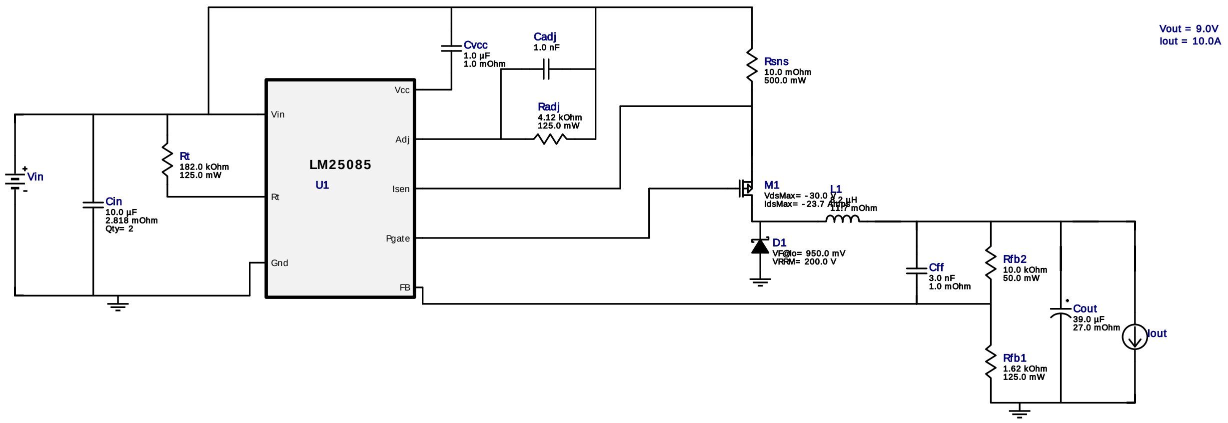
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 24.0V
VinMax = 24.0V
Vout = 9.0V
Iout = 10.0A

Device = LM25085MY/NOPB
Topology = Buck
Created = 2019-03-16 04:11:36.820
BOM Cost = $4.18
BOM Count = 15
Total Pd = 11.43W

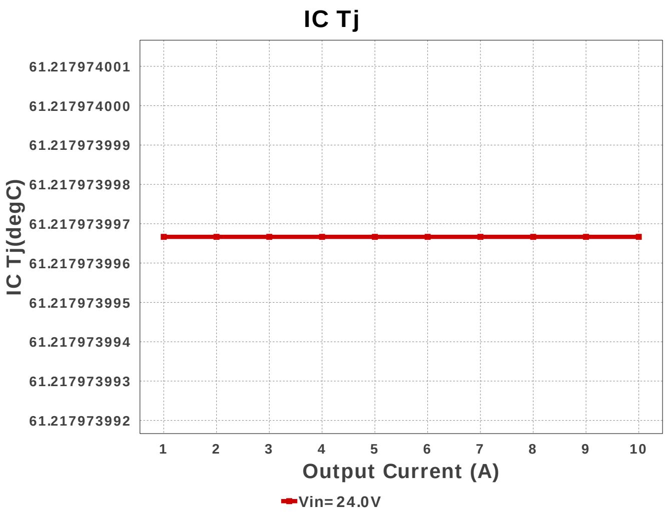
Design : 242 LM25085MY/NOPB
LM25085MY/NOPB 24V-24V to 9.00V @ 10A

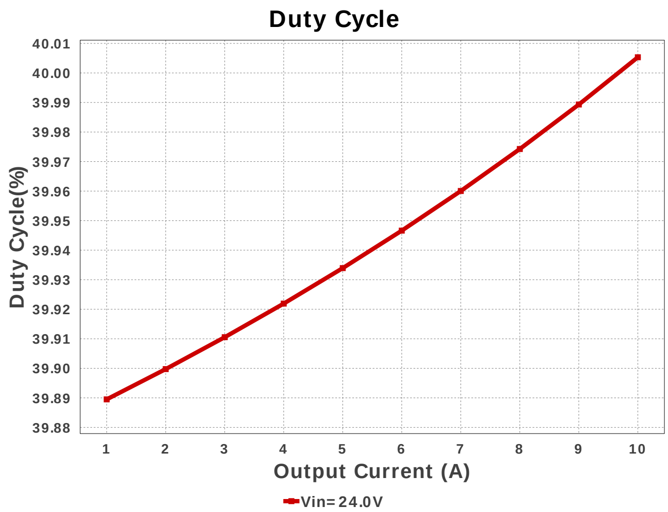


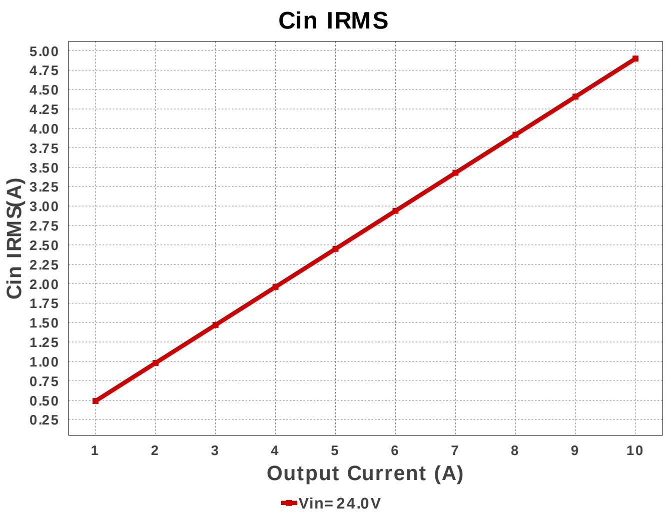
Electrical BOM

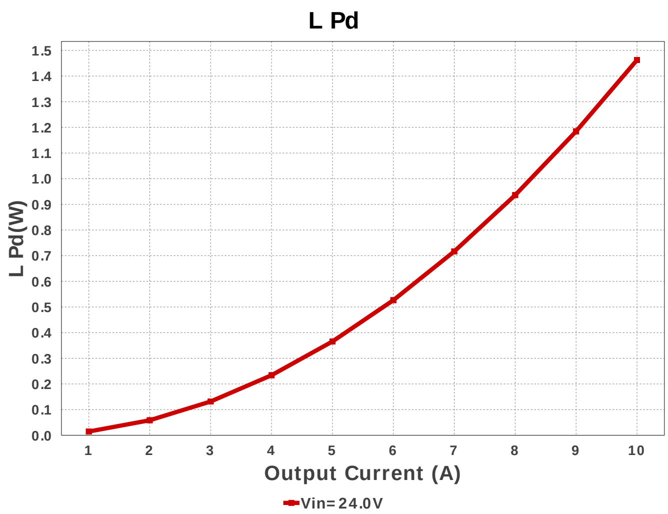
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cadj	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cff	MuRata	GRM1885C1H302JA01D Series= C0G/NP0	Cap= 3.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm²
Cin	TDK	C2012X5R1V106K085AC Series= X5R	Cap= 10.0 uF ESR= 2.818 mOhm VDC= 35.0 V IRMS= 3.8868 A	2	$0.18	0805 7 mm²
Cout	Panasonic	16SVPC39MV Series= SVPC	Cap= 39.0 uF ESR= 27.0 mOhm VDC= 16.0 V IRMS= 2.35 A	1	$0.31	SM_RADIAL_5MM 58 mm²
Cvcc	Taiyo Yuden	EMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	DPAK 102 mm²
L1	Coilcraft	XAL1010-822MEB	L= 8.2 µH 11.7 mOhm	1	$1.71	XAL1010 160 mm²
M1	Vishay-Siliconix	Si7149DP	VdsMax= -30.0 V IdsMax= -23.7 Amps	1	$0.76	PowerPAK_SO-8 55 mm²
Radj	Panasonic	ERJ-6ENF4121V Series= ERJ-6E	Res= 4.12 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²

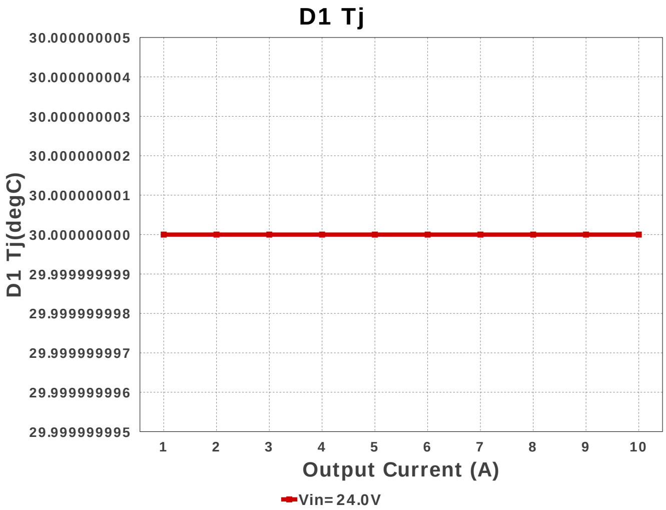
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfb1	Vishay-Dale	CRCW08051K62FKEA Series= CRCW..e3	Res= 1.62 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfb2	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsns	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	1206 11 mm^2
Rt	Vishay-Dale	CRCW0805182KFKEA Series= CRCW..e3	Res= 182.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	LM25085MY/NOPB	Switcher	1	$0.70	MUY08A 24 mm^2

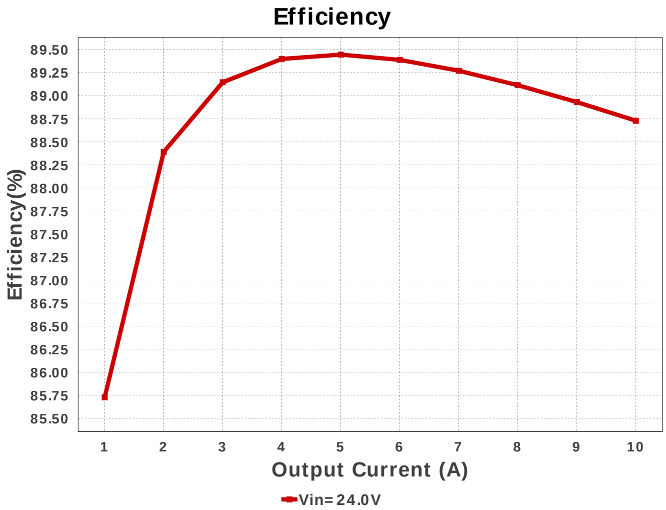


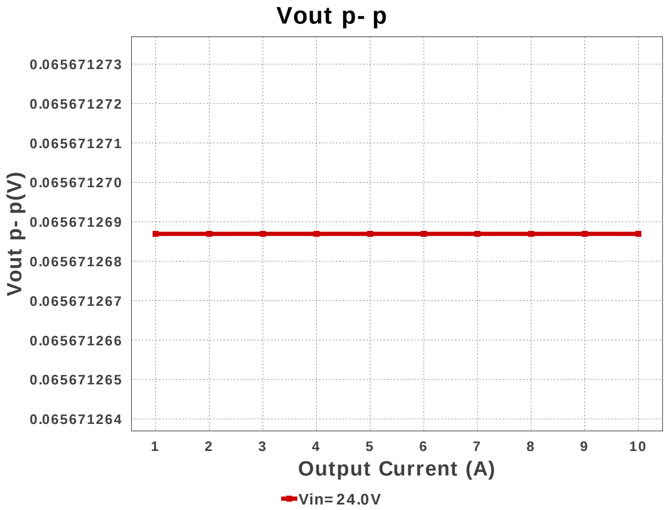


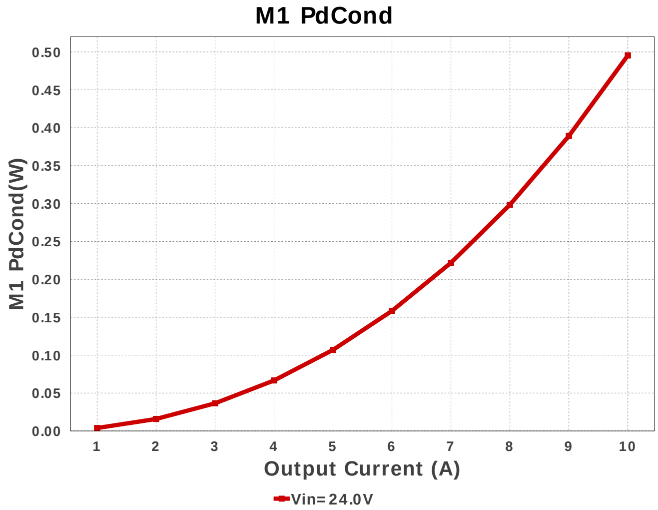


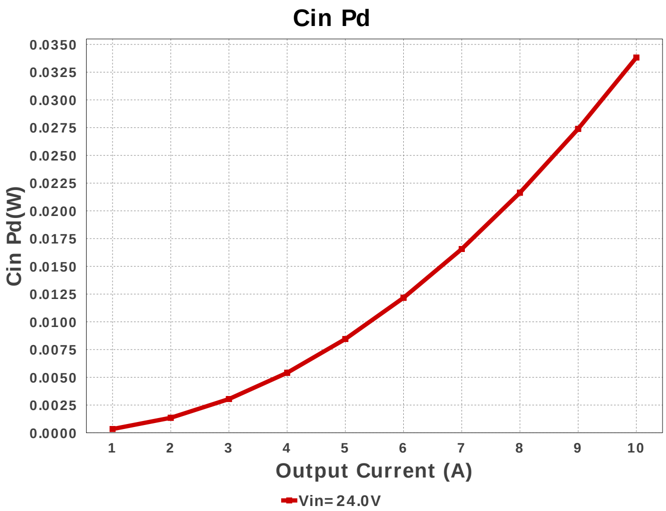


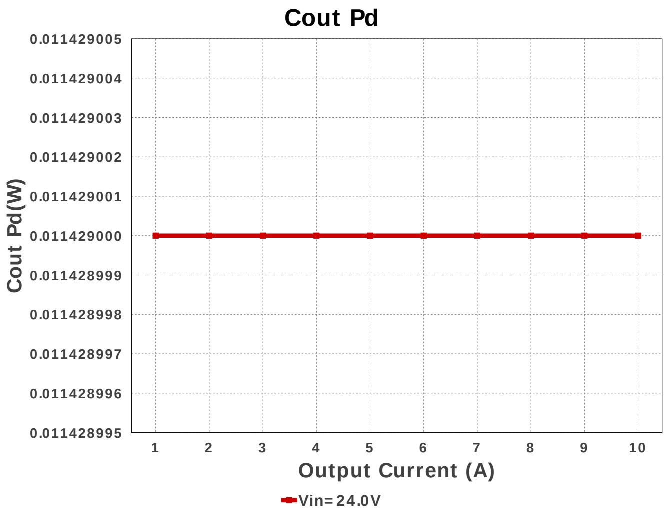

D1 Tj
D1 Tj(degC)
30.000000005
30.000000004
30.000000003
30.000000002
30.000000001
30.000000000
29.999999999
29.999999998
29.999999997
29.999999996
29.999999995
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

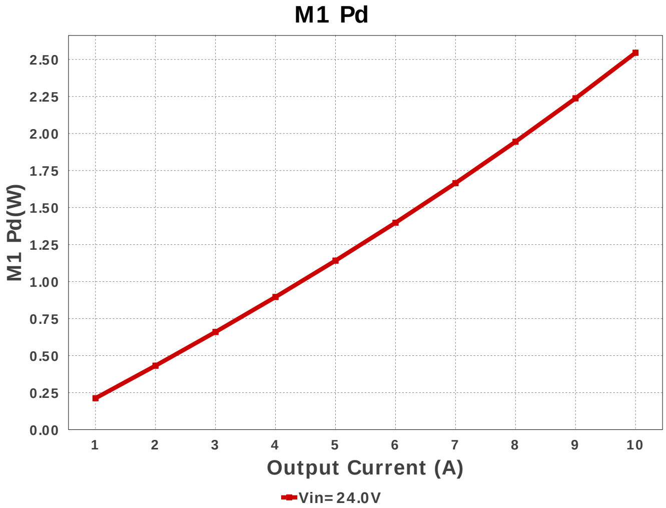

Efficiency
Efficiency(%)
89.50
89.25
89.00
88.75
88.50
88.25
88.00
87.75
87.50
87.25
87.00
86.75
86.50
86.25
86.00
85.75
85.50
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

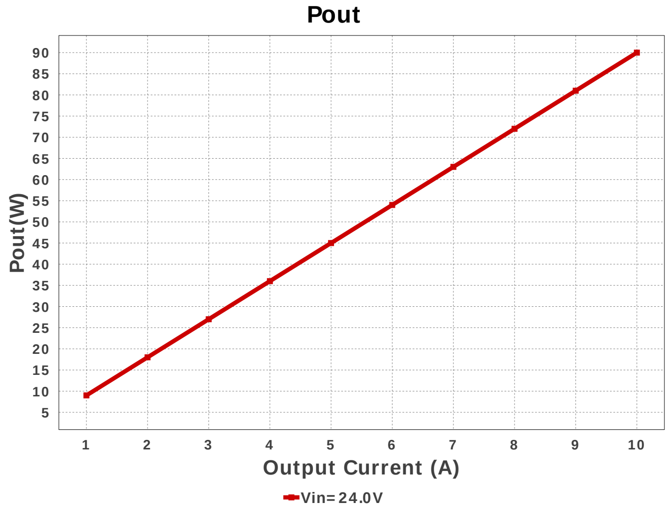

Vout p- p
Vout p- p(V)
0.065671273
0.065671272
0.065671271
0.065671270
0.065671269
0.065671268
0.065671267
0.065671266
0.065671265
0.065671264
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

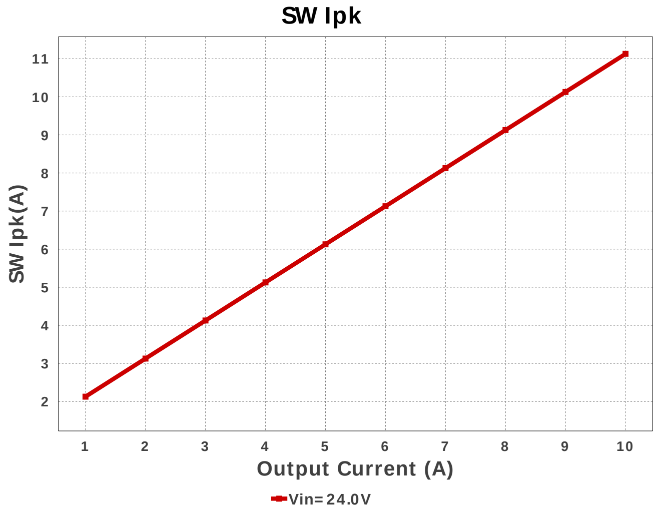

M1 PdCond
M1 PdCond(W)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

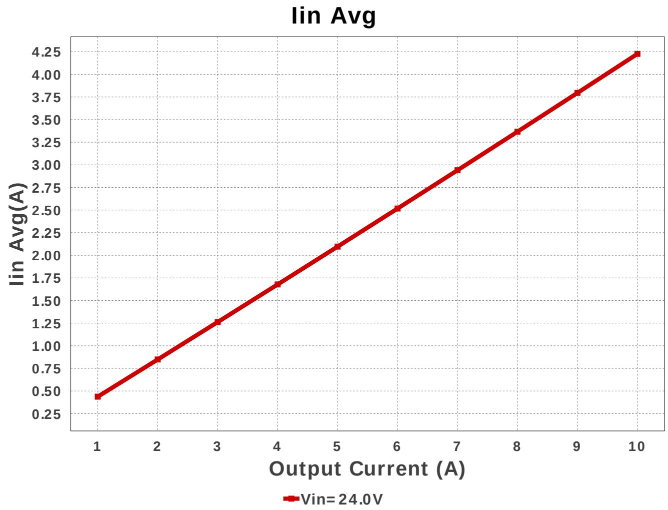

Cin Pd
Cin Pd(W)
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

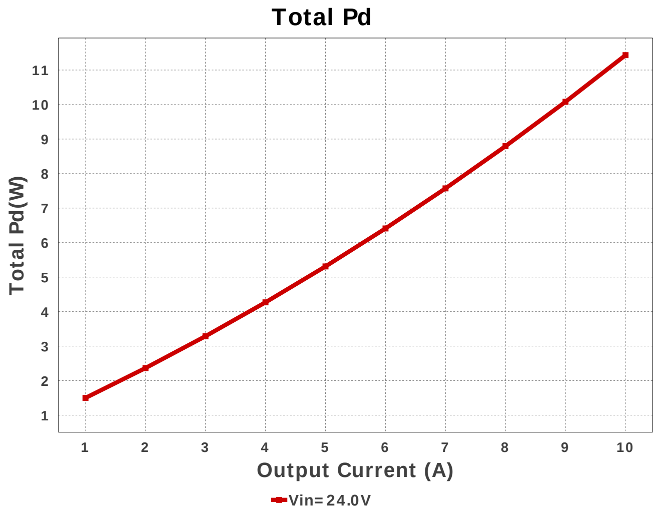

Cout Pd
Cout Pd(W)
0.011429005
0.011429004
0.011429003
0.011429002
0.011429001
0.011429000
0.011428999
0.011428998
0.011428997
0.011428996
0.011428995
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=24.0V

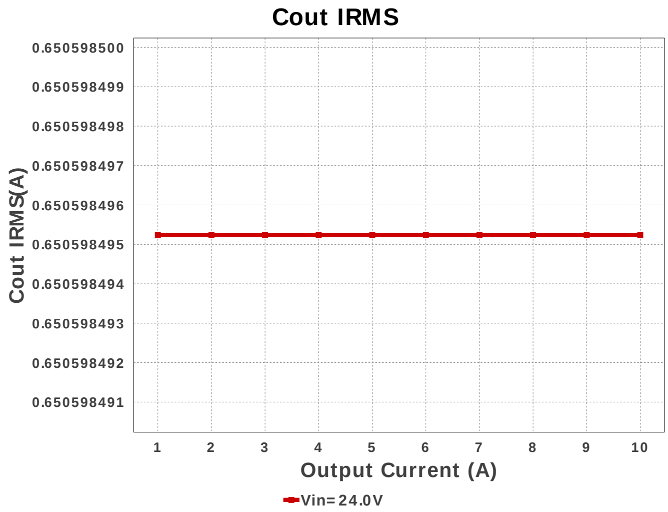

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=24.0V

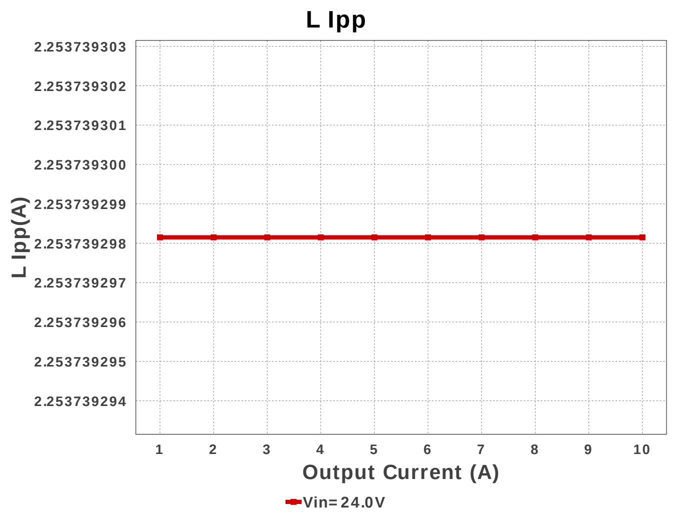

Pout
Pout(W)
Output Current (A)
Vin=24.0V

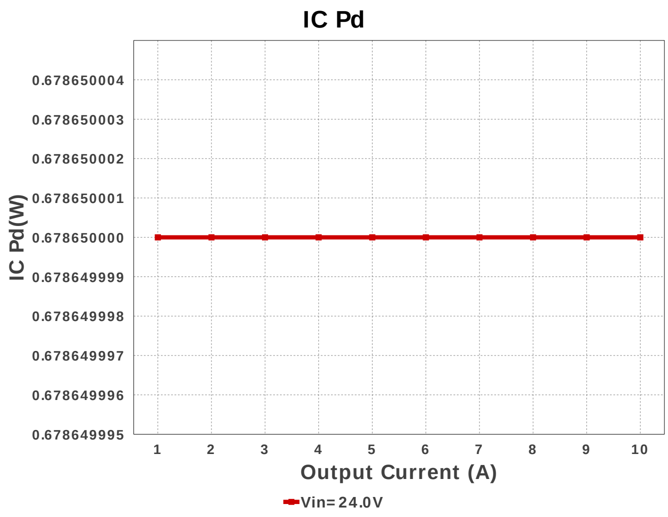

SW Ipk
SW Ipk(A)
Output Current (A)
Vin=24.0V

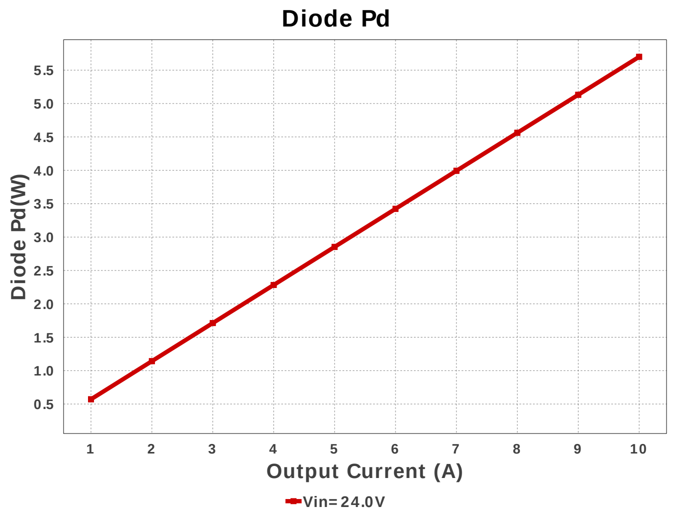

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=24.0V

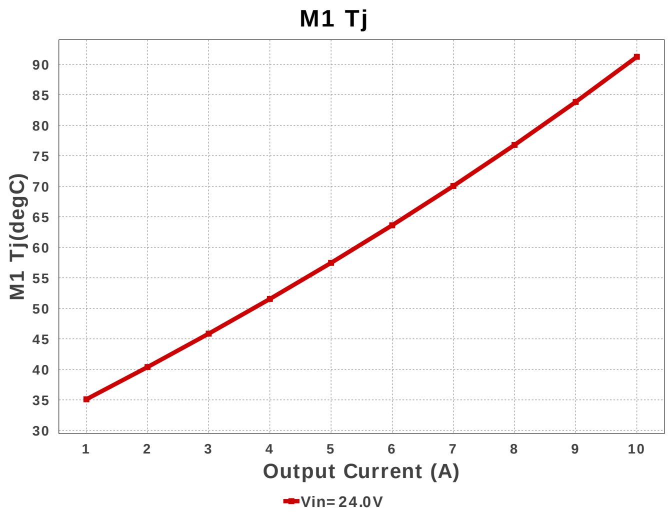

Total Pd
Total Pd(W)
Output Current (A)
Vin=24.0V

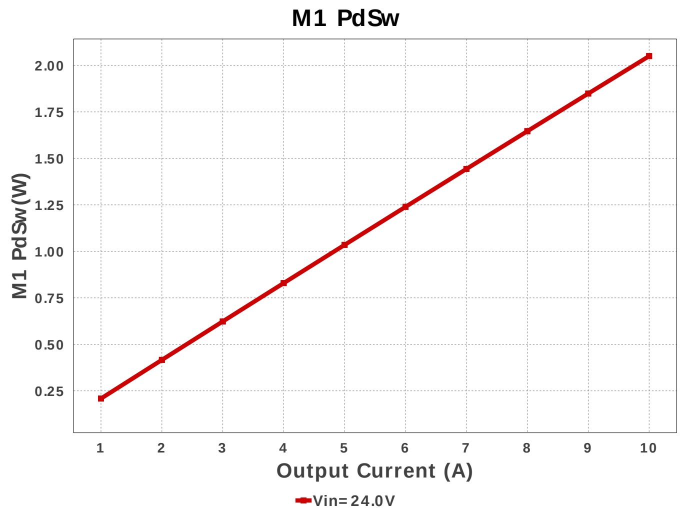

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=24.0V











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	15		Total Design BOM count
2.	Total BOM	$4.18		Total BOM Cost
3.	Cin IRMS	4.899 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	33.817 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	650.598 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	11.429 mW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	30.0 degC	Diode	D1 junction temperature
8.	Diode Pd	5.7 W	Diode	Diode power dissipation
9.	IC Pd	678.65 mW	IC	IC power dissipation
10.	IC Tj	61.218 degC	IC	IC junction temperature
11.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance

#	Name	Value	Category	Description
12.	ICThetaJA	46.0 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	4.226 A	IC	Average input current
14.	L Ipp	2.254 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	1.462 W	Inductor	Inductor power dissipation
16.	M1 Pd	2.545 W	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	495.45 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	2.05 W	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	91.213 degC	Mosfet	M1 MOSFET junction temperature
20.	Cin Pd	33.817 mW	Power	Input capacitor power dissipation
21.	Cout Pd	11.429 mW	Power	Output capacitor power dissipation
22.	Diode Pd	5.7 W	Power	Diode power dissipation
23.	IC Pd	678.65 mW	Power	IC power dissipation
24.	L Pd	1.462 W	Power	Inductor power dissipation
25.	M1 Pd	2.545 W	Power	M1 MOSFET total power dissipation
26.	M1 PdCond	495.45 mW	Power	M1 MOSFET conduction losses
27.	M1 PdSw	2.05 W	Power	M1 MOSFET switching losses
28.	Total Pd	11.431 W	Power	Total Power Dissipation
29.	Duty Cycle	40.005 %	System Information	Duty cycle
30.	Efficiency	88.73 %	System Information	Steady state efficiency
31.	FootPrint	460.0 mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	292.502 kHz	System Information	Switching frequency
33.	Iout	10.0 A	System Information	Iout operating point
34.	Mode	CCM	System Information	Conduction Mode
35.	Pout	90.0 W	System Information	Total output power
36.	SW Ipk	11.127 A	System Information	Peak switch current
37.	Vin	24.0 V	System Information	Vin operating point
38.	Vout	9.0 V	System Information	Operational Output Voltage
39.	Vout Actual	8.966 V	System Information	Vout Actual calculated based on selected voltage divider resistors
40.	Vout Tolerance	3.773 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	65.671 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	10.0	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	9.0	Output Voltage
base_pn	LM25085	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

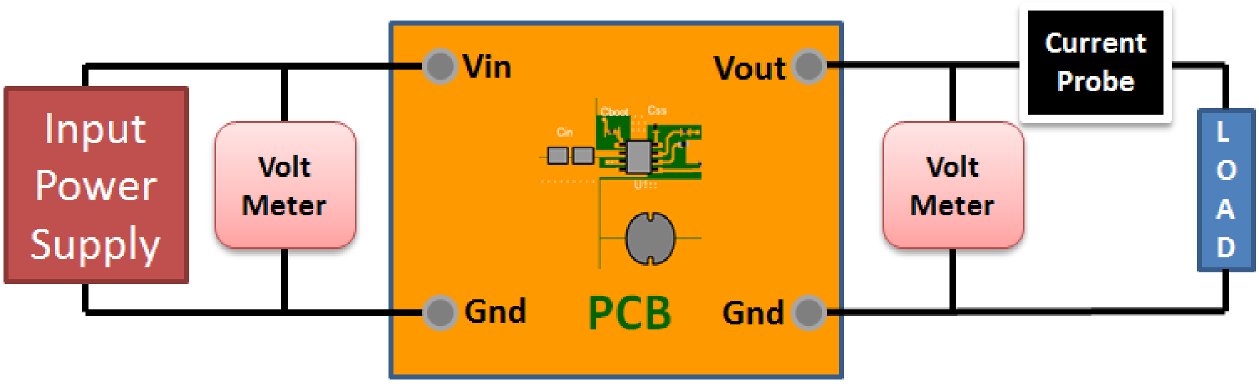
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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. For a Constant On Time device to be stable, we need to provide a ripple at the feedback comparator. There are various methods to implement the ripple. Depending on the circuit complexity vs. the allowable ripple, we have three options to choose from. The simplest option, 'Low Complexity', would require only a high ESR cap at the output. This means that the BOM count will be small, but the output voltage ripple will be quite large. The 'optimal solution' would require a feed-forward cap in parallel with the upper feedback resistor to AC couple the ripple to the feedback node. This increases the BOM count slightly, but now we have more control over the output voltage ripple. If the output voltage requirement is very tight, then the best option is to go for the 'Low Output Ripple' solution. In this option we can go with very low ESR output caps and have very good control over the output voltage ripple

2. Master key : 4A0AE5C69DC3DDC9[v1]

3. **LM25085** Product Folder : http://www.ti.com/product/LM25085 : contains the data sheet and other resources.

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