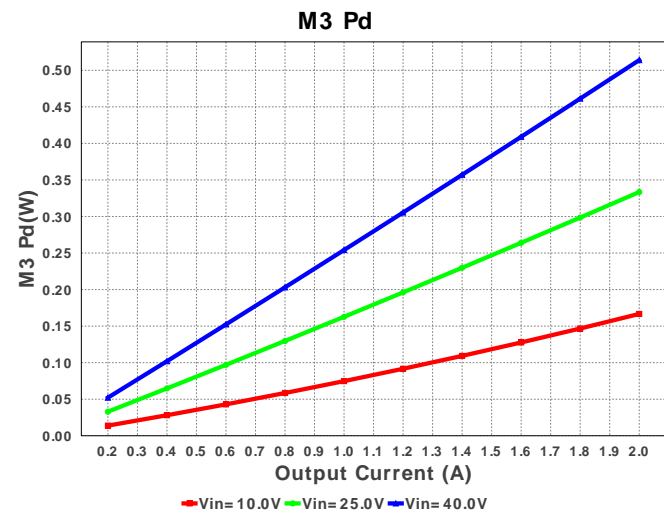
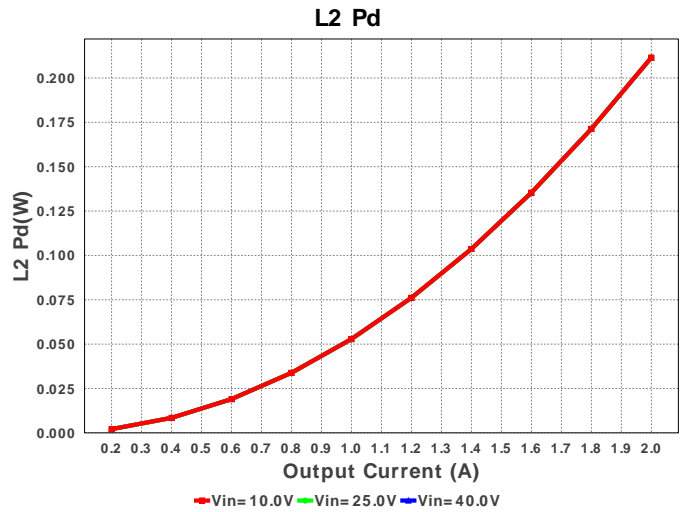
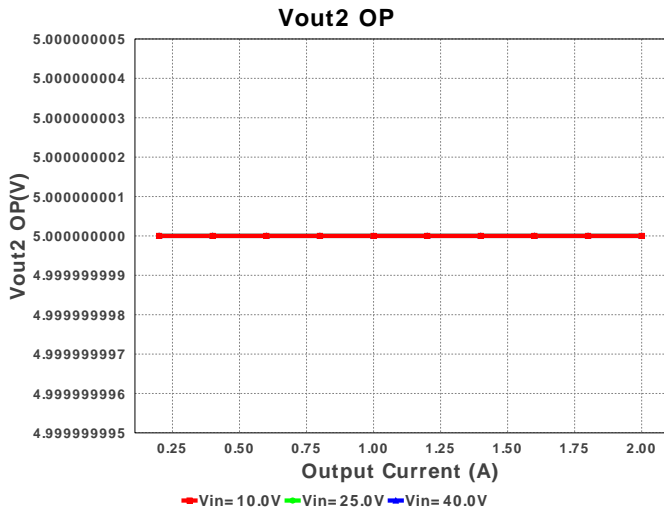
L1 Irms



M3 Irms







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	811.253 mA	Current	Input capacitor RMS ripple current
2.	Cout1 IRMS	224.785 mA	Current	Output capacitor1 RMS ripple current
3.	Cout2 IRMS	262.175 mA	Current	Output capacitor2 RMS ripple current
4.	Iin Avg	508.49 mA	Current	Average input current
5.	L1 Ipp	778.68 mA	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	2.013 A	Current	Inductor ripple current
7.	L2Ipp	908.201 mA	Current	Channel 2 Inductor Peak to peak Current
8.	L2 Irms	2.017 A	Current	Inductor ripple current
9.	M1 Irms	600.304 mA	Current	MOSFET RMS ripple current
10.	M2 Irms	1.908 A	Current	MOSFET RMS ripple current
11.	M3 Irms	727.206 mA	Current	MOSFET RMS ripple current
12.	M4 Irms	1.863 A	Current	MOSFET RMS ripple current
13.	SW1 Ipk	2.389 A	Current	Peak switch current
14.	SW2 Ipk	2.454 A	Current	Peak switch current
15.	BOM Count	41	General	Total Design BOM count
16.	FootPrint	915.0 mm ²	General	Total Foot Print Area of BOM components
17.	Frequency	424.559 kHz	General	Switching frequency
18.	IC Tolerance	12.0 mV	General	IC Feedback Tolerance
19.	M1 Rdson	17.334 mOhm	General	Drain-Source On-resistance
20.	M2 Rdson	72.003 mOhm	General	Drain-Source On-resistance
21.	Total BOM	\$7.28	General	Total BOM Cost
22.	IOUT1_OP	2.0 A	Op_Point	Iout1 operating point
23.	IOUT2_OP	2.0 A	Op_Point	Iout2 operating point
24.	M3 TjOP	55.242 degC	Op_Point	M3 MOSFET junction temperature
25.	M4 TjOP	48.304 degC	Op_Point	M4 MOSFET junction temperature
26.	Vout1 OP	3.304 V	Op_Point	Operational Voltage 1
27.	Vout2 OP	5.002 V	Op_Point	Operational Voltage 2
28.	Efficiency	81.675 %	Op_point	Steady state efficiency
29.	IC Tj	81.99 degC	Op_point	IC junction temperature
30.	M1 TjOP	55.071 degC	Op_point	M1 MOSFET junction temperature
31.	M2 TjOP	48.969 degC	Op_point	M2 MOSFET junction temperature

#	Name	Value	Category	Description
32.	VIN_OP	40.0 V	Op_point	Vin operating point
33.	Vout1 p-p	6.279 mV	Op_point	Peak-to-peak output1 ripple voltage
34.	Vout2 p-p	7.324 mV	Op_point	Peak-to-peak output2 ripple voltage
35.	Cin Pd	52.65 mW	Power	Input capacitor power dissipation
36.	Cout1 Pd	113.689 μ W	Power	Output capacitor1 power dissipation
37.	Cout2 Pd	309.311 μ W	Power	Output capacitor2 power dissipation
38.	IC Pd	1.3 W	Power	IC power dissipation
39.	L1 Pd	211.511 mW	Power	Inductor power dissipation
40.	L2 Pd	211.511 mW	Power	Inductor power dissipation
41.	M1 Pd	501.217 mW	Power	M1 MOSFET total power dissipation
42.	M1 PdCond	6.247 mW	Power	M1 MOSFET conduction losses
43.	M1 PdSw	494.97 mW	Power	M1 MOSFET switching losses
44.	M2 Pd	372.653 mW	Power	M2 MOSFET total power dissipation
45.	M2 PdCond	262.065 mW	Power	M2 MOSFET conduction losses
46.	M2 PdSw	110.587 mW	Power	M2 MOSFET switching losses
47.	M3 Pd	504.552 mW	Power	M3 MOSFET total power dissipation
48.	M3 PdCond	9.177 mW	Power	M3 MOSFET conduction losses
49.	M3 PdSw	495.375 mW	Power	M3 MOSFET switching losses
50.	M3 Rdson	17.353 mOhm	Power	Drain-Source On-resistance
51.	M4 Pd	359.675 mW	Power	M4 MOSFET total power dissipation
52.	M4 PdCond	249.084 mW	Power	M4 MOSFET conduction losses
53.	M4 PdSw	110.591 mW	Power	M4 MOSFET switching losses
54.	M4 Rdson	71.758 mOhm	Power	Drain-Source On-resistance
55.	Rsense1 Pd	109.189 mW	Power	Current Limit Sense Resistor Power Dissipation
56.	Rsense2 Pd	104.135 mW	Power	Current Limit Sense Resistor Power Dissipation
57.	Total Pd	3.727 W	Power	Total Power Dissipation
58.	Cross Freq Ch1	37.996 kHz	Unknown	Bode plot crossover frequency
59.	Cross Freq Ch2	37.79 kHz	Unknown	Bode plot crossover frequency
60.	Duty Cycle 1	9.009 %	Unknown	Duty cycle for Channel 1
61.	Duty Cycle 2	13.221 %	Unknown	Duty cycle for Channel 2
62.	Phase Marg Ch1	63.554 deg	Unknown	Bode Plot Phase Margin
63.	Phase Marg Ch2	59.241 deg	Unknown	Bode Plot Phase Margin
64.	Pout1	6.609 W	Unknown	Channel 1 output Power
65.	Pout2	10.003 W	Unknown	Channel 2 output Power

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	Iout1	2.0	Output Current #1
3.	Iout2	2.0	Output Current #2
4.	VinMax	40.0	Maximum input voltage
5.	VinMin	10.0	Minimum input voltage
6.	Vout	3.3	Output Voltage
7.	Vout1	3.3	Output Voltage #1
8.	Vout2	5.0	Output Voltage #2
9.	base_pn	LM5119-Q1	Base Product Number
10.	source	DC	Input Source Type
11.	Ta	30.0	Ambient temperature

Design Assistance

1. Outline The LM5119-Q1 is a dual 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. Sequencing the 2 outputs The LM(2)5119-Q1 contains an enable function allowing shutdown control of channel2, independent of channel1. If the EN2 pin is pulled below 2.0V, channel2 enters shutdown mode. If the EN2 input is greater than 2.5V, channel2 returns to normal operation. 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 LM(2)5119-Q1 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. Feature Highlights: Automotive Grade 5.5-65V Wide Vin, Current Mode Dual Synchronous Buck Controller

3. The LM5119-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

4. **LM5119-Q1 Product Folder** : <http://www.ti.com/product/LM5119Q> : contains the data sheet and other resources.

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