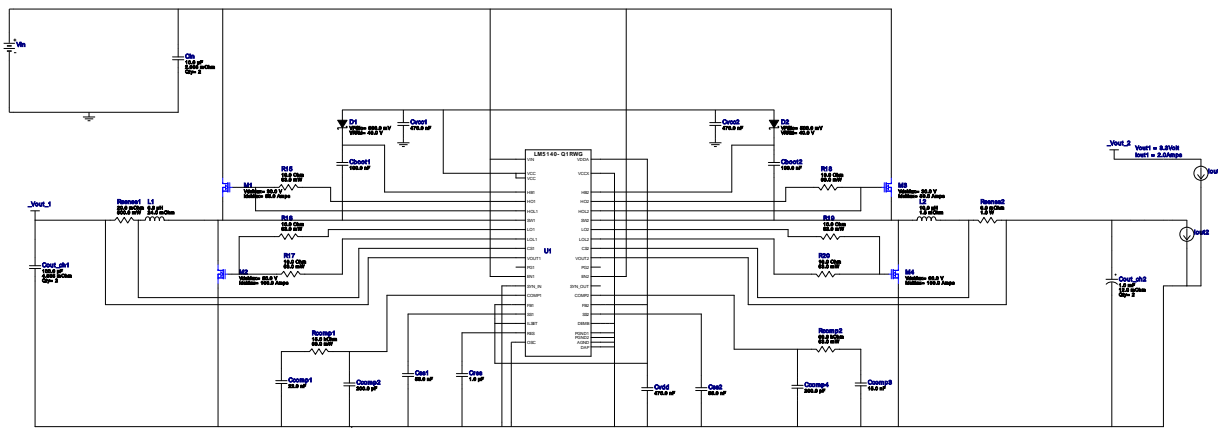


WEBENCH® Design Report

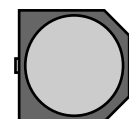
Design : 4758070/2 LM5140QRWGRQ1
LM5140QRWGRQ1 14.0V-22.0V to 5.00V @ 9.0A



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

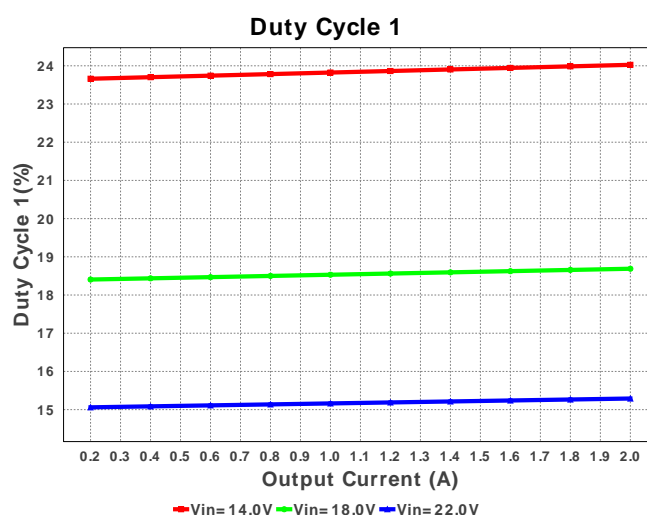
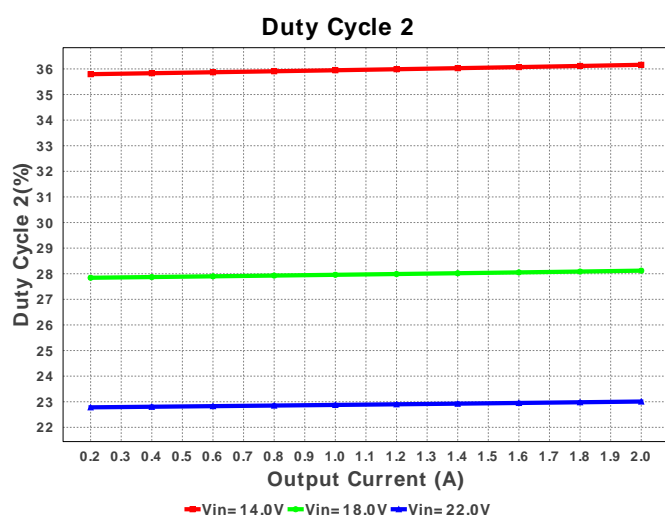
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cboot1	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
2.	Cboot2	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
3.	Ccomp1	Yageo America	CC0805KRX7R9BB223 Series= X7R	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
4.	Ccomp2	Samsung Electro-Mechanics	CL21C201JBANNNC Series= C0G/NP0	Cap= 200.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
5.	Ccomp3	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
6.	Ccomp4	Samsung Electro-Mechanics	CL21C201JBANNNC Series= C0G/NP0	Cap= 200.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
7.	Cin	MuRata	GRM32ER7YA106KA12L Series= X7R	Cap= 10.0 uF ESR= 2.008 mOhm VDC= 35.0 V IRMS= 4.6772 A	2	\$0.22	1210_280 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	2	\$0.14	1206_190 11 mm ²
9.	Cout_ch2	Panasonic	16SVPF1000M Series= ?	Cap= 1.0 mF ESR= 12.0 mOhm VDC= 16.0 V IRMS= 5.4 A	2	\$0.74	16SVPF1000M

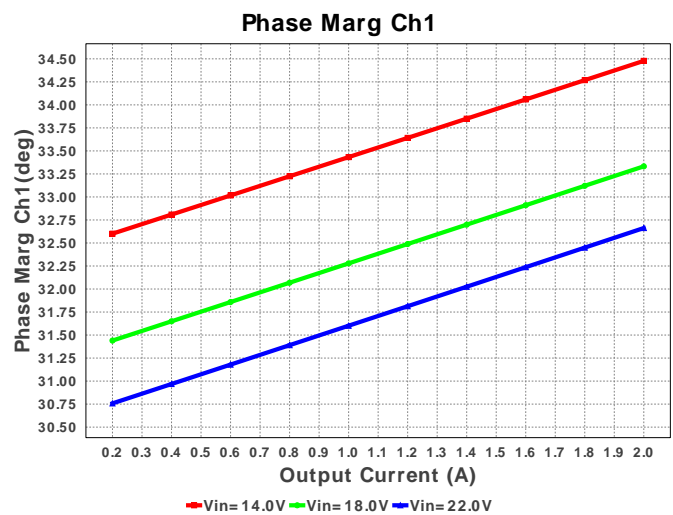
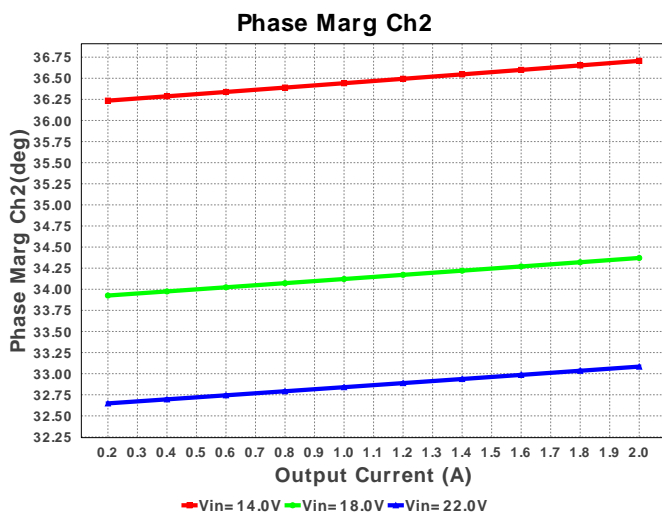
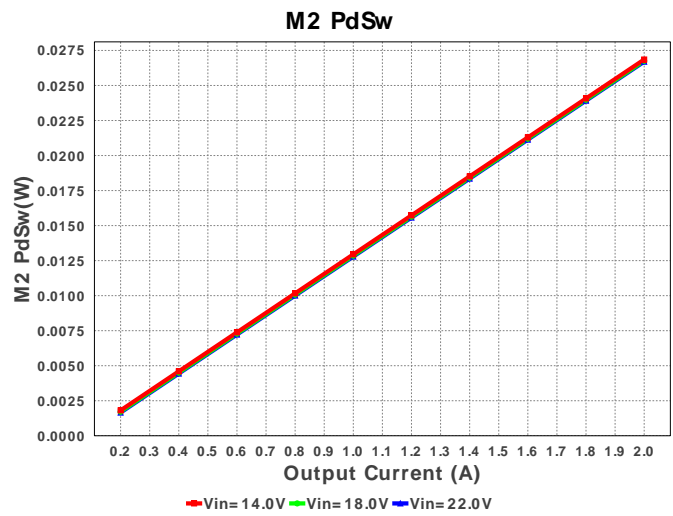
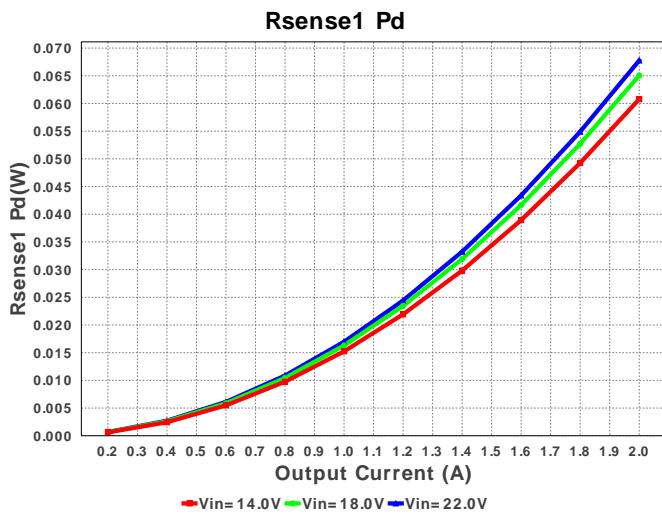
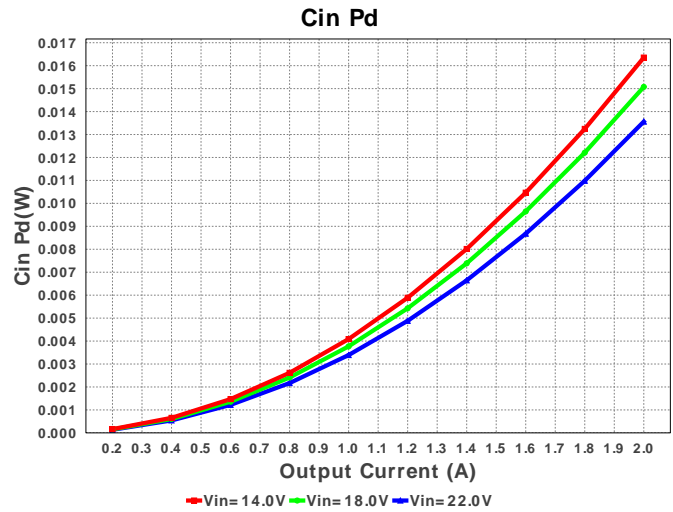
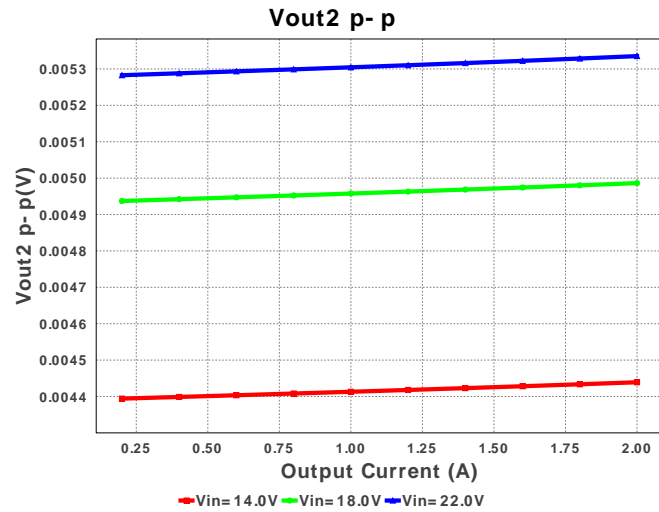


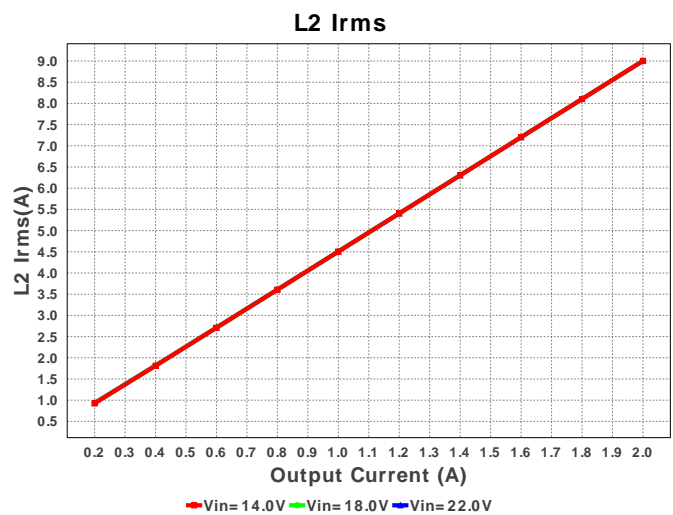
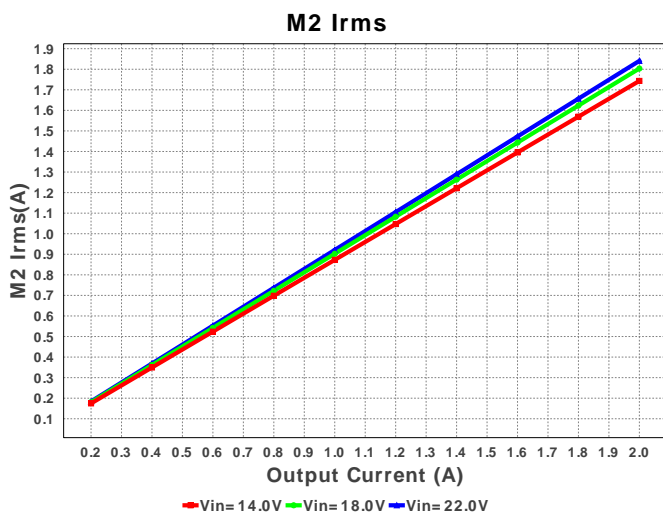
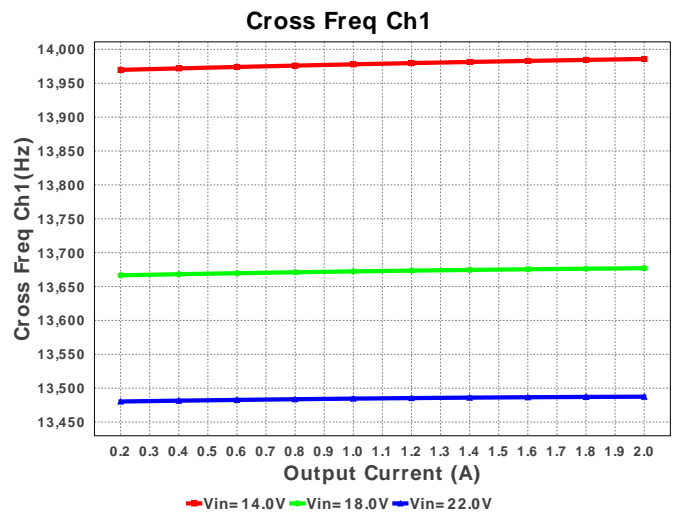
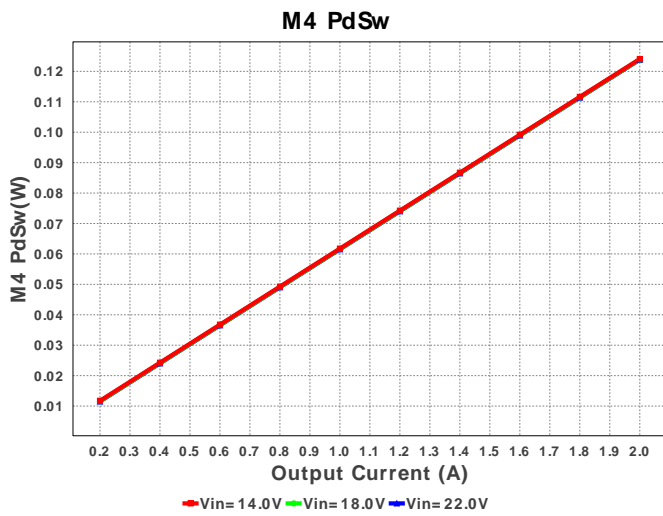
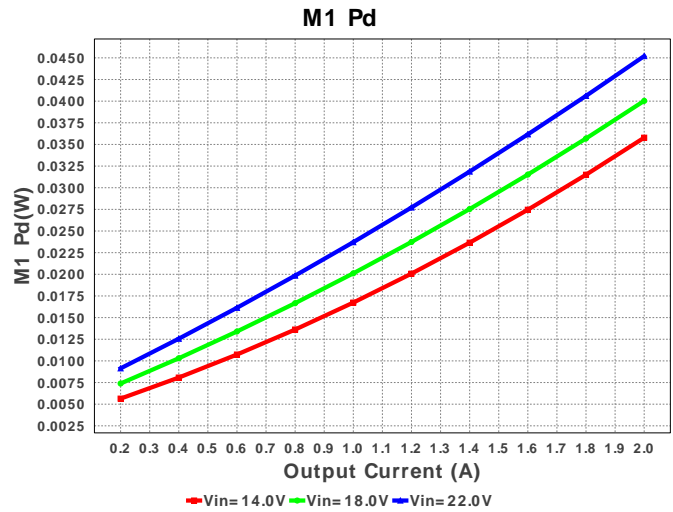
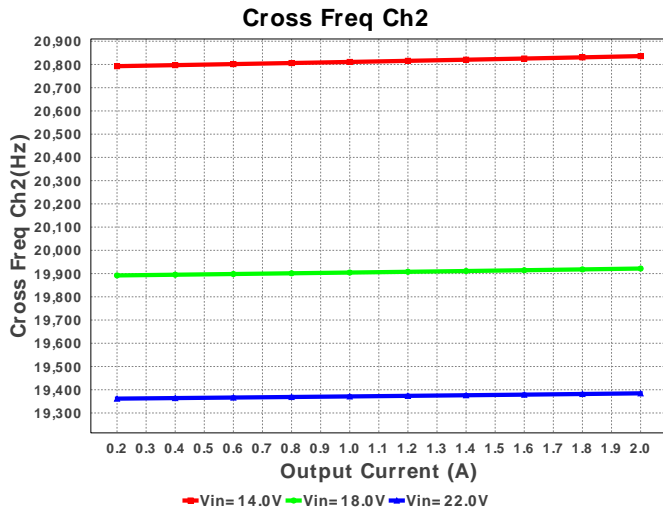
CAPSMT_62_F12 151 mm²

#	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 mm ²
11.	Css1	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
12.	Css2	MuRata	GRM155R61A563KA01D Series= X5R	Cap= 56.0 nF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
13.	Cvcc1	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
14.	Cvcc2	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
15.	Cvdd	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
16.	D1	Diodes Inc.	B240A-13-F	VF@Io= 500.0 mV VRRM= 40.0 V	1	\$0.09	 SMA 37 mm ²
17.	D2	Diodes Inc.	B240A-13-F	VF@Io= 500.0 mV VRRM= 40.0 V	1	\$0.09	 SMA 37 mm ²
18.	L1	TDK	VLP8040T-6R8M	L= 6.8 uH DCR= 24.0 mOhm	1	\$0.22	 VLP8040 113 mm ²
19.	L2	Coilcraft	SER2915L-103KL	L= 10.0 uH DCR= 1.5 mOhm	1	\$1.88	 SER2915L 652 mm ²
20.	M1	Texas Instruments	CSD17507Q5A	VdsMax= 30.0 V IdsMax= 65.0 Amps	1	\$0.25	 TRANS_NexFET_Q5A 55 mm ²
21.	M2	Texas Instruments	CSD18531Q5A	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	\$0.65	 TRANS_NexFET_Q5A 55 mm ²
22.	M3	Texas Instruments	CSD17308Q3	VdsMax= 30.0 V IdsMax= 50.0 Amps	1	\$0.28	 TRANS_NexFET_Q3 18 mm ²
23.	M4	Texas Instruments	CSD18531Q5A	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	\$0.65	 TRANS_NexFET_Q5A 55 mm ²
24.	R15	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
25.	R16	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²

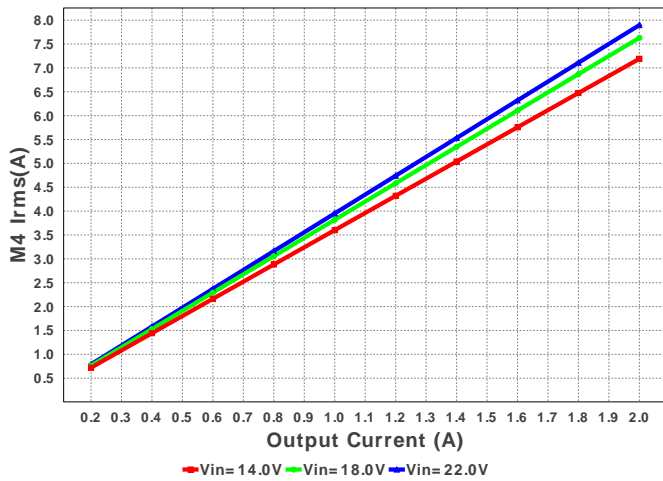
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26.	R17	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
27.	R18	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
28.	R19	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
29.	R20	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
30.	Rcomp1	Vishay-Dale	CRCW040215K0FKED Series= CRCW..e3	Res= 15.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
31.	Rcomp2	Vishay-Dale	CRCW040269K8FKED Series= CRCW..e3	Res= 69.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
32.	Rsense1	Stackpole Electronics Inc	CSR1206FK20L0 Series= ?	Res= 20.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	\$0.10	 1206 11 mm ²
33.	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 mm ²
34.	U1	Texas Instruments	LM5140QRWGRQ1	Switcher	1	\$3.90	 RWG0040A 64 mm ²



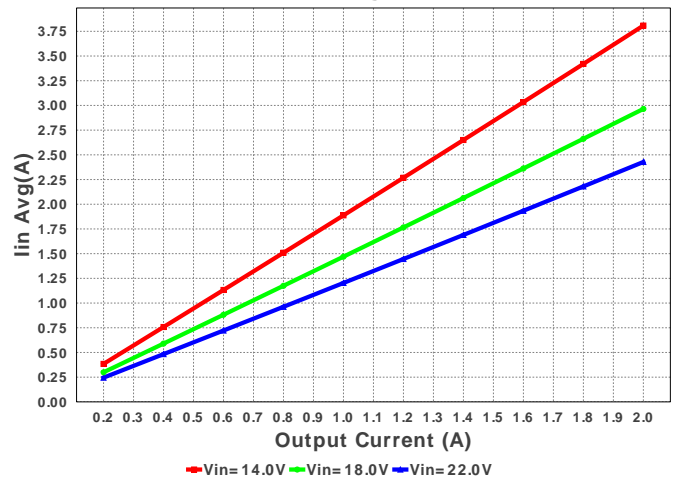




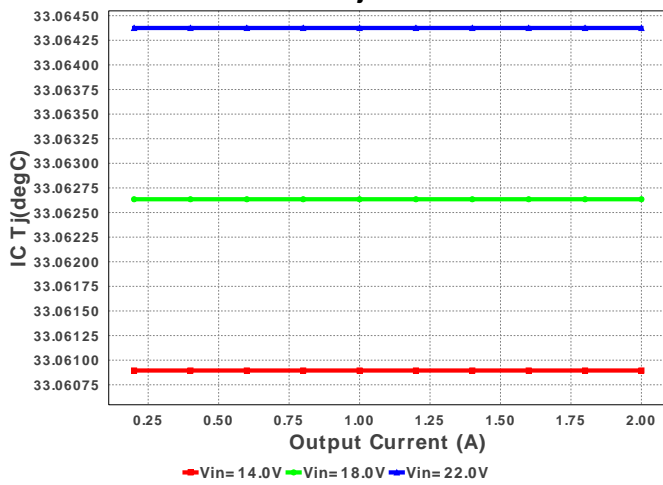
M4 Irms



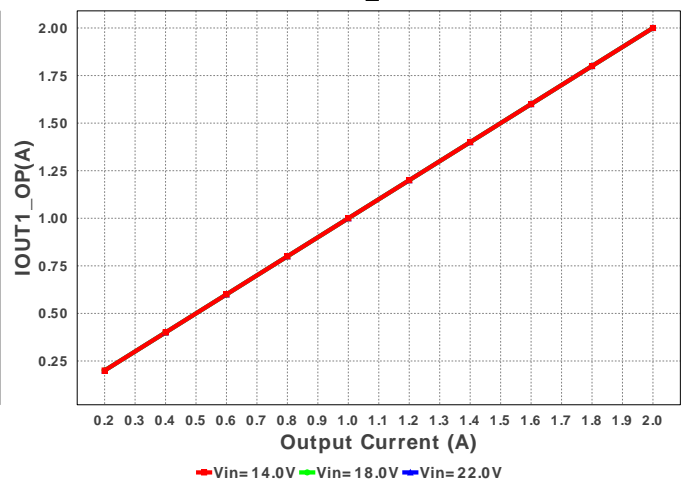
Iin Avg



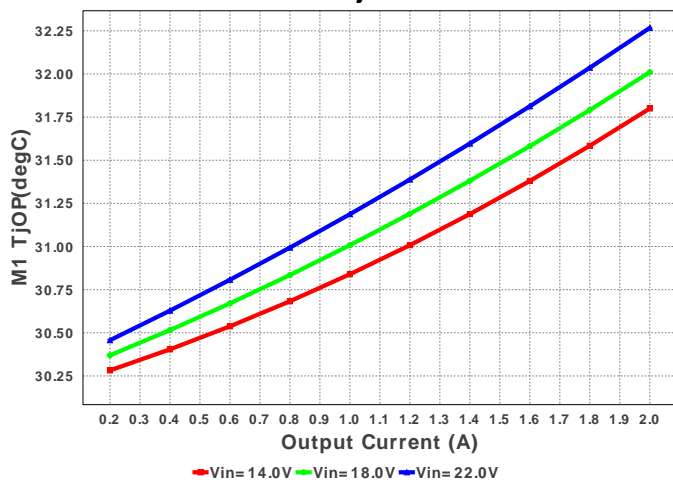
IC Tj



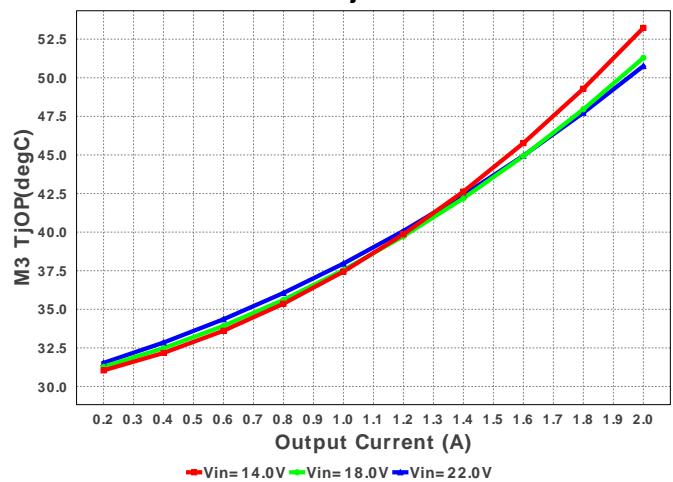
IOUT1_OP

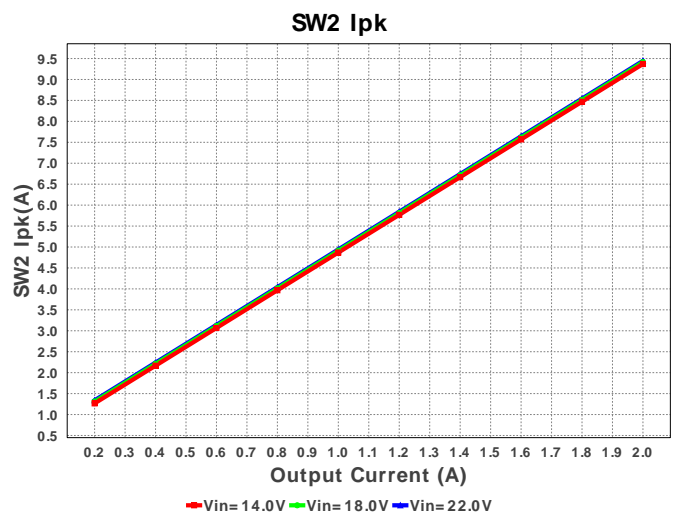
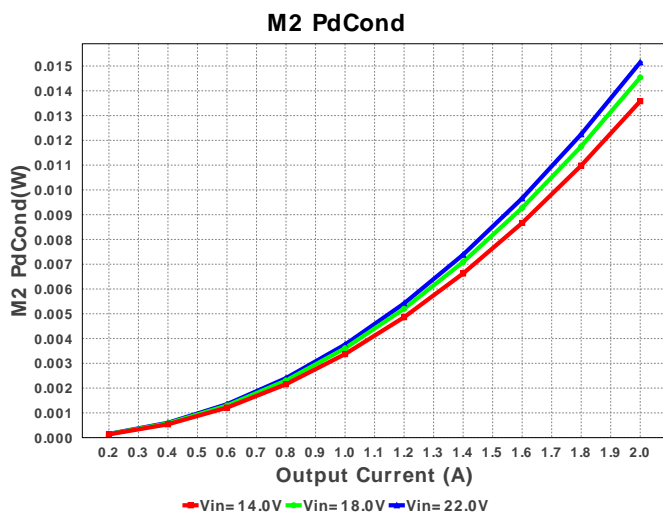
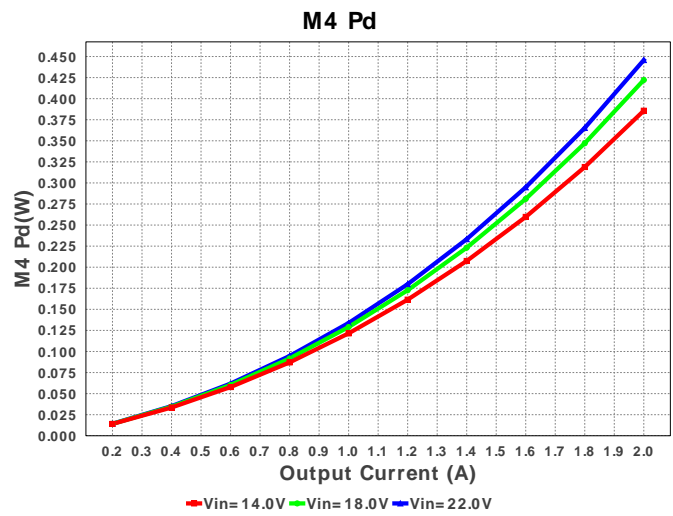
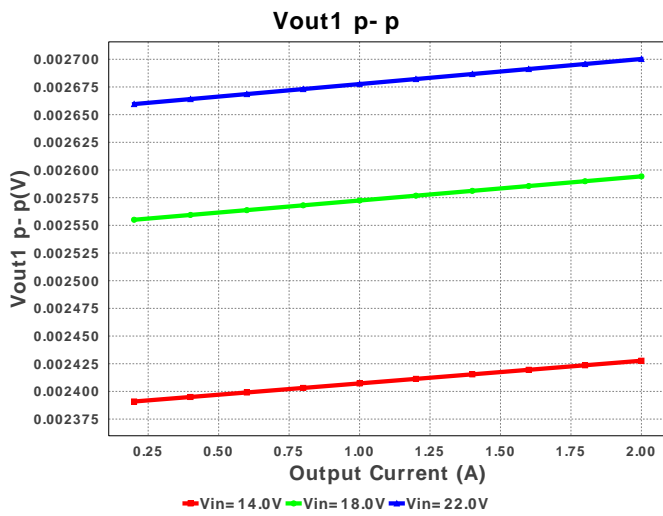
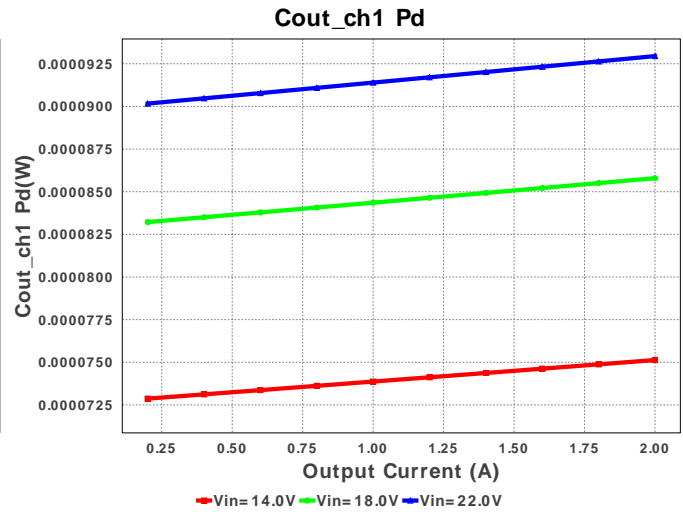
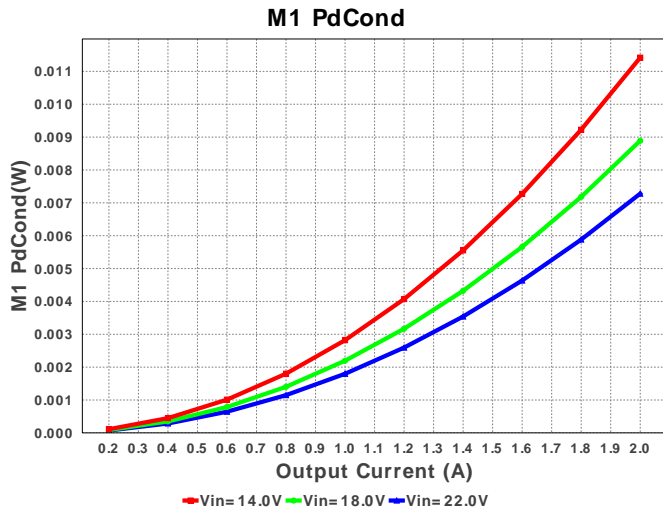


M1 TjOP

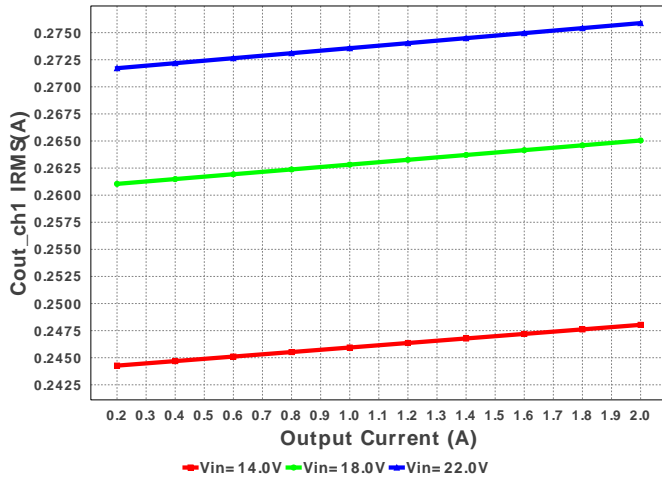


M3 TjOP

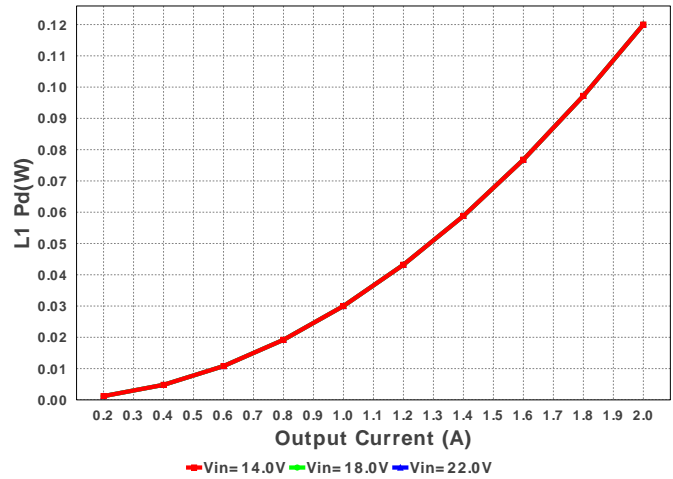




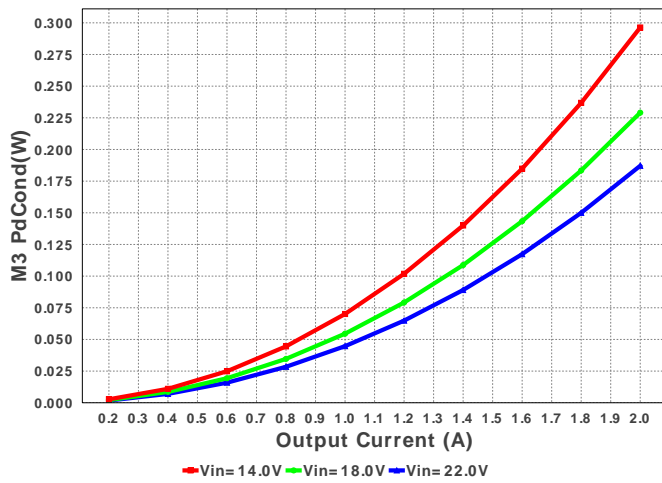
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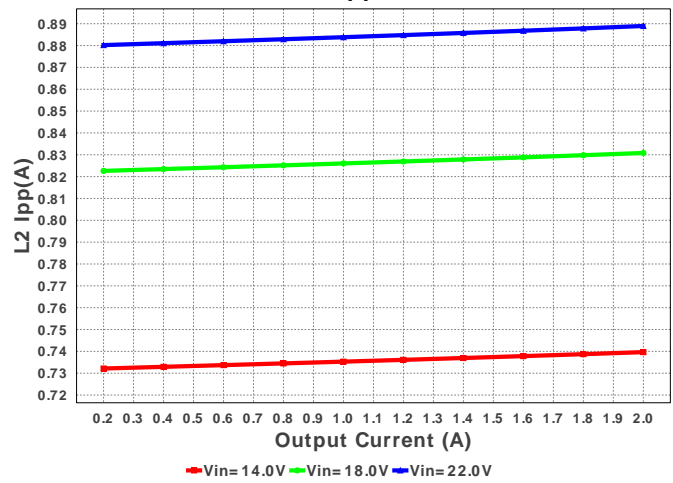
L1 Pd



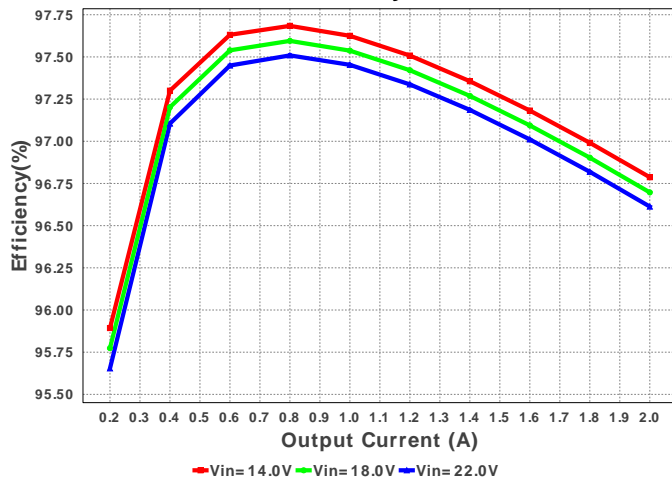
M3 PdCond



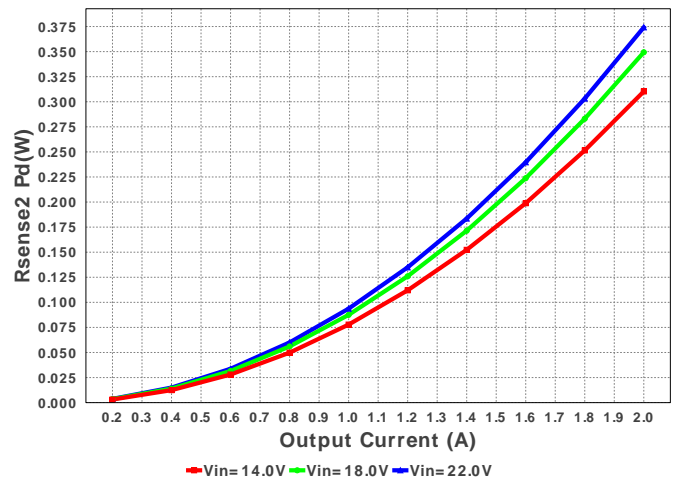
L2 Ipp

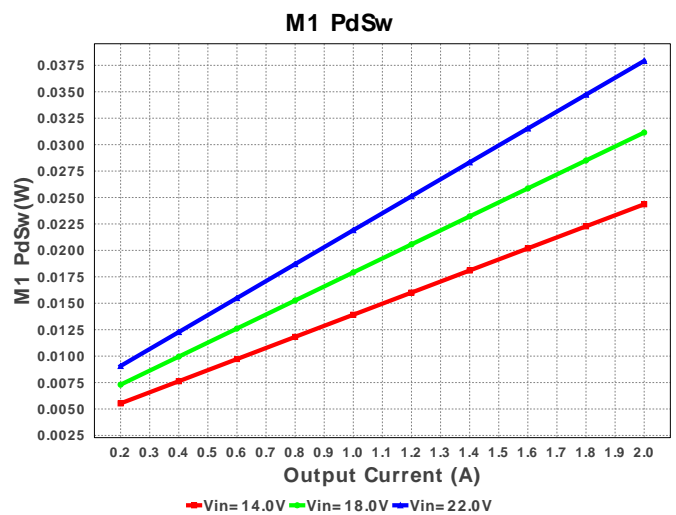
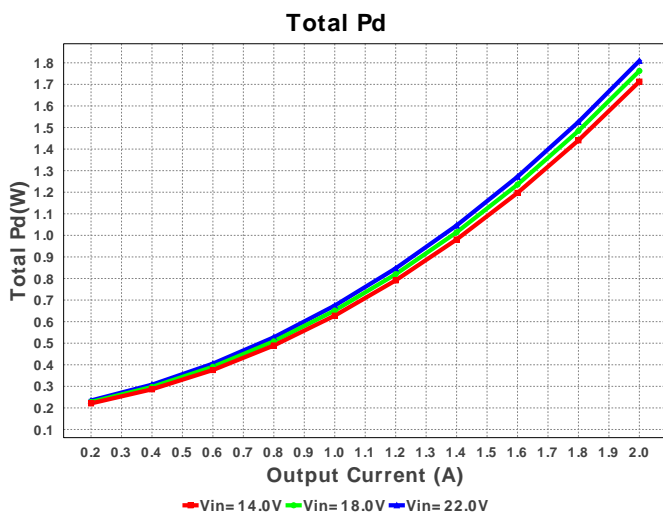
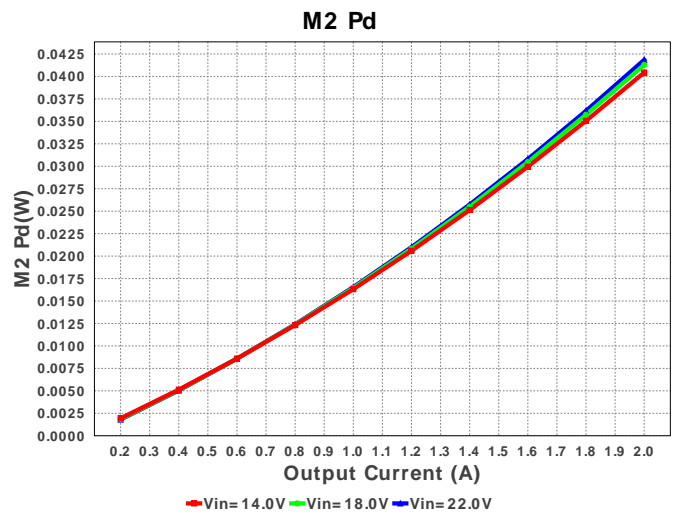
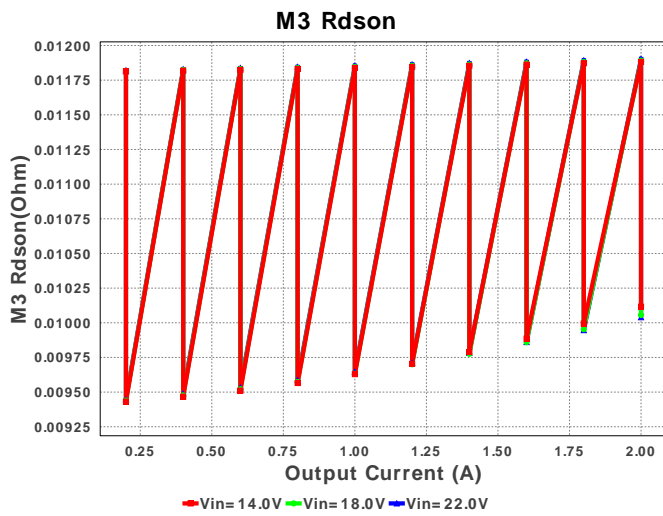
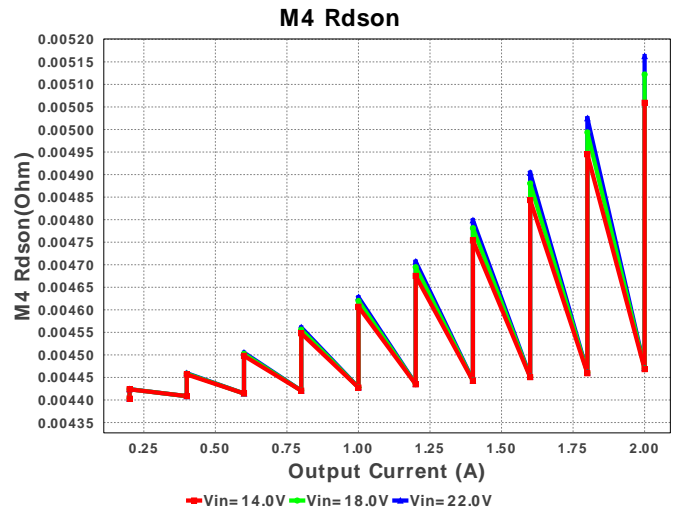
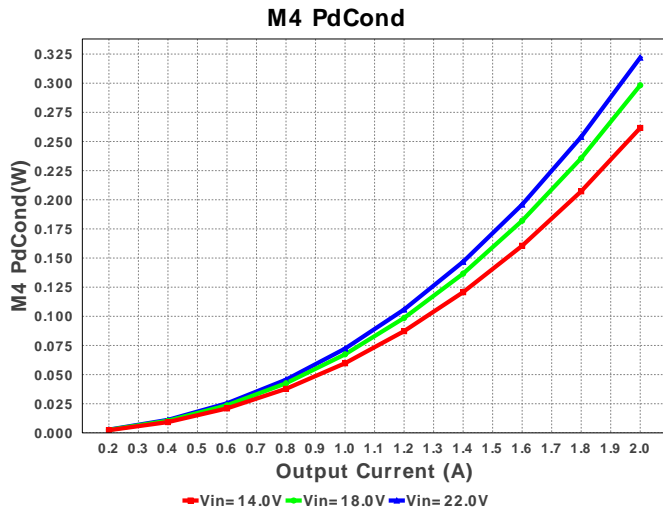


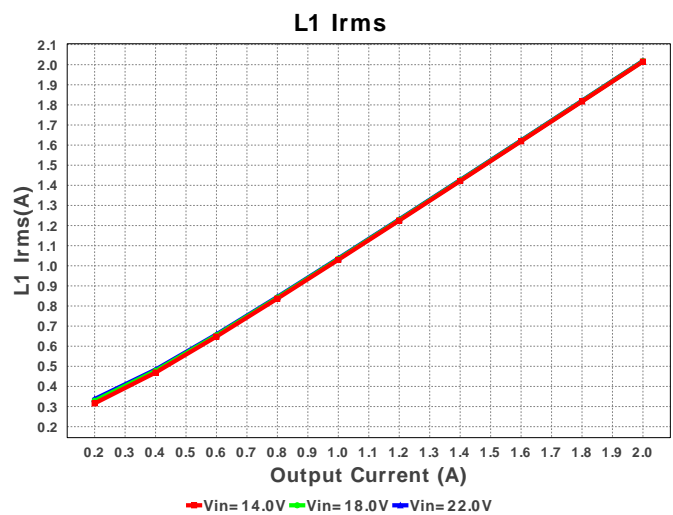
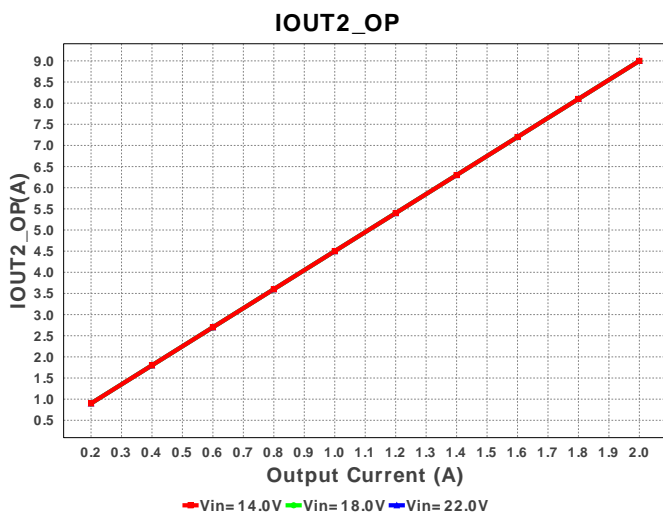
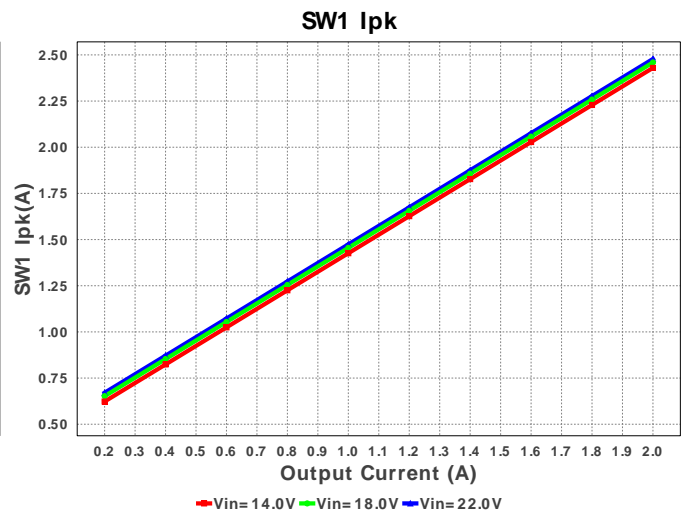
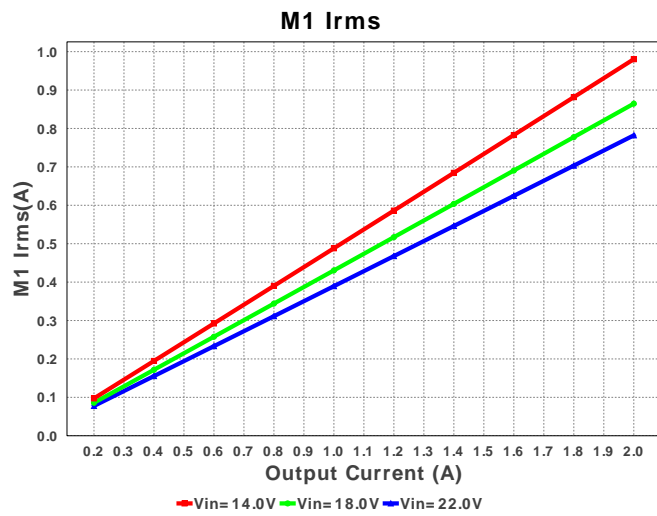
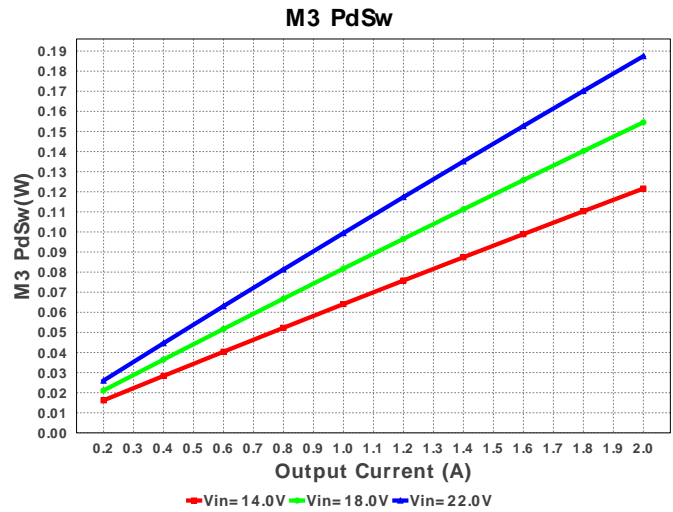
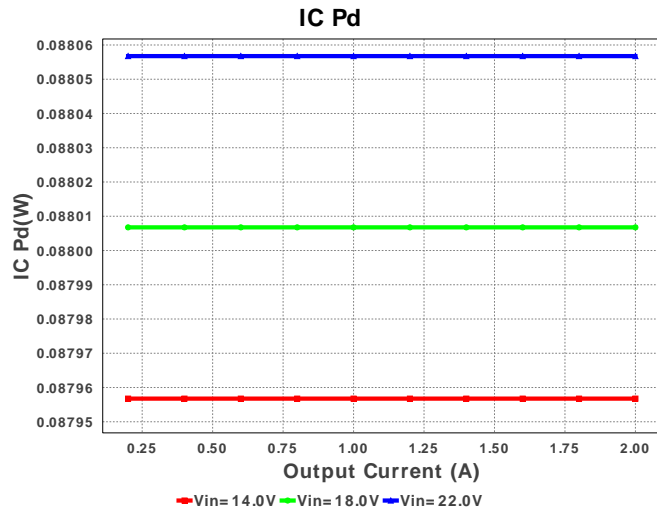
Efficiency



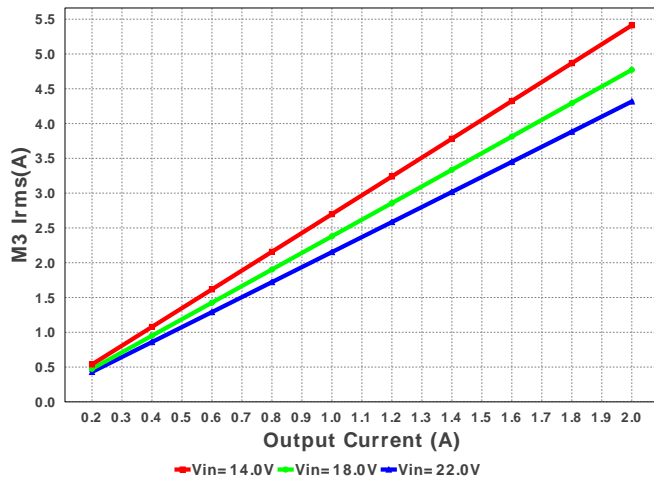
Rsense2 Pd



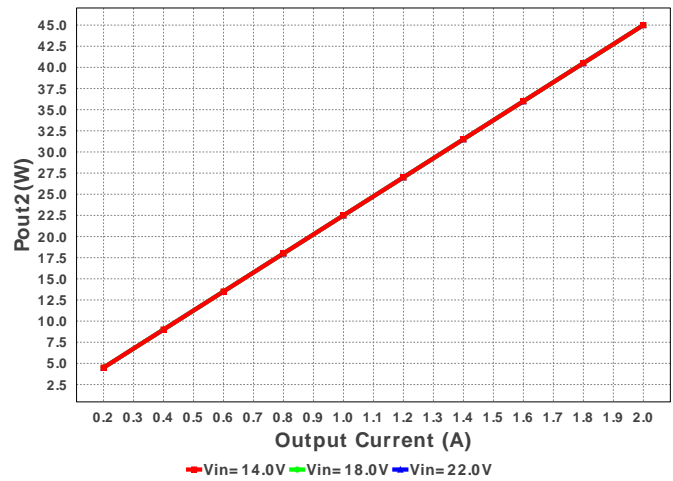




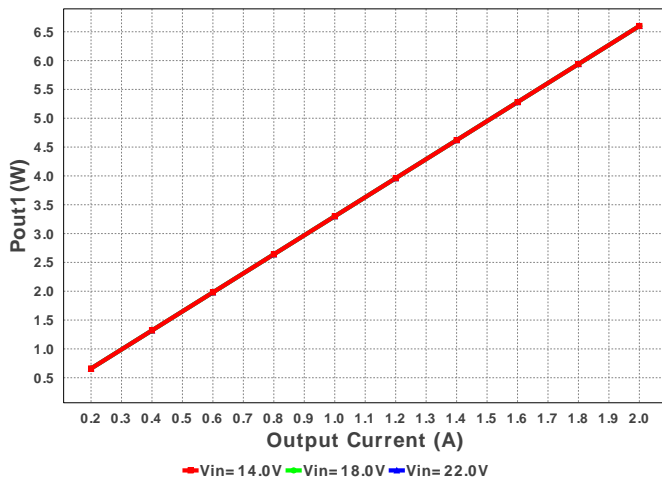
M3 Irms



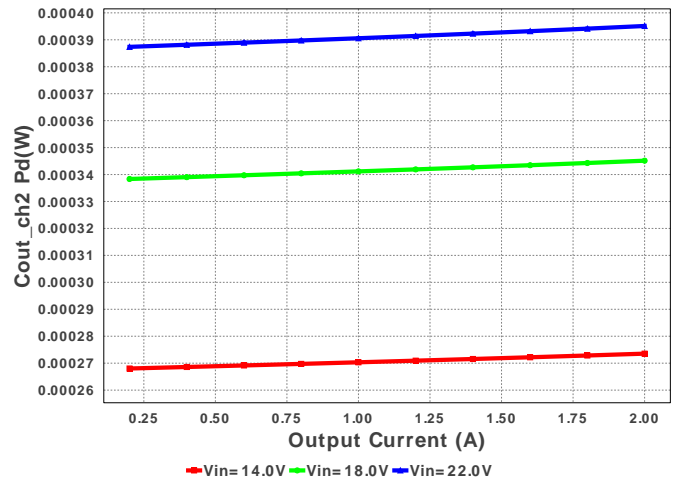
Pout2



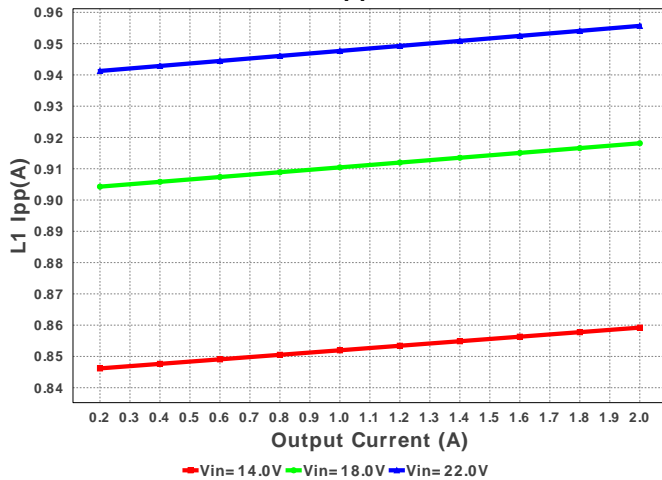
Pout1



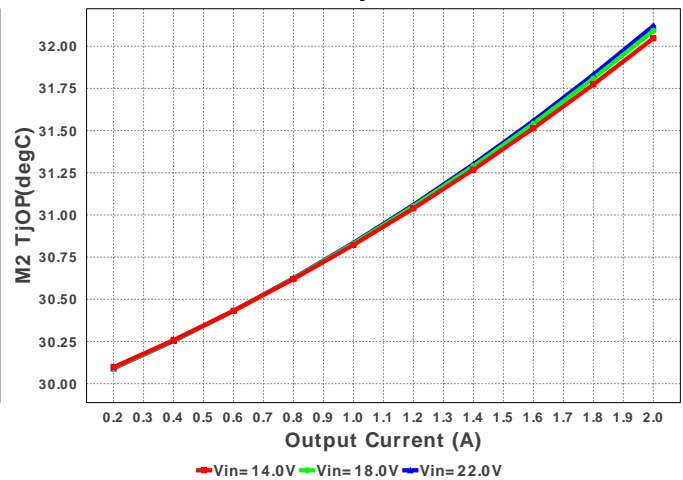
Cout_ch2 Pd

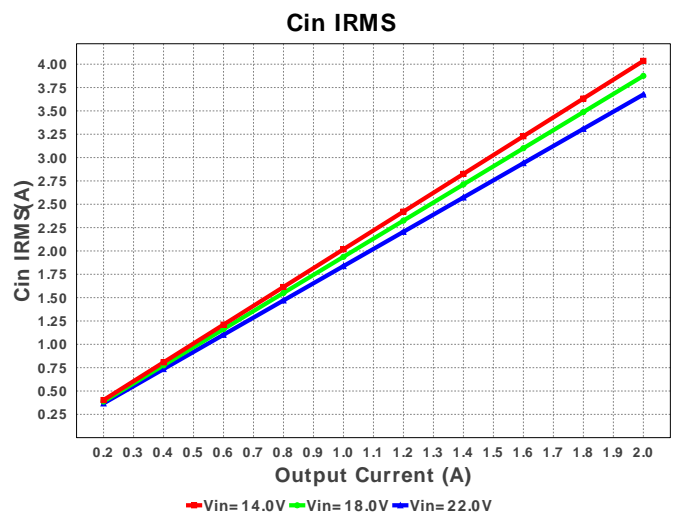
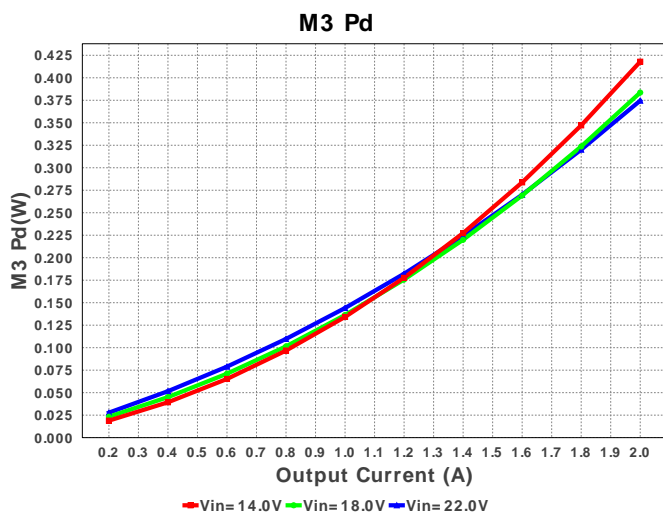
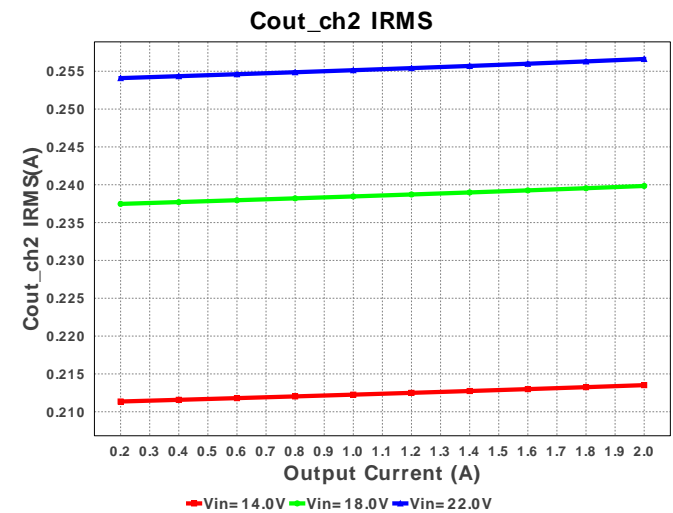
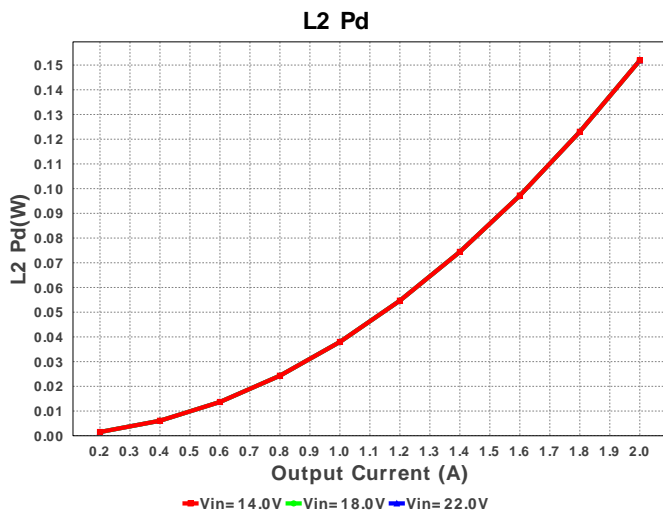
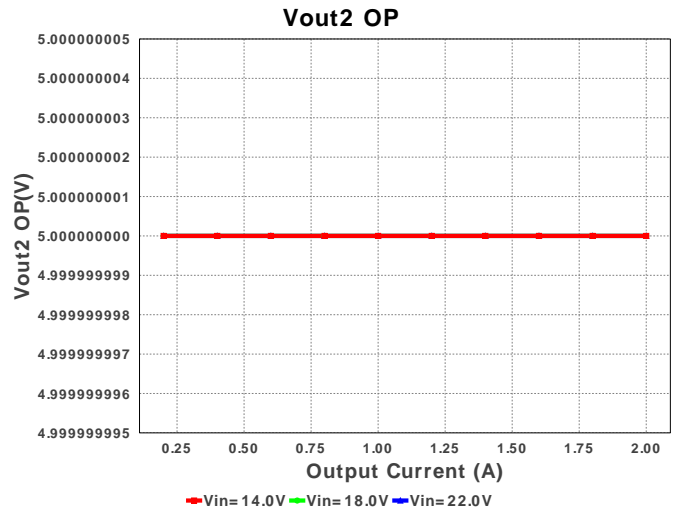
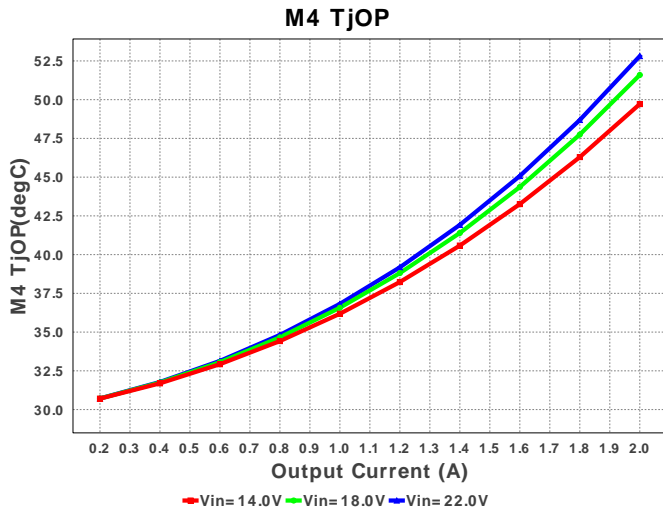


L1 Ipp



M2 TJOP





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.675 A	Current	Input capacitor RMS ripple current
2.	Cout_ch1 IRMS	275.88 mA	Current	Output Channel 1 Capacitor RMS ripple current
3.	Cout_ch2 IRMS	256.621 mA	Current	Output Channel 2 Capacitor RMS ripple current
4.	Iin Avg	2.428 A	Current	Average input current
5.	L1 Ipp	955.677 mA	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	2.019 A	Current	Inductor ripple current
7.	L2Ipp	888.96 mA	Current	Channel 2 Inductor Peak to peak Current
8.	L2 Irms	9.004 A	Current	Inductor ripple current
9.	M1 Irms	782.07 mA	Current	MOSFET RMS ripple current
10.	M2 Irms	1.841 A	Current	MOSFET RMS ripple current
11.	M3 Irms	4.317 A	Current	MOSFET RMS ripple current

#	Name	Value	Category	Description
12.	M4 Irms	7.897 A	Current	MOSFET RMS ripple current
13.	SW1 Ipk	2.478 A	Current	Peak switch current
14.	SW2 Ipk	9.444 A	Current	Peak switch current
15.	BOM Count	37	General	Total Design BOM count
16.	FootPrint	1.542 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	6.6 W	General	Channel 1 output Power
20.	Pout2	45.0 W	General	Channel 2 output Power
21.	Total BOM	\$10.71	General	Total BOM Cost
22.	M3 TjOP	50.797 degC	Op_Point	M3 MOSFET junction temperature
23.	M4 TjOP	52.812 degC	Op_Point	M4 MOSFET junction temperature
24.	Duty Cycle 1	15.291 %	Op_point	Duty cycle for Channel 1
25.	Duty Cycle 2	23.008 %	Op_point	Duty cycle for Channel 2
26.	Efficiency	96.612 %	Op_point	Steady state efficiency
27.	IC Tj	33.064 degC	Op_point	IC junction temperature
28.	IOUT1_OP	2.0 A	Op_point	Iout1 operating point
29.	IOUT2_OP	9.0 A	Op_point	Iout2 operating point
30.	M1 TjOP	32.272 degC	Op_point	M1 MOSFET junction temperature
31.	M2 TjOP	32.121 degC	Op_point	M2 MOSFET junction temperature
32.	VIN_OP	22.0 V	Op_point	Vin operating point
33.	Vout1 OP	3.3 V	Op_point	Operational Voltage 1
34.	Vout1 p-p	2.7 mV	Op_point	Peak-to-peak output1 ripple voltage
35.	Vout2 OP	5.0 V	Op_point	Operational Voltage 2
36.	Vout2 p-p	5.335 mV	Op_point	Peak-to-peak output2 ripple voltage
37.	Cin Pd	13.562 mW	Power	Input capacitor power dissipation
38.	Cout_ch1 Pd	92.949 μW	Power	Output channel 1 capacitor power dissipation
39.	Cout_ch2 Pd	395.125 μW	Power	Output channel 2 capacitor power dissipation
40.	IC Pd	88.057 mW	Power	IC power dissipation
41.	L1 Pd	120.0 mW	Power	Inductor power dissipation
42.	L2 Pd	151.875 mW	Power	Inductor power dissipation
43.	M1 Pd	45.303 mW	Power	M1 MOSFET total power dissipation
44.	M1 PdCond	7.28 mW	Power	M1 MOSFET conduction losses
45.	M1 PdSw	38.023 mW	Power	M1 MOSFET switching losses
46.	M2 Pd	41.848 mW	Power	M2 MOSFET total power dissipation
47.	M2 PdCond	15.149 mW	Power	M2 MOSFET conduction losses
48.	M2 PdSw	26.699 mW	Power	M2 MOSFET switching losses
49.	M3 Pd	375.257 mW	Power	M3 MOSFET total power dissipation
50.	M3 PdCond	187.136 mW	Power	M3 MOSFET conduction losses
51.	M3 PdSw	188.121 mW	Power	M3 MOSFET switching losses
52.	M1 Rdson	11.903 mOhm	Power	Drain-Source On-resistance
53.	M3 Rdson	10.041 mOhm	Power	Drain-Source On-resistance
54.	M4 Pd	445.805 mW	Power	M4 MOSFET total power dissipation
55.	M4 PdCond	321.97 mW	Power	M4 MOSFET conduction losses
56.	M4 PdSw	123.835 mW	Power	M4 MOSFET switching losses
57.	M2 Rdson	4.471 mOhm	Power	Drain-Source On-resistance
58.	M4 Rdson	5.163 mOhm	Power	Drain-Source On-resistance
59.	Rsense1 Pd	67.767 mW	Power	Current Limit Sense Resistor Power Dissipation
60.	Rsense2 Pd	374.179 mW	Power	Current Limit Sense Resistor Power Dissipation
61.	Total Pd	1.81 W	Power	Total Power Dissipation
62.	Cross Freq Ch1	13.482 kHz		Bode plot crossover frequency
63.	Cross Freq Ch2	39.084 kHz		Bode plot crossover frequency
64.	Phase Marg Ch1	32.642 deg		Bode Plot Phase Margin
65.	Phase Marg Ch2	91.239 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	9.0	Output Current #2
4.	VinMax	22.0	Maximum input voltage
5.	VinMin	14.0	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.

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