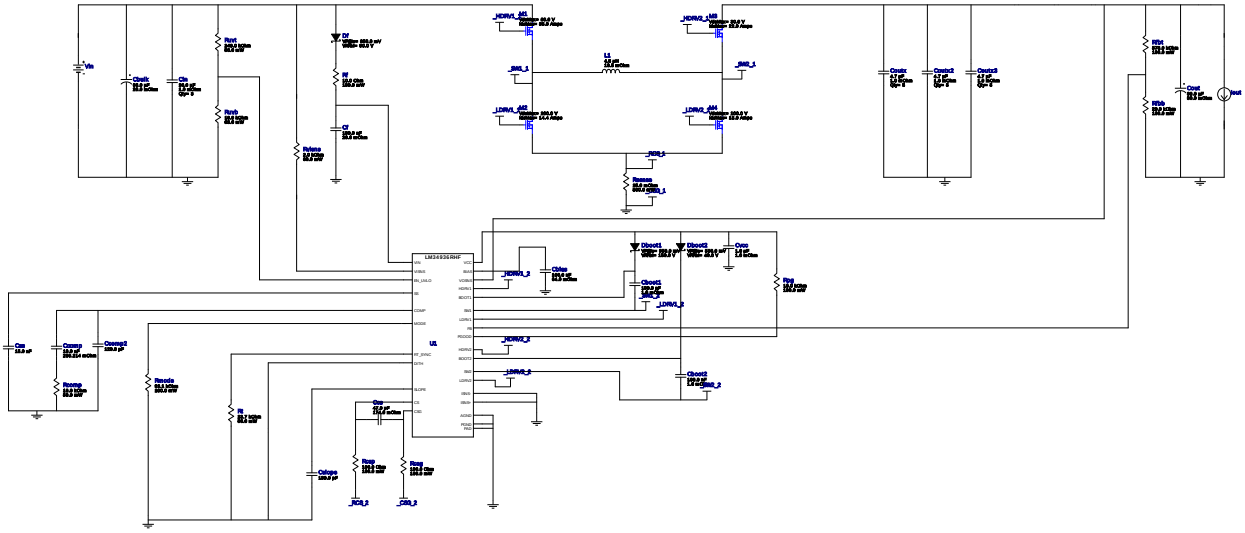
WEBENCH® Design Report

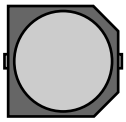
VinMin = 20.0V
VinMax = 30.0V
Vout = 24.0V
Iout = 4.0A

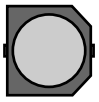
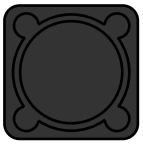
Device = LM34936RHFR
Topology = Buck_Boost
Created = 2020-07-03 06:36:32.730
BOM Cost = $8.87
BOM Count = 52
Total Pd = 1.41W

LM34936RHFR 20V-30V to 24.00V @ 4A

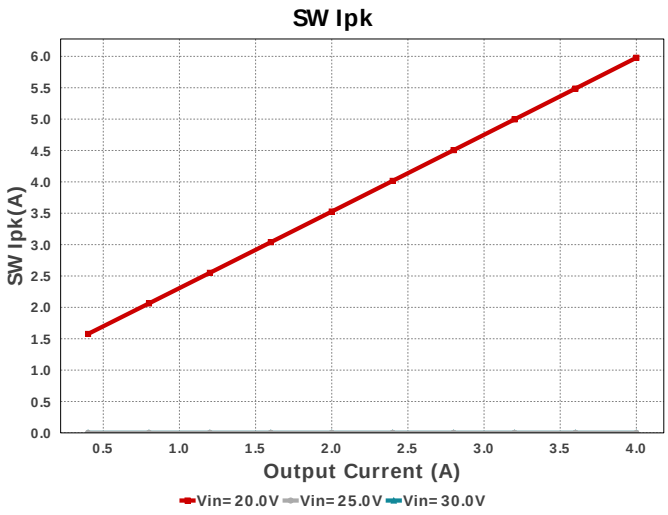


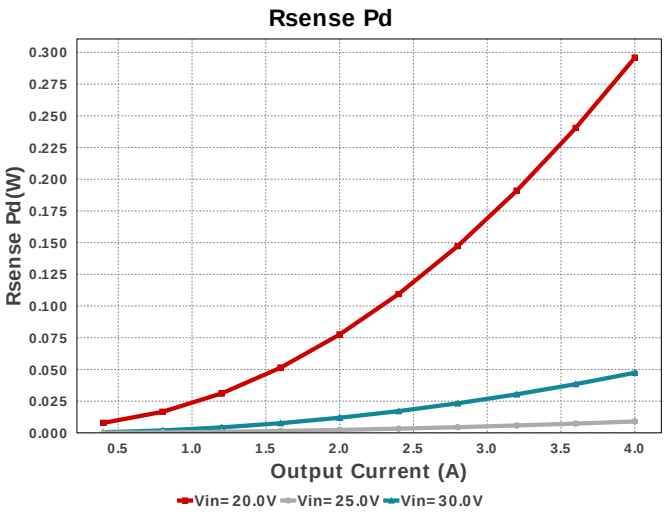
Electrical BOM

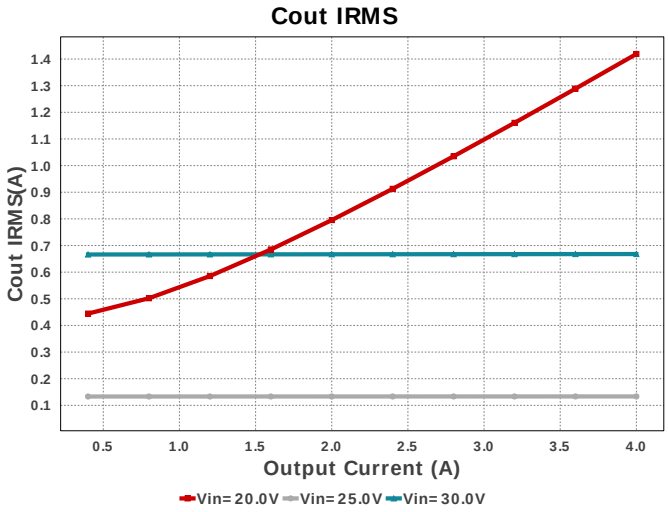
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
2.	Cboot1	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
3.	Cboot2	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
4.	Cbulk	Panasonic	50SVPF68M Series= SVPF	Cap= 68.0 uF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 4.3 A	1	$0.95	 CAPSMT_62_F12 151 mm^2
5.	Ccomp	TDK	CGA1A2X7R1A103K030BA Series= X7R	Cap= 10.0 nF ESR= 280.21 mOhm VDC= 10.0 V IRMS= 245.72 mA	1	$0.01	0201_033 2 mm^2
6.	Ccomp2	Samsung Electro-Mechanics	CL21C121JBANNNC Series= C0G/NP0	Cap= 120.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
7.	Ccs	AVX	06035A470JAT2A Series= C0G/NP0	Cap= 47.0 pF ESR= 174.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
8.	Cf	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm^2

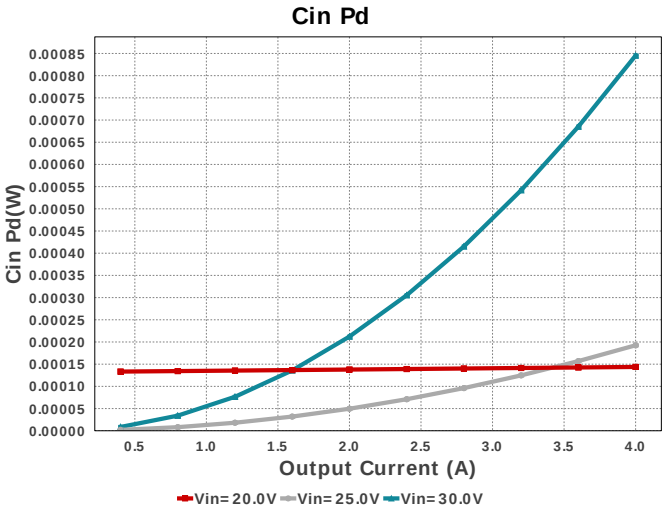
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cin	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	3	$0.28	 1210 15 mm²
10.	Cout	Panasonic	35SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 30.0 mOhm VDC= 35.0 V IRMS= 2.8 A	1	$0.52	 CAPSMT_62_E7 106 mm²
11.	Coutx	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	$0.18	 0805 7 mm²
12.	Coutx2	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	$0.18	 0805 7 mm²
13.	Coutx3	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	$0.18	 0805 7 mm²
14.	Cslope	Samsung Electro-Mechanics	CL10C131JB8NNNC Series= C0G/NP0	Cap= 130.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0603 5 mm²
15.	Css	Kemet	C0603C153J3GACTU Series= C0G/NP0	Cap= 15.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.10	 0603 5 mm²
16.	Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	 0603 5 mm²
17.	Dboot1	SMC Diode Solutions	SK215ATR	VF@Io= 950.0 mV VRRM= 150.0 V	1	$0.04	 SMA 37 mm²
18.	Dboot2	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	 SOD-123F 12 mm²
19.	Df	SMC Diode Solutions	SK19TR	VF@Io= 850.0 mV VRRM= 90.0 V	1	$0.04	 SMB 44 mm²
20.	L1	Bourns	SRR1280-4R5Y	L= 4.5 µH DCR= 13.5 mOhm	1	$0.45	 SRR1280 210 mm²
21.	M1	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V IdsMax= 35.0 Amps	1	$0.25	 DNH0008A 18 mm²
22.	M2	Texas Instruments	CSD19538Q2	VdsMax= 100.0 V IdsMax= 14.4 Amps	1	$0.15	DQK0006C 9 mm²
23.	M3	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.10	DQK0006C 9 mm²
24.	M4	Texas Instruments	CSD19538Q3A	VdsMax= 100.0 V IdsMax= 15.0 Amps	1	$0.15	 DNH0008A 18 mm²
25.	Rcomp	Yageo	RC0201FR-0710KL Series= ?	Res= 10000.0Ohm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
26.	Rcsg	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²

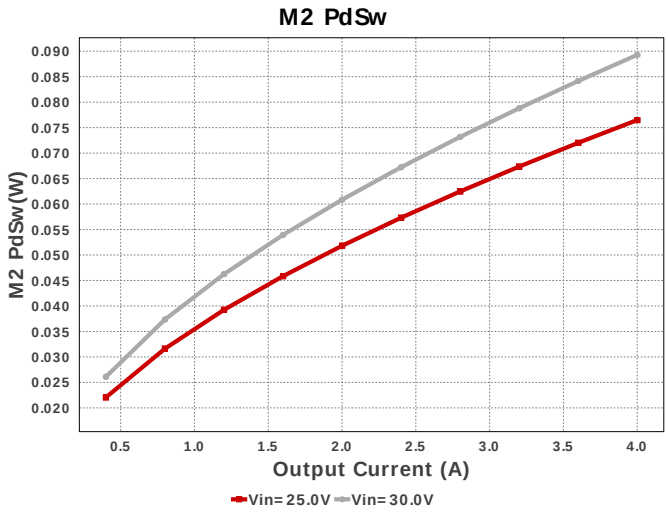
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27.	Rcsp	Vishay-Dale	CRCW0603100RFKEA Series= CRCW..e3	Res= 100.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
28.	Rf	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
29.	Rfbb	Vishay-Dale	CRCW060320K0FKEA Series= CRCW..e3	Res= 20000.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
30.	Rfbt	Yageo	RC0603FR-07576KL Series= ?	Res= 576000.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
31.	Rmode	Vishay-Dale	CRCW060393K1FKEA Series= CRCW..e3	Res= 93100.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
32.	Rpg	Vishay-Dale	CRCW060310K0FKEA Series= CRCW..e3	Res= 10000.0Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
33.	Rsense	Stackpole Electronics Inc	CSR1206FK15L0 Series= ?	Res= 0.015Ohm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	 1206 11 mm^2
34.	Rt	Yageo	RC0201FR-0723K7L Series= ?	Res= 23700.0Ohm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm^2
35.	Ruvb	Vishay-Dale	CRCW040216K9FKED Series= CRCW..e3	Res= 16900.0Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
36.	Ruvt	Yageo	RC0201FR-07249KL Series= ?	Res= 249000.0Ohm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm^2
37.	Rvisns	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2000.0Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
38.	U1	Texas Instruments	LM34936RHFR	Switcher	1	$2.20	RHF0028A 42 mm^2

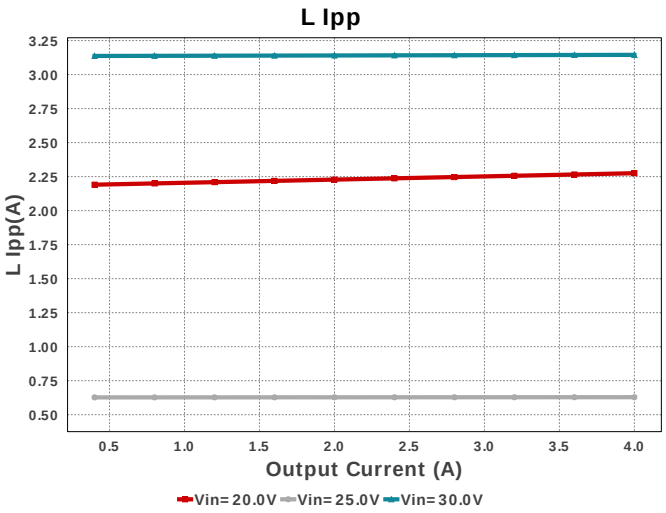


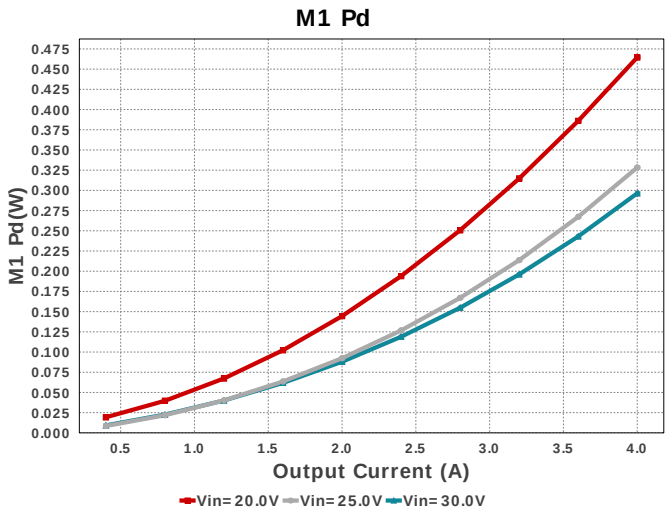


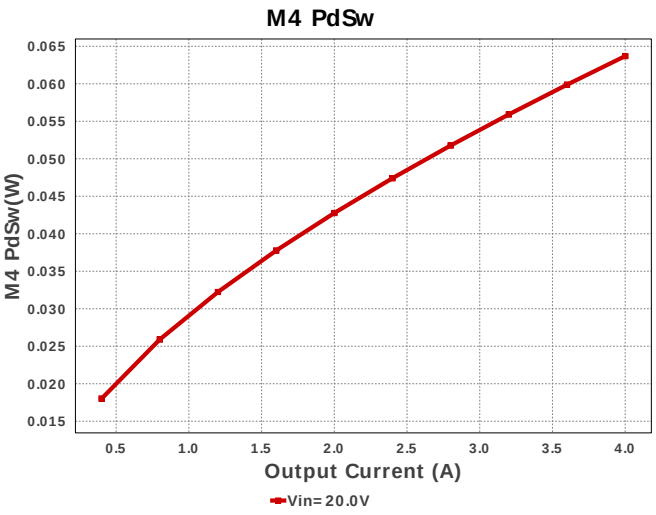


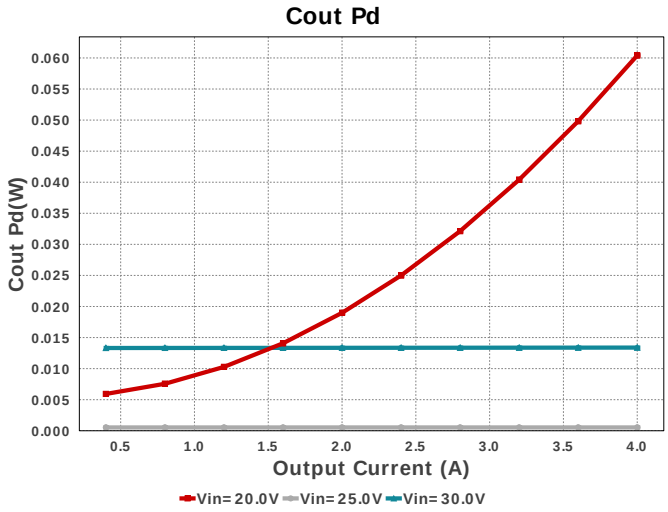


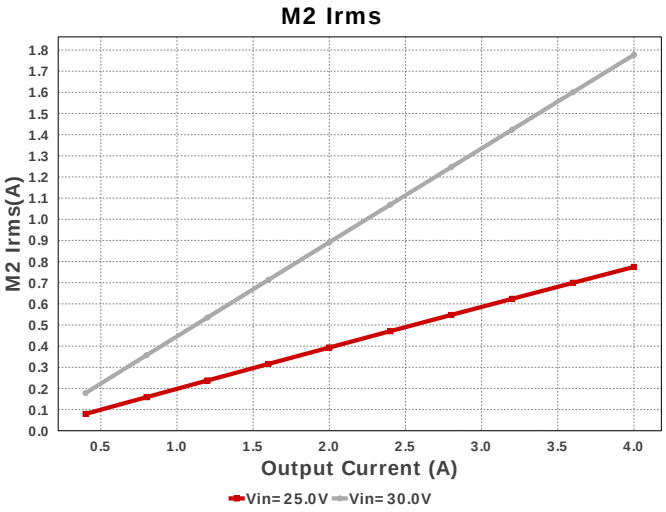


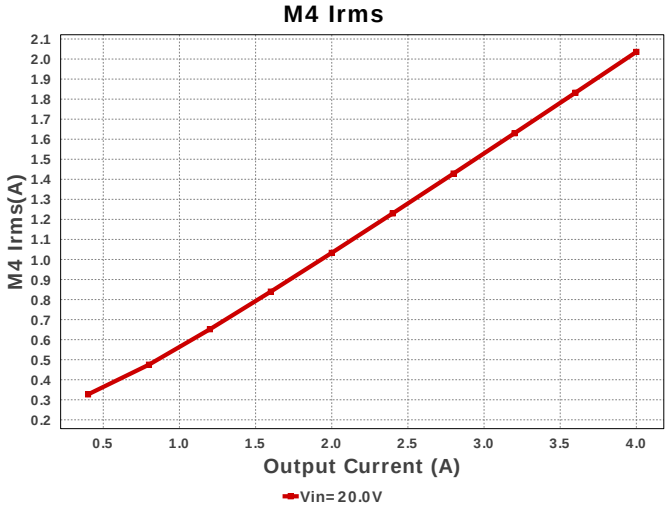


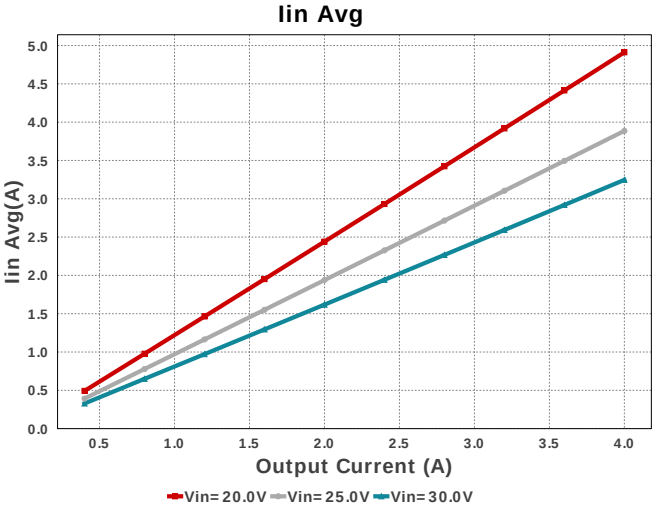


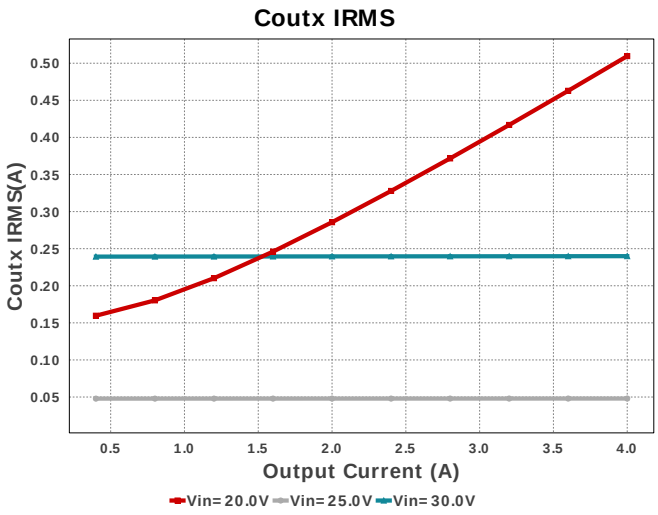


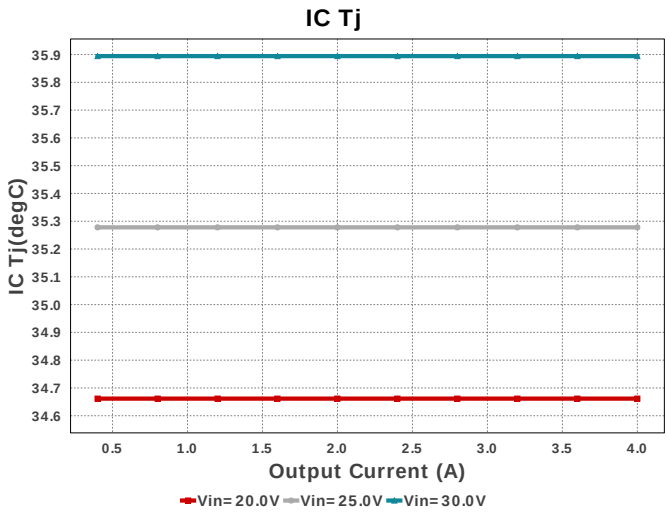


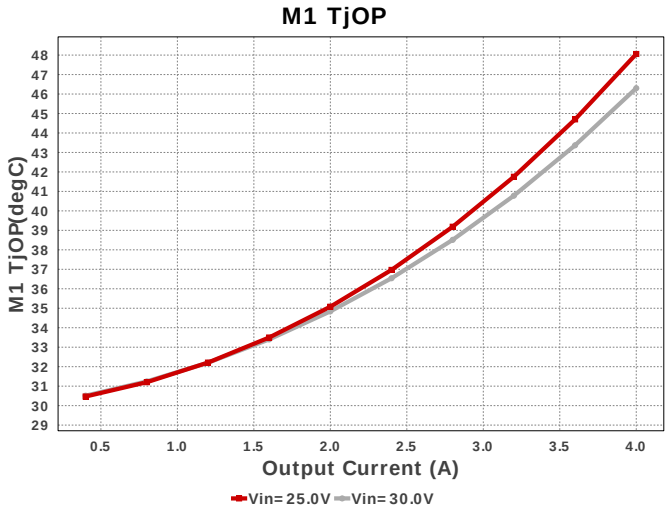


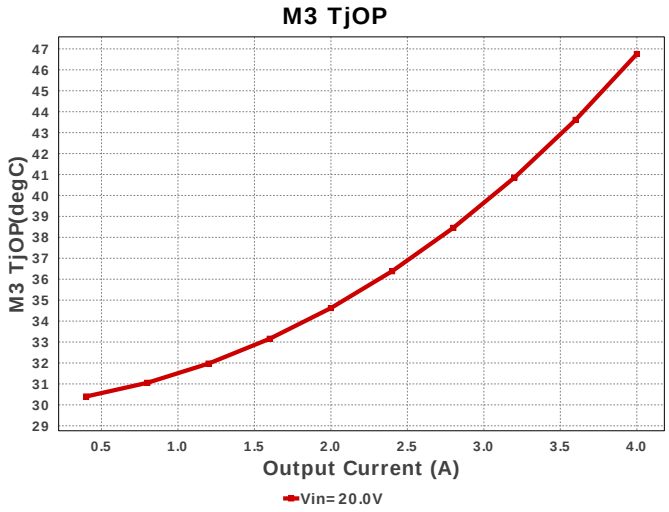


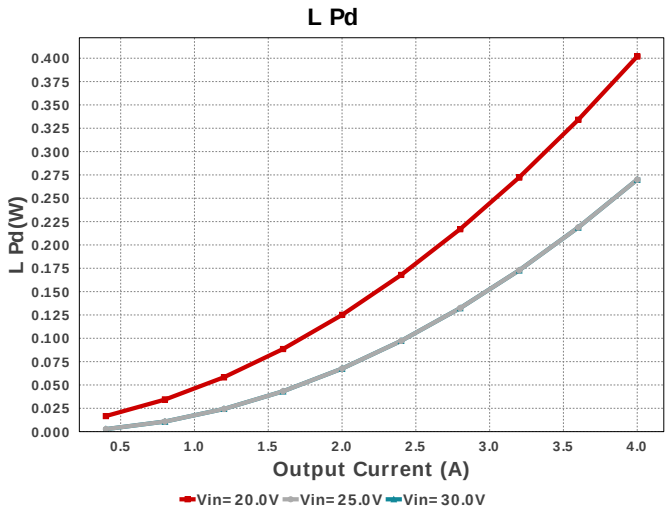


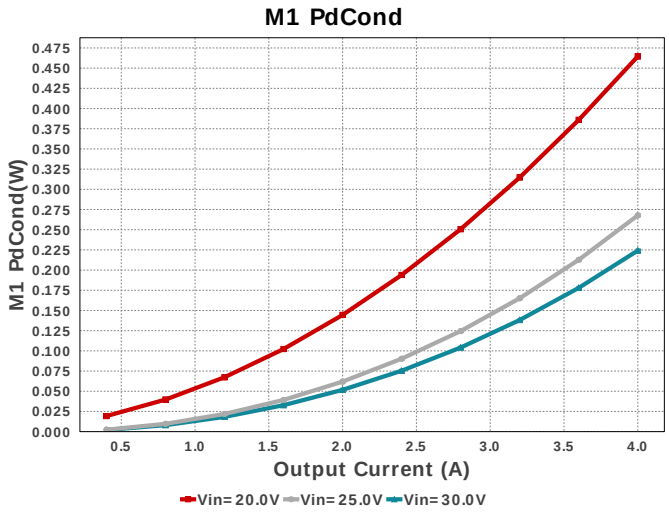


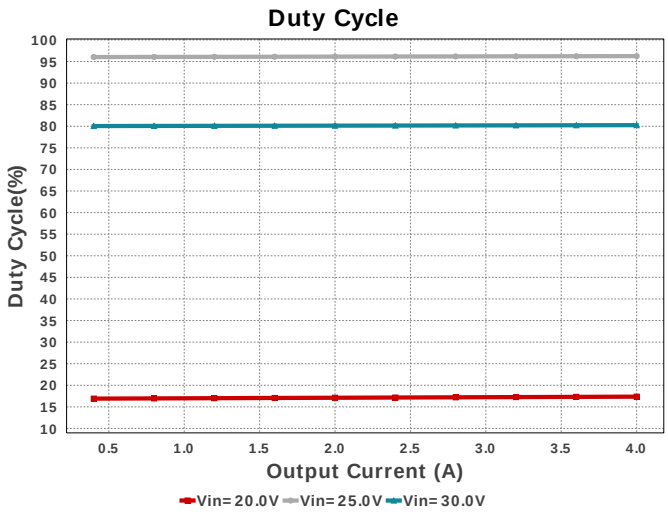


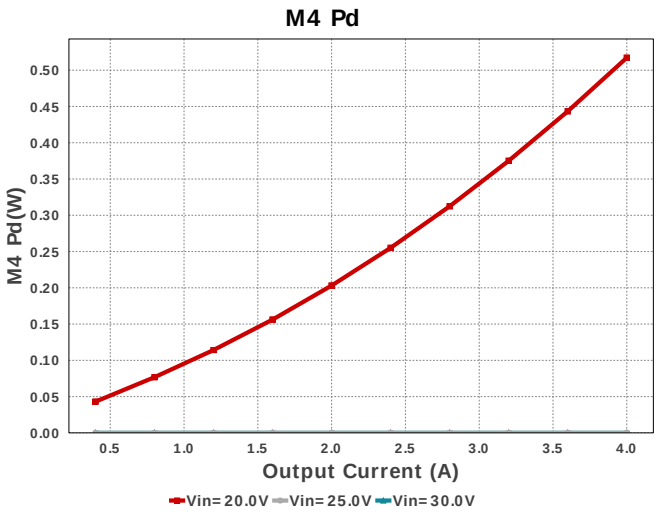


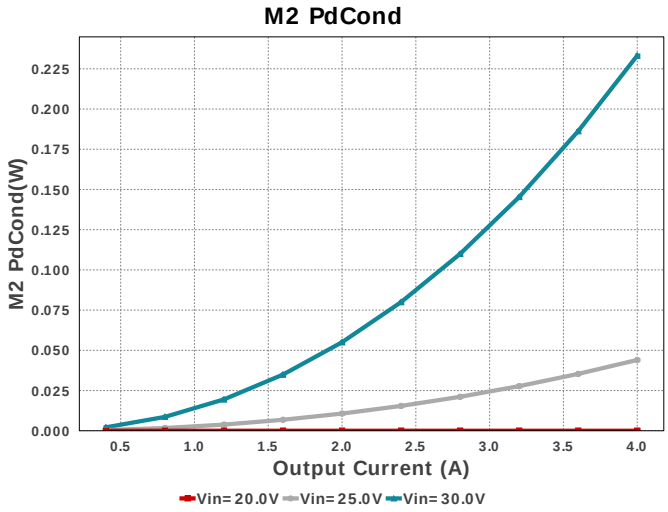


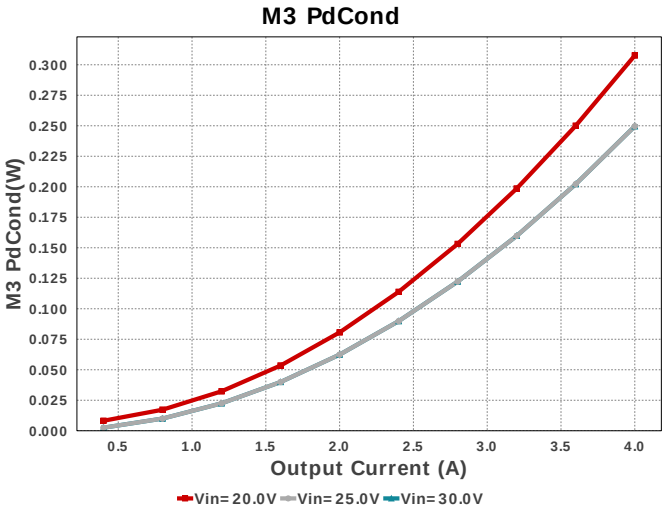


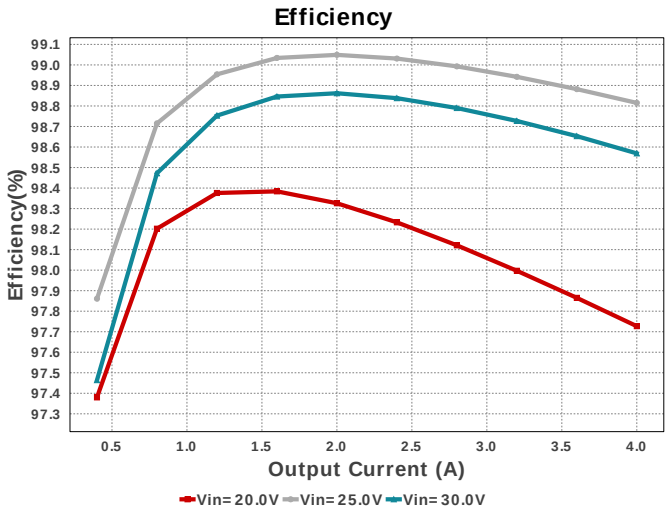


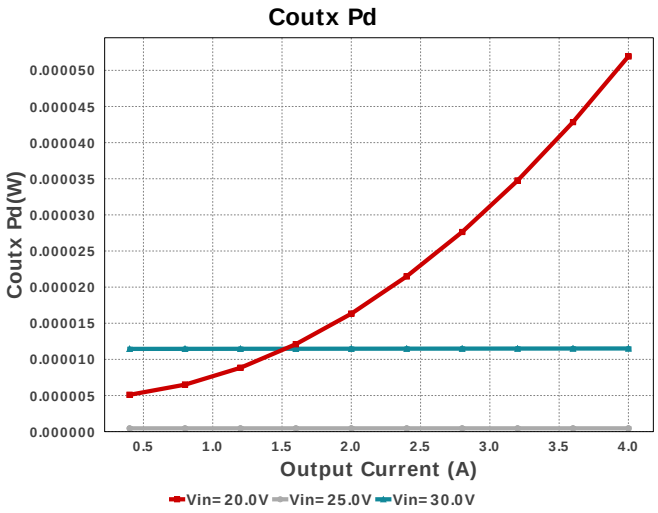


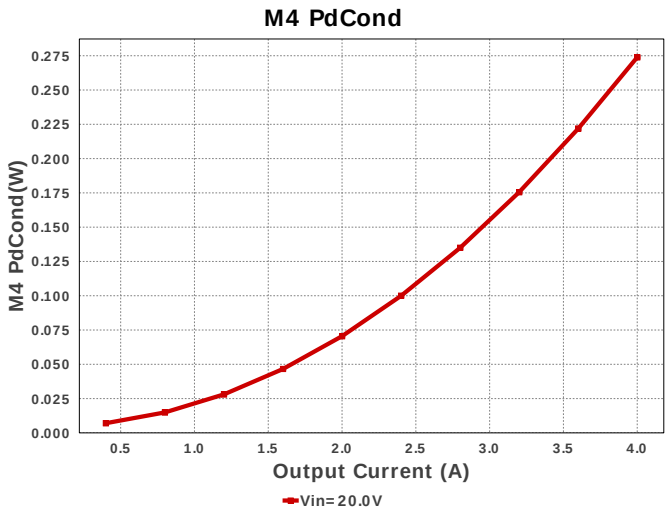


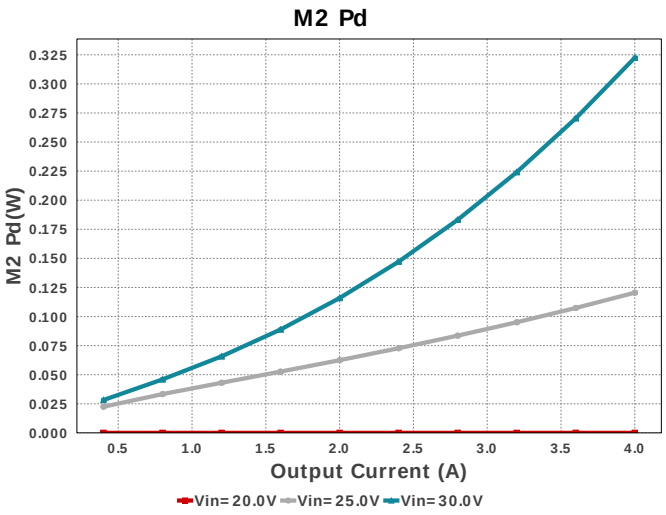


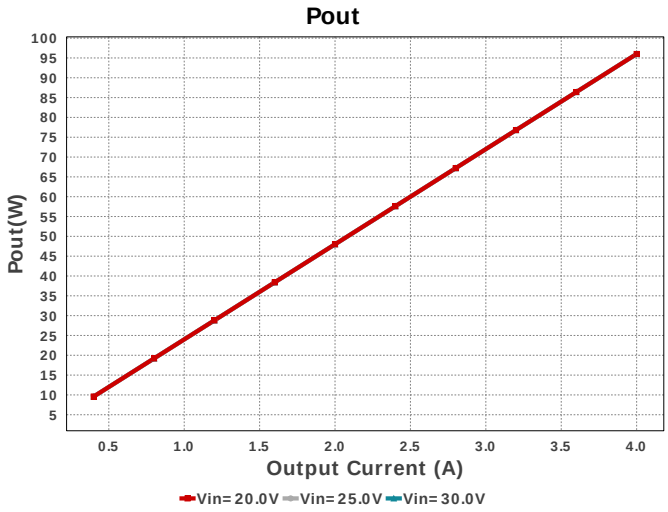


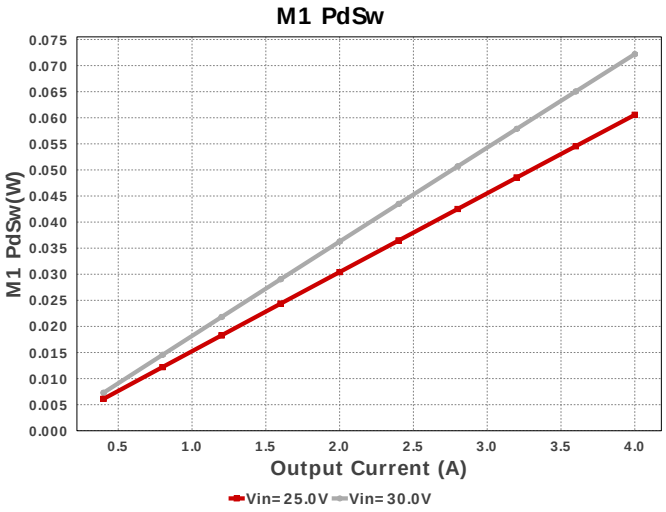


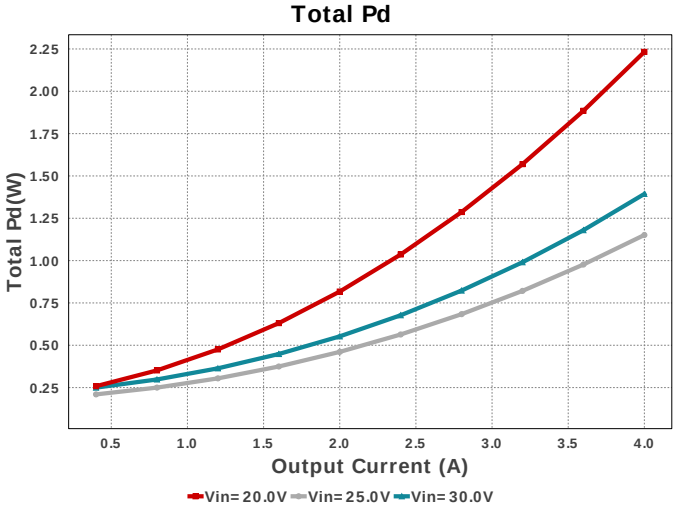


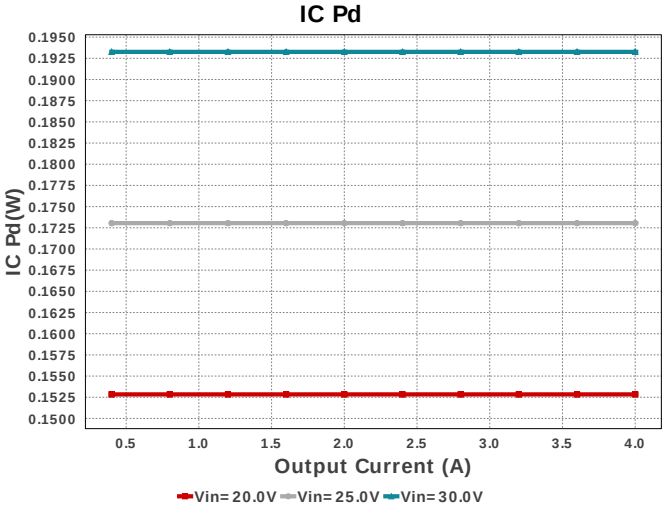


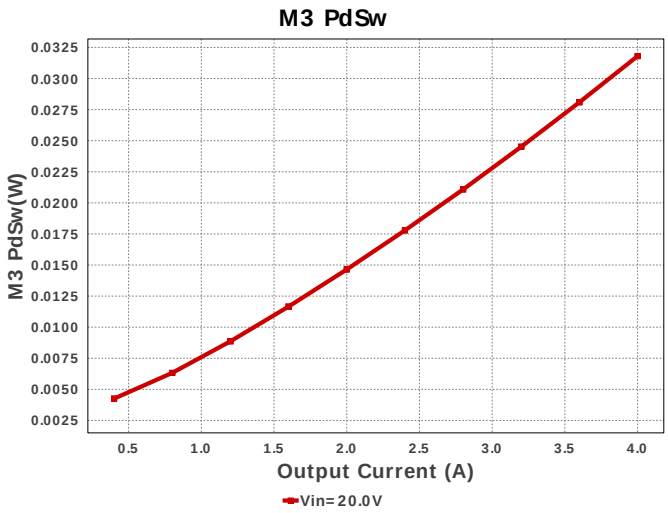


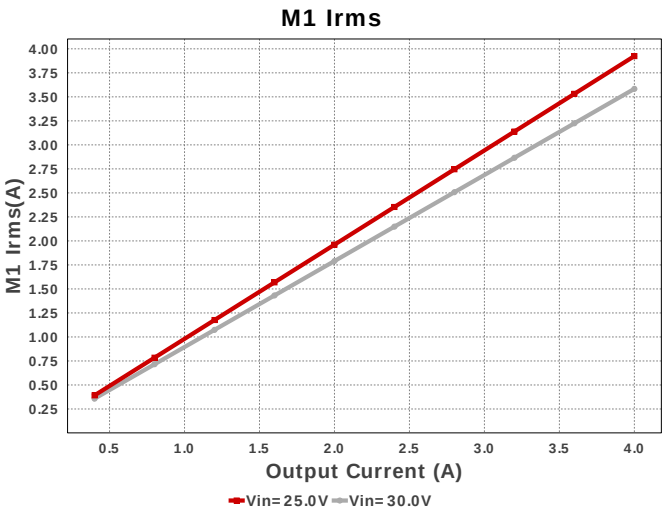


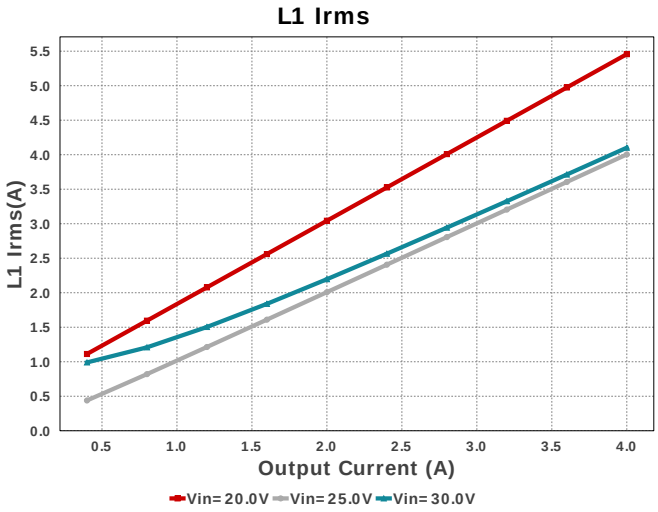


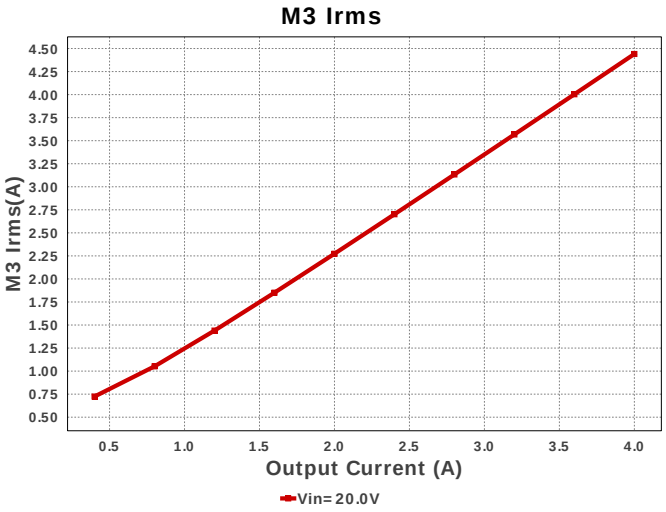


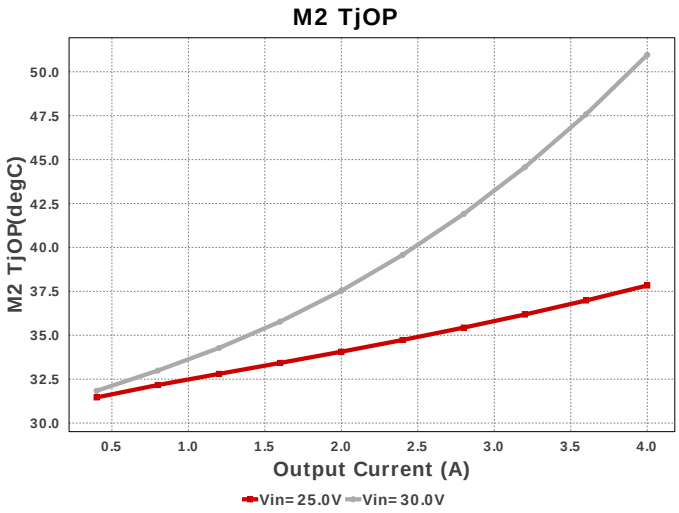


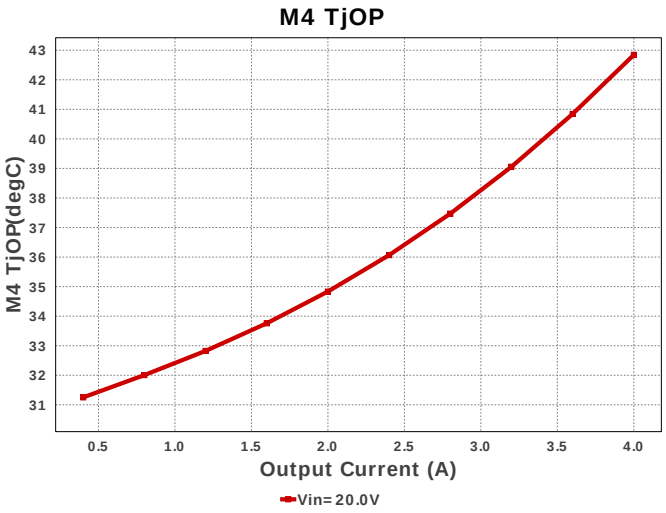


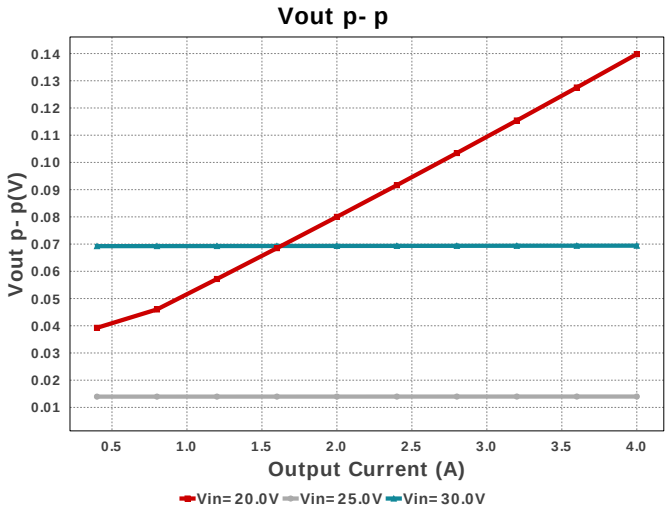


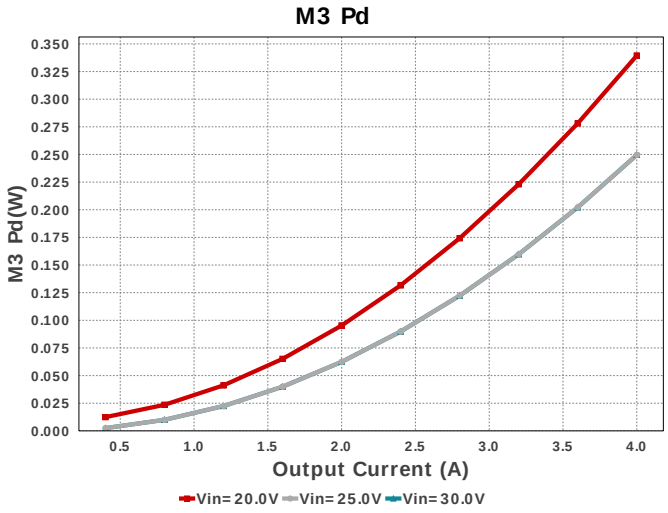


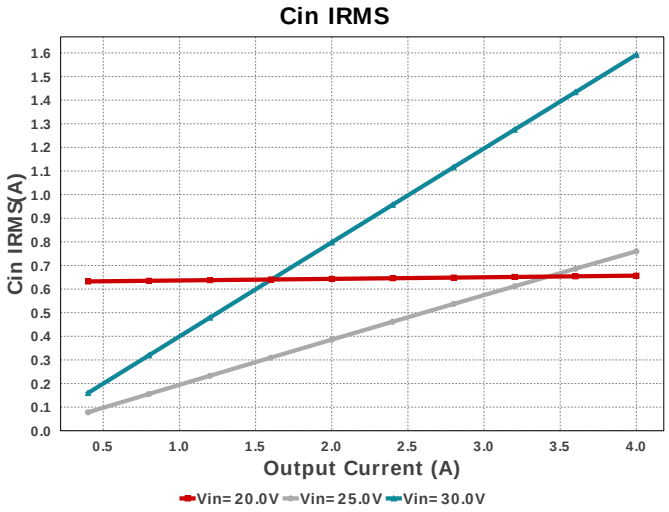


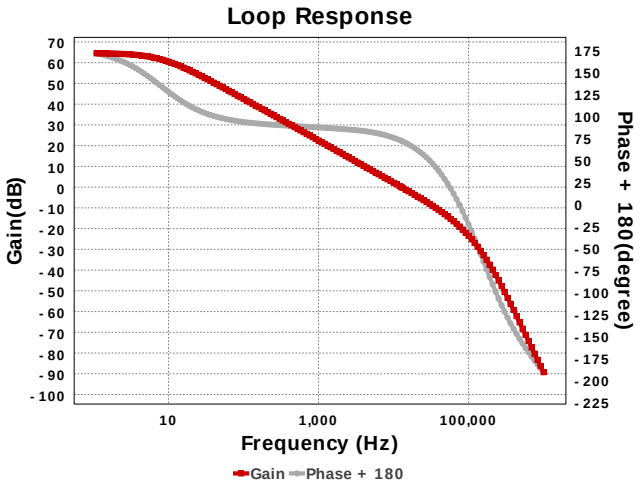












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.592 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	845.25 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	668.475 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	13.406 mW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	239.409 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	11.463 µW	Capacitor	Output capacitor_x power loss
7.	IC Pd	193.26 mW	IC	IC power dissipation
8.	IC Tj	35.894 degC	IC	IC junction temperature
9.	IC Tolerance	0.0 V	IC	IC Feedback Tolerance
10.	ICThetaJA	30.5 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	3.247 A	IC	Average input current
12.	L Ipp	3.145 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	270.0 mW	Inductor	Inductor power dissipation
14.	L1 Irms	4.102 A	Inductor	Inductor ripple current
15.	M1 Irms	3.583 A	Mosfet	MOSFET RMS ripple current
16.	M1 Pd	298.66 mW	Mosfet	MOSFET power dissipation
17.	M1 PdCond	226.46 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	72.203 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Rdson	15.6 mOhm	Mosfet	Drain-Source On-resistance
20.	M1 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
21.	M1 TjOP	46.426 degC	Mosfet	MOSFET junction temperature
22.	M2 Irms	1.778 A	Mosfet	MOSFET RMS ripple current
23.	M2 Pd	337.63 mW	Mosfet	MOSFET power dissipation
24.	M2 PdCond	248.35 mW	Mosfet	M2 MOSFET conduction losses
25.	M2 PdSw	89.276 mW	Mosfet	M2 MOSFET switching losses
26.	M2 Rdson	66.08 mOhm	Mosfet	Drain-Source On-resistance
27.	M2 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
28.	M2 TjOP	51.946 degC	Mosfet	MOSFET junction temperature
29.	M3 Pd	249.6 mW	Mosfet	M3 MOSFET total power dissipation
30.	M3 PdCond	249.6 mW	Mosfet	M3 MOSFET conduction losses
31.	M4 Pd	100.0 pW	Mosfet	M4 MOSFET total power dissipation
32.	Cin Pd	845.25 µW	Power	Input capacitor power dissipation

#	Name	Value	Category	Description
33.	Cout Pd	13.406 mW	Power	Output capacitor power dissipation
34.	Coutx Pd	11.463 µW	Power	Output capacitor_x power loss
35.	IC Pd	193.26 mW	Power	IC power dissipation
36.	L Pd	270.0 mW	Power	Inductor power dissipation
37.	M1 Pd	298.66 mW	Power	MOSFET power dissipation
38.	M1 PdCond	226.46 mW	Power	M1 MOSFET conduction losses
39.	M1 PdSw	72.203 mW	Power	M1 MOSFET switching losses
40.	M2 Pd	337.63 mW	Power	MOSFET power dissipation
41.	M2 PdCond	248.35 mW	Power	M2 MOSFET conduction losses
42.	M2 PdSw	89.276 mW	Power	M2 MOSFET switching losses
43.	M3 Pd	249.6 mW	Power	M3 MOSFET total power dissipation
44.	M3 PdCond	249.6 mW	Power	M3 MOSFET conduction losses
45.	M4 Pd	100.0 pW	Power	M4 MOSFET total power dissipation
46.	Rsense Pd	47.396 mW	Power	LED Current Rsns Power Dissipation
47.	Total Pd	1.41 W	Power	Total Power Dissipation
48.	Rsense Pd	47.396 mW	Resistor	LED Current Rsns Power Dissipation
49.	BOM Count	52	System Information	Total Design BOM count
50.	Cross Freq	12.727 kHz	System Information	Bode plot crossover frequency
51.	Duty Cycle	80.251 %	System Information	Duty cycle
52.	Efficiency	98.552 %	System Information	Steady state efficiency
53.	FootPrint	907.0 mm^2	System Information	Total Foot Print Area of BOM components
54.	Frequency	340.229 kHz	System Information	Switching frequency
55.	Gain Marg	-19.081 dB	System Information	Bode Plot Gain Margin
56.	Iout	4.0 A	System Information	Iout operating point
57.	Low Freq Gain	64.518 dB	System Information	Gain at 1Hz
58.	Mode	CCM	System Information	Conduction Mode
59.	Operating Topology	Buck	System Information	The current operating topology of the device
60.	Phase Marg	72.883 deg	System Information	Bode Plot Phase Margin
61.	Pout	96.0 W	System Information	Total output power
62.	SW Ipk	0.0 A	System Information	Peak switch current
63.	Total BOM	$8.87	System Information	Total BOM Cost
64.	Vin	30.0 V	System Information	Vin operating point
65.	Vout	24.0 V	System Information	Operational Output Voltage
66.	Vout Actual	23.84 V	System Information	Vout Actual calculated based on selected voltage divider resistors
67.	Vout Tolerance	1.952 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
68.	Vout p-p	69.471 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

#	Name	Value	Description
1.	Iout	4.0	Maximum Output Current
2.	VinMax	30.0	Maximum input voltage
3.	VinMin	20.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	acFrequency	60.0	AC Frequency
6.	base_pn	LM34936	Base Product Number
7.	source	DC	Input Source Type
8.	Ta	30.0	Ambient temperature

Design Assistance

1. Tip: Snubbers and/or gate resistors may be required to limit the SW1,2 node switching spikes below the IC and FET abs max ratings.
2. Tip: Slope Capacitor: smaller slope capacitors provide better transition region behavior.
3. **LM34936** Product Folder : http://www.ti.com/product/LM34936 : contains the data sheet and other resources.

