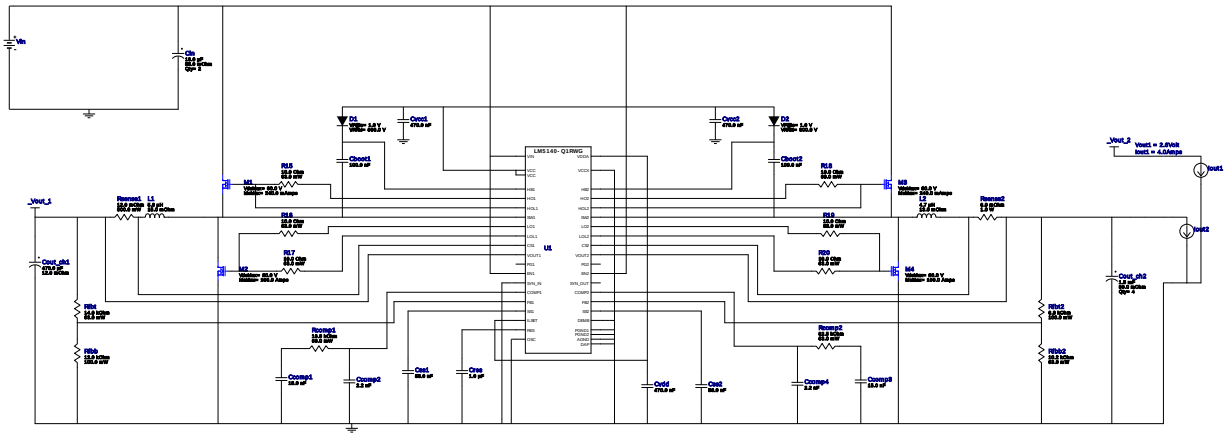
WEBENCH® Design Report

VinMin = 18.5V
VinMax = 30.0V
Vout = 2.6V
Iout = 4.0A

Device = LM5140QRWGRQ1
Topology = Buck
Created = 7/29/16 12:09:19 AM
BOM Cost = $11.20
BOM Count = 42
Total Pd = 3.2W

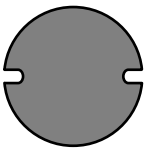
Design : 4755214/2 LM5140QRWGRQ1
LM5140QRWGRQ1 18.5V-30.0V to 2.00V @ 9.0A



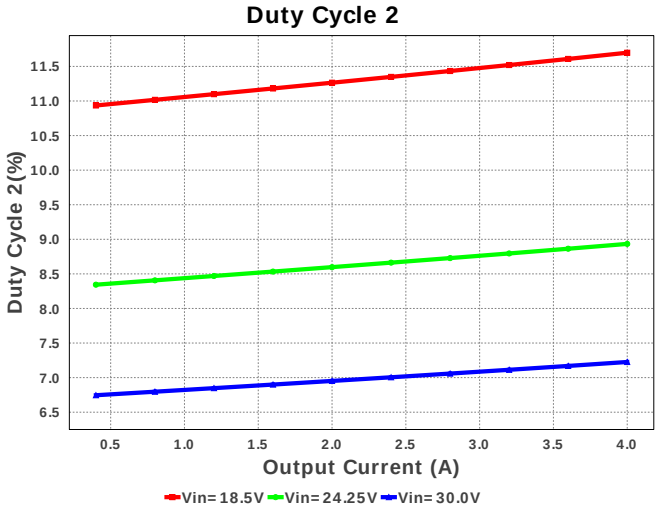
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific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

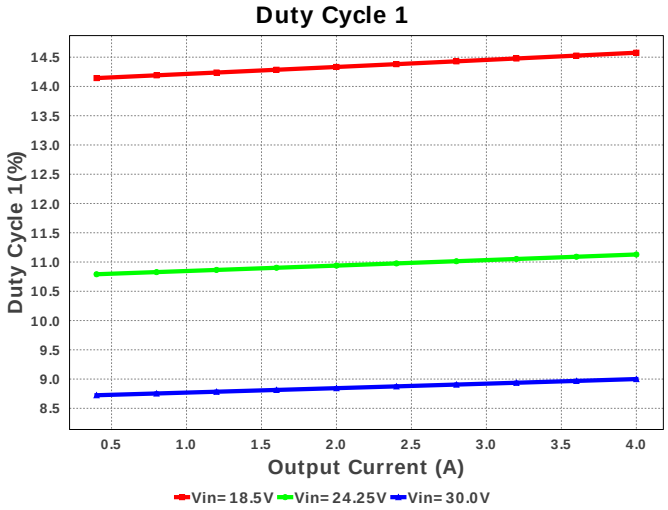
Electrical BOM

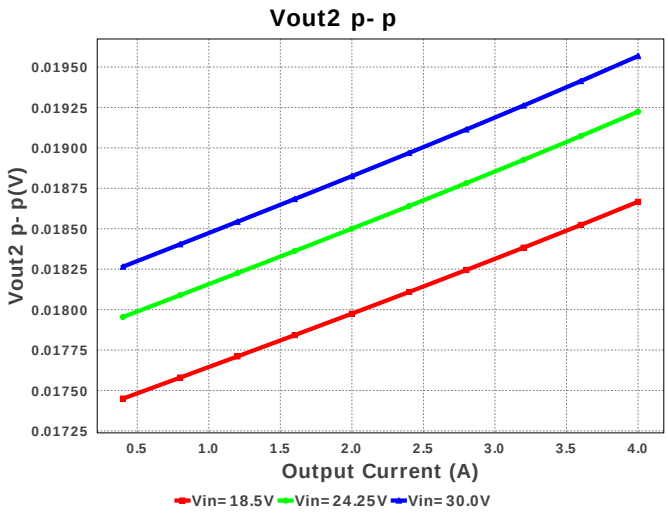
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot1	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
2.	Cboot2	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Ccomp1	Yageo America	CC0805KRX7R9BB183 Series= X7R	Cap= 18.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
4.	Ccomp2	Yageo America	CC0805KRX7R9BB222 Series= X7R	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
5.	Ccomp3	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
6.	Ccomp4	Yageo America	CC0805KRX7R9BB222 Series= X7R	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
7.	Cin	Panasonic	50SVPF18M Series= ?	Cap= 18.0 uF ESR= 35.0 mOhm VDC= 50.0 V IRMS= 2.7 A	2	$0.53	CAPSMT_62_E7 106 mm²
8.	Cout_ch1	Panasonic	4TPE470MCL Series= ?	Cap= 470.0 uF ESR= 12.0 mOhm VDC= 4.0 V IRMS= 3.5 A	1	$0.81	CAPSMT_6_D3L 62 mm²
9.	Cout_ch2	Panasonic	EEE-FK0J152P Series= FK	Cap= 1.5 mF ESR= 80.0 mOhm VDC= 6.3 V IRMS= 850.0 mA	4	$0.28	SM_RADIAL_G 172 mm²

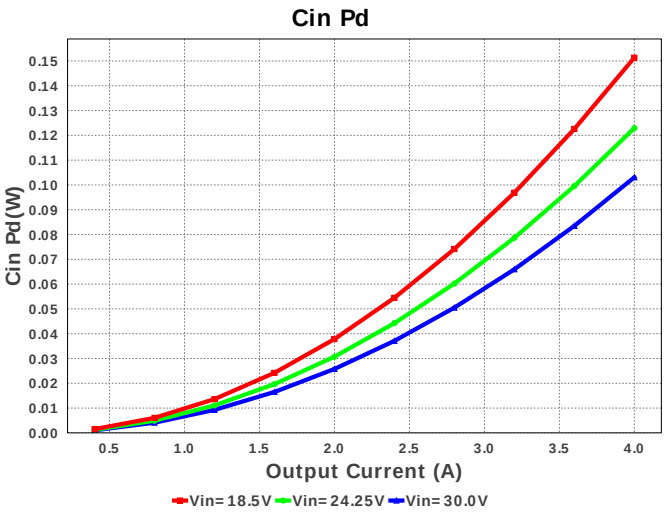
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Cres	Taiyo Yuden	EMK212B7105KG-T Series= X7R	Cap= 1.0 uF VDC= 16.0 V IRMS= 0.0 A	1	$0.02	 0805 7 mm²
11.	Css1	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
12.	Css2	MuRata	GRM155R61A563KA01D 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	Bourns	CD214B-R3600	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.10	 SMB 44 mm²
17.	D2	Bourns	CD214B-R3600	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.10	 SMB 44 mm²
18.	L1	Bourns	SDR1307-5R6ML	L= 5.6 µH DCR= 15.0 mOhm	1	$0.35	 SDR1307 227 mm²
19.	L2	Coilcraft	XAL7070-472MEB	L= 4.7 µH DCR= 13.0 mOhm	1	$1.19	 XAL7070 87 mm²
20.	M1	Vishay-Siliconix	2N7002E-T1-E3	VdsMax= 60.0 V IdsMax= 240.0 mAmps	1	$0.22	 SOT-23 14 mm²
21.	M2	Texas Instruments	CSD18563Q5A	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.68	 TRANS_NexFET_Q5A 55 mm²
22.	M3	Vishay-Siliconix	2N7002E-T1-E3	VdsMax= 60.0 V IdsMax= 240.0 mAmps	1	$0.22	 SOT-23 14 mm²
23.	M4	Texas Instruments	CSD18531Q5A	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.90	 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

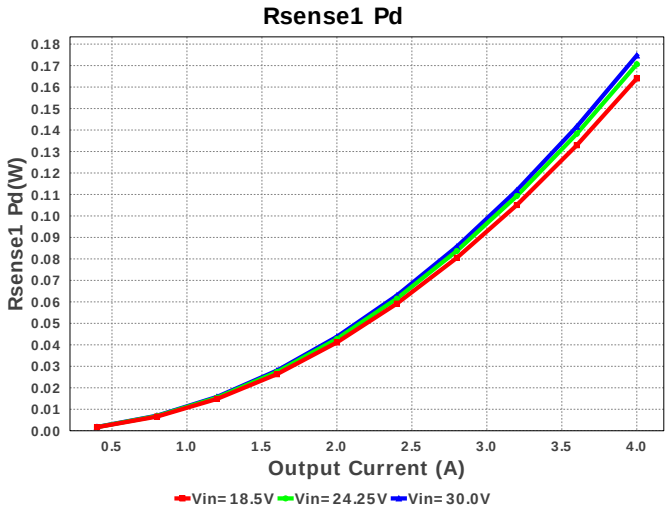
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
28.	R19	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
29.	R20	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
30.	Rcomp1	Vishay-Dale	CRCW040216K9FKED Series= CRCW..e3	Res= 16.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	Rcomp2	Vishay-Dale	CRCW040282K5FKED Series= CRCW..e3	Res= 82.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rfbb	Yageo America	RC0603FR-0712KL Series= ?	Res= 12.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
33.	Rfbb2	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
34.	Rfbt	Vishay-Dale	CRCW040214K0FKED Series= CRCW..e3	Res= 14.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
35.	Rfbt2	Yageo America	RC0603FR-076K8L Series= ?	Res= 6.8 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
36.	Rsense1	Stackpole Electronics Inc	CSR1206FK12L0 Series= ?	Res= 12.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	1206 11 mm²
37.	Rsense2	Susumu Co Ltd	PRL1632-R006-F-T1 Series= PRL1632	Res= 6.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.19	0612 11 mm²
38.	U1	Texas Instruments	LM5140QRWGRQ1	Switcher	1	$3.90	RWG0040A 64 mm²

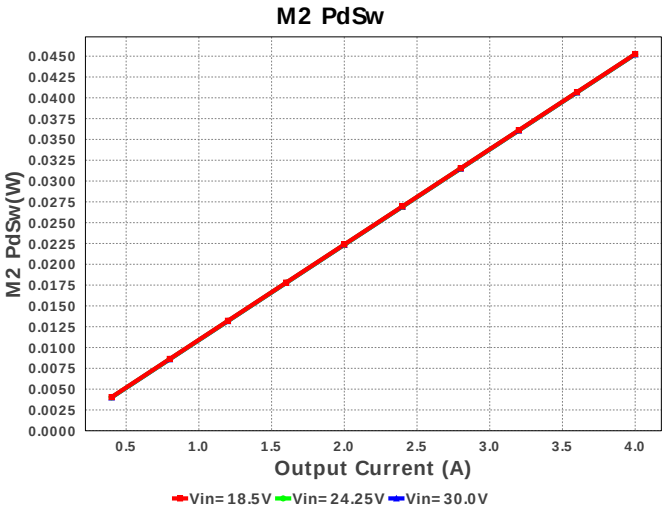


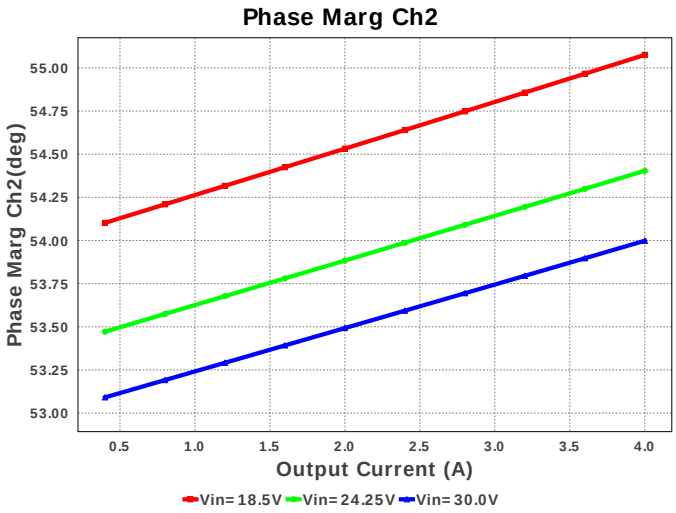


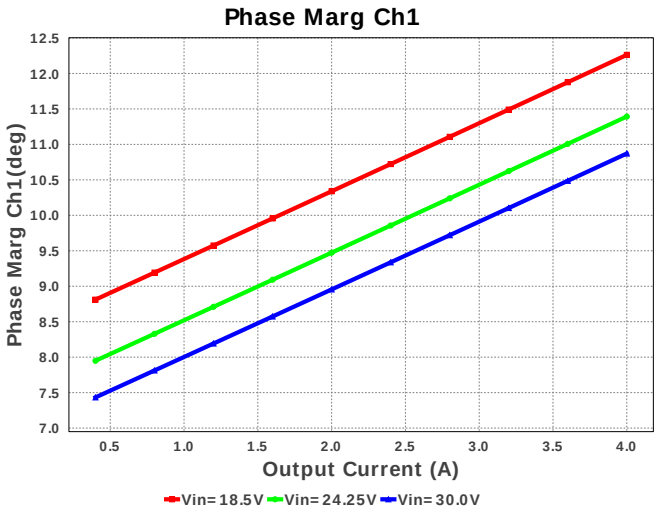


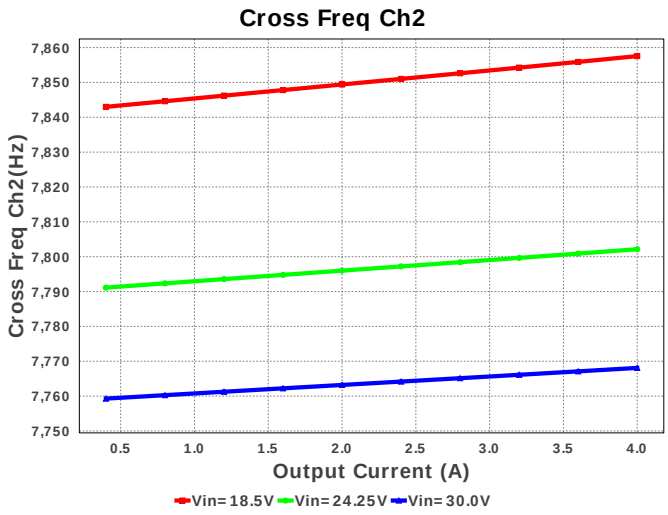


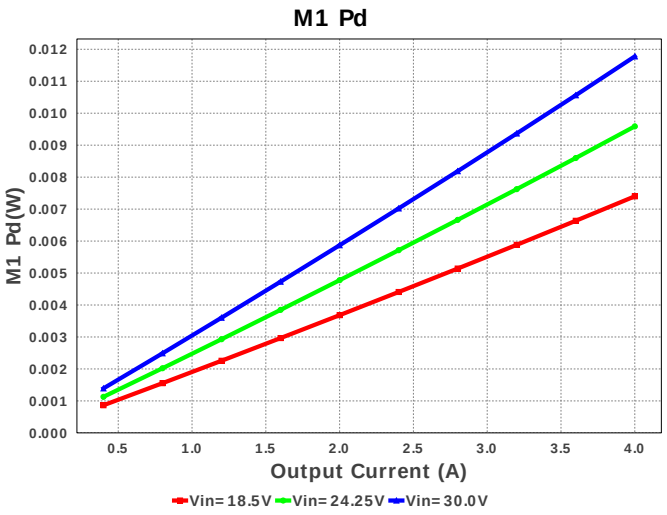


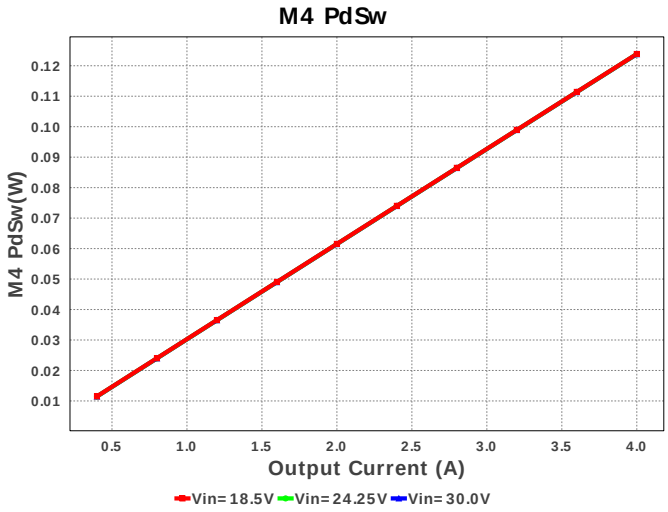


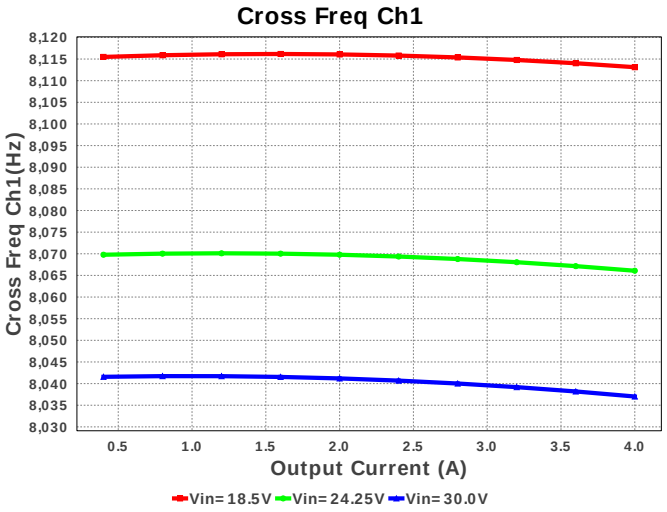


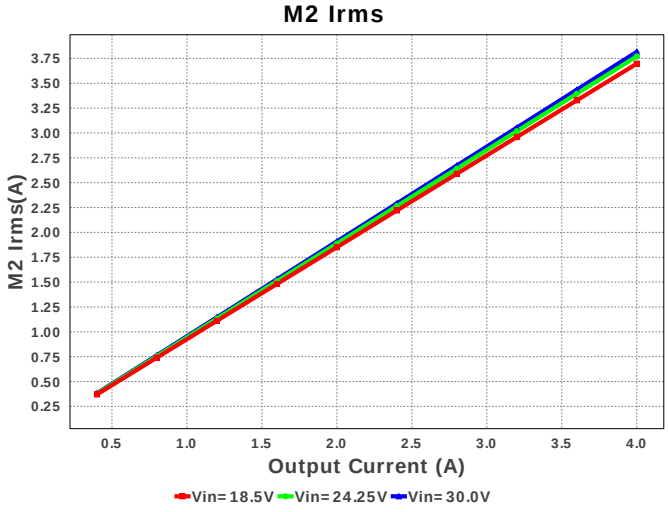


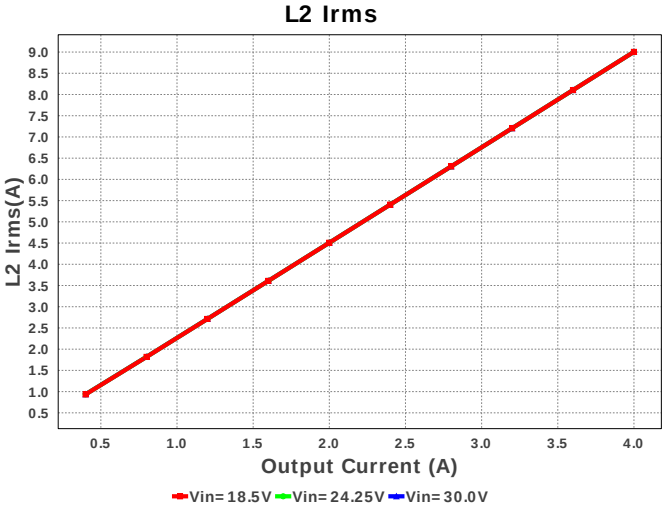


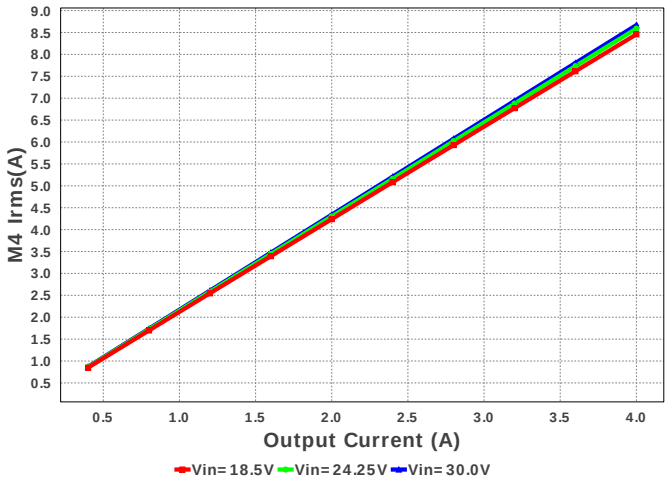


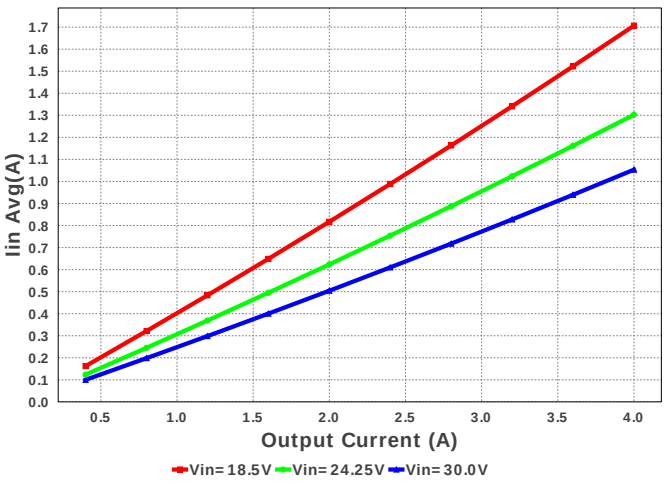


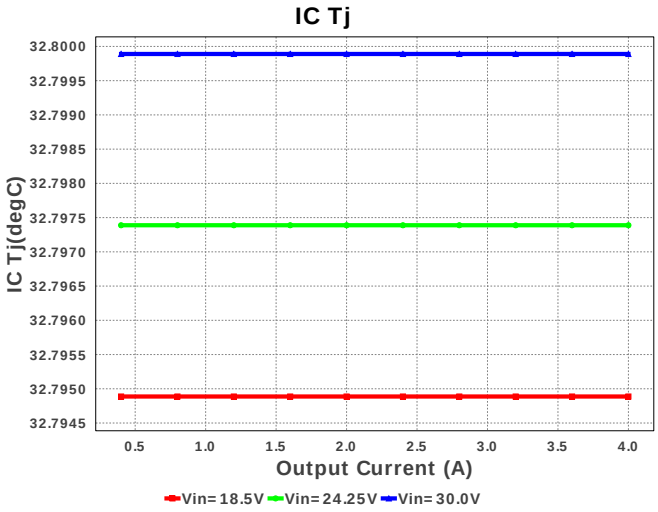


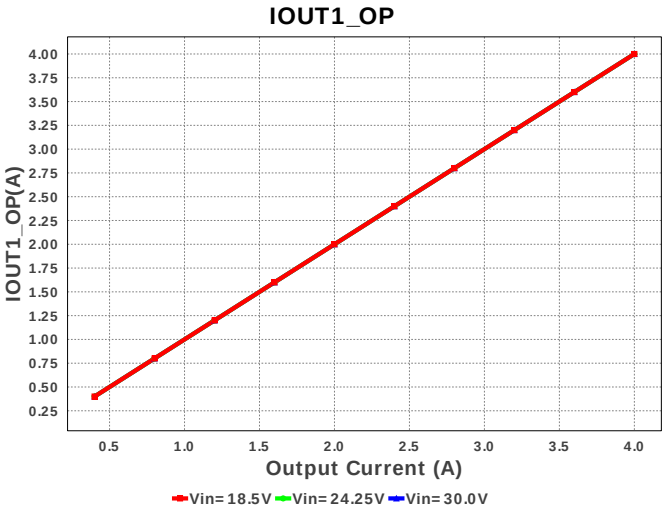


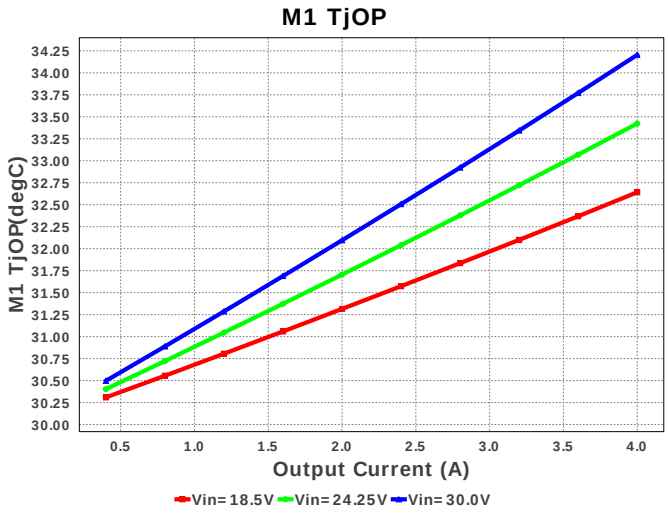


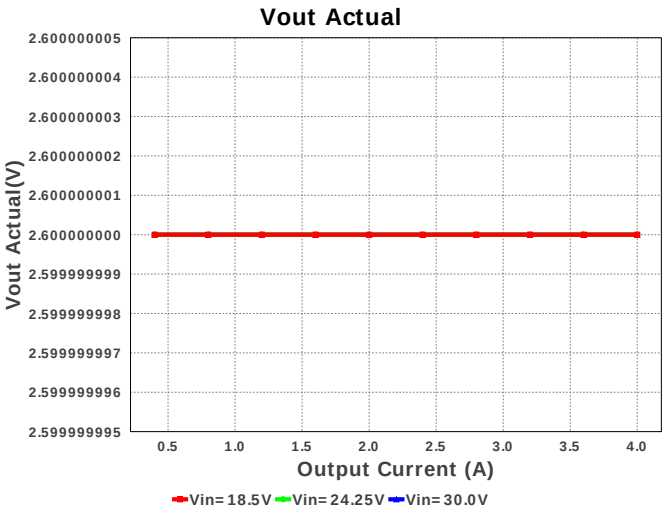


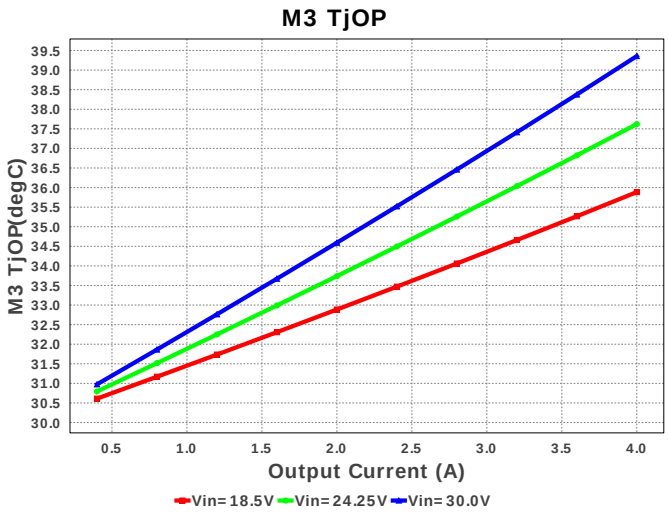


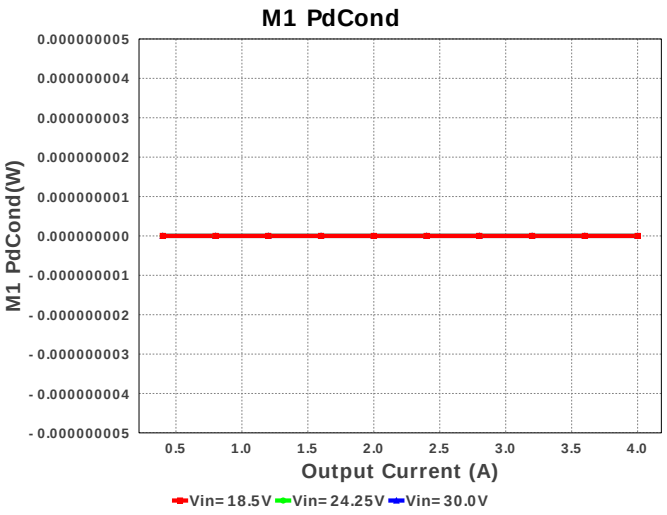


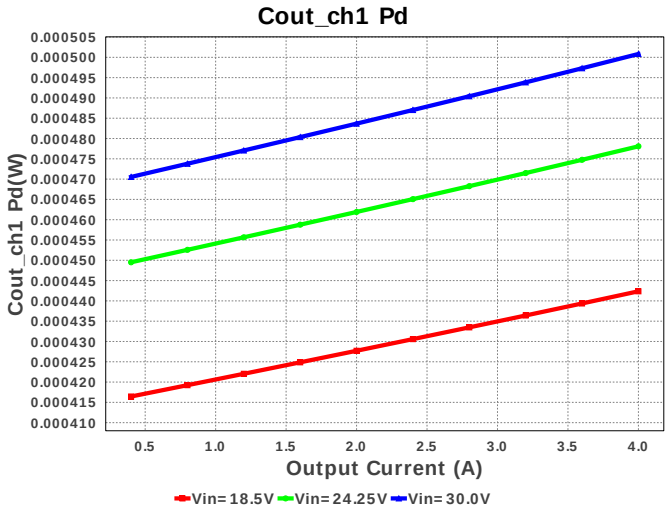


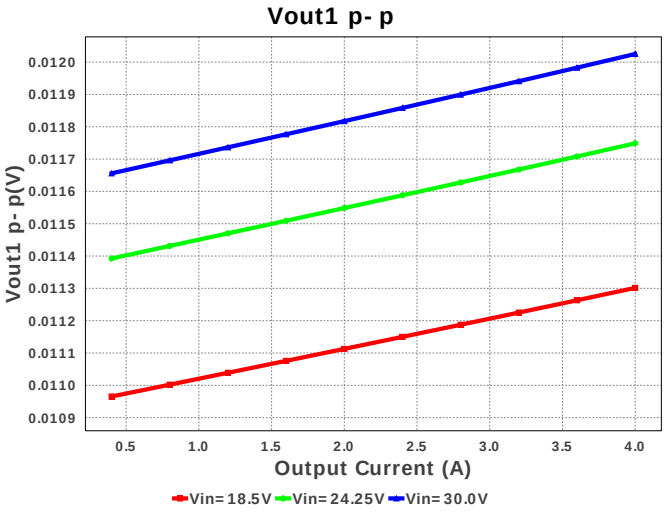


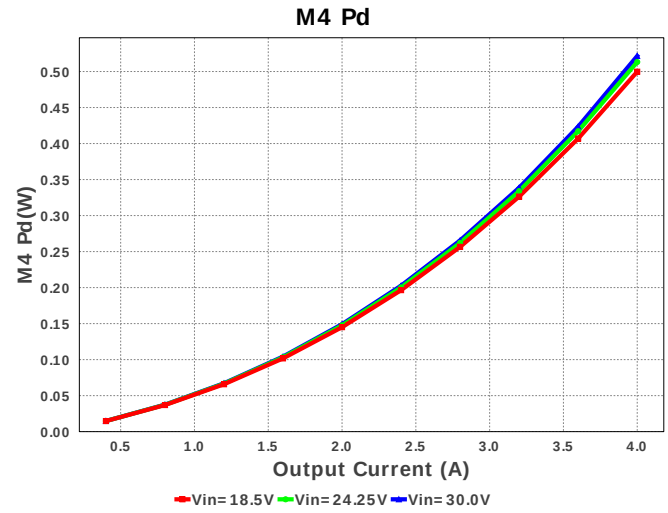


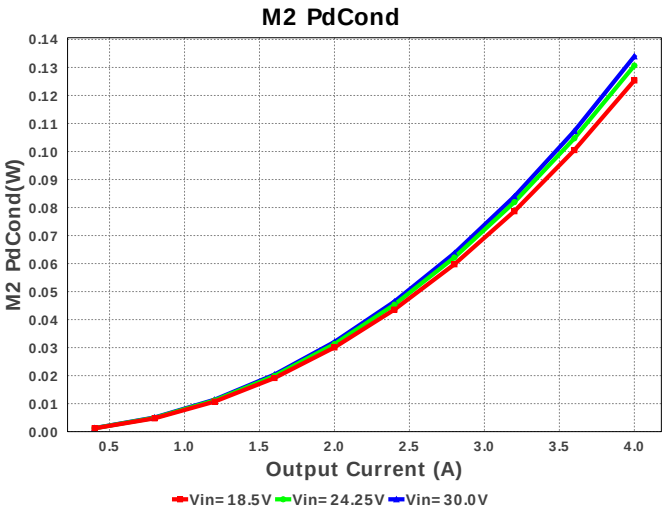


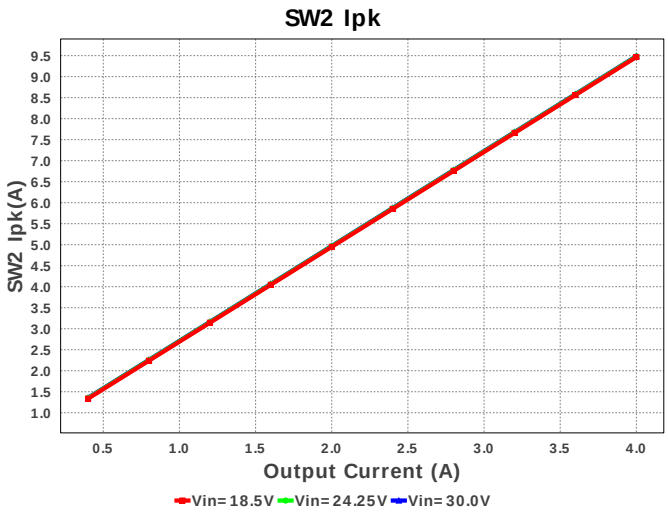


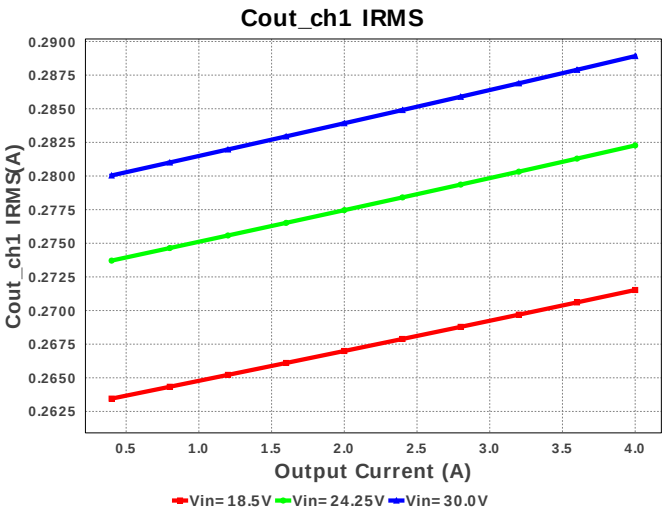


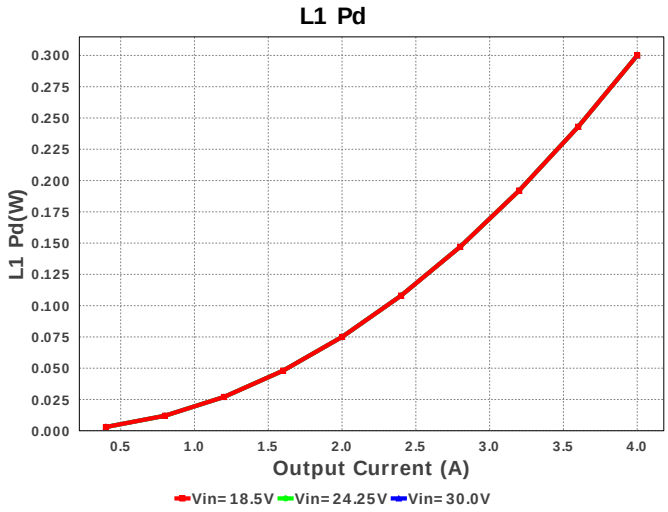


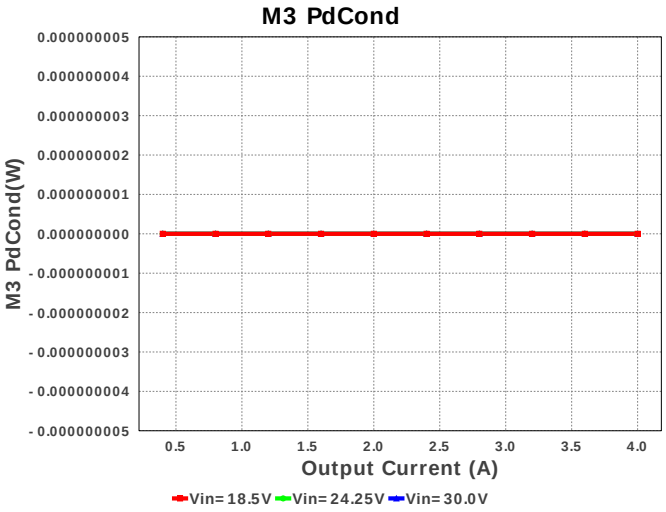


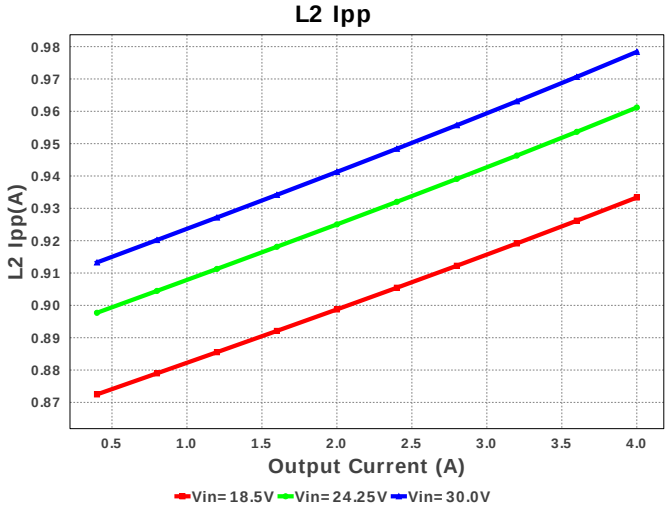


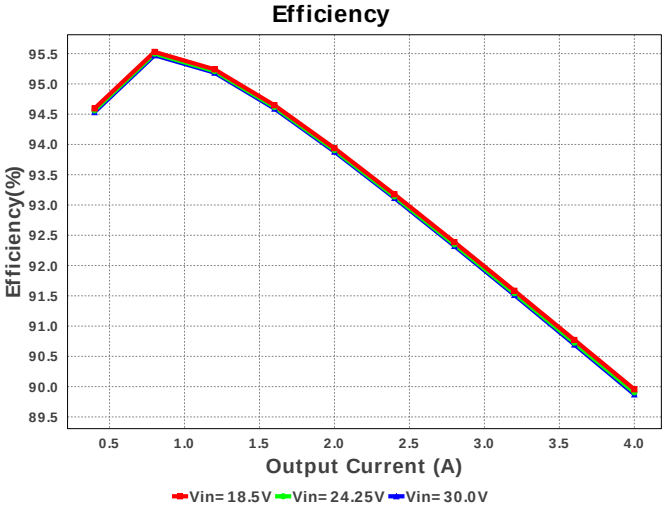


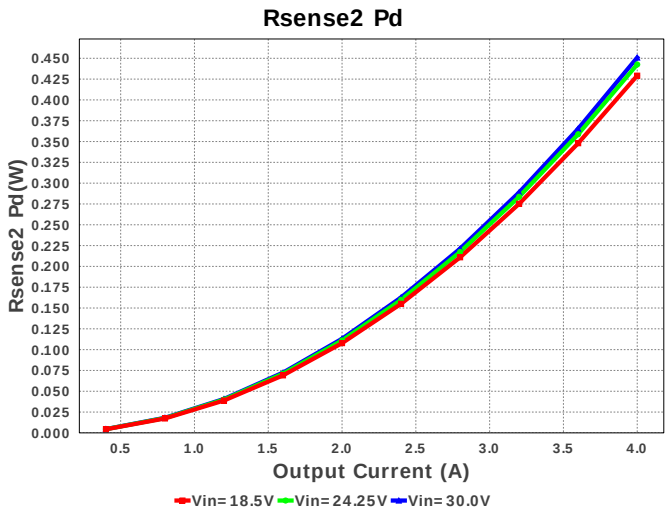


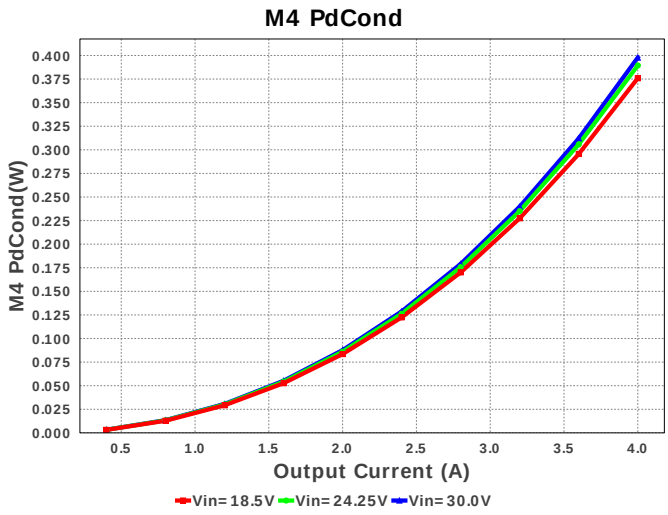


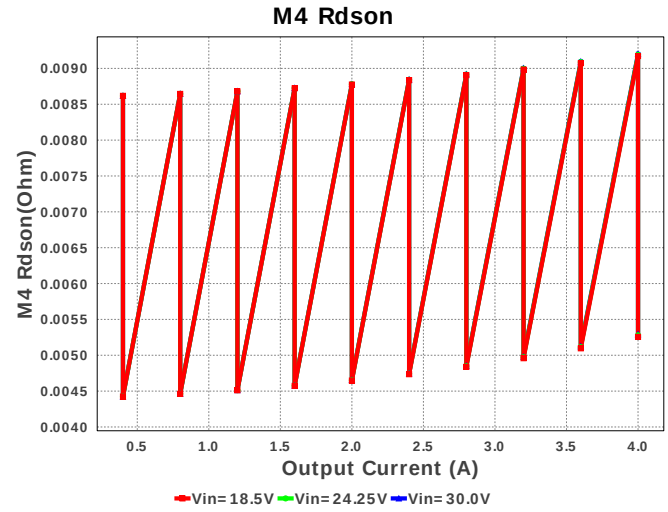


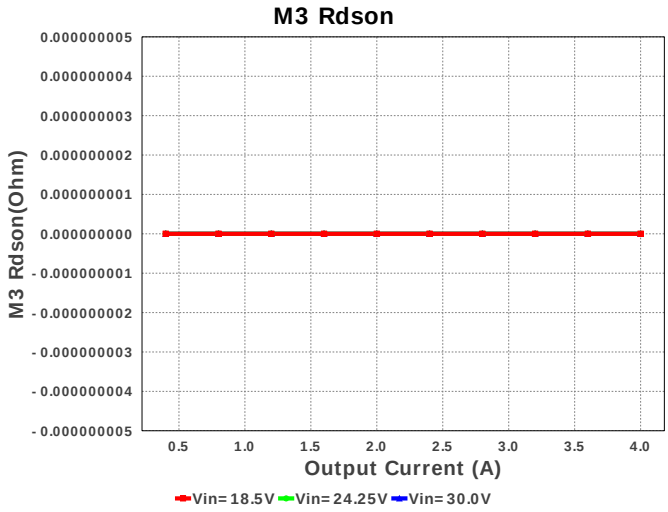


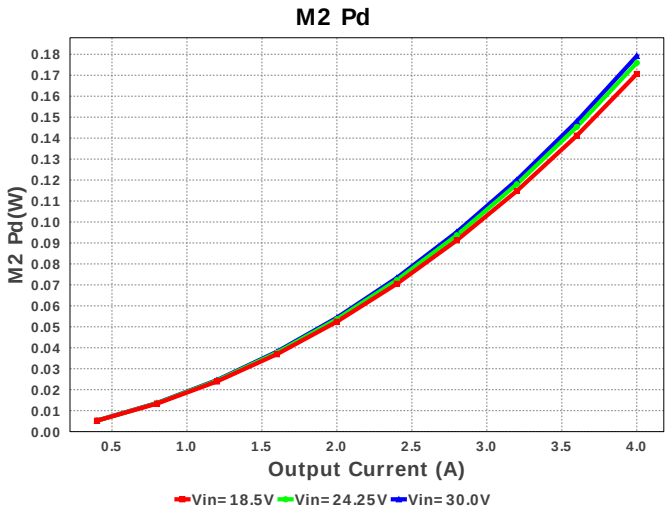


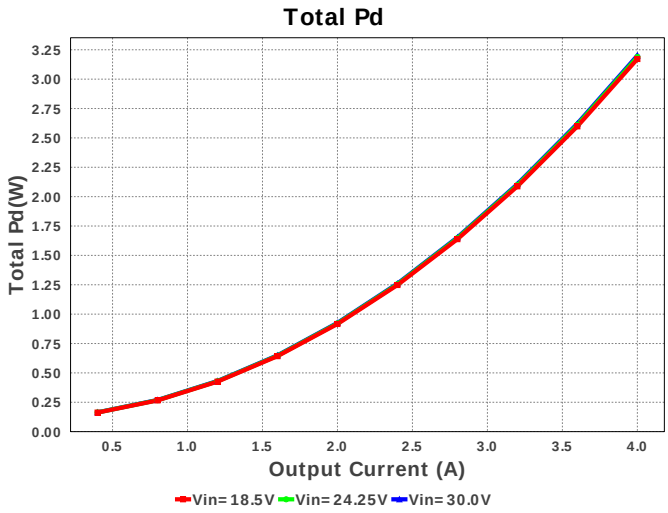


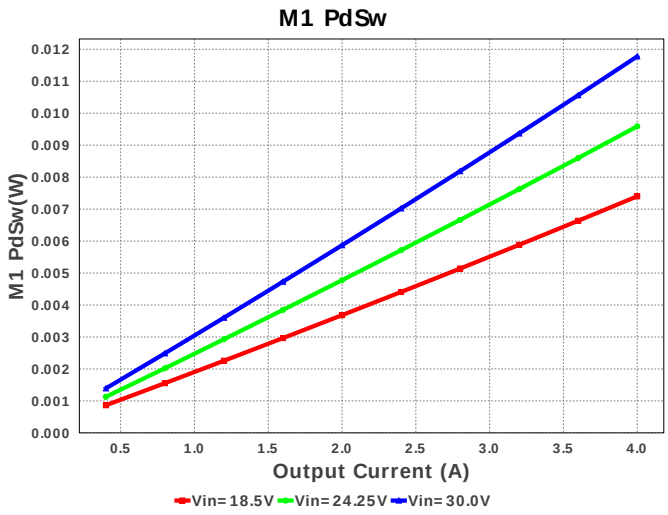


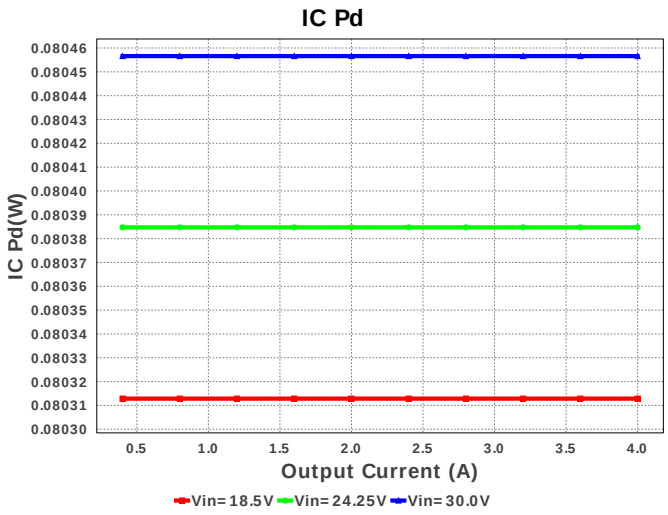


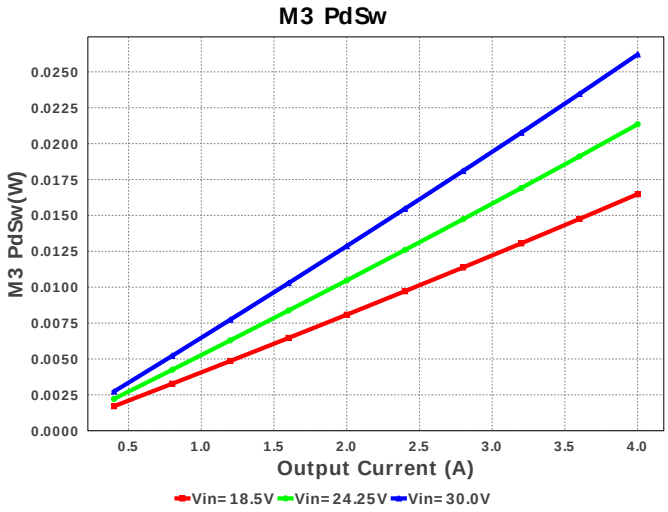


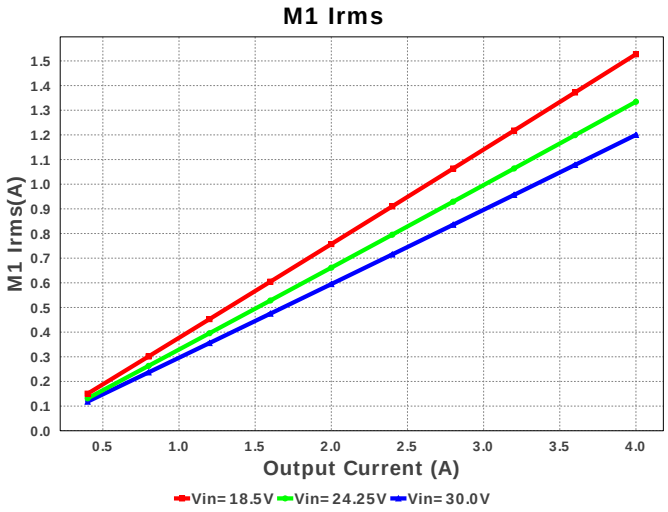


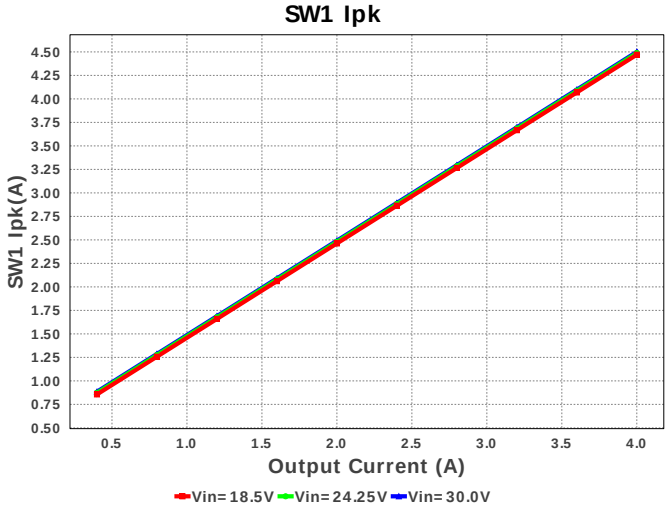


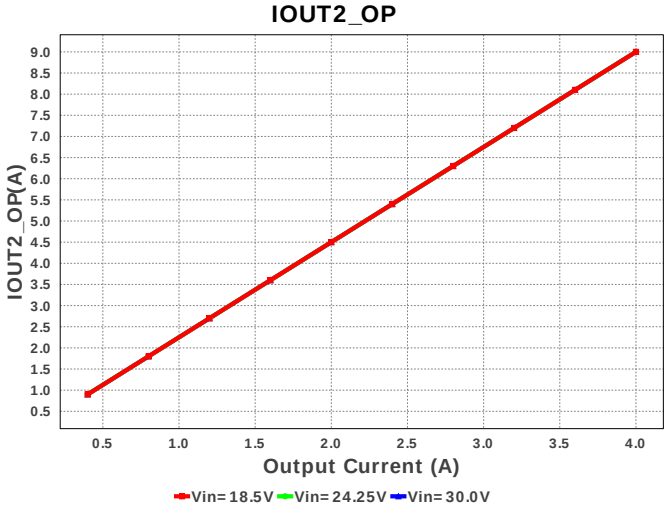


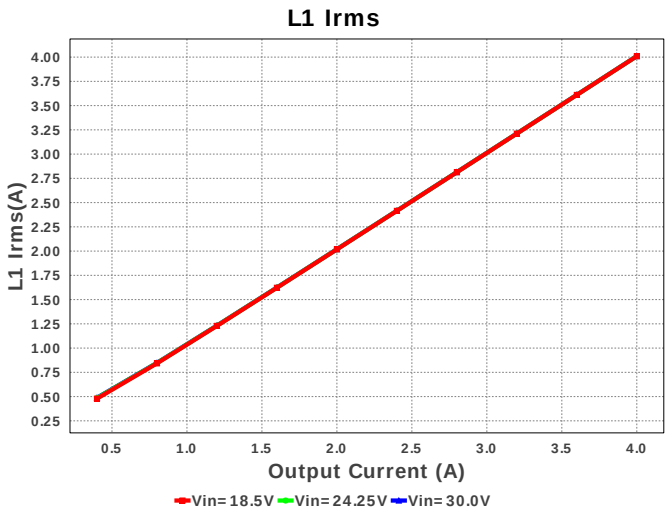


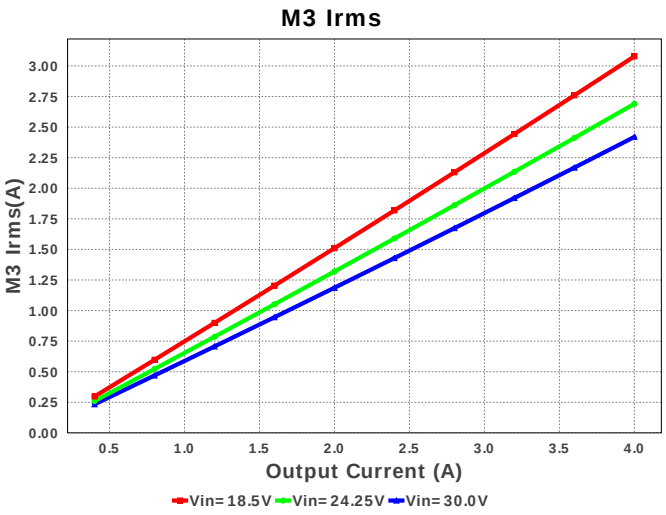


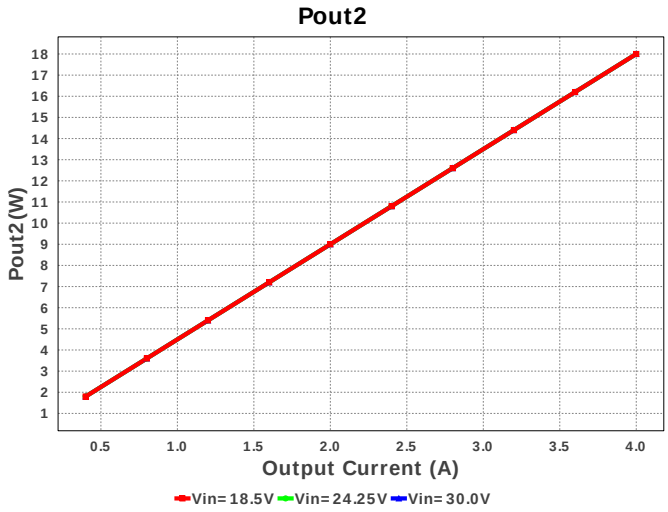


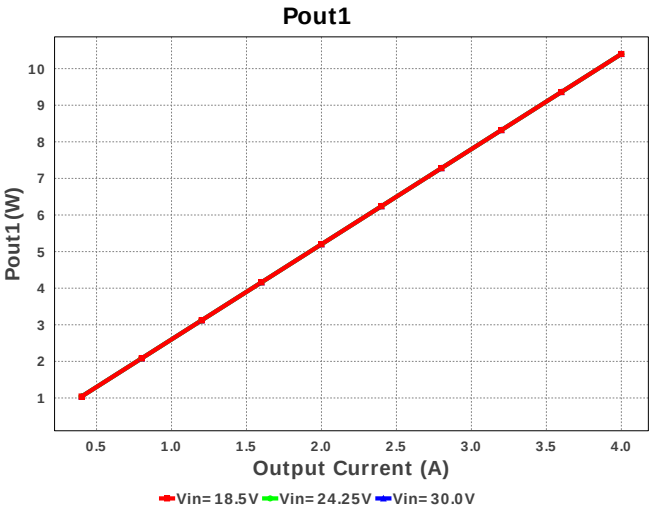


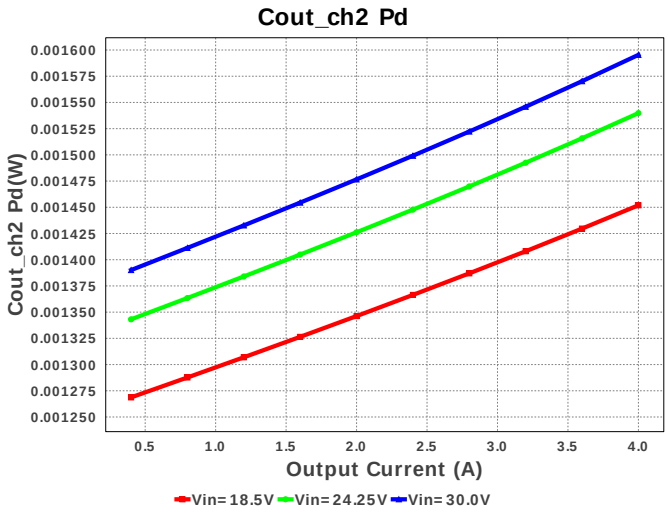


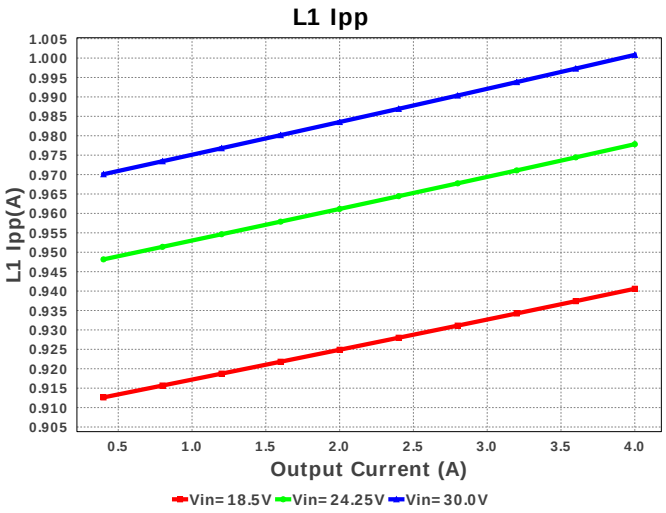


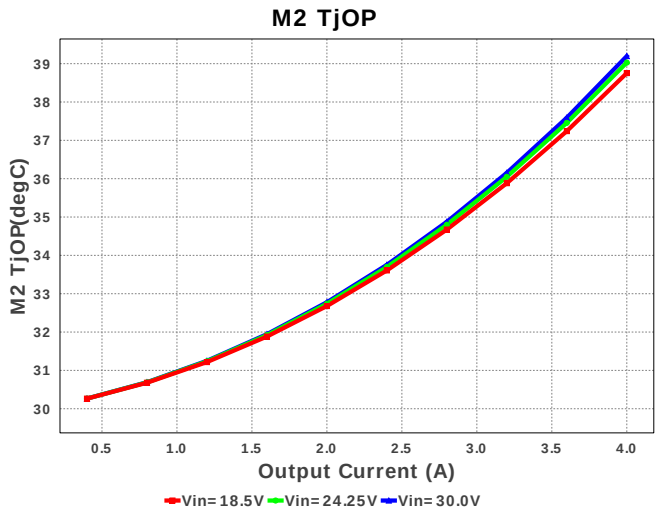


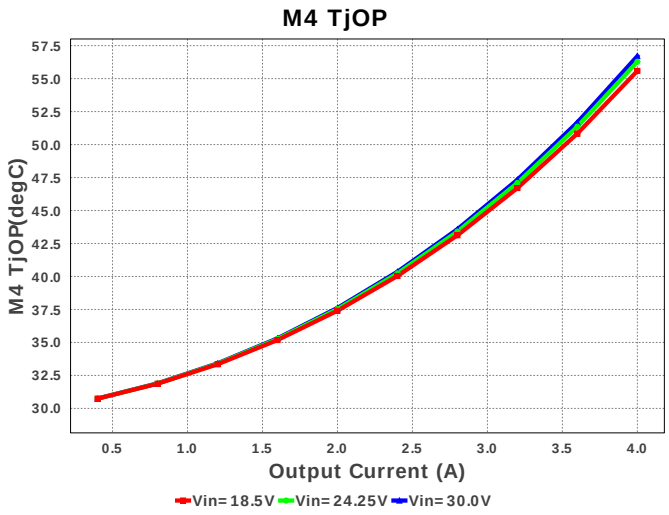


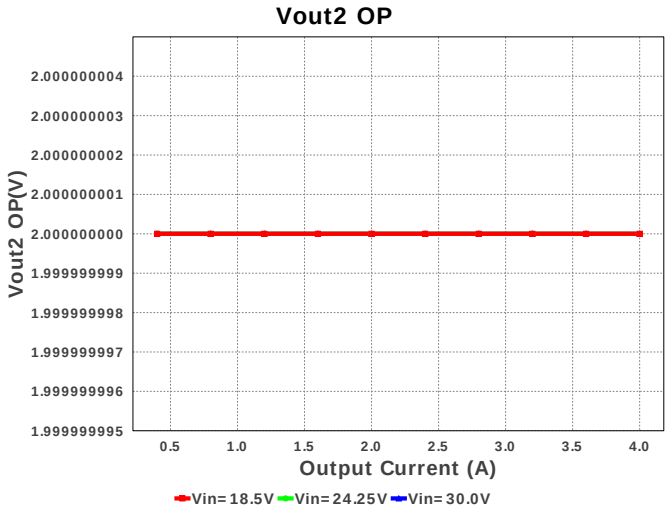


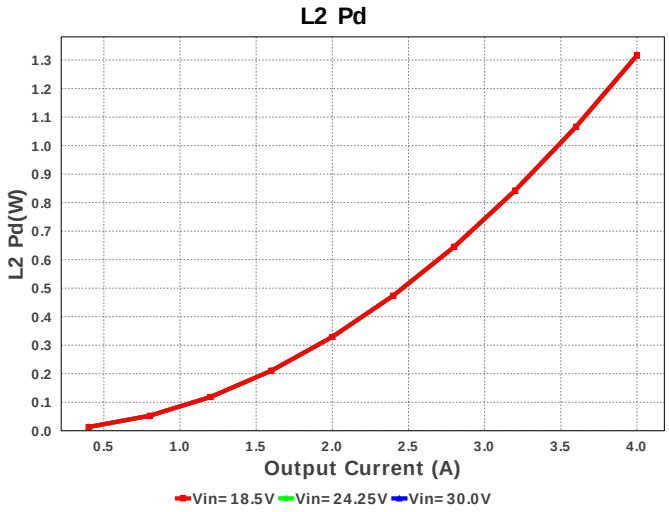


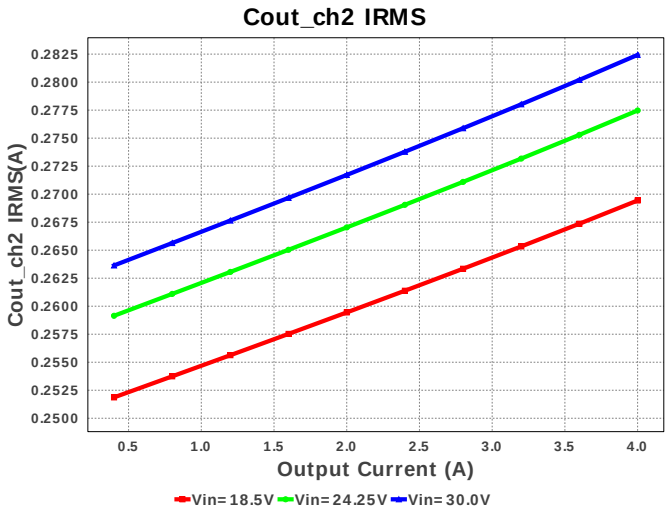


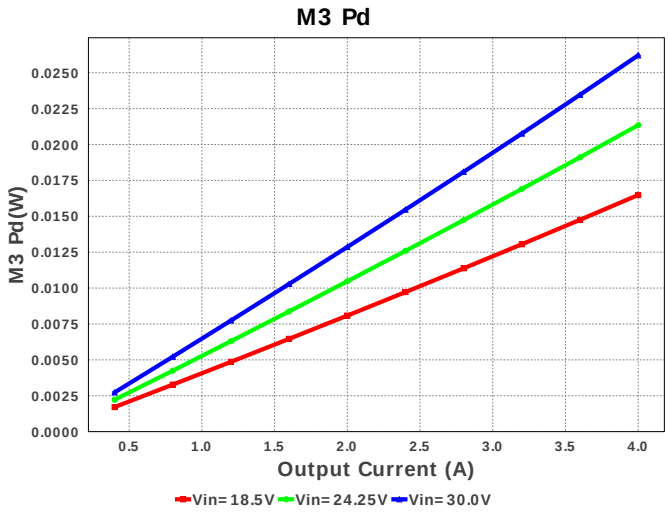


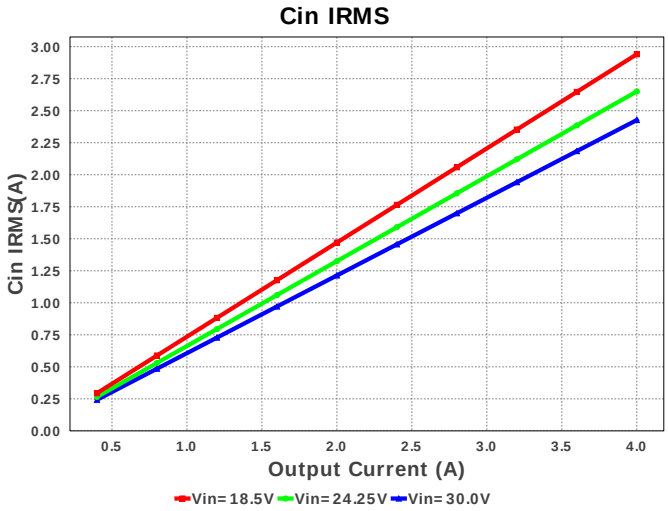












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.427 A	Current	Input capacitor RMS ripple current
2.	Cout_ch1 IRMS	288.914 mA	Current	Output Channel 1 Capacitor RMS ripple current
3.	Cout_ch2 IRMS	282.433 mA	Current	Output Channel 2 Capacitor RMS ripple current
4.	Iin Avg	1.053 A	Current	Average input current
5.	L1 Ipp	1.001 A	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	4.01 A	Current	Inductor ripple current
7.	L2Ipp	978.377 mA	Current	Channel 2 Inductor Peak to peak Current
8.	L2 Irms	9.004 A	Current	Inductor ripple current
9.	M1 Irms	1.2 A	Current	MOSFET RMS ripple current
10.	M2 Irms	3.816 A	Current	MOSFET RMS ripple current
11.	M3 Irms	2.419 A	Current	MOSFET RMS ripple current
12.	M4 Irms	8.669 A	Current	MOSFET RMS ripple current
13.	SW1 Ipk	4.5 A	Current	Peak switch current
14.	SW2 Ipk	9.489 A	Current	Peak switch current
15.	BOM Count	42	General	Total Design BOM count
16.	FootPrint	1.683 k 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	10.4 W	General	Channel 1 output Power
20.	Pout2	18.0 W	General	Channel 2 output Power
21.	Total BOM	$11.2	General	Total BOM Cost
22.	M3 TjOP	39.4 degC	Op_Point	M3 MOSFET junction temperature
23.	M4 TjOP	56.706 degC	Op_Point	M4 MOSFET junction temperature
24.	Vout Actual	2.6 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
25.	Duty Cycle 1	9.0 %	Op_point	Duty cycle for Channel 1
26.	Duty Cycle 2	7.226 %	Op_point	Duty cycle for Channel 2
27.	Efficiency	89.872 %	Op_point	Steady state efficiency
28.	IC Tj	32.8 degC	Op_point	IC junction temperature
29.	IOUT1_OP	4.0 A	Op_point	Iout1 operating point
30.	IOUT2_OP	9.0 A	Op_point	Iout2 operating point
31.	M1 TjOP	34.222 degC	Op_point	M1 MOSFET junction temperature
32.	M2 TjOP	39.197 degC	Op_point	M2 MOSFET junction temperature
33.	VIN_OP	30.0 V	Op_point	Vin operating point
34.	Vout1 OP	2.6 V	Op_point	Operational Voltage 1
35.	Vout1 p-p	12.025 mV	Op_point	Peak-to-peak output1 ripple voltage
36.	Vout2 OP	2.0 V	Op_point	Operational Voltage 2
37.	Vout2 p-p	19.568 mV	Op_point	Peak-to-peak output2 ripple voltage
38.	Cin Pd	103.084 mW	Power	Input capacitor power dissipation
39.	Cout_ch1 Pd	500.826 µW	Power	Ouput channel 1 capacitor power dissipation
40.	Cout_ch2 Pd	1.595 mW	Power	Ouput channel 2 capacitor power dissipation
41.	IC Pd	80.457 mW	Power	IC power dissipation
42.	L1 Pd	300.0 mW	Power	Inductor power dissipation
43.	L2 Pd	1.316 W	Power	Inductor power dissipation
44.	M1 Pd	11.826 mW	Power	M1 MOSFET total power dissipation
45.	M1 PdCond	0.0 W	Power	M1 MOSFET conduction losses
46.	M1 PdSw	11.826 mW	Power	M1 MOSFET switching losses
47.	M2 Pd	179.187 mW	Power	M2 MOSFET total power dissipation
48.	M2 PdCond	133.968 mW	Power	M2 MOSFET conduction losses
49.	M2 PdSw	45.218 mW	Power	M2 MOSFET switching losses
50.	M3 Pd	26.331 mW	Power	M3 MOSFET total power dissipation
51.	M3 PdCond	0.0 W	Power	M3 MOSFET conduction losses
52.	M3 PdSw	26.331 mW	Power	M3 MOSFET switching losses

#	Name	Value	Category	Description
53.	M1 Rdson	0.0 Ohm	Power	Drain-Source On-resistance
54.	M3 Rdson	0.0 Ohm	Power	Drain-Source On-resistance
55.	M4 Pd	521.553 mW	Power	M4 MOSFET total power dissipation
56.	M4 PdCond	397.756 mW	Power	M4 MOSFET conduction losses
57.	M4 PdSw	123.797 mW	Power	M4 MOSFET switching losses
58.	M2 Rdson	9.201 mOhm	Power	Drain-Source On-resistance
59.	M4 Rdson	5.293 mOhm	Power	Drain-Source On-resistance
60.	Rsense1 Pd	174.72 mW	Power	Current Limit Sense Resistor Power Dissipation
61.	Rsense2 Pd	450.882 mW	Power	Current Limit Sense Resistor Power Dissipation
62.	Total Pd	3.201 W	Power	Total Power Dissipation
63.	Cross Freq Ch1	8.035 kHz		Bode plot crossover frequency
64.	Cross Freq Ch2	125.885 kHz		Bode plot crossover frequency
65.	Phase Marg Ch1	10.832 deg		Bode Plot Phase Margin
66.	Phase Marg Ch2	93.089 deg		Bode Plot Phase Margin
67.	Vout Tolerance	2.099 %		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.	Iout1	4.0	Output Current #1
3.	Iout2	9.0	Output Current #2
4.	VinMax	30.0	Maximum input voltage
5.	VinMin	18.5	Minimum input voltage
6.	Vout	2.6	Output Voltage
7.	Vout1	2.6	Output Voltage #1
8.	Vout2	2.0	Output Voltage #2
9.	Vout3	8.0	Output Voltage #3
10.	base_pn	LM5140-Q1	Base Product Number
11.	source	DC	Input Source Type
12.	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.