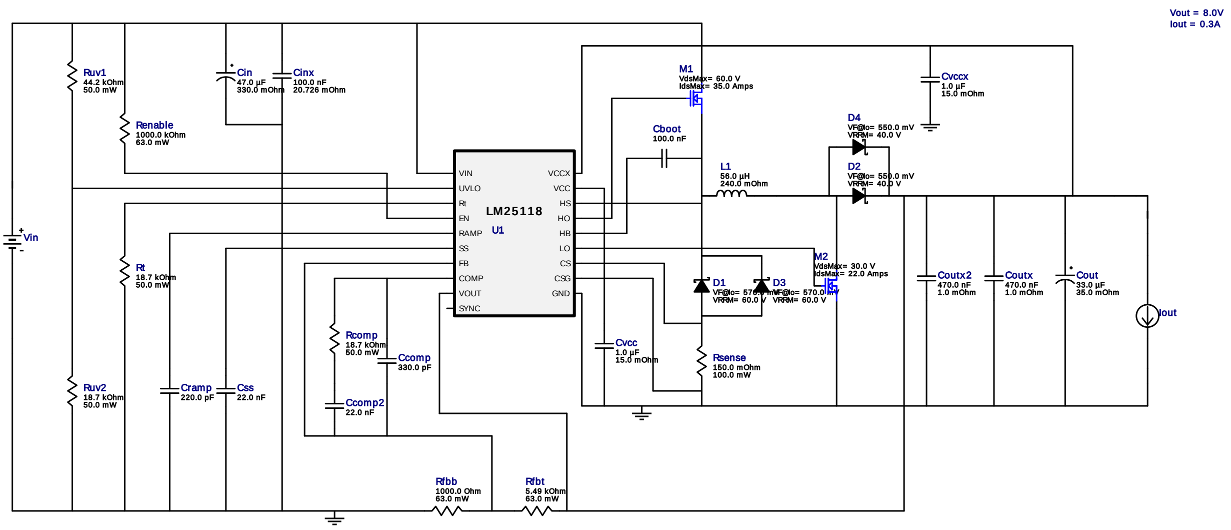
TEXAS INSTRUMENTS

WEBENCH ® Design Report

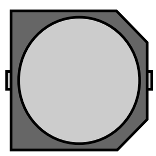
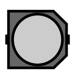
VinMin = 5.0V
VinMax = 42.0V
Vout = 8.0V
Iout = 0.3A

Device = LM25118MH/NOPB
Topology = Buck_Boost
Created = 2020-02-27 18:50:08.941
BOM Cost = $4.33
BOM Count = 28
Total Pd = 0.41W

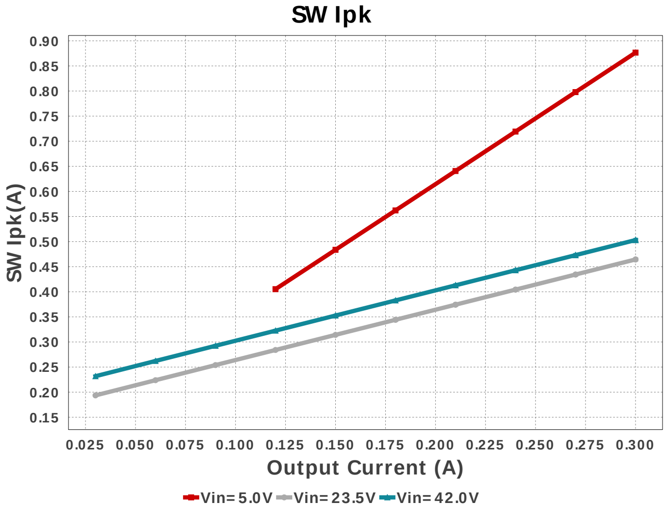
Design : 120 LM25118MH/NOPB
LM25118MH/NOPB 5V-42V to 8.00V @ 1A

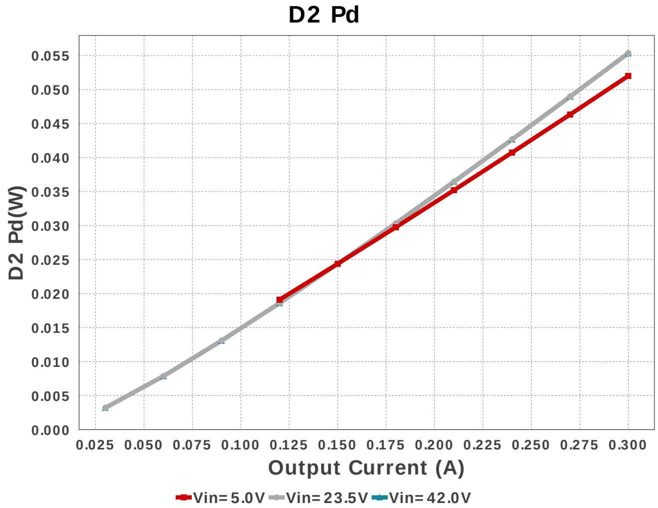


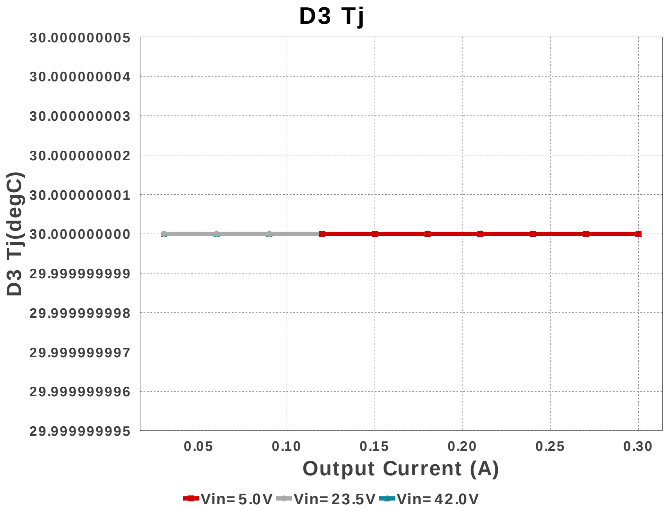
Electrical BOM

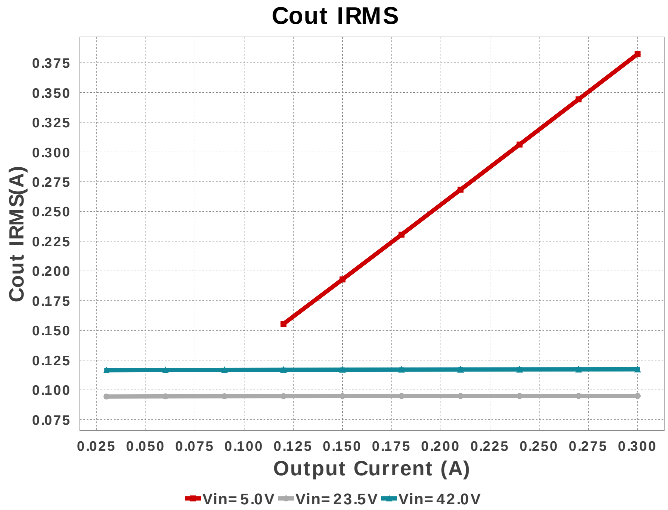
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
Ccomp	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccomp2	TDK	CGA4J2C0G1H223J125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm^2
Cin	Chemi-Con	EMVY101ATR470MKE0S Series= MVY	Cap= 47.0 uF ESR= 330.0 mOhm VDC= 100.0 V IRMS= 450.0 mA	1	$0.37	 CAPSMT_62_KE0 225 mm^2
Cinx	TDK	C2012X7R2A104K125AA Series= X7R	Cap= 100.0 nF ESR= 20.726 mOhm VDC= 100.0 V IRMS= 1.456 A	1	$0.03	0805 7 mm^2
Cout	Chemi-Con	APXE160ARA330ME61G Series= PXE	Cap= 33.0 uF ESR= 35.0 mOhm VDC= 16.0 V IRMS= 2.07 A	1	$0.39	 CAPSMT_62_E61 53 mm^2
Coutx	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm^2
Coutx2	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm^2

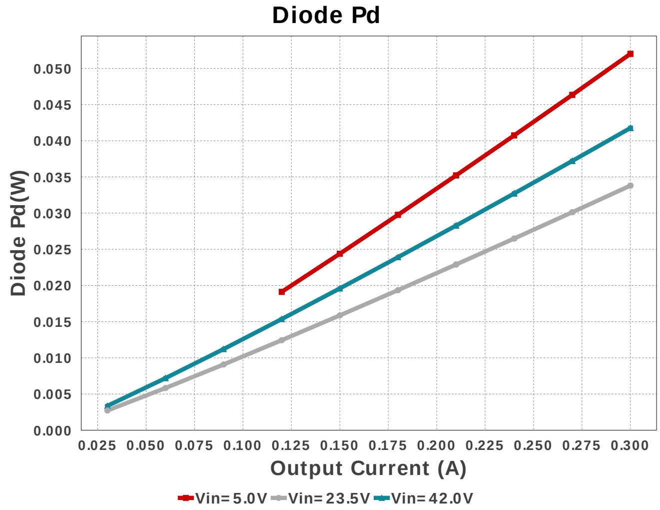
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cramp	Samsung Electro-Mechanics	CL21C221JBANNNC Series= C0G/NP0	Cap= 220.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Css	TDK	CGA4J2C0G1H223J125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm^2
Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
Cvccx	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
D1	Nexperia	PMEG6010CEH,115	VF@Io= 570.0 mV VRRM= 60.0 V	1	$0.04	SOD-123F 12 mm^2
D2	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	SOD-123F 12 mm^2
D3	Nexperia	PMEG6010CEH,115	VF@Io= 570.0 mV VRRM= 60.0 V	1	$0.04	SOD-123F 12 mm^2
D4	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	SOD-123F 12 mm^2
L1	NIC Components	NPI75C560KTRF	L= 56.0 µH 240.0 mOhm	1	$0.15	IND_NPI75C 94 mm^2
M1	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V IdsMax= 35.0 Amps	1	$0.28	DNH0008A 18 mm^2
M2	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.13	DQK0006C 9 mm^2
Rcomp	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Renable	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW04025K49FKED Series= CRCW..e3	Res= 5.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Panasonic	ERJ-3RSFR15V Series= ERJ-3R	Res= 150.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm^2
Rt	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Ruv1	Vishay-Dale	CRCW020144K2FNED Series= ?	Res= 44.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Ruv2	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	LM25118MH/NOPB	Switcher	1	$2.40	MXA20A 71 mm^2

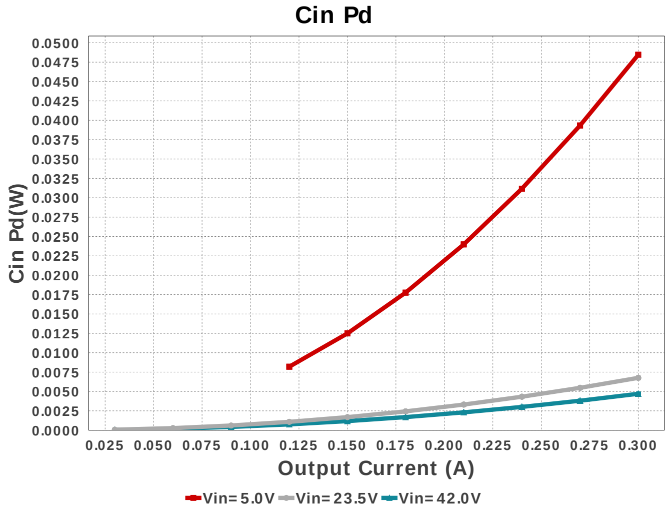

SW Ipk
SW Ipk(A)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

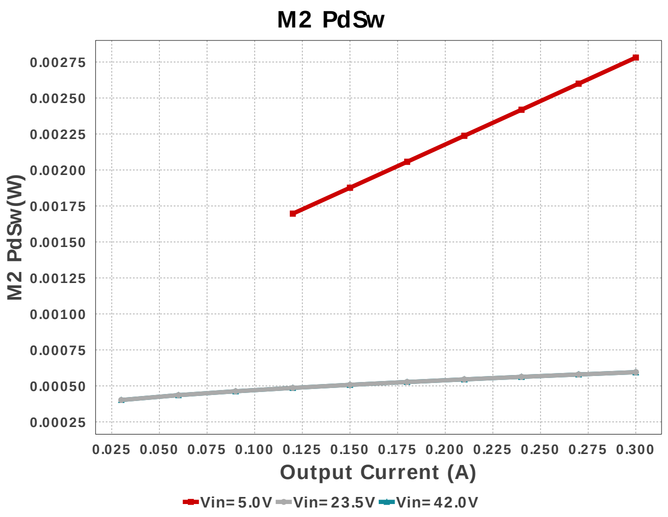

D2 Pd
D2 Pd(W)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

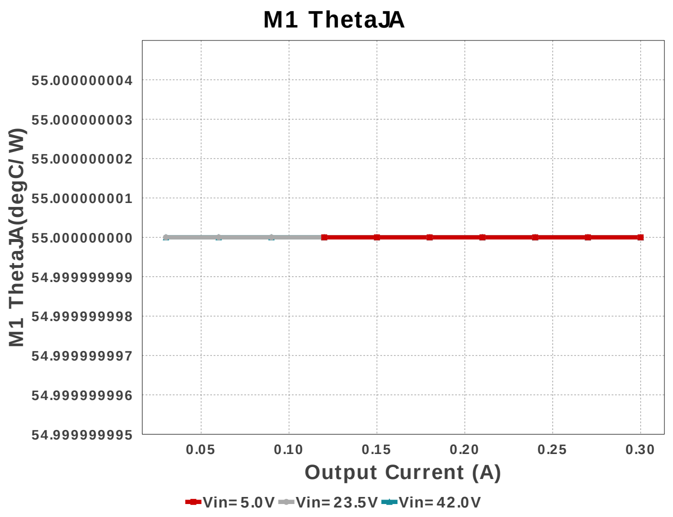

D3 Tj
D3 Tj(degC)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

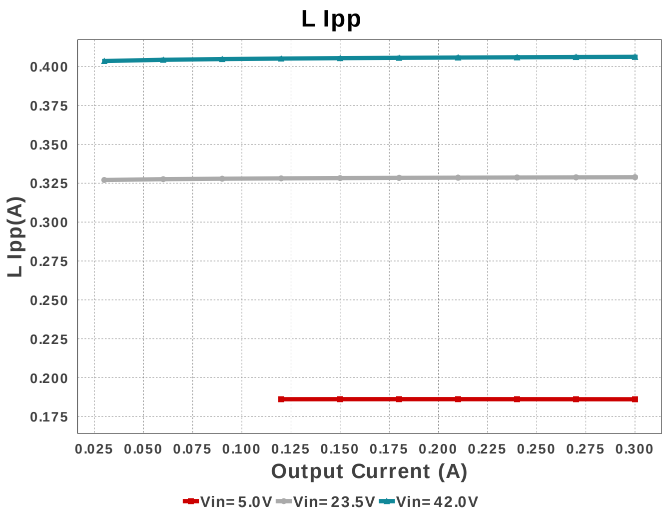

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

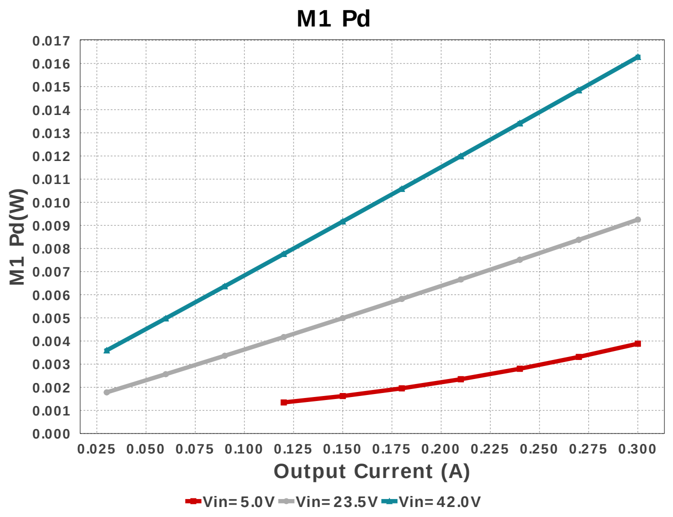

Diode Pd
Diode Pd(W)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

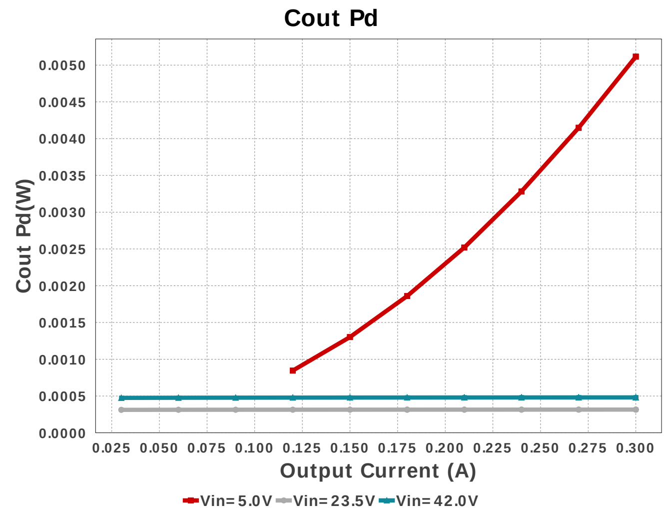

Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 5.0V Vin= 23.5V Vin= 42.0V

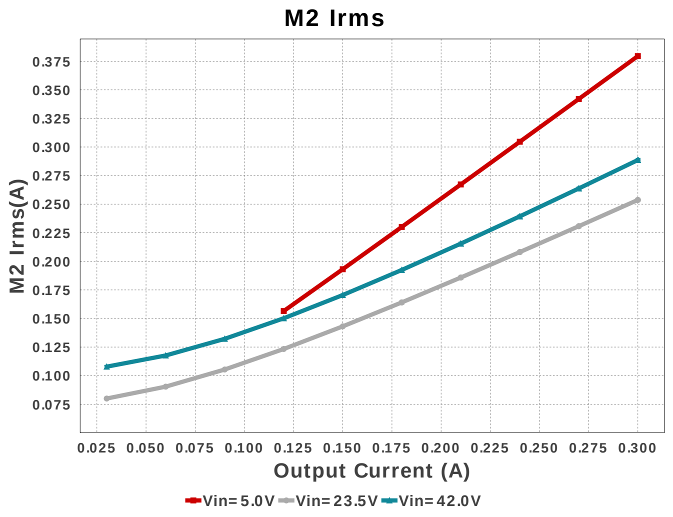

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V


M1 ThetaJA
M1 ThetaJA(degC/W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

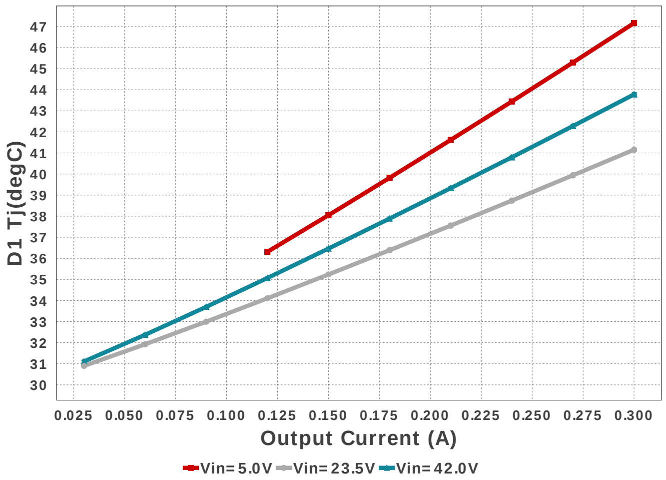

L Ipp
L Ipp(A)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

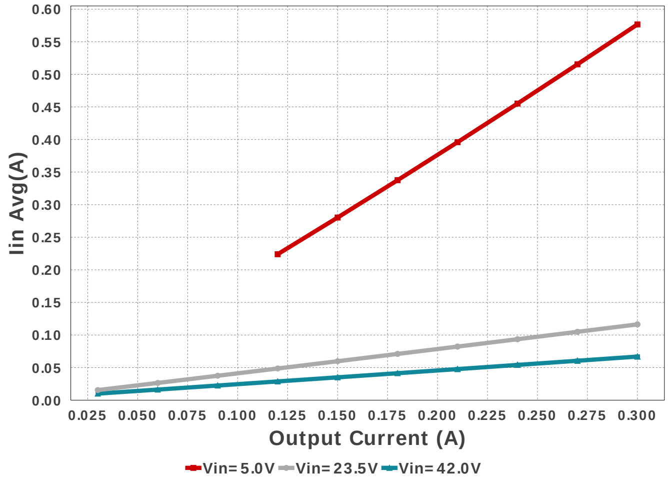

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V


M2 Irms
M2 Irms(A)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

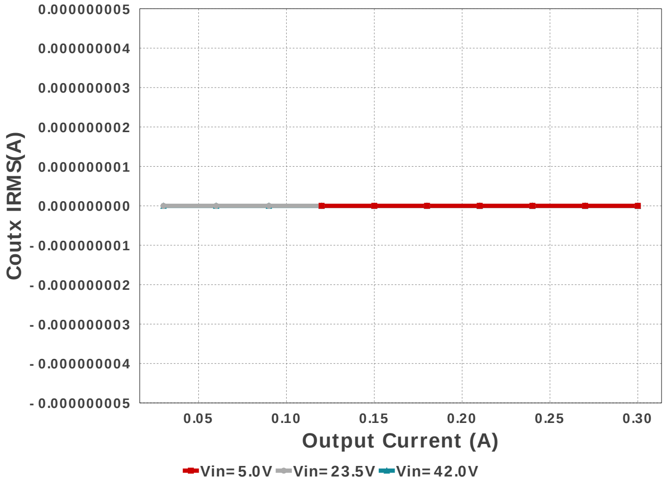
D1 Tj



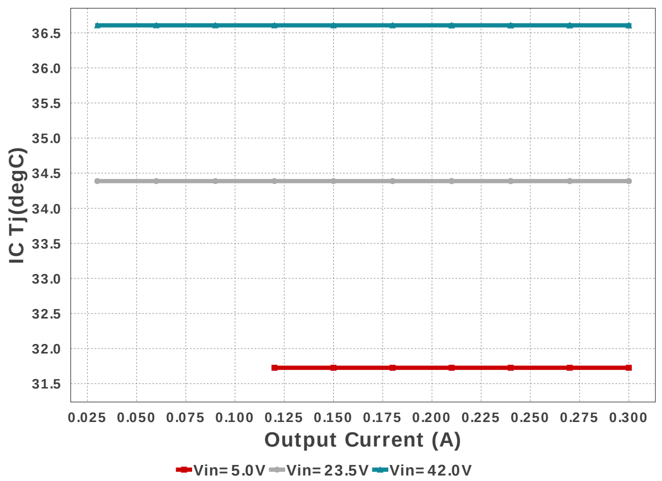
Iin Avg



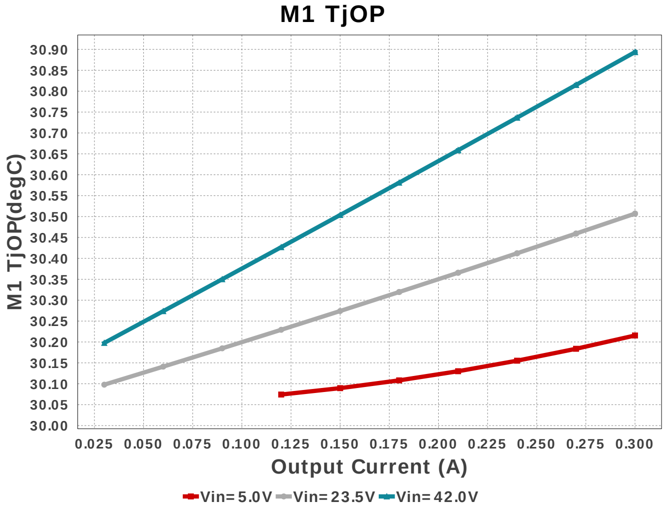
Coutx IRMS



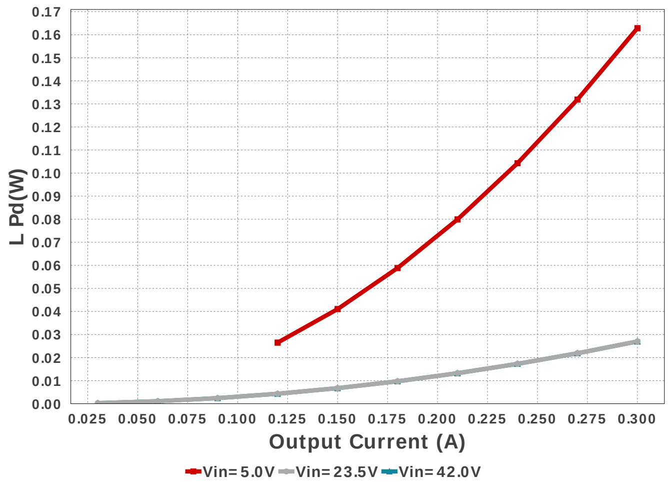
IC Tj



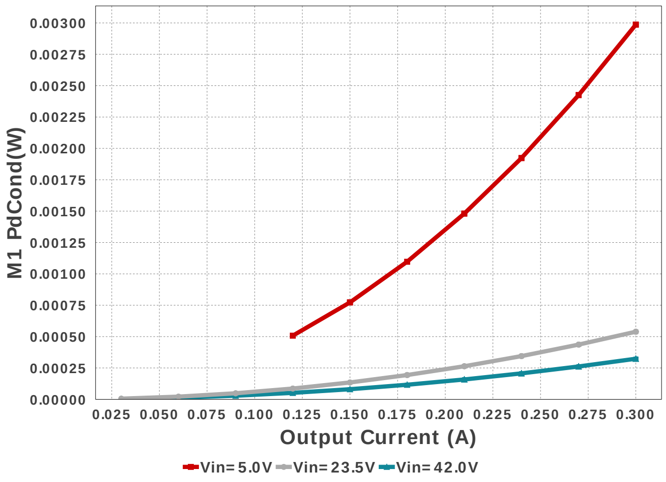
M1 TjOP



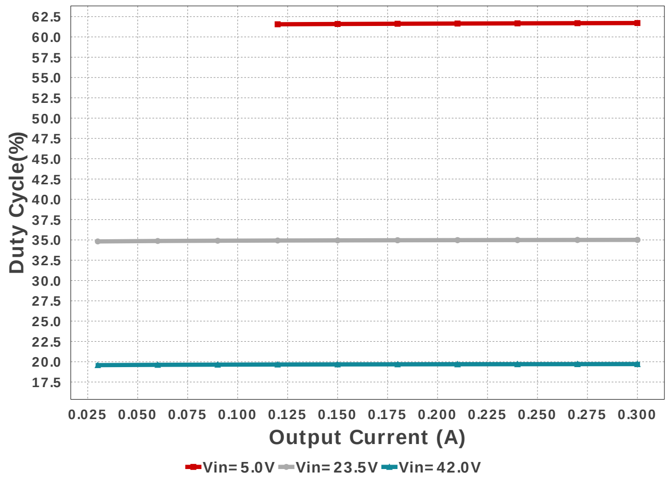
L Pd



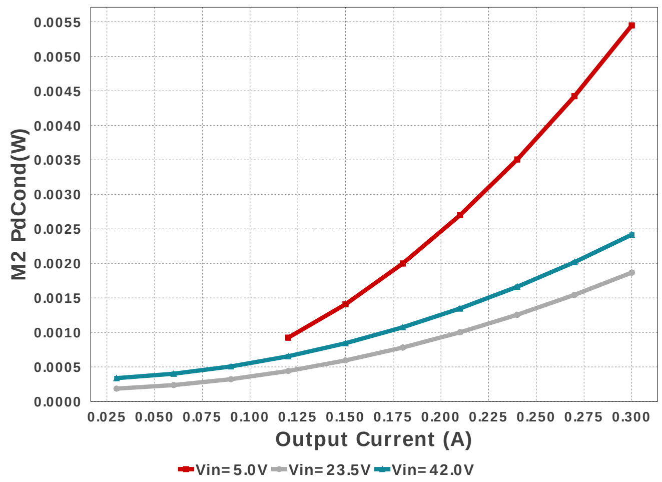
M1 PdCond



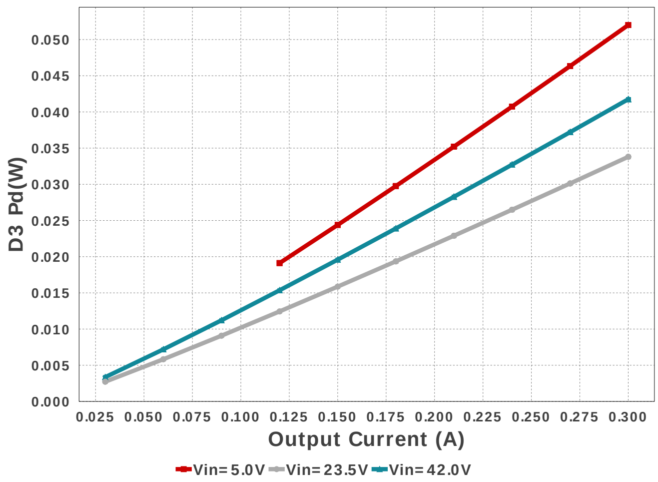
Duty Cycle



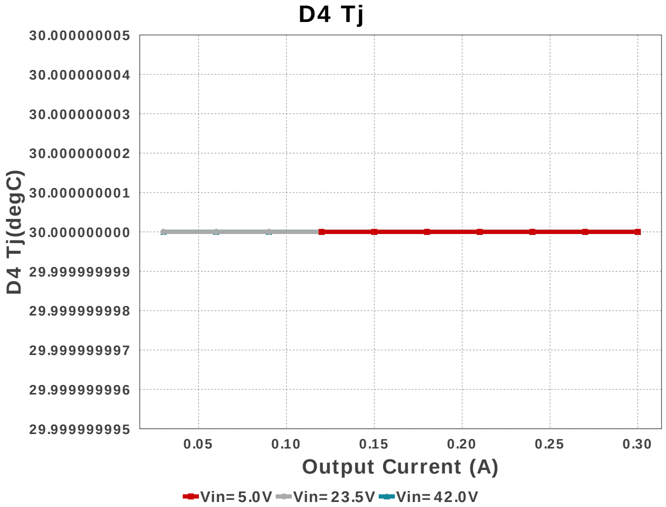
M2 PdCond



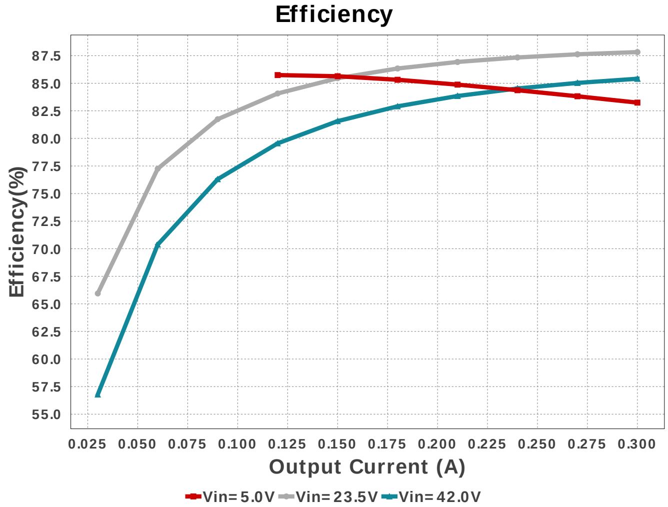
D3 Pd

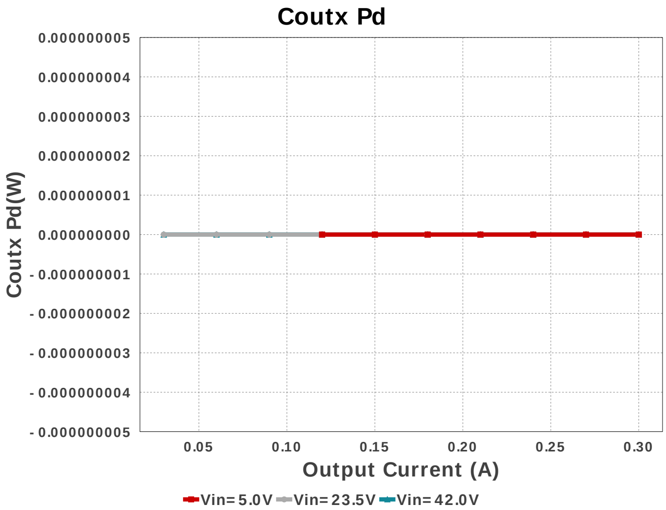


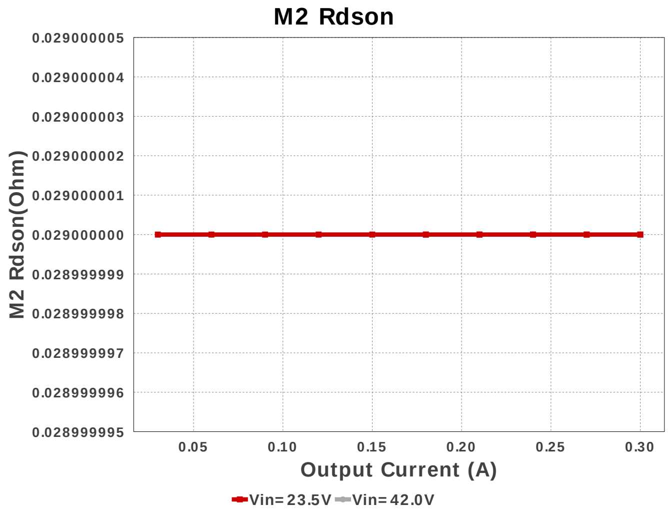
D4 Tj

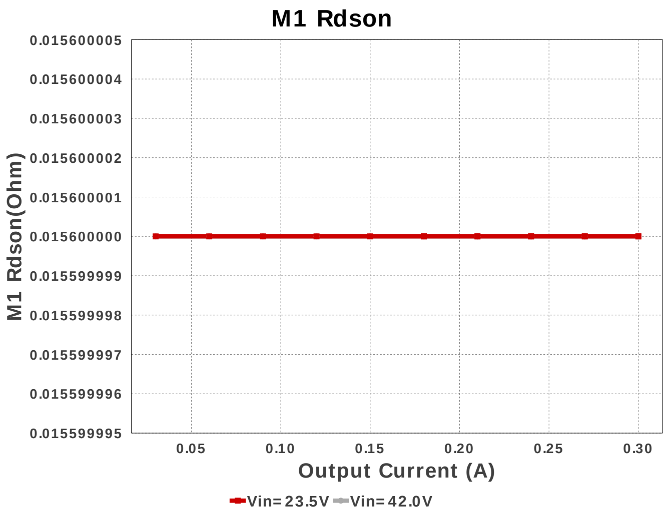


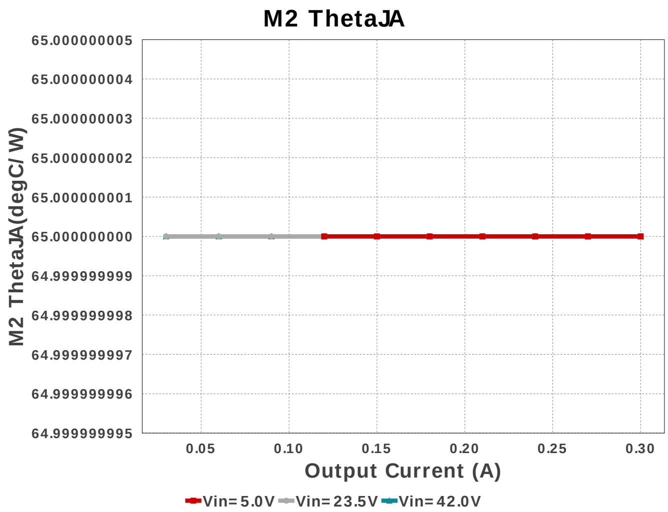
Efficiency

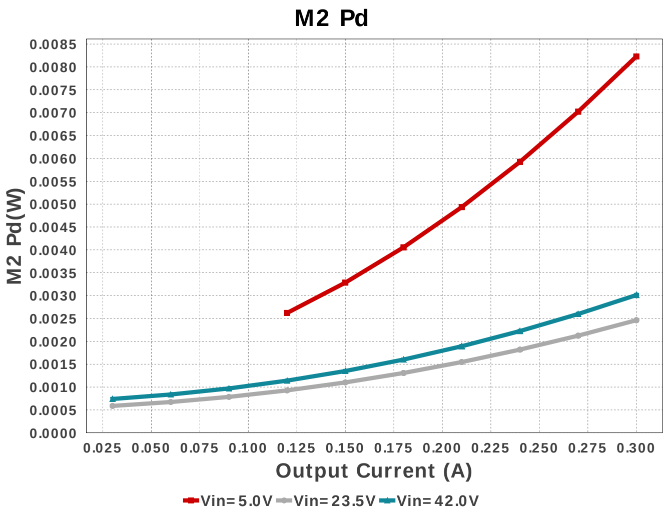


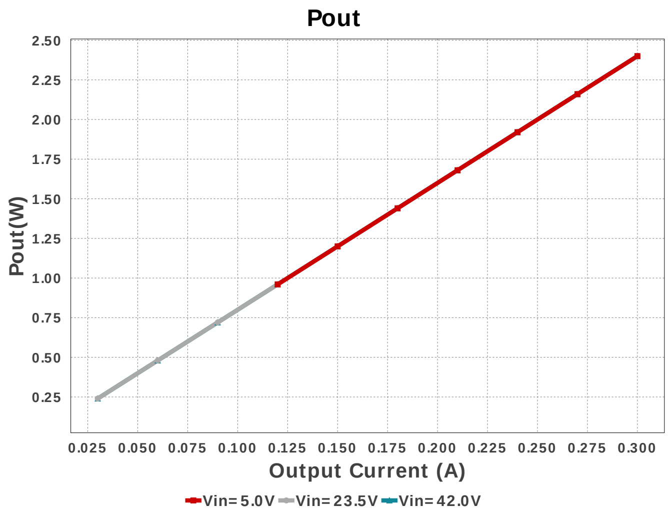

Coutx Pd
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
Coutx Pd(W)
0.05 0.10 0.15 0.20 0.25 0.30
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

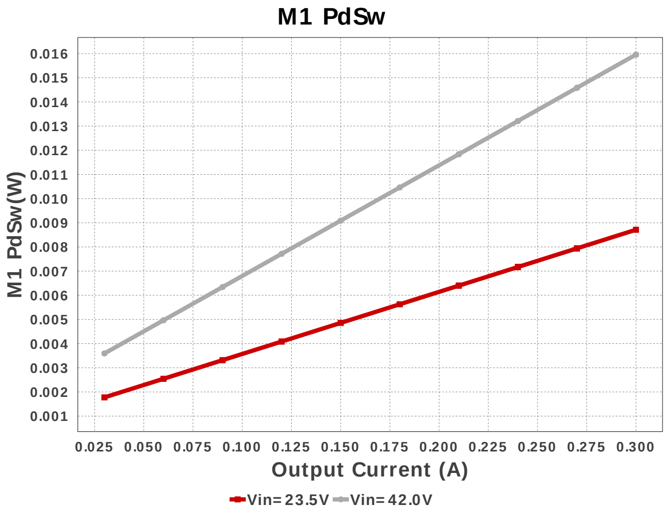

M2 Rdson
0.029000005
0.029000004
0.029000003
0.029000002
0.029000001
0.029000000
0.028999999
0.028999998
0.028999997
0.028999996
0.028999995
M2 Rdson(Ohm)
0.05 0.10 0.15 0.20 0.25 0.30
Output Current (A)
Vin=23.5V Vin=42.0V

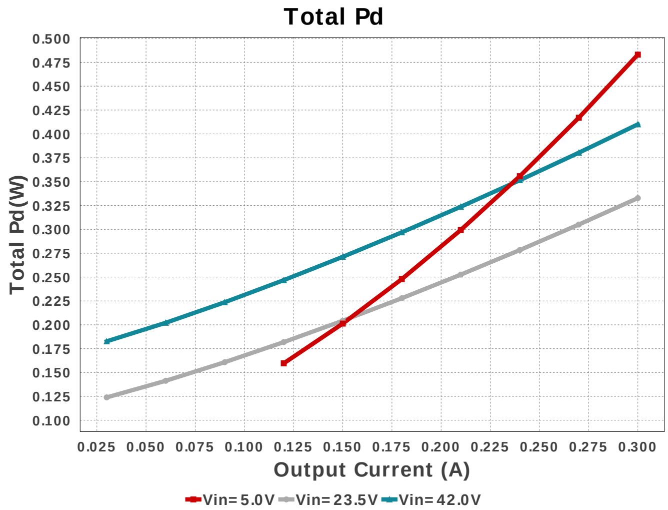

M1 Rdson
0.015600005
0.015600004
0.015600003
0.015600002
0.015600001
0.015600000
0.015599999
0.015599998
0.015599997
0.015599996
0.015599995
M1 Rdson(Ohm)
0.05 0.10 0.15 0.20 0.25 0.30
Output Current (A)
Vin=23.5V Vin=42.0V

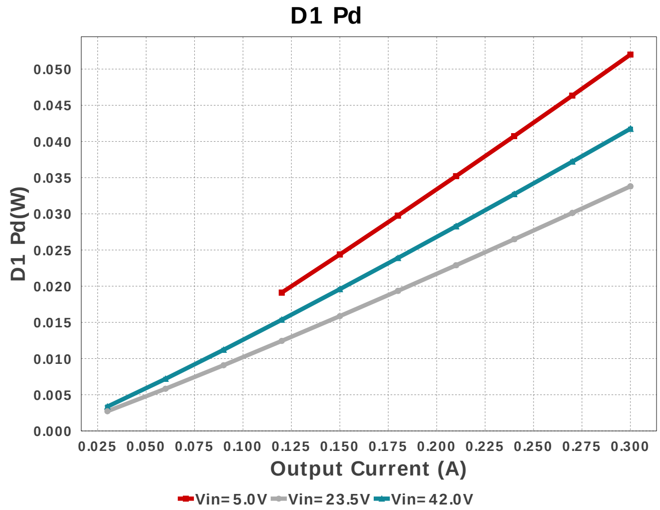

M2 ThetaJA
65.000000005
65.000000004
65.000000003
65.000000002
65.000000001
65.000000000
64.999999999
64.999999998
64.999999997
64.999999996
64.999999995
M2 ThetaJA(degC/W)
0.05 0.10 0.15 0.20 0.25 0.30
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

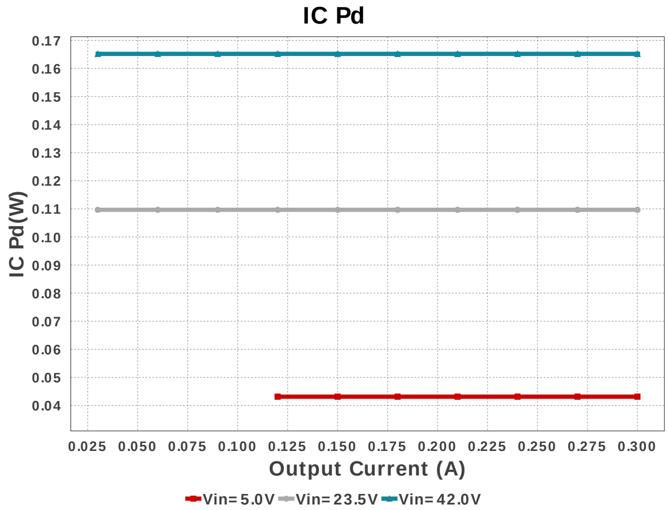

M2 Pd
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
M2 Pd(W)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

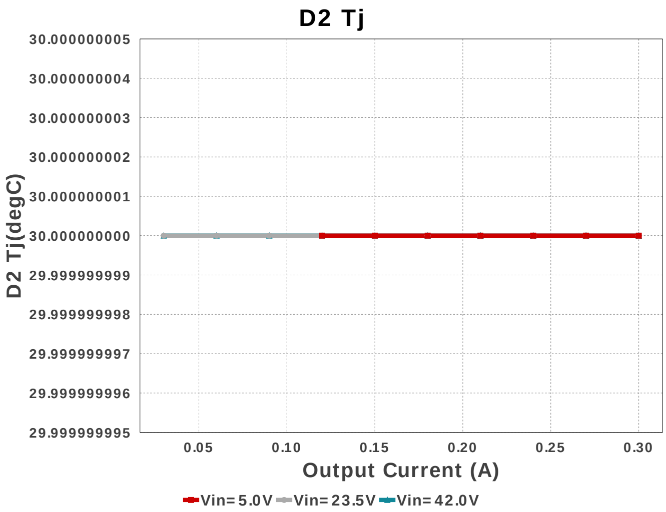

Pout
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
Pout(W)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

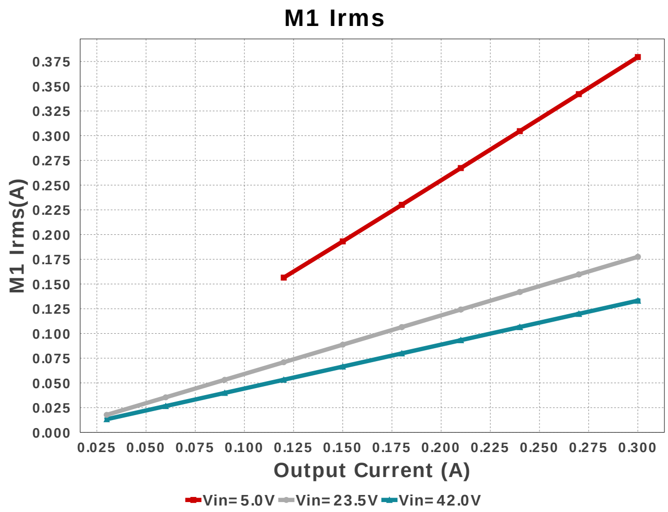

M1 PdSw
M1 PdSw(W)
Output Current (A)
Vin=23.5V Vin=42.0V

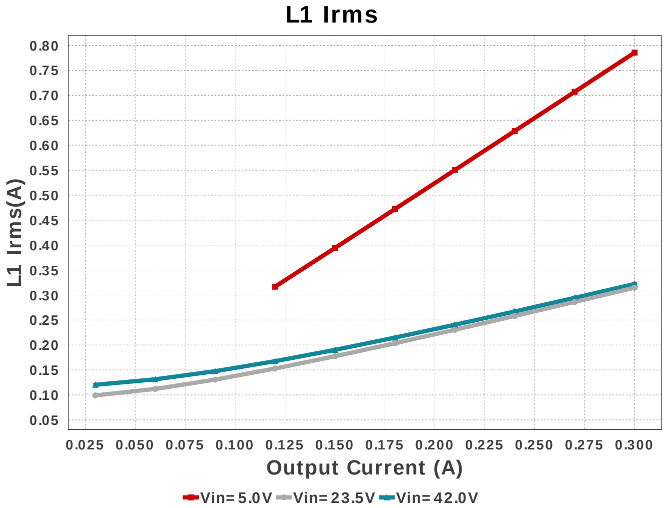

Total Pd
Total Pd(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

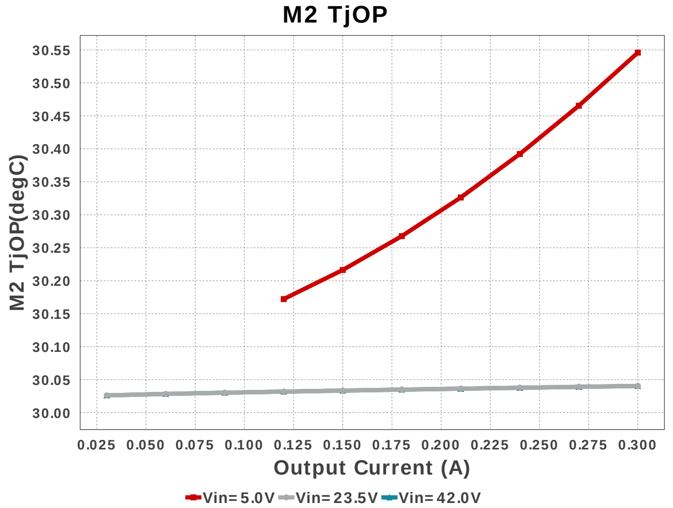

D1 Pd
D1 Pd(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

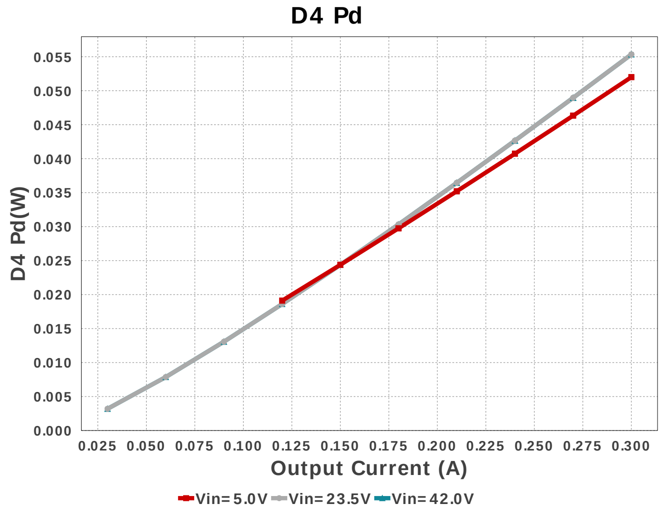

IC Pd
IC Pd(W)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

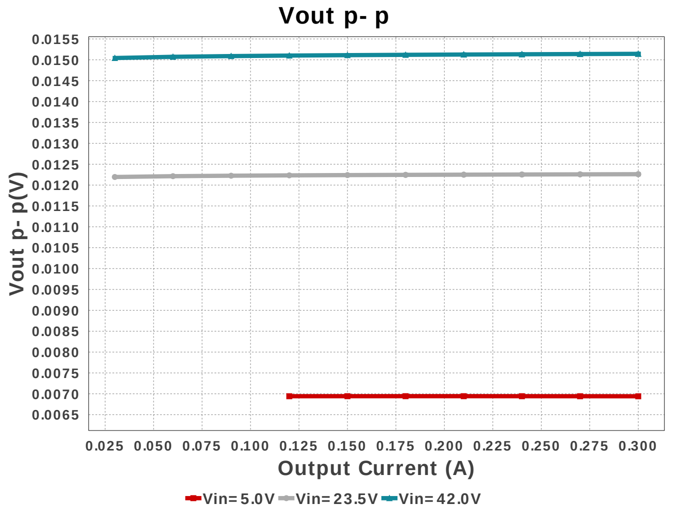

D2 Tj
D2 Tj(degC)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

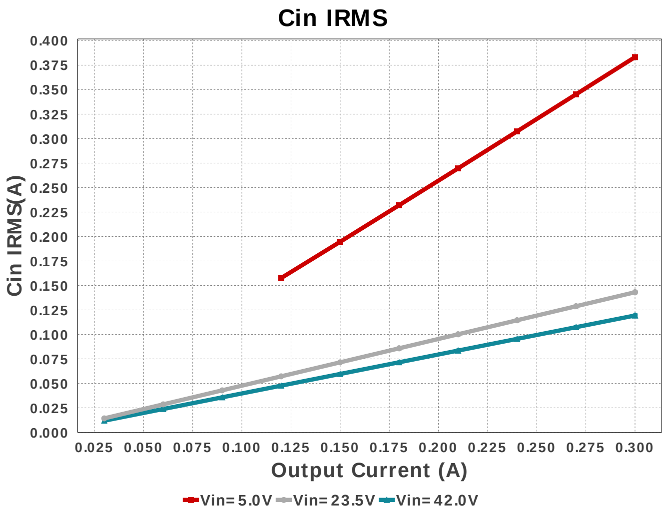

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=5.0V Vin=23.5V Vin=42.0V

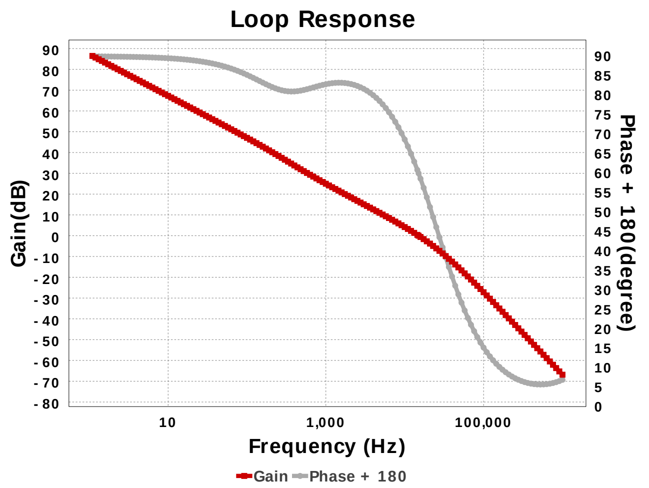












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	119.346 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	4.7 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	117.247 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	481.14 µW	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	41.754 mW	Diode	Diode power dissipation
8.	D1 Tj	43.779 degC	Diode	D1 junction temperature
9.	D1 Tj	43.779 degC	Diode	D1 junction temperature
10.	D2 Pd	55.346 mW	Diode	Diode2 power dissipation
11.	D3 Pd	41.754 mW	Diode	Diode3 power dissipation

#	Name	Value	Category	Description
12.	D4 Pd	55.346 mW	Diode	Diode4 power dissipation
13.	Diode Pd	41.754 mW	Diode	Diode power dissipation
14.	IC Pd	158.84 mW	IC	IC power dissipation
15.	IC Tj	36.354 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	66.841 mA	IC	Average input current
19.	L Ipp	406.15 mA	Inductor	Peak-to-peak inductor ripple current
20.	L Pd	27.0 mW	Inductor	Inductor power dissipation
21.	L1 Irms	322.097 mA	Inductor	Inductor ripple current
22.	M1 Irms	133.193 mA	Mosfet	MOSFET RMS ripple current
23.	M1 Pd	19.944 mW	Mosfet	MOSFET power dissipation
24.	M1 PdCond	325.01 µW	Mosfet	M1 MOSFET conduction losses
25.	M1 PdSw	19.619 mW	Mosfet	M1 MOSFET switching losses
26.	M1 Rdson	15.6 mOhm	Mosfet	Drain-Source On-resistance
27.	M1 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
28.	M1 TjOP	31.095 degC	Mosfet	MOSFET junction temperature
29.	M2 Irms	288.611 mA	Mosfet	MOSFET RMS ripple current
30.	M2 Pd	5.062 mW	Mosfet	MOSFET power dissipation
31.	M2 PdCond	2.422 mW	Mosfet	M2 MOSFET conduction losses
32.	M2 PdSw	2.64 mW	Mosfet	M2 MOSFET switching losses
33.	M2 Rdson	29.0 mOhm	Mosfet	Drain-Source On-resistance
34.	M2 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
35.	M2 TjOP	30.454 degC	Mosfet	MOSFET junction temperature
36.	Cin Pd	4.7 mW	Power	Input capacitor power dissipation
37.	Cout Pd	481.14 µW	Power	Output capacitor power dissipation
38.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
39.	D1 Pd	41.754 mW	Power	Diode power dissipation
40.	D2 Pd	55.346 mW	Power	Diode2 power dissipation
41.	D3 Pd	41.754 mW	Power	Diode3 power dissipation
42.	D4 Pd	55.346 mW	Power	Diode4 power dissipation
43.	Diode Pd	41.754 mW	Power	Diode power dissipation
44.	IC Pd	158.84 mW	Power	IC power dissipation
45.	L Pd	27.0 mW	Power	Inductor power dissipation
46.	M1 Pd	19.944 mW	Power	MOSFET power dissipation
47.	M1 PdCond	325.01 µW	Power	M1 MOSFET conduction losses
48.	M1 PdSw	19.619 mW	Power	M1 MOSFET switching losses
49.	M2 Pd	5.062 mW	Power	MOSFET power dissipation
50.	M2 PdCond	2.422 mW	Power	M2 MOSFET conduction losses
51.	M2 PdSw	2.64 mW	Power	M2 MOSFET switching losses
52.	Total Pd	407.342 mW	Power	Total Power Dissipation
53.	BOM Count	28	System Information	Total Design BOM count
54.	Cross Freq	14.987 kHz	System Information	Bode plot crossover frequency
55.	D2 Tj	37.748 degC	System Information	D2 junction temperature
56.	D3 Tj	43.779 degC	System Information	D3 junction temperature
57.	D4 Tj	37.748 degC	System Information	D4 junction temperature
58.	Duty Cycle	19.712 %	System Information	Duty cycle
59.	Efficiency	85.49 %	System Information	Steady state efficiency
60.	FootPrint	600.0 mm^2	System Information	Total Foot Print Area of BOM components
61.	Frequency	294.659 kHz	System Information	Switching frequency
62.	Gain Marg	-64.05 dB	System Information	Bode Plot Gain Margin
63.	Iout	300.0 mA	System Information	Iout operating point
64.	Low Freq Gain	86.465 dB	System Information	Gain at 1Hz
65.	Mode	CCM	System Information	Conduction Mode
66.	Operating Topology	Buck	System Information	The current operating topology of the device
67.	Phase Marg	59.916 deg	System Information	Bode Plot Phase Margin
68.	Pout	2.4 W	System Information	Total output power
69.	SW Ipk	503.077 mA	System Information	Peak switch current

#	Name	Value	Category	Description
70.	Total BOM	$4.33	System Information	Total BOM Cost
71.	Vin	42.0 V	System Information	Vin operating point
72.	Vout	8.0 V	System Information	Operational Output Voltage
73.	Vout Actual	7.983 V	System Information	Vout Actual calculated based on selected voltage divider resistors
74.	Vout Tolerance	3.197 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
75.	Vout p-p	15.144 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	300.0 m	Maximum Output Current
VinMax	42.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	8.0	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

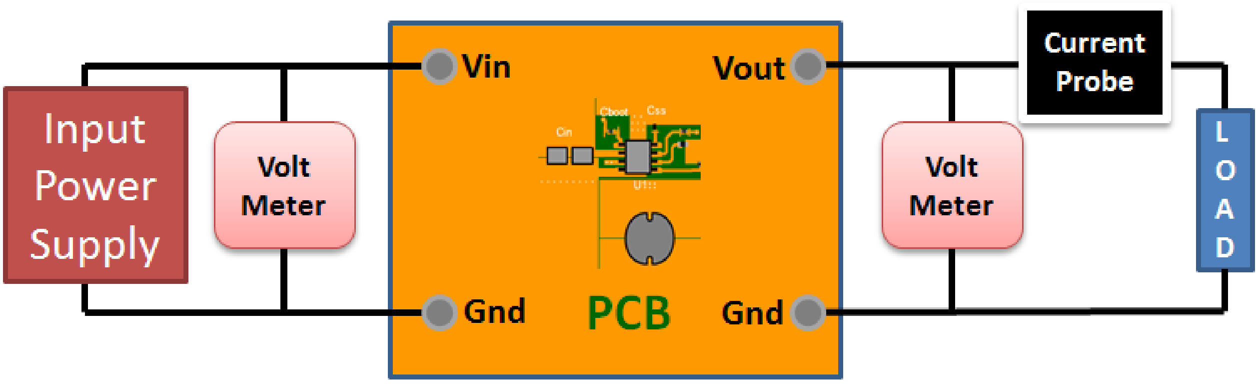
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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 : AF99C0F79980F96C[v1]

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