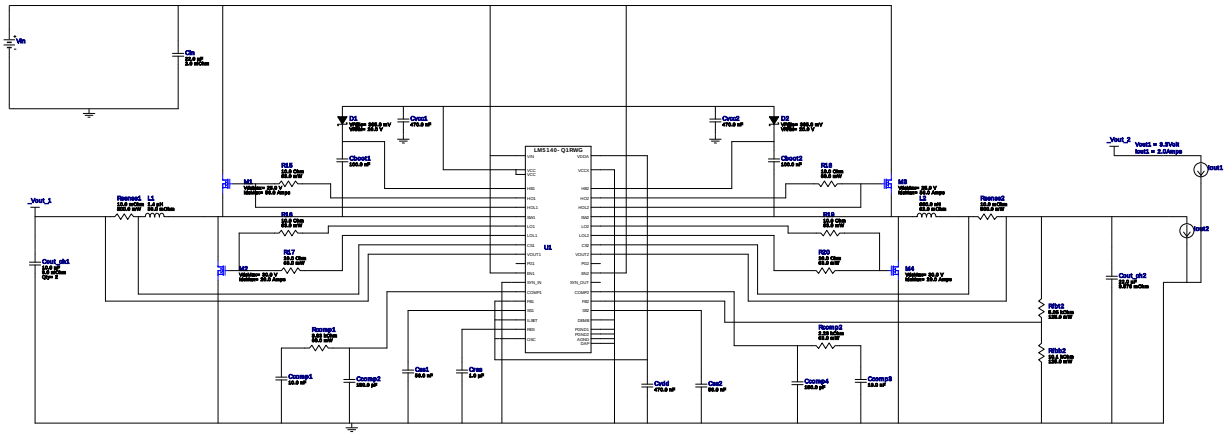
WEBENCH® Design Report

VinMin = 5.0V
VinMax = 13.0V
Vout = 3.3V
Iout = 2.0A

Device = LM5140QRWGRQ1
Topology = Buck
Created = 8/10/16 5:17:37 PM
BOM Cost = $6.09
BOM Count = 37
Total Pd = 0.89W

Design : 4759963/9 LM5140QRWGRQ1
LM5140QRWGRQ1 5.0V-13.0V to 1.80V @ 1.0A



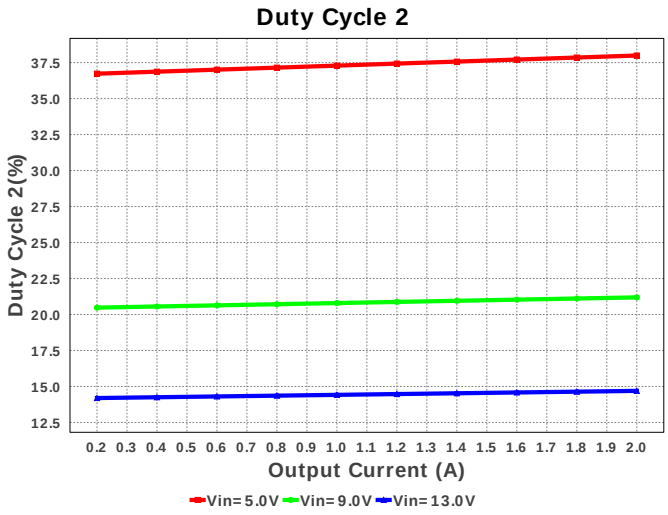
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific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

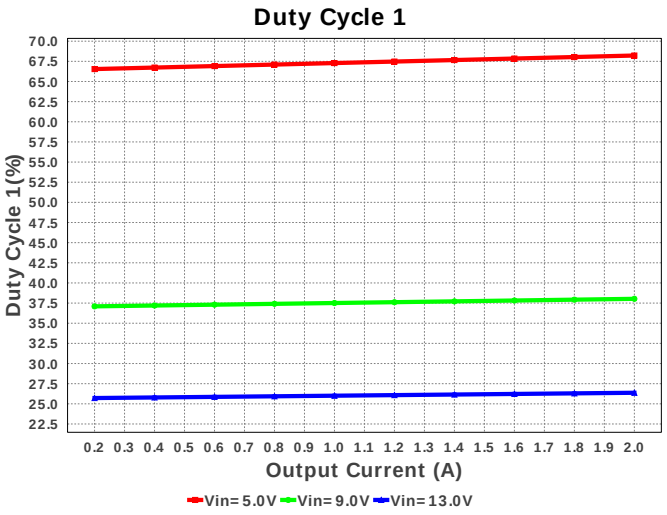
Electrical BOM

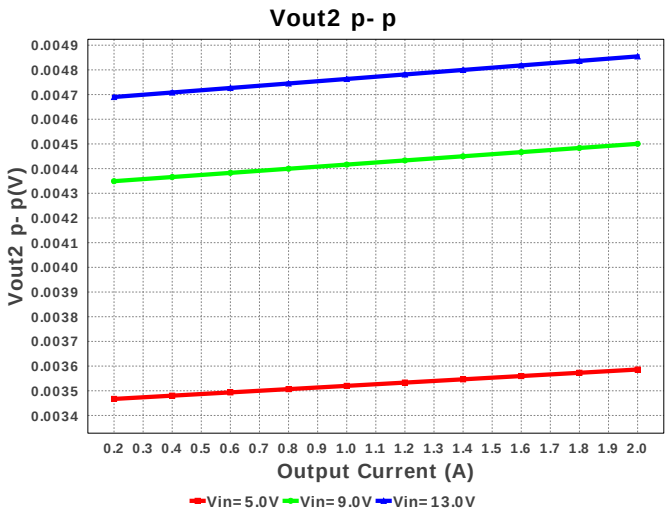
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot1	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
2.	Cboot2	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
3.	Ccomp1	MuRata	GRM216R71H103KA01D Series= X7R	Cap= 10.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Ccomp2	TDK	C2012C0G1H151J Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
5.	Ccomp3	Yageo America	CC0805KRX7R9BB183 Series= X7R	Cap= 18.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
6.	Ccomp4	TDK	C2012C0G1H151J Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
7.	Cin	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	1	$0.16	1210 15 mm^2
8.	Cout_ch1	MuRata	GRM188R60J106ME47D Series= X5R	Cap= 10.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 2.74 A	2	$0.02	0603 5 mm^2
9.	Cout_ch2	MuRata	GRM21BC80G226ME39L Series= X6S	Cap= 22.0 uF ESR= 3.578 mOhm VDC= 4.0 V IRMS= 3.29633 A	1	$0.04	0805 7 mm^2
10.	Cres	Taiyo Yuden	EMK212B7105KG-T Series= X7R	Cap= 1.0 uF VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2

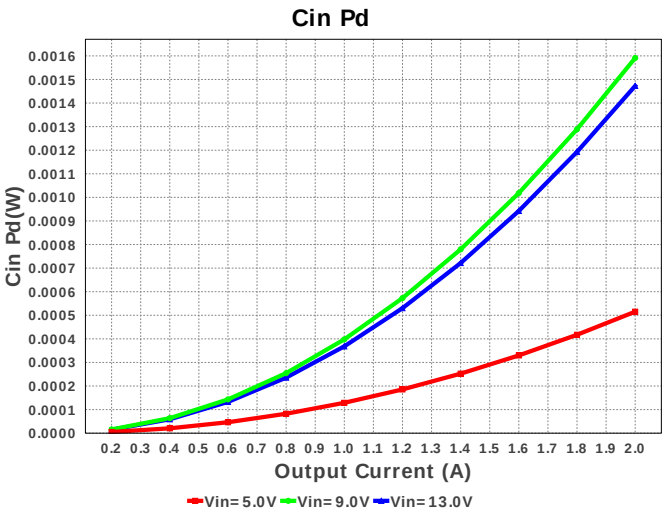
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
11.	Css1	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
12.	Css2	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
13.	Cvcc1	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
14.	Cvcc2	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
15.	Cvdd	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
16.	D1	ON Semiconductor	MBR0520LT1G	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.06	 SOD-123 13 mm²
17.	D2	ON Semiconductor	MBR0520LT1G	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.06	 SOD-123 13 mm²
18.	L1	Bourns	SDR0403-1R4ML	L= 1.4 µH DCR= 38.0 mOhm	1	$0.18	 SDR0403 28 mm²
19.	L2	TDK	VLS252010ET-R68N	L= 680.0 nH DCR= 62.0 mOhm	1	$0.15	 VLS252010ET 11 mm²
20.	M1	Texas Instruments	CSD16411Q3	VdsMax= 25.0 V IdsMax= 56.0 Amps	1	$0.31	 TRANS_NexFET_Q3 18 mm²
21.	M2	Texas Instruments	CSD17579Q3A	VdsMax= 30.0 V IdsMax= 20.0 Amps	1	$0.19	 TRANS_NexFET_Q3A 18 mm²
22.	M3	Texas Instruments	CSD16411Q3	VdsMax= 25.0 V IdsMax= 56.0 Amps	1	$0.31	 TRANS_NexFET_Q3 18 mm²
23.	M4	Texas Instruments	CSD17579Q3A	VdsMax= 30.0 V IdsMax= 20.0 Amps	1	$0.19	 TRANS_NexFET_Q3A 18 mm²
24.	R15	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	R16	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
26.	R17	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
27.	R18	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
28.	R19	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
29.	R20	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
30.	Rcomp1	Vishay-Dale	CRCW04023K83FKED Series= CRCW..e3	Res= 3.83 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

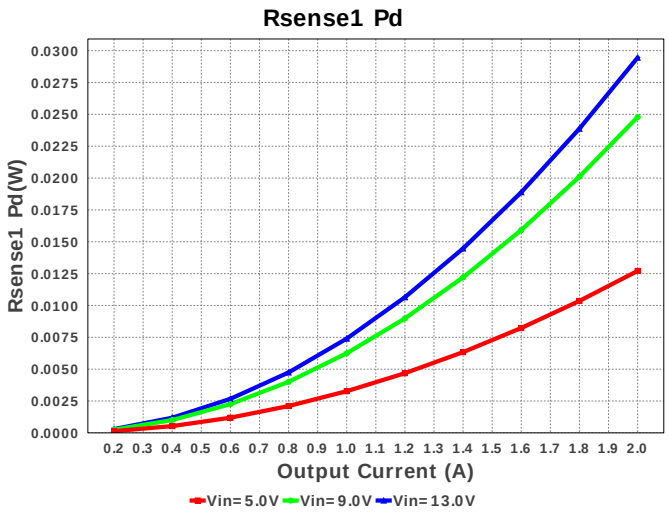
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
31.	Rcomp2	Vishay-Dale	CRCW04022K26FKED Series= CRCW..e3	Res= 2.26 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rfbb2	Yageo America	RT0805BRD0710K1L Series= ?	Res= 10.1 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.04	0805 7 mm²
33.	Rfbt2	Yageo America	RT0805BRD075K05L Series= ?	Res= 5.05 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.04	0805 7 mm²
34.	Rsense1	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	1206 11 mm²
35.	Rsense2	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	1206 11 mm²
36.	U1	Texas Instruments	LM5140QRWGRQ1	Switcher	1	$3.90	RWG0040A 64 mm²

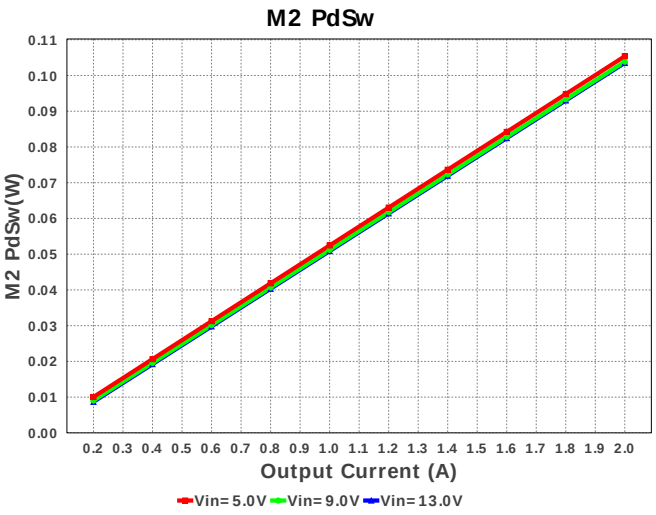


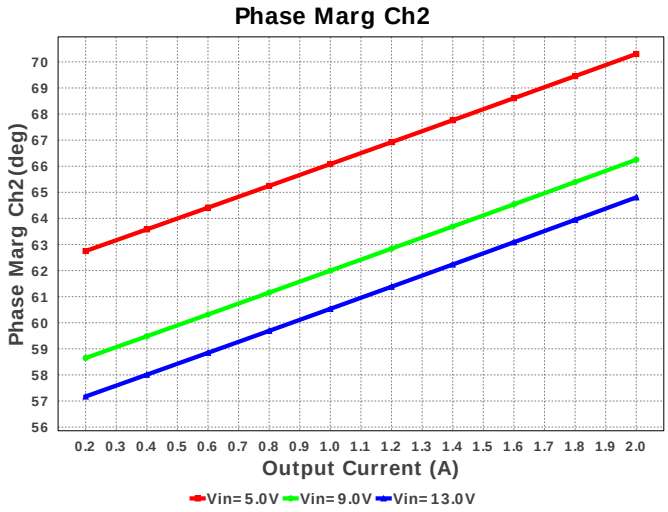


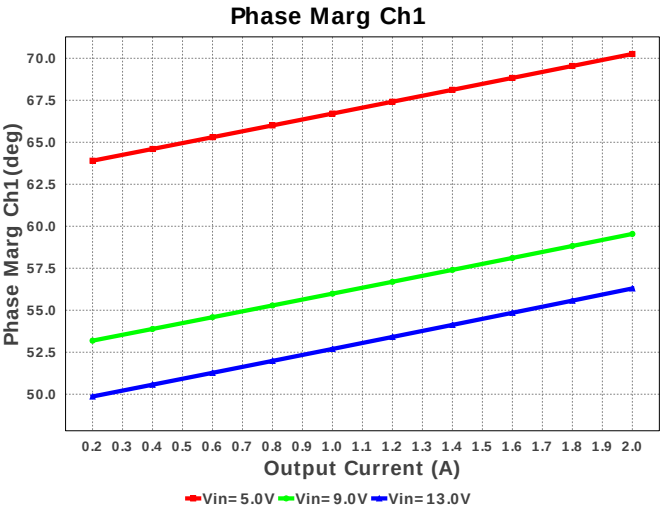


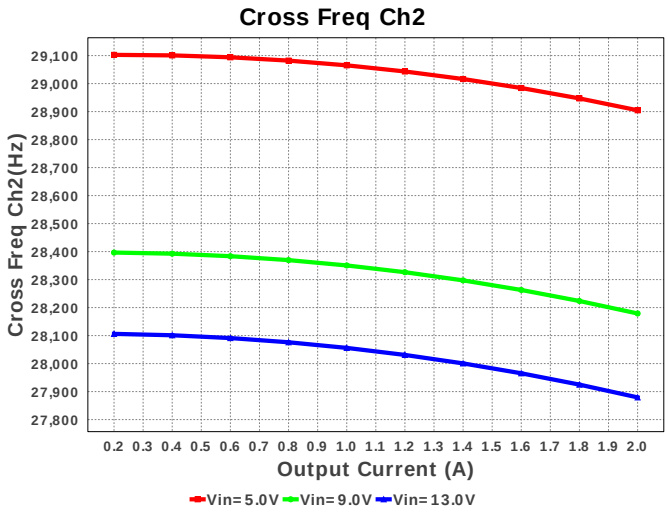


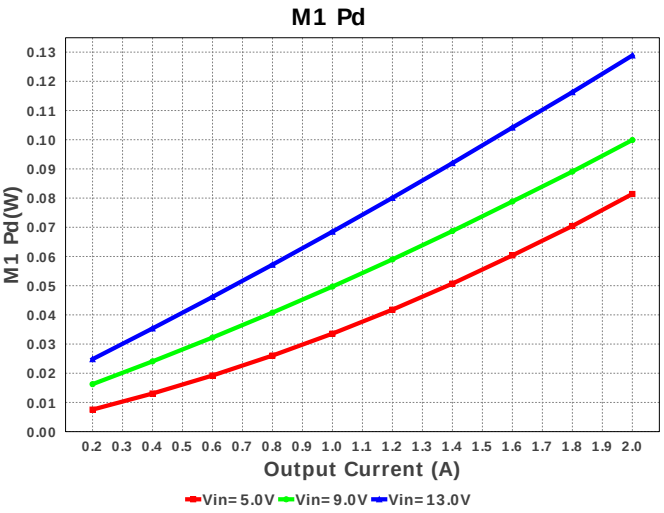




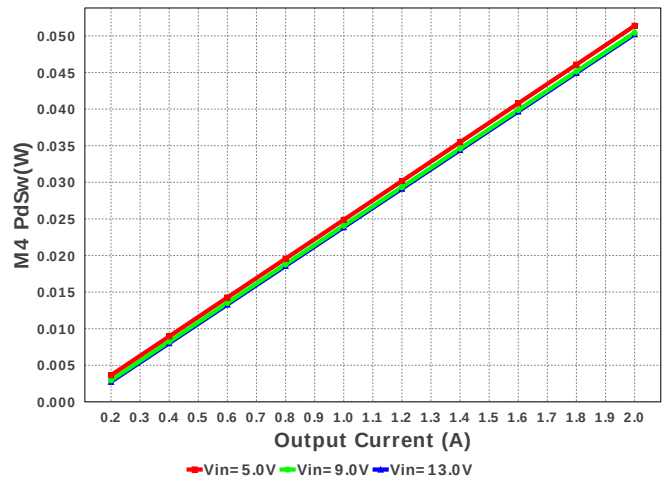




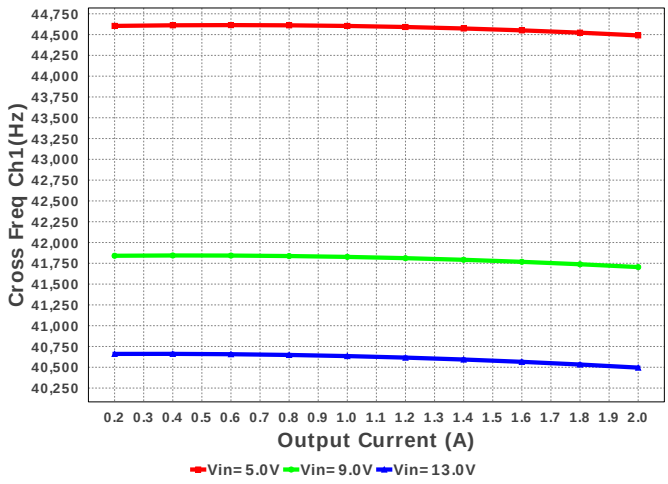




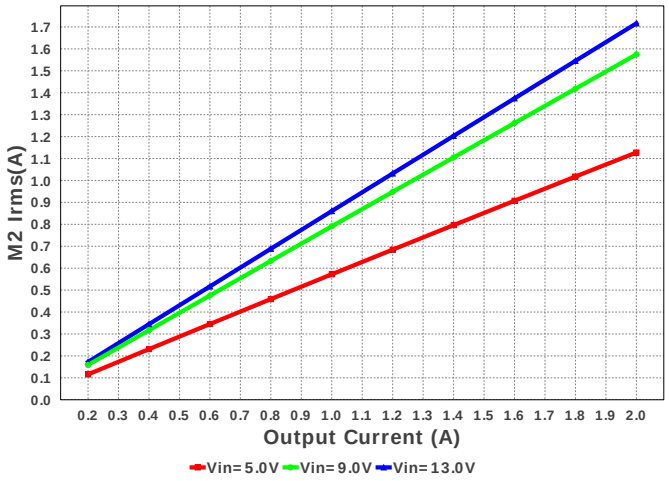
M4 PdSw



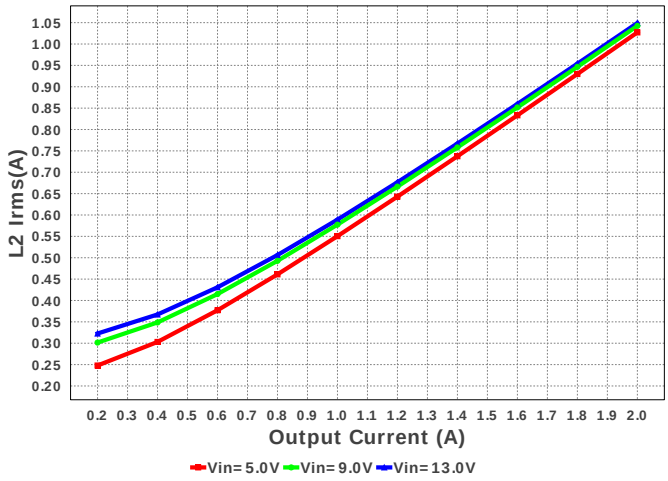
Cross Freq Ch1



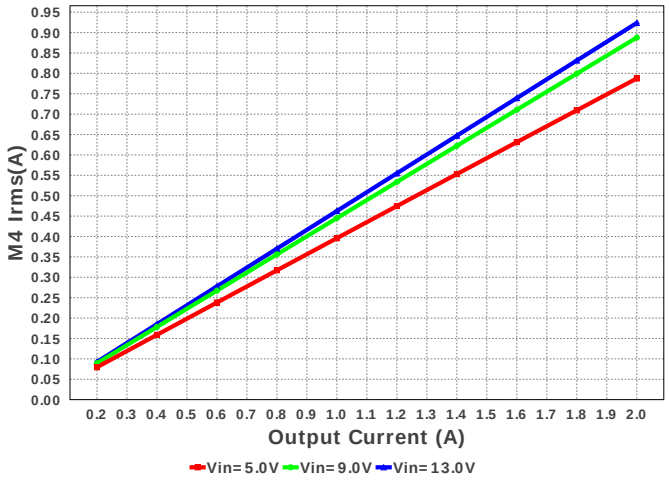
M2 Irms



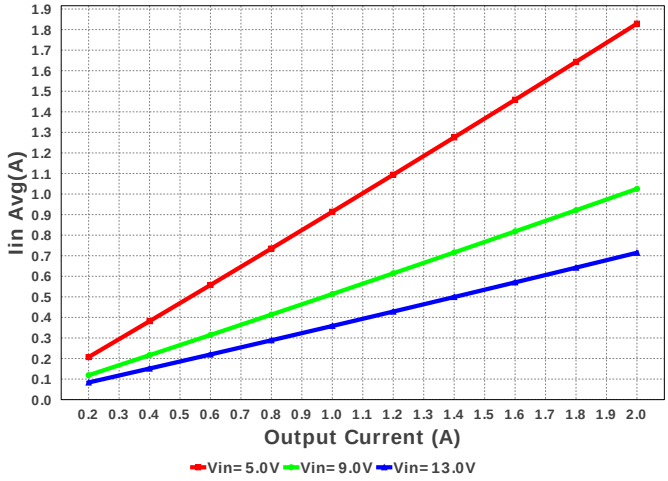
L2 Irms

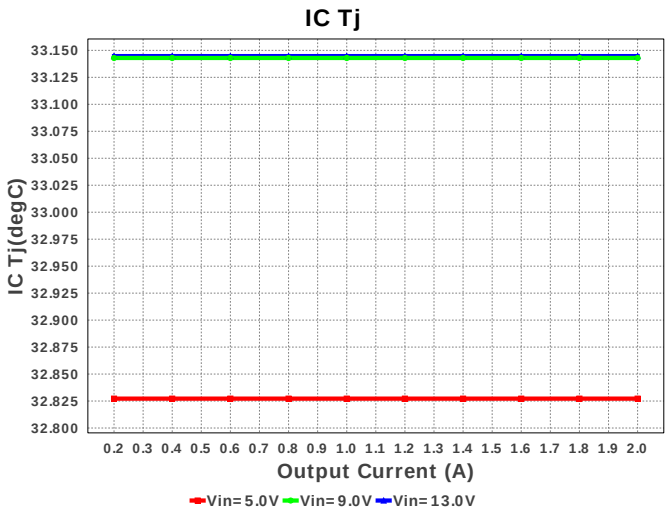


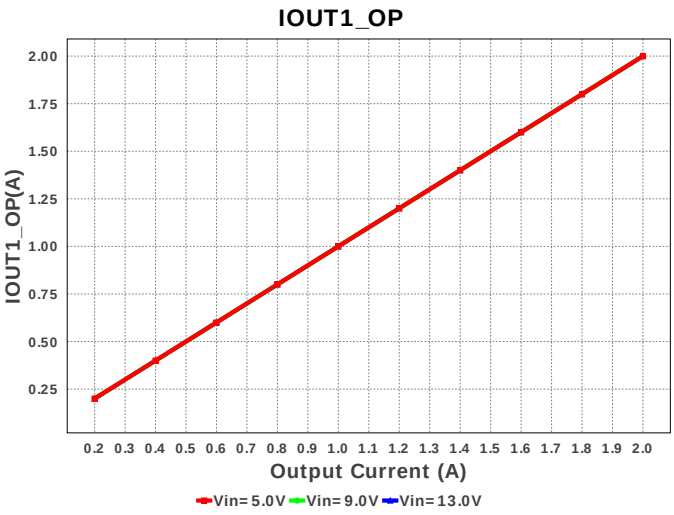
M4 Irms

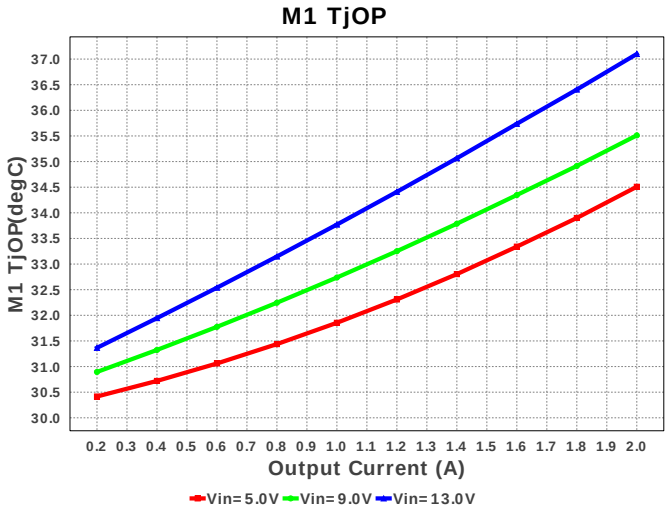


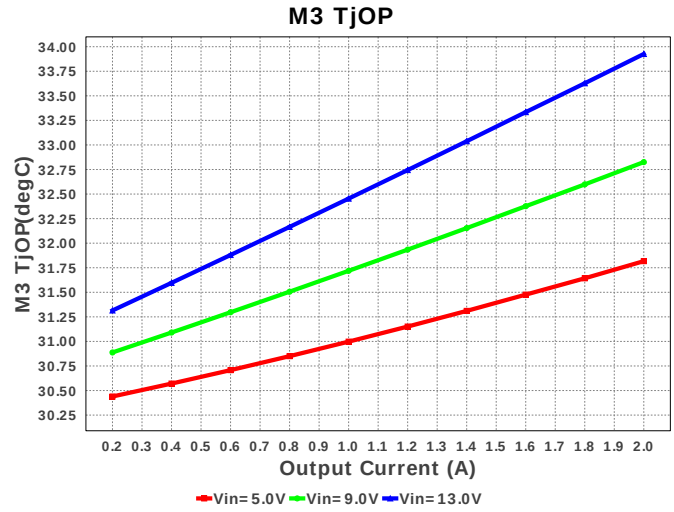
Iin Avg

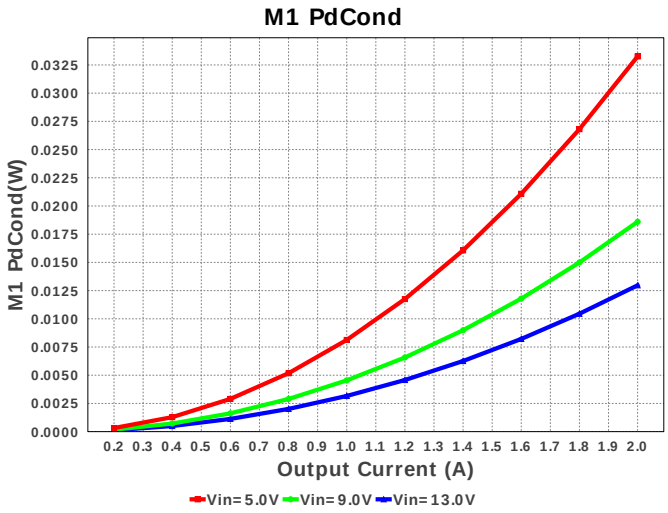


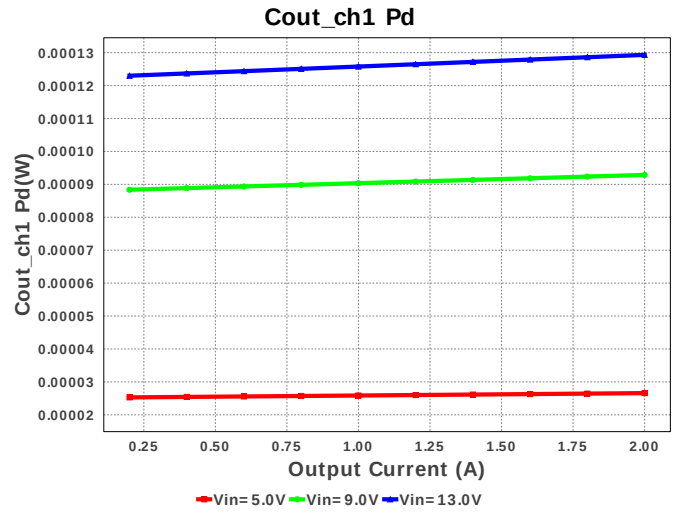


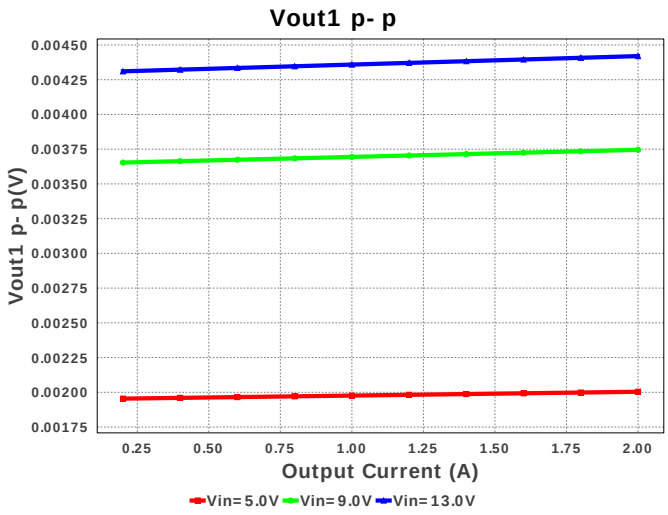


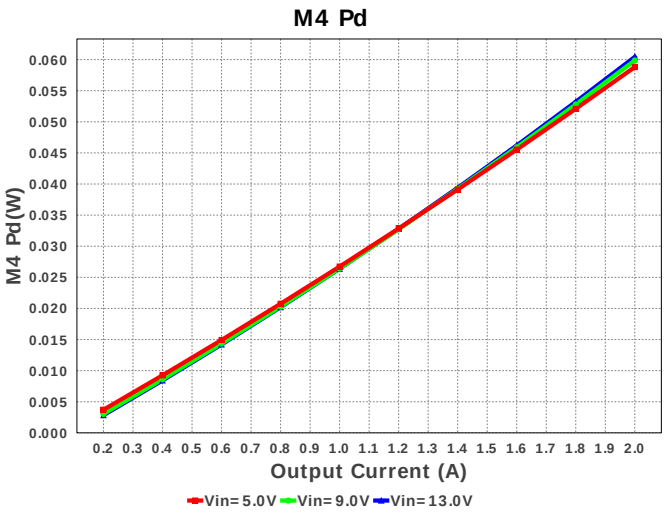


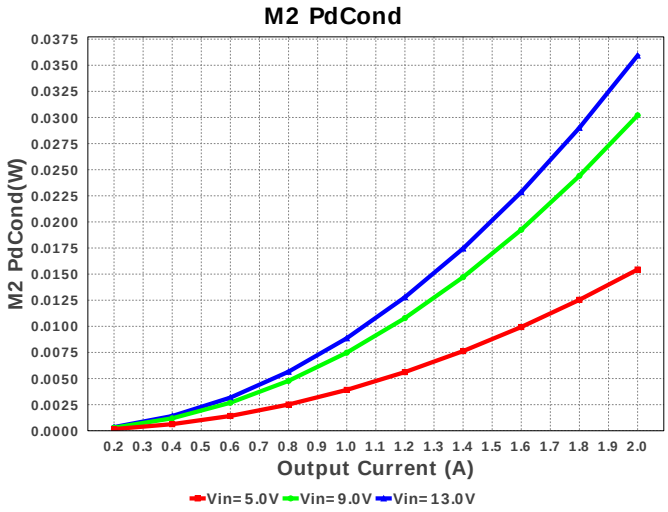


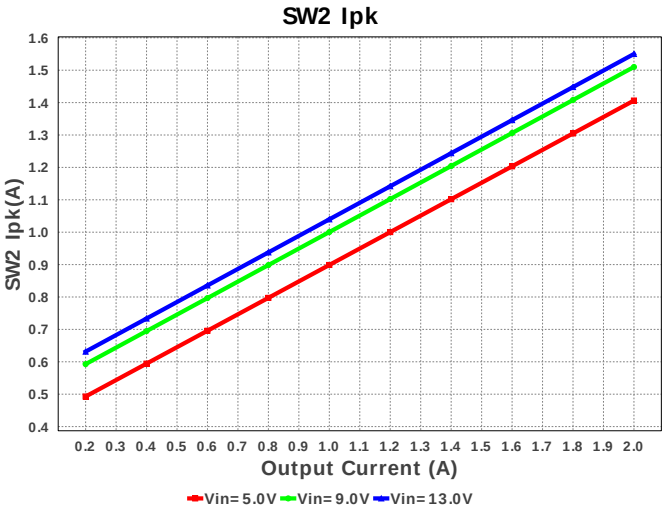


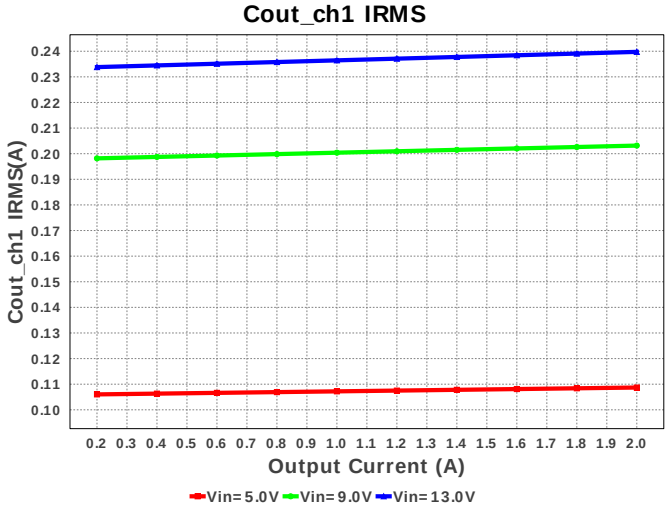


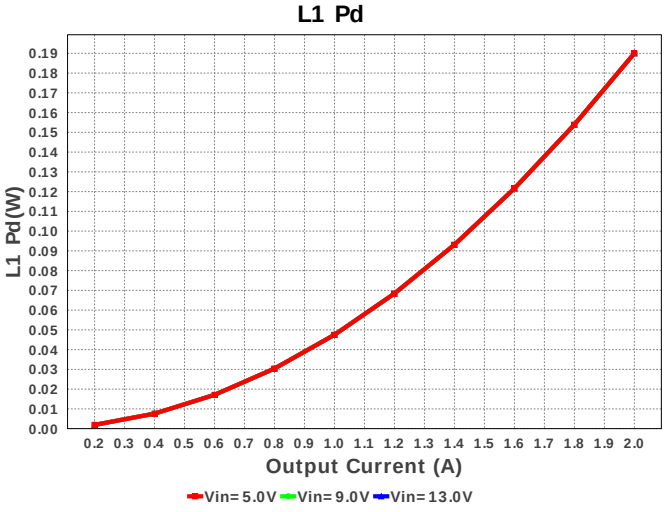


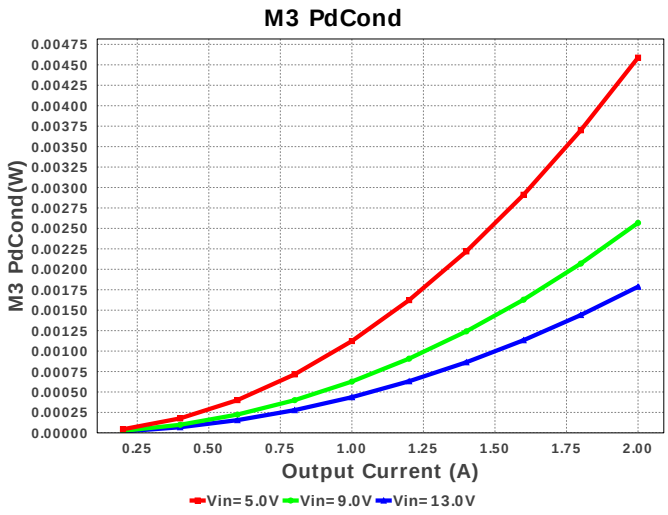


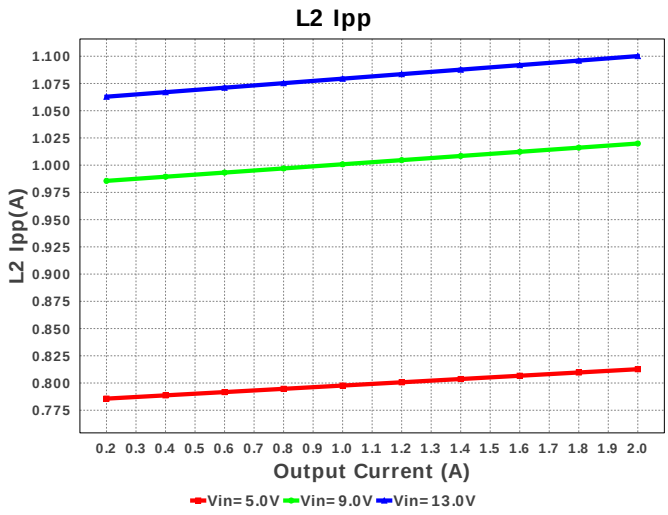


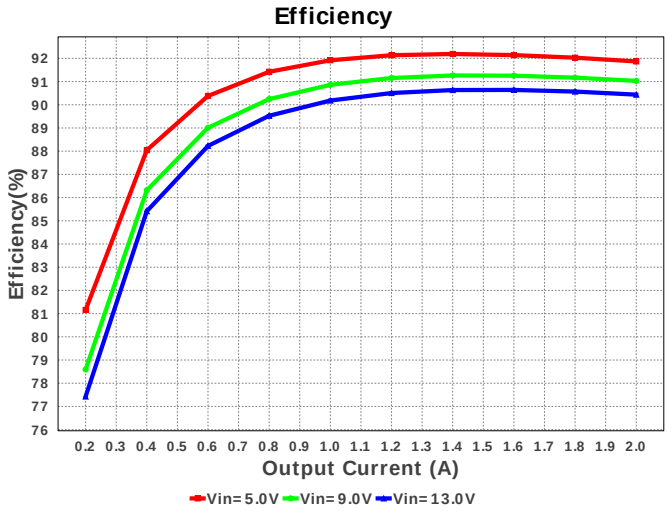


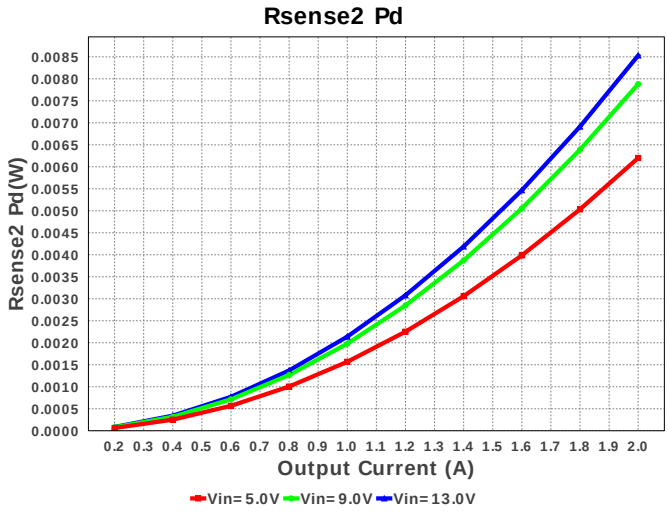


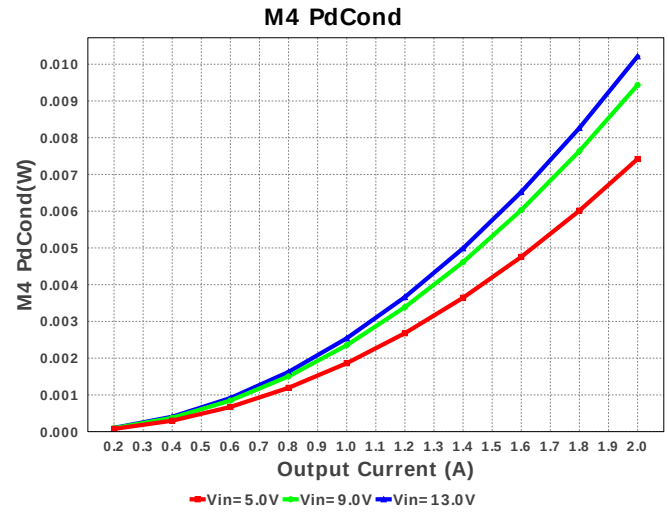


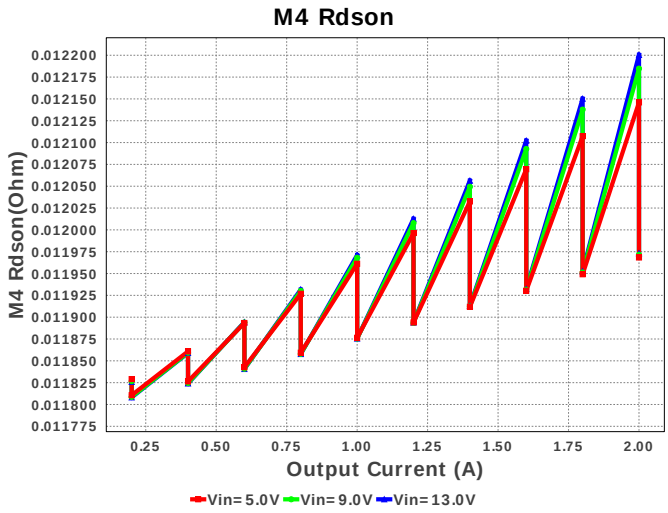


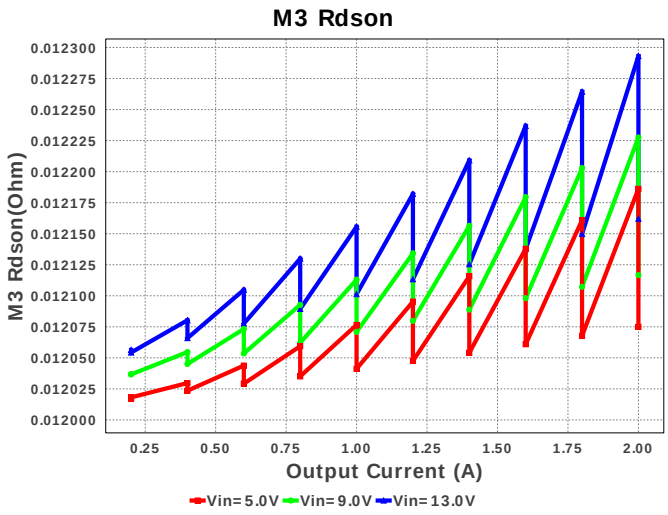


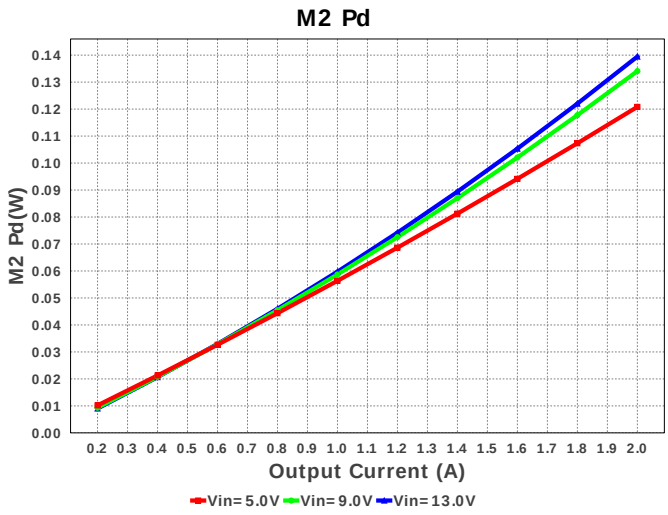


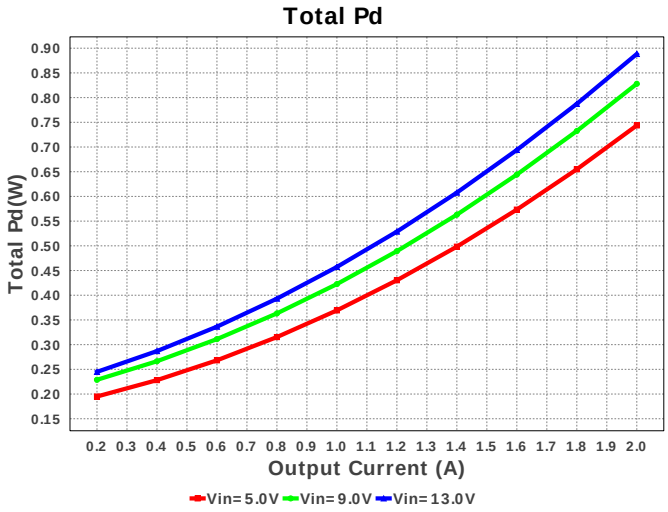


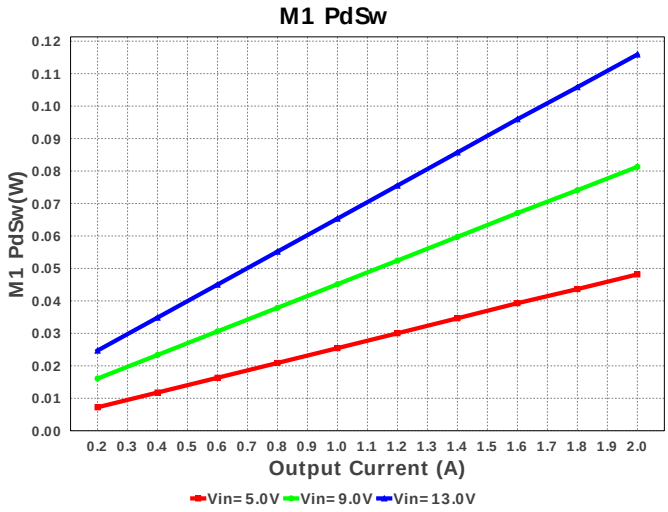


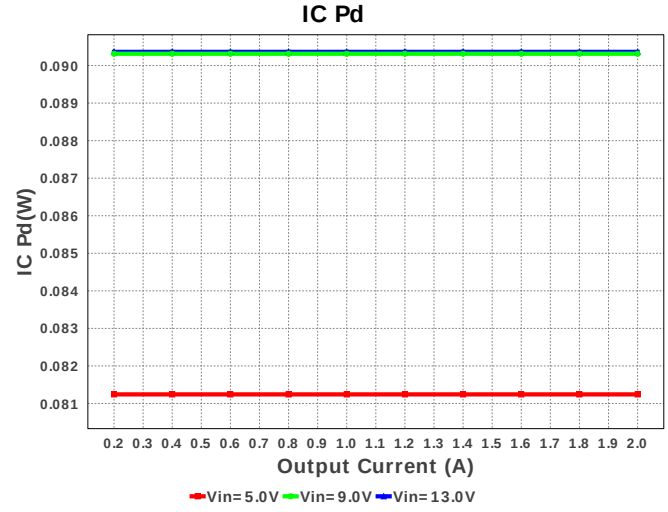


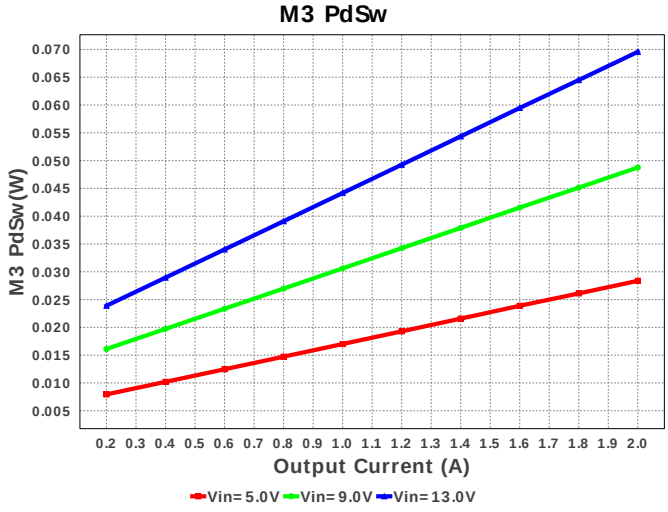


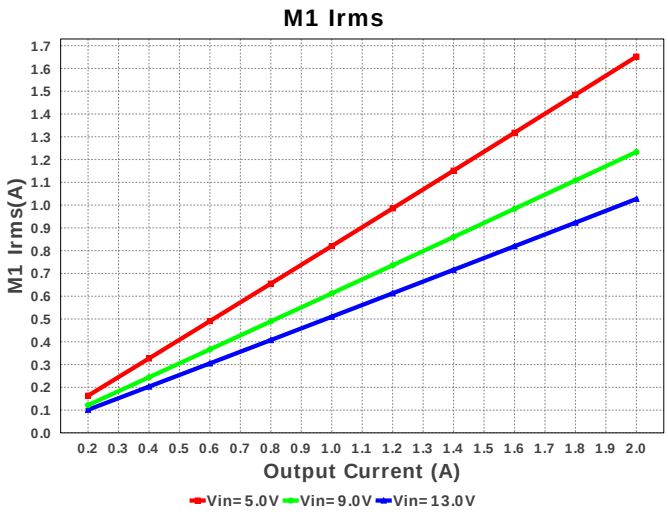


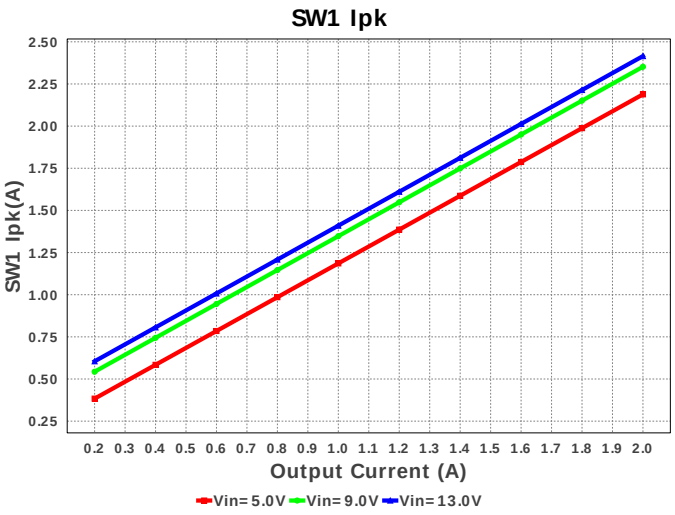


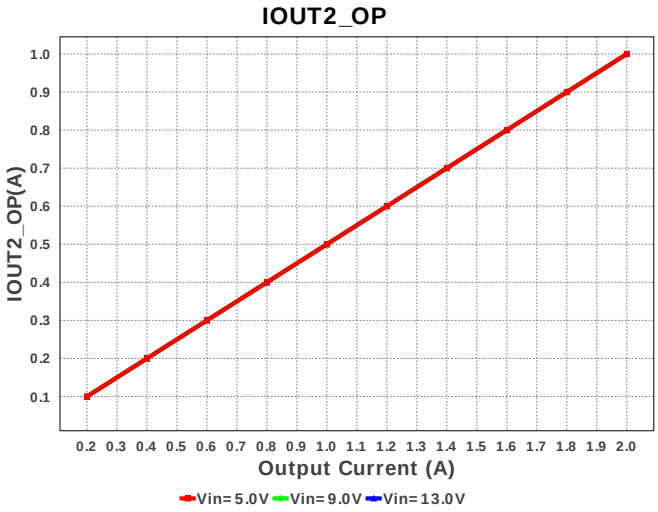


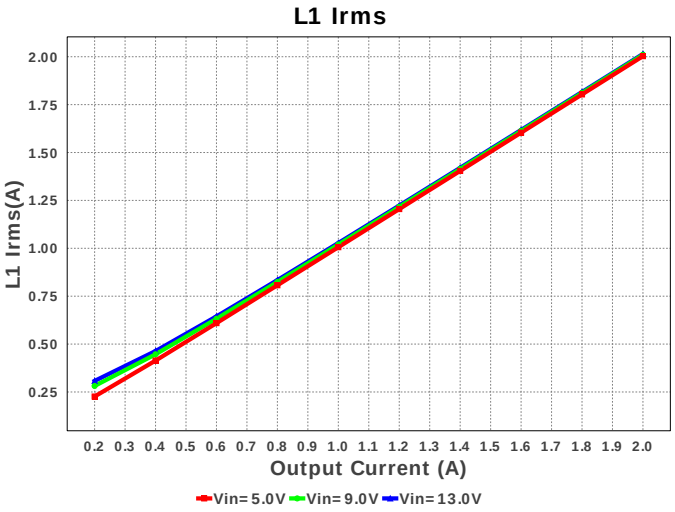


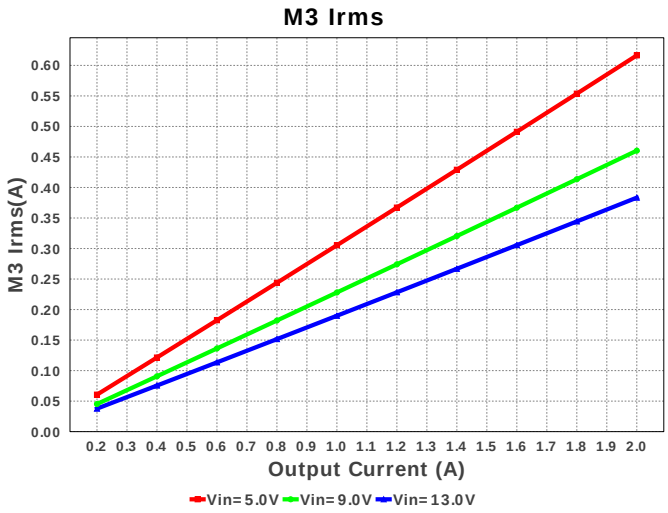


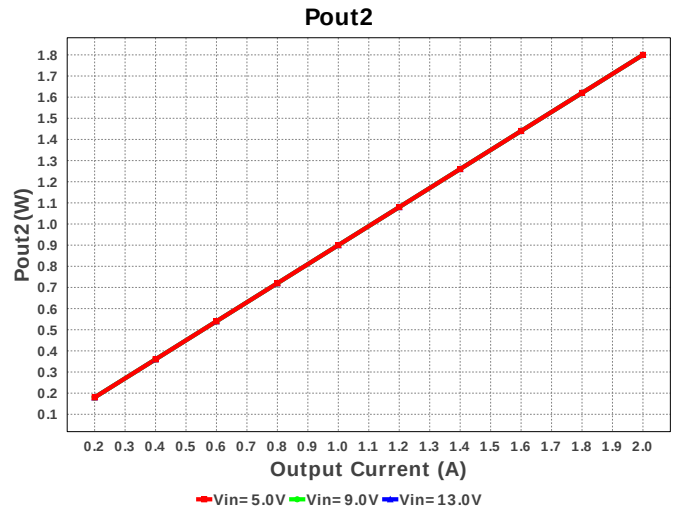


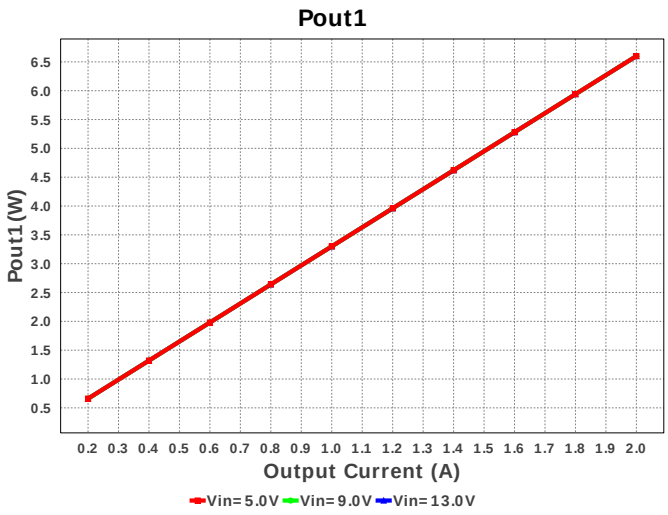


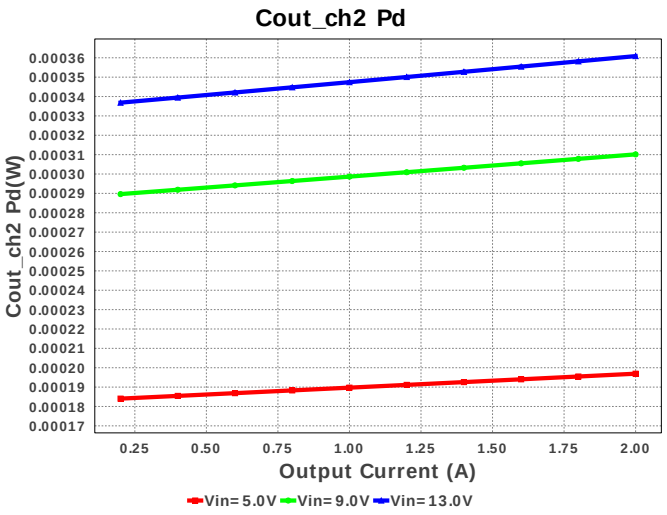


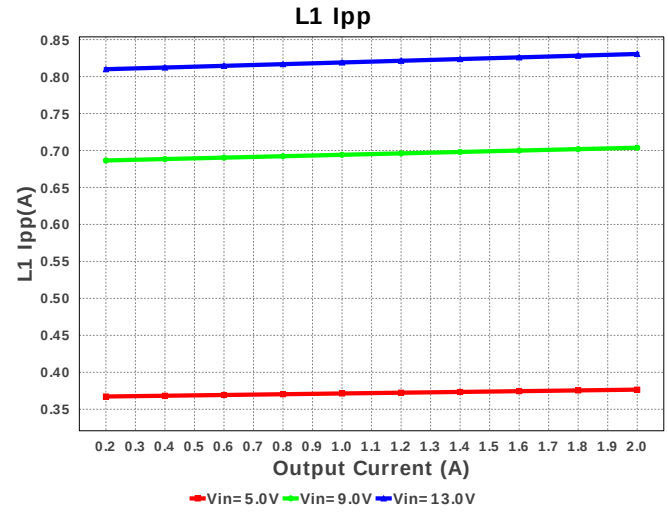


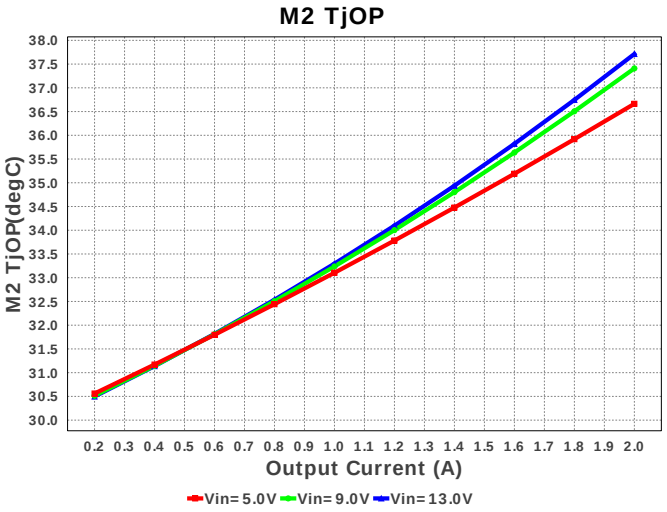


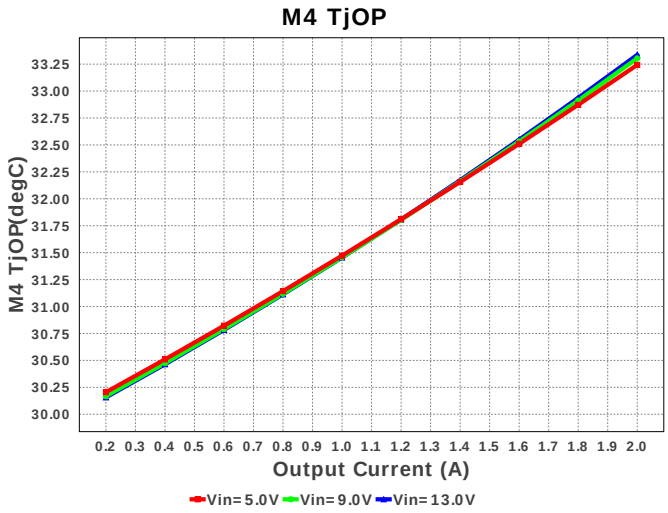


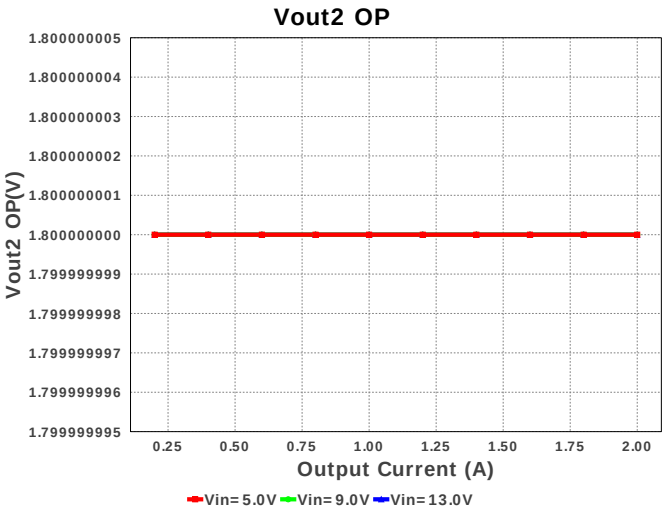


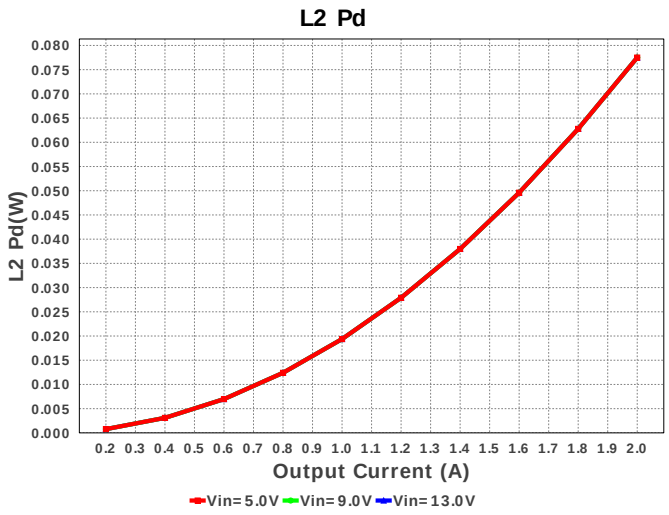


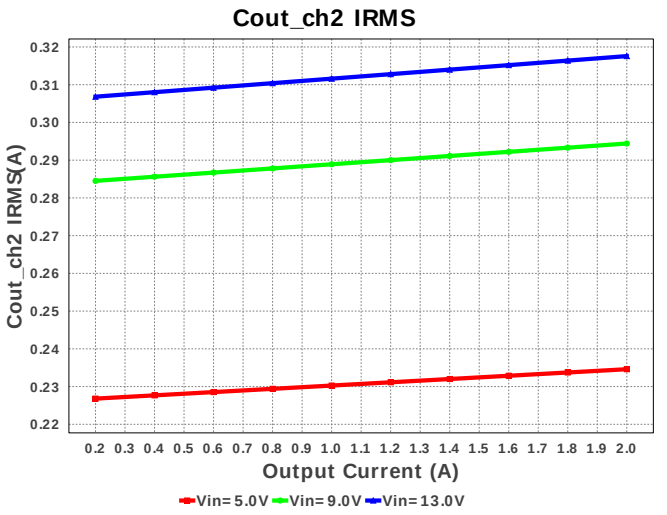


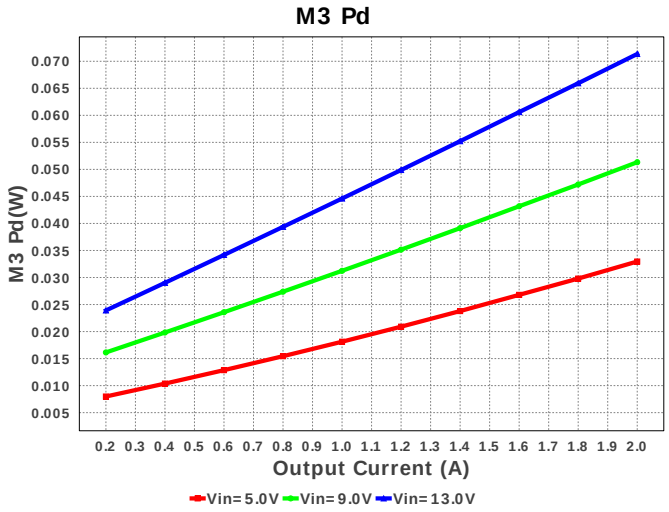


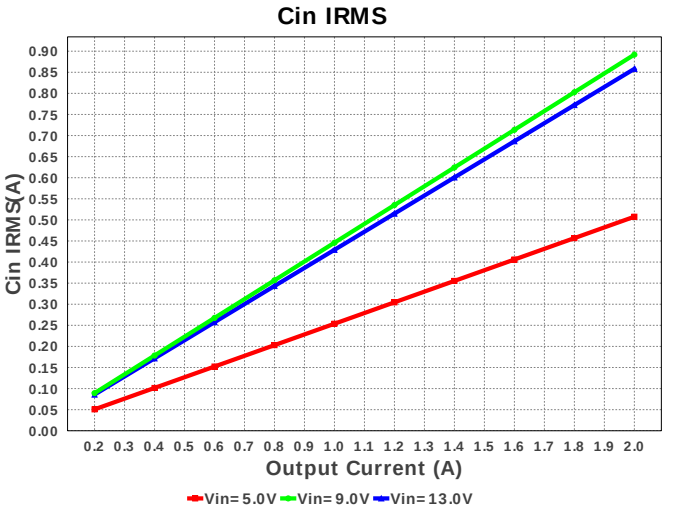












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	858.098 mA	Current	Input capacitor RMS ripple current
2.	Cout_ch1 IRMS	239.754 mA	Current	Output Channel 1 Capacitor RMS ripple current
3.	Cout_ch2 IRMS	317.581 mA	Current	Output Channel 2 Capacitor RMS ripple current
4.	Iin Avg	714.47 mA	Current	Average input current
5.	L1 Ipp	830.533 mA	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	2.014 A	Current	Inductor ripple current
7.	L2 Ipp	1.1 A	Current	Inductor 2 peak to peak current
8.	L2 Irms	1.049 A	Current	Inductor ripple current
9.	M1 Irms	1.027 A	Current	MOSFET RMS ripple current
10.	M2 Irms	1.716 A	Current	MOSFET RMS ripple current
11.	M3 Irms	383.336 mA	Current	MOSFET RMS ripple current
12.	M4 Irms	923.609 mA	Current	MOSFET RMS ripple current
13.	SW1 Ipk	2.415 A	Current	Peak switch current
14.	SW2 Ipk	1.55 A	Current	Peak switch current
15.	BOM Count	37	General	Total Design BOM count
16.	FootPrint	348.0 mm^2	General	Total Foot Print Area of BOM components
17.	Frequency	2.2 MHz	General	Switching frequency
18.	IC Tolerance	12.0 mV	General	IC Feedback Tolerance
19.	Pout1	6.6 W	General	Channel 1 output Power
20.	Pout2	1.8 W	General	Channel 2 output Power
21.	Total BOM	$6.09	General	Total BOM Cost
22.	ch1 Mode	CCM	General	Conduction Mode
23.	ch2 Mode	CCM	General	Conduction Mode
24.	M3 TjOP	33.924 degC	Op_Point	M3 MOSFET junction temperature
25.	M4 TjOP	33.336 degC	Op_Point	M4 MOSFET junction temperature
26.	Duty Cycle 1	26.372 %	Op_point	Duty cycle for Channel 1
27.	Duty Cycle 2	14.695 %	Op_point	Duty cycle for Channel 2
28.	Efficiency	90.438 %	Op_point	Steady state efficiency
29.	IC Tj	33.145 degC	Op_point	IC junction temperature
30.	IOUT1_OP	2.0 A	Op_point	Iout1 operating point
31.	IOUT2_OP	1.0 A	Op_point	Iout2 operating point

#	Name	Value	Category	Description
32.	M1 TjOP	37.092 degC	Op_point	M1 MOSFET junction temperature
33.	M2 TjOP	37.713 degC	Op_point	M2 MOSFET junction temperature
34.	VIN_OP	13.0 V	Op_point	Vin operating point
35.	Vout1 OP	3.3 V	Op_point	Operational Voltage 1
36.	Vout1 p-p	4.42 mV	Op_point	Peak-to-peak output1 ripple voltage
37.	Vout2 OP	1.8 V	Op_point	Operational Voltage 2
38.	Vout2 p-p	4.855 mV	Op_point	Peak-to-peak output2 ripple voltage
39.	Cin Pd	1.473 mW	Power	Input capacitor power dissipation
40.	Cout_ch1 Pd	129.335 µW	Power	Ouput channel 1 capacitor power dissipation
41.	Cout_ch2 Pd	360.868 µW	Power	Ouput channel 2 capacitor power dissipation
42.	IC Pd	90.364 mW	Power	IC power dissipation
43.	L1 Pd	190.0 mW	Power	Inductor power dissipation
44.	L2 Pd	77.5 mW	Power	Inductor power dissipation
45.	M1 Pd	128.725 mW	Power	M1 MOSFET total power dissipation
46.	M1 PdCond	12.967 mW	Power	M1 MOSFET conduction losses
47.	M1 PdSw	115.758 mW	Power	M1 MOSFET switching losses
48.	M2 Pd	139.468 mW	Power	M2 MOSFET total power dissipation
49.	M2 PdCond	35.932 mW	Power	M2 MOSFET conduction losses
50.	M2 PdSw	103.536 mW	Power	M2 MOSFET switching losses
51.	M3 Pd	71.309 mW	Power	M3 MOSFET total power dissipation
52.	M3 PdCond	1.787 mW	Power	M3 MOSFET conduction losses
53.	M3 PdSw	69.522 mW	Power	M3 MOSFET switching losses
54.	M3 Rdson	12.293 mOhm	Power	Drain-Source On-resistance
55.	M3 Rdson	12.162 mOhm	Power	Drain-Source On-resistance
56.	M4 Pd	60.434 mW	Power	M4 MOSFET total power dissipation
57.	M4 PdCond	10.214 mW	Power	M4 MOSFET conduction losses
58.	M4 PdSw	50.22 mW	Power	M4 MOSFET switching losses
59.	M4 Rdson	12.2 mOhm	Power	Drain-Source On-resistance
60.	M4 Rdson	11.973 mOhm	Power	Drain-Source On-resistance
61.	Rsense1 Pd	29.451 mW	Power	Current Limit Sense Resistor Power Dissipation
62.	Rsense2 Pd	8.531 mW	Power	Current Limit Sense Resistor Power Dissipation
63.	Total Pd	888.109 mW	Power	Total Power Dissipation
64.	Cross Freq Ch1	40.429 kHz		Bode plot crossover frequency
65.	Cross Freq Ch2	27.893 kHz		Bode plot crossover frequency
66.	Phase Marg Ch1	56.133 deg		Bode Plot Phase Margin
67.	Phase Marg Ch2	68.03 deg		Bode Plot Phase Margin
68.	Vout Tolerance	666.67 m%		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	Iout1	2.0	Output Current #1
3.	Iout2	1.0	Output Current #2
4.	VinMax	13.0	Maximum input voltage
5.	VinMin	5.0	Minimum input voltage
6.	Vout	3.3	Output Voltage
7.	Vout1	3.3	Output Voltage #1
8.	Vout2	1.8	Output Voltage #2
9.	base_pn	LM5140-Q1	Texas Instruments Base Part Number
10.	source	DC	Input Source Type
11.	ta	30.0	Ambient temperature

Design Assistance

1. The LM5140-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

2. LM5140-Q1 Product Folder : http://www.ti.com/product/LM5140%2Dq1 : contains the data sheet and other resources.