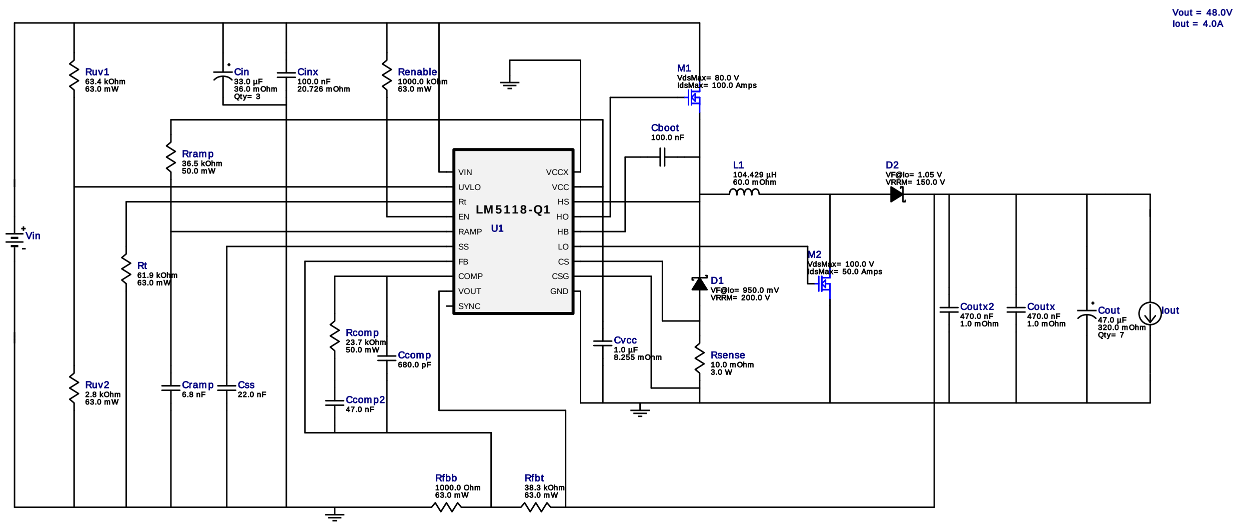
VinMin = 36.0V
VinMax = 58.0V
Vout = 48.0V
Iout = 4.0A

Device = LM5118Q1MH/NOPB
Topology = Buck_Boost
Created = 2023-08-10 02:56:38.695
BOM Cost = NA
BOM Count = 34
Total Pd = 10.65W

WEBENCH® Design Report

Design : 61 LM5118Q1MH/NOPB
LM5118Q1MH/NOPB 36V-58V to 48.00V @ 4A

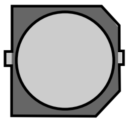
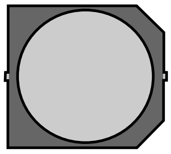


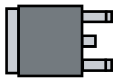
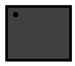
Design Alerts

LM5118-Q1 Design

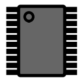
Tool Tip for Keep selected FETs during Redesign Configuration Option: By Default if you hit REDESIGN button, Webench re-designs all the external components including Fets. But if we have checked this configuration option, currently selected fets in schematic will get locked and re-design happens for only other external components. This helps to update the desing by keeping Fets unchanged.

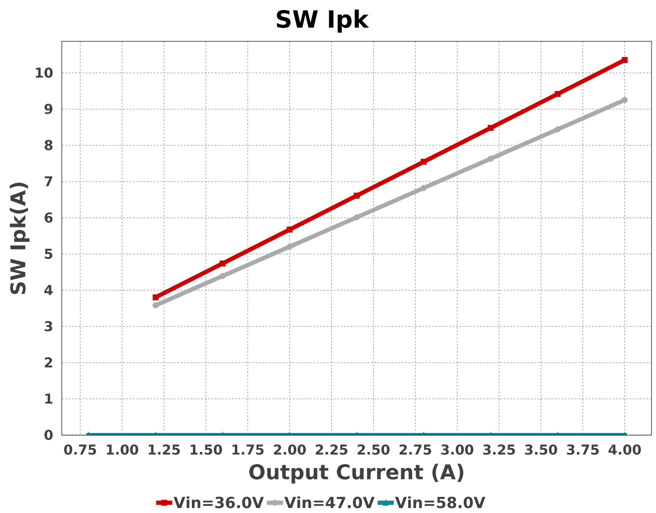
Electrical BOM

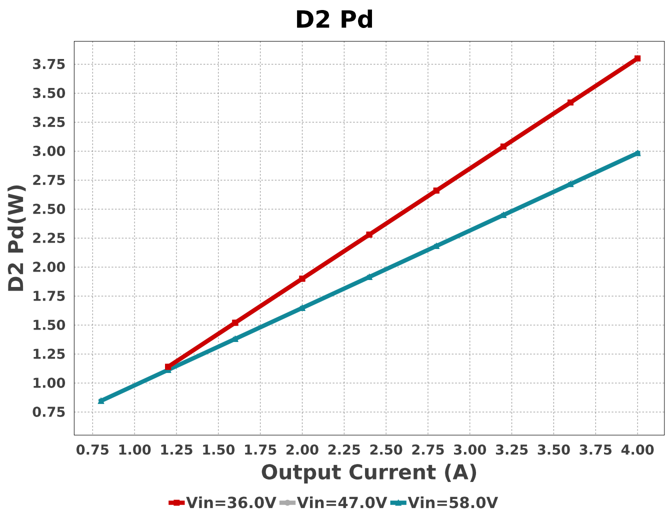
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm²
Ccomp	Samsung Electro-Mechanics	CL05C681JB5NNNC Series= C0G/NP0	Cap= 680.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp2	Kemet	C0805C473J3GACTU Series= C0G/NP0	Cap= 47.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.21	0805 7 mm²
Cin	Panasonic	EEHZA1K330P Series= ZA	Cap= 33.0 uF ESR= 36.0 mOhm VDC= 80.0 V IRMS= 1.7 A	3	$1.34	 SM_RADIAL_10BMM 160 mm²
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 mm²
Cout	Panasonic	EEV-FK2A470Q Series= FK	Cap= 47.0 uF ESR= 320.0 mOhm VDC= 100.0 V IRMS= 500.0 mA	7	$0.93	 SM_RADIAL_H13 264 mm²

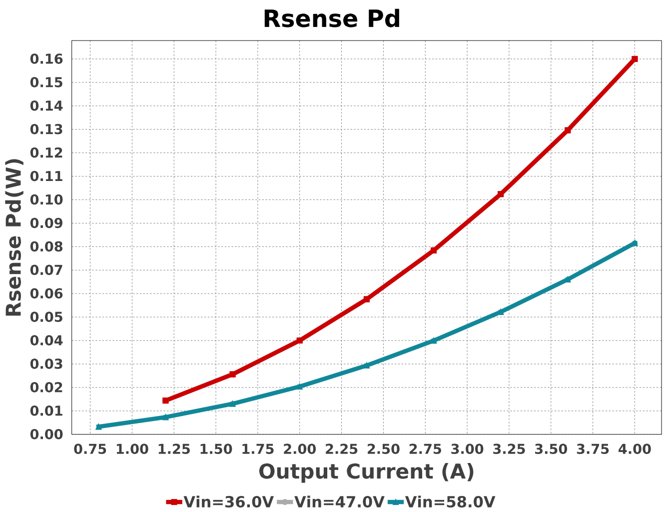
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Coutx	MuRata	GRM21BR72A474KA73L Series= X7R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.13	0805 7 mm^2
Coutx2	MuRata	GRM21BR72A474KA73L Series= X7R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.13	0805 7 mm^2
Cramp	TDK	C2012C0G1H682J060AA Series= C0G/NP0	Cap= 6.8 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Css	TDK	CGA4J2C0G1H223J125AA Series= C0G/NP0	Cap= 22.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.07	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	$0.11	0805 7 mm^2
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.18	 DPAK 102 mm^2
D2	SMC Diode Solutions	SB20150TR	VF@Io= 1.05 V VRRM= 150.0 V	1	$0.32	 DO-201AD 166 mm^2
L1	CUSTOM	CUSTOM	L= 104.429 µH 60.0 mOhm	1	NA	CUSTOM 0 mm^2
M1	Texas Instruments	CSD19502Q5B	VdsMax= 80.0 V IdsMax= 100.0 Amps	1	$0.81	DQK0006C 9 mm^2
M2	Texas Instruments	CSD19534Q5A	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.30	 TRANS_NexFET_Q5A 55 mm^2
Rcomp	Yageo	RC0201FR-0723K7L Series= ?	Res= 23.7 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	CRCW040238K3FKED Series= CRCW..e3	Res= 38.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rramp	Yageo	RC0201FR-0736K5L Series= ?	Res= 36.5 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsense	Bourns	CRA2512-FZ-R010ELF Series= CRA	Res= 10.0 mOhm Power= 3.0 W Tolerance= 1.0%	1	$0.13	 2512 43 mm^2
Rt	Vishay-Dale	CRCW040261K9FKED Series= CRCW..e3	Res= 61.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruv1	Vishay-Dale	CRCW040263K4FKED Series= CRCW..e3	Res= 63.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruv2	Vishay-Dale	CRCW04022K80FKED Series= CRCW..e3	Res= 2.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

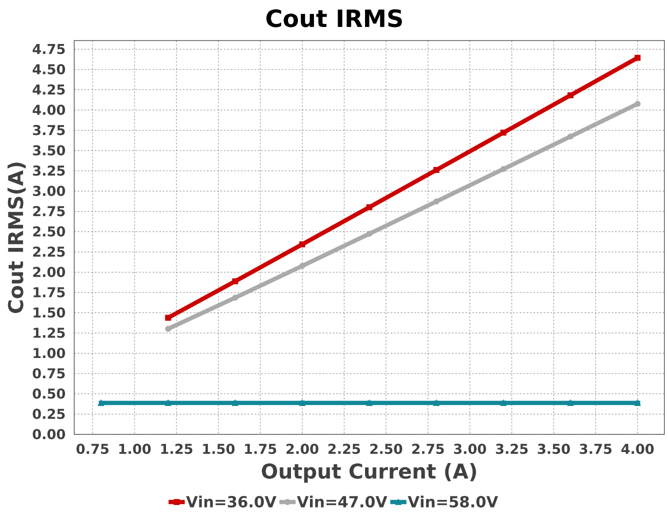
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LM5118Q1MH/NOPB	Switcher	1	$3.18	MXA20A 71 mm^2

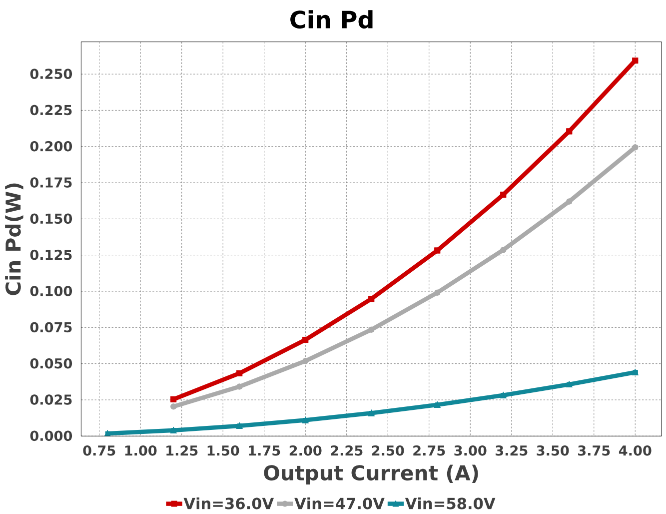


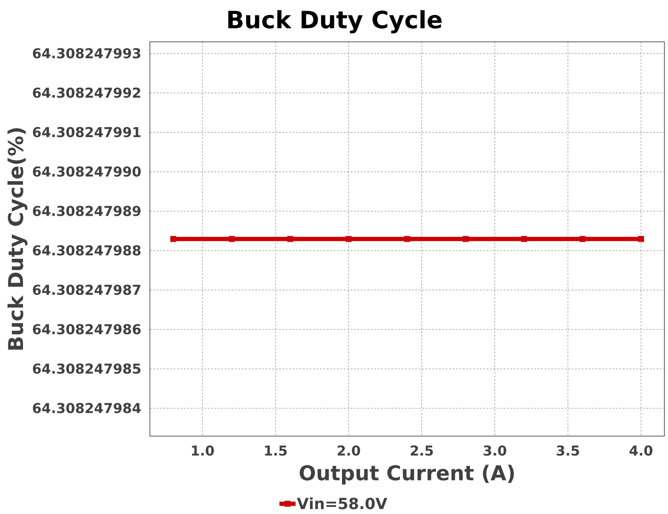


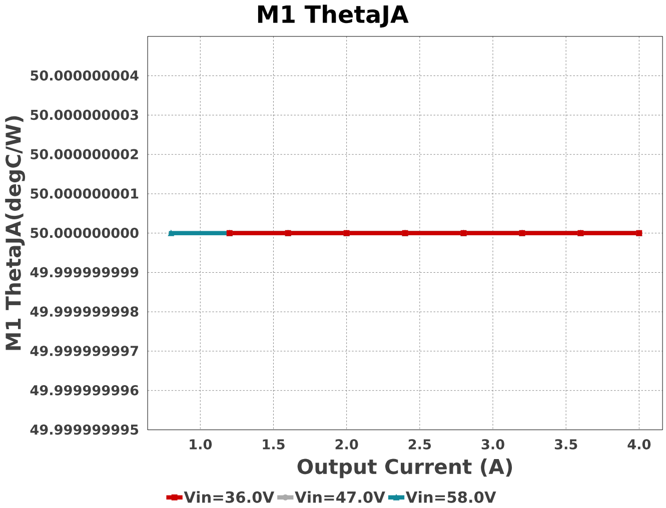


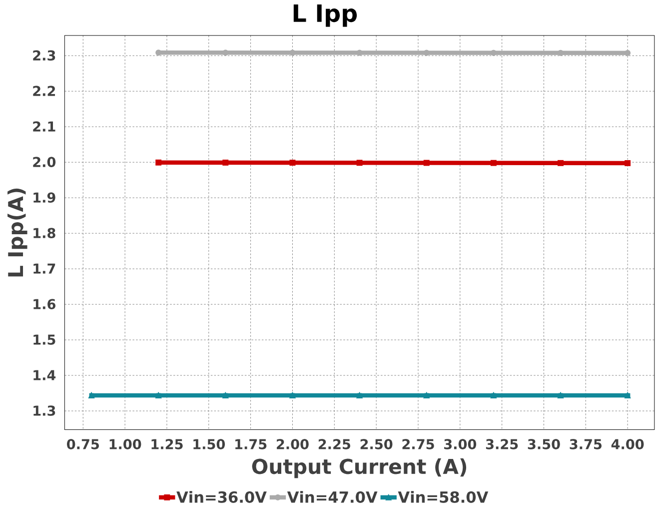


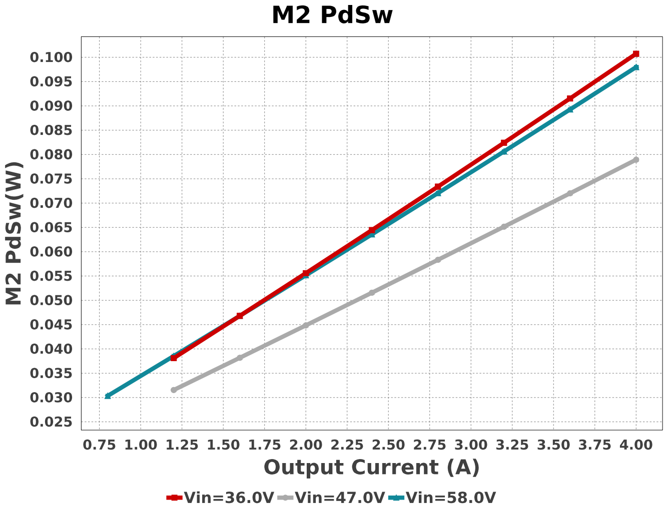


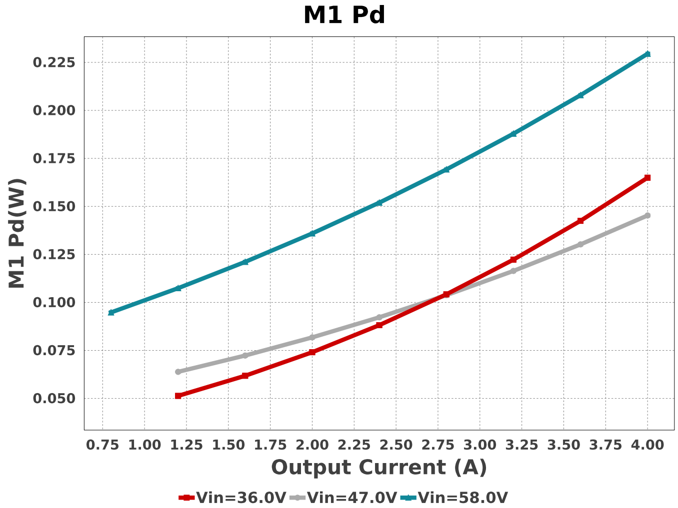


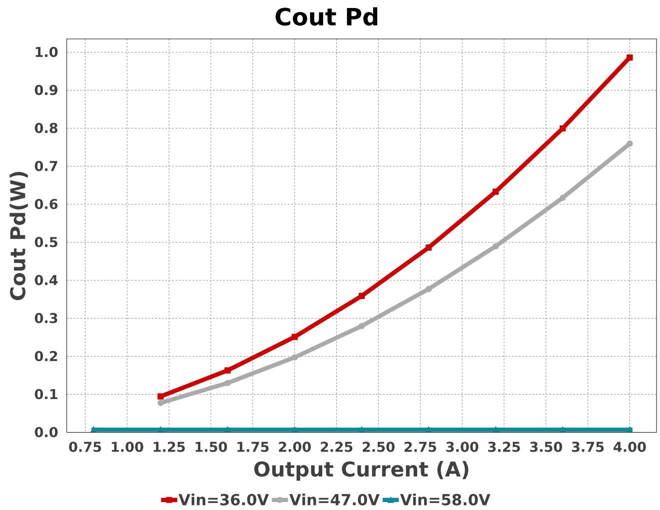


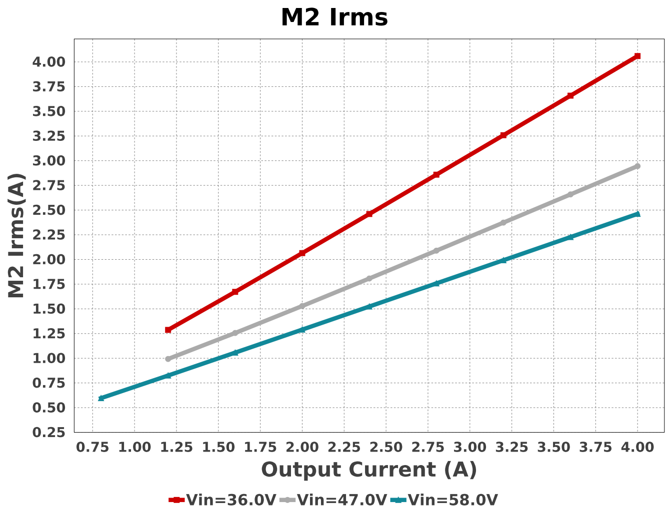

M1 ThetaJA
M1 ThetaJA(degC/W)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

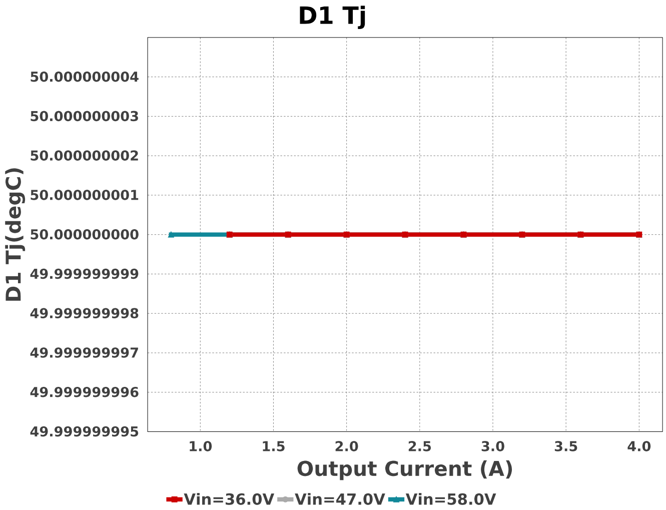

L Ipp
L Ipp(A)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

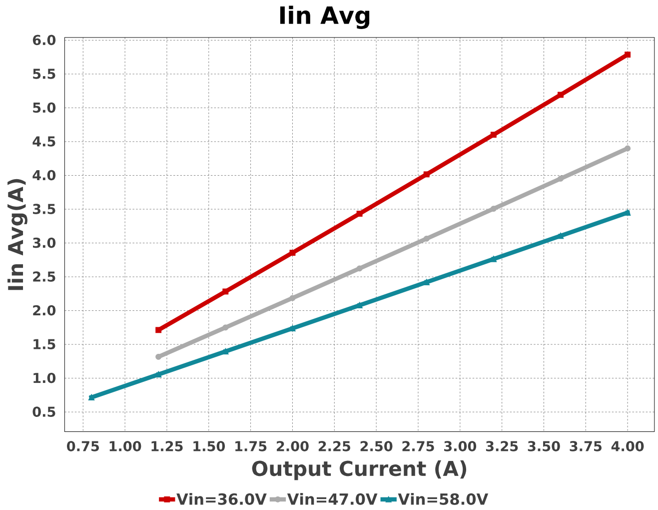

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

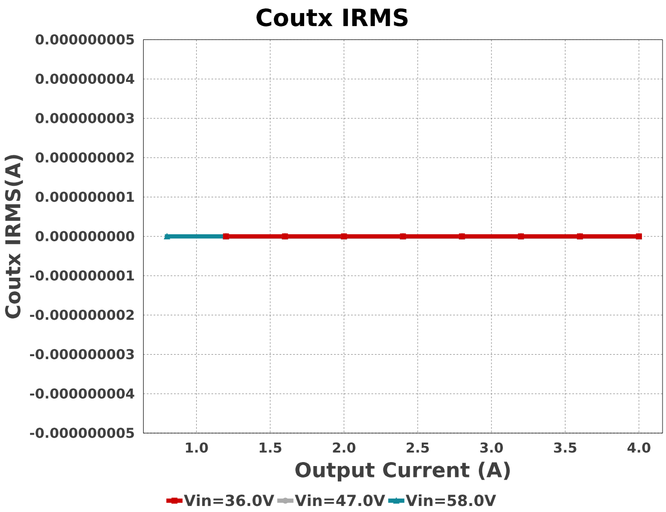

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

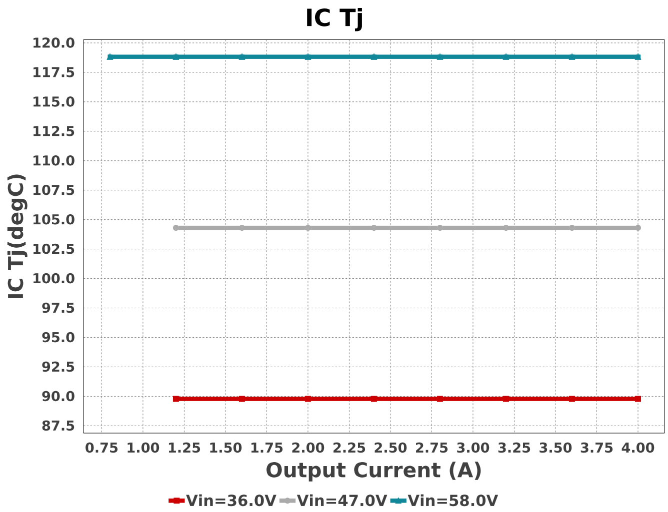

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

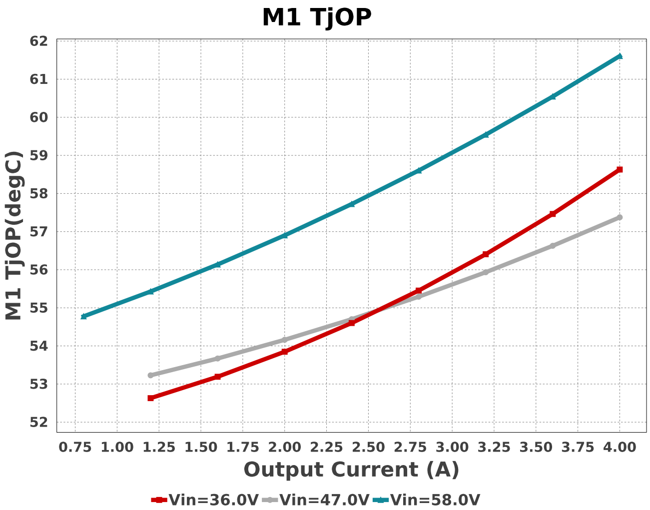

M2 Irms
M2 Irms(A)
Output Current (A)
Vin=36.0V Vin=47.0V Vin=58.0V

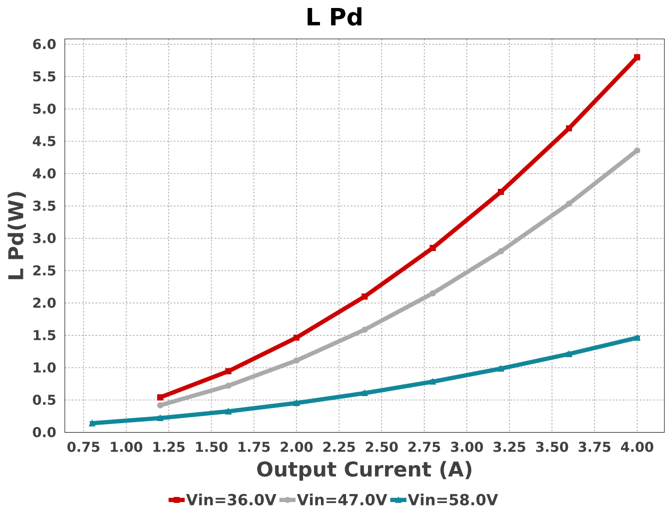

D1 Tj
D1 Tj(degC)
50.000000004
50.000000003
50.000000002
50.000000001
50.000000000
49.999999999
49.999999998
49.999999997
49.999999996
49.999999995
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V


Iin Avg
Iin Avg(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

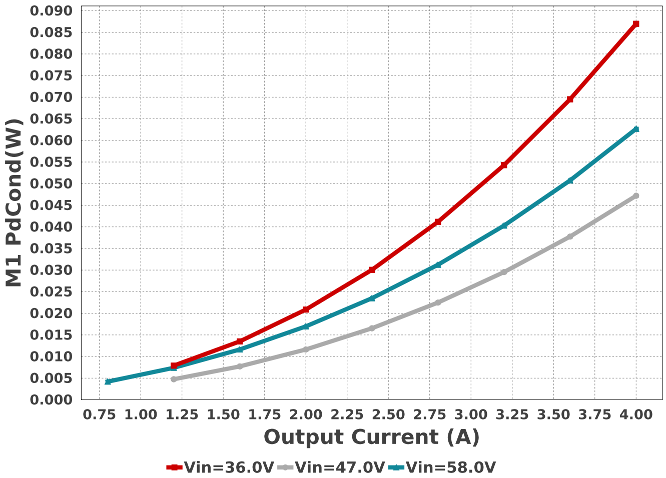

Coutx IRMS
Coutx IRMS(A)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V


IC Tj
IC Tj(degC)
120.0
117.5
115.0
112.5
110.0
107.5
105.0
102.5
100.0
97.5
95.0
92.5
90.0
87.5
0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

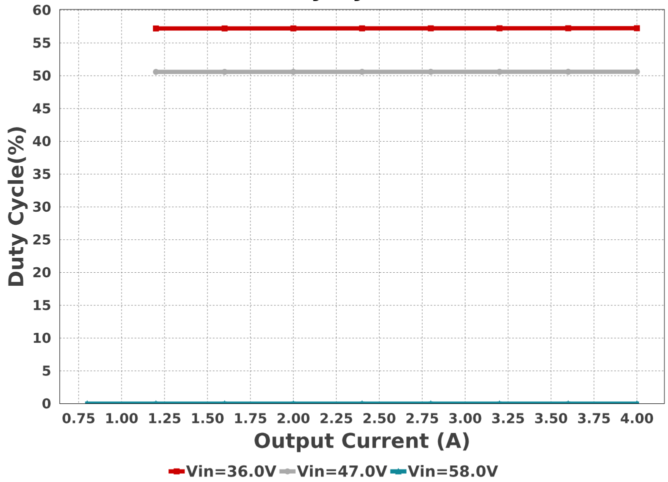

M1 TjOP
M1 TjOP(degC)
62
61
60
59
58
57
56
55
54
53
52
0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V


L Pd
L Pd(W)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

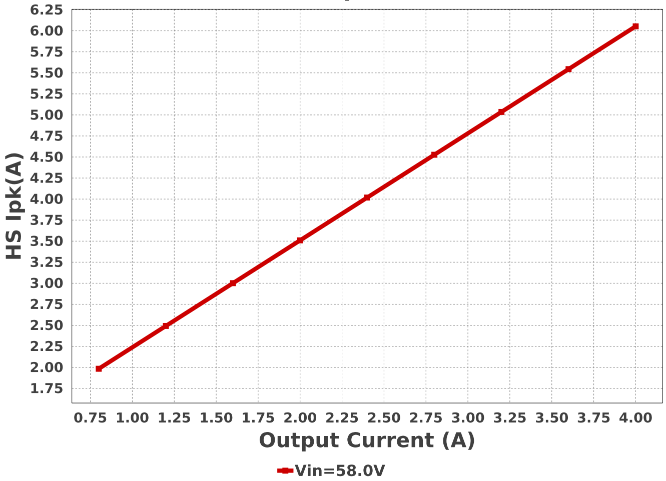
M1 PdCond



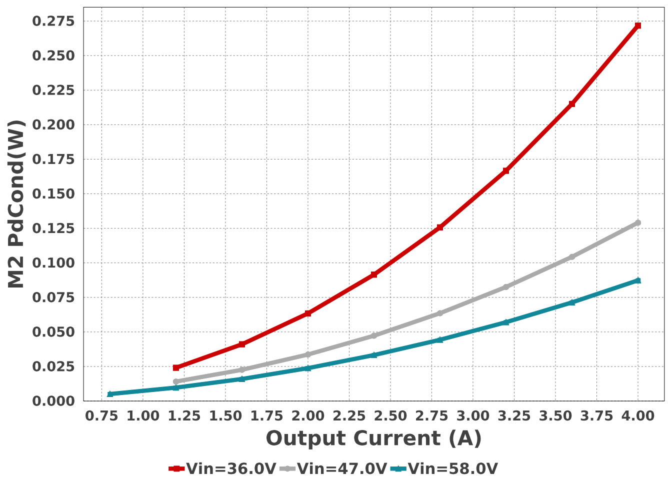
Duty Cycle



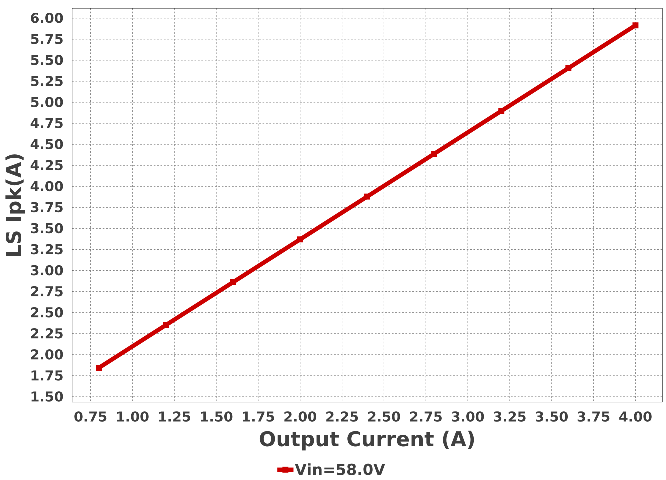
HS Ipk



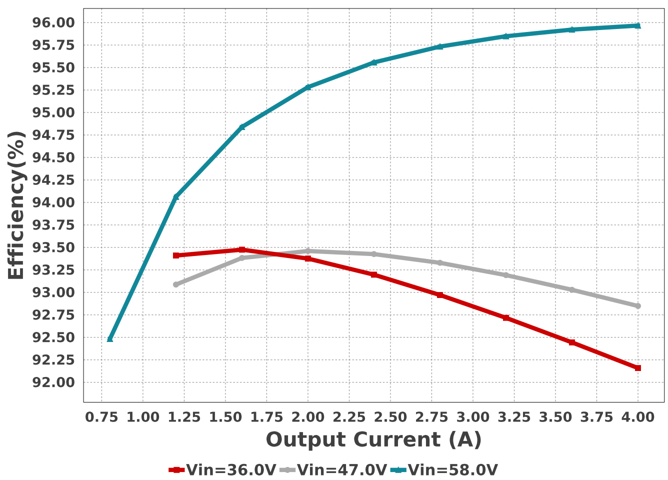
M2 PdCond



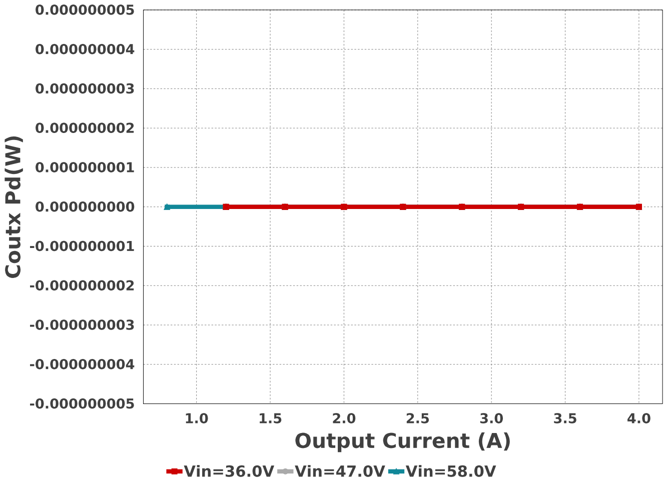
LS Ipk



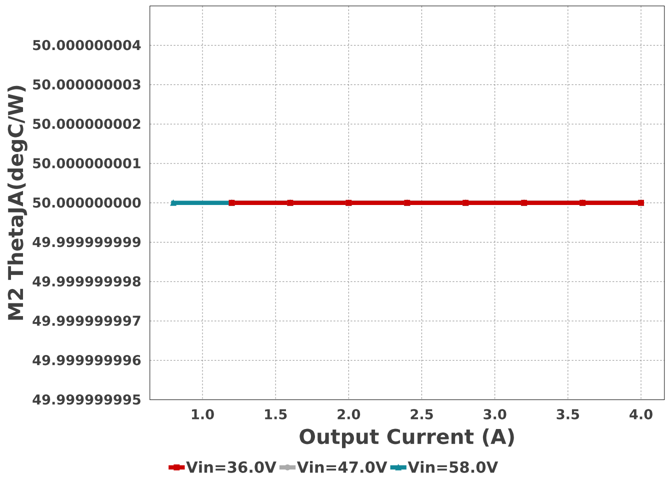
Efficiency



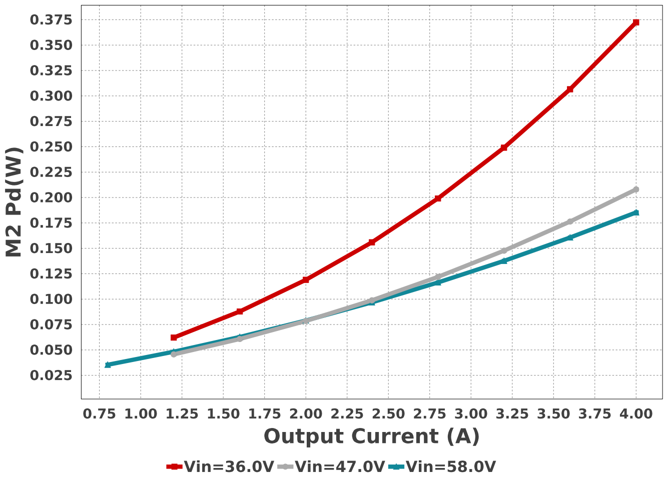
Coutx Pd



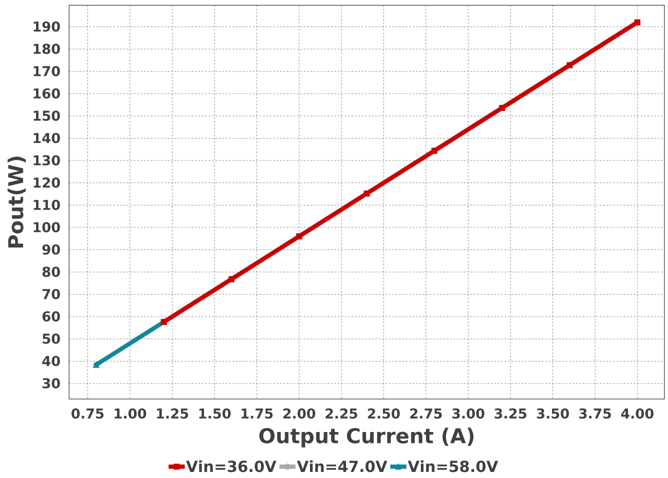
M2 ThetaJA



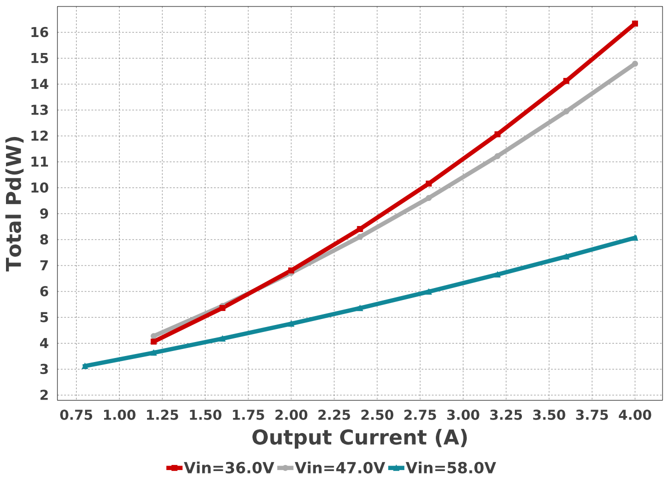
M2 Pd



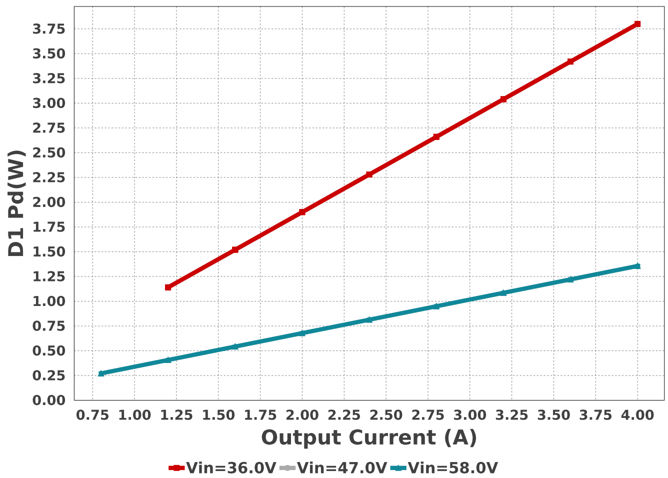
Pout

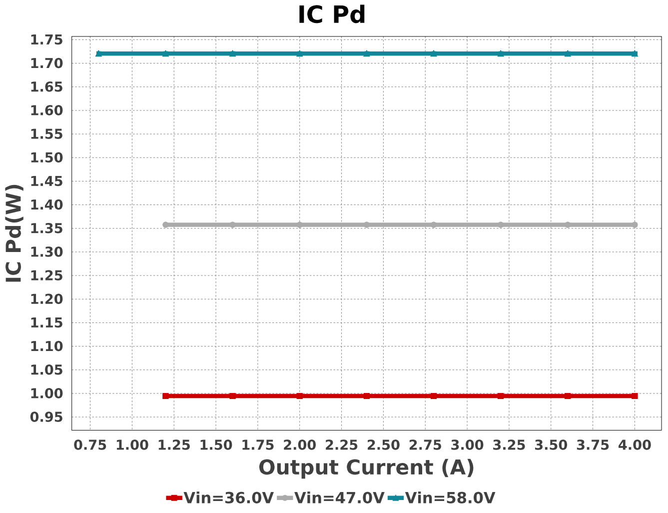


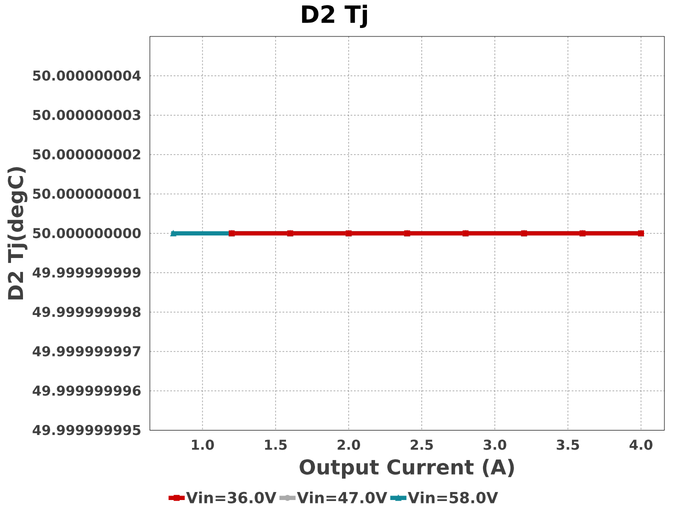
Total Pd

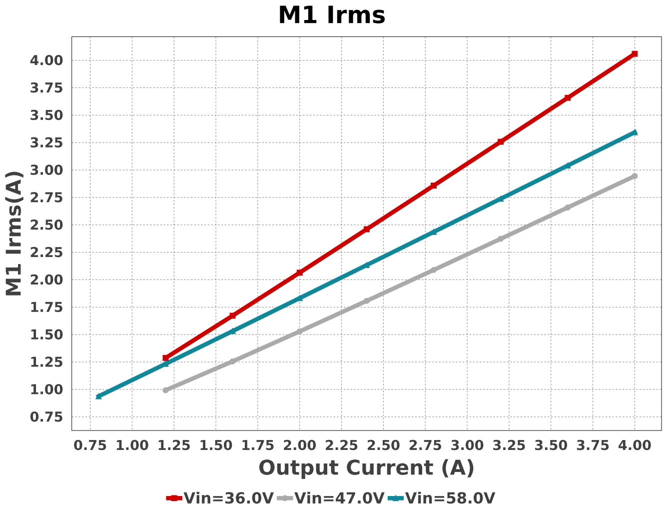


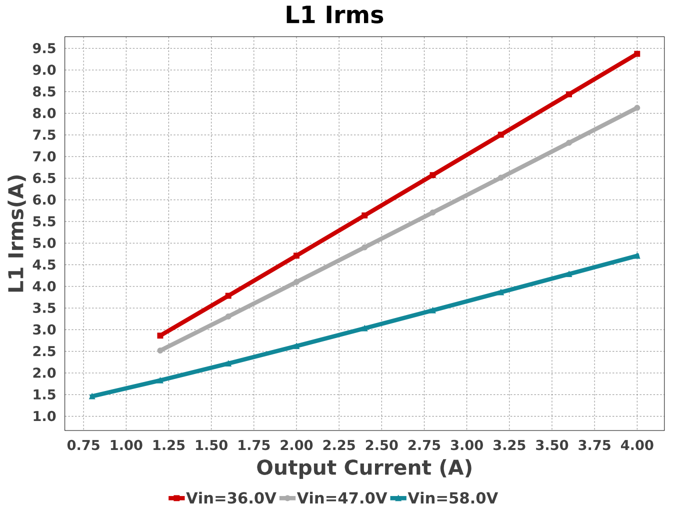
D1 Pd

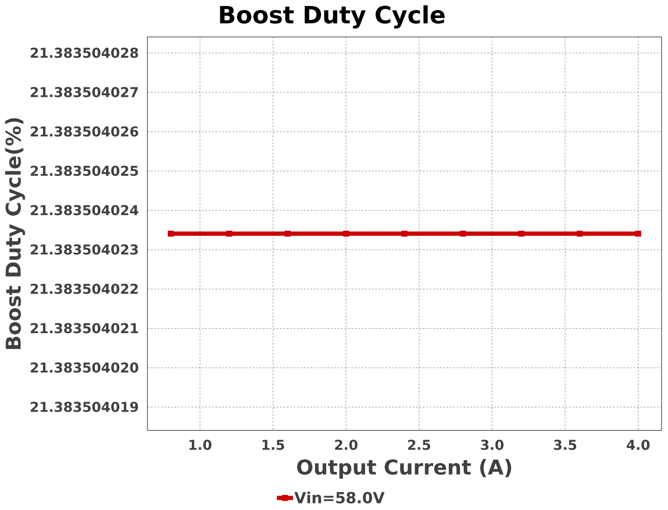


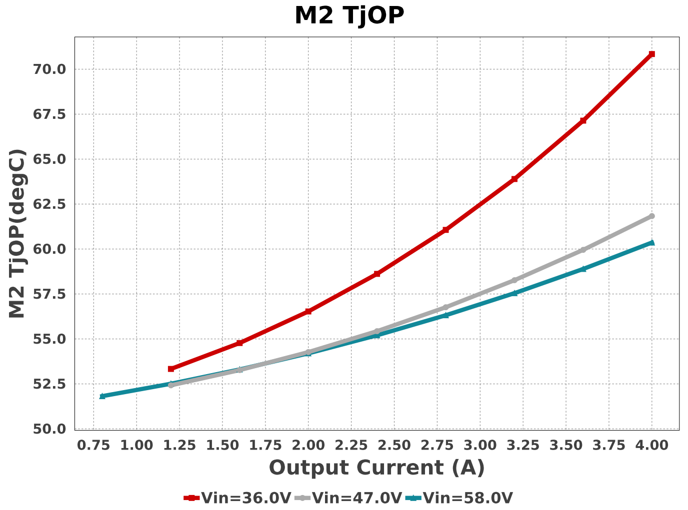

IC Pd
IC Pd(W)
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

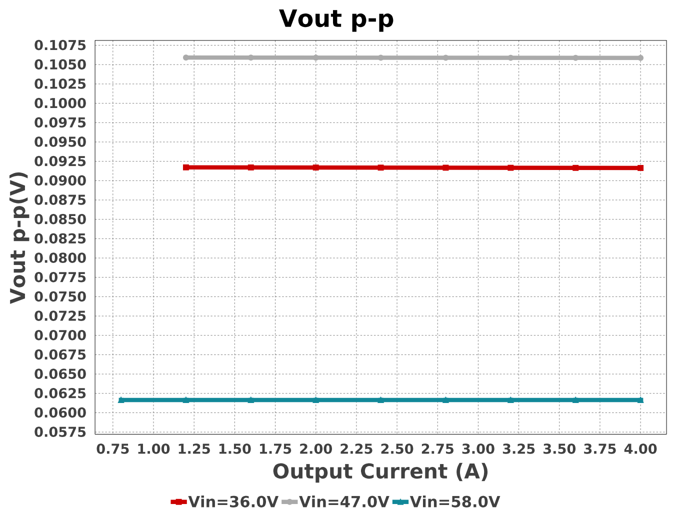

D2 Tj
D2 Tj(degC)
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

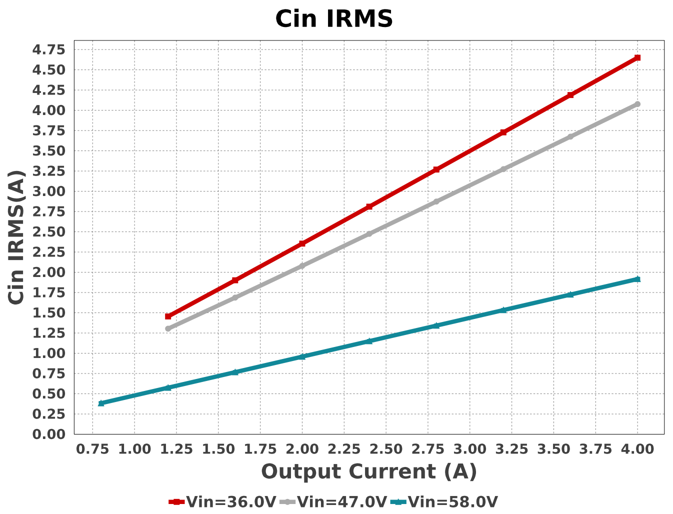

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V

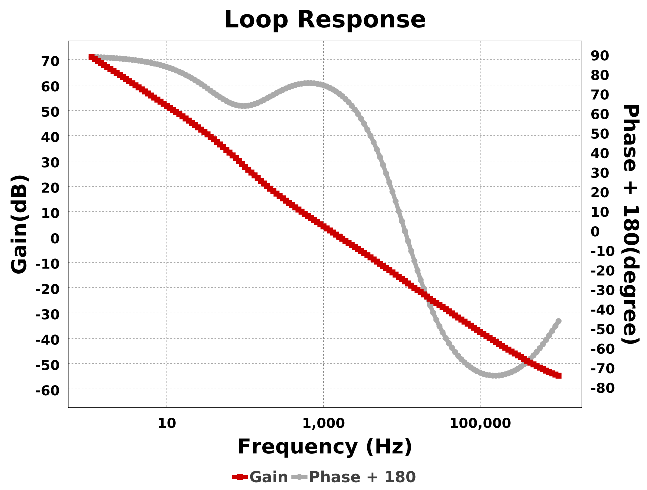

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V


Boost Duty Cycle
Boost Duty Cycle(%)
Output Current (A)
Vin=58.0V


M2 TjOP
M2 TjOP(degC)
Output Current (A)
Vin=36.0V
Vin=47.0V
Vin=58.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	4.65 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	259.43 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	4.644 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	986.09 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	3.8 W	Diode	Diode power dissipation
8.	D1 Tj	50.0 degC	Diode	D1 junction temperature
9.	D2 Pd	3.8 W	Diode	Diode2 power dissipation
10.	IC Pd	1.721 W	IC	IC power dissipation
11.	IC Tj	118.822 degC	IC	IC junction temperature
12.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	3.606 A	IC	Average input current
15.	L Ipp	1.997 A	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	5.801 W	Inductor	Inductor power dissipation
17.	L1 Irms	9.375 A	Inductor	Inductor ripple current
18.	M1 Irms	4.068 A	Mosfet	MOSFET RMS ripple current
19.	M1 Pd	191.4 mW	Mosfet	MOSFET power dissipation
20.	M1 PdCond	113.43 mW	Mosfet	M1 MOSFET conduction losses
21.	M1 ThetaJA	50.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
22.	M1 TjOP	58.649 degC	Mosfet	MOSFET junction temperature
23.	M2 Irms	4.068 A	Mosfet	MOSFET RMS ripple current
24.	M2 Pd	438.63 mW	Mosfet	MOSFET power dissipation
25.	M2 PdCond	337.91 mW	Mosfet	M2 MOSFET conduction losses
26.	M2 PdSw	100.72 mW	Mosfet	M2 MOSFET switching losses
27.	M2 ThetaJA	50.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
28.	M2 TjOP	70.913 degC	Mosfet	MOSFET junction temperature
29.	Cin Pd	259.43 mW	Power	Input capacitor power dissipation
30.	Cout Pd	986.09 mW	Power	Output capacitor power dissipation
31.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
32.	D1 Pd	3.8 W	Power	Diode power dissipation

#	Name	Value	Category	Description
33.	D2 Pd	3.8 W	Power	Diode2 power dissipation
34.	IC Pd	1.721 W	Power	IC power dissipation
35.	L Pd	5.801 W	Power	Inductor power dissipation
36.	M1 Pd	191.4 mW	Power	MOSFET power dissipation
37.	M1 PdCond	113.43 mW	Power	M1 MOSFET conduction losses
38.	M2 Pd	438.63 mW	Power	MOSFET power dissipation
39.	M2 PdCond	337.91 mW	Power	M2 MOSFET conduction losses
40.	M2 PdSw	100.72 mW	Power	M2 MOSFET switching losses
41.	Rsense Pd	160.0 mW	Power	LED Current Rsns Power Dissipation
42.	Total Pd	10.649 W	Power	Total Power Dissipation
43.	Rsense Pd	160.0 mW	Resistor	LED Current Rsns Power Dissipation
44.	BOM Count	34	System Information	Total Design BOM count
45.	Cross Freq	1.611 kHz	System Information	Bode plot crossover frequency
46.	D2 Tj	50.0 degC	System Information	D2 junction temperature
47.	Duty Cycle	57.252 %	System Information	Duty cycle
48.	Efficiency	91.797 %	System Information	Steady state efficiency
49.	FootPrint	3.65 k mm^2	System Information	Total Foot Print Area of BOM components
50.	Frequency	98.583 kHz	System Information	Switching frequency
51.	Gain Marg	-17.51 dB	System Information	Bode Plot Gain Margin
52.	Iout	4.0 A	System Information	Iout operating point
53.	Low Freq Gain	71.095 dB	System Information	Gain at 1Hz
54.	Mode	CCM	System Information	Conduction Mode
55.	Operating Topology	Buck-Boost	System Information	The current operating topology of the device
56.	Phase Marg	70.354 deg	System Information	Bode Plot Phase Margin
57.	Pout	192.0 W	System Information	Total output power
58.	SW Ipk	10.356 A	System Information	Peak switch current
59.	Total BOM	NA	System Information	Total BOM Cost
60.	Vin	36.0 V	System Information	Vin operating point
61.	Vout	48.0 V	System Information	Operational Output Voltage
62.	Vout Actual	48.339 V	System Information	Vout Actual calculated based on selected voltage divider resistors
63.	Vout Tolerance	3.461 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
64.	Vout p-p	91.629 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	4.0	Maximum Output Current
VinMax	58.0	Maximum input voltage
VinMin	36.0	Minimum input voltage
Vout	48.0	Output Voltage
base_pn	LM5118-Q1	Base Product Number
source	DC	Input Source Type
Ta	50.0	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

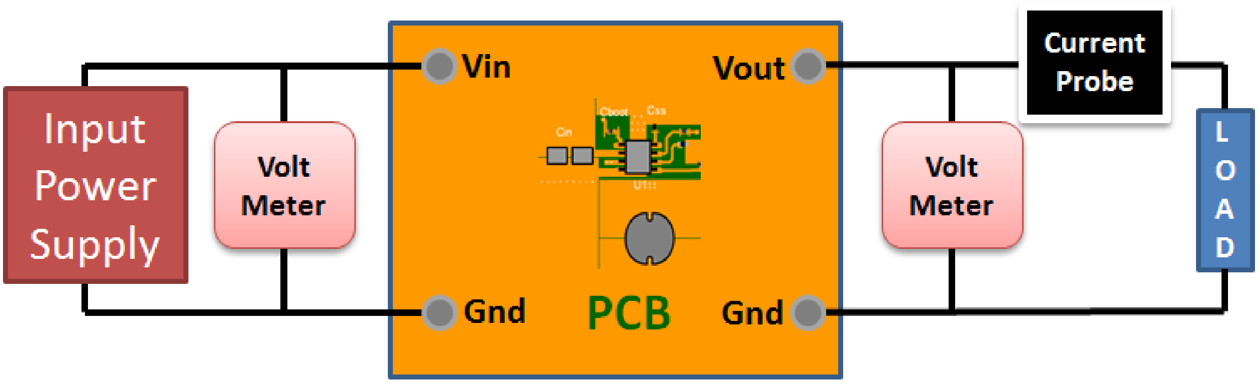
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 36.0V 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 LM5118-Q1 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 : F1AEBBBE3F2F05F3[v1]

3. **LM5118-Q1** Product Folder : http://www.ti.com/product/LM5118%2DQ1 : contains the data sheet and other resources.

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