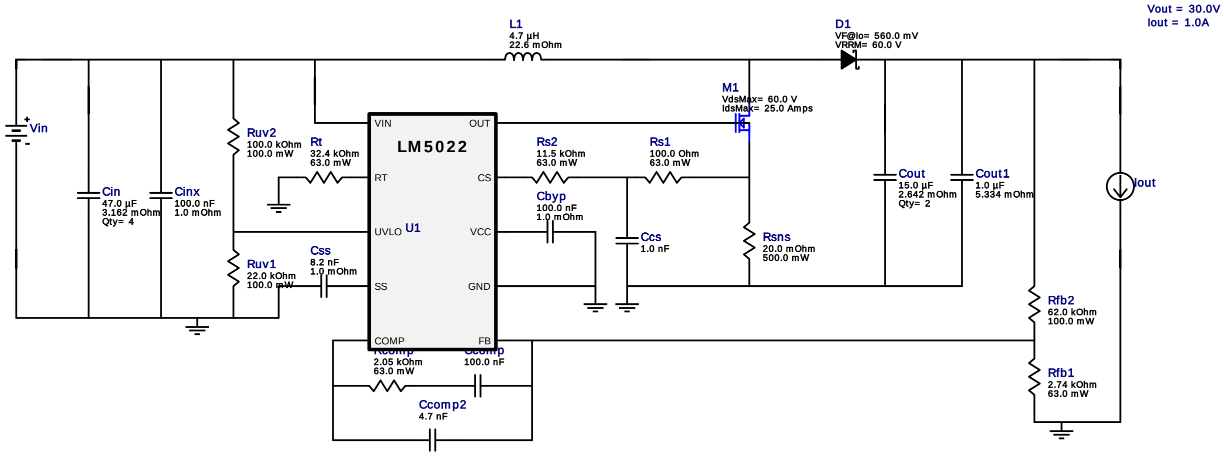
Device = LM5022MM/NOPB
Topology = Boost
Created = 2024-05-06 01:32:12.627
BOM Cost = $9.73
BOM Count = 26
Total Pd = 2.82W

VinMin = 6.8V
VinMax = 8.6V
Vout = 30.0V
Iout = 1.0A

WEBENCH ® Design Report

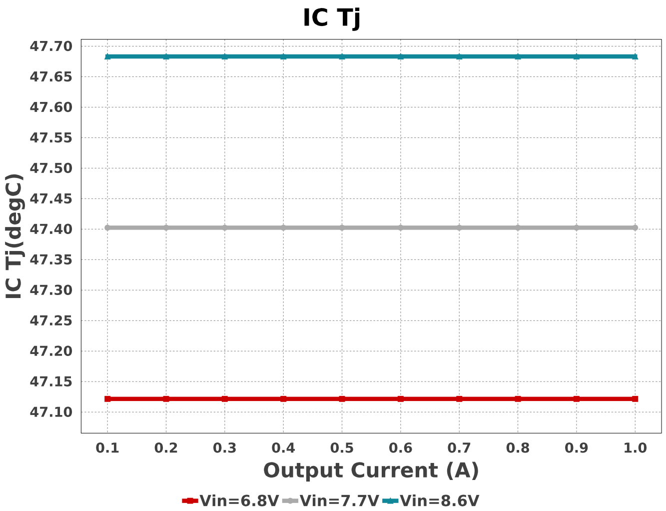
Design : 67 LM5022MM/NOPB
LM5022MM/NOPB 6V-9V to 30.00V @ 1A

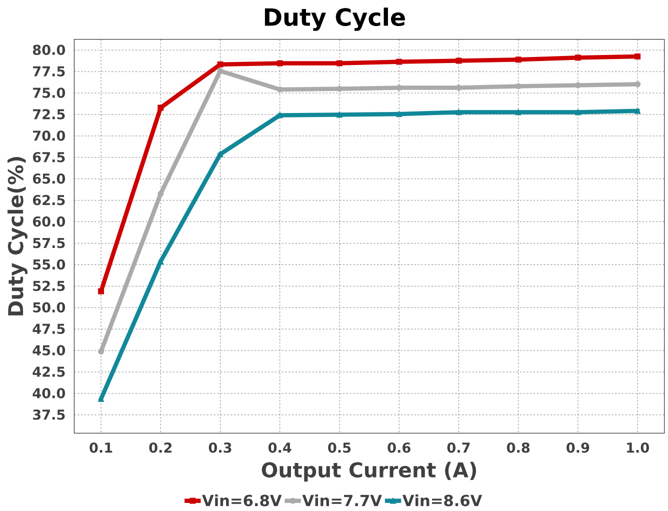


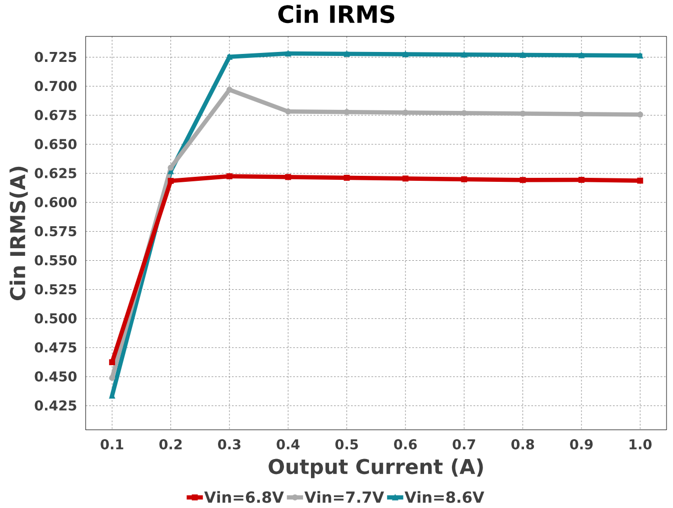
Electrical BOM

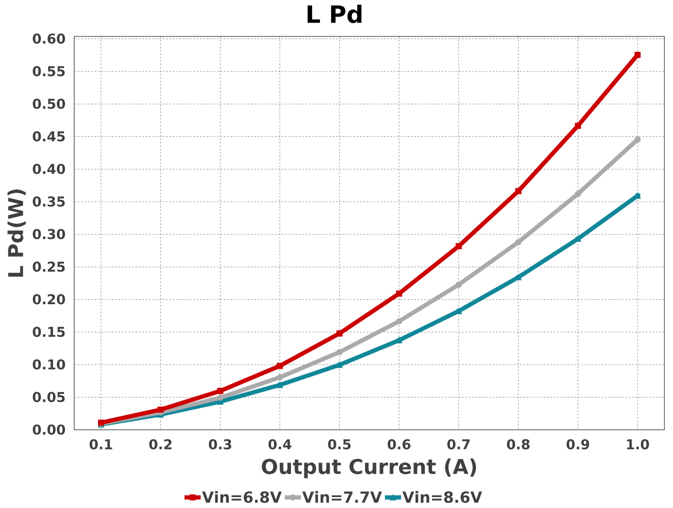
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbyp	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm²
Ccomp2	TDK	CGA4C2C0G1H472J060AA Series= C0G/NP0	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccs	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	CGA9N3X7R1C476M230KB Series= X7R	Cap= 47.0 uF ESR= 3.162 mOhm VDC= 16.0 V IRMS= 5.1344 A	4	$0.67	2220_250 54 mm²
Cinx	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cout	TDK	C5750X7S2A156M250KB Series= X7S	Cap= 15.0 uF ESR= 2.642 mOhm VDC= 100.0 V IRMS= 5.6162 A	2	$1.13	2220_280 54 mm²
Cout1	MuRata	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	$0.11	1206_190 11 mm²
Css	MuRata	GRM155R71E822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
D1	Diodes Inc.	PDS760-13	VF@Io= 560.0 mV VRRM= 60.0 V	1	$0.36	PowerDI5 50 mm²

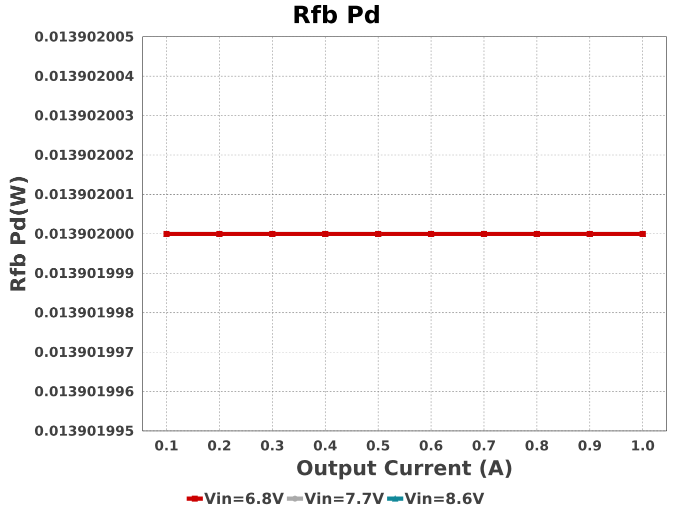
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Vishay-Dale	IHLP3232DZER4R7M11	L= 4.7 µH 22.6 mOhm	1	$0.71	IHLP-3232DZ 112 mm²
M1	ON Semiconductor	NVMFS5C682NLWFAFT3G	VdsMax= 60.0 V IdsMax= 25.0 Amps	1	$0.64	FP-NVMFS5C682NLWFAFT3G_DFN5-MFG 0 mm²
Rcomp	Vishay-Dale	CRCW04022K05FKED Series= CRCW..e3	Res= 2.05 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb1	Vishay-Dale	CRCW04022K74FKED Series= CRCW..e3	Res= 2.74 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb2	Susumu Co Ltd	RG1608P-623-B-T5 Series= RG1608	Res= 62.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rs1	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rs2	Vishay-Dale	CRCW040211K5FKED Series= CRCW..e3	Res= 11.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsns	Stackpole Electronics Inc	CSR1206FK20L0 Series= ?	Res= 20.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	1206 11 mm²
Rt	Vishay-Dale	CRCW040232K4FKED Series= CRCW..e3	Res= 32.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ruv1	Yageo	RC0603FR-0722KL Series= ?	Res= 22.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Ruv2	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	LM5022MM/NOPB	Switcher	1	$2.59	MUB10A 24 mm²

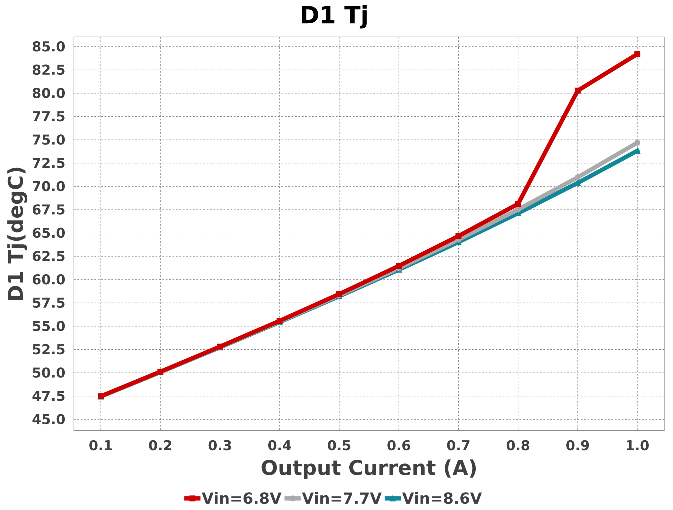


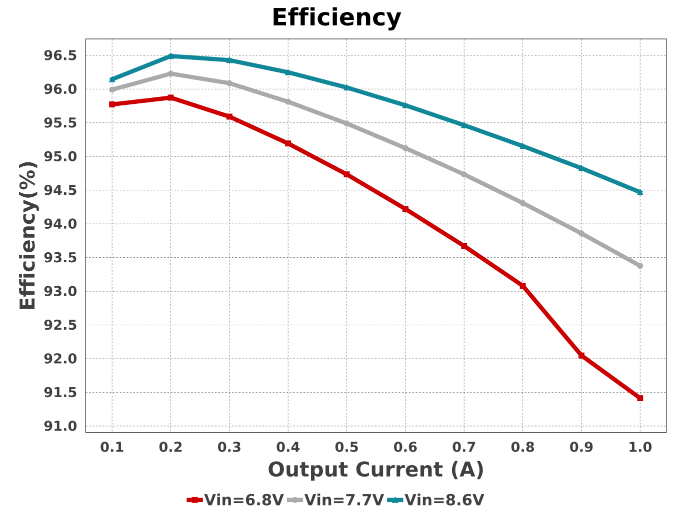


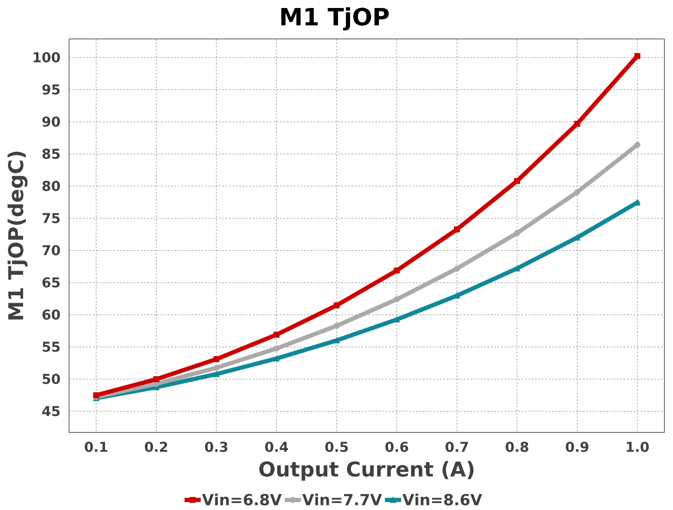

Cin IRMS
Cin IRMS(A)
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.475
0.450
0.425
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

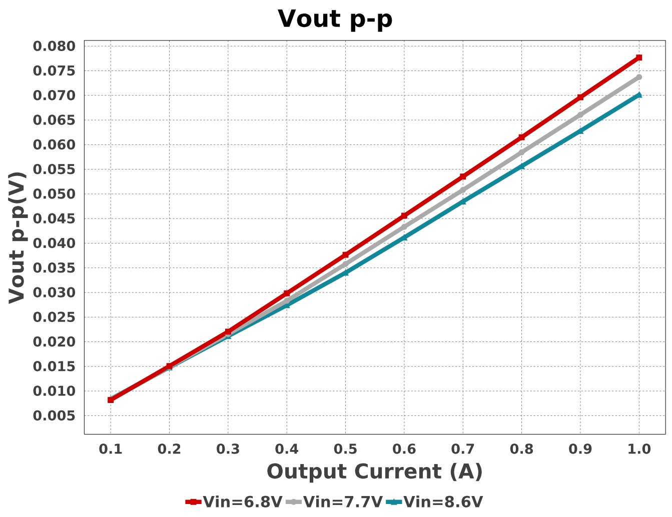

L Pd
L Pd(W)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

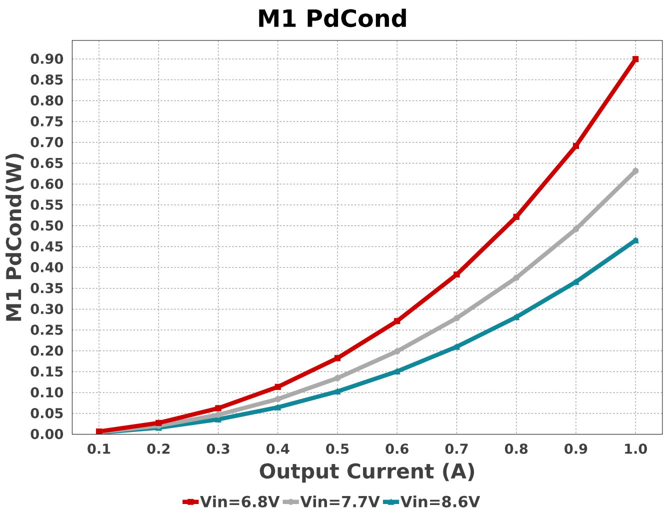

Rfb Pd
Rfb Pd(W)
0.013902005
0.013902004
0.013902003
0.013902002
0.013902001
0.013902000
0.013901999
0.013901998
0.013901997
0.013901996
0.013901995
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

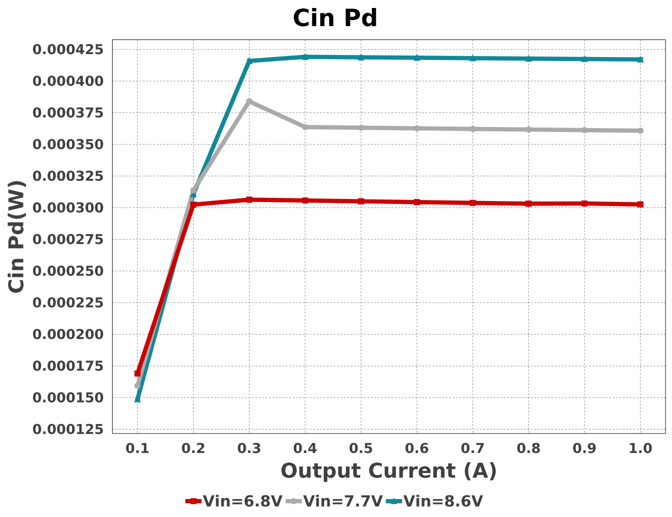

D1 Tj
D1 Tj(degC)
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

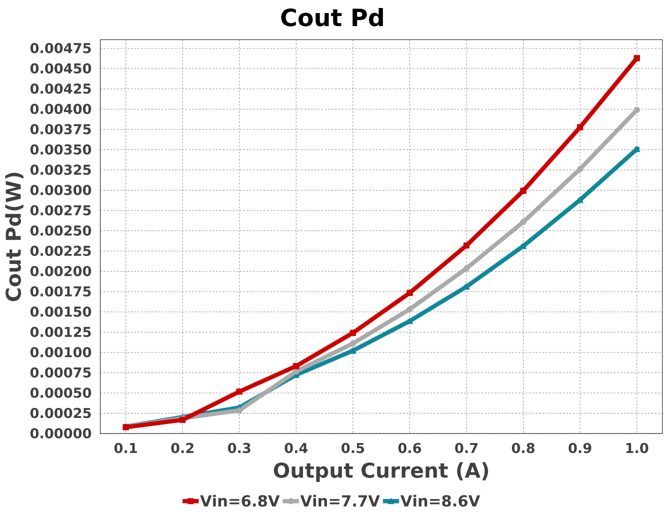

Efficiency
Efficiency(%)
96.5
96.0
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
91.5
91.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

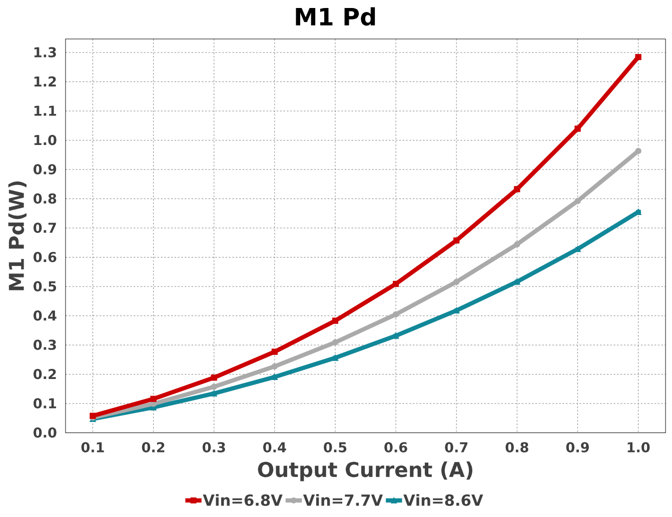

M1 TjOP
M1 TjOP(degC)
100
95
90
85
80
75
70
65
60
55
50
45
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

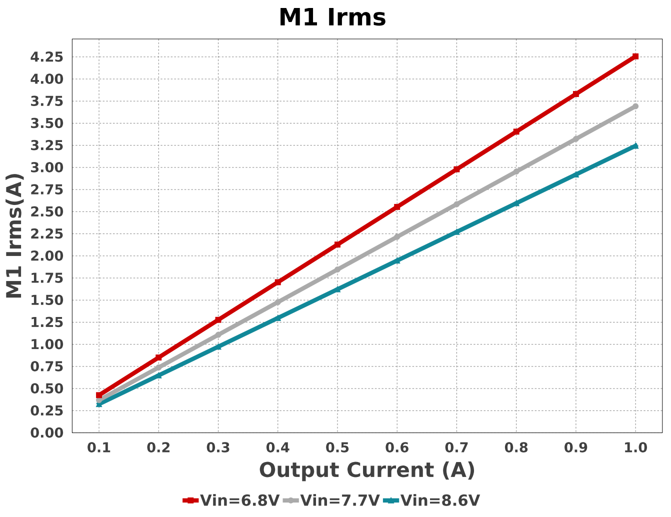

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

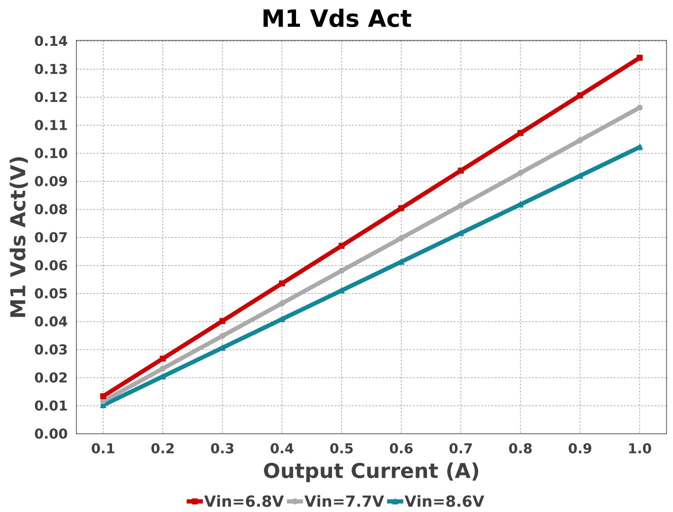

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

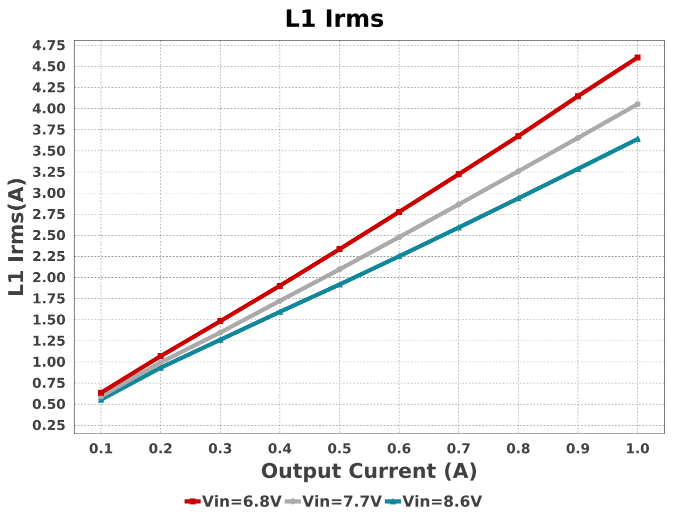

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

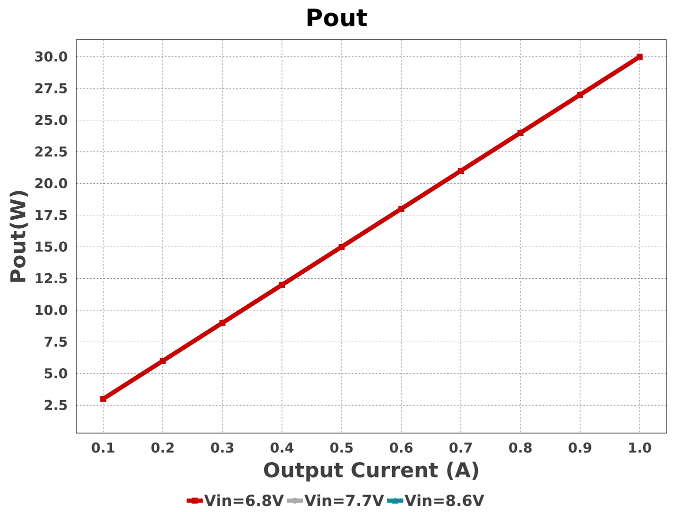

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

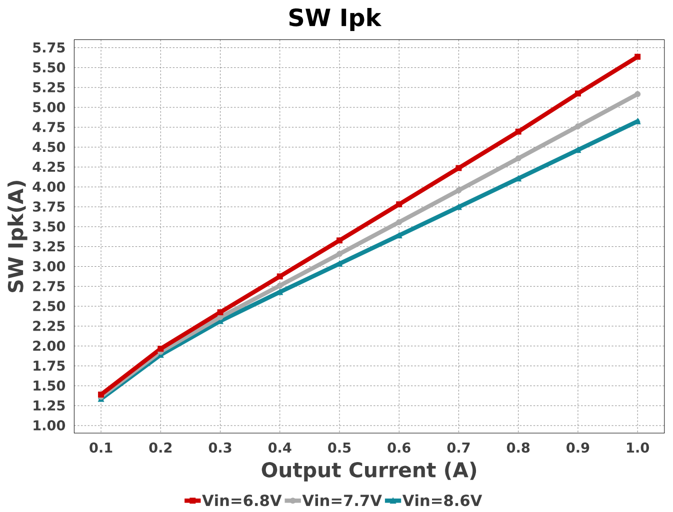

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

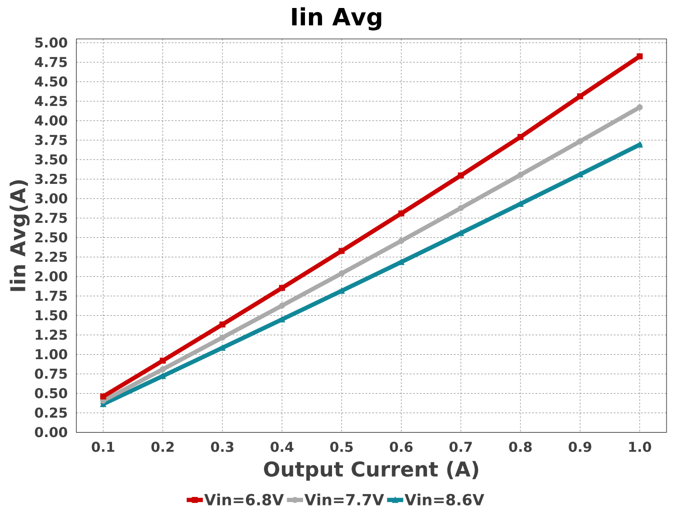

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

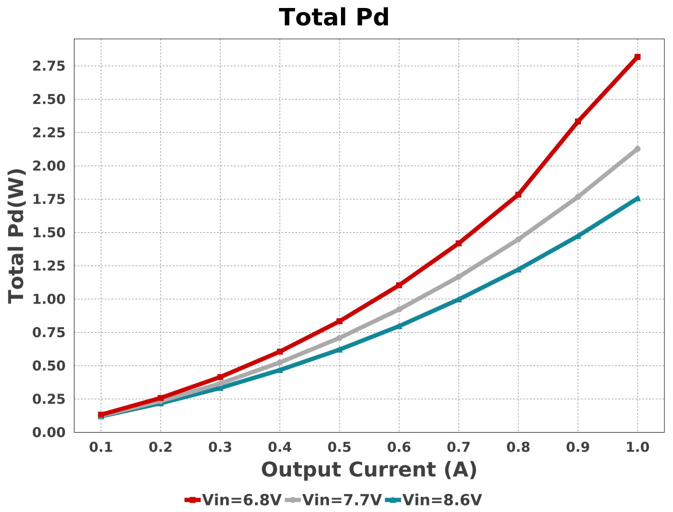

M1 Vds Act
M1 Vds Act(V)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

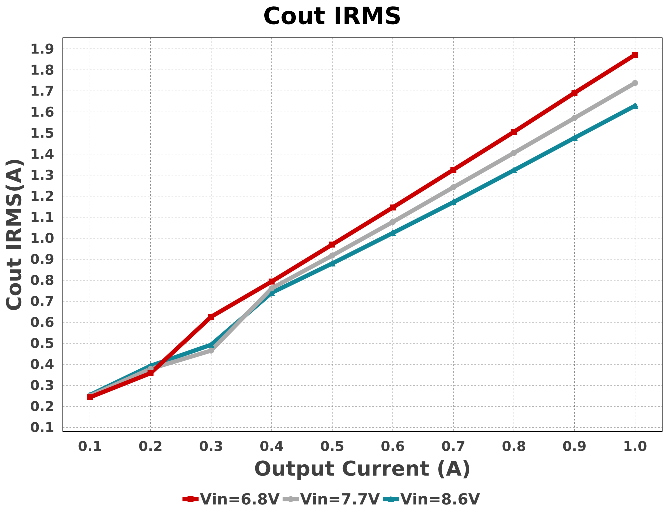

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

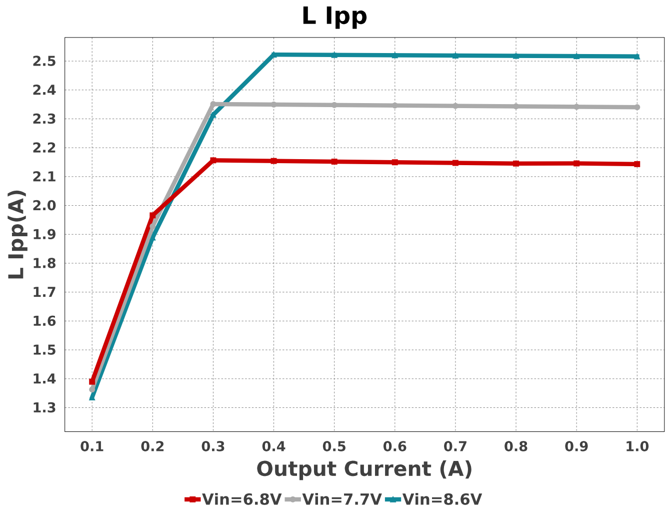

Pout
Pout(W)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

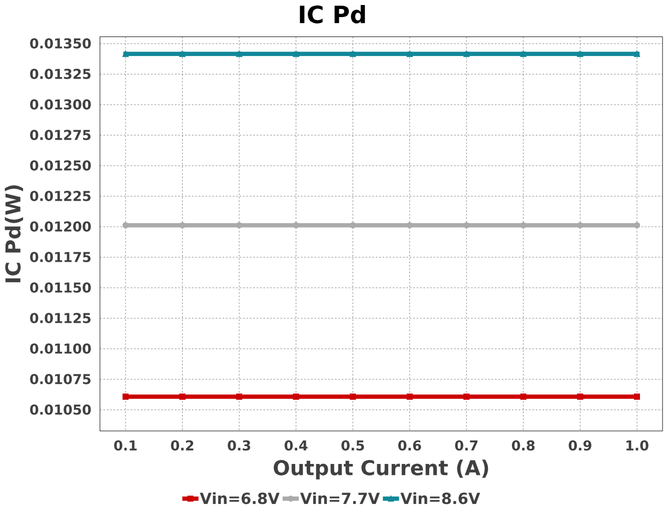

SW Ipk
SW Ipk(A)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

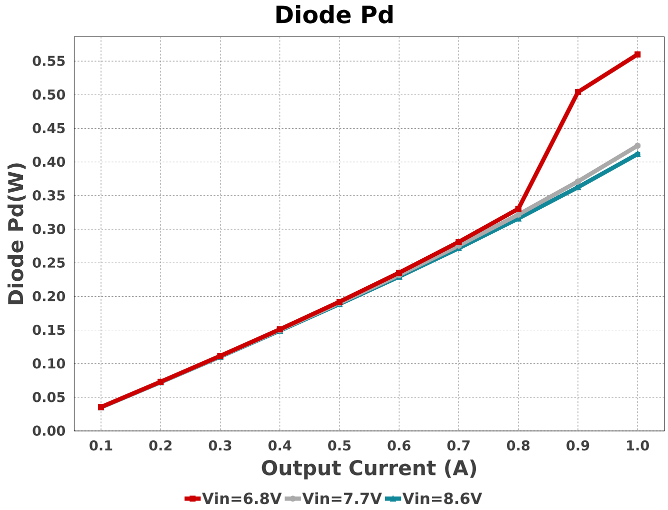

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

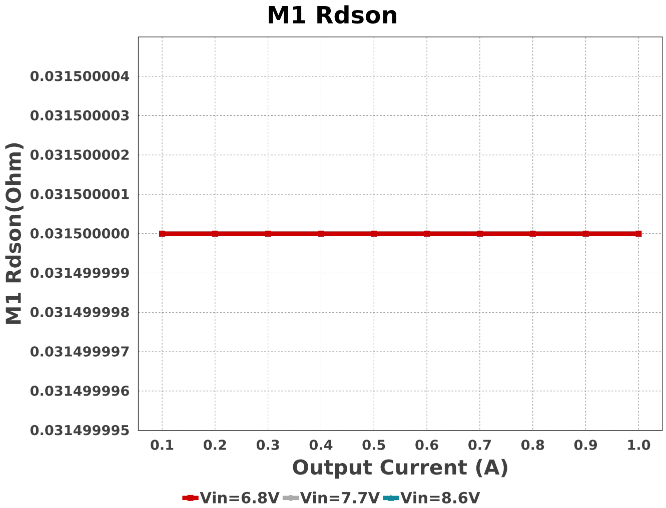

Total Pd
Total Pd(W)
Output Current (A)
Vin=6.8V
Vin=7.7V
Vin=8.6V

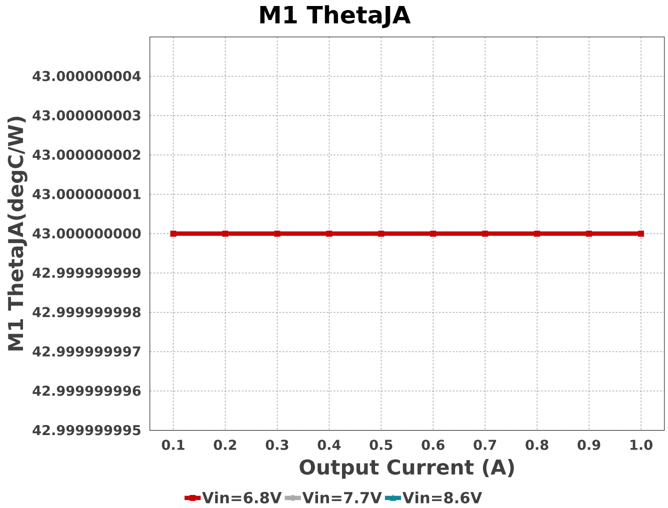

Cout IRMS
Cout IRMS(A)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

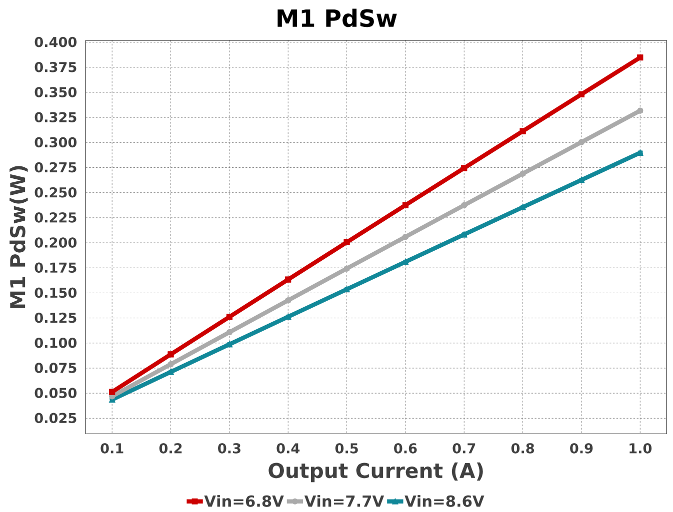

L Ipp
L Ipp(A)
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V

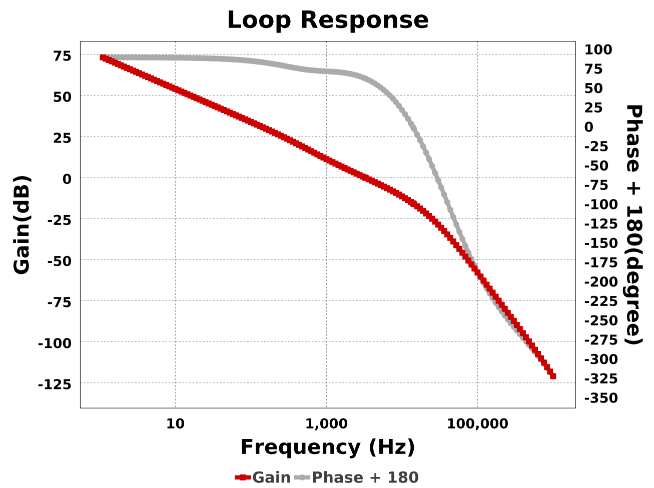

IC Pd
IC Pd(W)
0.01350
0.01325
0.01300
0.01275
0.01250
0.01225
0.01200
0.01175
0.01150
0.01125
0.01100
0.01075
0.01050
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V


Diode Pd
Diode Pd(W)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V


M1 Rdson
M1 Rdson(Ohm)
0.031500004
0.031500003
0.031500002
0.031500001
0.031500000
0.031499999
0.031499998
0.031499997
0.031499996
0.031499995
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V


M1 ThetaJA
M1 ThetaJA(degC/W)
43.000000004
43.000000003
43.000000002
43.000000001
43.000000000
42.999999999
42.999999998
42.999999997
42.999999996
42.999999995
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=6.8V Vin=7.7V Vin=8.6V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	26		Total Design BOM count
2.	Total BOM	$9.734		Total BOM Cost
3.	Cin IRMS	618.719 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	302.61 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	1.872 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	4.629 mW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	84.2 degC	Diode	D1 junction temperature
8.	Diode Pd	560.0 mW	Diode	Diode power dissipation
9.	IC Pd	10.608 mW	IC	IC power dissipation
10.	IC Tj	47.122 degC	IC	IC junction temperature
11.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance
12.	ICThetaJA	200.0 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	4.826 A	IC	Average input current
14.	L Ipp	2.143 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	575.39 mW	Inductor	Inductor power dissipation
16.	L1 Irms	4.606 A	Inductor	Inductor ripple current
17.	M1 Irms	4.256 A	Mosfet	M1 MOSFET Irms
18.	M1 Pd	1.284 W	Mosfet	M1 MOSFET total power dissipation
19.	M1 PdCond	899.65 mW	Mosfet	M1 MOSFET conduction losses
20.	M1 PdSw	384.79 mW	Mosfet	M1 MOSFET switching losses
21.	M1 Rdson	31.5 mOhm	Mosfet	Drain-Source On-resistance
22.	M1 ThetaJA	43.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
23.	M1 TjOP	100.231 degC	Mosfet	M1 MOSFET junction temperature
24.	Cin Pd	302.61 µW	Power	Input capacitor power dissipation
25.	Cout Pd	4.629 mW	Power	Output capacitor power dissipation
26.	Diode Pd	560.0 mW	Power	Diode power dissipation
27.	IC Pd	10.608 mW	Power	IC power dissipation
28.	L Pd	575.39 mW	Power	Inductor power dissipation
29.	M1 Pd	1.284 W	Power	M1 MOSFET total power dissipation
30.	M1 PdCond	899.65 mW	Power	M1 MOSFET conduction losses
31.	M1 PdSw	384.79 mW	Power	M1 MOSFET switching losses
32.	Rfb Pd	13.902 mW	Power	Rfb Power Dissipation
33.	Total Pd	2.818 W	Power	Total Power Dissipation
34.	Rfb Pd	13.902 mW	Resistor	Rfb Power Dissipation
35.	Cross Freq	2.516 kHz	System Information	Bode plot crossover frequency
36.	Duty Cycle	79.261 %	System Information	Duty cycle
37.	Efficiency	91.414 %	System Information	Steady state efficiency
38.	FootPrint	585.0 mm^2	System Information	Total Foot Print Area of BOM components
39.	Frequency	518.995 kHz	System Information	Switching frequency
40.	Gain Marg	-16.845 dB	System Information	Bode Plot Gain Margin
41.	Iout	1.0 A	System Information	Iout operating point
42.	Low Freq Gain	70.827 dB	System Information	Gain at 1Hz
43.	Mode	CCM	System Information	Conduction Mode

#	Name	Value	Category	Description
44.	Phase Marg	65.776 deg	System Information	Bode Plot Phase Margin
45.	Pout	30.0 W	System Information	Total output power
46.	SW Ipk	5.636 A	System Information	Peak switch current
47.	Vin	6.8 V	System Information	Vin operating point
48.	Vout	30.0 V	System Information	Operational Output Voltage
49.	Vout Actual	29.771 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	3.069 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	77.677 mV	System Information	Peak-to-peak output ripple voltage
52.	M1 Vds Act	134.063 mV		M Vds

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	8.6	Maximum input voltage
VinMin	6.8	Minimum input voltage
Vout	30.0	Output Voltage
base_pn	LM5022	Base Product Number
source	DC	Input Source Type
Ta	45.0	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

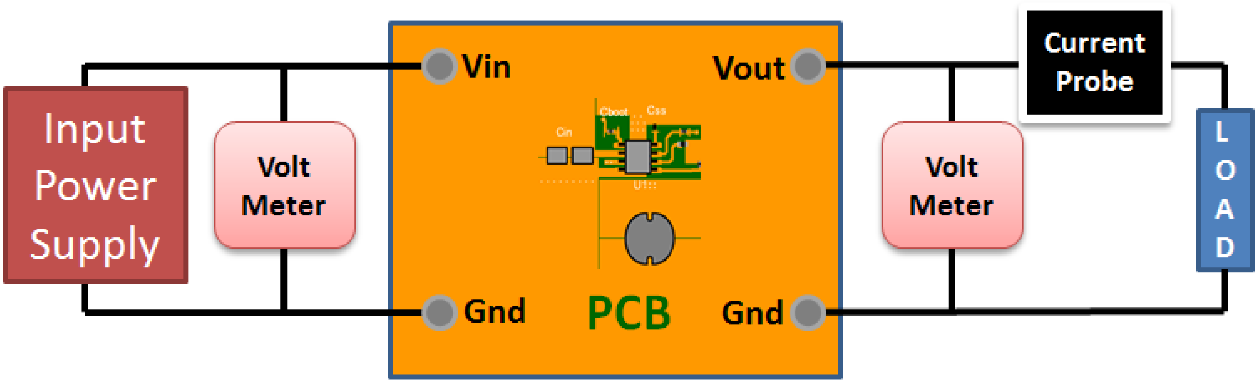
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.8V 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.

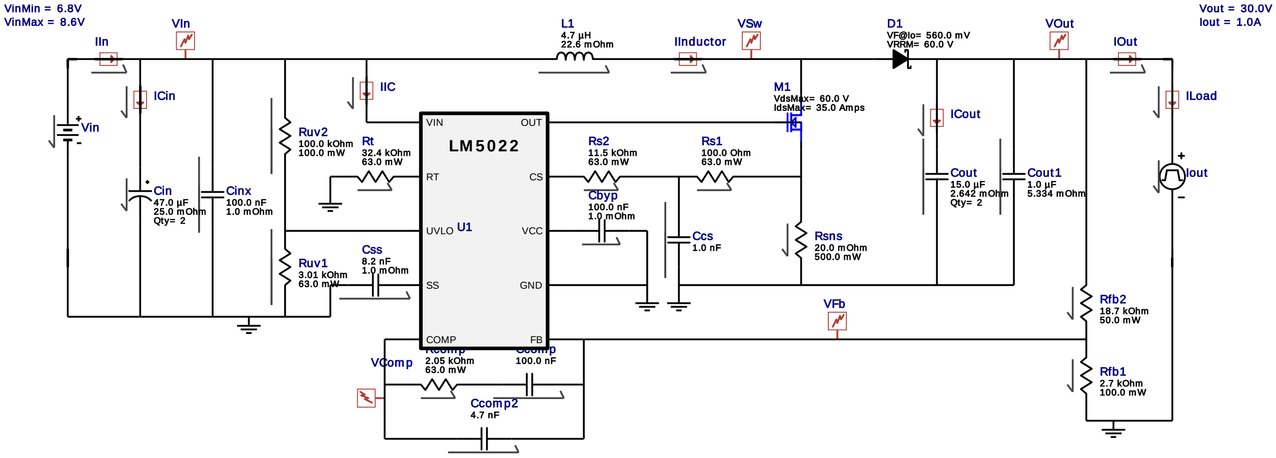


WEBENCH® Electrical Simulation Report

Design Id = 67

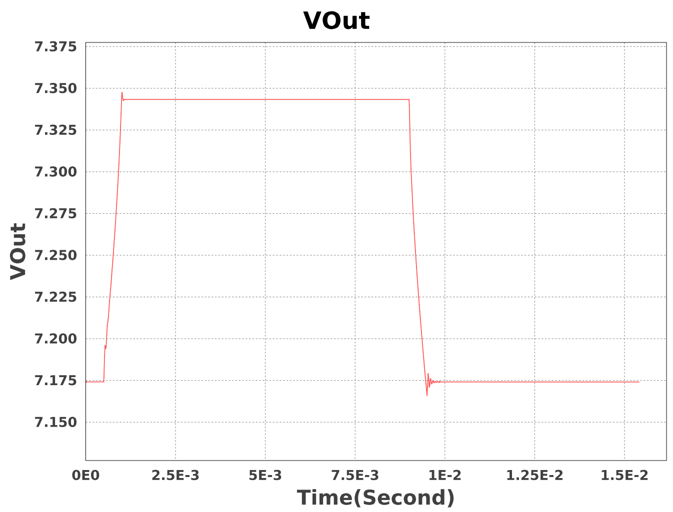
sim_id = 11

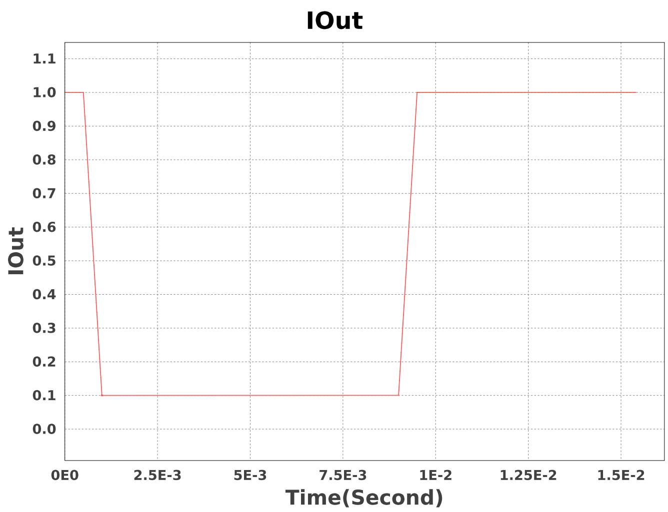
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Current	1.0 A
		I2	Peak Current	0.1 A
		Td	Initial Delay Time	0.5m Sec
		Tr	Rise Time	500u Sec
		Tf	Fall Time	500u Sec
		Pw	Pulse Width	8m





Design Assistance

1. Master key : F3797F68311A7FDDFEF6AEAC6E9C81D8[v1]

2. **LM5022** Product Folder : http://www.ti.com/product/LM5022 : contains the data sheet and other resources.

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