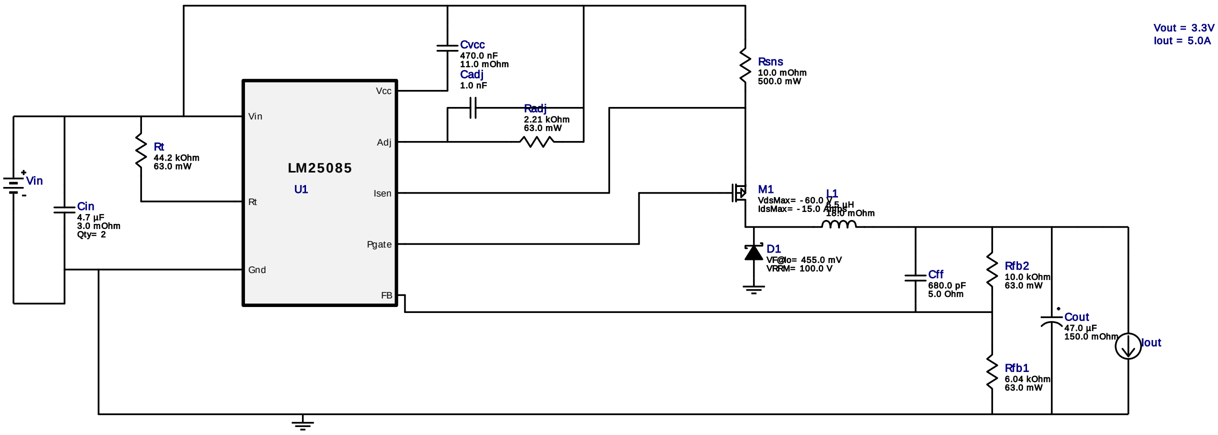
![Texas Instruments]

WEBENCH® Design Report

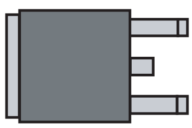
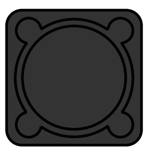
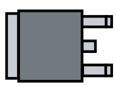
VinMin = 12.0V
VinMax = 24.0V
Vout = 3.3V
Iout = 5.0A

Device = LM25085MY/NOPB
Topology = Buck
Created = 7/17/16 9:06:29 AM
BOM Cost = $3.54
BOM Count = 15
Total Pd = 3.9W

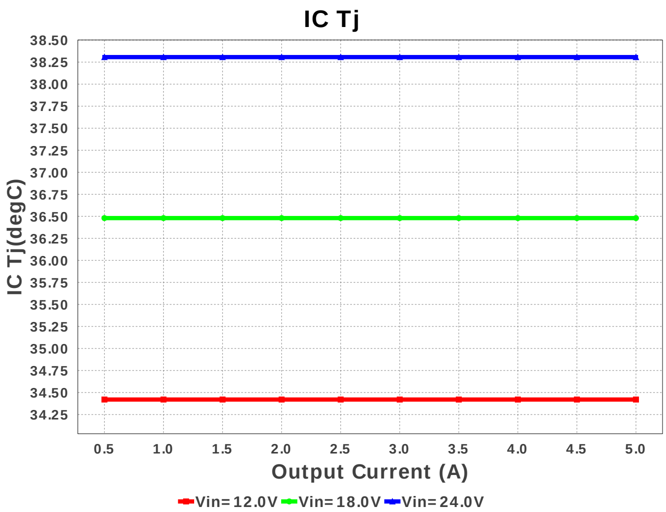
Design : 4466246/73 LM25085MY/NOPB
LM25085MY/NOPB 12.0V-24.0V to 3.30V @ 5.0A

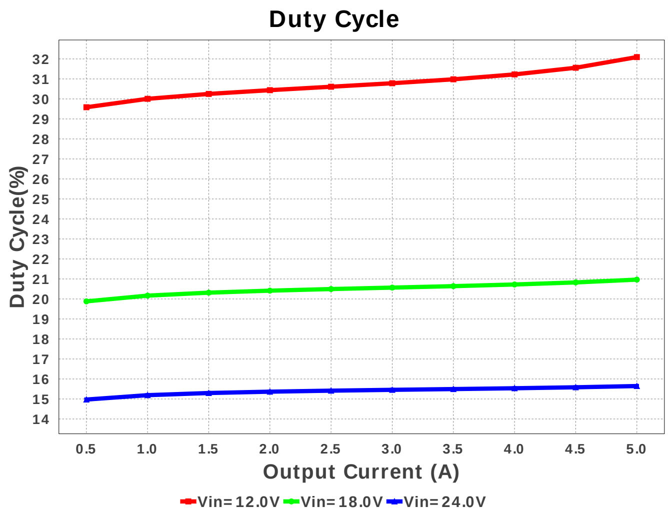


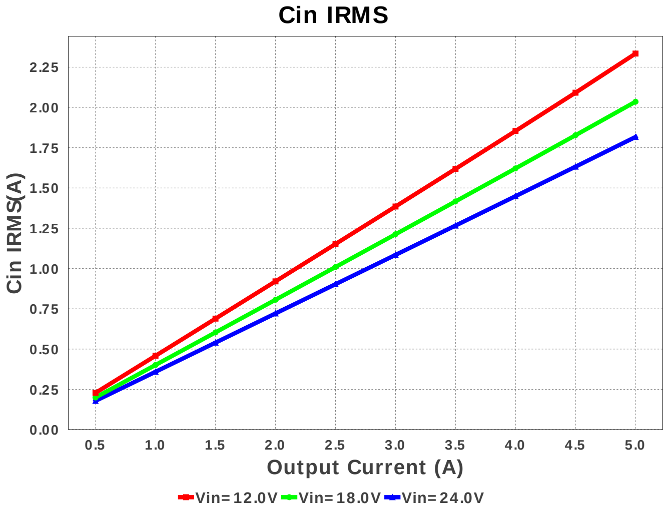
Electrical BOM

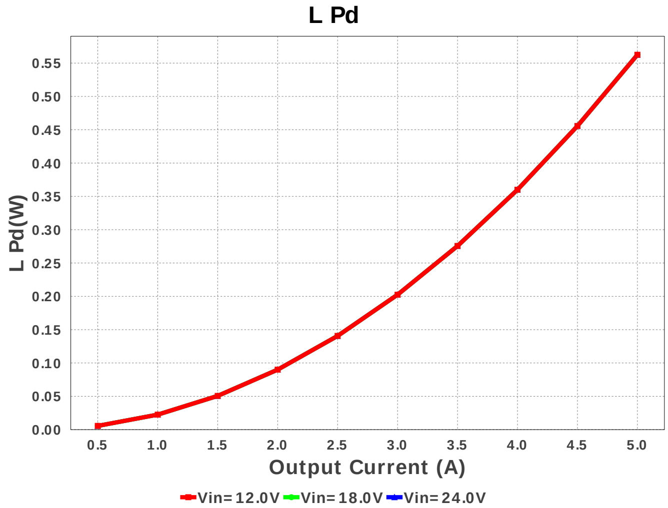
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cadj	Samsung Electro-Mechanics	CL21C102JBCNFNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
2.	Cff	MuRata	GRM188R72E681KW07D Series= X7R	Cap= 680.0 pF ESR= 5.0 Ohm VDC= 250.0 V IRMS= 70.0 mA	1	$0.12	0603 5 mm²
3.	Cin	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	2	$0.07	1206 11 mm²
4.	Cout	Panasonic	6TPU47MSI Series= ?	Cap= 47.0 uF ESR= 150.0 mOhm VDC= 6.3 V IRMS= 510.0 mA	1	$0.46	CAPSMT_6_S09 7 mm²
5.	Cvcc	AVX	0805YC474KAT2A Series= X7R	Cap= 470.0 nF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
6.	D1	STMicroelectronics	STPS20M100SG-TR	VF@Io= 455.0 mV VRRM= 100.0 V	1	$1.33	 DDPAK 210 mm²
7.	L1	Bourns	SRR1208-6R5ML	L= 6.5 µH DCR= 18.0 mOhm	1	$0.37	 SRR1208 216 mm²
8.	M1	Fairchild Semiconductor	FDD5614P	VdsMax= -60.0 V IdsMax= -15.0 Amps	1	$0.24	 DPAK 102 mm²

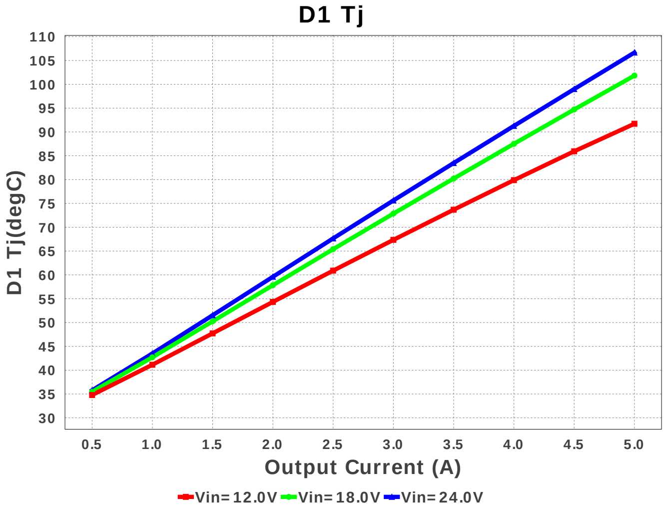
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Radj	Vishay-Dale	CRCW04022K21FKED Series= CRCW..e3	Res= 2.21 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
10.	Rfb1	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
11.	Rfb2	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
12.	Rsns	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	1206 11 mm²
13.	Rt	Vishay-Dale	CRCW040244K2FKED Series= CRCW..e3	Res= 44.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
14.	U1	Texas Instruments	LM25085MY/NOPB	Switcher	1	$0.70	MUY08A 24 mm²

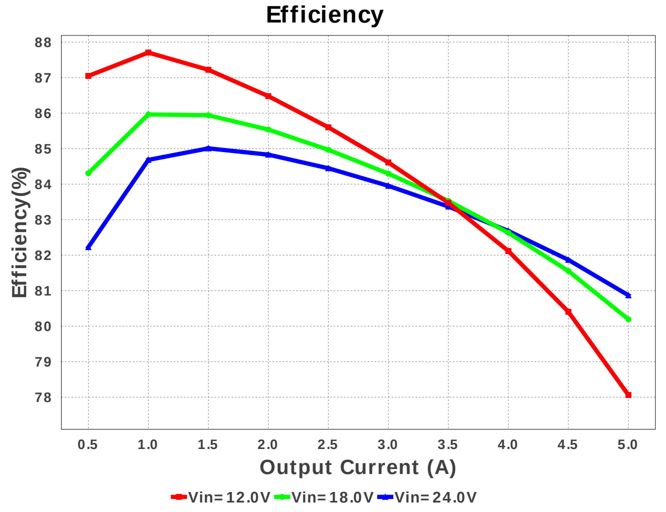


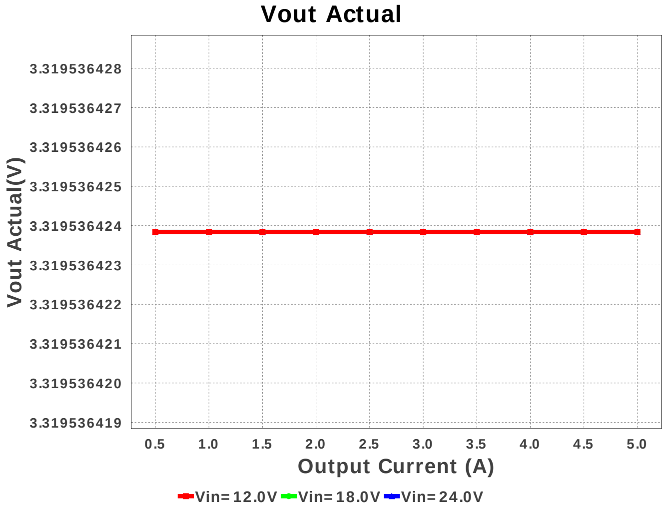


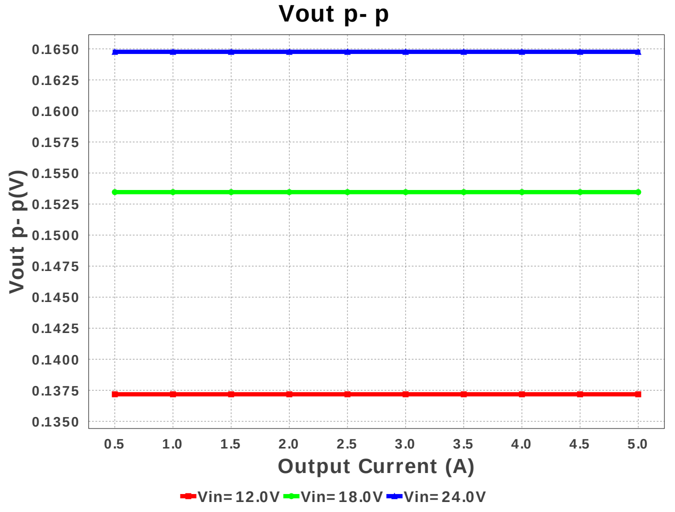


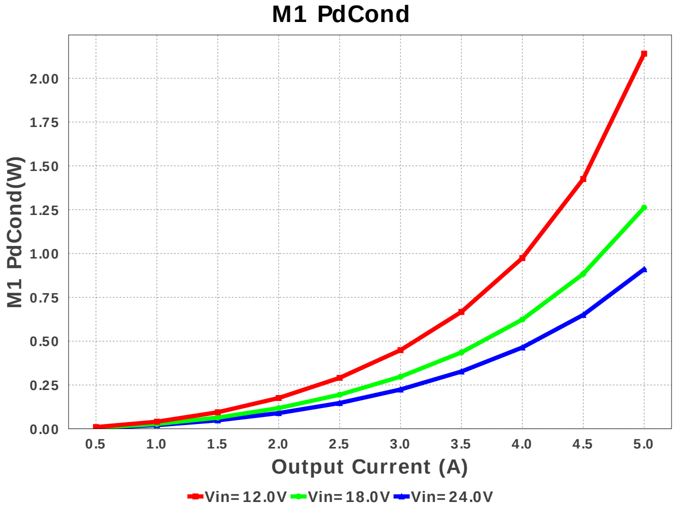


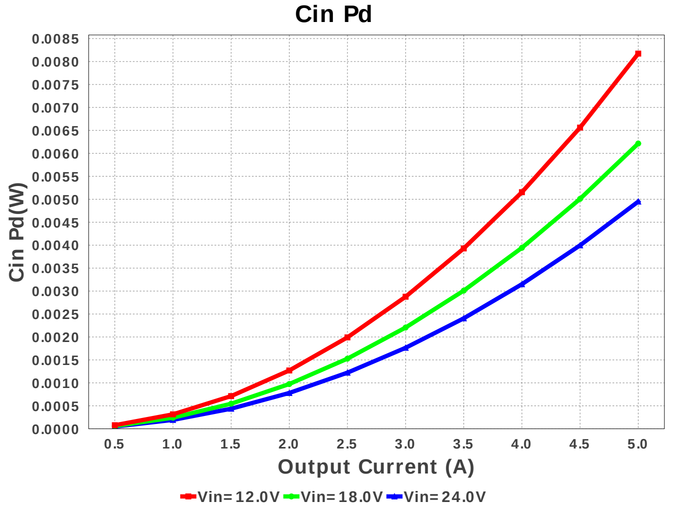

D1 Tj
D1 Tj(degC)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

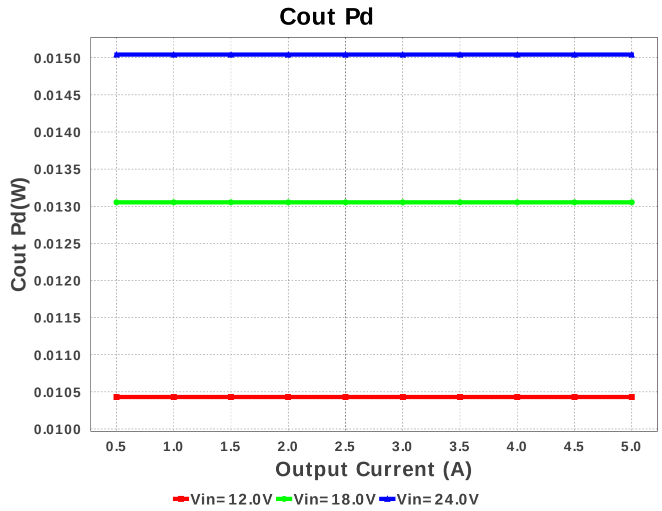

Efficiency
Efficiency(%)
88
87
86
85
84
83
82
81
80
79
78
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

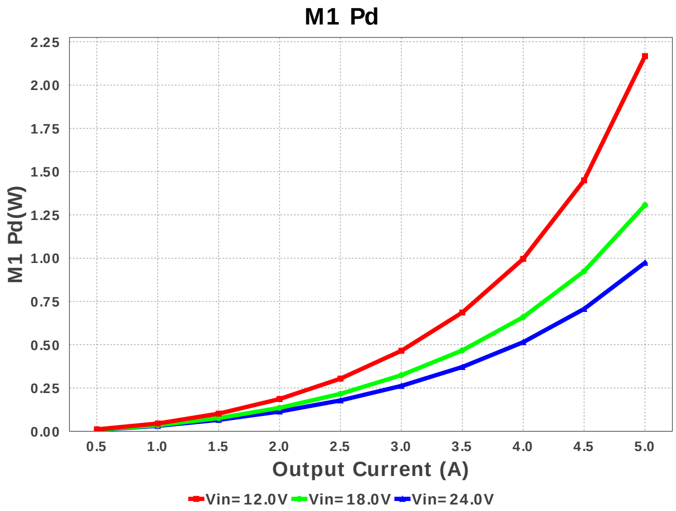

Vout Actual
Vout Actual(V)
3.319536428
3.319536427
3.319536426
3.319536425
3.319536424
3.319536423
3.319536422
3.319536421
3.319536420
3.319536419
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

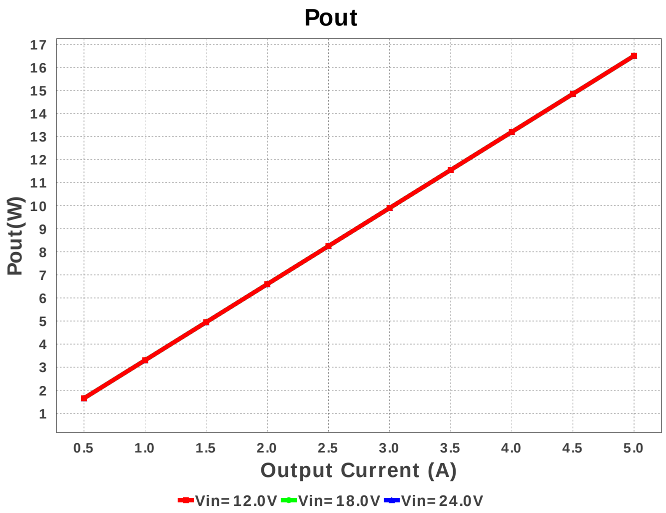

Vout p-p
Vout p-p(V)
0.1650
0.1625
0.1600
0.1575
0.1550
0.1525
0.1500
0.1475
0.1450
0.1425
0.1400
0.1375
0.1350
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

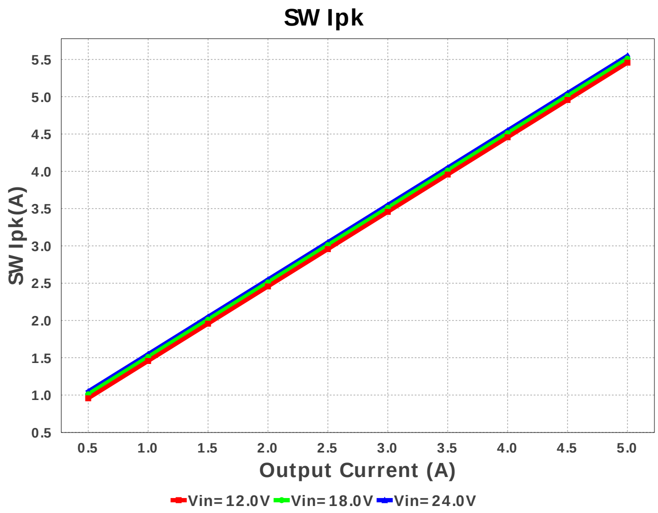

M1 PdCond
M1 PdCond(W)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

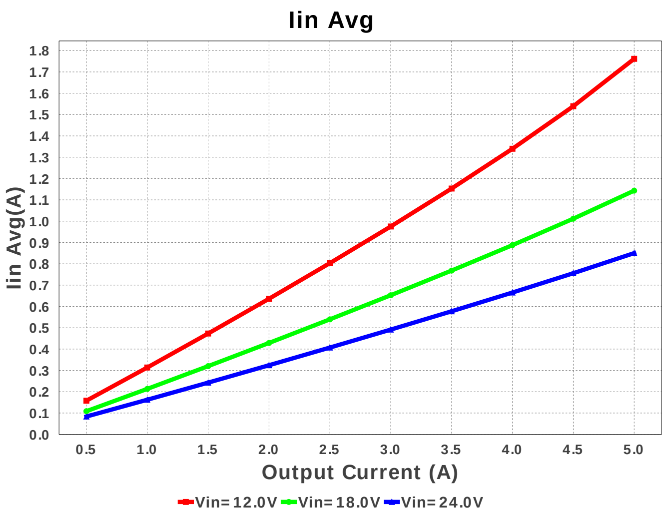

Cin Pd
Cin Pd(W)
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

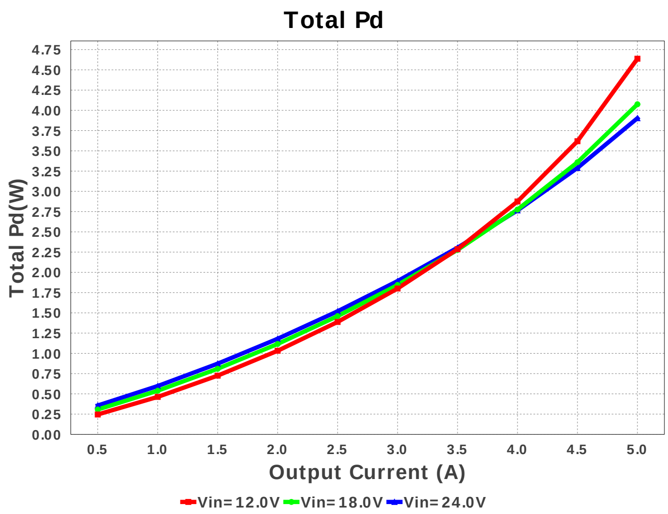

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

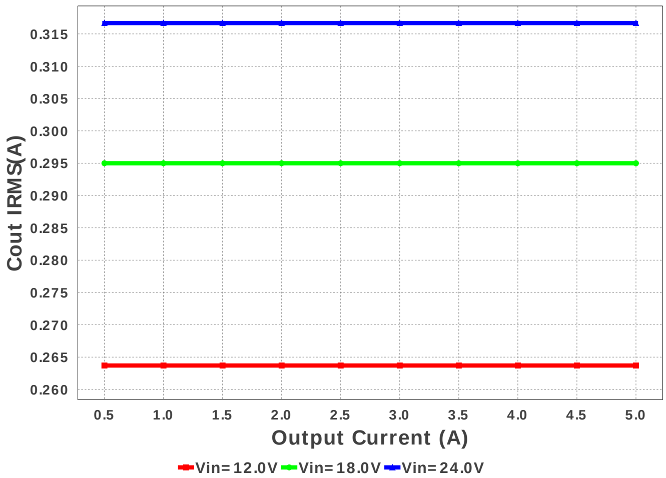

Pout
Pout(W)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V


SW Ipk
SW Ipk(A)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

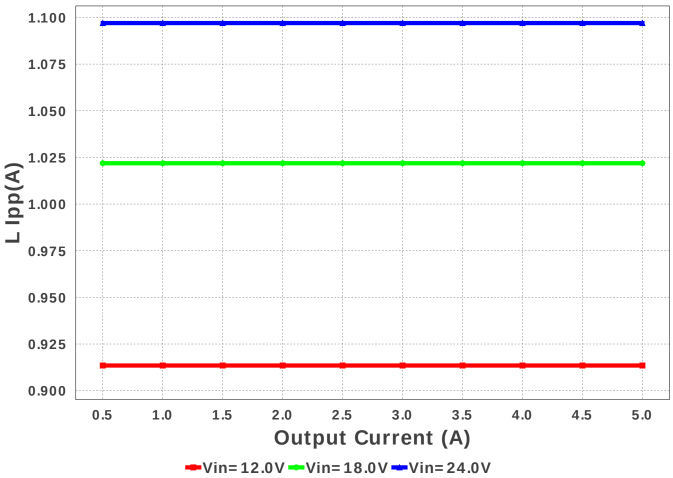

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=12.0V Vin=18.0V Vin=24.0V

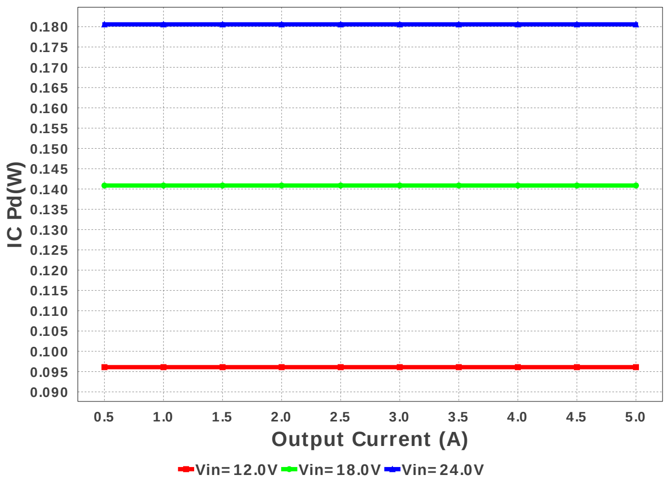
Cout IRMS



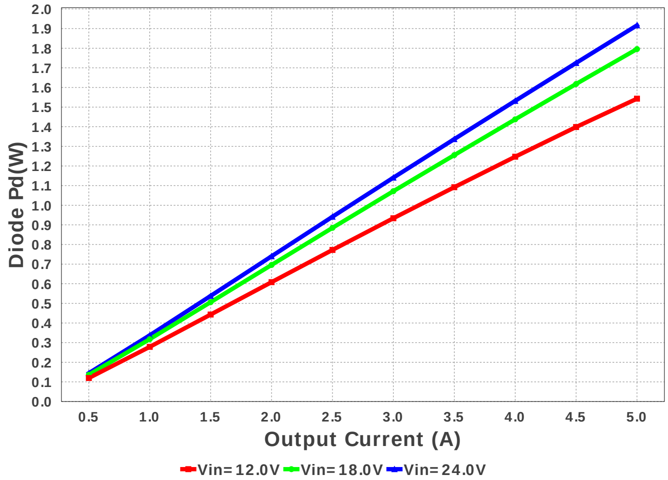
L Ipp



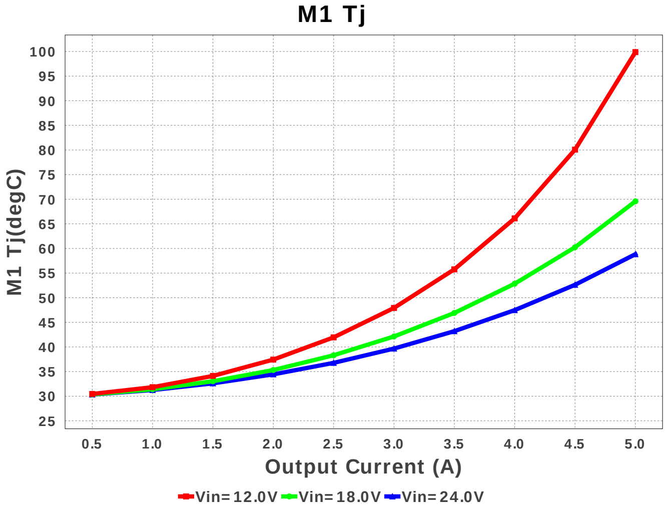
IC Pd



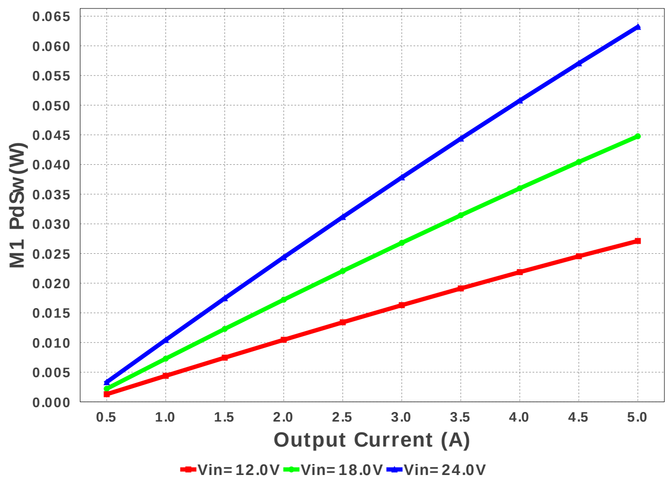
Diode Pd



M1 Tj



M1 PdSw



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.816 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	316.677 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	850.03 mA	Current	Average input current
4.	L Ipp	1.097 A	Current	Peak-to-peak inductor ripple current
5.	SW Ipk	5.549 A	Current	Peak switch current
6.	BOM Count	15	General	Total Design BOM count
7.	FootPrint	621.0 mm^2	General	Total Foot Print Area of BOM components
8.	Frequency	348.57 kHz	General	Switching frequency
9.	IC Tolerance	25.0 mV	General	IC Feedback Tolerance
10.	Pout	16.5 W	General	Total output power
11.	Total BOM	$3.54	General	Total BOM Cost

#	Name	Value	Category	Description
12.	D1 Tj	106.663 degC	Op_Point	D1 junction temperature
13.	Vout Actual	3.32 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
14.	Vout OP	3.3 V	Op_Point	Operational Output Voltage
15.	Duty Cycle	15.645 %	Op_point	Duty cycle
16.	Efficiency	80.879 %	Op_point	Steady state efficiency
17.	IC Tj	38.307 degC	Op_point	IC junction temperature
18.	ICThetaJA	46.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
19.	IOUT_OP	5.0 A	Op_point	Iout operating point
20.	M1 Tj	58.83 degC	Op_point	M1 MOSFET junction temperature
21.	VIN_OP	24.0 V	Op_point	Vin operating point
22.	Vout p-p	164.763 mV	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	4.949 mW	Power	Input capacitor power dissipation
24.	Cout Pd	15.043 mW	Power	Output capacitor power dissipation
25.	Diode Pd	1.917 W	Power	Diode power dissipation
26.	IC Pd	180.582 mW	Power	IC power dissipation
27.	L Pd	562.5 mW	Power	Inductor power dissipation
28.	M1 Pd	971.145 mW	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	907.941 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	63.204 mW	Power	M1 MOSFET switching losses
31.	Total Pd	3.901 W	Power	Total Power Dissipation
32.	Vout Tolerance	3.285 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	5.0	Maximum Output Current
2.	VinMax	24.0	Maximum input voltage
3.	VinMin	12.0	Minimum input voltage
4.	Vout	3.3	Output Voltage
5.	base_pn	LM25085	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

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