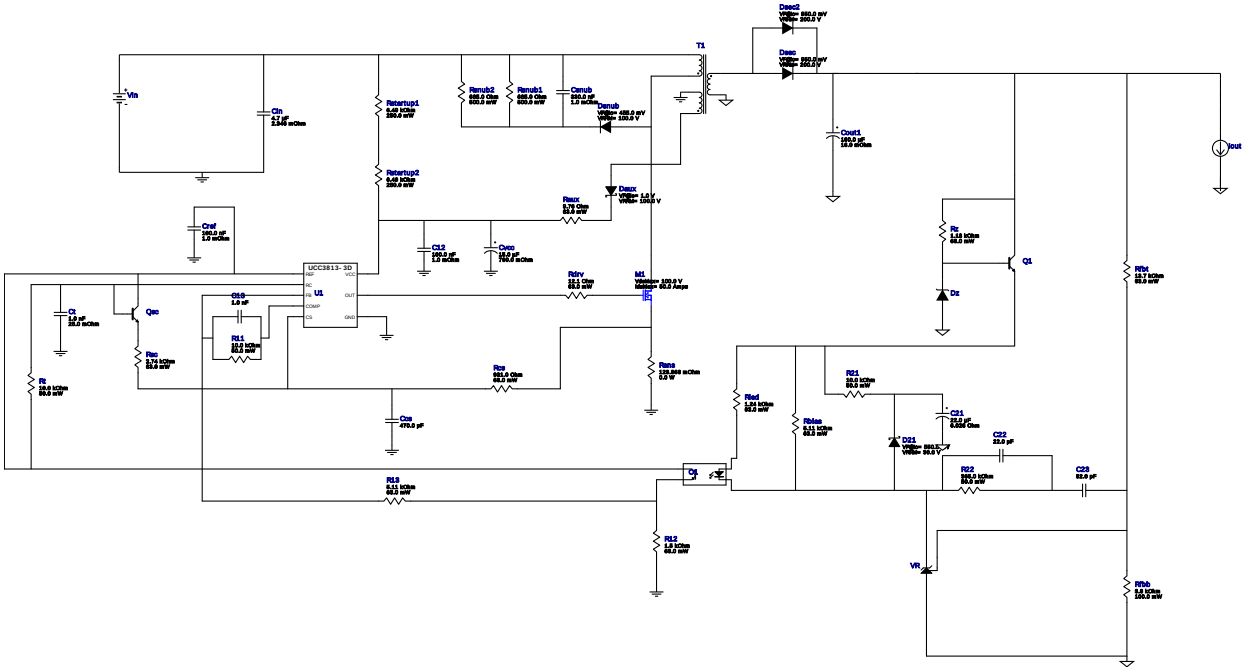
WEBENCH® Design Report

VinMin = 7.5V
VinMax = 30.0V
Vout = 12.0V
Iout = 1.0A

Device = UCC3813DTR-3
Topology = Flyback
Created = 2018-12-19 06:53:35.537
BOM Cost = NA
BOM Count = 45
Total Pd = 2.19W

Design : 952 UCC3813DTR-3
UCC3813DTR-3 7.5V-30V to 12.00V @ 1A

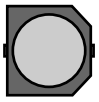
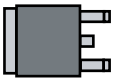
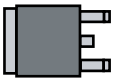
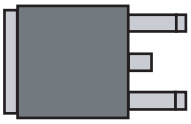


Design Alerts

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.

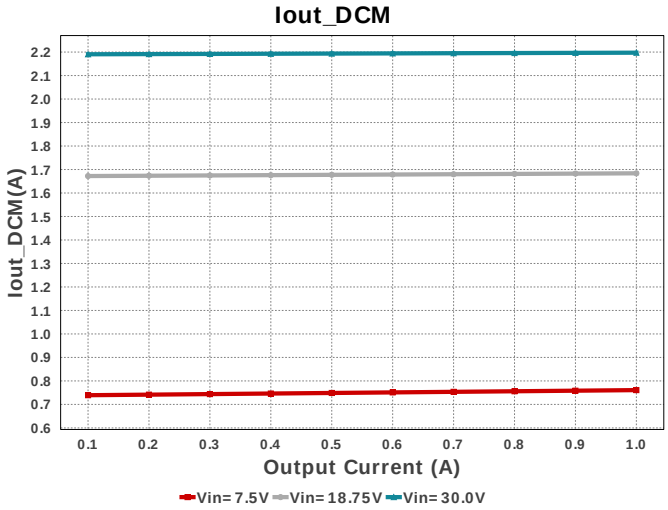
Electrical BOM

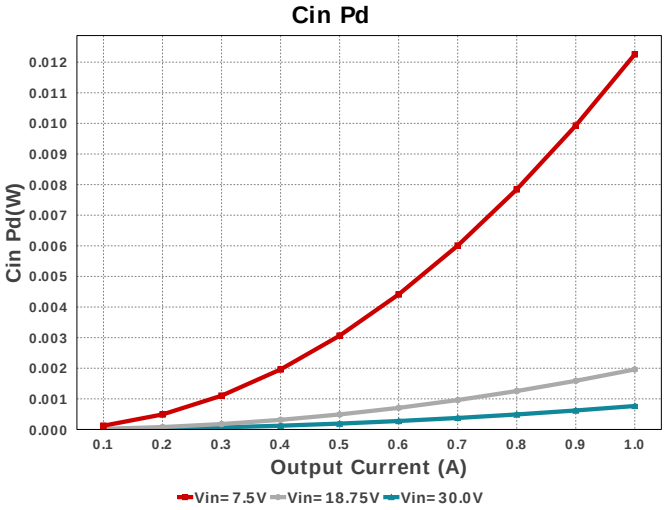
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	MuRata	GRM155R61C104KA88D Series= X5R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
C13	MuRata	GRM1885C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
C21	Panasonic	EEUFC1H220 Series= FC	Cap= 22.0 uF ESR= 6.028 Ohm VDC= 50.0 V IRMS= 155.0 mA	1	$0.06	Panasonic_500x1100 49 mm^2
C22	Samsung Electro-Mechanics	CL21C220KBANNNC Series= C0G/NP0	Cap= 22.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
C23	Samsung Electro-Mechanics	CL21C820JBANNNC Series= C0G/NP0	Cap= 82.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccs	AVX	04025A471JAT2A Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2

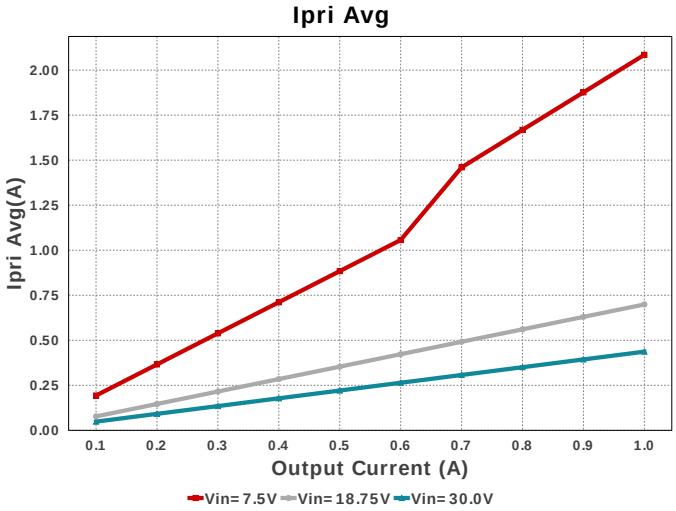
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	C2012X6S1H475K125AC Series= X6S	Cap= 4.7 uF ESR= 2.346 mOhm VDC= 50.0 V IRMS= 4.2602 A	1	$0.20	 0805 7 mm^2
Cout1	Panasonic	25SVPF180M Series= SVPF	Cap= 180.0 uF ESR= 16.0 mOhm VDC= 25.0 V IRMS= 4.65 A	1	$0.66	 CAPSMT_62_E12 106 mm^2
Cref	MuRata	GRM155R61C104KA88D Series= X5R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm^2
Csnub	Kemet	C0603C334Z3VACTU Series= Y5V	Cap= 330.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.09	 0603 5 mm^2
Ct	Kemet	C0805C102J1GACTU Series= C0G/NP0	Cap= 1.0 nF ESR= 25.0 mOhm VDC= 100.0 V IRMS= 1.71 A	1	$0.10	 0805 7 mm^2
Cvcc	Nichicon	UUD1E150MCL1GS Series= uD	Cap= 15.0 uF ESR= 760.0 mOhm VDC= 25.0 V IRMS= 150.0 mA	1	$0.11	 SM_RADIAL_5MM 58 mm^2
D21	Panasonic	DB2S31600L	VF@Io= 550.0 mV VRRM= 30.0 V	1	$0.04	 SOD-523 5 mm^2
Daux	Comchip Technology	CDBW46-G	VF@Io= 1.0 V VRRM= 100.0 V	1	$0.03	 SOD-123 13 mm^2
Dsec	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
Dsec2	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm^2
Dsnub	STMicroelectronics	STPS20M100SG-TR	VF@Io= 455.0 mV VRRM= 100.0 V	1	$1.39	 DDPAK 210 mm^2
Dz	ON Semiconductor	MMBZ5239BLT1G	Zener	1	$0.03	 SOT-23 14 mm^2
M1	Texas Instruments	CSD19537Q3	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.41	 DQG0008A 18 mm^2
O1	Fairchild Semiconductor	FOD817A	Optocoupler	1	$0.13	 DIP-4 71 mm^2
Q1	Diodes Inc.	MMBT3904-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm^2
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	$1.02	 TO-18 57 mm^2
R11	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm^2

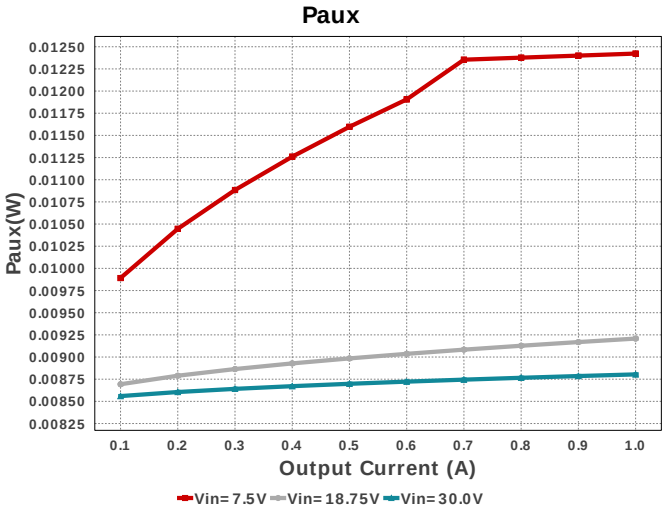
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R12	Vishay-Dale	CRCW04021K50FKED Series= CRCW..e3	Res= 1.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
R13	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
R21	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
R22	Yageo	RC0201FR-07365KL Series= ?	Res= 365.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Raux	Vishay-Dale	CRCW04029R76FKED Series= CRCW..e3	Res= 9.76 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rbias	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	Vishay-Dale	CRCW0402931RFKED Series= CRCW..e3	Res= 931.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rdrv	Vishay-Dale	CRCW040212R1FKED Series= CRCW..e3	Res= 12.1 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0603FR-073K6L Series= ?	Res= 3.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rled	Vishay-Dale	CRCW04021K24FKED Series= CRCW..e3	Res= 1.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsc	Vishay-Dale	CRCW04022K74FKED Series= CRCW..e3	Res= 2.74 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsns	CUSTOM	CUSTOM Series= ?	Res= 123.863 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rsnub1	Panasonic	ERJ14NF6650U Series= ERJ-14	Res= 665.0 Ohm Power= 500.0 mW Tolerance= 1.0%	1	NA	1210 15 mm^2
Rsnub2	Panasonic	ERJ14NF6650U Series= ERJ-14	Res= 665.0 Ohm Power= 500.0 mW Tolerance= 1.0%	1	NA	1210 15 mm^2
Rstartup1	Vishay-Dale	CRCW12066K49FKEA Series= CRCW..e3	Res= 6.49 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rstartup2	Vishay-Dale	CRCW12066K49FKEA Series= CRCW..e3	Res= 6.49 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rz	Vishay-Dale	CRCW04021K18FKED Series= CRCW..e3	Res= 1.18 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

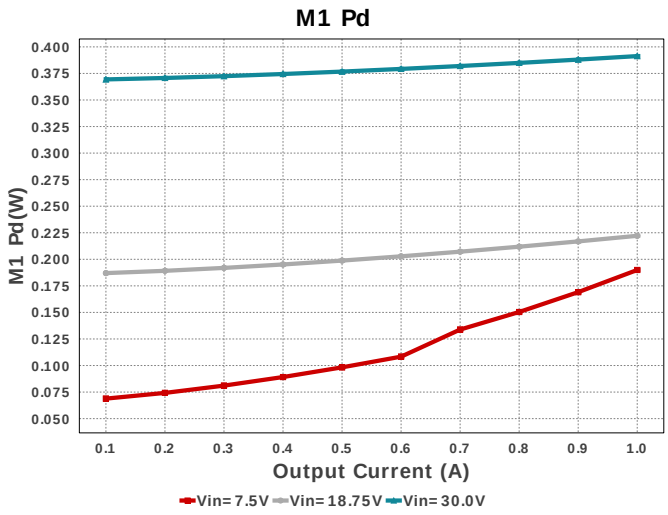
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
T1	Core=TDK , CoilFormer=TDK	Core=B65807P0000R049 , CoilFormer=B65808E1508T001	Lp= 9.0 µH Turns Ratio(Nas)= 8:10 Turns Ratio(Nps)= 7:10 Npri= 7.0 Naux= 8.0 Nsec= 10.0	1	$0.59	 TDK_B65803 271 mm^2
U1	Texas Instruments	UCC3813DTR-3	Switcher	1	$1.14	 D0008A 57 mm^2
VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	 DBZ0003A 14 mm^2

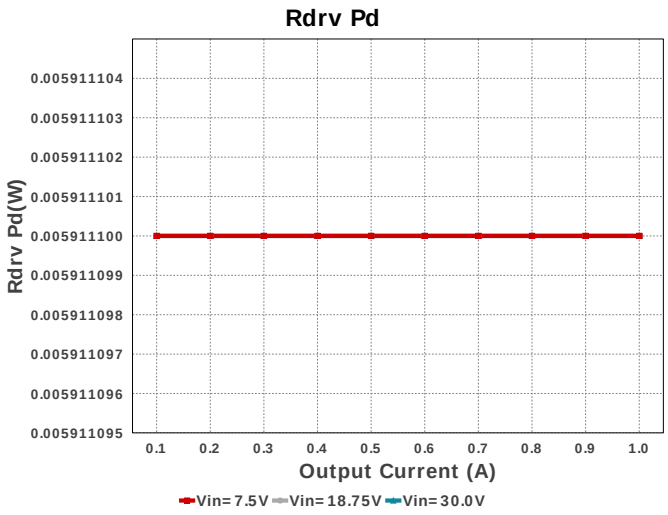


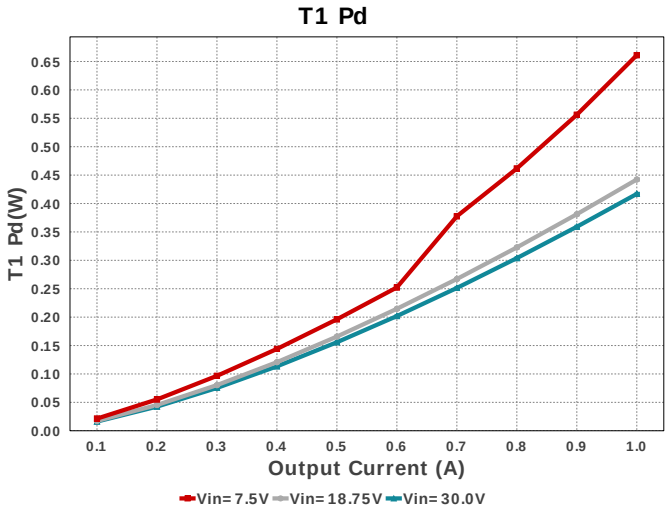


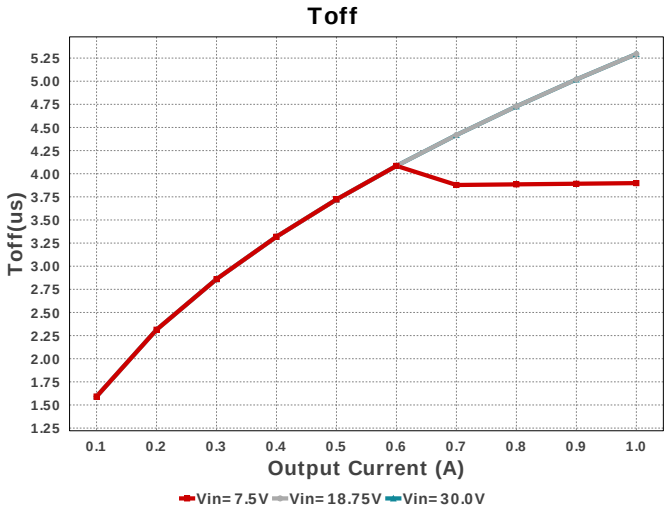


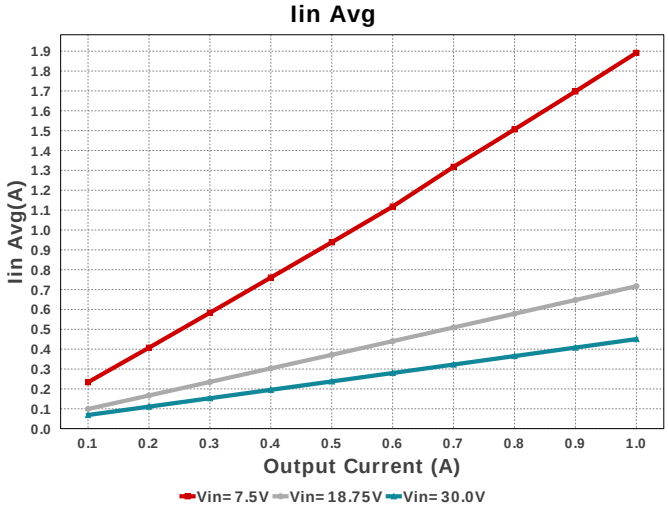


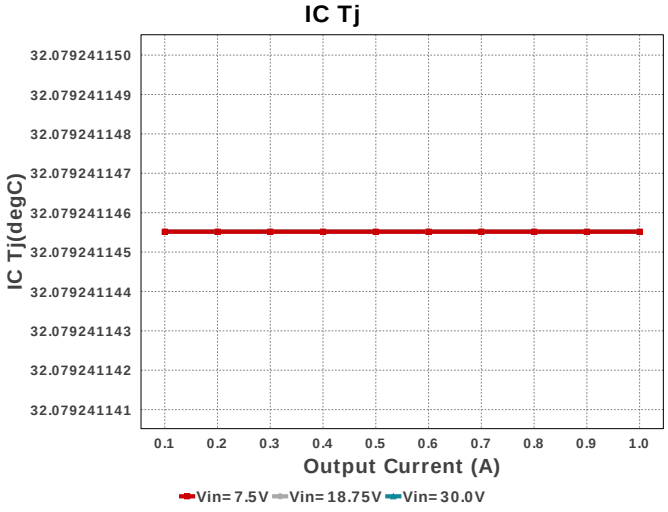


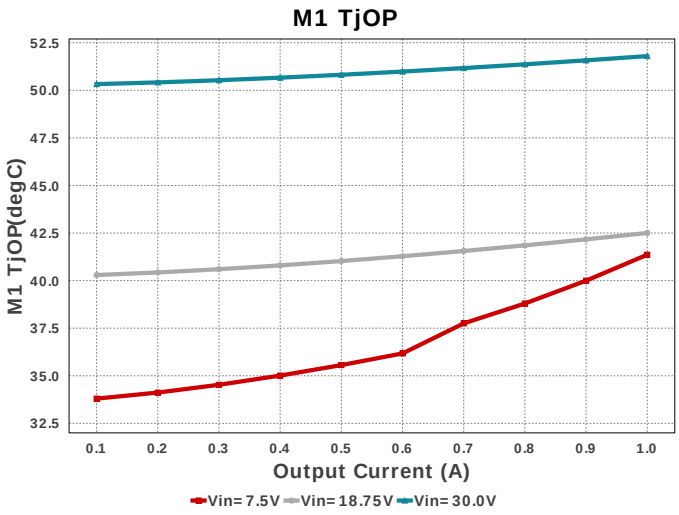


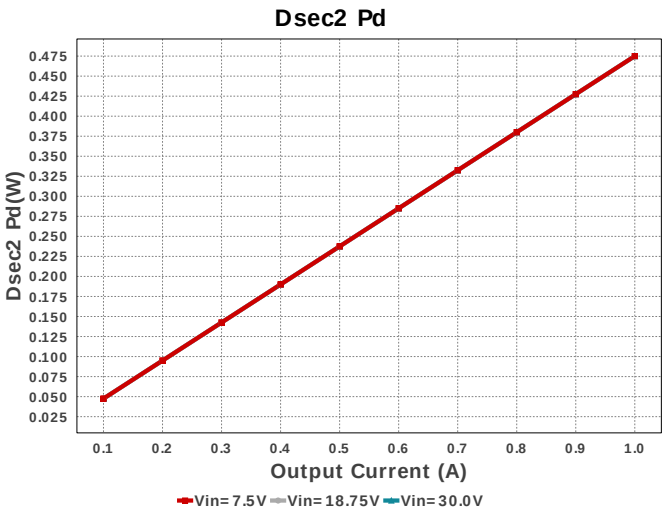


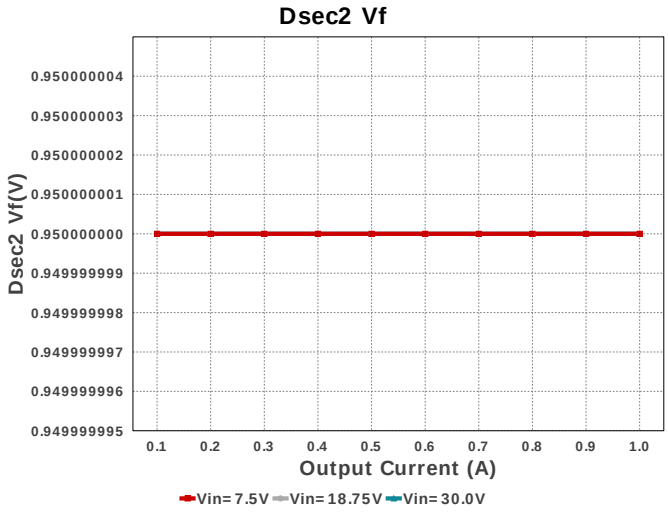


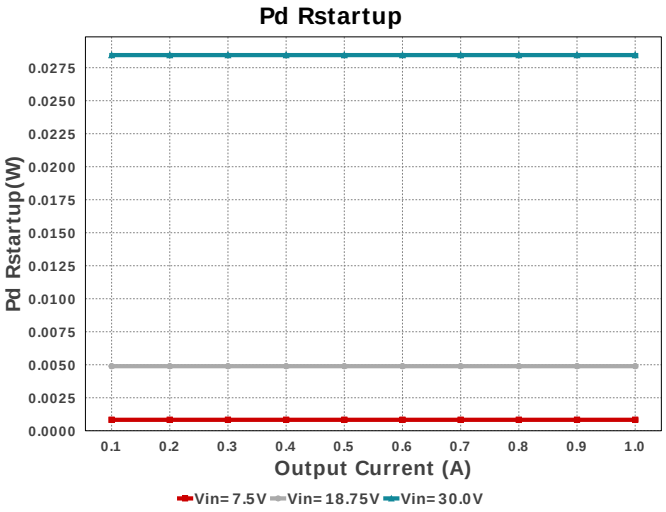


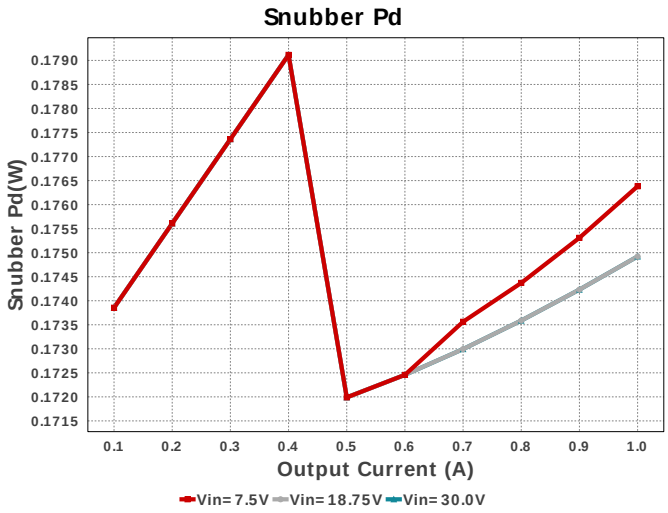


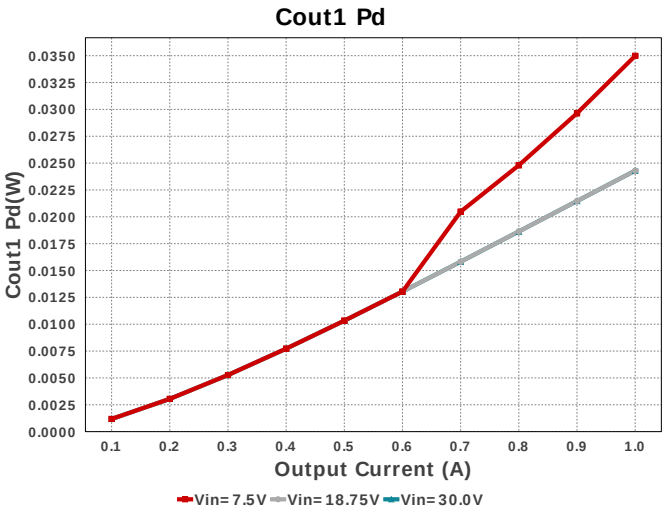


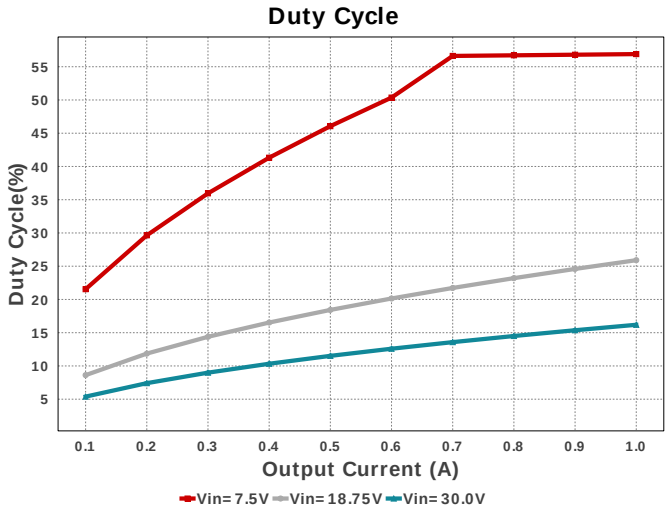


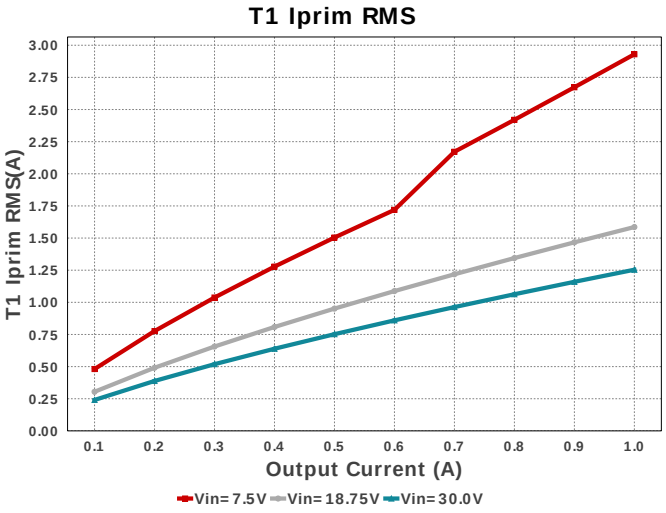


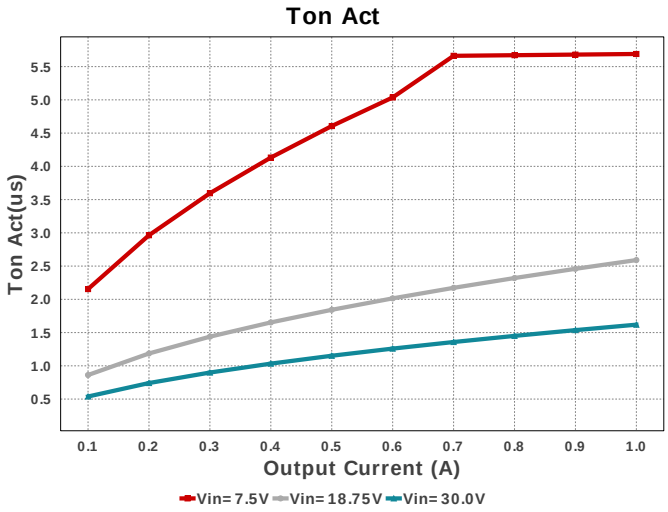


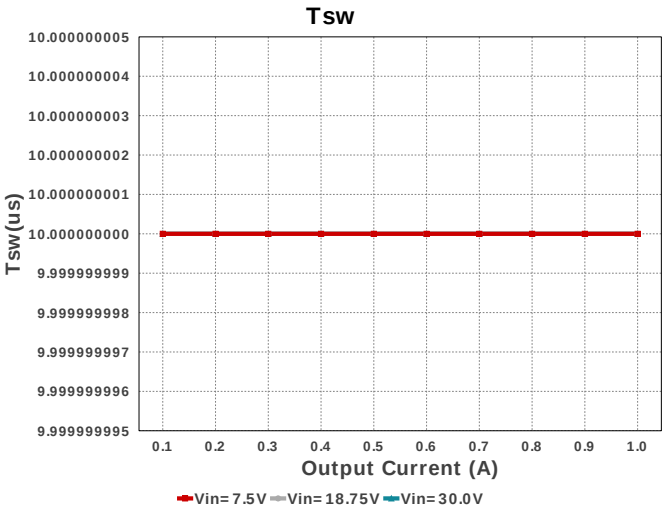


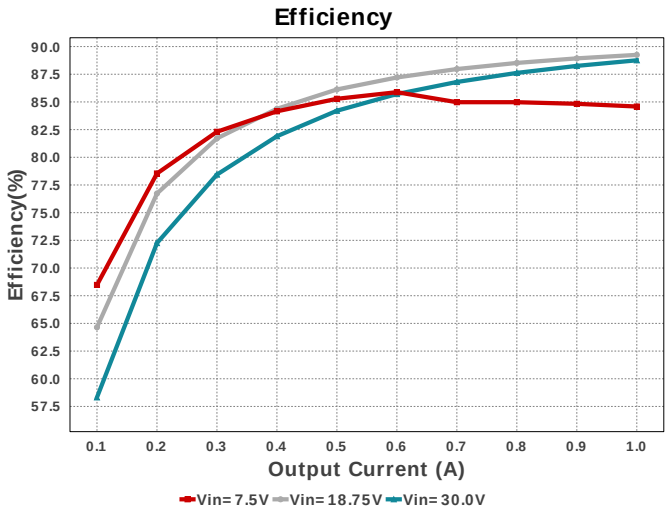


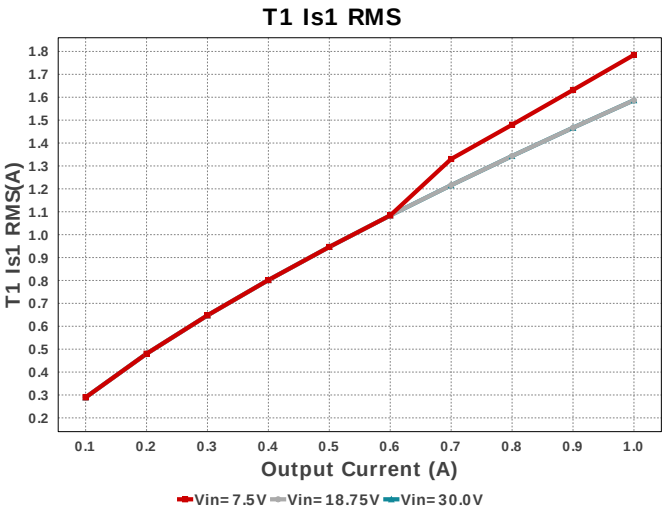


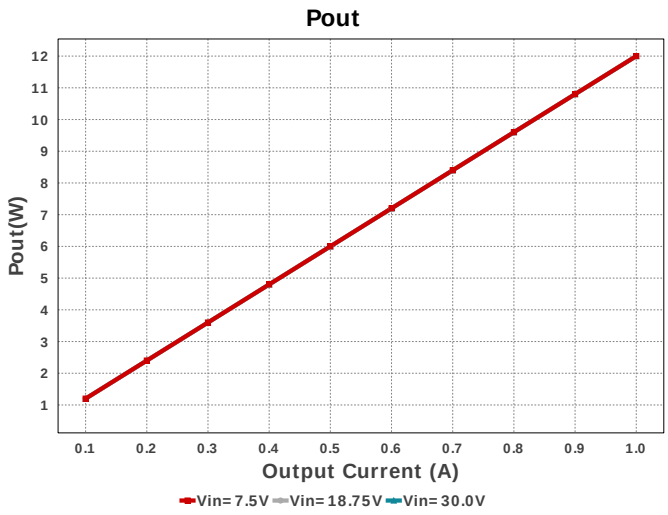


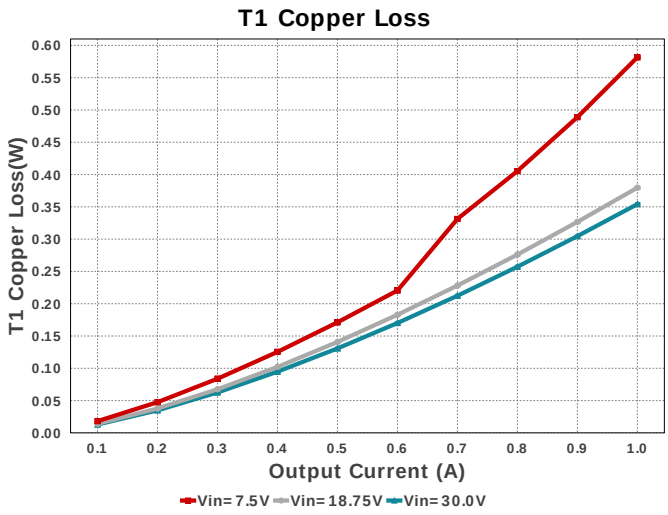


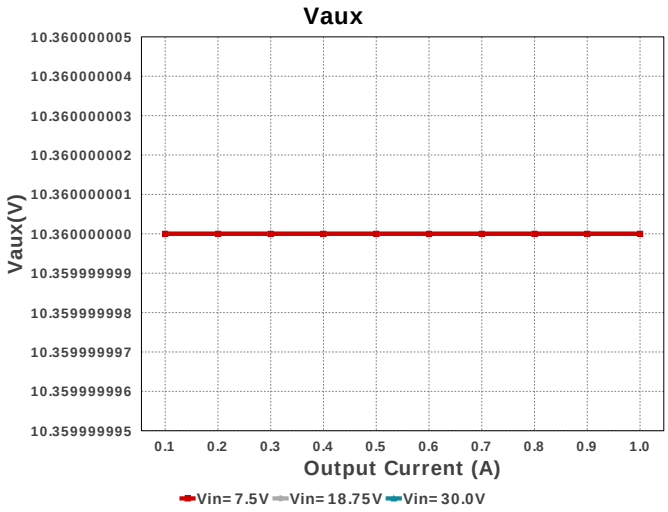


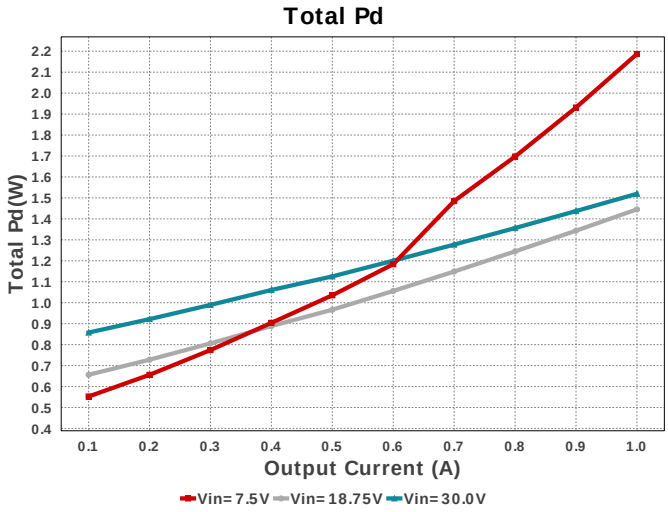


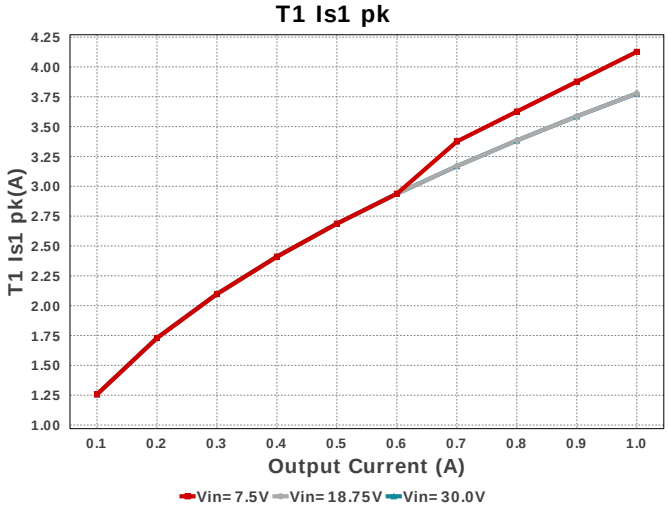


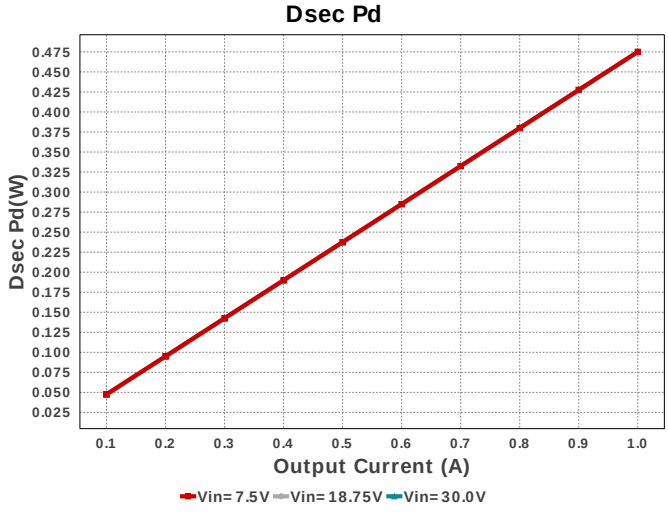


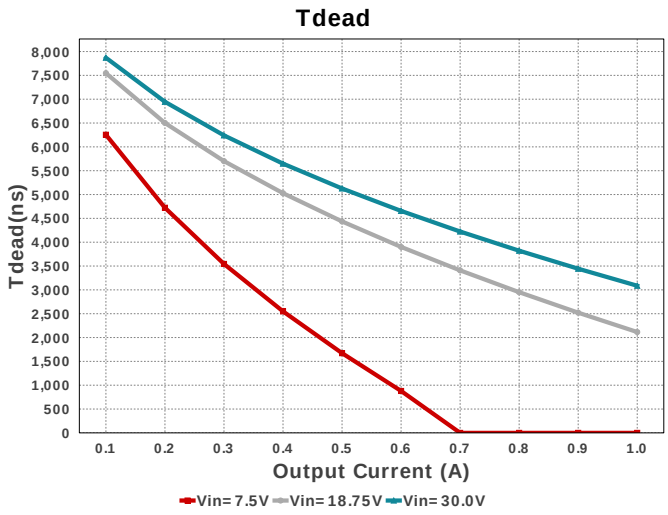


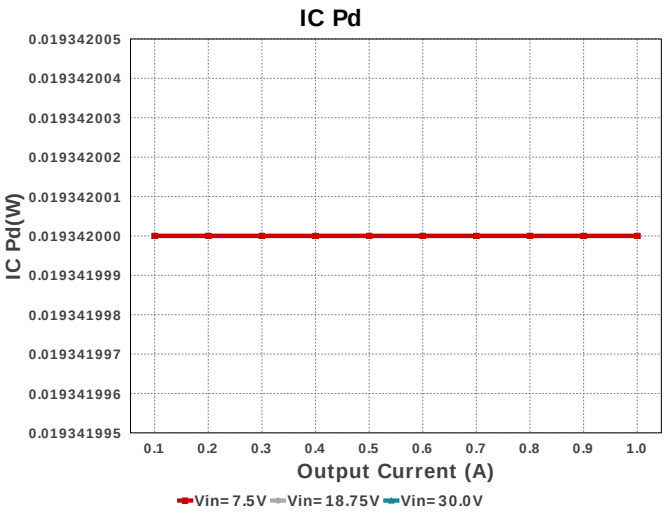


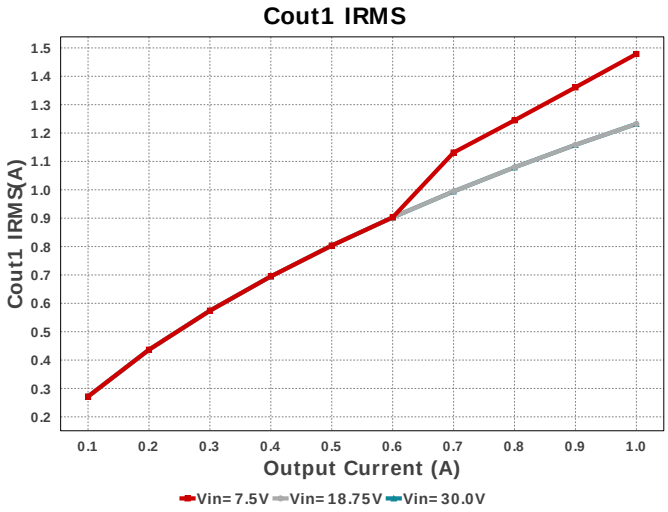


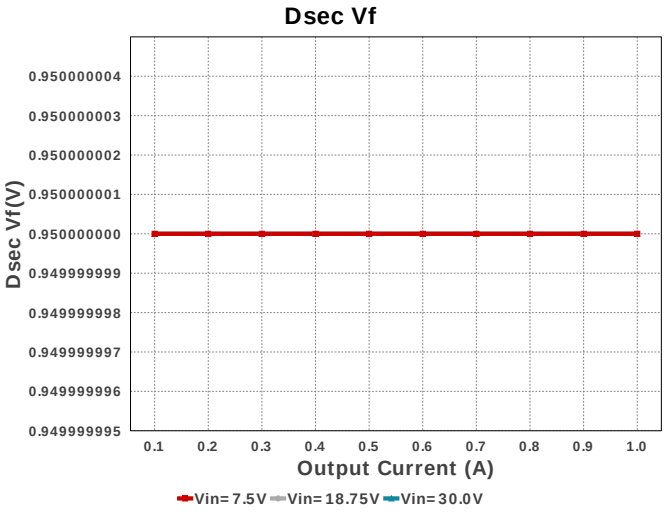


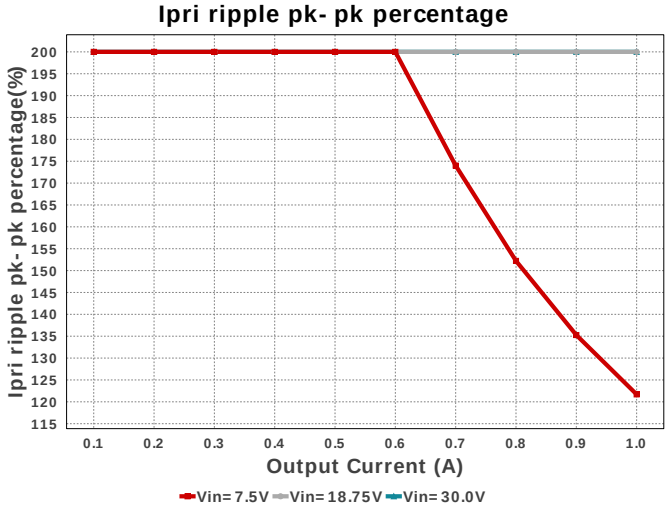


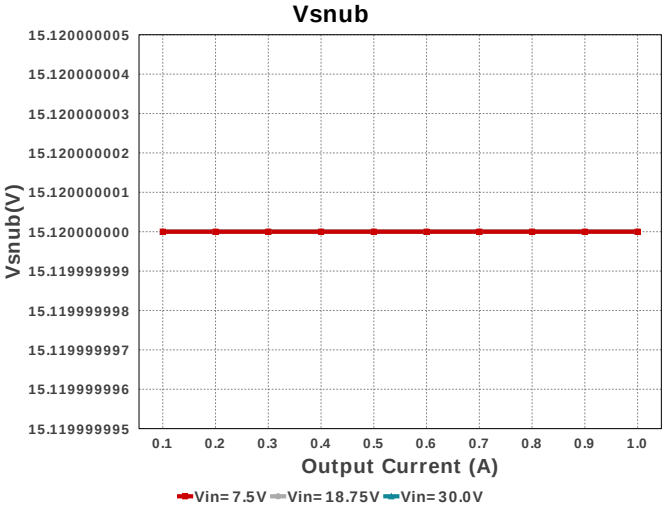


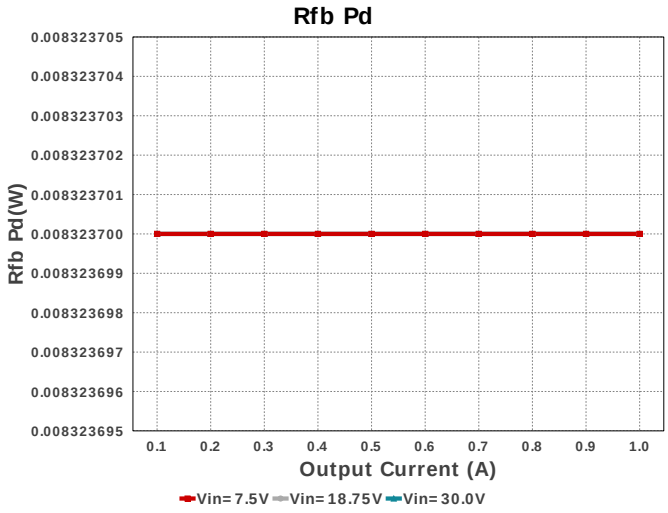


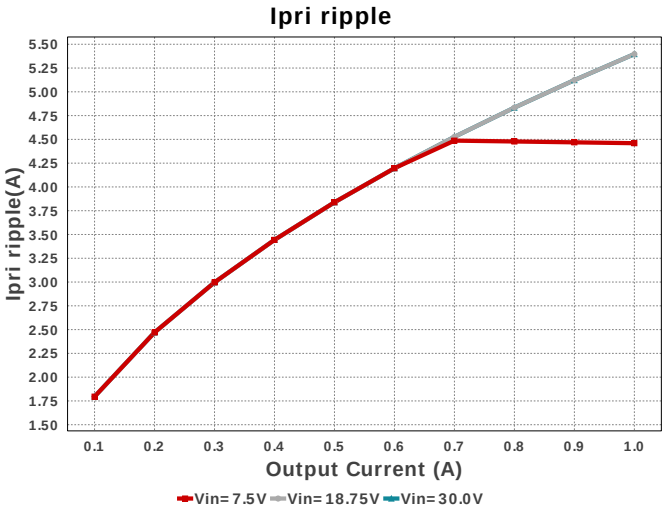


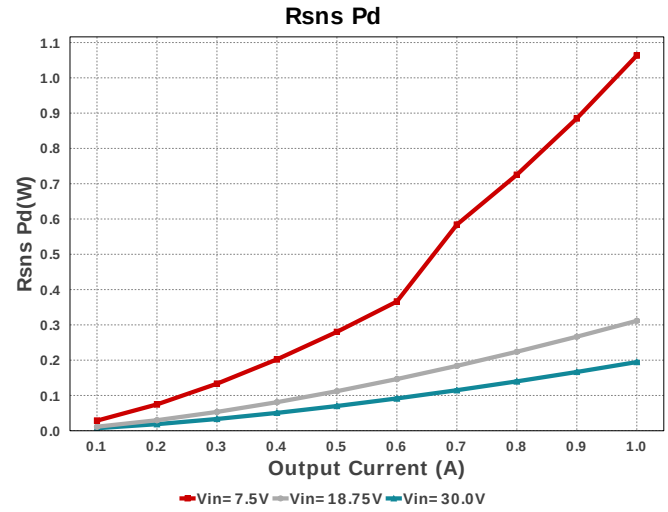


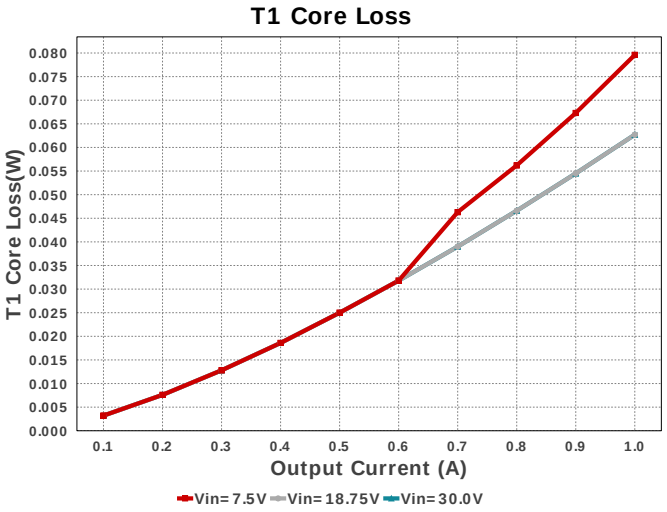


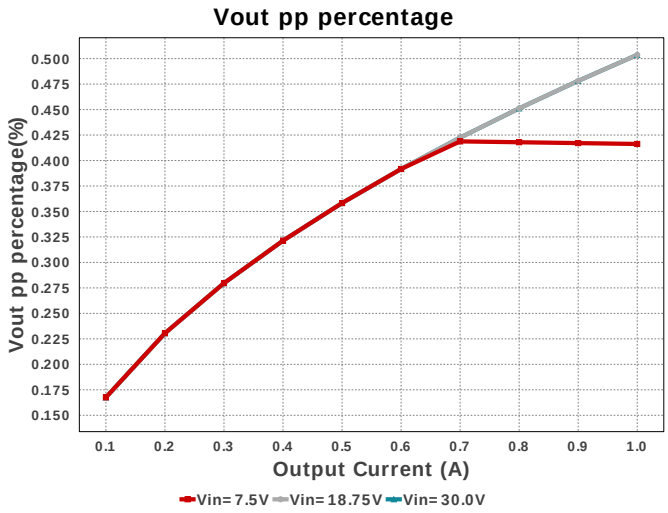


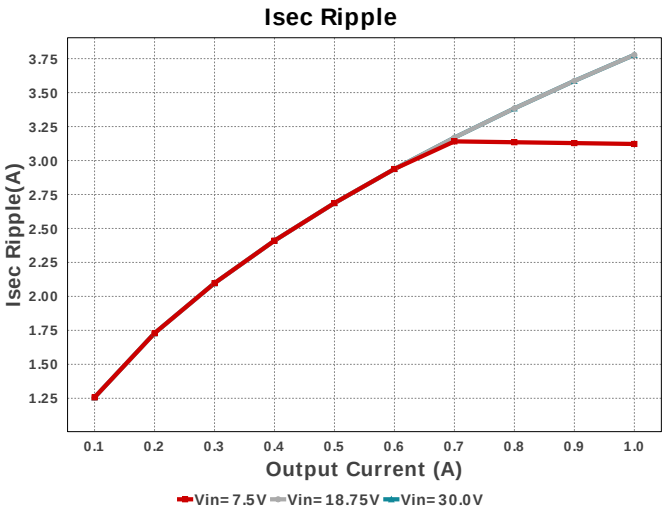


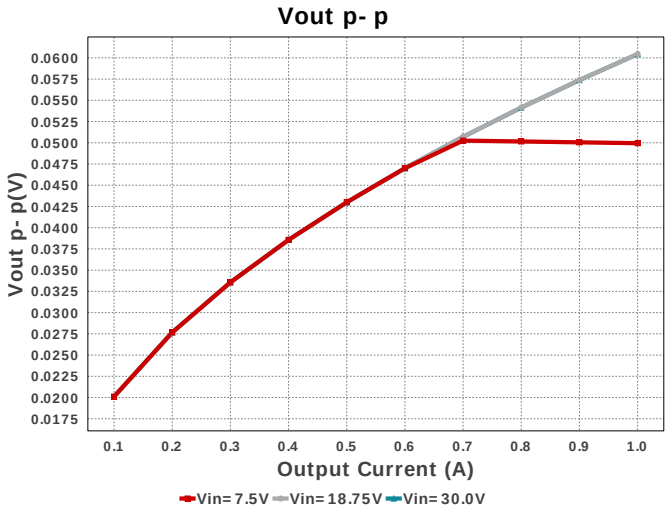


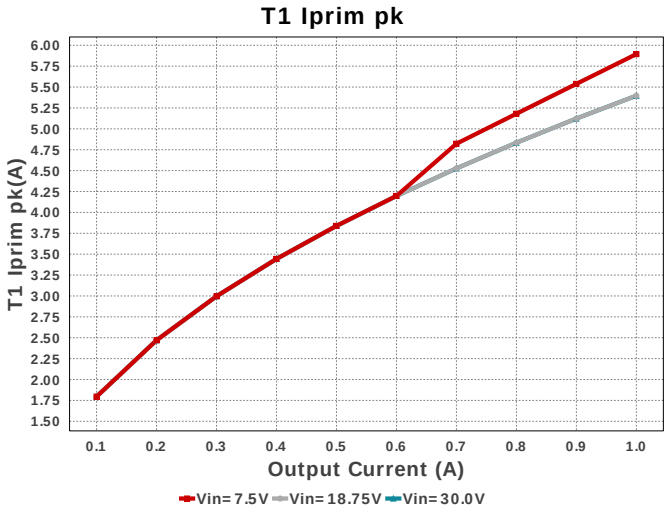












Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	12.257 mW	Capacitor	Input capacitor power dissipation
2.	Cout1 IRMS	1.479 A	Capacitor	Output capacitor1 RMS ripple current
3.	Cout1 Pd	34.98 mW	Capacitor	Output capacitor1 power dissipation
4.	Daux trr	0.0 ns	Diode	Auxiliary Diode Reverse Recovery Time
5.	Dsec Pd	475.0 mW	Diode	Secondary Diode Power Dissipation
6.	Dsec Vf	950.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
7.	Dsec trr	0.0 ns	Diode	Output Diode Reverse Recovery Time
8.	Dsec2 Pd	475.0 mW	Diode	Secondary Diode Power Dissipation
9.	Dsec2 Vf	950.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
10.	Dsnub trr	0.0 ns	Diode	Snubber Diode Reverse Recovery Time
11.	IC Pd	19.342 mW	IC	IC power dissipation
12.	IC Tj	32.079 degC	IC	IC junction temperature
13.	ICThetaJA	107.5 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	1.892 A	IC	Average input current
15.	M1 Pd	189.95 mW	Mosfet	M1 MOSFET total power dissipation
16.	M1 TjOP	41.361 degC	Mosfet	M1 MOSFET junction temperature
17.	Cin Pd	12.257 mW	Power	Input capacitor power dissipation
18.	Cout1 Pd	34.98 mW	Power	Output capacitor1 power dissipation
19.	Dsec Pd	475.0 mW	Power	Secondary Diode Power Dissipation
20.	Dsec2 Pd	475.0 mW	Power	Secondary Diode Power Dissipation
21.	IC Pd	19.342 mW	Power	IC power dissipation
22.	M1 Pd	189.95 mW	Power	M1 MOSFET total power dissipation
23.	Paux	12.423 mW	Power	Power Dissipation in Raux and Daux
24.	Pd Rstartup	829.8 µW	Power	Power Dissipation in Rstartup1 and Rstartup2
25.	Rdrv Pd	5.911 mW	Power	Power Dissipation in Gate Drive Resistor
26.	Rfb Pd	8.324 mW	Power	Rfb Power Dissipation
27.	Rsns Pd	1.063 W	Power	Current Limit Sense Resistor Power Dissipation
28.	Snubber Pd	176.381 mW	Power	Snubber Power Dissipation
29.	T1 Copper Loss	419.46 mW	Power	Transformer Copper Loss Power Dissipation
30.	T1 Core Loss	74.5 mW	Power	Transformer Core Loss Power Dissipation
31.	T1 Pd	493.96 mW	Power	Estimated Losses in Transformer
32.	Total Pd	2.187 W	Power	Total Power Dissipation
33.	Pd Rstartup	829.8 µW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
34.	Rdrv Pd	5.911 mW	Resistor	Power Dissipation in Gate Drive Resistor
35.	Rfb Pd	8.324 mW	Resistor	Rfb Power Dissipation
36.	Rsns Pd	1.063 W	Resistor	Current Limit Sense Resistor Power Dissipation
37.	BOM Count	45	System Information	Total Design BOM count
38.	Duty Cycle	56.899 %	System Information	Duty cycle
39.	Efficiency	84.586 %	System Information	Steady state efficiency
40.	FootPrint	1.306 k mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	100.0 kHz	System Information	Switching frequency
42.	Iout	1.0 A	System Information	Iout operating point
43.	Iout_DCM	760.897 mA	System Information	Approximate Current below which DCM mode of operation will begin
44.	Mode	CCM	System Information	Conduction Mode

#	Name	Value	Category	Description
45.	Pout	12.0 W	System Information	Total output power
46.	Tdead	0.0 ns	System Information	Approximate Dead Time of the Regulator
47.	Toff	3.898 us	System Information	Approximate Converter Off Time
48.	Ton Act	5.69 us	System Information	Approximate Converter On Time
49.	Total BOM	NA	System Information	Total BOM Cost
50.	Tsw	10.0 us	System Information	Switching Time Period
51.	Vin	7.5 V	System Information	Vin operating point
52.	Vout	12.0 V	System Information	Operational Output Voltage
53.	Vout Actual	11.99 V	System Information	Vout Actual calculated based on selected voltage divider resistors
54.	Vout Tolerance	1.926 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
55.	Vout p-p	49.949 mV	System Information	Peak-to-peak output ripple voltage
56.	Vout pp percentage	416.245 m%	System Information	Output Voltage ripple percentage
57.	Vsnub	15.12 V	System Information	Voltage Across the Snubber
58.	Ipri Avg	2.085 A	Transformer	Average Current in Primary Winding over the complete Switching Period
59.	Ipri ripple	4.46 A	Transformer	Ripple Current in the Primary Winding
60.	Ipri ripple pk-pk percentage	121.698 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
61.	Isec Ripple	3.122 A	Transformer	Ripple Current in the Secondary Winding
62.	Paux	12.423 mW	Transformer	Power Dissipation in Raux and Daux
63.	T1 Copper Loss	419.46 mW	Transformer	Transformer Copper Loss Power Dissipation
64.	T1 Core Loss	74.5 mW	Transformer	Transformer Core Loss Power Dissipation
65.	T1 Iprim RMS	2.93 A	Transformer	Transformer Primary RMS Current
66.	T1 Iprim pk	5.894 A	Transformer	Transformer Primary Peak Current
67.	T1 Is1 RMS	1.785 A	Transformer	Transformer Secondary1 RMS Current
68.	T1 Is1 pk	4.126 A	Transformer	Transformer Secondary1 Peak Current
69.	T1 Pd	493.96 mW	Transformer	Estimated Losses in Transformer
70.	Vaux	10.36 V	Transformer	Auxiliary Voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	30.0	Maximum input voltage
VinMin	7.5	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	UCC3813-3	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

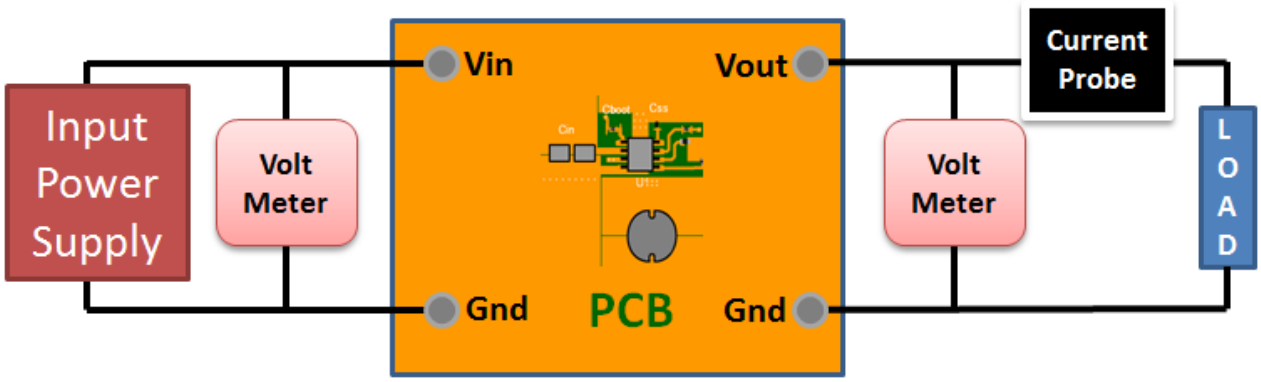
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 7.5V 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	B65807P0000R049
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B65808E1508T001
4.	Coil Former Manufacturer	TDK

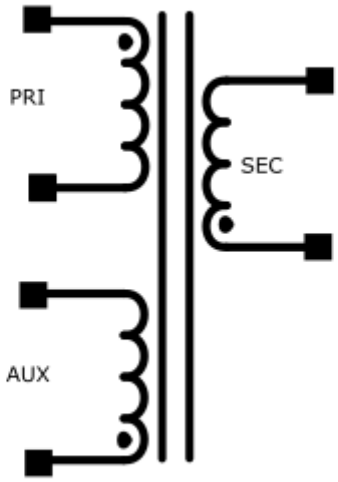
Transformer Electrical Diagram

Primary

Turns	7.0
AWG	27.0
Layers	2.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire

Auxiliary

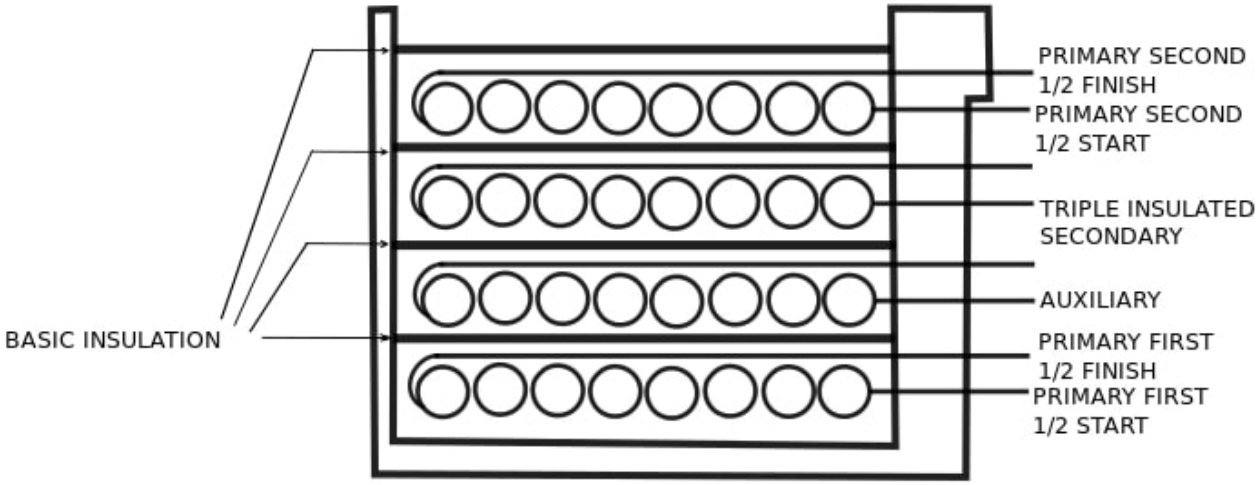
Turns	8.0
AWG	28.0
Layers	1.0
Strands	2.0
Insulation Type	Heavy Insulated Magnet Wire



Secondary

Turns	10.0
AWG	30.0
Layers	1.0
Strands	1.0
Insulation Type	Triple Insulated

Transformer Construction Diagram



Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	27.0	4	Clockwise

Winding	AWG	Turns	Winding Orientation
Auxiliary	28.0	8.0	Counter Clockwise
Triple Insulated Secondary	30.0	10.0	Counter Clockwise
Primary Second 1/2.0	27.0	3	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	9.0E-6H
2.	Inductance Factor(Al)	189.0nH
3.	Npri	7.0
4.	Nsec	10.0
5.	Naux	8.0
6.	Core Type	RM6 LP
7.	Core Material	N49
8.	Bmax	0.20T
9.	Switching Frequency	100.00kHz
10.	DMax	0.6
11.	Ipk(Primary)	5.59A
12.	Irms(Primary)	2.71A
13.	Ipk(Secondary)	3.91A
14.	Irms(Secondary)	1.55A

Design Assistance

1. Master key : EF483DADD0DB6778[v1]
2. **UCC3813-3** Product Folder : http://www.ti.com/product/UCC3813%2D3 : contains the data sheet and other resources.