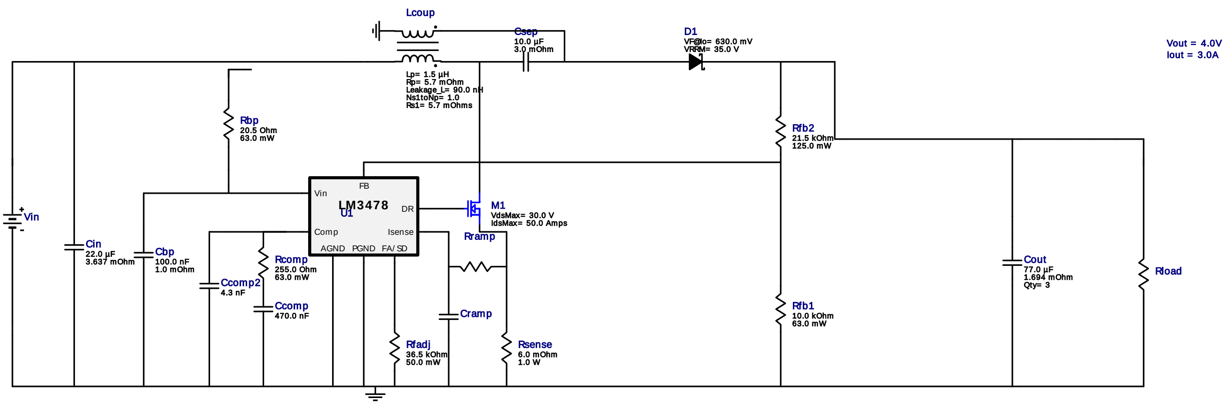
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.0V
VinMax = 5.0V
Vout = 4.0V
Iout = 3.0A

Device = LM3478MMX/NOPB
Topology = SEPIC
Created = 2018-09-25 14:15:08.111
BOM Cost = $5.05
BOM Count = 18
Total Pd = 3.44W

Design : 114 LM3478MMX/NOPB
LM3478MMX/NOPB 3.0V-5.0V to 4.00V @ 3.0A

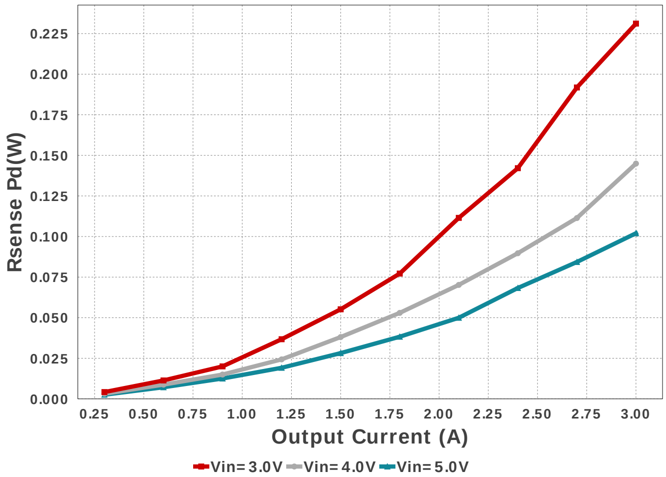


Electrical BOM

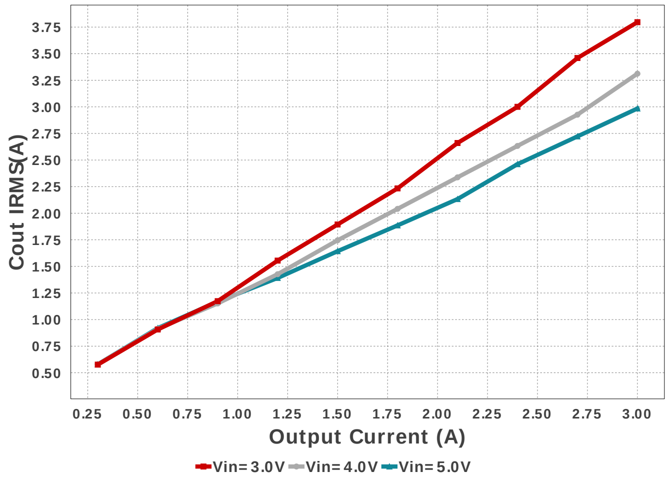
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	Panasonic	ECPU1C474MA5 Series= ECPU(A)	Cap= 470.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.20	1206 11 mm²
Ccomp2	Kemet	C0603C432J5GAC7867 Series= C0G/NP0	Cap= 4.3 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.11	0603 5 mm²
Cin	MuRata	GRM31CR61A226KE19L Series= X5R	Cap= 22.0 uF ESR= 3.637 mOhm VDC= 10.0 V IRMS= 3.56456 A	1	$0.09	1206_190 11 mm²
Cout	TDK	C2012X5R1A336M125AC Series= X5R	Cap= 77.0 uF ESR= 1.694 mOhm VDC= 10.0 V IRMS= 5.0128 A	3	$0.36	0805 7 mm²
Csep	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm²
D1	Vishay-Semiconductor	MBRB1635PBF	VF@Io= 630.0 mV VRRM= 35.0 V	1	$1.10	DDPAK 210 mm²
Lcoup	Coiltronics	DRQ125-1R5-R	Lp= 1.5 µH Rp= 5.7 mOhm Leakage_L= 90.0 nH Ns1toNp= 1.0 Rs1= 5.7 mOhms	1	$0.99	DRQ125 210 mm²
M1	Texas Instruments	CSD17308Q3	VdsMax= 30.0 V IdsMax= 50.0 Amps	1	$0.25	DQG0008A 18 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rbp	Vishay-Dale	CRCW040220R5FKED Series= CRCW..e3	Res= 20.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp	Vishay-Dale	CRCW0402255RFKED Series= CRCW..e3	Res= 255.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfadj	Yageo	RC0201FR-0736K5L Series= ?	Res= 36.5 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfb1	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfb2	Vishay-Dale	CRCW080521K5FKEA Series= CRCW..e3	Res= 21.5 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rsense	Susumu Co Ltd	PRL1632-R006-F-T1 Series= PRL1632	Res= 6.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	0612 11 mm^2
U1	Texas Instruments	LM3478MMX/NOPB	Switcher	1	$0.83	MUA08A 24 mm^2

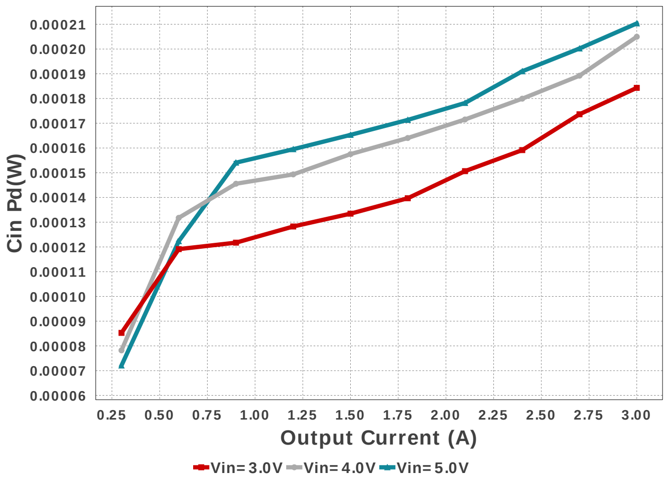
Rsense Pd



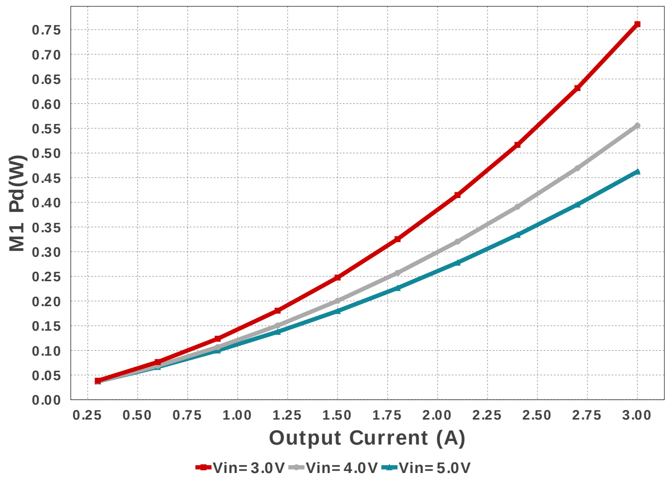
Cout IRMS

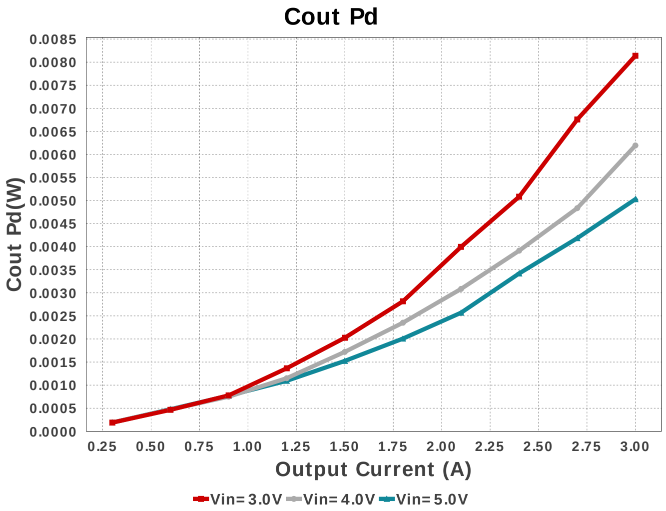


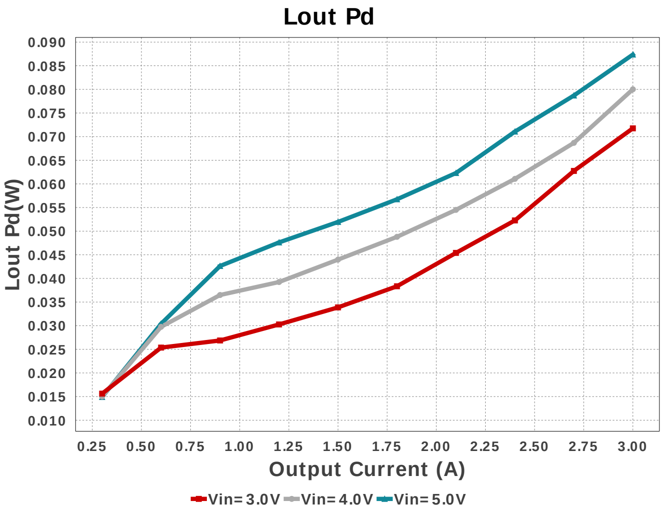
Cin Pd

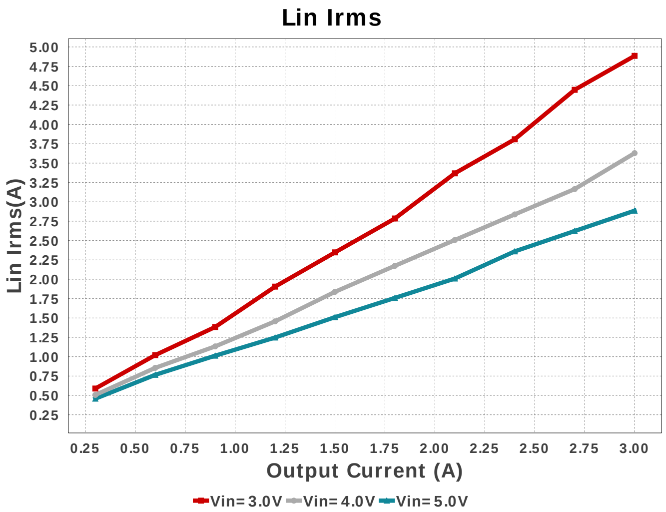


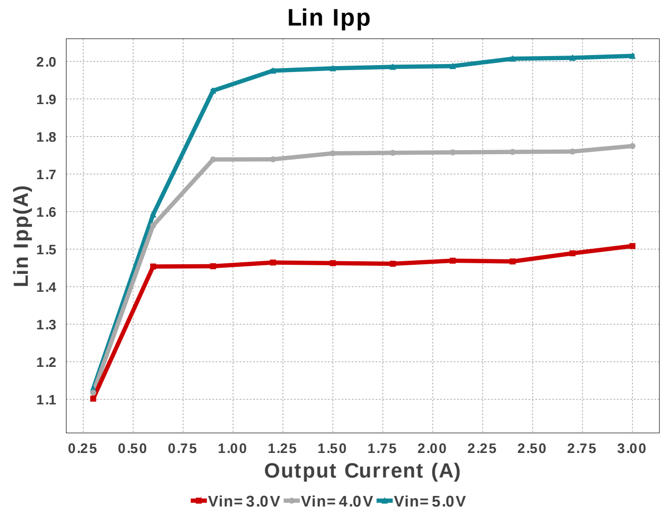
M1 Pd

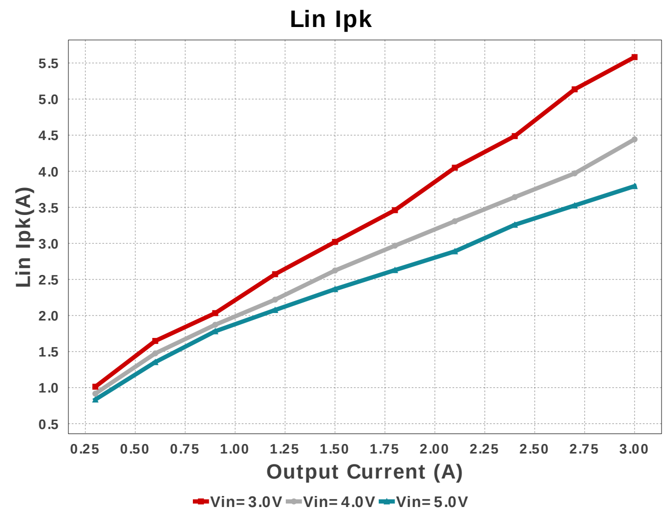


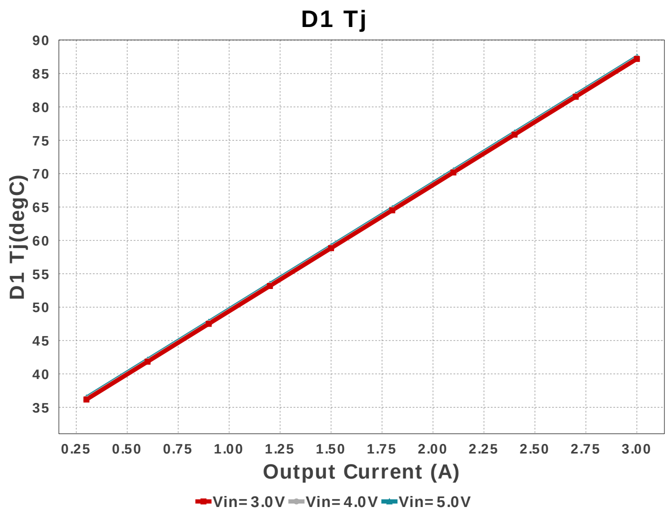

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

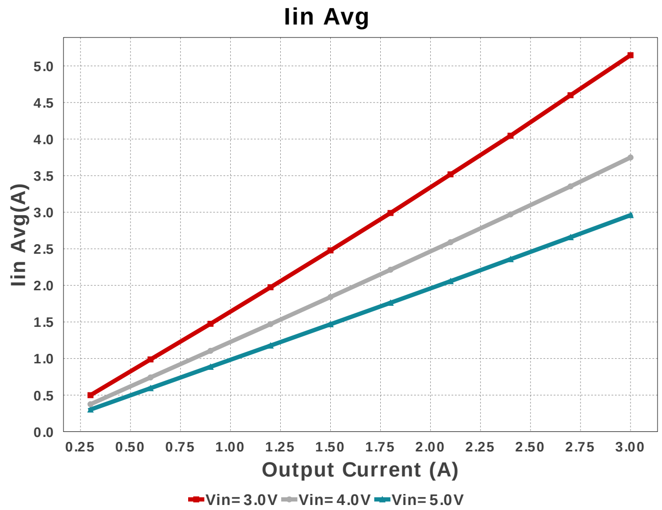

Lout Pd
Lout Pd(W)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

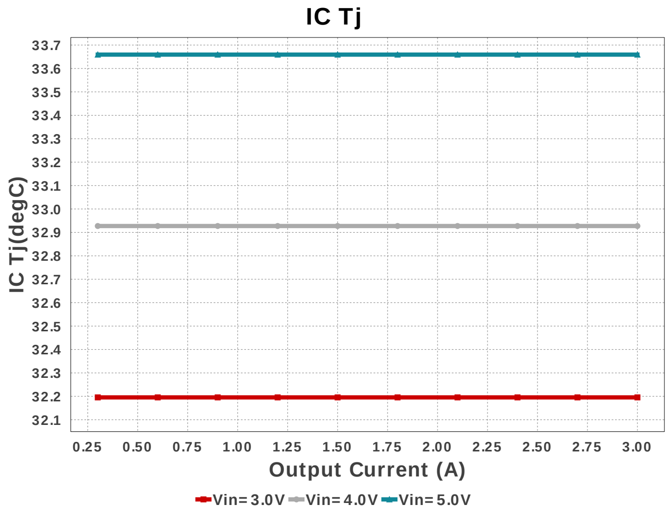

Lin Irms
Lin Irms(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

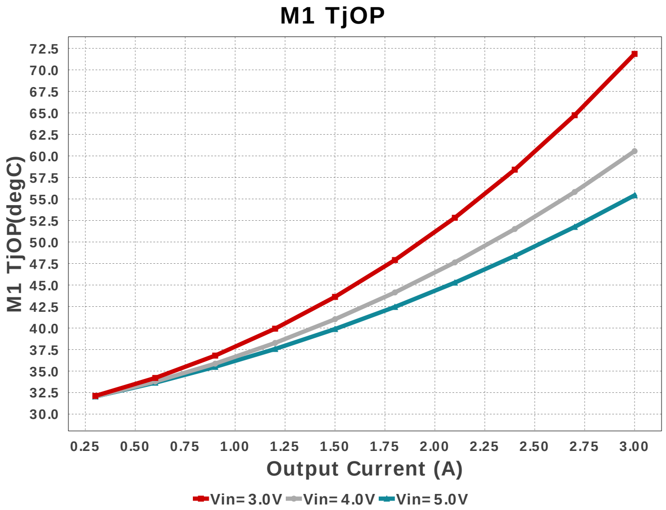

Lin Ipp
Lin Ipp(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

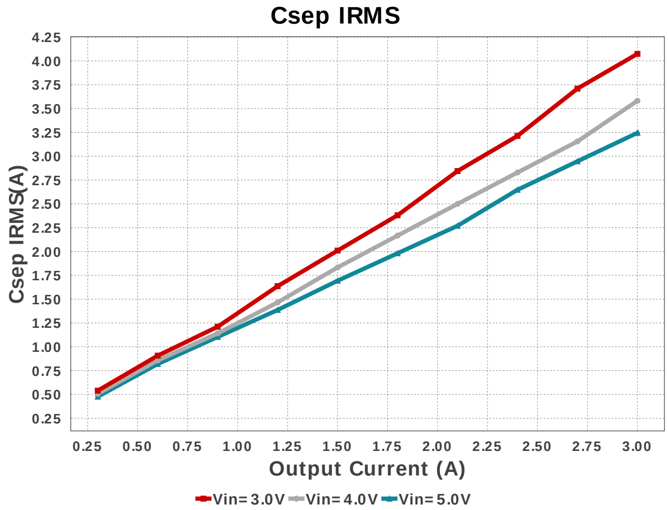

Lin Ipk
Lin Ipk(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

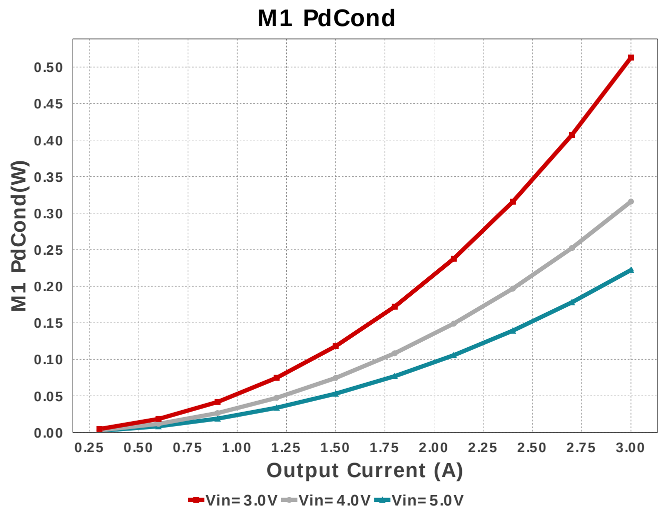

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

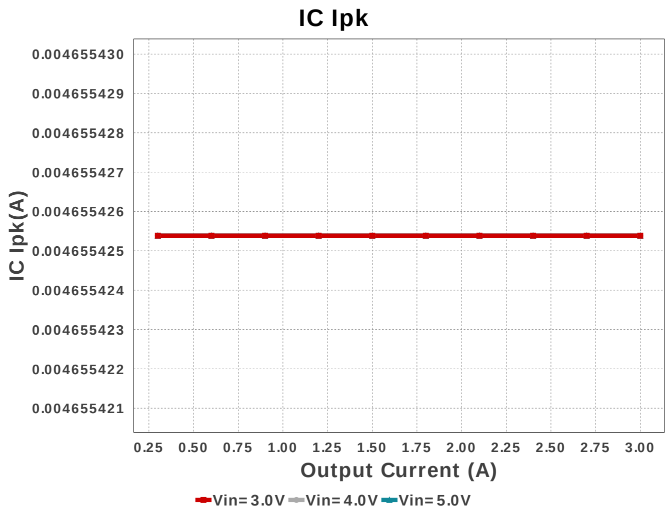

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

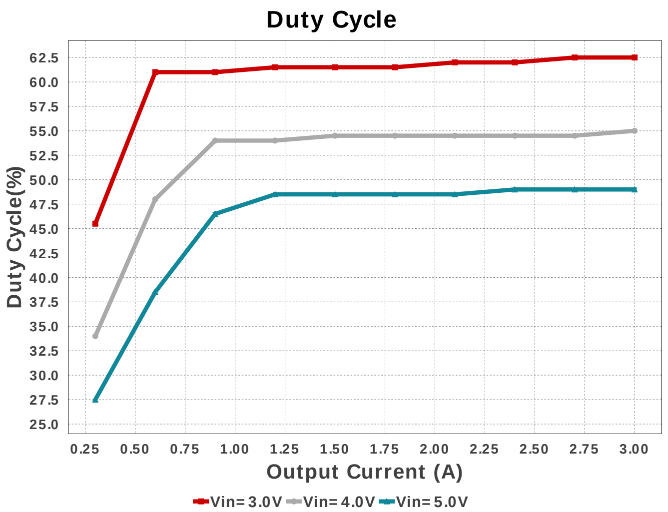

IC Tj
IC Tj(degC)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

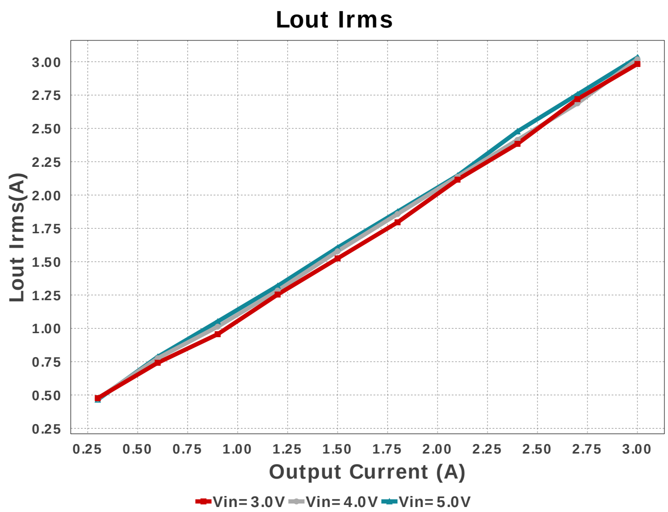

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

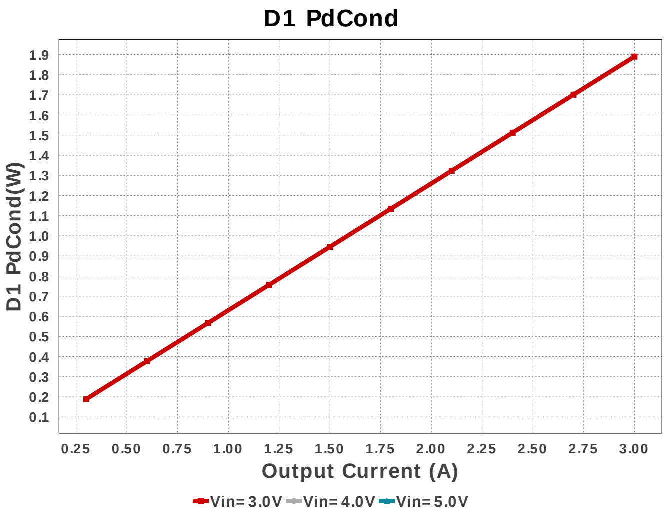

Csep IRMS
Csep IRMS(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

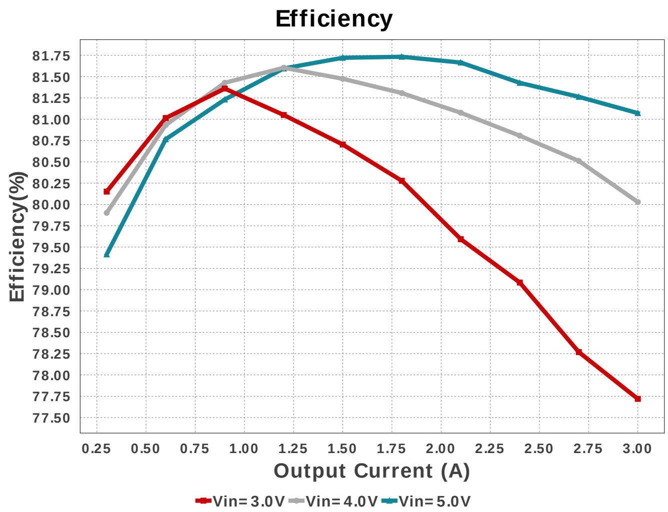

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

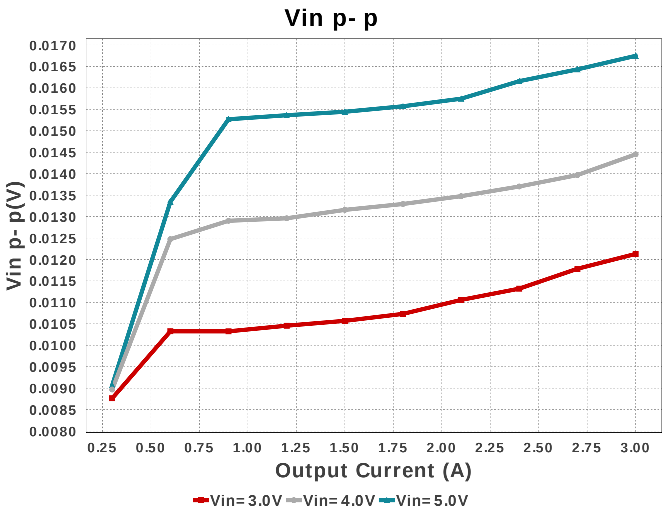

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

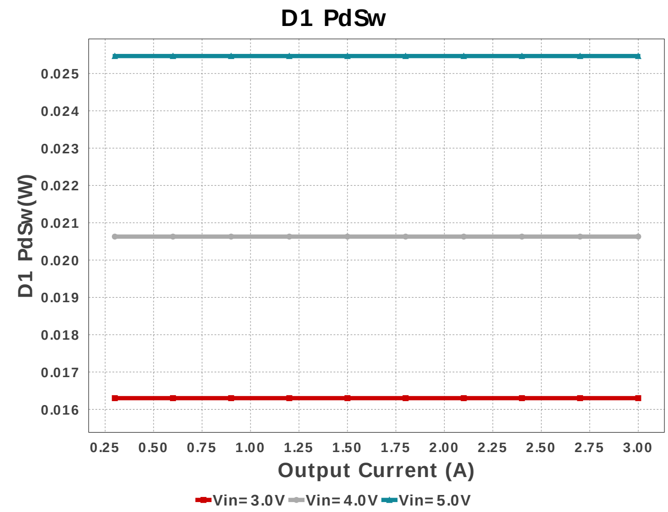

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

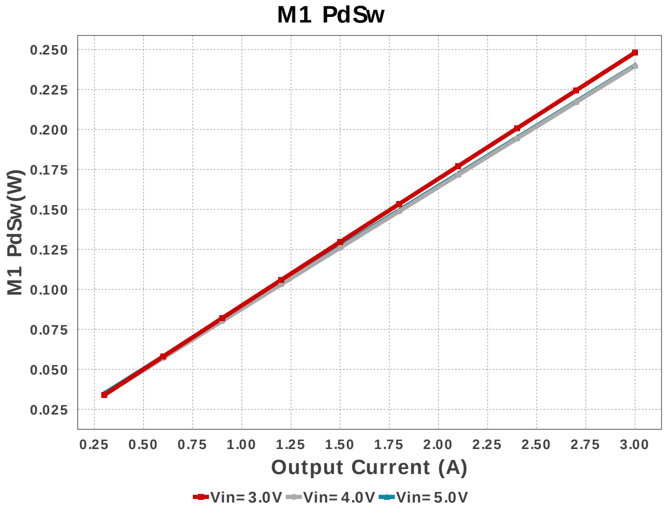

Lout Irms
Lout Irms(A)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

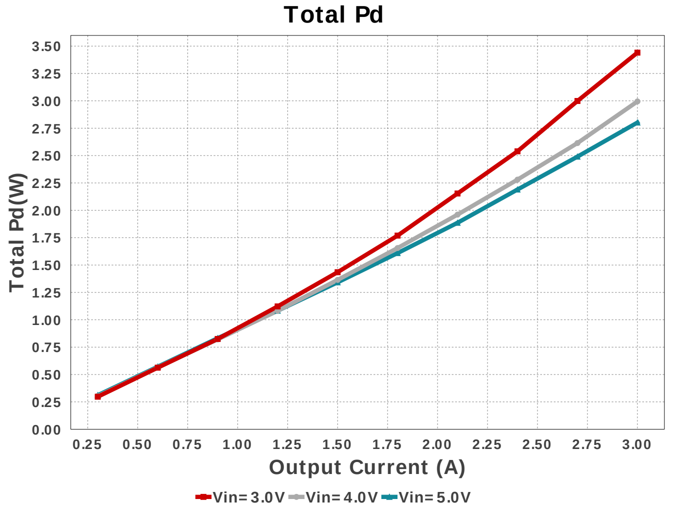

D1 PdCond
D1 PdCond(W)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

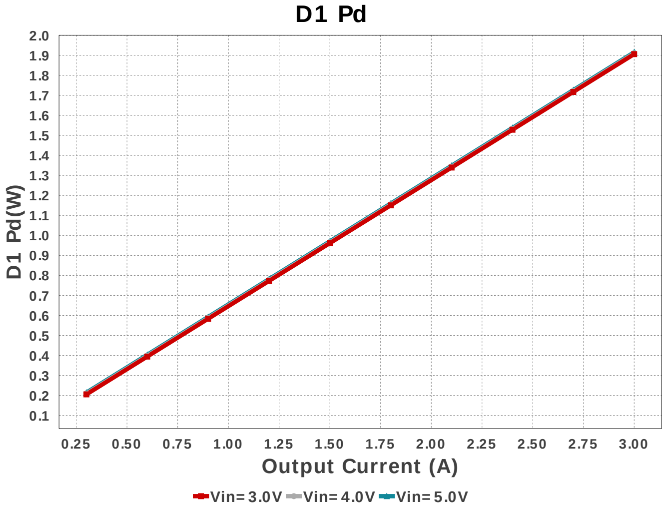

Efficiency
Efficiency(%)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

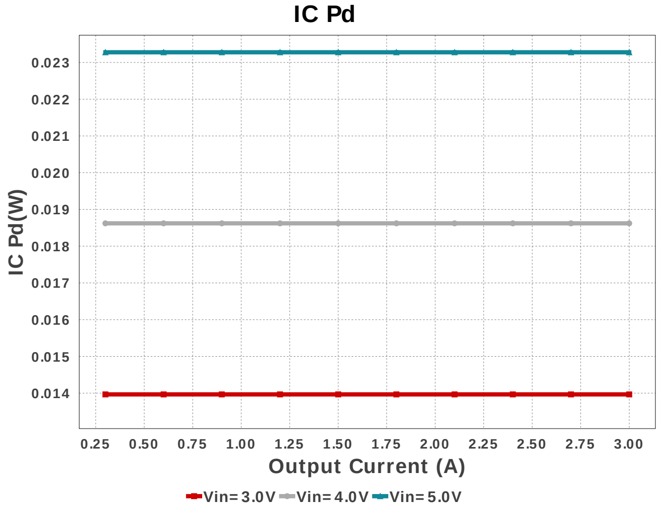

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

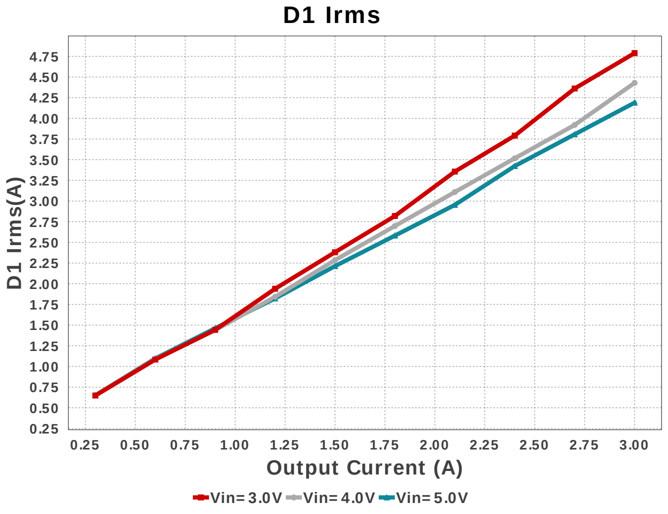

D1 PdSw
D1 PdSw(W)
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

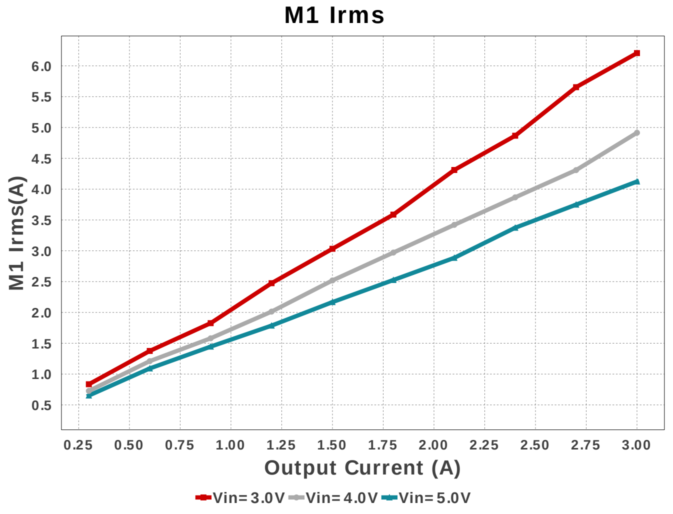

M1 PdSw
M1 PdSw(W)
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

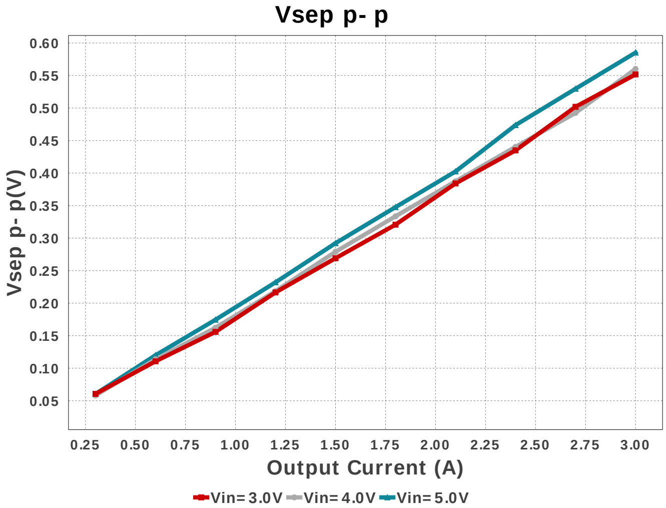

Total Pd
Total Pd(W)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

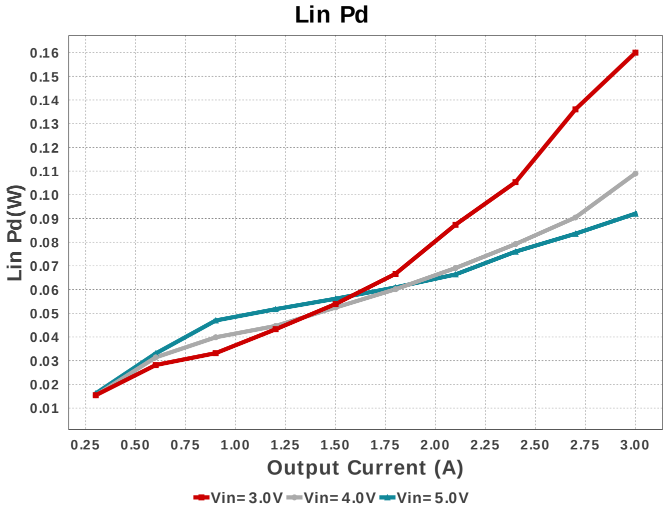

D1 Pd
D1 Pd(W)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

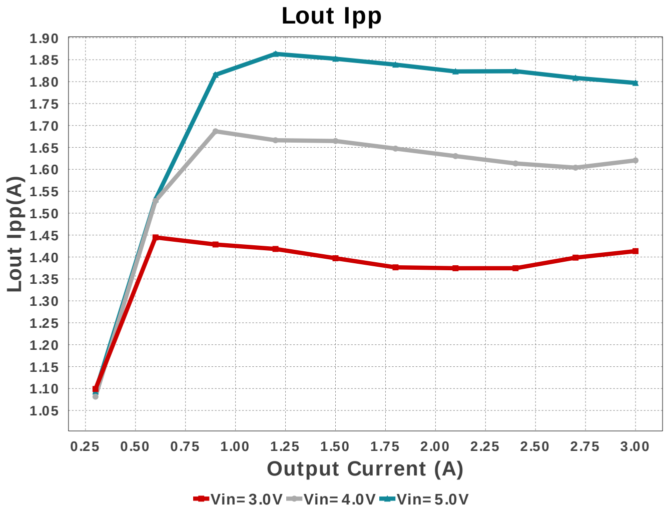

IC Pd
IC Pd(W)
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

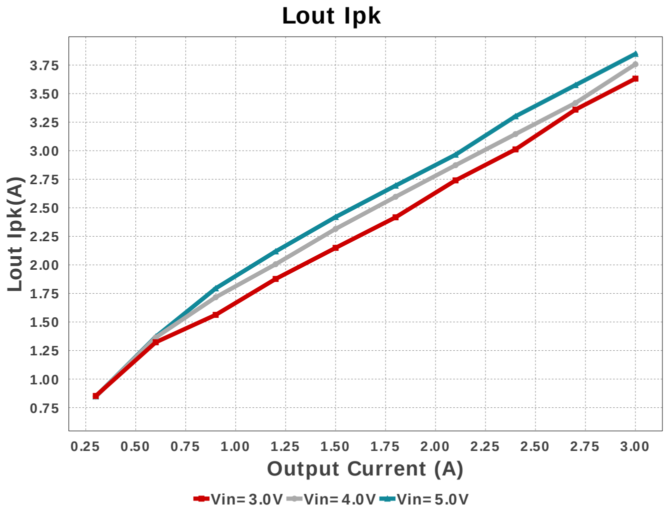

D1 Irms
D1 Irms(A)
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

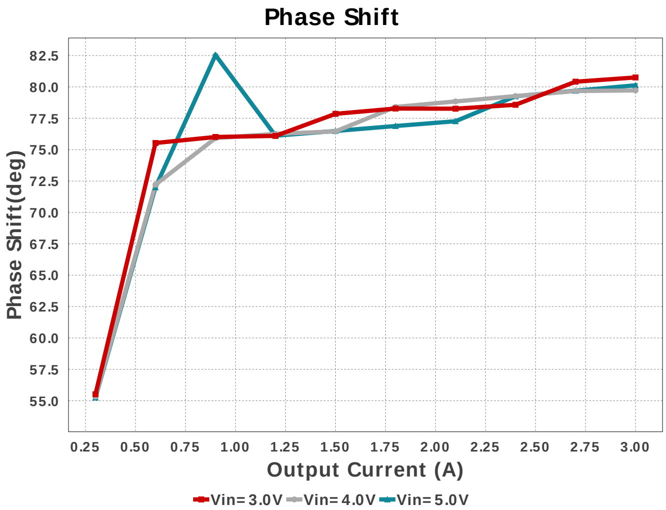

M1 Irms
M1 Irms(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=3.0V Vin=4.0V Vin=5.0V

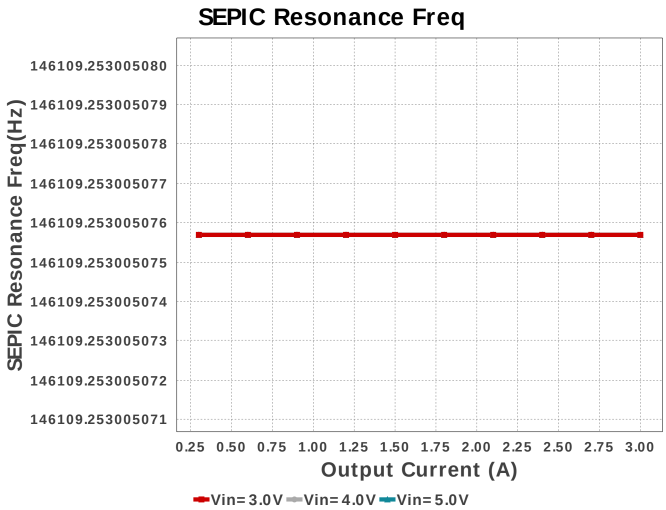

Vsep p- p
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Vsep p- p(V)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V

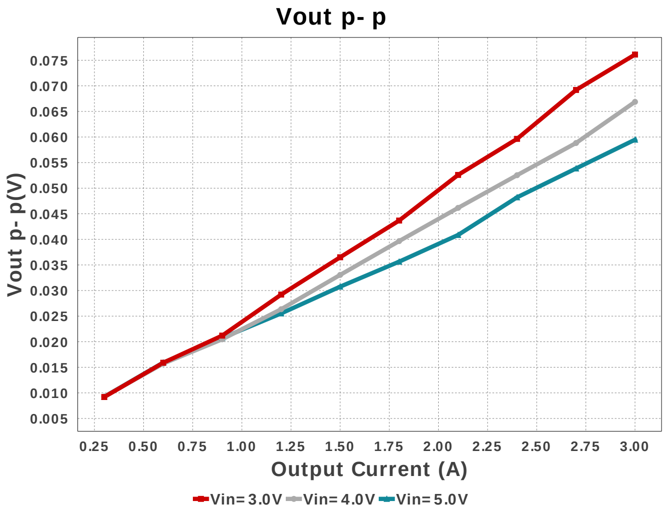

Lin Pd
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
Lin Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V

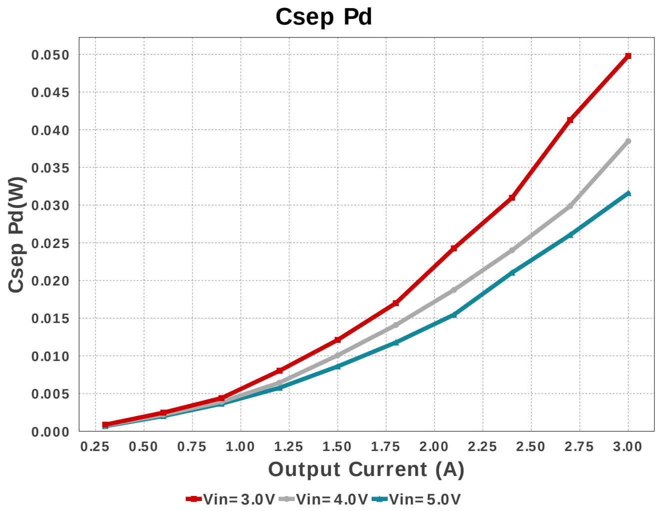

Lout Ipp
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
Lout Ipp(A)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V

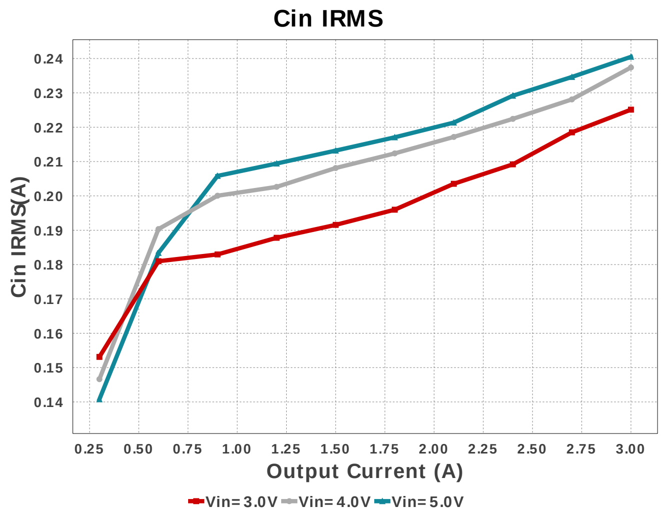

Lout Ipk
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
Lout Ipk(A)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V

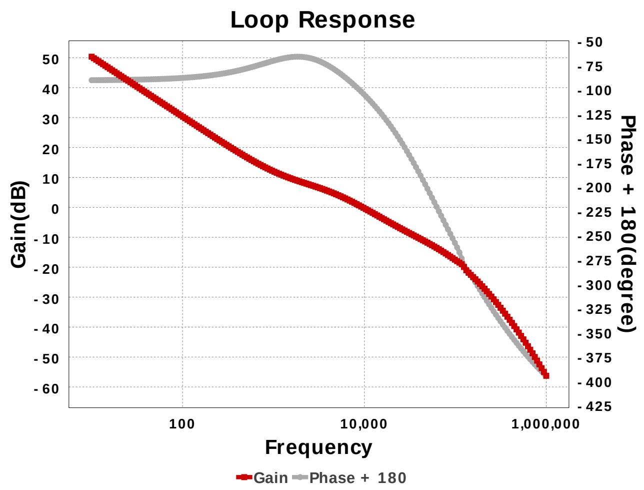

Phase Shift
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
Phase Shift(deg)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V


SEPIC Resonance Freq
146109.253005080
146109.253005079
146109.253005078
146109.253005077
146109.253005076
146109.253005075
146109.253005074
146109.253005073
146109.253005072
146109.253005071
SEPIC Resonance Freq(Hz)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin= 3.0V Vin= 4.0V Vin= 5.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	226.958 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	187.342 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	3.797 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	8.141 mW	Capacitor	Output capacitor power dissipation
5.	Csep IRMS	4.081 A	Capacitor	SEPIC capacitor RMS ripple current
6.	Csep Pd	49.961 mW	Capacitor	SEPIC capacitor power dissipation
7.	D1 Irms	4.79 A	Current	D1 Irms
8.	Lin Ipk	5.592 A	Current	Lin peak current
9.	Lin Irms	4.886 A	Current	Lin ripple current
10.	Lout Ipk	3.641 A	Current	Lout peak current
11.	Lout Irms	2.985 A	Current	Lout ripple current
12.	D1 Pd	1.906 W	Diode	Diode power dissipation
13.	D1 PdCond	1.89 W	Diode	Diode conduction losses
14.	D1 PdSw	16.128 mW	Diode	Diode switching losses
15.	D1 Tj	87.184 degC	Diode	D1 junction temperature
16.	IC Ipk	4.638 mA	IC	Peak switch current in IC
17.	IC Pd	23.19 mW	IC	IC power dissipation
18.	IC Tj	33.645 degC	IC	IC junction temperature
19.	IC Tolerance	24.3 mV	IC	IC Feedback Tolerance
20.	Iin Avg	5.146 A	IC	Average input current
21.	SEPIC Resonance Freq	146.109 kHz	IC	SEPIC Resonance Frequency
22.	Vsep p-p	558.246 mV	IC	Peak-to-peak sepic voltage
23.	Lin Ipp	1.528 A	Inductor	Peak-to-peak input inductor ripple current
24.	Lout Ipp	1.433 A	Inductor	Peak-to-peak output inductor ripple current
25.	M1 Irms	6.208 A	Mosfet	M1 MOSFET Irms
26.	M1 Pd	758.219 mW	Mosfet	M1 MOSFET total power dissipation
27.	M1 PdCond	512.73 mW	Mosfet	M1 MOSFET conduction losses
28.	M1 PdSw	245.489 mW	Mosfet	M1 MOSFET switching losses
29.	M1 TjOP	71.703 degC	Mosfet	M1 MOSFET junction temperature
30.	IOUT_OP	3.0 A	Op Point	Iout operating point
31.	VIN_OP	3.0 V	Op Point	Vin operating point

#	Name	Value	Category	Description
32.	Lin Pd	160.402 mW	Power	Lin power dissipation
33.	Lout Pd	72.166 mW	Power	Lout power dissipation
34.	Total Pd	3.438 W	Power	Total Power Dissipation
35.	Rsense Pd	231.242 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	18	System Information	Total Design BOM count
37.	Cross Freq	9.222 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	62.5 %	System Information	Duty cycle
39.	Efficiency	77.728 %	System Information	Steady state efficiency
40.	FootPrint	547.0 mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	420.0 kHz	System Information	Switching frequency
42.	Gain Marg	10.172 db	System Information	Bode Plot Gain Margin
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	78.513 deg	System Information	Bode Plot Phase Margin
45.	Phase Shift	80.771 deg	System Information	Bode Plot Phase Shift
46.	Total BOM	$5.05	System Information	Total BOM Cost
47.	Vin p-p	12.352 mV	System Information	Peak-to-peak input voltage
48.	Vout p-p	76.878 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	5.0	Maximum input voltage
VinMin	3.0	Minimum input voltage
Vout	4.0	Output Voltage
base_pn	LM3478	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

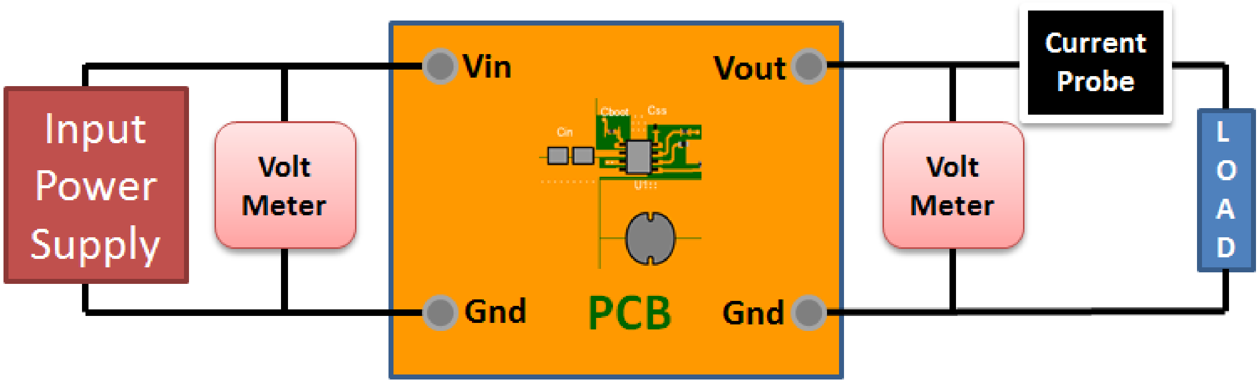
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.0V 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. Master key : 850A79C3C5B3212C[v1]

2. **LM3478** Product Folder : http://www.ti.com/product/LM3478 : contains the data sheet and other resources.