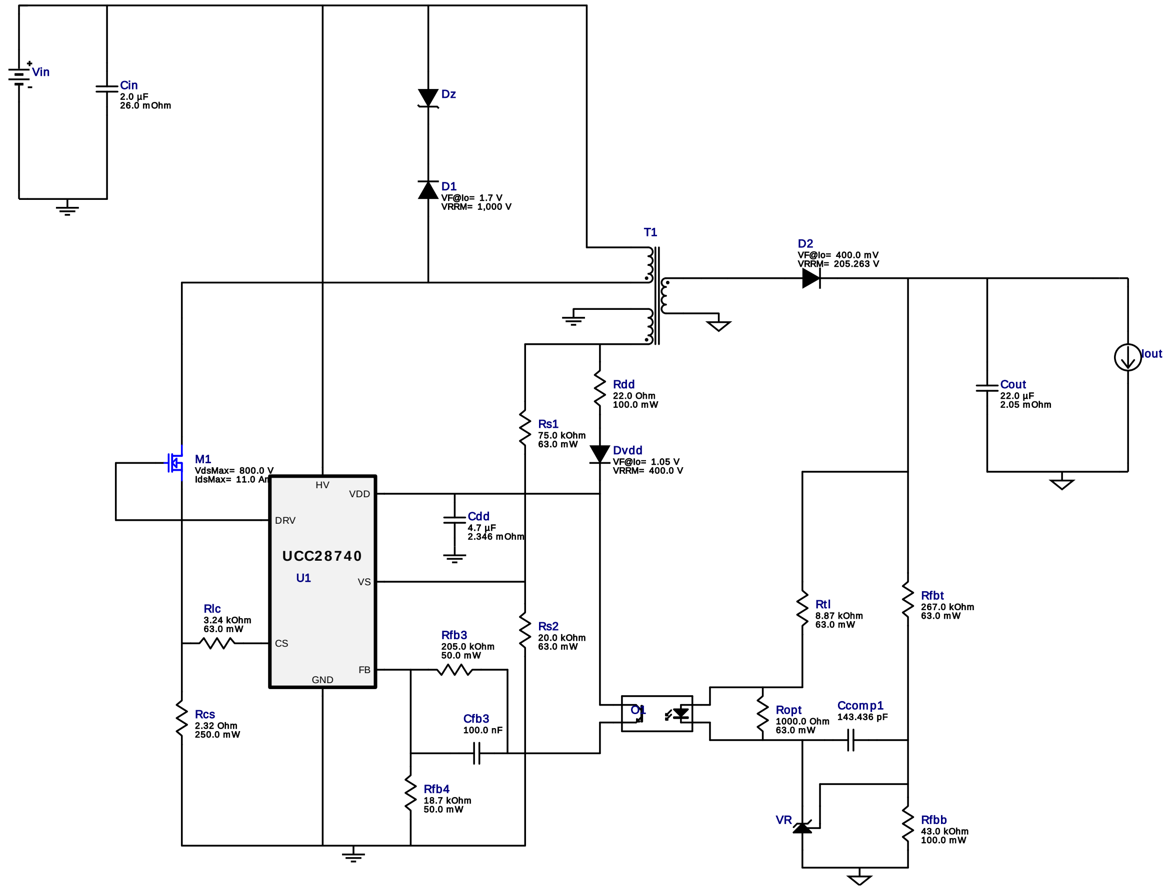
VinMin = 50.0V	Device = UCC28740DR
VinMax = 500.0V	Topology = Flyback
Vout = 18.0V	Created = 2022-06-02 15:16:05.161
Iout = 0.2A	BOM Cost = NA
	BOM Count = 26
	Total Pd =

WEBENCH ® Design Report

Design : 43 UCC28740DR
UCC28740DR 50V-500V to 18.00V @ 0.2A



1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.

2. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

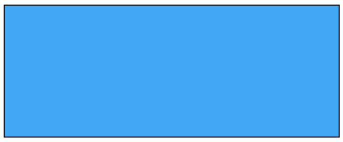
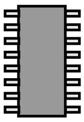
Design Alerts

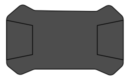
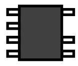
Component Selection Information

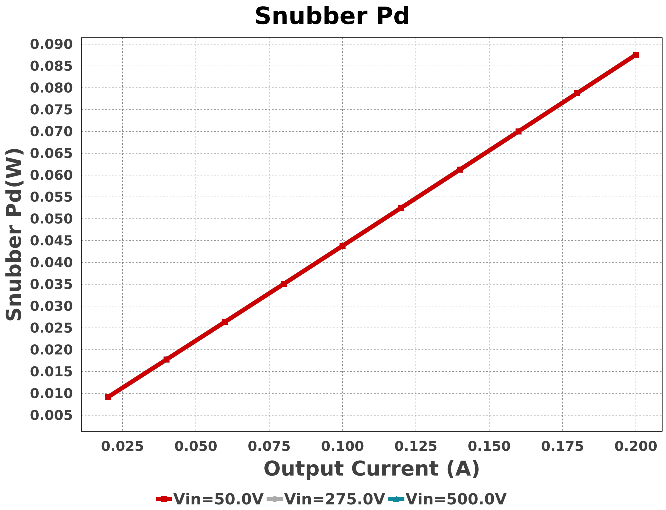
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

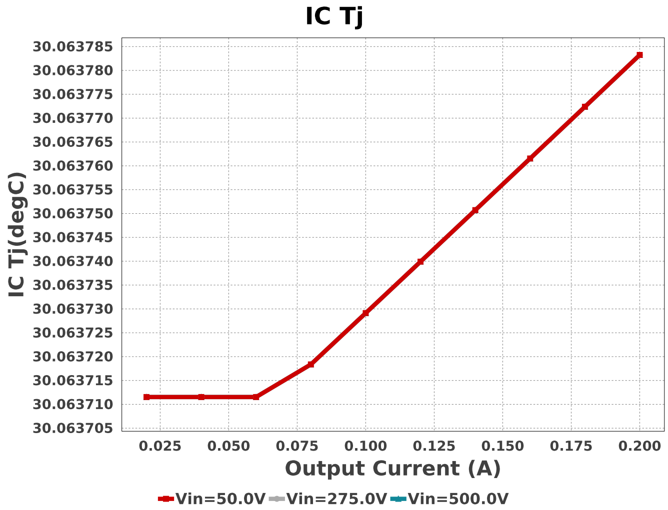
Electrical BOM

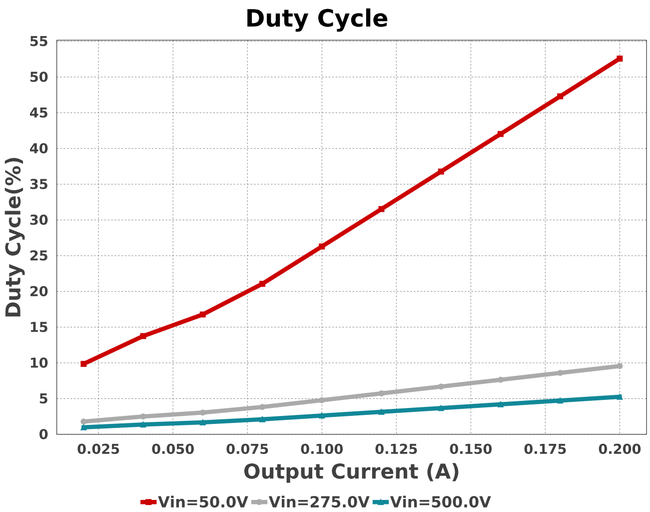
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp1	CUSTOM	CUSTOM Series= ?	Cap= 143.436 pF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
Cdd	TDK	C2012X7R1V475K125AC Series= X7R	Cap= 4.7 uF ESR= 2.346 mOhm VDC= 35.0 V IRMS= 4.2602 A	1	$0.18	0805 7 mm^2
Cfb3	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2

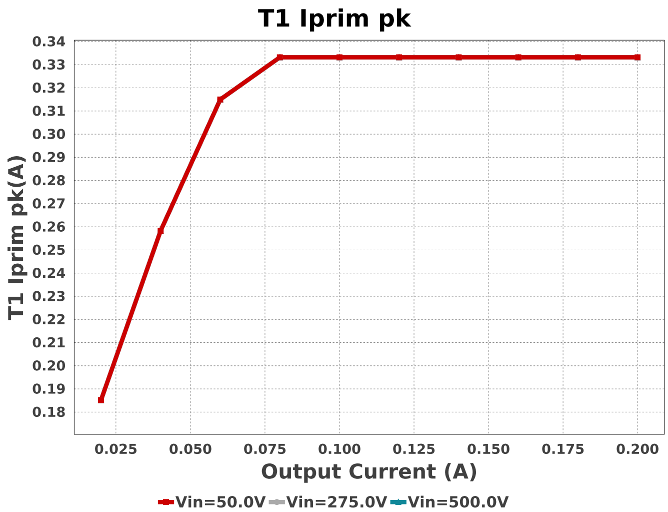
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	B32774D205K Series= B32774	Cap= 2.0 uF ESR= 26.0 mOhm VDC= 1.1 kV IRMS= 4.5 A	1	$1.99	 B32774_3150x2150x1250 486 mm²
Cout	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.33	0805 7 mm²
D1	SMC Diode Solutions	UF4007TA	VF@Io= 1.7 V VRRM= 1,000.0 V	1	$0.22	 DO-41 43 mm²
D2	CUSTOM	CUSTOM	VF@Io= 400.0 mV VRRM= 205.263 V	1	NA	CUSTOM 0 mm²
Dvdd	Bourns	CD1408-FU1400	VF@Io= 1.05 V VRRM= 400.0 V	1	$0.13	Diode_1408 13 mm²
Dz	CUSTOM	CUSTOM	Zener	1	NA	CUSTOM 0 mm²
M1	Infineon Technologies	SPA11N80C3	VdsMax= 800.0 V IdsMax= 11.0 Amps	1	$1.36	 TO-220FP 79 mm²
O1	California Eastern Laboratories	PS2811-4	Optocoupler	1	$2.30	 SSOP-16 55 mm²
Rcs	Vishay-Dale	CRCW12062R32FKEA Series= CRCW..e3	Res= 2.32 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rdd	Yageo	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfb3	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfb4	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfbb	Yageo	RC0603FR-0743KL Series= ?	Res= 43.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Vishay-Dale	CRCW0402267KFKED Series= CRCW..e3	Res= 267.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rlc	Vishay-Dale	CRCW04023K24FKED Series= CRCW..e3	Res= 3.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ropt	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rs1	Vishay-Dale	CRCW040275K0FKED Series= CRCW..e3	Res= 75.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rs2	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rtl	Vishay-Dale	CRCW04028K87FKED Series= CRCW..e3	Res= 8.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

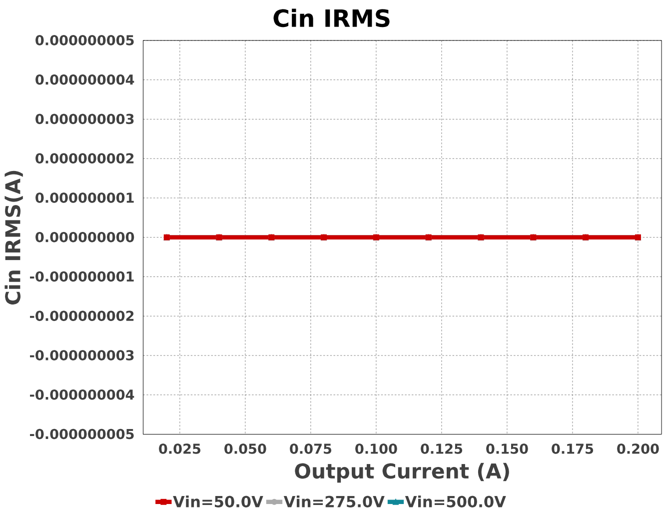
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
T1	Core=TDK , CoilFormer=TDK	Core=B65807J0000R049 , CoilFormer=B65808E1508T001	Lp= 832.0 µH Turns Ratio(Nas)= 13:13 Turns Ratio(Nps)= 38:13 Npri= 38.0 Naux= 13.0 Nsec= 13.0	1	$1.54	 TDK_B65803 341 mm^2
U1	Texas Instruments	UCC28740DR	Switcher	1	$0.38	 R-PDSO-G7 55 mm^2
VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.10	 DBZ0003A 14 mm^2

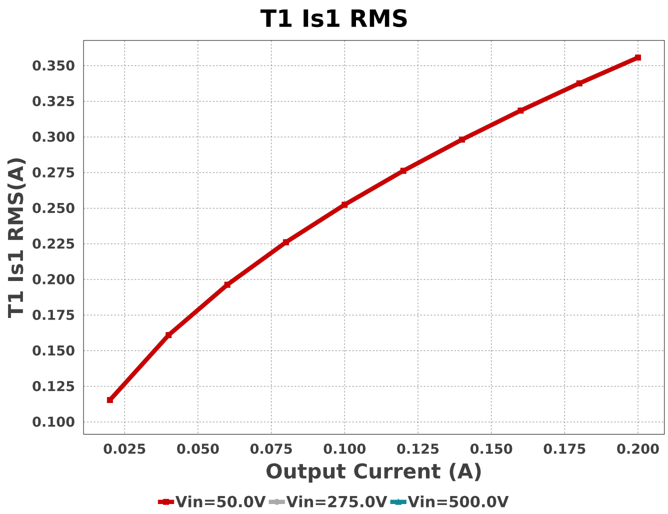


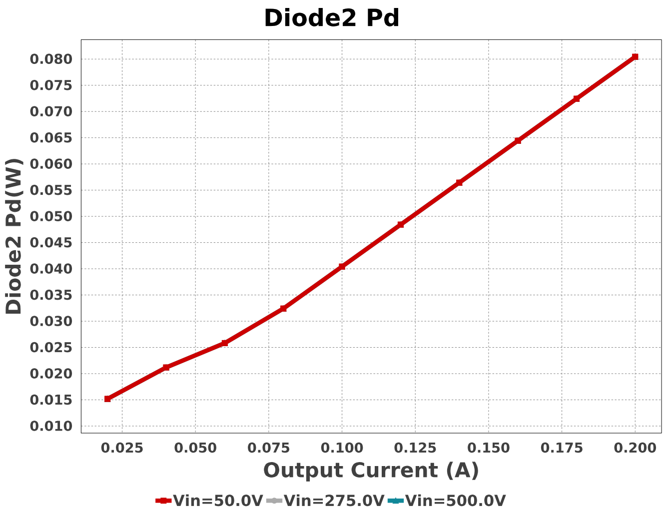


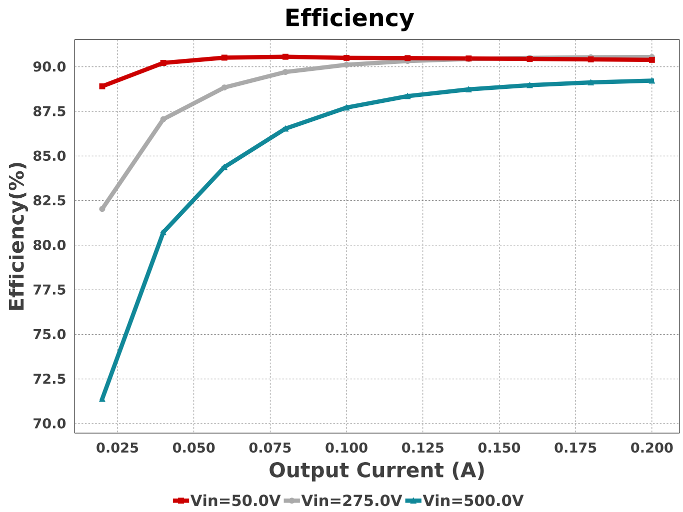


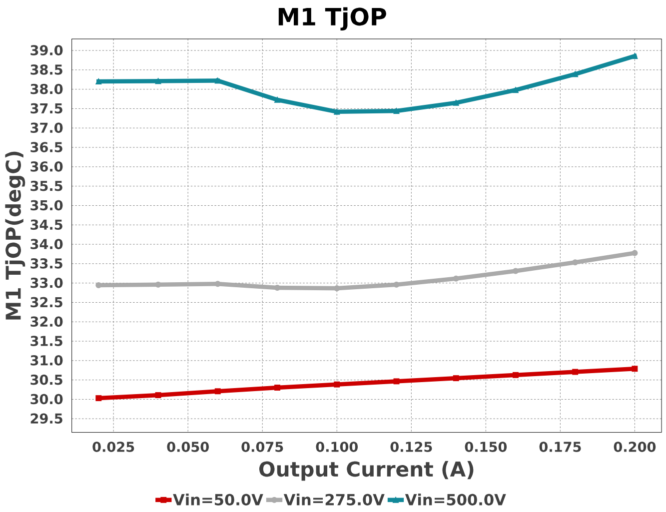


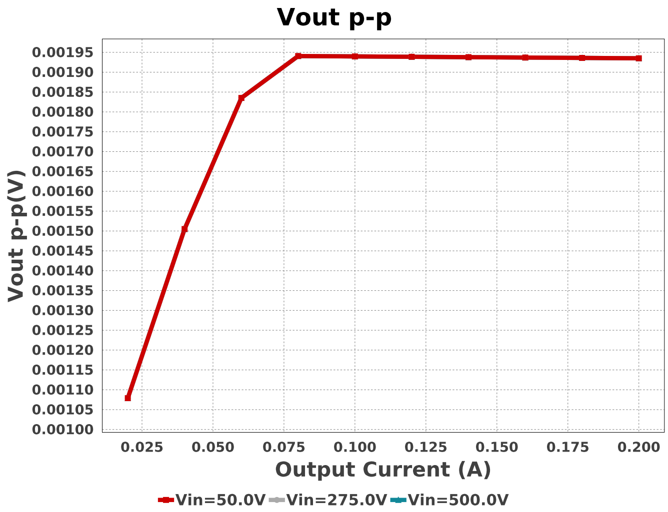

Cin IRMS
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
Cin IRMS(A)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

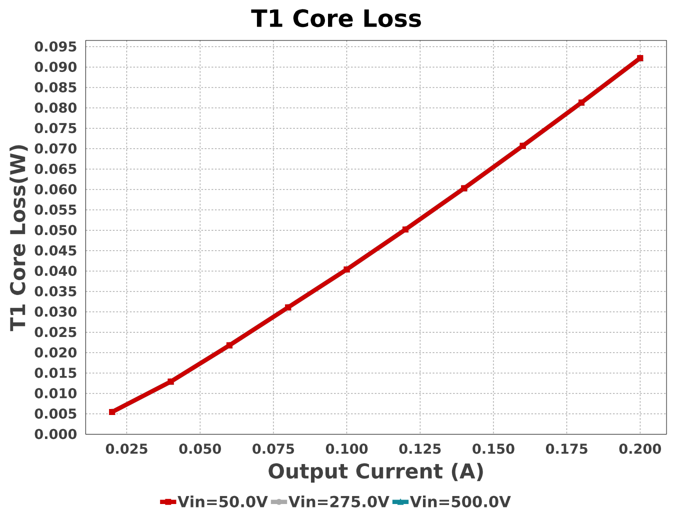

T1 Is1 RMS
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
T1 Is1 RMS(A)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

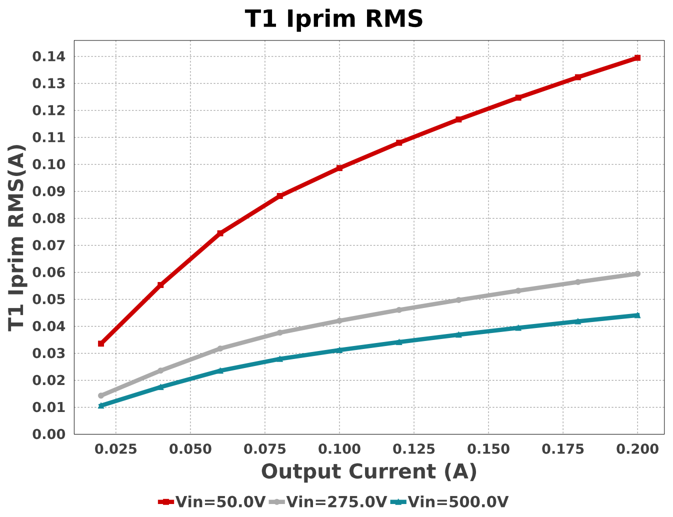

Diode2 Pd
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
Diode2 Pd(W)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

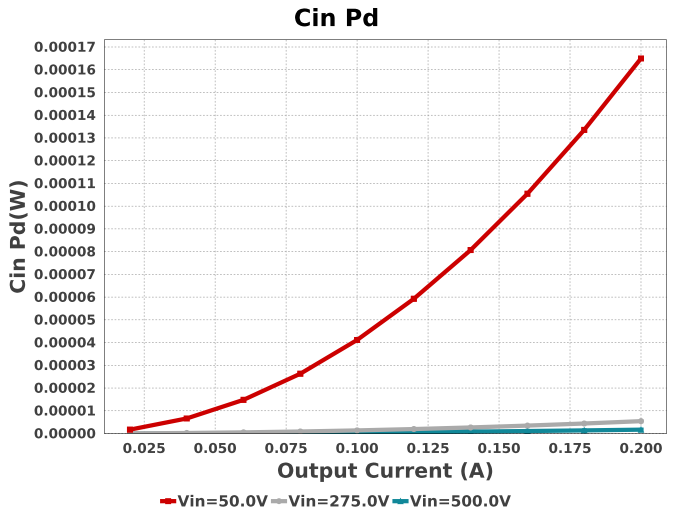

Efficiency
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
Efficiency(%)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

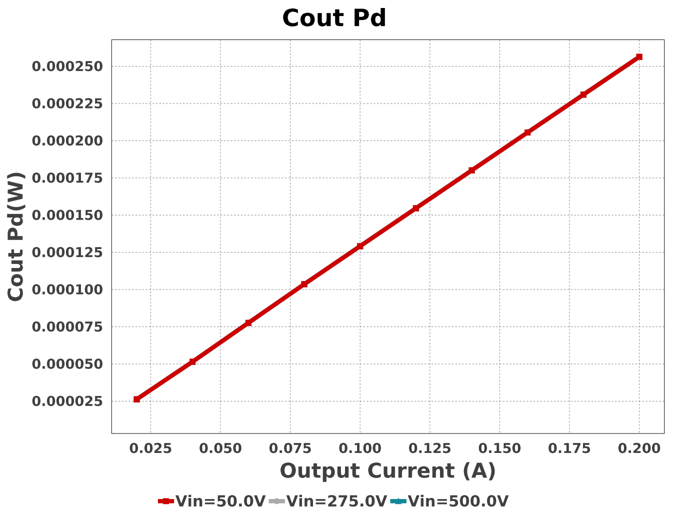

M1 TjOP
39.0
38.5
38.0
37.5
37.0
36.5
36.0
35.5
35.0
34.5
34.0
33.5
33.0
32.5
32.0
31.5
31.0
30.5
30.0
29.5
M1 TjOP(degC)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

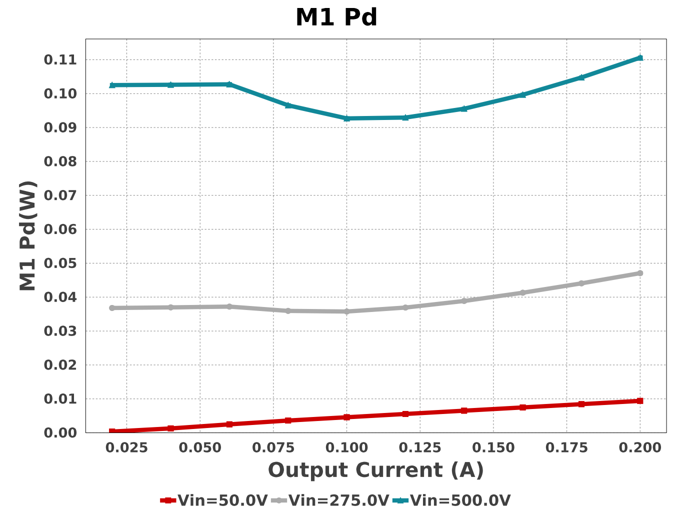

Vout p-p
0.00195
0.00190
0.00185
0.00180
0.00175
0.00170
0.00165
0.00160
0.00155
0.00150
0.00145
0.00140
0.00135
0.00130
0.00125
0.00120
0.00115
0.00110
0.00105
0.00100
Vout p-p(V)
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

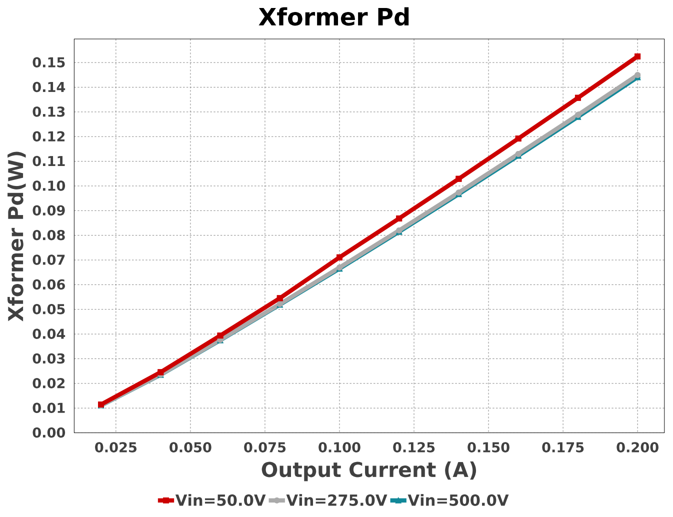

T1 Core Loss
T1 Core Loss(W)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

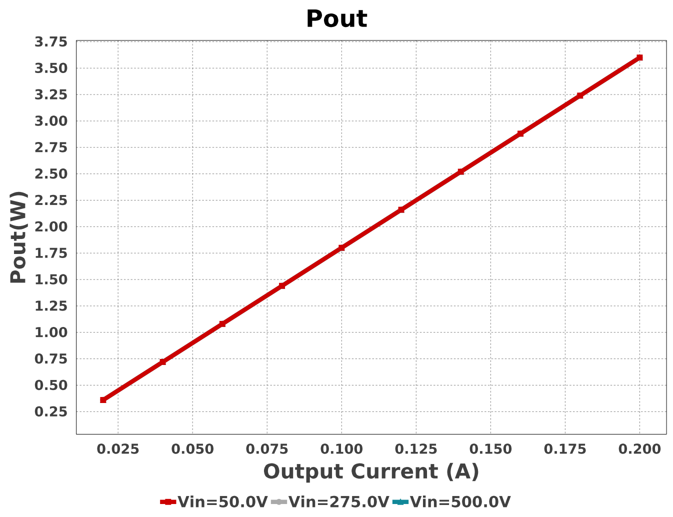

T1 Iprim RMS
T1 Iprim RMS(A)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

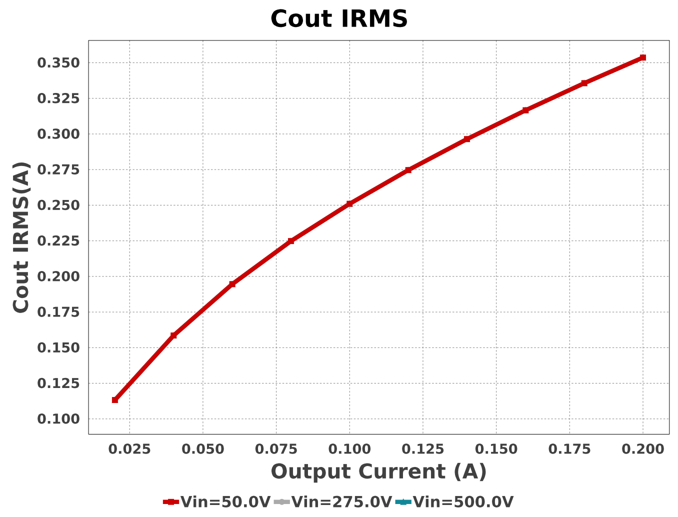

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

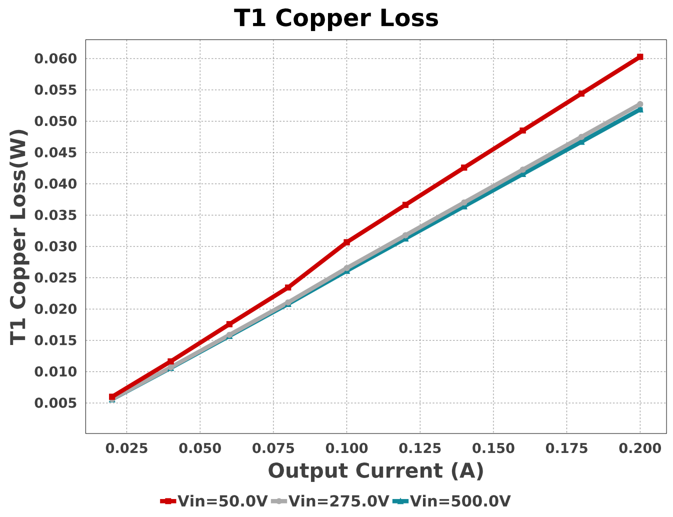

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

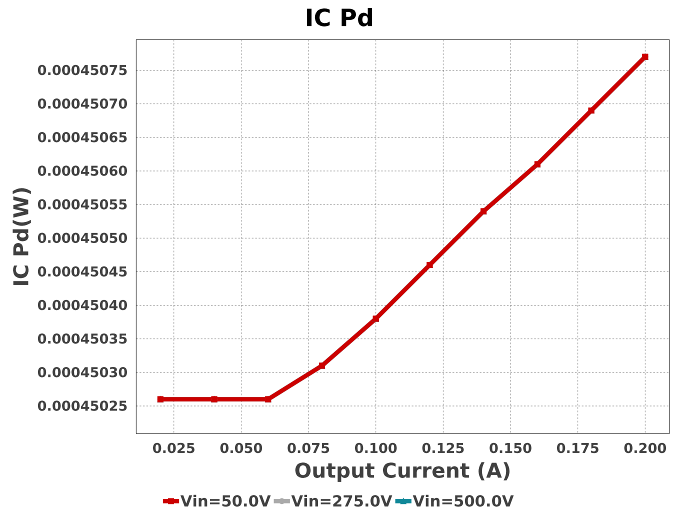

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V

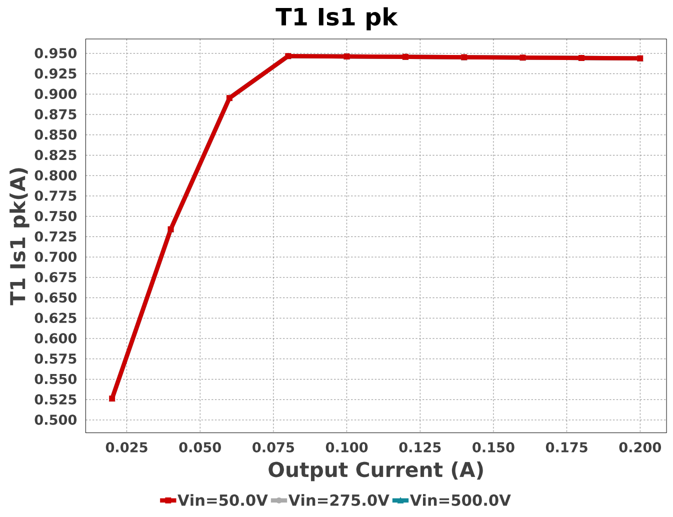

Xformer Pd
Xformer Pd(W)
Output Current (A)
Vin=50.0V Vin=275.0V Vin=500.0V











Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	4.5 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	164.94 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	353.634 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	256.37 µW	Capacitor	Output capacitor power dissipation
5.	Diode2 Pd	80.437 mW	Diode	Diode2 power dissipation
6.	IC Pd	450.77 µW	IC	IC power dissipation
7.	IC Tj	30.064 degC	IC	IC junction temperature
8.	ICThetaJA	141.5 degC/W	IC	IC junction-to-ambient thermal resistance
9.	M1 Pd	9.394 mW	Mosfet	M1 MOSFET total power dissipation
10.	M1 TjOP	30.789 degC	Mosfet	M1 MOSFET junction temperature
11.	Cin Pd	164.94 µW	Power	Input capacitor power dissipation

#	Name	Value	Category	Description
12.	Cout Pd	256.37 µW	Power	Output capacitor power dissipation
13.	Diode2 Pd	80.437 mW	Power	Diode2 power dissipation
14.	IC Pd	450.77 µW	Power	IC power dissipation
15.	M1 Pd	9.394 mW	Power	M1 MOSFET total power dissipation
16.	Snubber Pd	87.591 mW	Power	Snubber Power Dissipation
17.	T1 Copper Loss	65.739 mW	Power	Transformer Copper Loss Power Dissipation
18.	T1 Core Loss	86.5 mW	Power	Transformer Core Loss Power Dissipation
19.	Xformer Pd	152.24 mW	Power	Transformer power dissipation
20.	BOM Count	26	System Information	Total Design BOM count
21.	Duty Cycle	52.577 %	System Information	Duty cycle
22.	Efficiency	90.394 %	System Information	Steady state efficiency
23.	FootPrint	1.423 k mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	94.832 kHz	System Information	Switching frequency
25.	Frequency	94.832 kHz	System Information	Switching frequency
26.	Iout	200.0 mA	System Information	Iout operating point
27.	Mode	DCM	System Information	Conduction Mode
28.	Pout	3.6 W	System Information	Total output power
29.	Total BOM	NA	System Information	Total BOM Cost
30.	Vin	500.0 V	System Information	Vin operating point
31.	Vout	18.0 V	System Information	Operational Output Voltage
32.	Vout Actual	18.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
33.	Vout Tolerance	2.068 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
34.	Vout p-p	1.935 mV	System Information	Peak-to-peak output ripple voltage
35.	T1 Copper Loss	65.739 mW	Transformer	Transformer Copper Loss Power Dissipation
36.	T1 Core Loss	86.5 mW	Transformer	Transformer Core Loss Power Dissipation
37.	T1 Iprim RMS	139.486 mA	Transformer	Transformer Primary RMS Current
38.	T1 Iprim pk	333.19 mA	Transformer	Transformer Primary Peak Current
39.	T1 Is1 RMS	355.726 mA	Transformer	Transformer Secondary1 RMS Current
40.	T1 Is1 pk	943.899 mA	Transformer	Transformer Secondary1 Peak Current
41.	Xformer Pd	152.24 mW	Transformer	Transformer power dissipation

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	500.0	Maximum input voltage
VinMin	50.0	Minimum input voltage
Vout	18.0	Output Voltage
base_pn	UCC28740	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

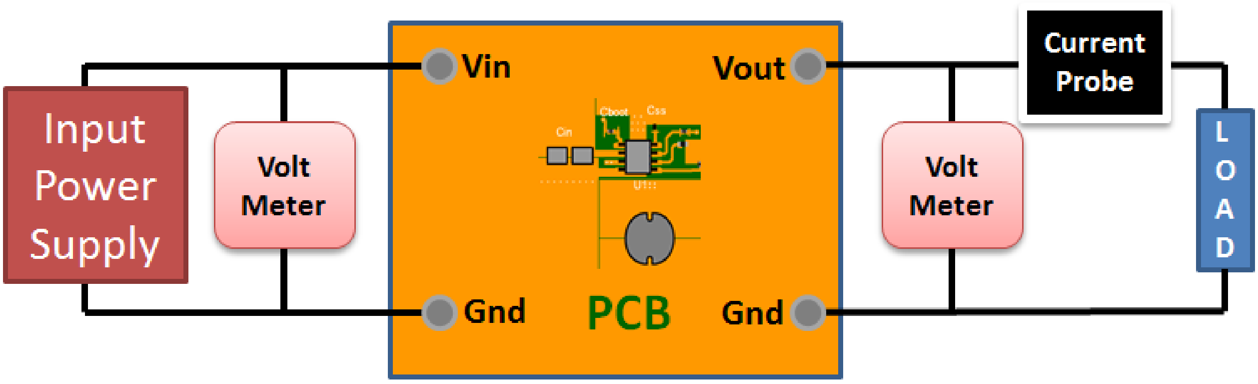
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 50.0V 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.



WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B65807J0000R049
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B65808E1508T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	38.0
AWG	30.0
Layers	2.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	13.0
AWG	35.0
Layers	1.0
Strands	1.0
Insulation Type	Triple Insulated

Auxiliary

Turns	13.0
AWG	28.0
Layers	1.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	30.0	19	Clockwise
Auxiliary	28.0	13.0	Counter Clockwise
Triple Insulated Secondary	35.0	13.0	Counter Clockwise
Primary Second 1/2.0	30.0	19	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	8.32E-4H
2.	Inductance Factor(Al)	577.0nH
3.	Npri	38.0
4.	Nsec	13.0
5.	Naux	13.0
6.	Core Type	RM6
7.	Core Material	N49

#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	90.00kHz
10.	DMax	0.49
11.	Ipk(Primary)	0.33A
12.	Irms(Primary)	0.13A
13.	Ipk(Secondary)	0.97A
14.	Irms(Secondary)	0.37A

Design Assistance

1. Application Hints Rlc Rlc provides the function of feed-forward line compensation to eliminate change in IPP due to change in di/dt and the propagation delay of the internal comparator and MOSFET turn-off time. For best results the chosen value may need to be adjusted based on board, FET and transformer parasitics. Rtl Rtl is added to prevent excessive diode current and limit Iopt to the maximum value necessary for regulationThe Rtl value may be adjusted for optimal limiting later during the porotype evaluation process. Rfbt & Rfbb The feedback resistors will set the output voltage of the circuit. The values chosen may need to be fined tuned based on the final Transformer turns ratios and the voltage across the output diode at close to zero current. Rfb3 & Cfb3 Rfb3 is necessary to limit the current into FB and to avoid excess draining of Cvdd during this type of transient situation.The value of Rfb3 is chosen to limit the excess Ifb and Rfb4 current to an acceptable level when the optocoupler is saturatedCfb3 helps improve the transient response and is estimated initially by equating the time constant to 1ms. This can later beadjusted for optimal performance during prototype evaluation Rfb4 Rfb4 speeds up the turnoff time of the optocoupler in the case of a heavy load-step transient condition. This value tends to fallwithin the range of 10k and 100k. A tradeoff must be made between a lower value for faster transient response and a higher value forlower standby power. Rfb4 also serves to set a minimum bias current for the optocoupler and to drain dark current Part Description The UCC28740 isolated-flyback controller provides Constant-Voltage (CV) using an optical coupler toimprove transient response. Constant-Current (CC) regulation is accomplished through Primary Side Regulation (PSR) techniques. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28740.pdf

2. Master key : 4252A3B24B4CB103[v1]

3. **UCC28740** Product Folder : http://www.ti.com/product/UCC28740 : contains the data sheet and other resources.