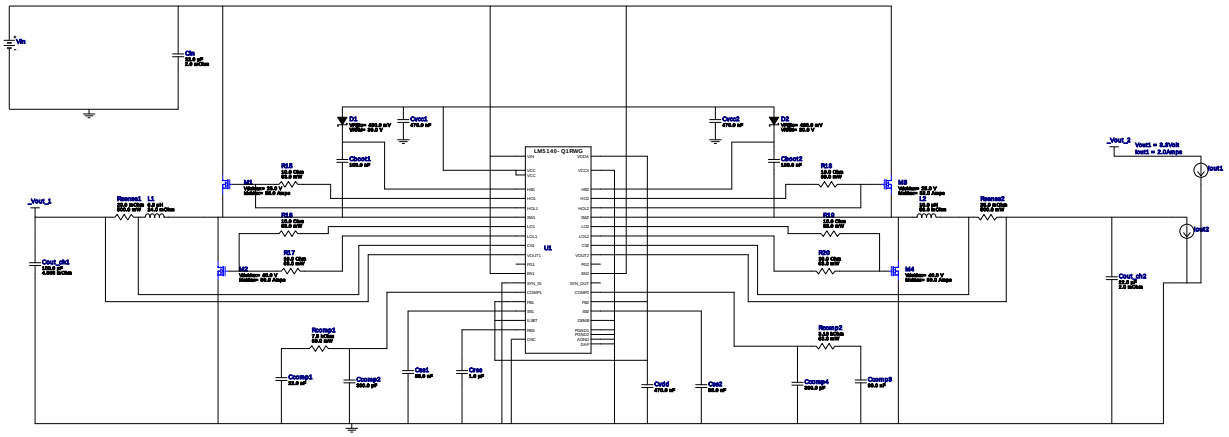
WEBENCH® Design Report

VinMin = 9.0V
VinMax = 18.0V
Vout = 3.3V
Iout = 2.0A

Device = LM5140QRWGRQ1
Topology = Buck
Created = 7/12/16 7:54:00 PM
BOM Cost = $7.03
BOM Count = 34
Total Pd = 0.46W

Design : 4006436/7 LM5140QRWGRQ1
LM5140QRWGRQ1 9.0V-18.0V to 5.00V @ 1.0A



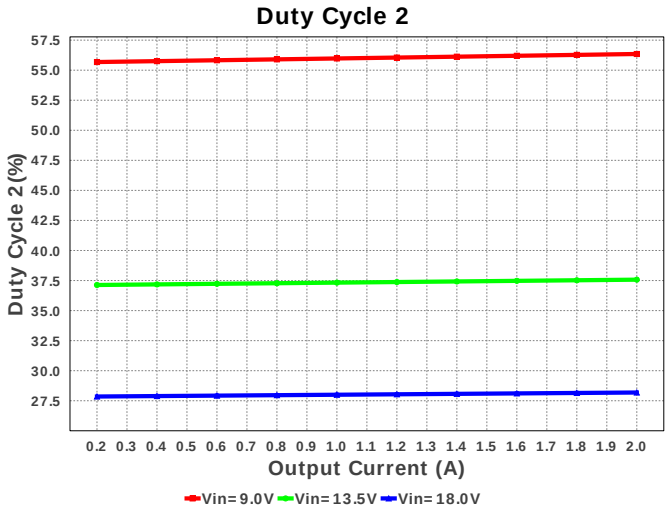
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific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

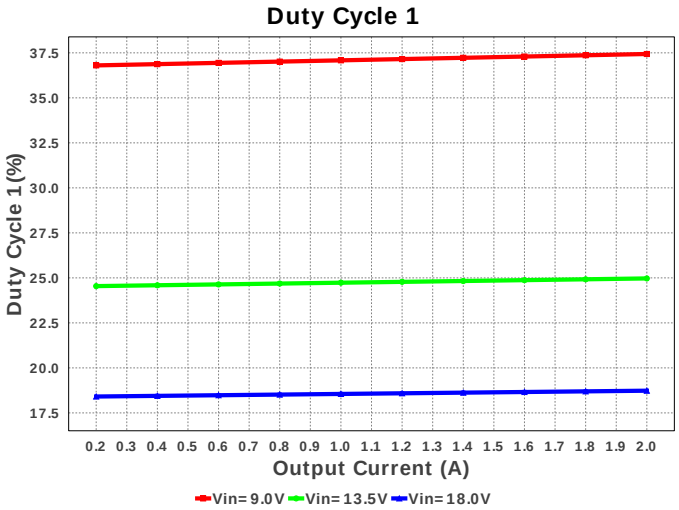
Electrical BOM

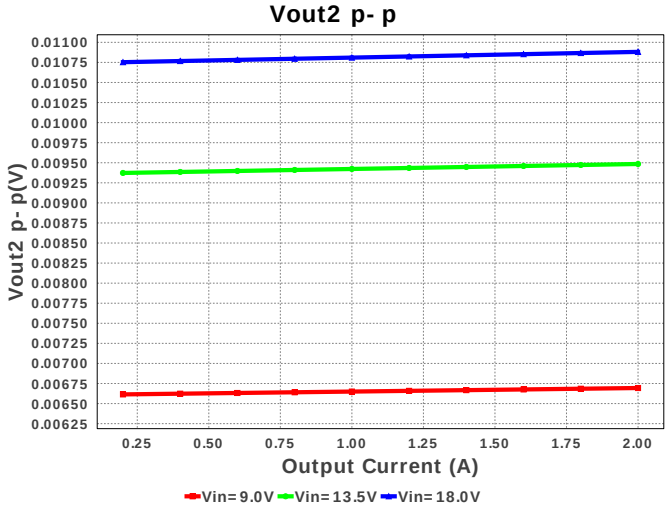
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot1	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
2.	Cboot2	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
3.	Ccomp1	Yageo America	CC0805KRX7R9BB223 Series= X7R	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Ccomp2	Yageo America	CC0805KRX7R9BB391 Series= X7R	Cap= 390.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
5.	Ccomp3	MuRata	GRM033R60J333KE01D Series= X5R	Cap= 33.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
6.	Ccomp4	Yageo America	CC0805KRX7R9BB391 Series= X7R	Cap= 390.0 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	GRM31CR60J107ME39L Series= X5R	Cap= 100.0 uF ESR= 4.885 mOhm VDC= 6.3 V IRMS= 4.4118 A	1	$0.14	1206_190 11 mm^2
9.	Cout_ch2	MuRata	GRM32ER61C226ME20L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 16.0 V IRMS= 3.68 A	1	$0.12	1210 15 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

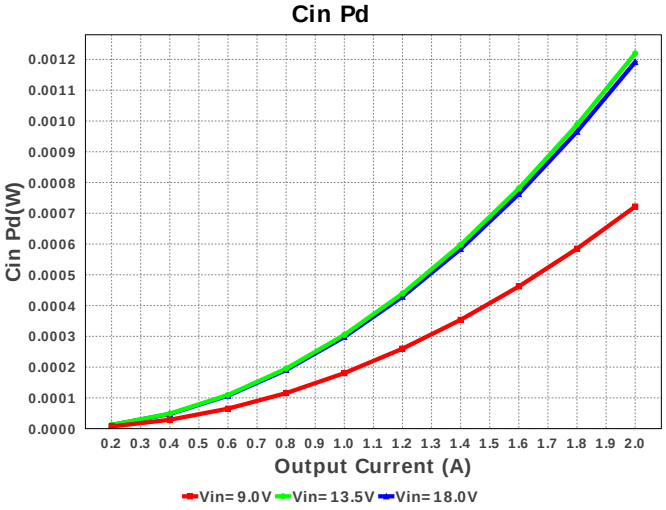
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
11.	Css1	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
12.	Css2	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
13.	Cvcc1	MuRata	GRM155C80J474KE19D 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	MBR0530T1G	VF@Io= 430.0 mV VRRM= 30.0 V	1	$0.06	SOD-123 13 mm²
17.	D2	ON Semiconductor	MBR0530T1G	VF@Io= 430.0 mV VRRM= 30.0 V	1	$0.06	SOD-123 13 mm²
18.	L1	TDK	VLP8040T-6R8M	L= 6.8 µH DCR= 24.0 mOhm	1	$0.22	VLP8040 113 mm²
19.	L2	Bourns	SRN6045-100M	L= 10.0 µH DCR= 58.6 mOhm	1	$0.16	SRN6045 64 mm²
20.	M1	Texas Instruments	CSD16411Q3	VdsMax= 25.0 V IdsMax= 56.0 Amps	1	$0.34	TRANS_NexFET_Q3 18 mm²
21.	M2	Texas Instruments	CSD18504Q5A	VdsMax= 40.0 V IdsMax= 50.0 Amps	1	$0.56	TRANS_NexFET_Q5A 55 mm²
22.	M3	Texas Instruments	CSD16412Q5A	VdsMax= 25.0 V IdsMax= 52.0 Amps	1	$0.34	TRANS_NexFET_Q5A 55 mm²
23.	M4	Texas Instruments	CSD18504Q5A	VdsMax= 40.0 V IdsMax= 50.0 Amps	1	$0.56	TRANS_NexFET_Q5A 55 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

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
30.	Rcomp1	Vishay-Dale	CRCW04027K50FKED Series= CRCW..e3	Res= 7.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	Rcomp2	Vishay-Dale	CRCW04023K16FKED Series= CRCW..e3	Res= 3.16 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rsense1	Stackpole Electronics Inc	CSR1206FK20L0 Series= ?	Res= 20.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	1206 11 mm²
33.	Rsense2	Stackpole Electronics Inc	CSR1206FK25L0 Series= ?	Res= 25.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	1206 11 mm²
34.	U1	Texas Instruments	LM5140QRWGRQ1	Switcher	1	$3.90	RWG0040A 64 mm²

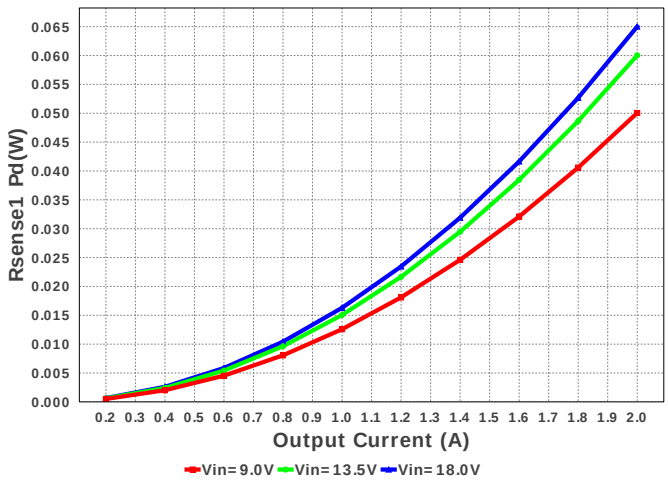




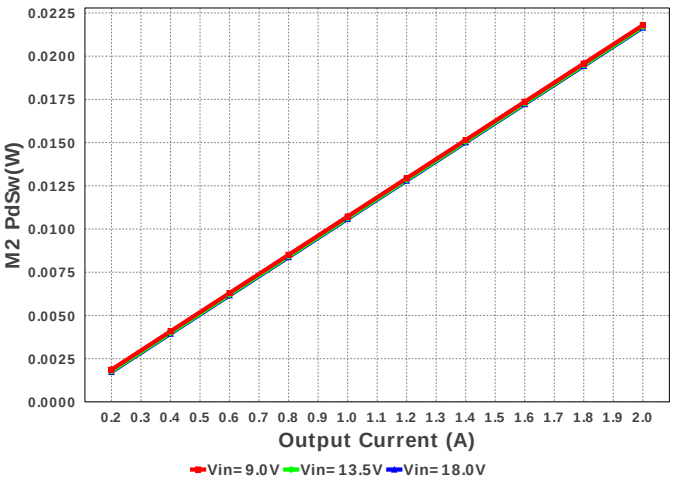




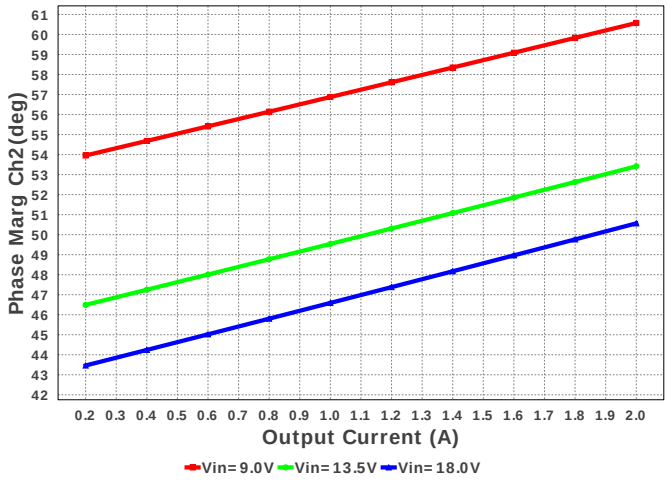
Rsense1 Pd



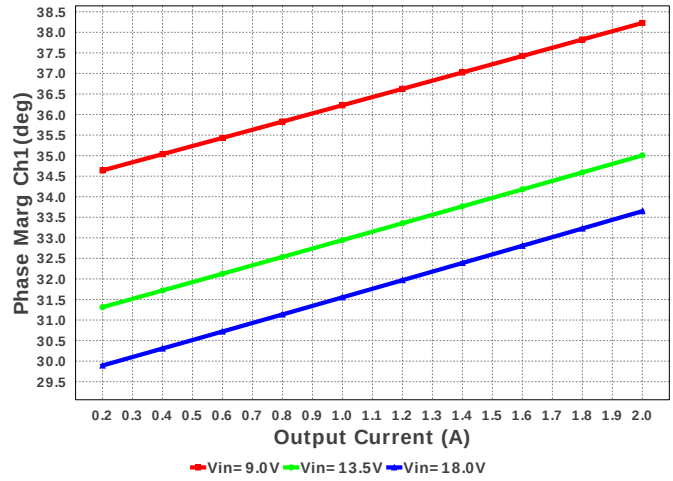
M2 PdSw



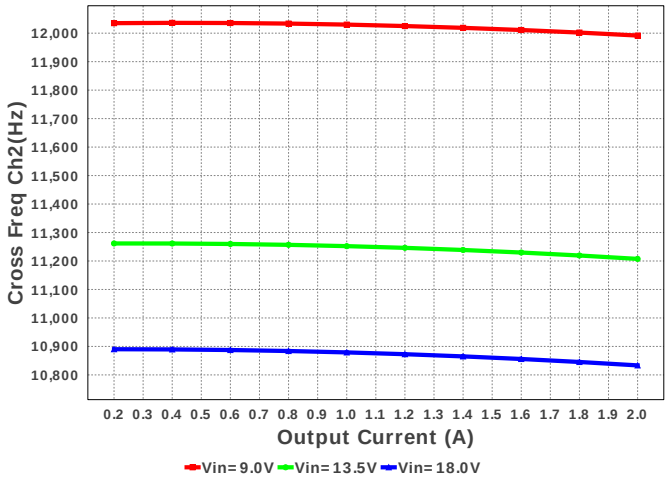
Phase Marg Ch2



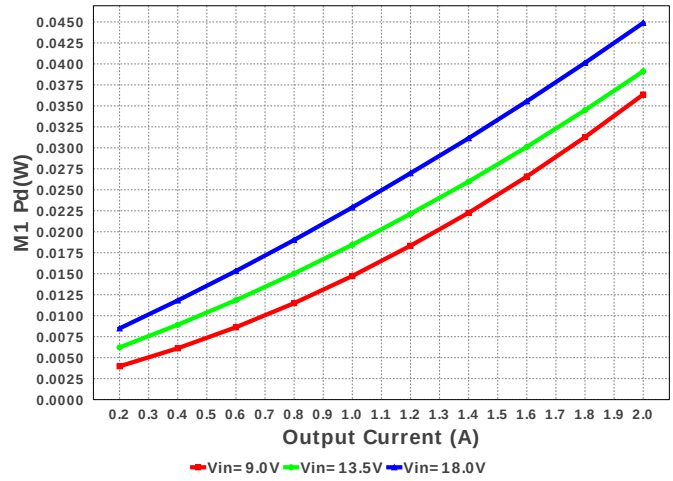
Phase Marg Ch1



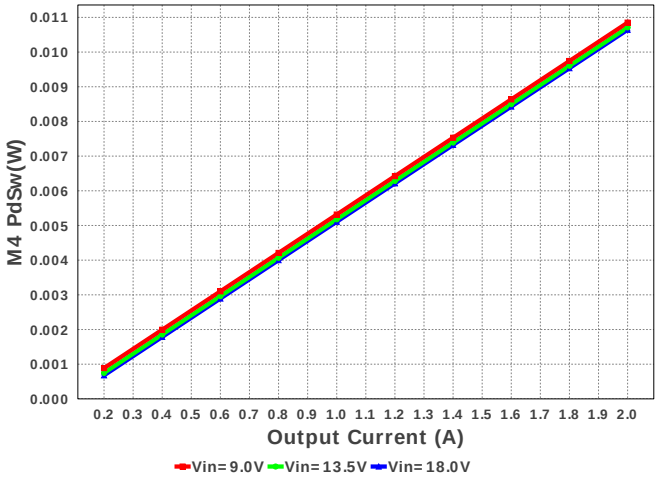
Cross Freq Ch2



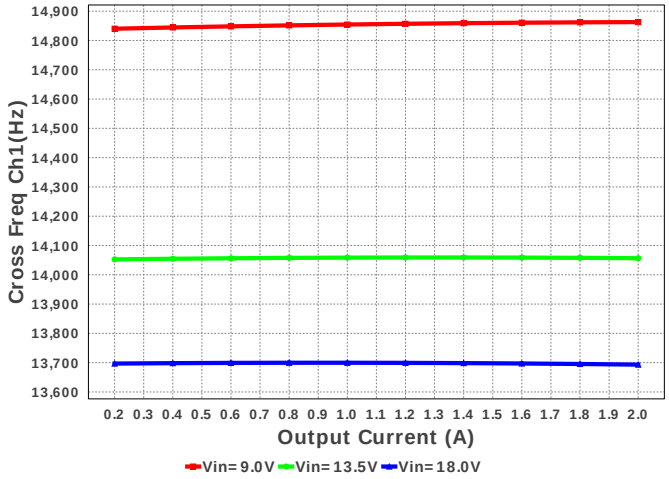
M1 Pd



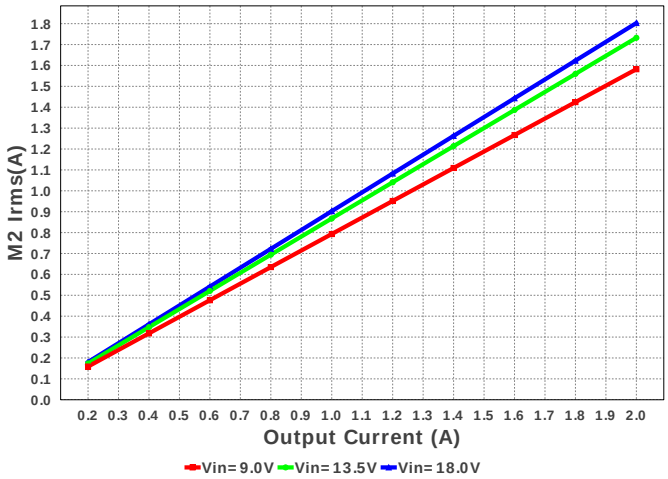
M4 PdSw



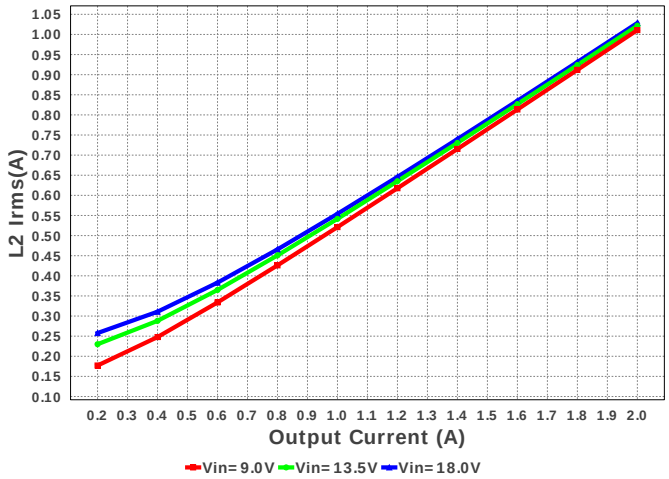
Cross Freq Ch1



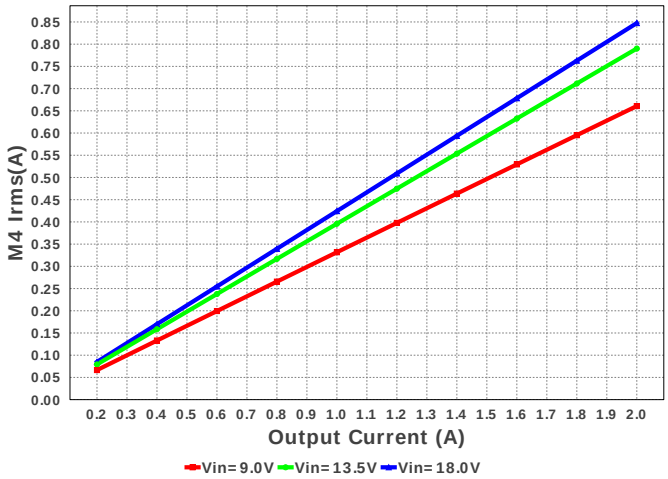
M2 Irms



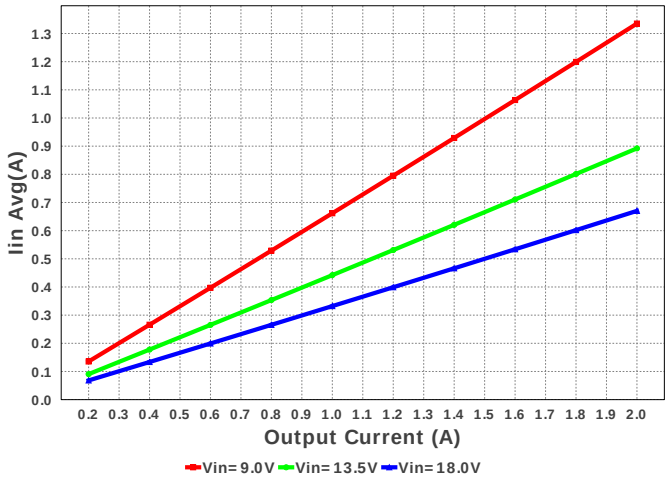
L2 Irms

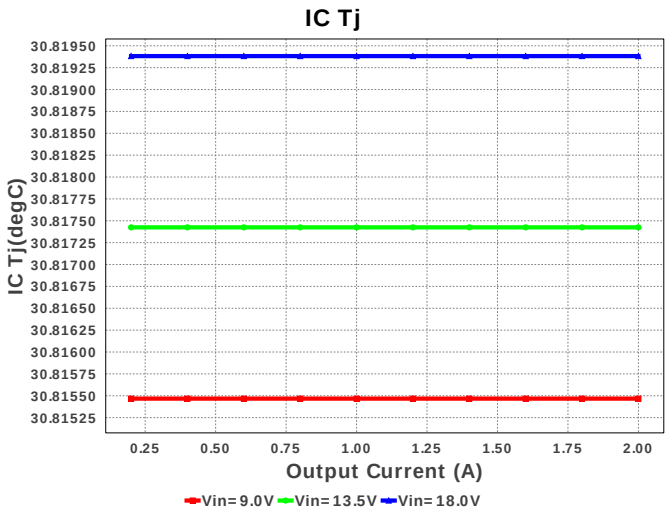


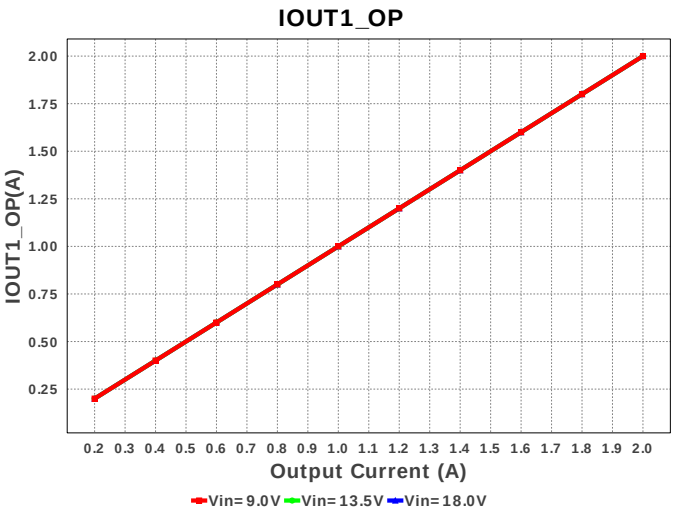
M4 Irms

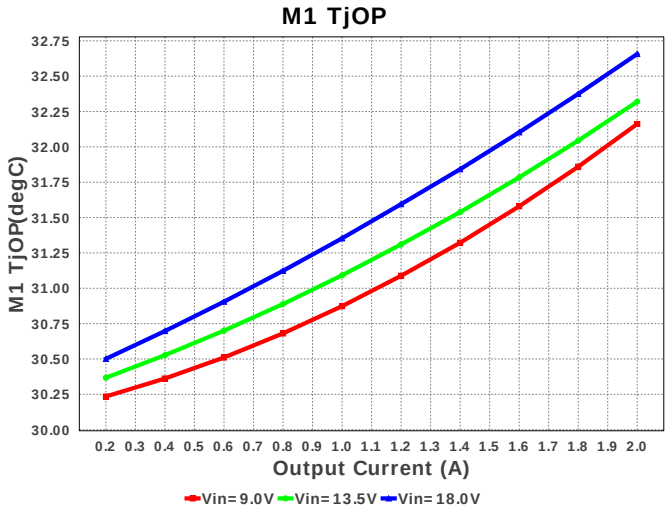


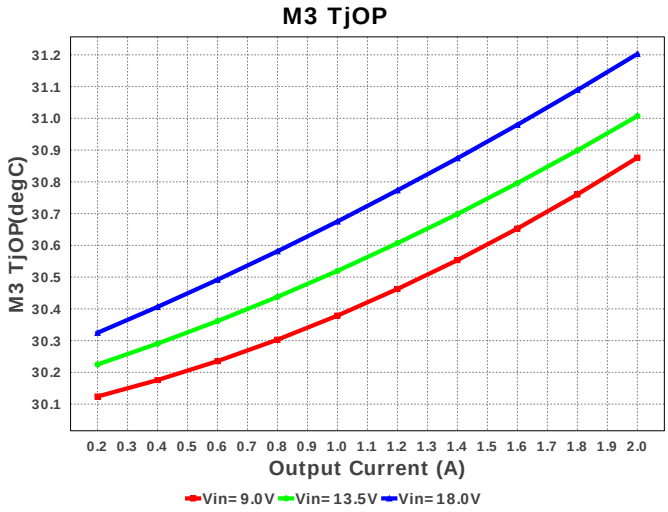
Iin Avg

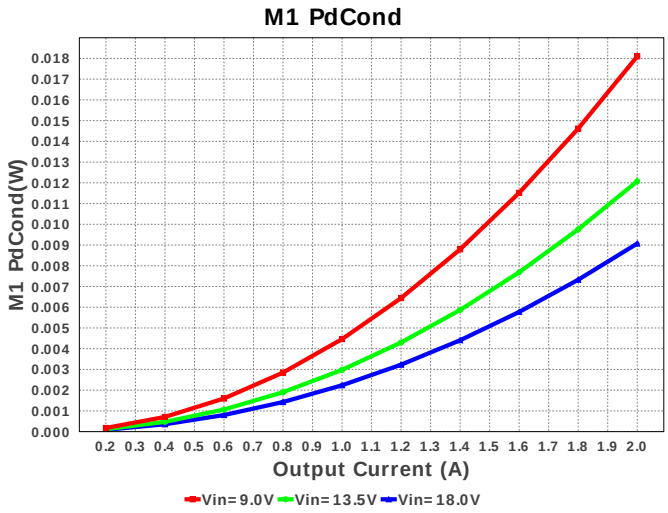


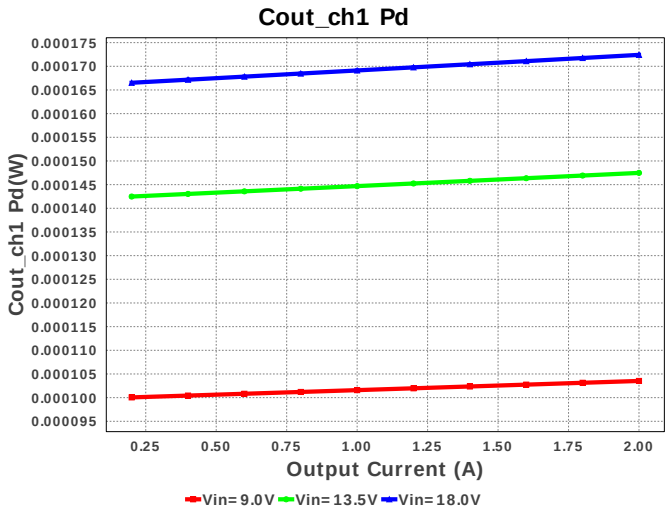


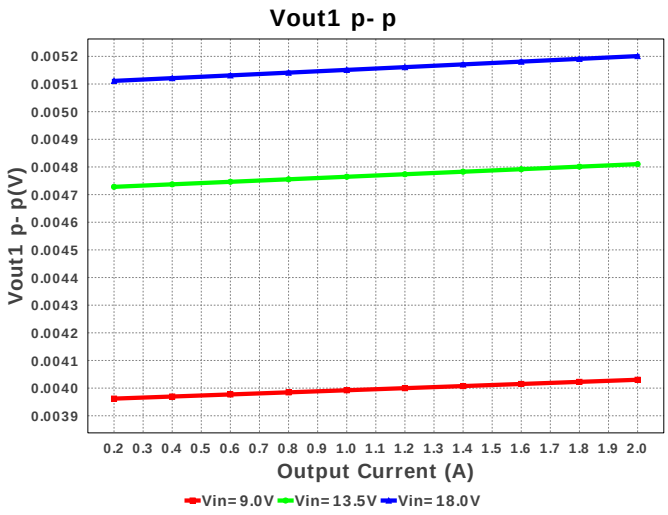


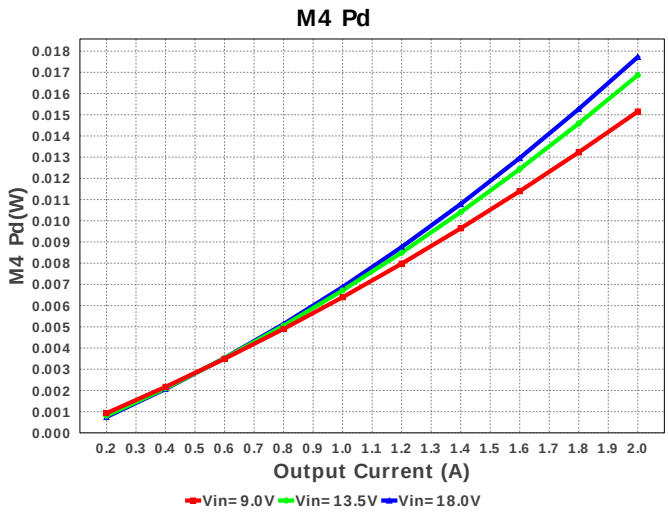


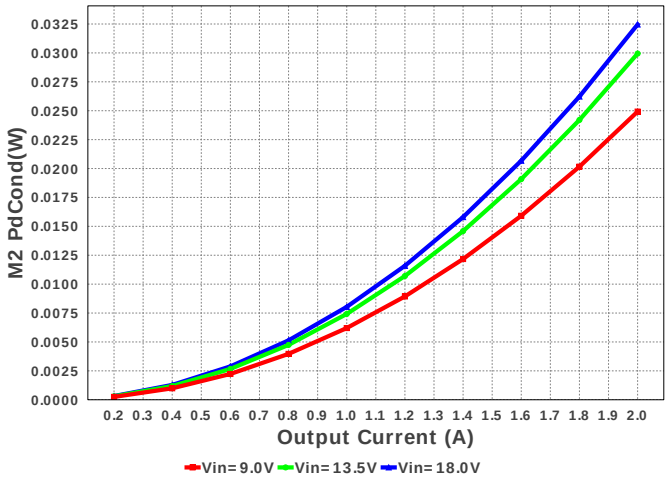


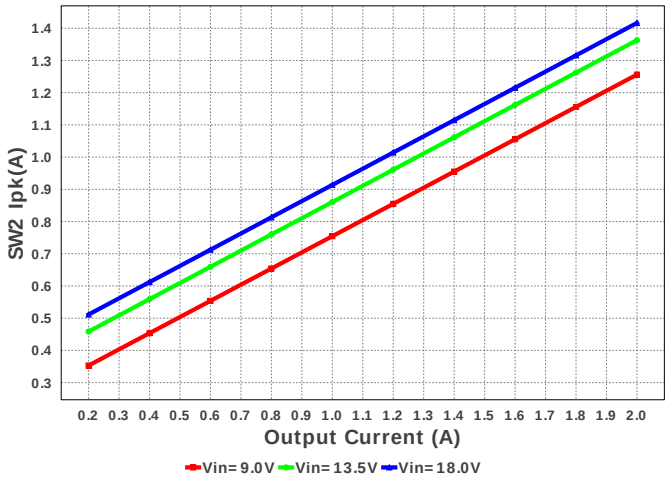


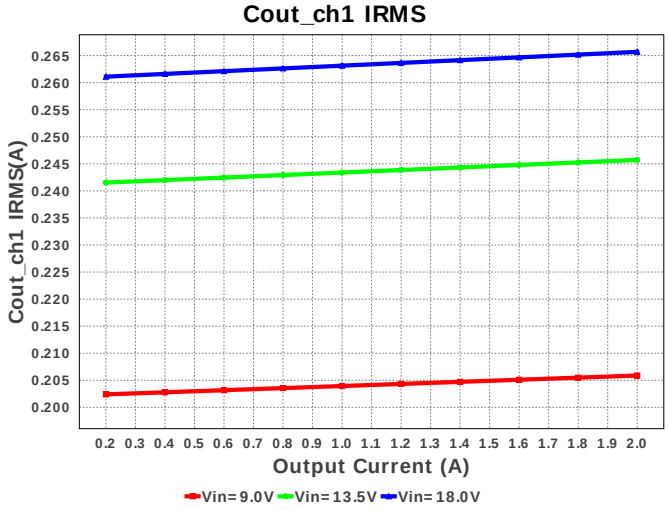


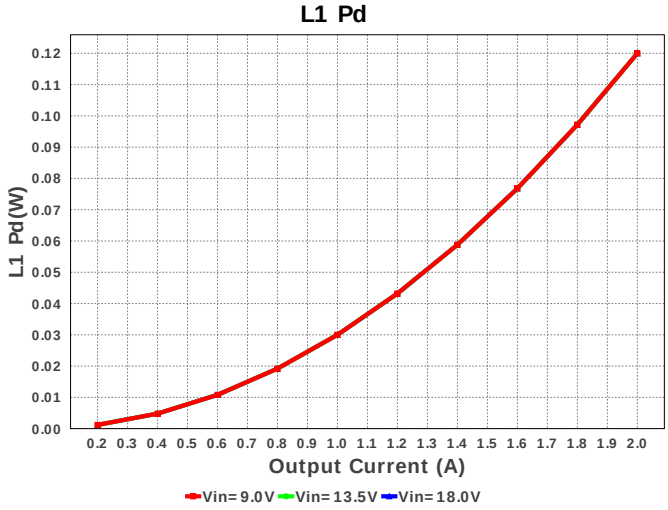


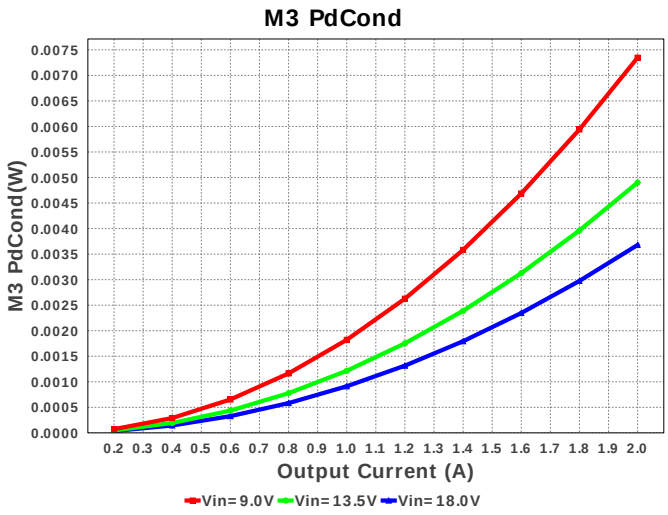


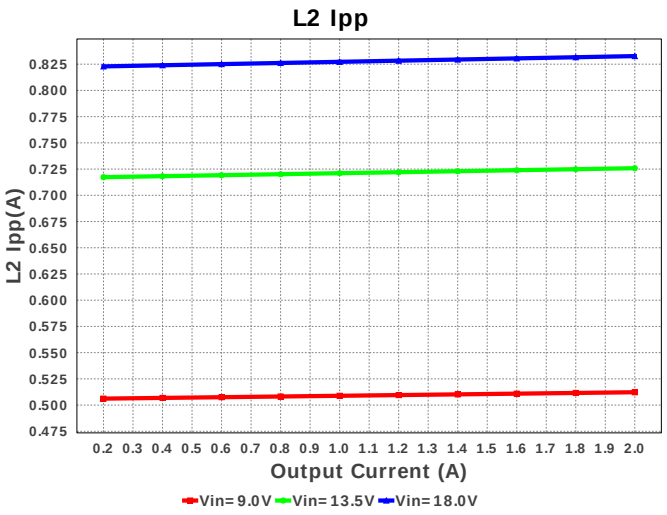


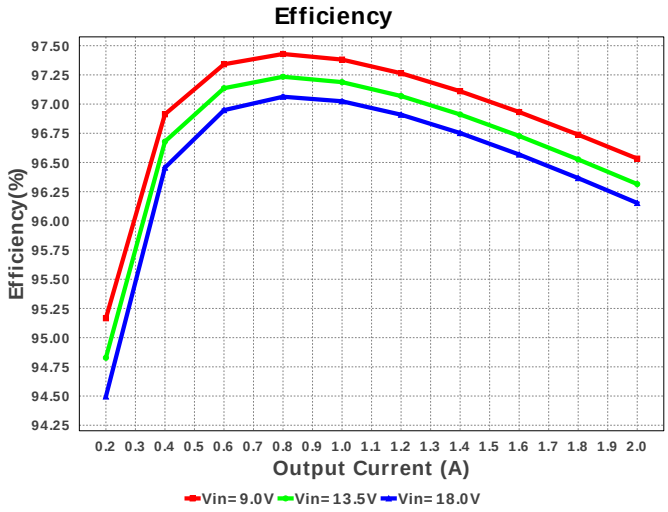


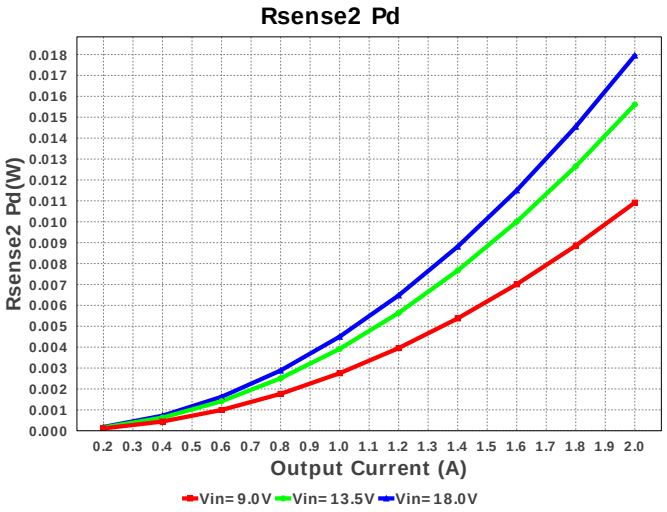


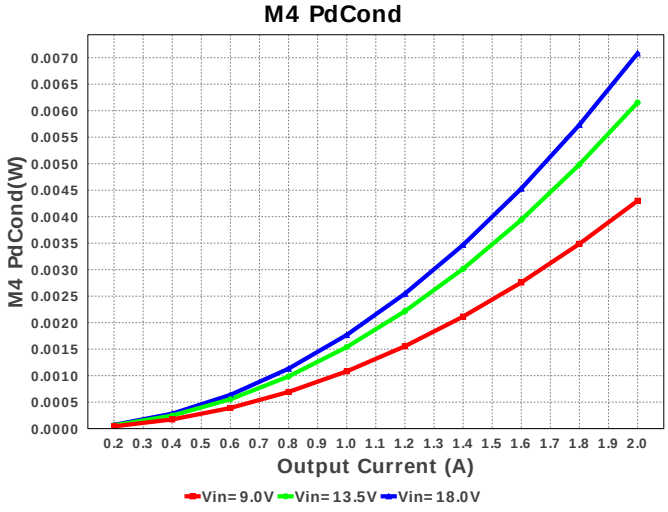


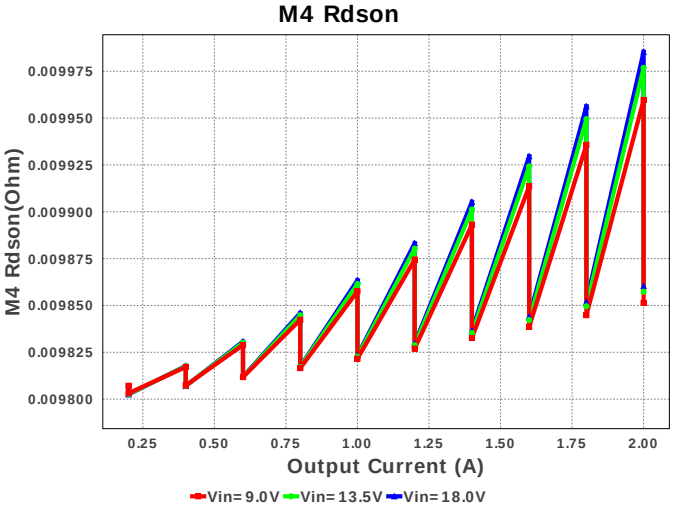


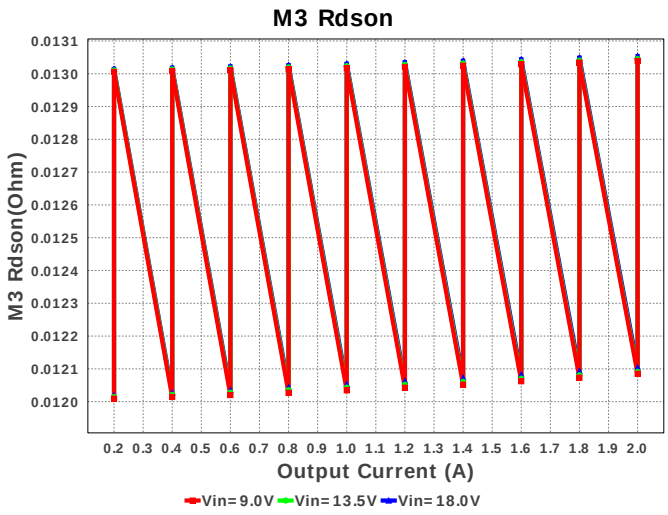


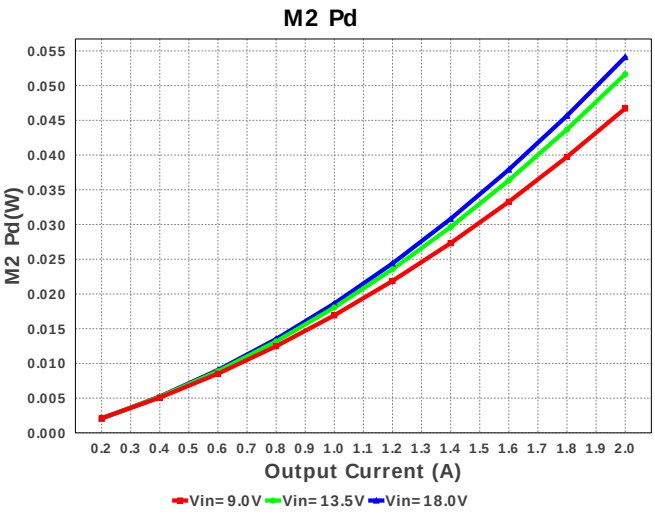


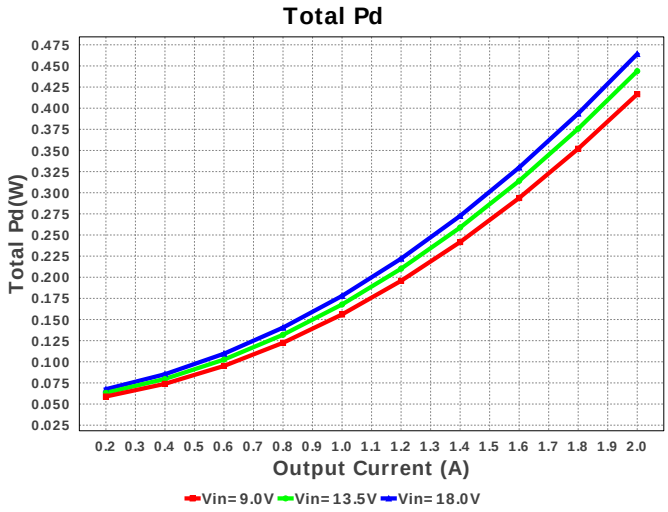


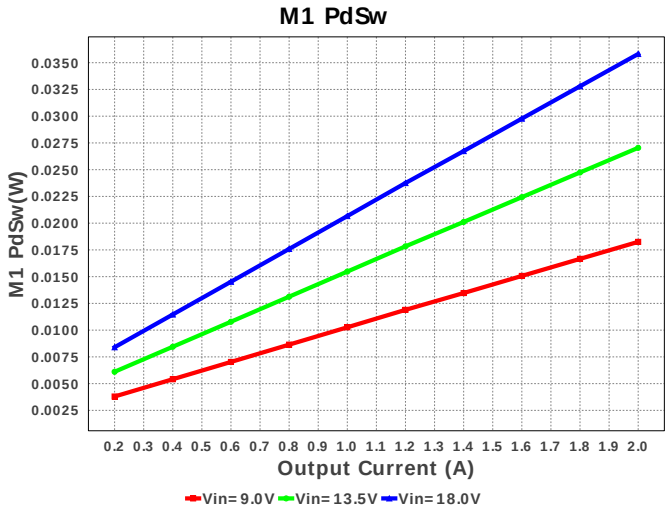


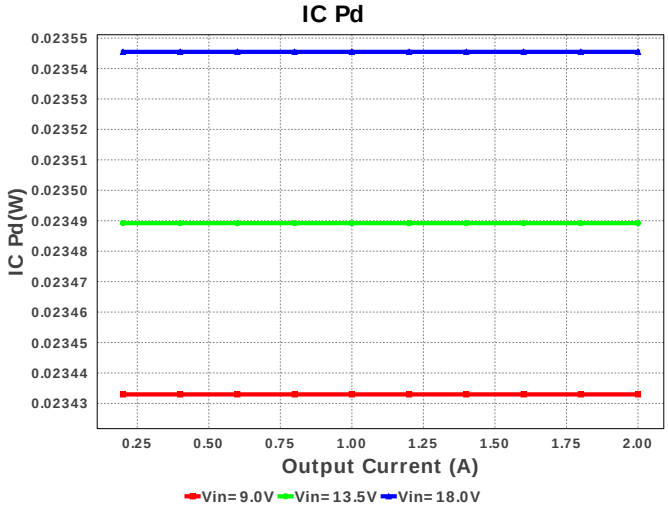


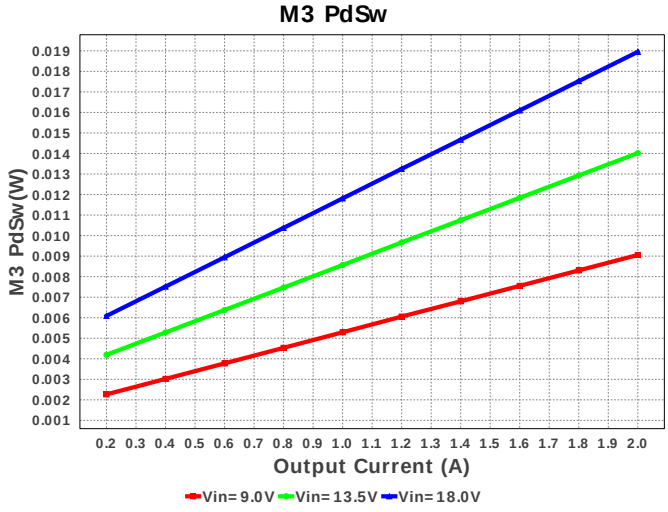


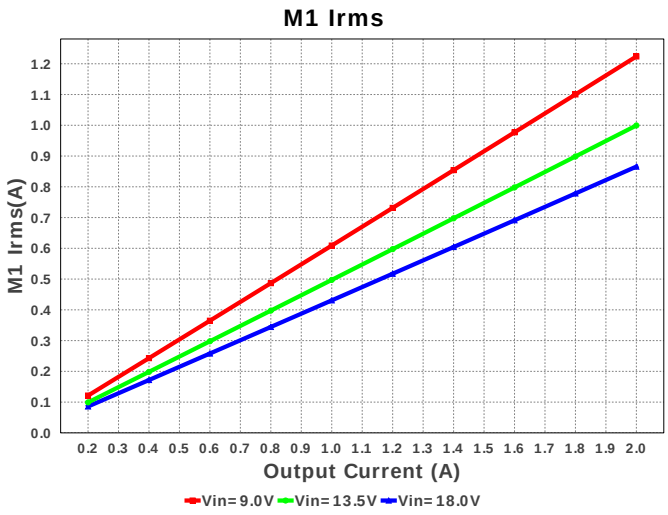


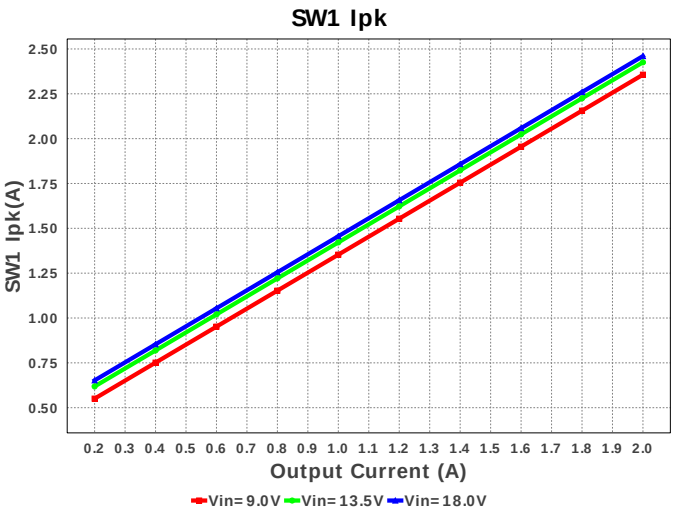


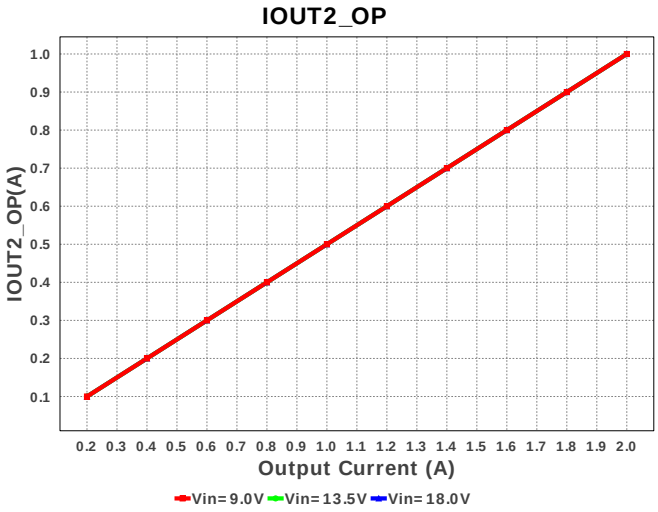


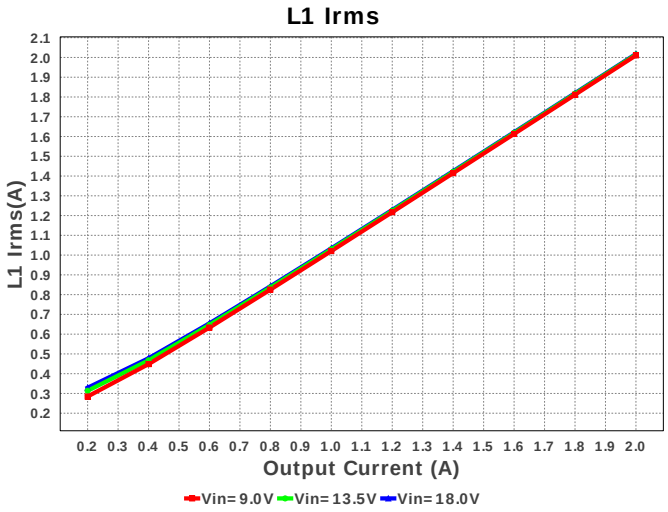


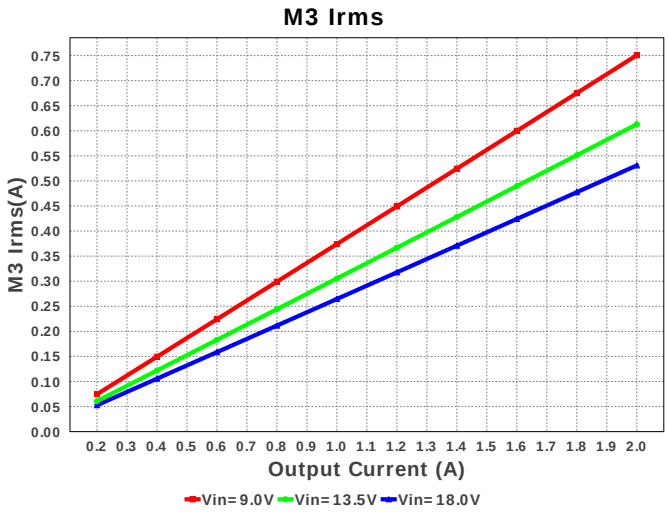


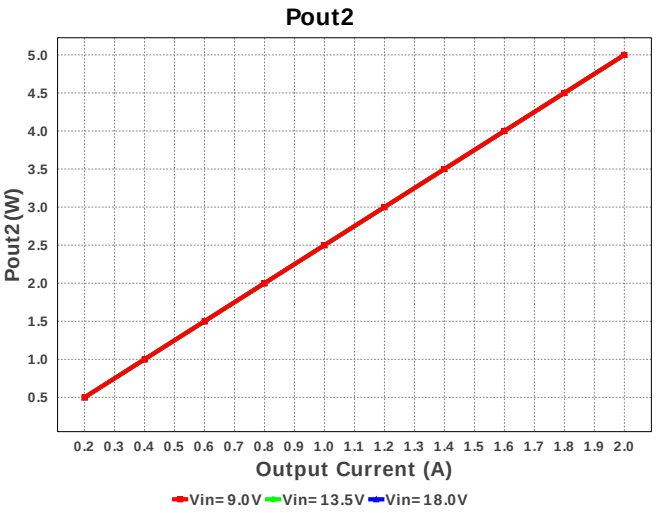


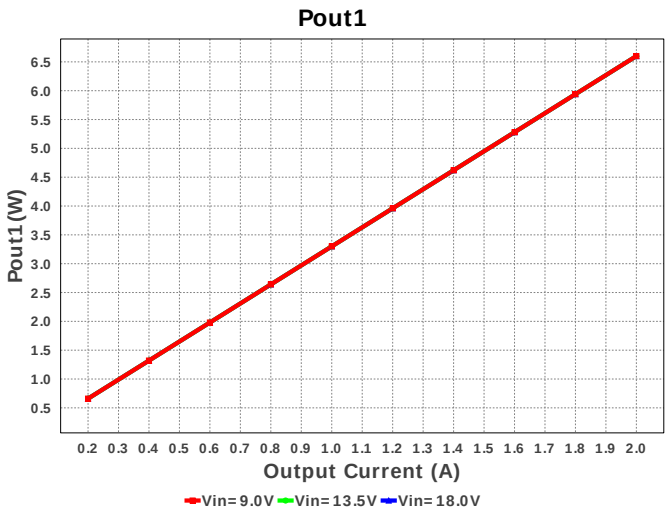


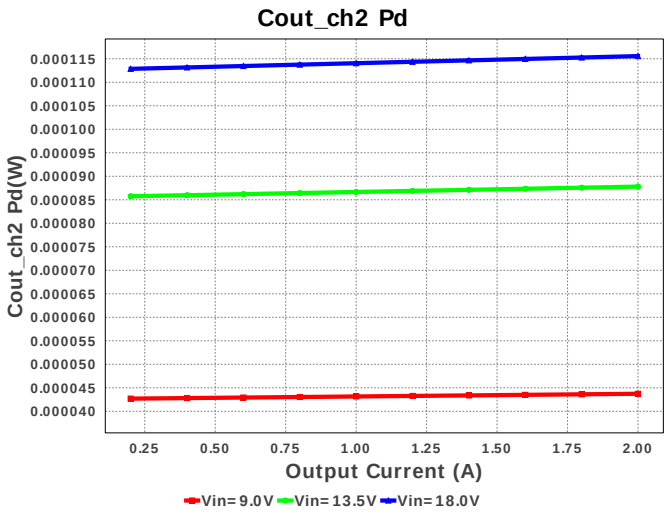


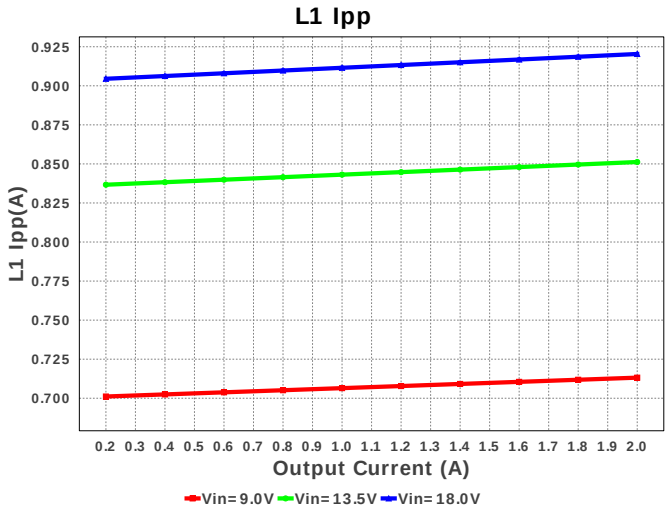


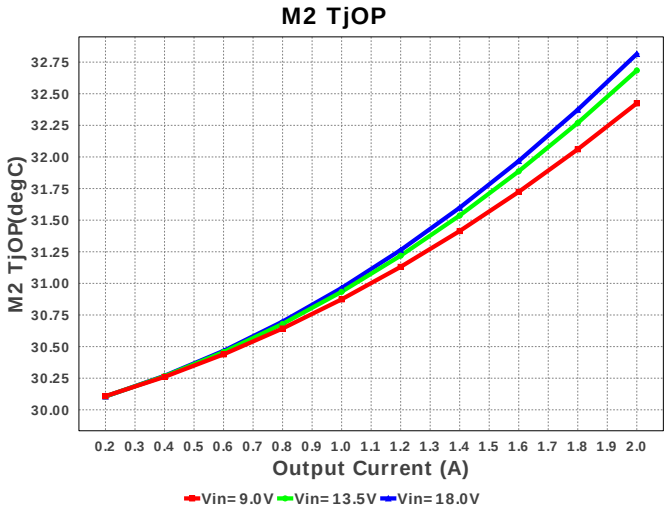


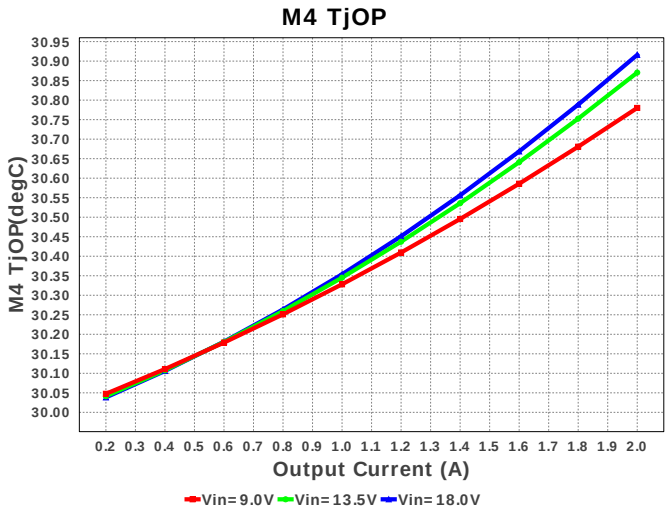


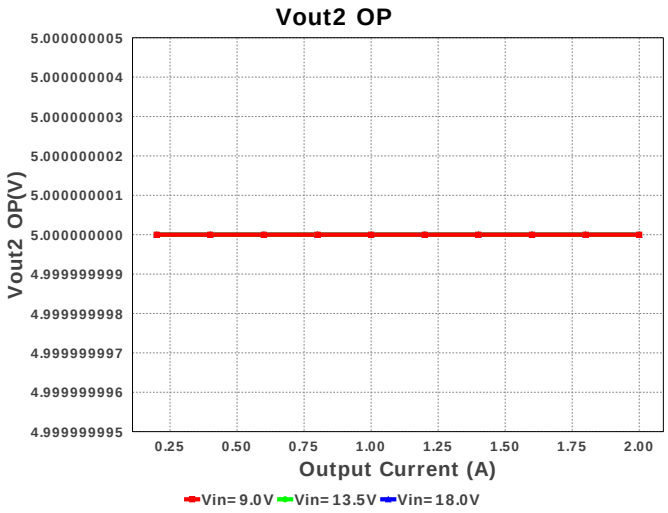


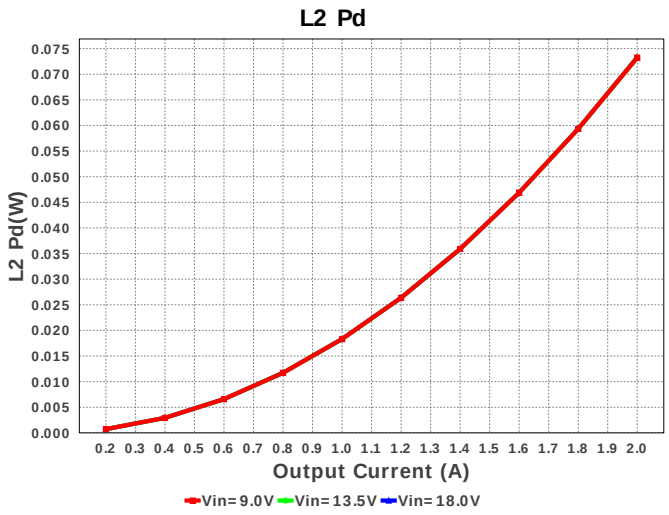


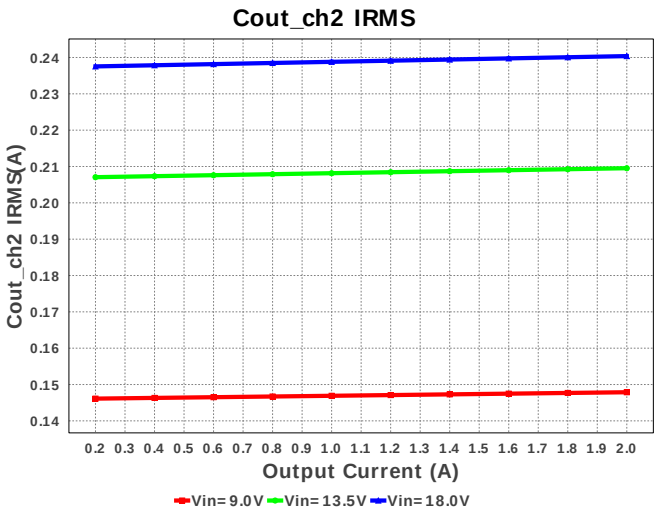


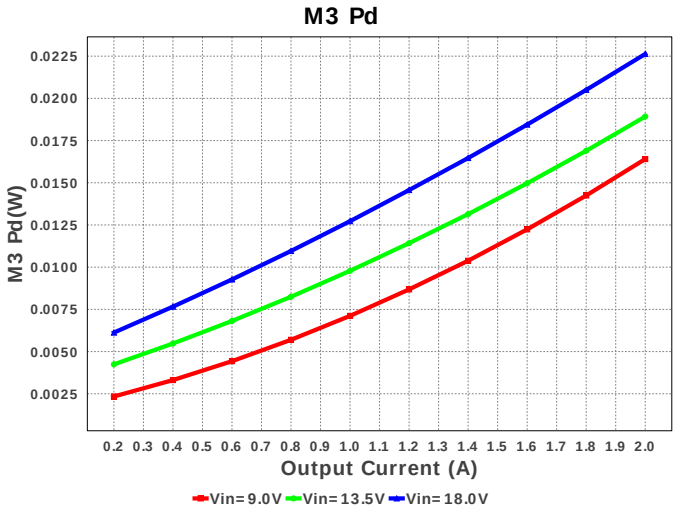


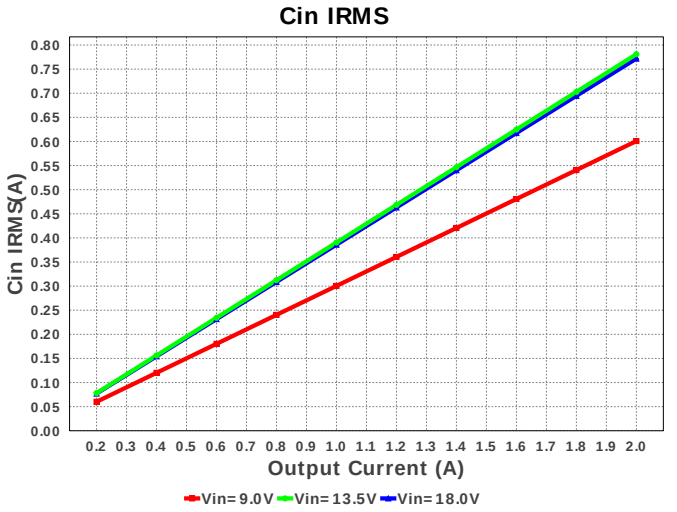












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	771.882 mA	Current	Input capacitor RMS ripple current
2.	Cout_ch1 IRMS	265.686 mA	Current	Output Channel 1 Capacitor RMS ripple current
3.	Cout_ch2 IRMS	240.383 mA	Current	Output Channel 2 Capacitor RMS ripple current
4.	Iin Avg	670.23 mA	Current	Average input current
5.	L1 Ipp	920.363 mA	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	2.018 A	Current	Inductor ripple current
7.	L2Ipp	832.709 mA	Current	Channel 2 Inductor Peak to peak Current
8.	L2 Irms	1.028 A	Current	Inductor ripple current
9.	M1 Irms	865.629 mA	Current	MOSFET RMS ripple current
10.	M2 Irms	1.803 A	Current	MOSFET RMS ripple current
11.	M3 Irms	530.886 mA	Current	MOSFET RMS ripple current
12.	M4 Irms	847.443 mA	Current	MOSFET RMS ripple current
13.	SW1 Ipk	2.46 A	Current	Peak switch current
14.	SW2 Ipk	1.416 A	Current	Peak switch current
15.	BOM Count	34	General	Total Design BOM count
16.	FootPrint	588.0 mm^2	General	Total Foot Print Area of BOM components
17.	Frequency	440.0 kHz	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	5.0 W	General	Channel 2 output Power
21.	Total BOM	$7.03	General	Total BOM Cost
22.	M3 TjOP	31.203 degC	Op_Point	M3 MOSFET junction temperature
23.	M4 TjOP	30.916 degC	Op_Point	M4 MOSFET junction temperature
24.	Duty Cycle 1	18.733 %	Op_point	Duty cycle for Channel 1
25.	Duty Cycle 2	28.184 %	Op_point	Duty cycle for Channel 2
26.	Efficiency	96.152 %	Op_point	Steady state efficiency
27.	IC Tj	30.819 degC	Op_point	IC junction temperature
28.	IOUT1_OP	2.0 A	Op_point	Iout1 operating point
29.	IOUT2_OP	1.0 A	Op_point	Iout2 operating point
30.	M1 TjOP	32.659 degC	Op_point	M1 MOSFET junction temperature
31.	M2 TjOP	32.814 degC	Op_point	M2 MOSFET junction temperature

#	Name	Value	Category	Description
32.	VIN_OP	18.0 V	Op_point	Vin operating point
33.	Vout1 OP	3.3 V	Op_point	Operational Voltage 1
34.	Vout1 p-p	5.201 mV	Op_point	Peak-to-peak output1 ripple voltage
35.	Vout2 OP	5.0 V	Op_point	Operational Voltage 2
36.	Vout2 p-p	10.881 mV	Op_point	Peak-to-peak output2 ripple voltage
37.	Cin Pd	1.192 mW	Power	Input capacitor power dissipation
38.	Cout_ch1 Pd	172.414 µW	Power	Ouput channel 1 capacitor power dissipation
39.	Cout_ch2 Pd	115.567 µW	Power	Ouput channel 2 capacitor power dissipation
40.	IC Pd	23.545 mW	Power	IC power dissipation
41.	L1 Pd	120.0 mW	Power	Inductor power dissipation
42.	L2 Pd	73.25 mW	Power	Inductor power dissipation
43.	M1 Pd	44.919 mW	Power	M1 MOSFET total power dissipation
44.	M1 PdCond	9.07 mW	Power	M1 MOSFET conduction losses
45.	M1 PdSw	35.849 mW	Power	M1 MOSFET switching losses
46.	M2 Pd	54.114 mW	Power	M2 MOSFET total power dissipation
47.	M2 PdCond	32.459 mW	Power	M2 MOSFET conduction losses
48.	M2 PdSw	21.655 mW	Power	M2 MOSFET switching losses
49.	M3 Pd	22.64 mW	Power	M3 MOSFET total power dissipation
50.	M3 PdCond	3.679 mW	Power	M3 MOSFET conduction losses
51.	M3 PdSw	18.961 mW	Power	M3 MOSFET switching losses
52.	M1 Rdson	12.105 mOhm	Power	Drain-Source On-resistance
53.	M3 Rdson	13.054 mOhm	Power	Drain-Source On-resistance
54.	M4 Pd	17.724 mW	Power	M4 MOSFET total power dissipation
55.	M4 PdCond	7.081 mW	Power	M4 MOSFET conduction losses
56.	M4 PdSw	10.643 mW	Power	M4 MOSFET switching losses
57.	M2 Rdson	9.985 mOhm	Power	Drain-Source On-resistance
58.	M4 Rdson	9.86 mOhm	Power	Drain-Source On-resistance
59.	Rsense1 Pd	65.014 mW	Power	Current Limit Sense Resistor Power Dissipation
60.	Rsense2 Pd	17.954 mW	Power	Current Limit Sense Resistor Power Dissipation
61.	Total Pd	464.185 mW	Power	Total Power Dissipation
62.	Cross Freq Ch1	13.684 kHz		Bode plot crossover frequency
63.	Cross Freq Ch2	10.857 kHz		Bode plot crossover frequency
64.	Phase Marg Ch1	33.613 deg		Bode Plot Phase Margin
65.	Phase Marg Ch2	55.256 deg		Bode Plot Phase Margin
66.	Vout Tolerance	240.0 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	18.0	Maximum input voltage
5.	VinMin	9.0	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	LM5140-Q1	Base Product 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.