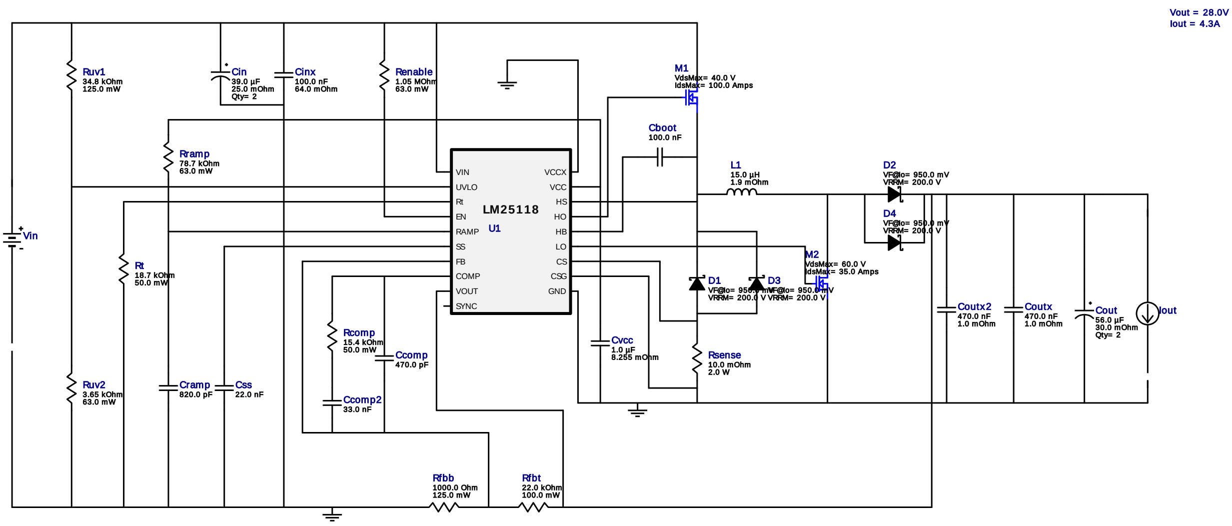
TEXAS INSTRUMENTS

WEBENCH ® Design Report

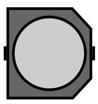
VinMin = 16.0V
VinMax = 32.0V
Vout = 28.0V
Iout = 4.3A

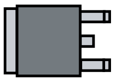
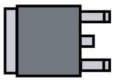
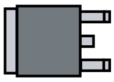
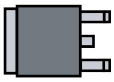
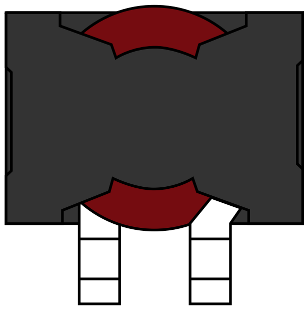
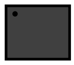
Device = LM25118MH/NOPB
Topology = Buck_Boost
Created = 2019-04-11 01:36:18.679
BOM Cost = $9.90
BOM Count = 30
Total Pd = 5.73W

Design : 21 LM25118MH/NOPB
LM25118MH/NOPB 16V-32V to 28.00V @ 4.3A

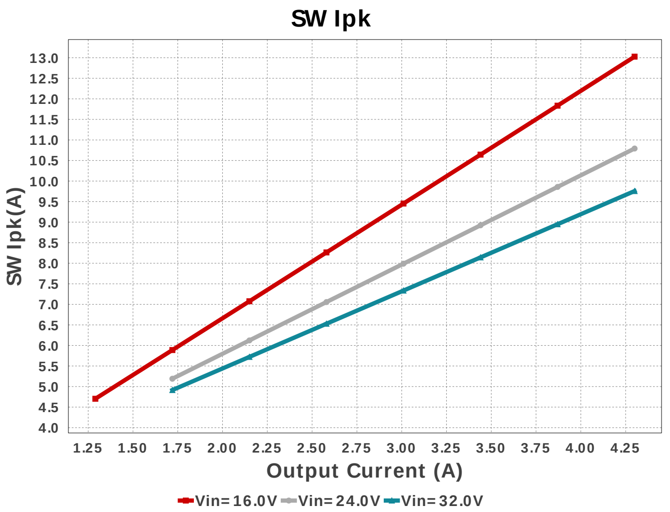


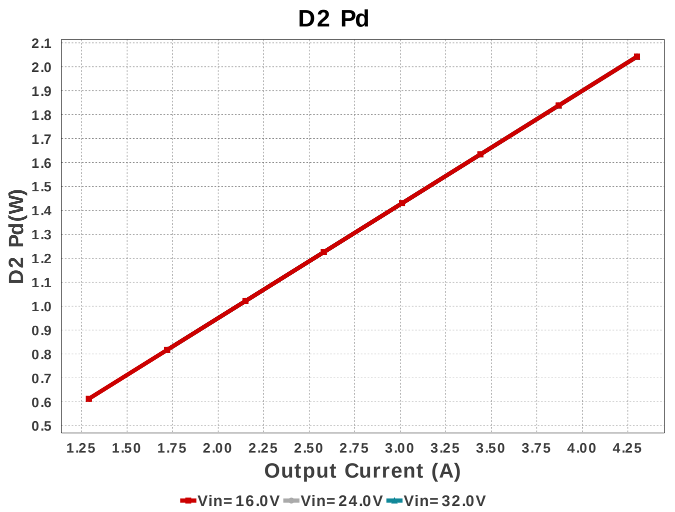
Electrical BOM

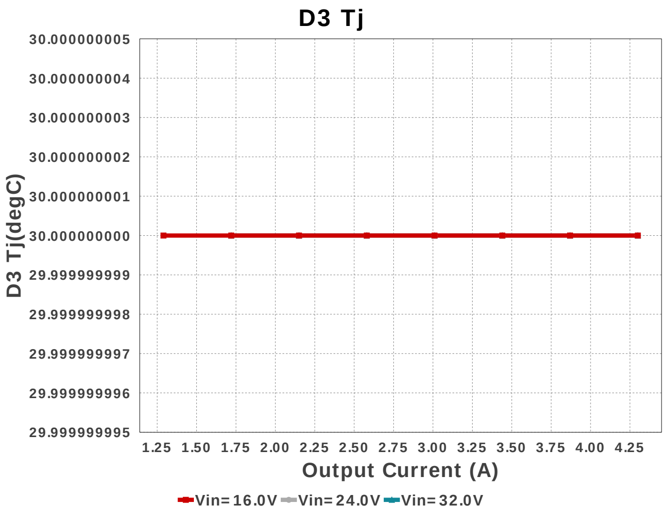
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm^2
Ccomp	Samsung Electro-Mechanics	CL21C471KBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccomp2	TDK	CGA4J2C0G1H333J125AA Series= C0G/NP0	Cap= 33.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	0805 7 mm^2
Cin	Panasonic	50SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 3.8 A	2	$0.74	 CAPSMT_62_E12 106 mm^2
Cinx	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
Cout	Panasonic	EEHZA1J560P Series= ZA	Cap= 56.0 uF ESR= 30.0 mOhm VDC= 63.0 V IRMS= 1.8 A	2	$1.07	Panasonic_G 151 mm^2
Coutx	Taiyo Yuden	GMK212BJ474KG-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Coutx2	Taiyo Yuden	GMK212BJ474KG-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Cramp	Samsung Electro-Mechanics	CL05C821JB5NNNC Series= C0G/NP0	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2

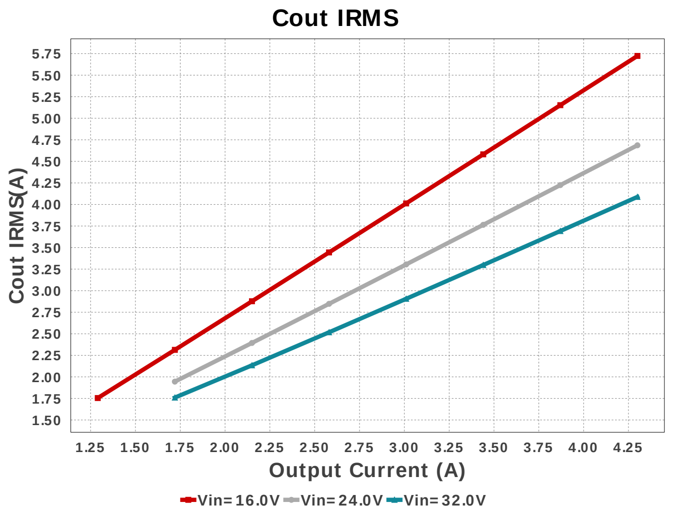
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Css	TDK	C2012C0G1H223K125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	0805 7 mm^2
Cvcc	TDK	C2012X7S2A105K125AB Series= X7S	Cap= 1.0 uF ESR= 8.255 mOhm VDC= 100.0 V IRMS= 2.27442 A	1	$0.13	0805 7 mm^2
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
D2	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
D3	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
D4	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
L1	Coilcraft	SER2915H-153KL	L= 15.0 µH 1.9 mOhm	1	$1.95	 SER2915H 652 mm^2
M1	Texas Instruments	CSD18511Q5A	VdsMax= 40.0 V IdsMax= 100.0 Amps	1	$0.44	 TRANS_NexFET_Q5A 55 mm^2
M2	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V IdsMax= 35.0 Amps	1	$0.27	 DNH0008A 18 mm^2
Rcomp	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Renable	Vishay-Dale	CRCW04021M05FKED Series= CRCW..e3	Res= 1.05 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Panasonic	ERJ-6ENF1001V Series= ERJ-6E	Res= 1000.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbt	Yageo	RC0603FR-0722KL Series= ?	Res= 22.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rramp	Vishay-Dale	CRCW040278K7FKED Series= CRCW..e3	Res= 78.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Rohm	PMR100HZPFU10L0 Series= PMR100	Res= 10.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	$0.17	 2512 43 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rt	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Ruv1	Panasonic	ERJ-6ENF3482V Series= ERJ-6E	Res= 34.8 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Ruv2	Vishay-Dale	CRCW04023K65FKED Series= CRCW..e3	Res= 3.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM25118MH/NOPB	Switcher	1	$2.40	MXA20A 71 mm²

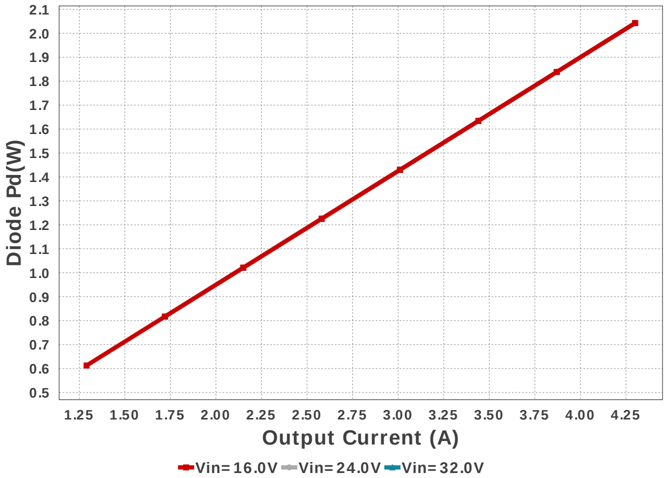




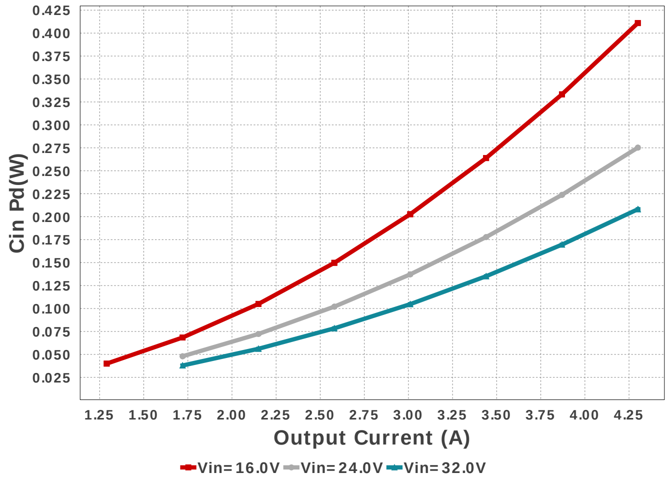




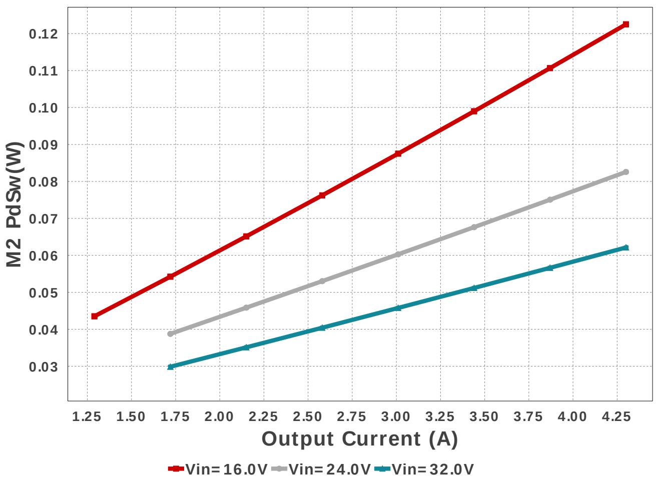
Diode Pd



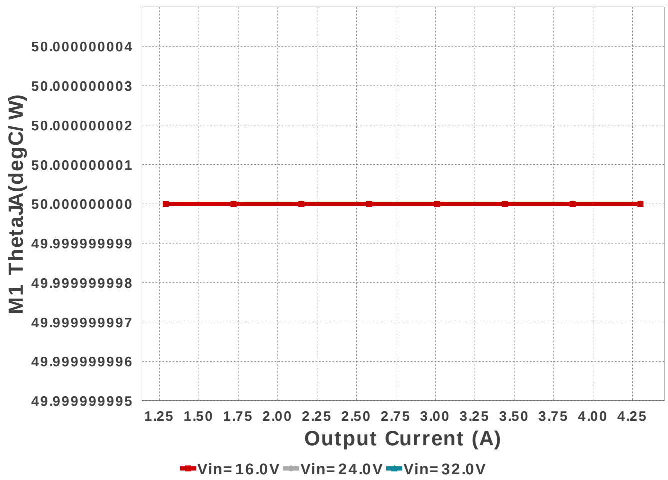
Cin Pd



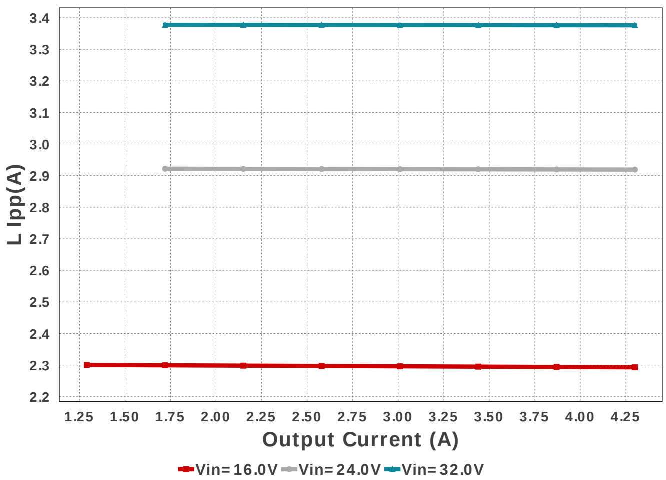
M2 PdSw



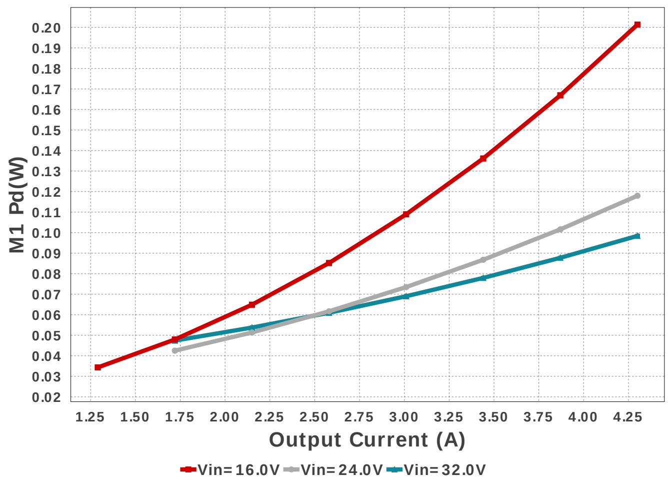
M1 ThetaJA



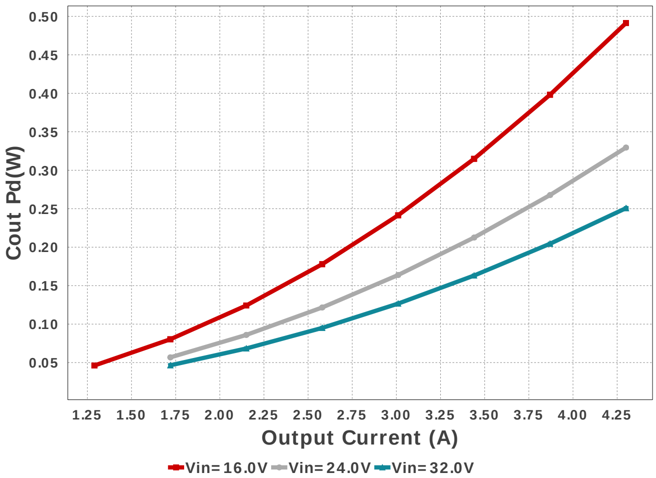
L Ipp



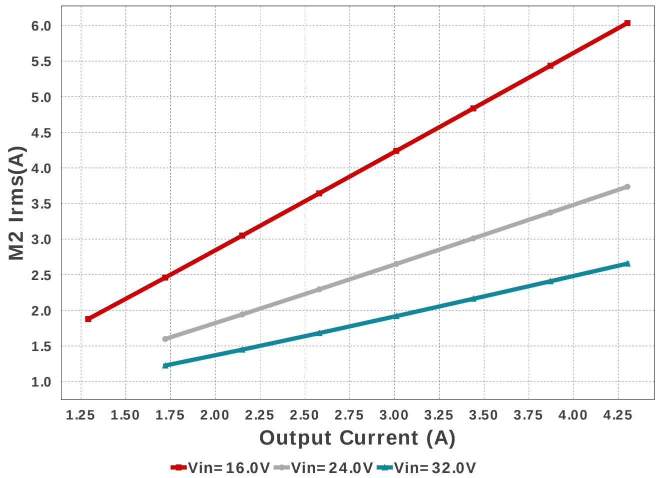
M1 Pd



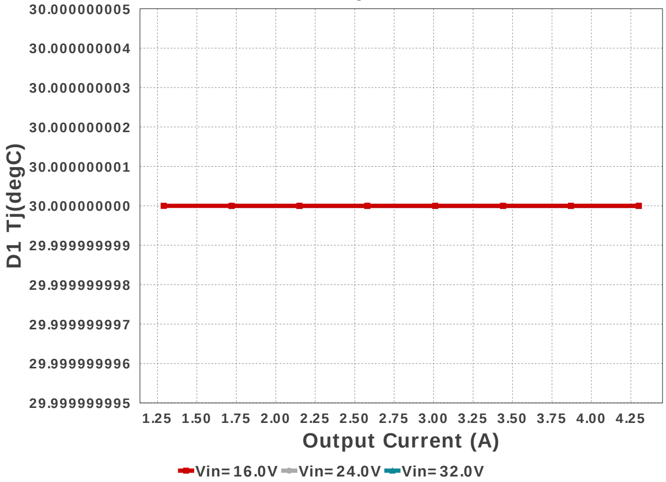
Cout Pd



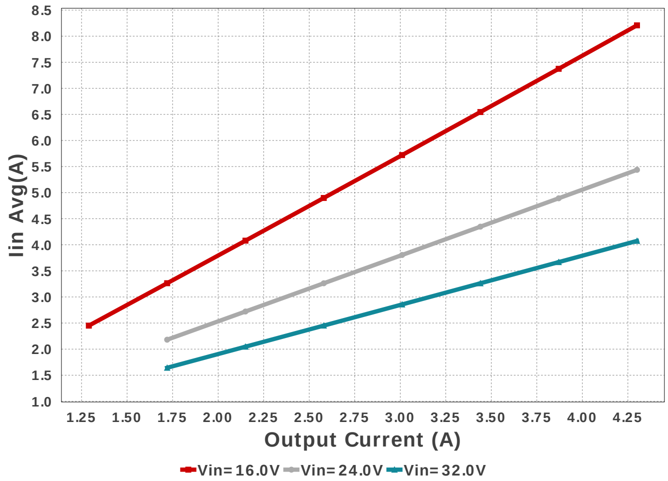
M2 Irms



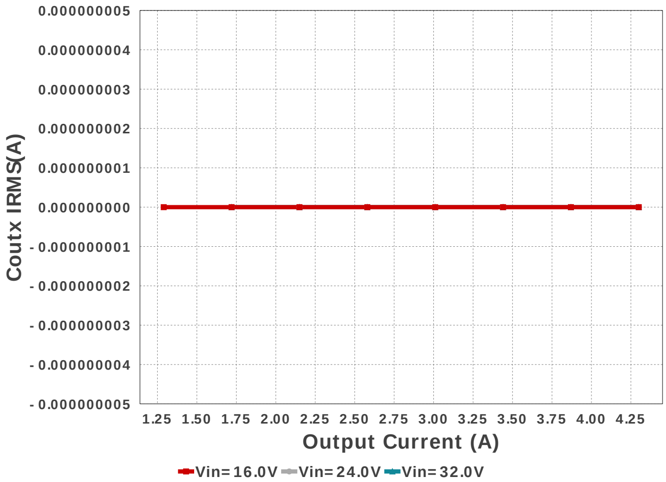
D1 Tj



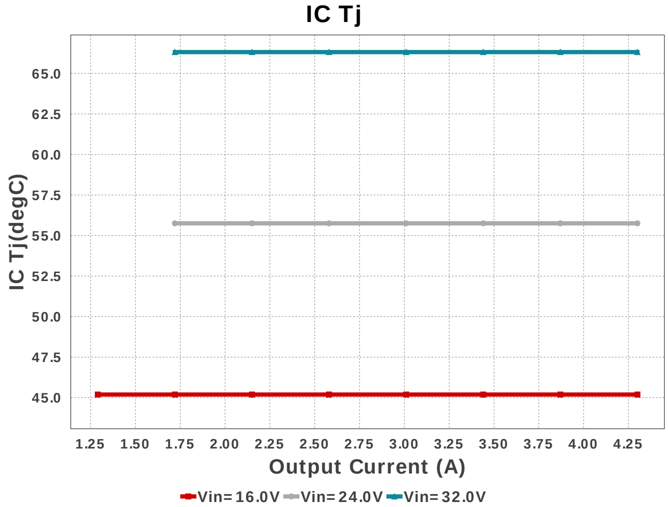
Iin Avg

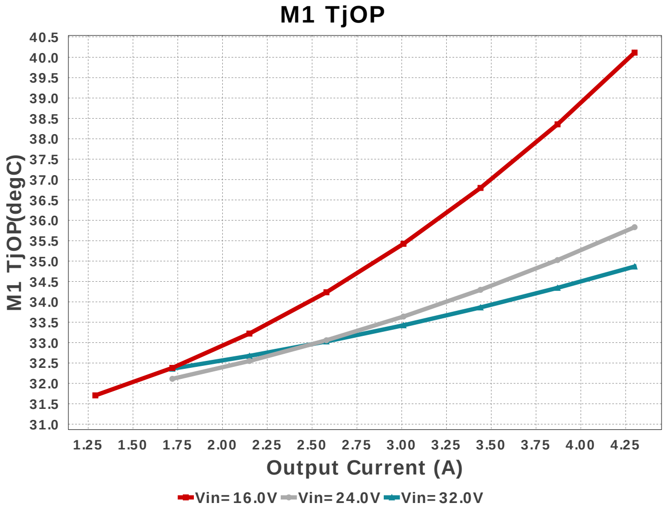


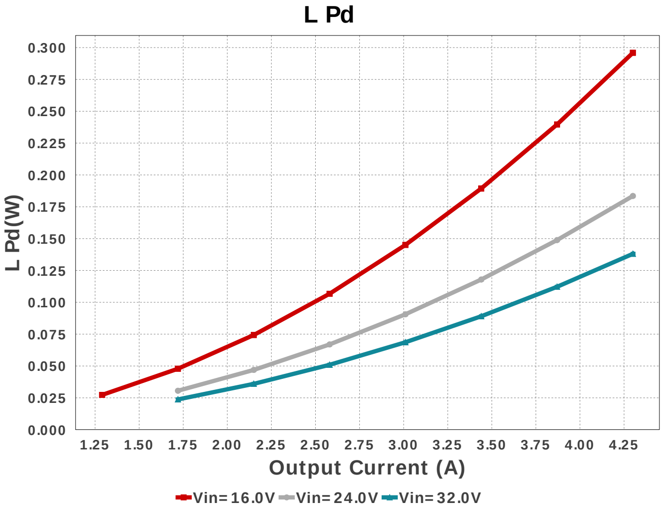
Coutx IRMS

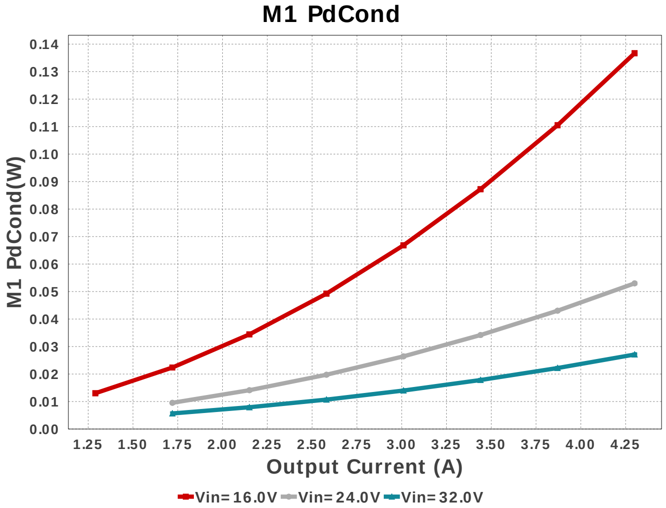


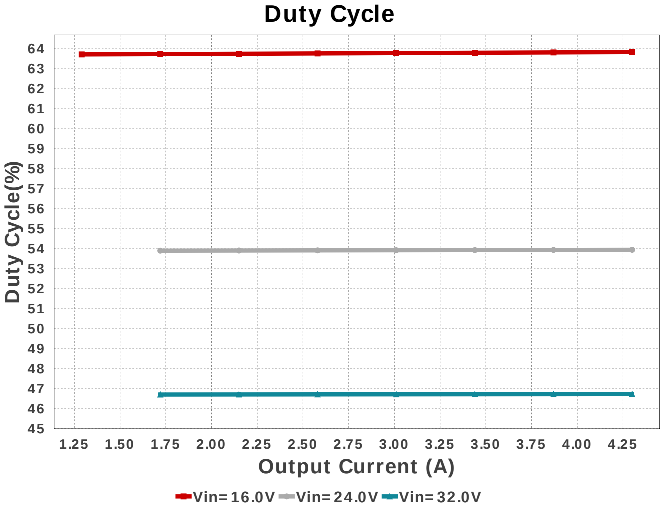
IC Tj

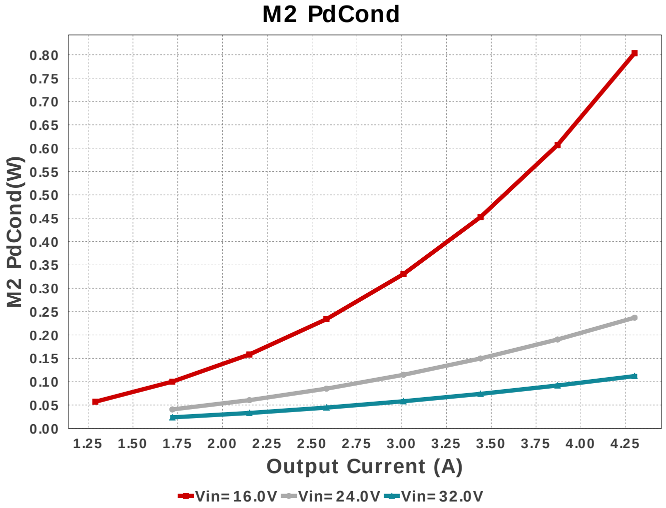


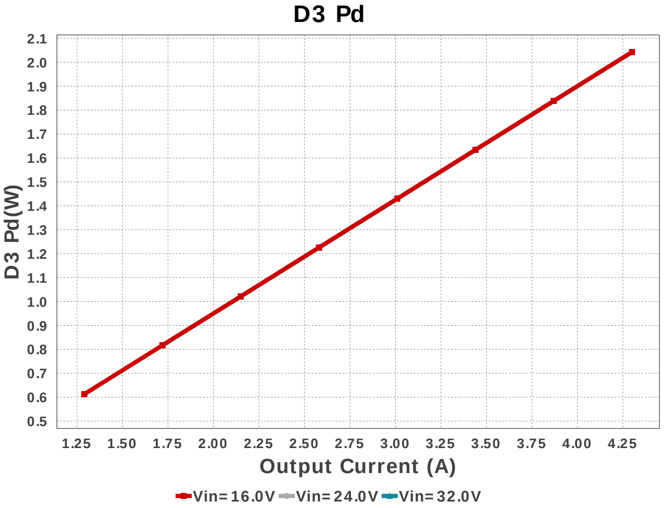

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

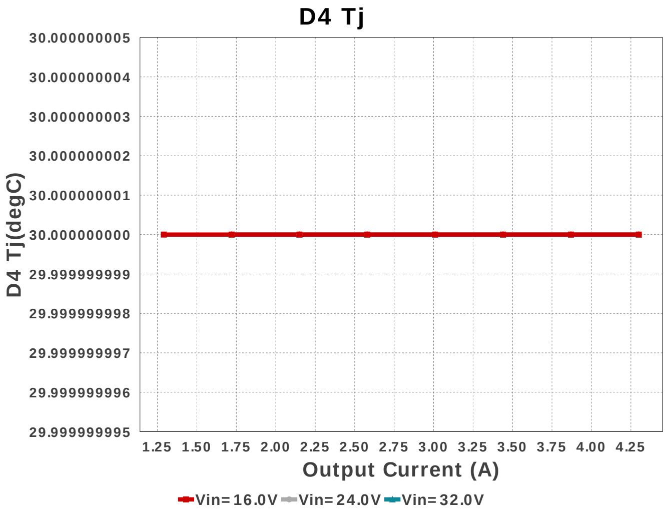

L Pd
L Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

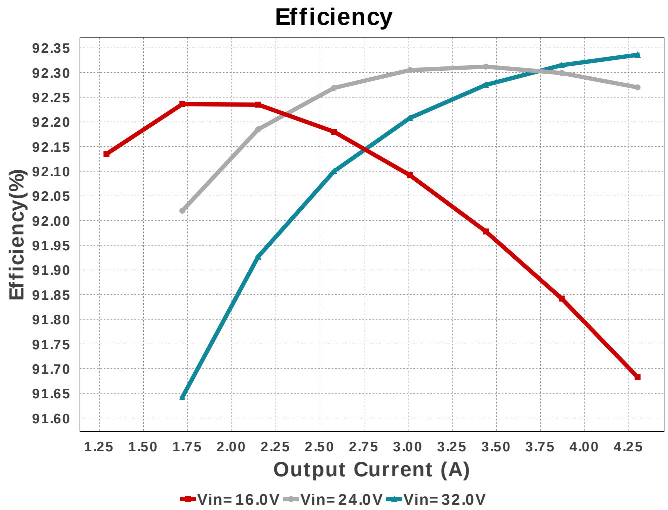

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

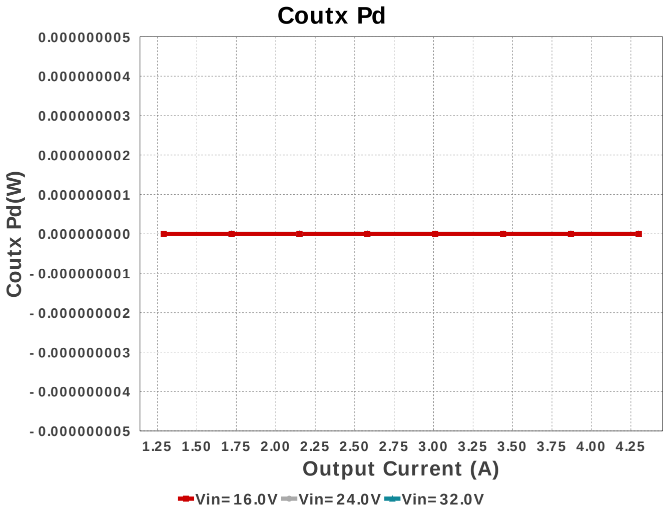

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

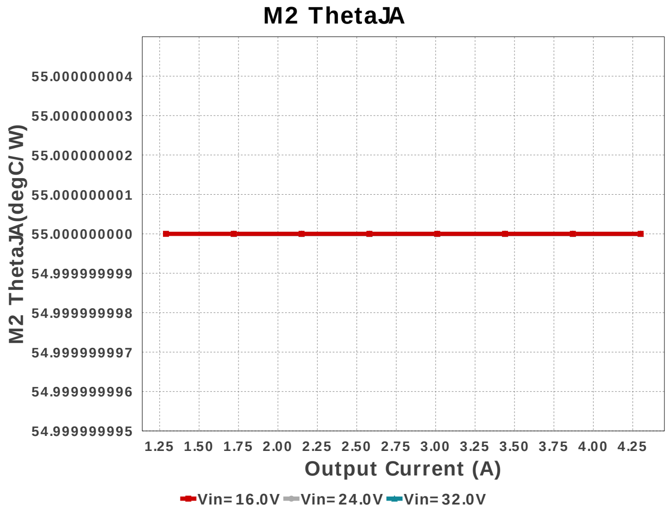

M2 PdCond
M2 PdCond(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

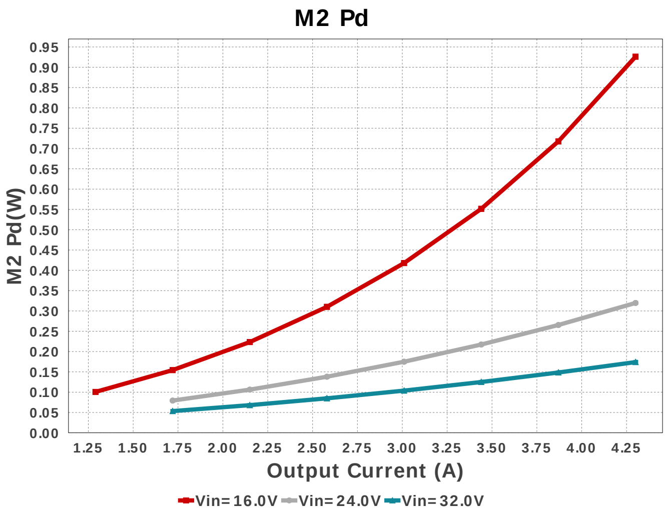

D3 Pd
D3 Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

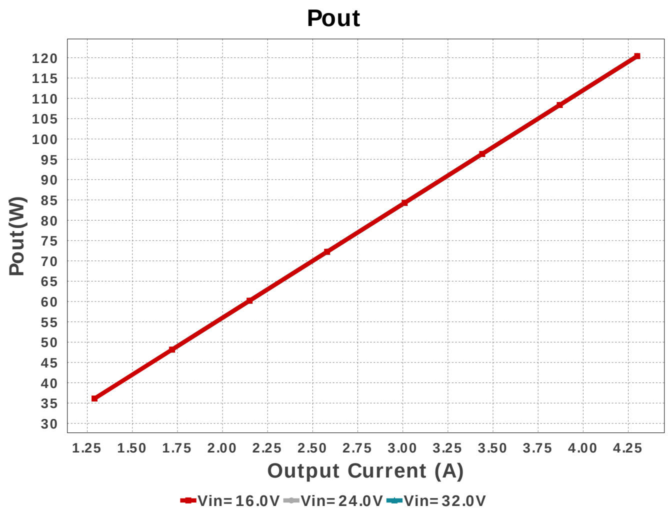

D4 Tj
D4 Tj(degC)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

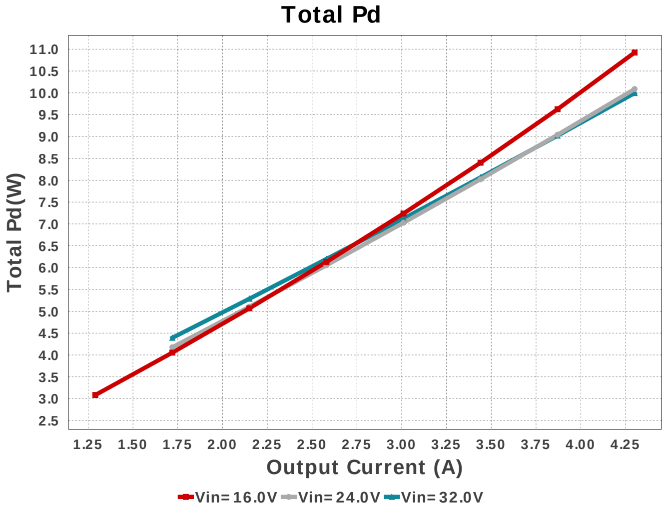

Efficiency
Efficiency(%)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

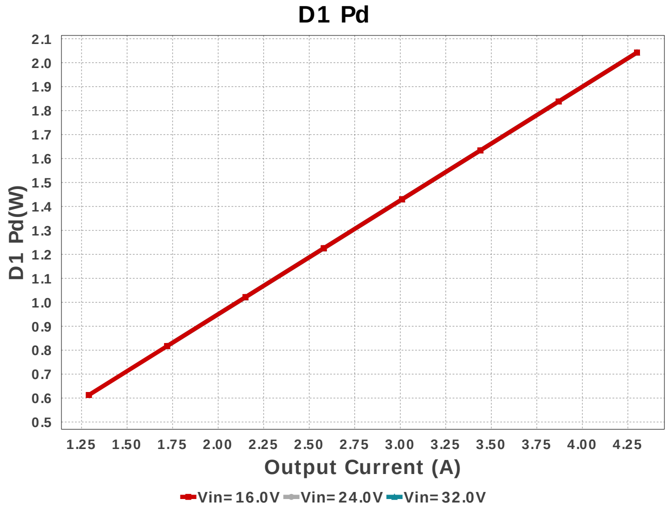

Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

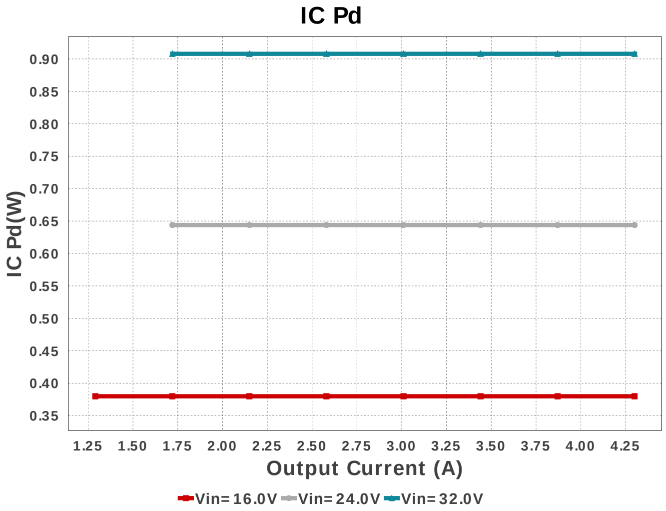

M2 ThetaJA
M2 ThetaJA(degC/W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

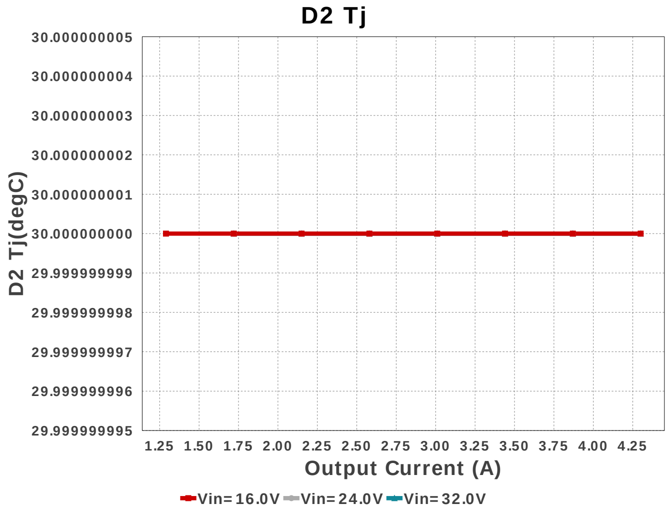

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

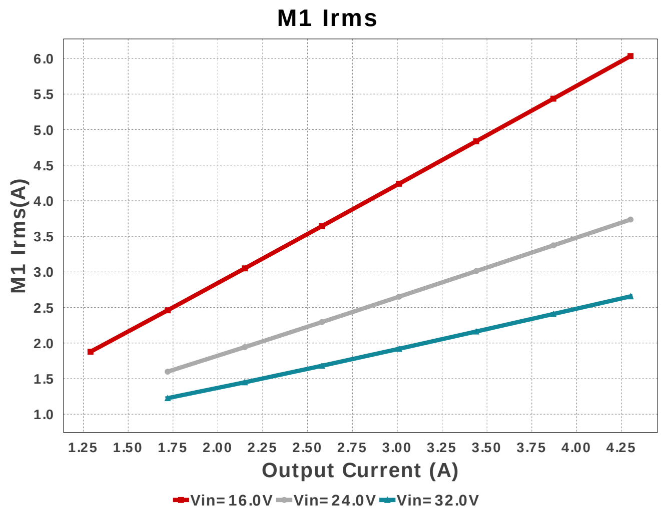

Pout
Pout(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

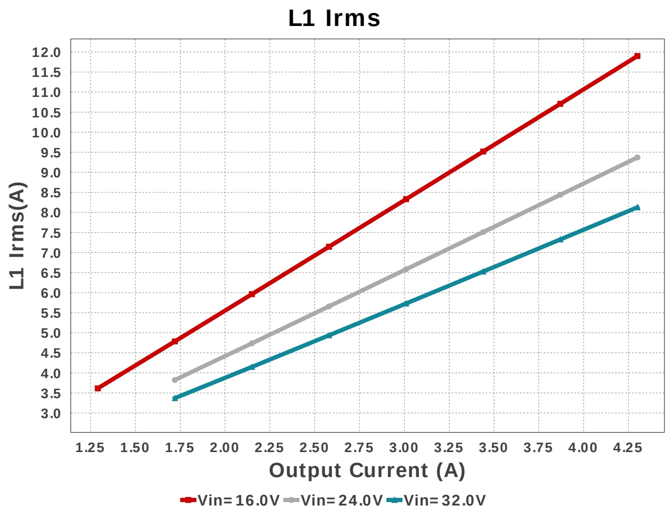

Total Pd
Total Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

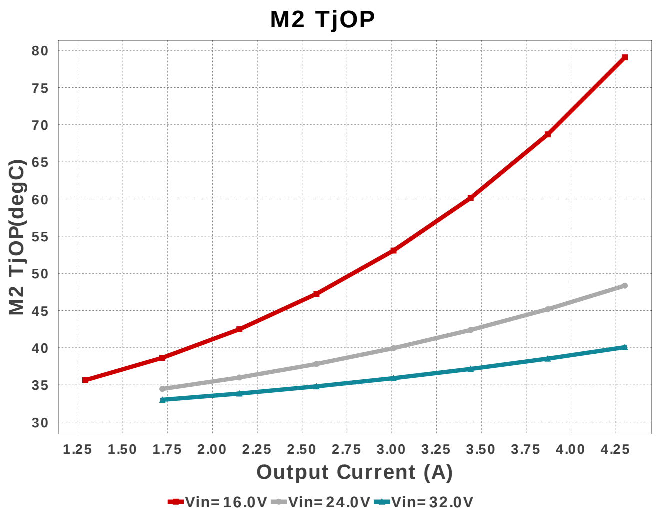

D1 Pd
D1 Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

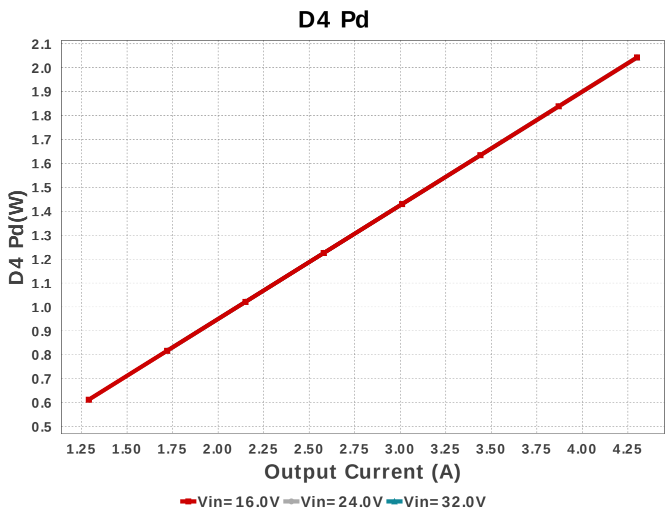

IC Pd
IC Pd(W)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

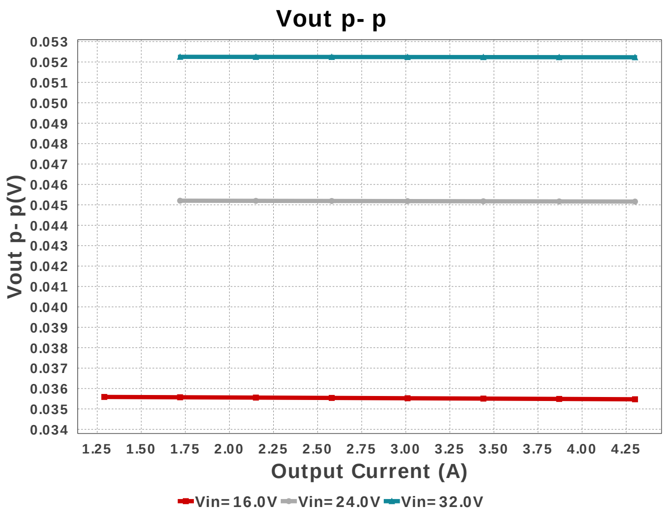

D2 Tj
D2 Tj(degC)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

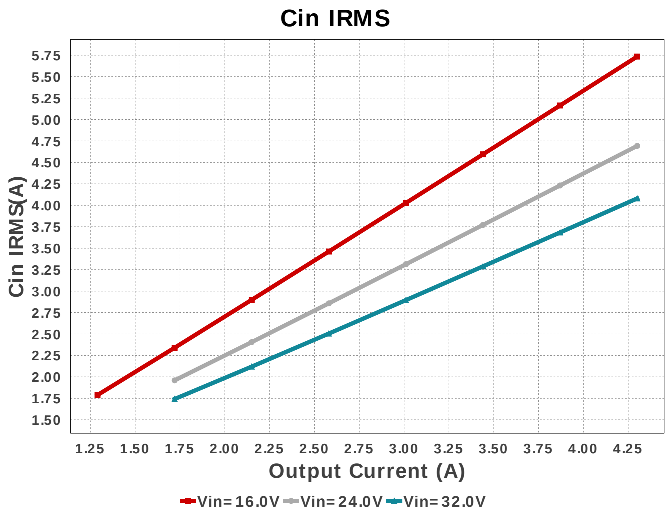

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V

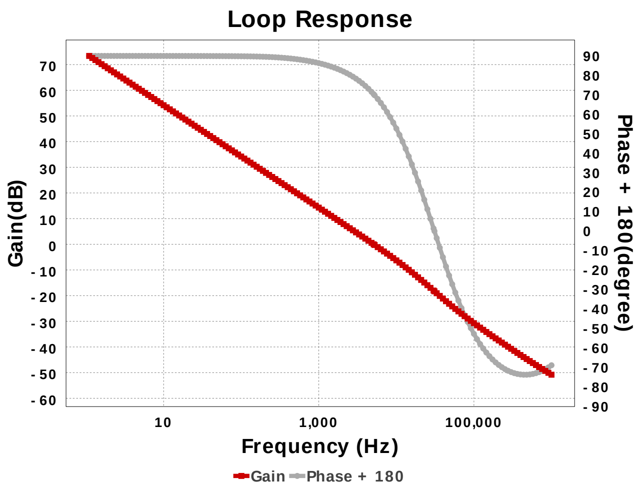

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=16.0V Vin=24.0V Vin=32.0V











Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	5.734 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	411.02 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	5.724 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	491.4 mW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	0.0 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	0.0 W	Capacitor	Output capacitor_x power loss
7.	D1 Pd	2.042 W	Diode	Diode power dissipation
8.	D1 Tj	30.0 degC	Diode	D1 junction temperature
9.	D1 Tj	30.0 degC	Diode	D1 junction temperature
10.	D2 Pd	2.042 W	Diode	Diode2 power dissipation
11.	D3 Pd	2.042 W	Diode	Diode3 power dissipation

#	Name	Value	Category	Description
12.	D4 Pd	2.042 W	Diode	Diode4 power dissipation
13.	Diode Pd	2.042 W	Diode	Diode power dissipation
14.	IC Pd	907.84 mW	IC	IC power dissipation
15.	IC Tj	66.314 degC	IC	IC junction temperature
16.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
17.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
18.	Iin Avg	4.121 A	IC	Average input current
19.	L Ipp	2.293 A	Inductor	Peak-to-peak inductor ripple current
20.	L Pd	295.98 mW	Inductor	Inductor power dissipation
21.	L1 Irms	11.9 A	Inductor	Inductor ripple current
22.	M1 Irms	6.035 A	Mosfet	MOSFET RMS ripple current
23.	M1 Pd	220.71 mW	Mosfet	MOSFET power dissipation
24.	M1 PdCond	156.04 mW	Mosfet	M1 MOSFET conduction losses
25.	M1 ThetaJA	50.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
26.	M1 TjOP	40.115 degC	Mosfet	MOSFET junction temperature
27.	M2 Irms	6.035 A	Mosfet	MOSFET RMS ripple current
28.	M2 Pd	917.8 mW	Mosfet	MOSFET power dissipation
29.	M2 PdCond	795.3 mW	Mosfet	M2 MOSFET conduction losses
30.	M2 PdSw	122.5 mW	Mosfet	M2 MOSFET switching losses
31.	M2 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
32.	M2 TjOP	79.063 degC	Mosfet	MOSFET junction temperature
33.	Cin Pd	411.02 mW	Power	Input capacitor power dissipation
34.	Cout Pd	491.4 mW	Power	Output capacitor power dissipation
35.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
36.	D1 Pd	2.042 W	Power	Diode power dissipation
37.	D2 Pd	2.042 W	Power	Diode2 power dissipation
38.	D3 Pd	2.042 W	Power	Diode3 power dissipation
39.	D4 Pd	2.042 W	Power	Diode4 power dissipation
40.	Diode Pd	2.042 W	Power	Diode power dissipation
41.	IC Pd	907.84 mW	Power	IC power dissipation
42.	L Pd	295.98 mW	Power	Inductor power dissipation
43.	M1 Pd	220.71 mW	Power	MOSFET power dissipation
44.	M1 PdCond	156.04 mW	Power	M1 MOSFET conduction losses
45.	M2 Pd	917.8 mW	Power	MOSFET power dissipation
46.	M2 PdCond	795.3 mW	Power	M2 MOSFET conduction losses
47.	M2 PdSw	122.5 mW	Power	M2 MOSFET switching losses
48.	Total Pd	5.731 W	Power	Total Power Dissipation
49.	BOM Count	30	System Information	Total Design BOM count
50.	Cross Freq	5.098 kHz	System Information	Bode plot crossover frequency
51.	D2 Tj	30.0 degC	System Information	D2 junction temperature
52.	D3 Tj	30.0 degC	System Information	D3 junction temperature
53.	D4 Tj	30.0 degC	System Information	D4 junction temperature
54.	Duty Cycle	63.81 %	System Information	Duty cycle
55.	Efficiency	91.308 %	System Information	Steady state efficiency
56.	FootPrint	1.85 k mm^2	System Information	Total Foot Print Area of BOM components
57.	Frequency	294.659 kHz	System Information	Switching frequency
58.	Gain Marg	-18.317 dB	System Information	Bode Plot Gain Margin
59.	Iout	4.3 A	System Information	Iout operating point
60.	Low Freq Gain	73.382 dB	System Information	Gain at 1Hz
61.	Mode	CCM	System Information	Conduction Mode
62.	Operating Topology	Buck-Boost	System Information	The current operating topology of the device
63.	Phase Marg	70.361 deg	System Information	Bode Plot Phase Margin
64.	Pout	120.4 W	System Information	Total output power
65.	SW Ipk	13.028 A	System Information	Peak switch current
66.	Total BOM	$9.9	System Information	Total BOM Cost
67.	Vin	16.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
68.	Vout	28.0 V	System Information	Operational Output Voltage
69.	Vout Actual	28.29 V	System Information	Vout Actual calculated based on selected voltage divider resistors
70.	Vout Tolerance	3.424 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
71.	Vout p-p	35.469 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	4.3	Maximum Output Current
VinMax	32.0	Maximum input voltage
VinMin	16.0	Minimum input voltage
Vout	28.0	Output Voltage
base_pn	LM25118	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

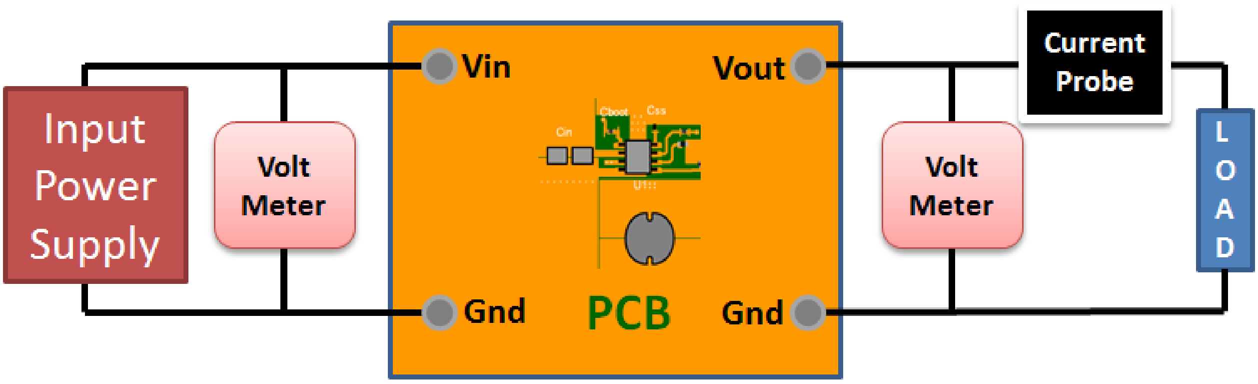
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 16.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. The LM25118 is a wide range buck-boost controller which is operable in an ultra wide input range of 3 to 75V. A buck-boost regulator can maintain regulation for input voltages either higher or lower than the output voltage. The challenge is that buck-boost power converters are not as efficient as buck regulators. The LM5118 has been designed as a dual mode controller whereby the power converter acts as a buck regulator while the input voltage is above the output. As the input voltage approaches the output voltage, a gradual transition to the buck-boost mode occurs. This gradual transition between modes eliminates disturbances at the output during transitions.

2. Master key : CC8ADF8FCCECDEF8[v1]

3. **LM25118** Product Folder : http://www.ti.com/product/LM25118 : contains the data sheet and other resources.

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