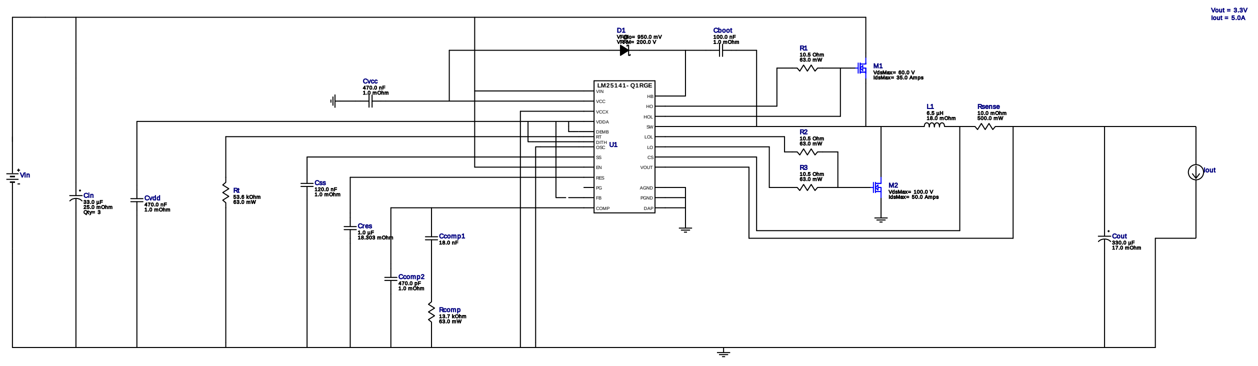
VinMin = 4.0V
VinMax = 40.0V
Vout = 3.3V
Iout = 5.0A

Device = LM25141QRGERQ1
Topology = Buck
Created = 2018-09-19 05:30:04.261
BOM Cost = $8.35
BOM Count = 22
Total Pd = 1.92W

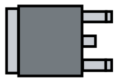
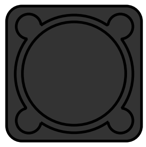
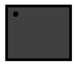
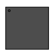
WEBENCH ® Design Report

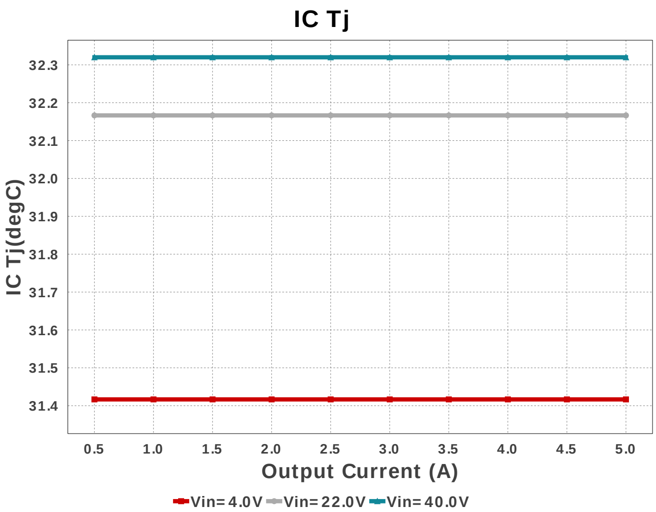
Design : 239 LM25141QRGERQ1
LM25141QRGERQ1 4.0V-40.0V to 3.30V @ 5.0A

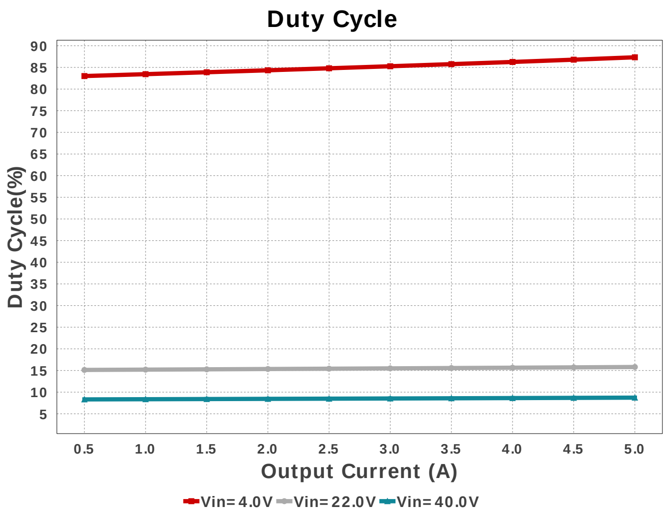


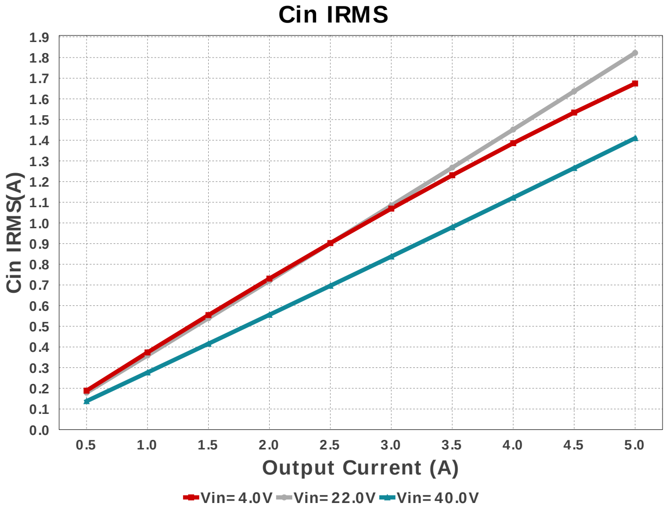
Electrical BOM

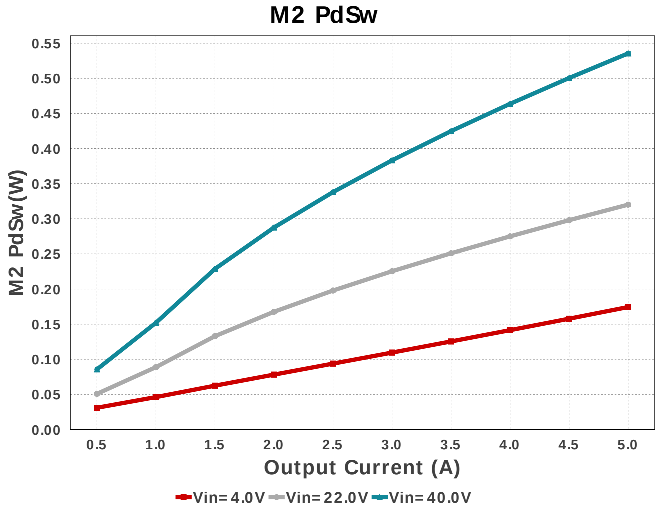
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R60J104KA01D Series= X5R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp1	Kemet	C1812C183J5GACTU Series= C0G/NP0	Cap= 18.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.78	1812 23 mm²
Ccomp2	MuRata	GRM216R71E471KA01D Series= X7R	Cap= 470.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cin	Panasonic	63SXV33M Series= SXV	Cap= 33.0 uF ESR= 25.0 mOhm VDC= 63.0 V IRMS= 2.95 A	3	$1.24	CAPSMT_62_E12 106 mm²
Cout	Panasonic	6SVPC330M Series= SVPC	Cap= 330.0 uF ESR= 17.0 mOhm VDC= 6.3 V IRMS= 3.39 A	1	$0.35	SM_RADIAL_6.3AMM 80 mm²
Cres	MuRata	GRM185D71A105KE36D Series= X7T	Cap= 1.0 uF ESR= 18.303 mOhm VDC= 10.0 V IRMS= 848.11 mA	1	$0.01	0603 5 mm²
Css	MuRata	GRM188R71A124KA01D Series= X7R	Cap= 120.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm²
Cvcc	Taiyo Yuden	EMK212B7474KD-T Series= X7R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cvdd	Taiyo Yuden	EMK212B7474KD-T Series= X7R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²

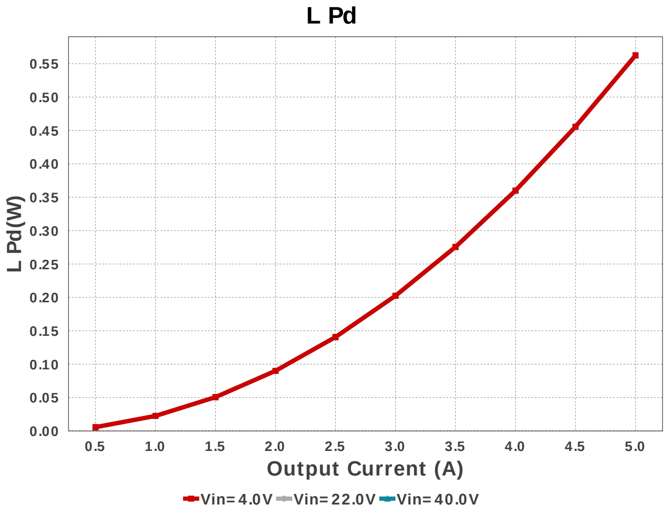
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
L1	Bourns	SRR1208-6R5ML	L= 6.5 µH DCR= 18.0 mOhm	1	$0.43	 SRR1208 216 mm^2
M1	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V IdsMax= 35.0 Amps	1	$0.27	 DNH0008A 18 mm^2
M2	Texas Instruments	CSD19534Q5A	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.34	 TRANS_NexFET_Q5A 55 mm^2
R1	Vishay-Dale	CRCW040210R5FKED Series= CRCW..e3	Res= 10.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
R2	Vishay-Dale	CRCW040210R5FKED Series= CRCW..e3	Res= 10.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
R3	Vishay-Dale	CRCW040210R5FKED Series= CRCW..e3	Res= 10.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsense	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	 1206 11 mm^2
Rt	Vishay-Dale	CRCW040253K6FKED Series= CRCW..e3	Res= 53.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM25141QRGERQ1	Switcher	1	$2.07	 RGE0024J 25 mm^2

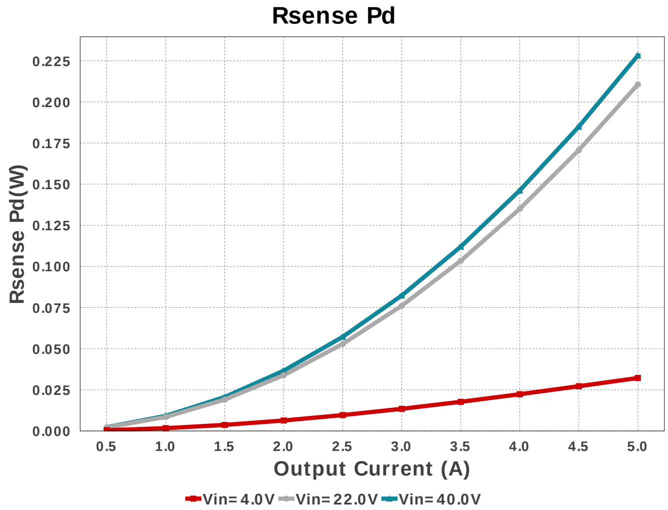


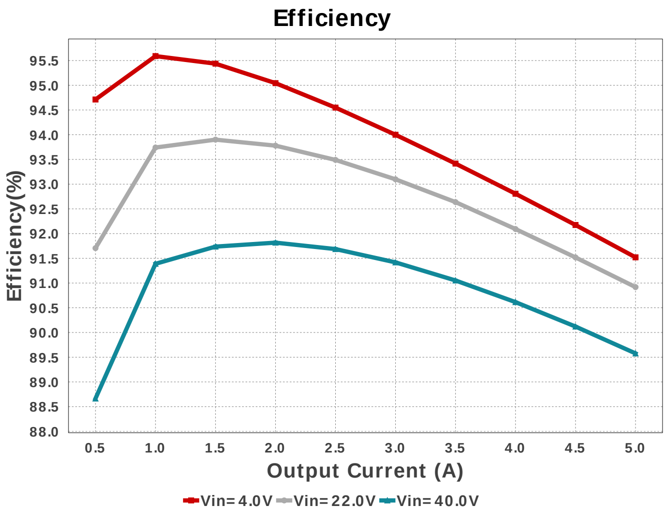


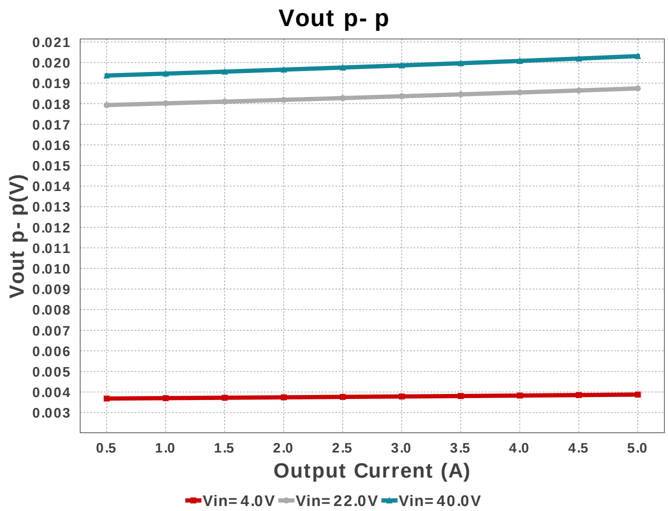

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

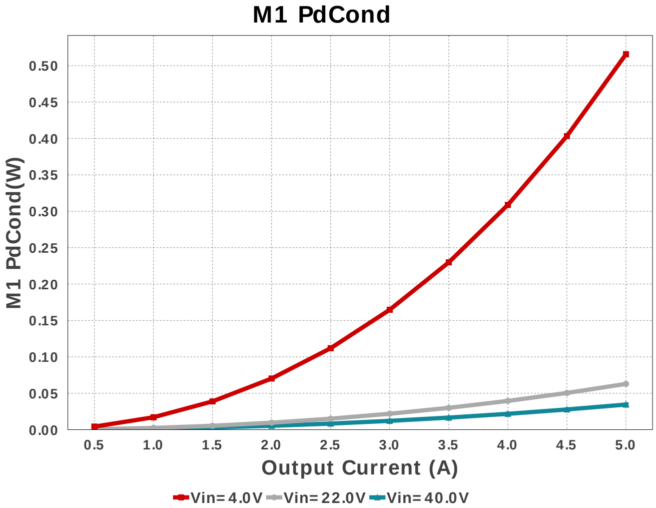

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

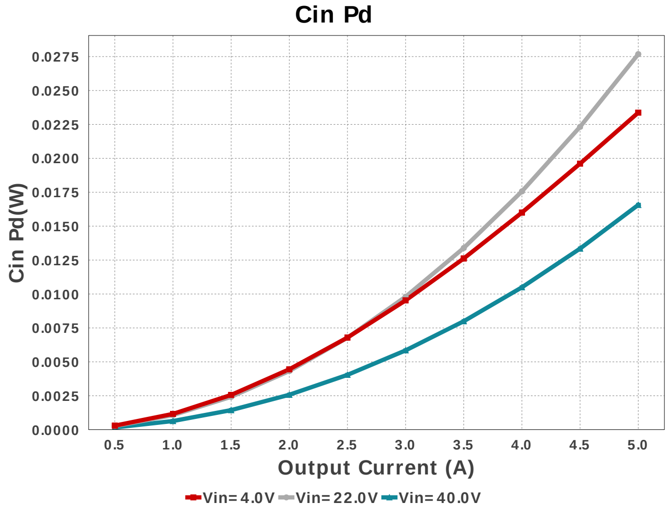

L Pd
L Pd(W)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

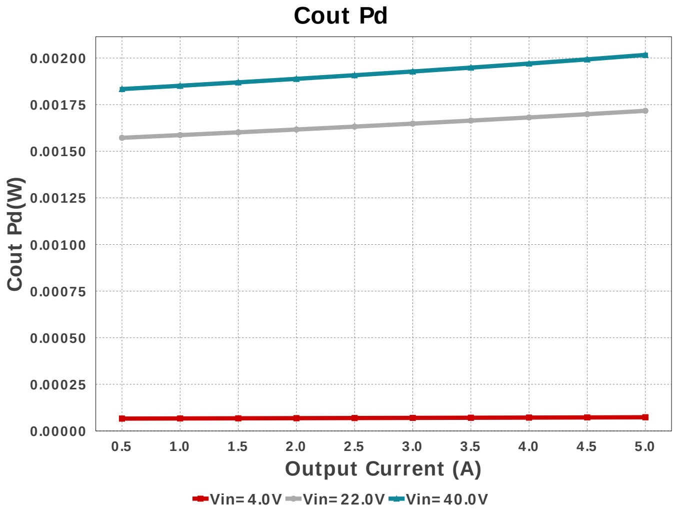

Rsense Pd
Rsense Pd(W)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

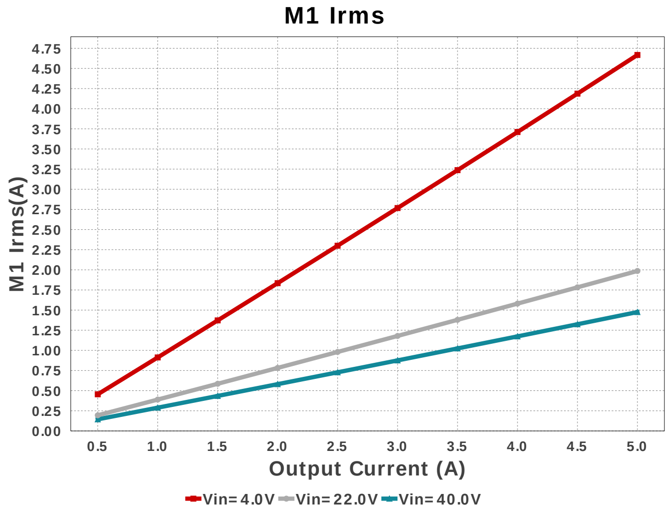

Efficiency
Efficiency(%)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

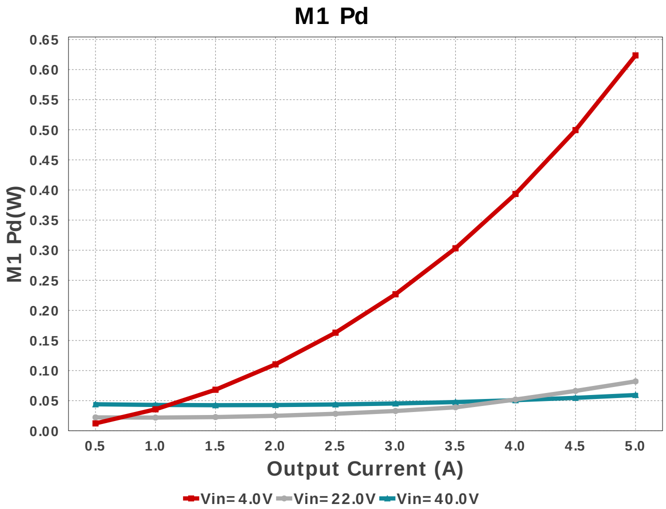

Vout p- p
Vout p- p(V)
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

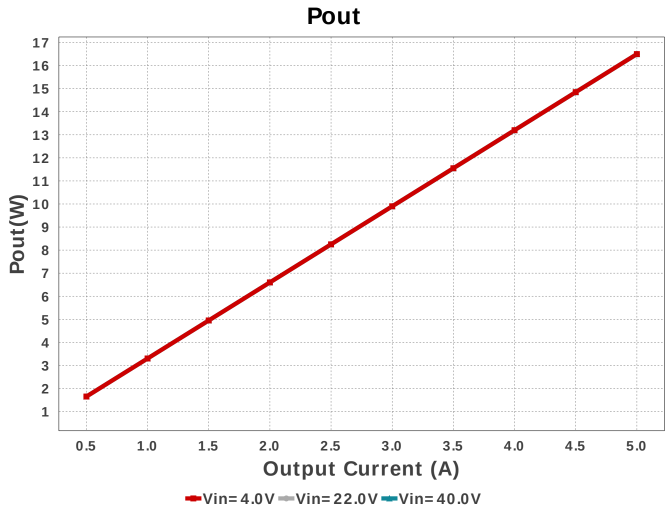

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V


Cin Pd
Cin Pd(W)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V

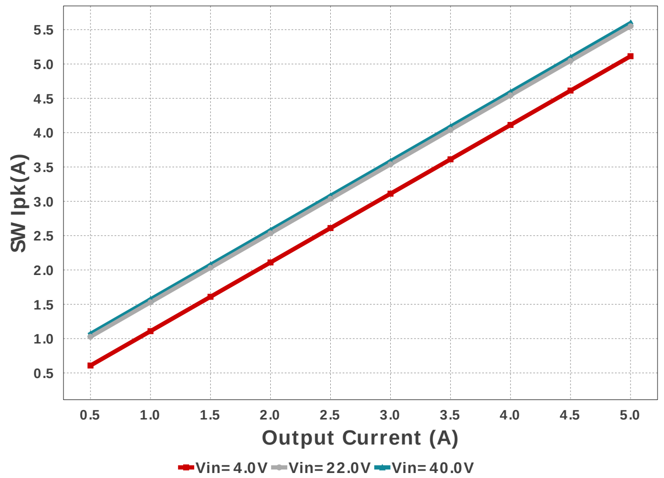

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V


M1 Irms
M1 Irms(A)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V

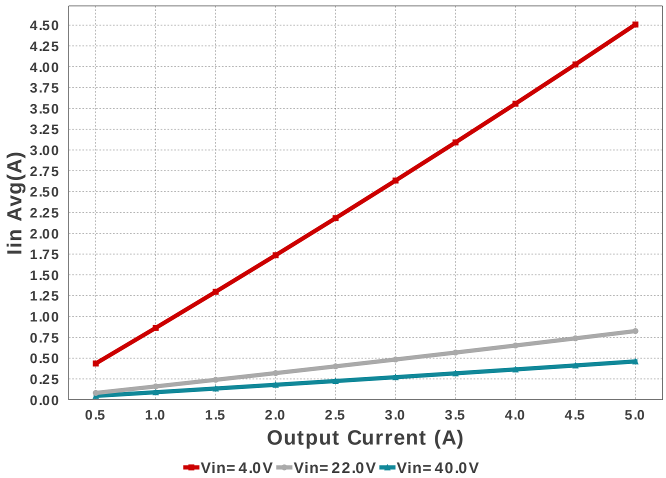

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V


Pout
Pout(W)
Output Current (A)
Vin=4.0V Vin=22.0V Vin=40.0V

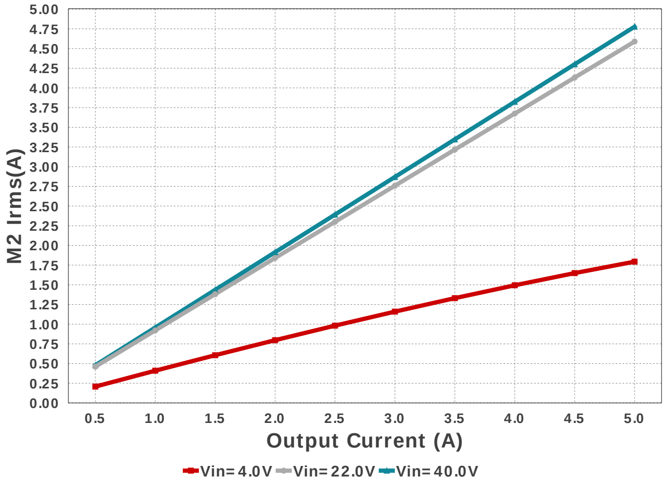
SW Ipk



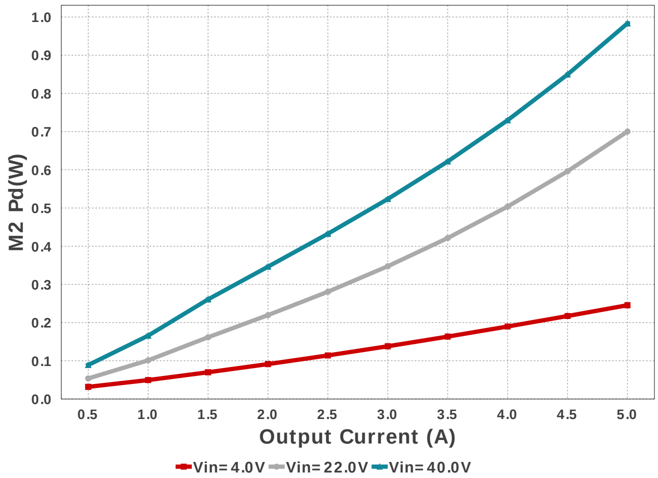
Iin Avg



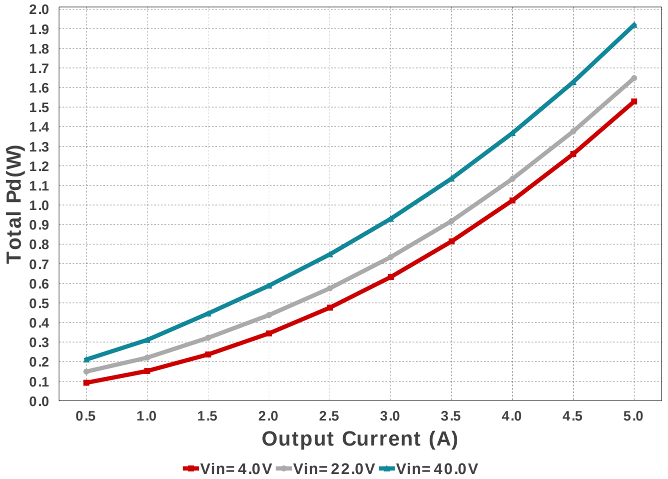
M2 Irms



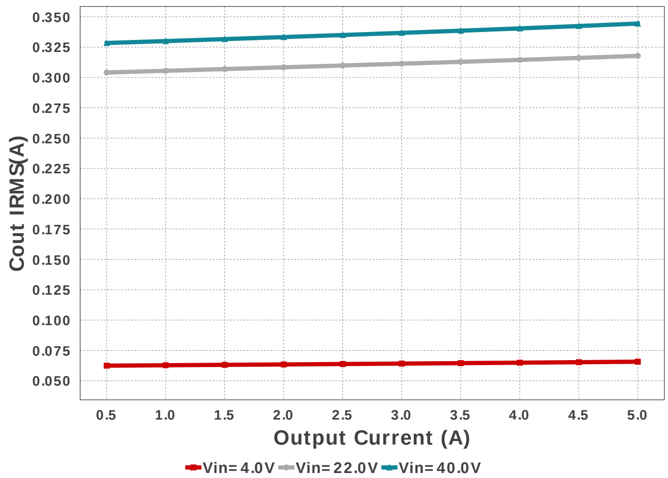
M2 Pd

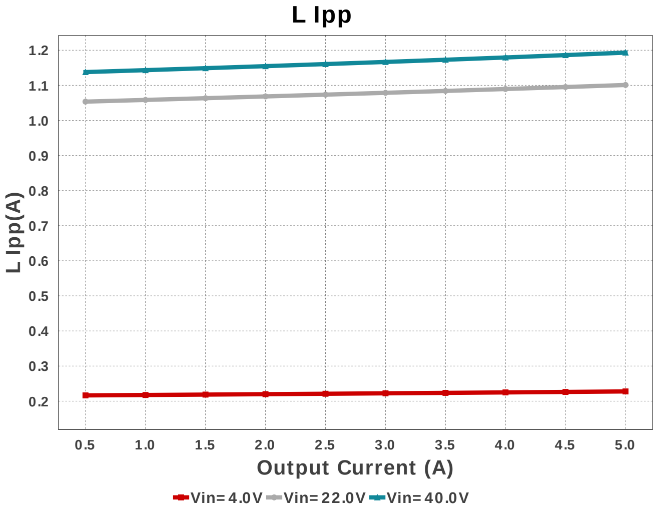


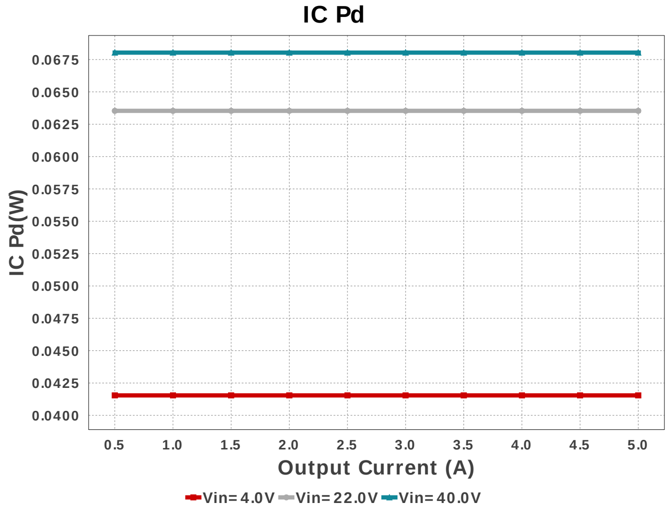
Total Pd

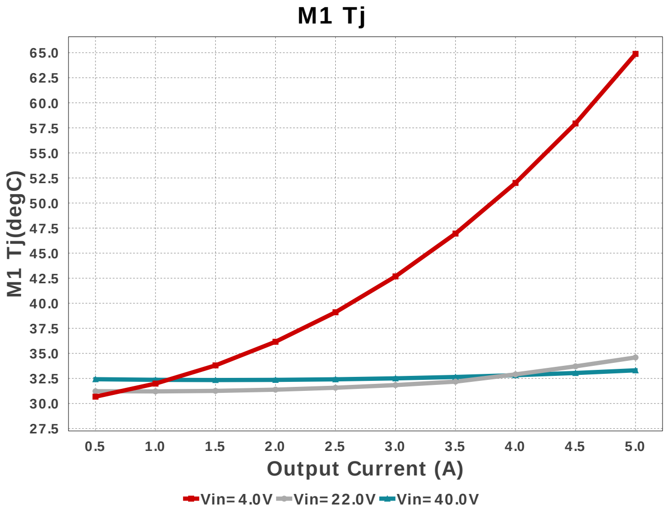


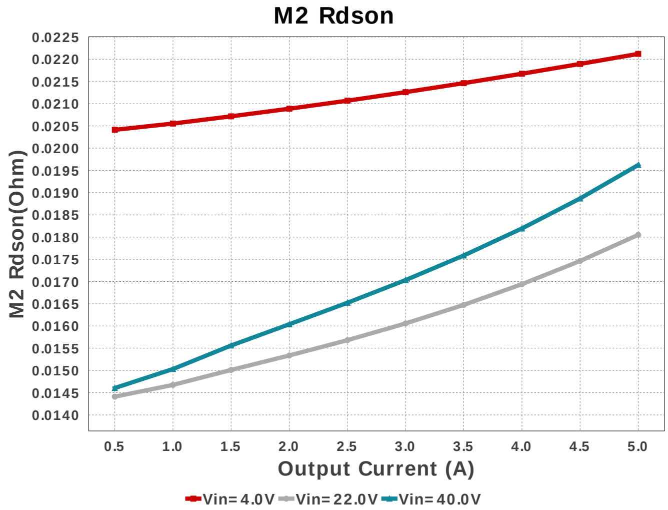
Cout IRMS

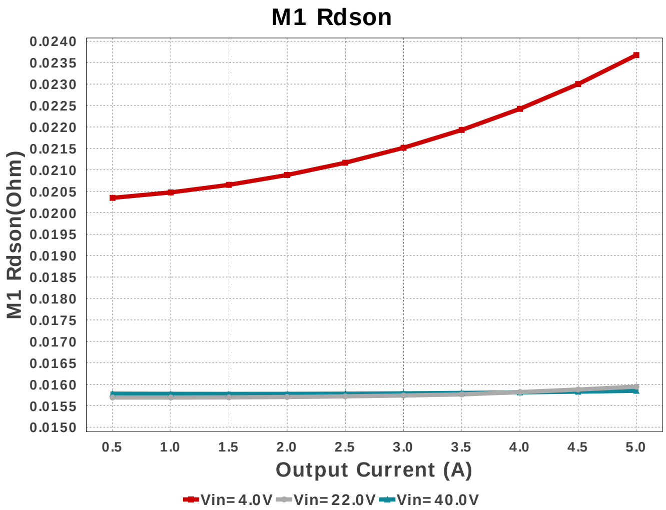


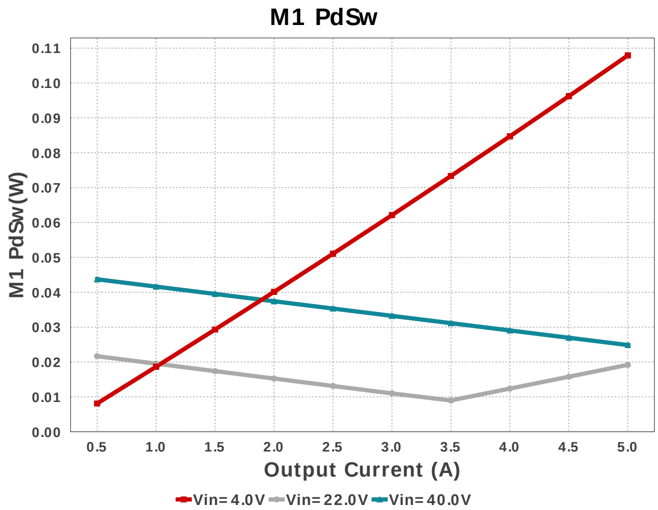

L Ipp
L Ipp(A)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

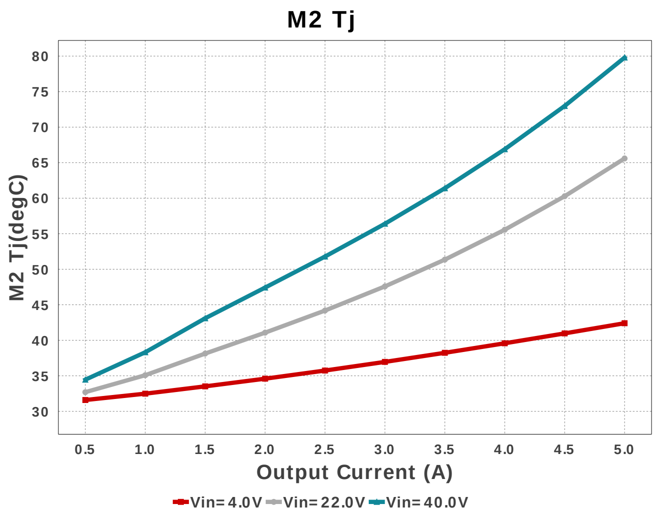

IC Pd
IC Pd(W)
0.0675
0.0650
0.0625
0.0600
0.0575
0.0550
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

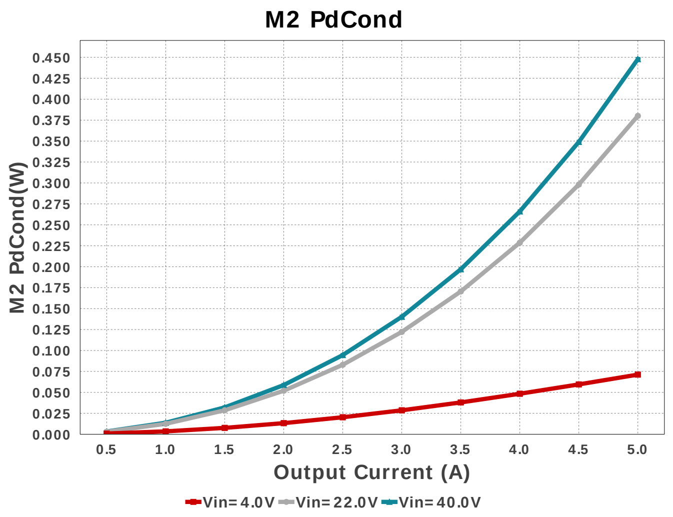

M1 Tj
M1 Tj(degC)
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V

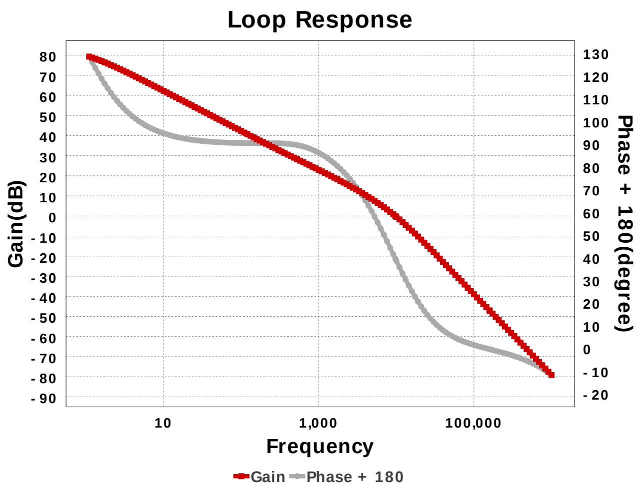

M2 Rdson
M2 Rdson(Ohm)
0.0225
0.0220
0.0215
0.0210
0.0205
0.0200
0.0195
0.0190
0.0185
0.0180
0.0175
0.0170
0.0165
0.0160
0.0155
0.0150
0.0145
0.0140
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V


M1 Rdson
M1 Rdson(Ohm)
0.0240
0.0235
0.0230
0.0225
0.0220
0.0215
0.0210
0.0205
0.0200
0.0195
0.0190
0.0185
0.0180
0.0175
0.0170
0.0165
0.0160
0.0155
0.0150
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V


M1 PdSw
M1 PdSw(W)
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin= 4.0V Vin= 22.0V Vin= 40.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.41 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	16.567 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	344.422 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	2.017 mW	Capacitor	Output capacitor power dissipation
5.	IC Pd	68.035 mW	IC	IC power dissipation
6.	IC Tj	32.32 degC	IC	IC junction temperature
7.	IC Tolerance	12.0 mV	IC	IC Feedback Tolerance
8.	Iin Avg	460.5 mA	IC	Average input current
9.	L Ipp	1.193 A	Inductor	Peak-to-peak inductor ripple current
10.	L Pd	562.5 mW	Inductor	Inductor power dissipation
11.	Frequency Note	NA	Mosfet	The frequency was set based upon either ton requirements or FET temperature limits
12.	M1 Irms	1.476 A	Mosfet	MOSFET RMS ripple current
13.	M1 Pd	59.384 mW	Mosfet	M1 MOSFET total power dissipation
14.	M1 PdCond	34.513 mW	Mosfet	M1 MOSFET conduction losses
15.	M1 PdSw	24.87 mW	Mosfet	M1 MOSFET switching losses
16.	M1 Rdson	15.848 mOhm	Mosfet	Drain-Source On-resistance
17.	M1 Tj	33.311 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Irms	4.777 A	Mosfet	MOSFET RMS ripple current
19.	M2 Pd	983.24 mW	Mosfet	M2 MOSFET total power dissipation
20.	M2 PdCond	447.8 mW	Mosfet	M2 MOSFET conduction losses
21.	M2 PdSw	535.44 mW	Mosfet	M2 MOSFET switching losses
22.	M2 Rdson	19.621 mOhm	Mosfet	Drain-Source On-resistance
23.	M2 Tj	79.793 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	16.567 mW	Power	Input capacitor power dissipation
25.	Cout Pd	2.017 mW	Power	Output capacitor power dissipation
26.	IC Pd	68.035 mW	Power	IC power dissipation
27.	L Pd	562.5 mW	Power	Inductor power dissipation
28.	M1 Pd	59.384 mW	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	34.513 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	24.87 mW	Power	M1 MOSFET switching losses
31.	M2 Pd	983.24 mW	Power	M2 MOSFET total power dissipation

#	Name	Value	Category	Description
32.	M2 PdCond	447.8 mW	Power	M2 MOSFET conduction losses
33.	M2 PdSw	535.44 mW	Power	M2 MOSFET switching losses
34.	Rsense Pd	228.22 mW	Power	LED Current Rsns Power Dissipation
35.	Total Pd	1.92 W	Power	Total Power Dissipation
36.	Rsense Pd	228.22 mW	Resistor	LED Current Rsns Power Dissipation
37.	BOM Count	22	System Information	Total Design BOM count
38.	Cross Freq	9.69 kHz	System Information	Bode plot crossover frequency
39.	Duty Cycle	8.711 %	System Information	Duty cycle
40.	Efficiency	89.577 %	System Information	Steady state efficiency
41.	FootPrint	896.0 mm^2	System Information	Total Foot Print Area of BOM components
42.	Frequency	412.235 kHz	System Information	Switching frequency
43.	Gain Marg	-47.173 dB	System Information	Bode Plot Gain Margin
44.	Iout	5.0 A	System Information	Iout operating point
45.	Low Freq Gain	79.298 dB	System Information	Gain at 1Hz
46.	Mode	CCM	System Information	Conduction Mode
47.	Phase Marg	39.858 deg	System Information	Bode Plot Phase Margin
48.	Pout	16.5 W	System Information	Total output power
49.	SW Ipk	5.597 A	System Information	Peak switch current
50.	Total BOM	$8.35	System Information	Total BOM Cost
51.	Vin	40.0 V	System Information	Vin operating point
52.	Vout Tolerance	363.64 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
53.	Vout p-p	20.313 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	5.0	Maximum Output Current
VinMax	40.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
VinTyp	12.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	LM25141-Q1	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

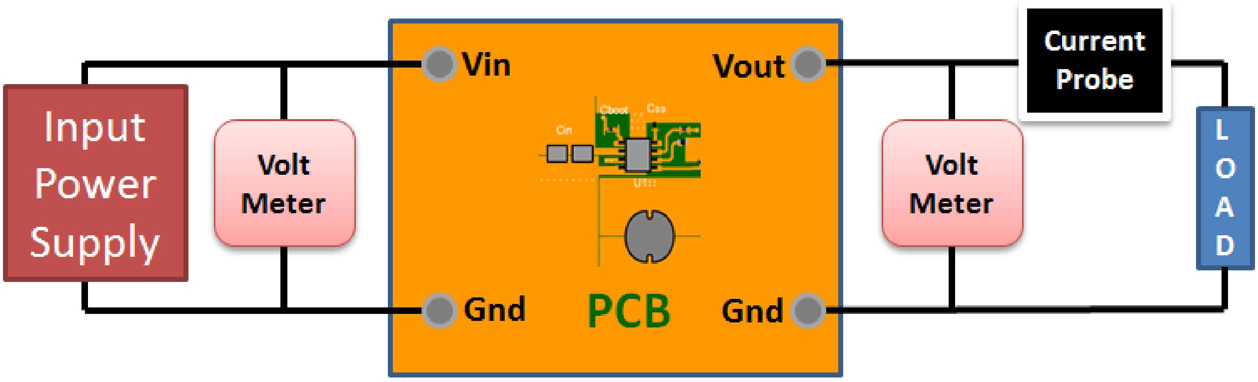
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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 LM25141-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

2. Master key : 1C9F5D76CD3B045A[v1]

3. **LM25141-Q1** Product Folder : http://www.ti.com/product/LM25141%2Dq1 : contains the data sheet and other resources.

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