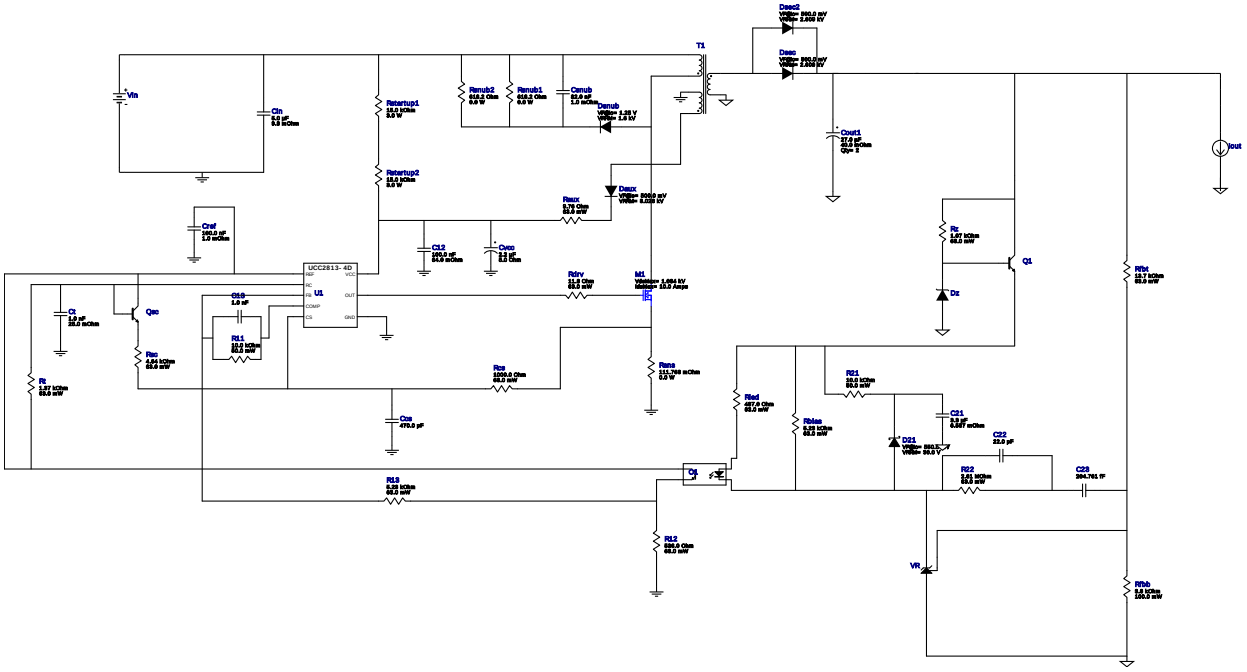
WEBENCH® Design Report

VinMin = 20.0V
VinMax = 1000.0V
Vout = 12.0V
Iout = 2.0A

Device = UCC2813DTR-4
Topology = Flyback
Created = 2018-09-03 07:44:59.351
BOM Cost = $0.00
BOM Count = 46
Total Pd =

Design : 40 UCC2813DTR-4
UCC2813DTR-4 20.0V-1000.0V to 12.00V @ 2.0A



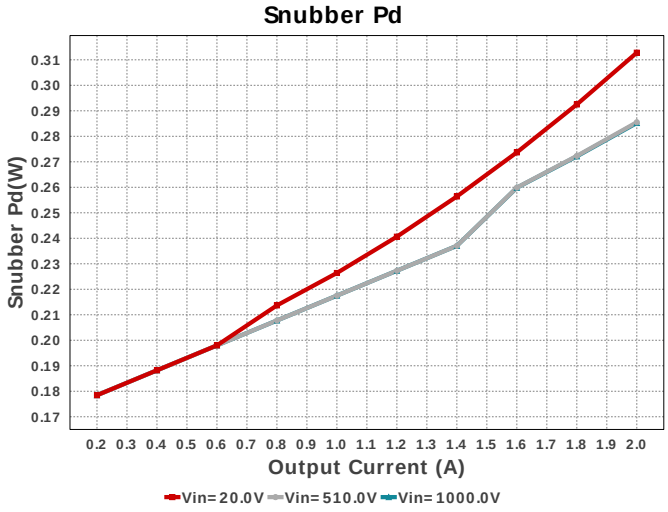
Electrical BOM

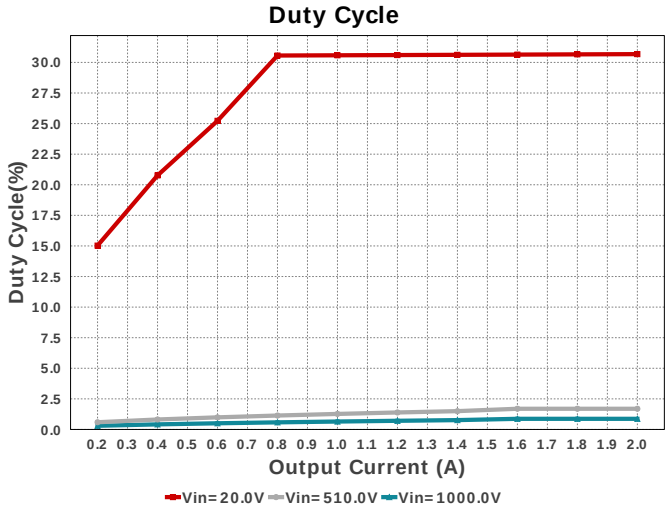
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
C13	Samsung Electro-Mechanics	CL10C102JB8NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
C21	MuRata	GRM21BR61E335KA12L Series= X5R	Cap= 3.3 uF ESR= 6.587 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.12	0805 7 mm^2
C22	Taiyo Yuden	TMK063CG220JT-F Series= C0G/NP0	Cap= 22.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
C23	CUSTOM	CUSTOM Series= ?	Cap= 204.761 fF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
Ccs	MuRata	GRM1555C1H471JA01J Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2

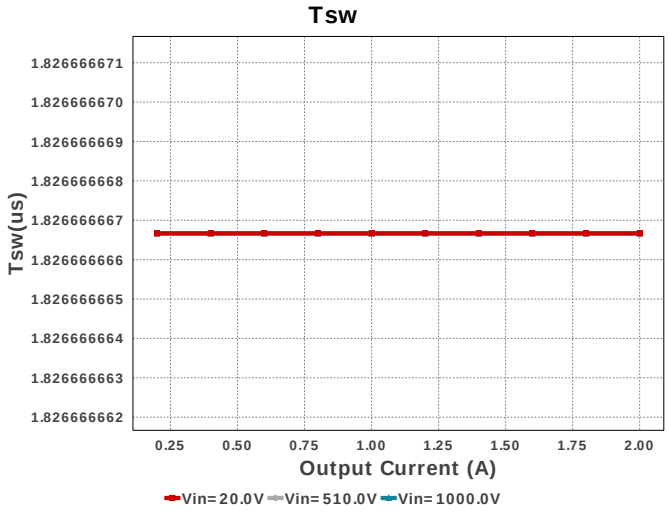
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	B32774D1505K Series= B32774	Cap= 5.0 uF ESR= 9.8 mOhm VDC= 1.3 kV IRMS= 10.5 A	1	$3.12	 B32774_3150x2200x3650 804 mm^2
Cout1	Panasonic	25SVPF27MX Series= SVPF	Cap= 27.0 uF ESR= 40.0 mOhm VDC= 25.0 V IRMS= 2.45 A	2	$0.38	 CAPSMT_62_E61 53 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	MuRata	GRM188R71H823KA93D Series= X7R	Cap= 82.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.03	 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	$0.09	 0805 7 mm^2
Cvcc	Chemi-Con	EMVY500ADA2R2MD55G Series= MVY	Cap= 2.2 uF ESR= 5.0 Ohm VDC= 50.0 V IRMS= 30.0 mA	1	$0.08	 CAPSMT_62_D55 28 mm^2
D21	Panasonic	DB2S31600L	VF@Io= 550.0 mV VRRM= 30.0 V	1	$0.04	 SOD-523 5 mm^2
Daux	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 3.026 kV	1	NA	CUSTOM 0 mm^2
Dsec	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 2.609 kV	1	NA	CUSTOM 0 mm^2
Dsec2	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 2.609 kV	1	NA	CUSTOM 0 mm^2
Dsnub	Bourns	CD214A-R11600	VF@Io= 1.25 V VRRM= 1.6 kV	1	$0.09	 SMA 37 mm^2
Dz	ON Semiconductor	MMBZ5239BLT1G	Zener	1	$0.03	 SOT-23 14 mm^2
M1	NA	IdealFET	VdsMax= 1.084 kV IdsMax= 10.0 Amps	1	NA	NA 0 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
R12	Vishay-Dale	CRCW0402536RFKED Series= CRCW..e3	Res= 536.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2

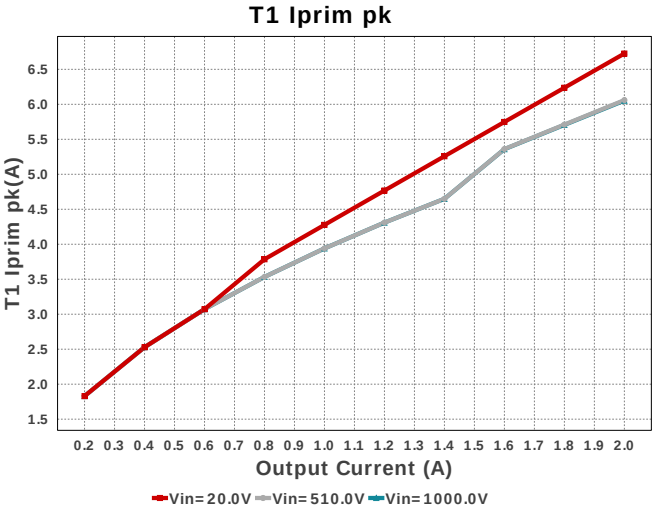
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R13	Vishay-Dale	CRCW04025K23FKED Series= CRCW..e3	Res= 5.23 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
R21	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
R22	Vishay-Dale	CRCW04022M61FKED Series= CRCW..e3	Res= 2.61 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Raux	Vishay-Dale	CRCW04029R76FKED Series= CRCW..e3	Res= 9.76 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rbias	Vishay-Dale	CRCW04025K23FKED Series= CRCW..e3	Res= 5.23 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcs	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rdrv	Vishay-Dale	CRCW040211R8FKED Series= CRCW..e3	Res= 11.8 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Yageo	RC0603FR-073K6L Series= ?	Res= 3.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rled	Vishay-Dale	CRCW0402487RFKED Series= CRCW..e3	Res= 487.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsc	Vishay-Dale	CRCW04024K64FKED Series= CRCW..e3	Res= 4.64 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsns	CUSTOM	CUSTOM Series= ?	Res= 111.763 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rsnub1	CUSTOM	CUSTOM Series= ?	Res= 618.2 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rsnub2	CUSTOM	CUSTOM Series= ?	Res= 618.2 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rstartup1	Vishay-Bccomponents	PR03000201502JAC00 Series= ?	Res= 15.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.17	PR03 197 mm²
Rstartup2	Vishay-Bccomponents	PR03000201502JAC00 Series= ?	Res= 15.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.17	PR03 197 mm²
Rt	Vishay-Dale	CRCW04021K37FKED Series= CRCW..e3	Res= 1.37 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rz	Vishay-Dale	CRCW04021K07FKED Series= CRCW..e3	Res= 1.07 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B65807P0000R049 , CoilFormer=B65808E1508T001	Lp= 3.0 µH Turns Ratio(Nas)= 4:3 Turns Ratio(Nps)= 2:3 Npri= 2.0 Naux= 4.0 Nsec= 3.0	1	$1.19	TDK_B65803 271 mm²

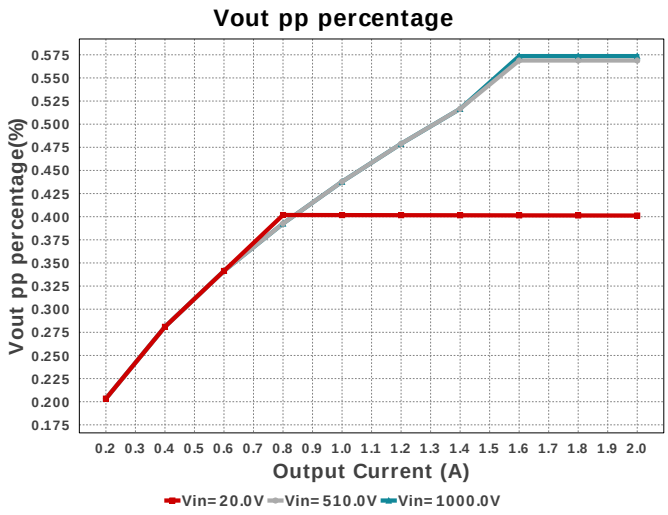
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	UCC2813DTR-4	Switcher	1	$1.19	 D0008A 57 mm^2
VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	 DBZ0003A 14 mm^2

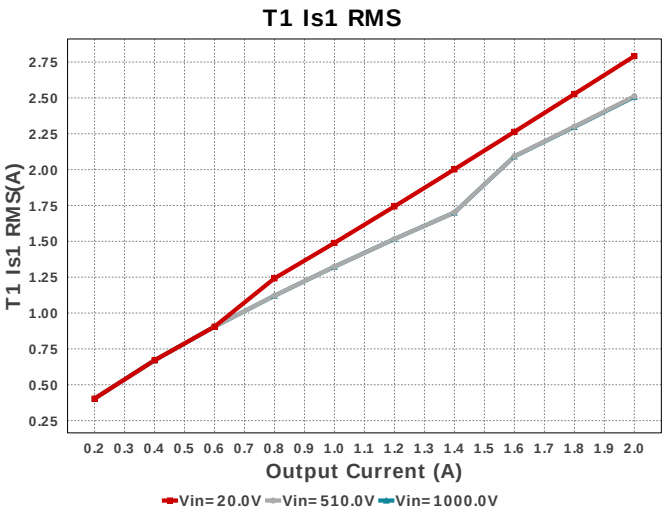


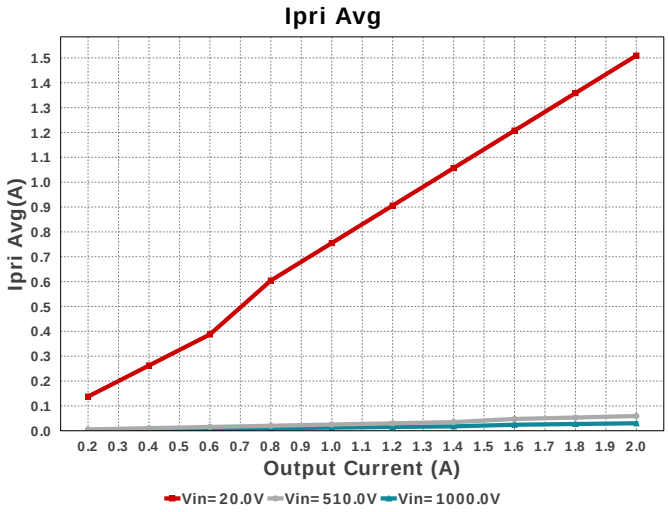


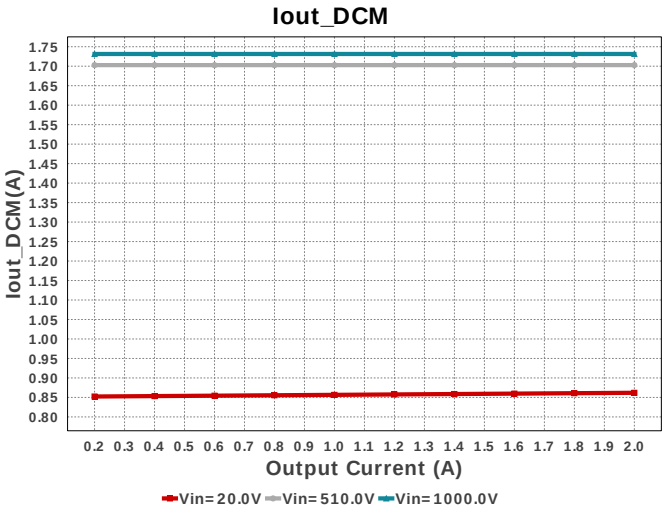


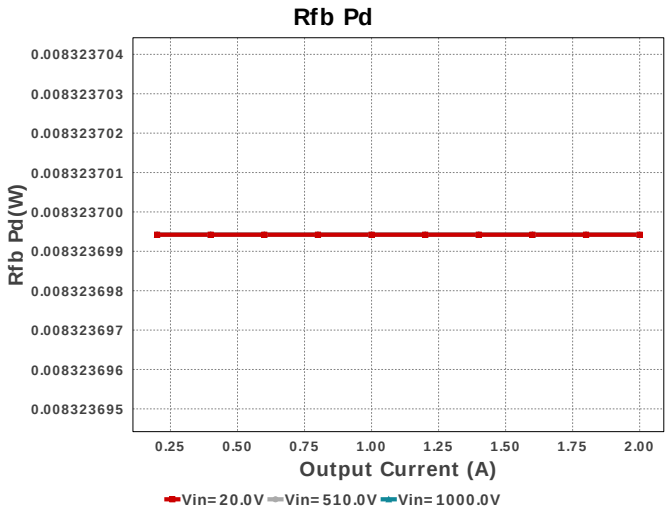


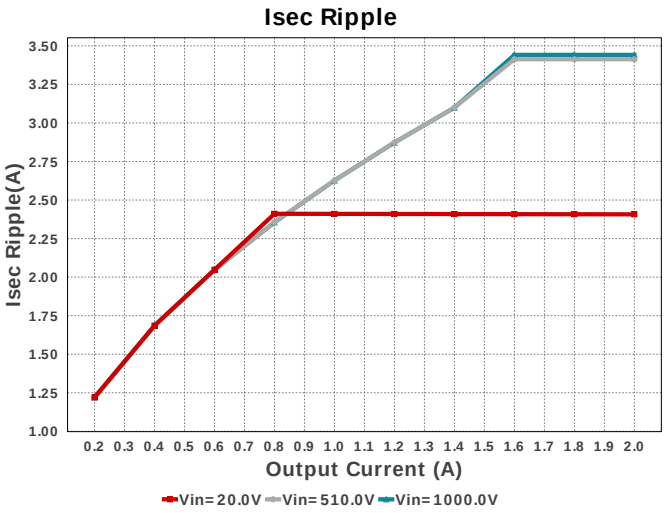


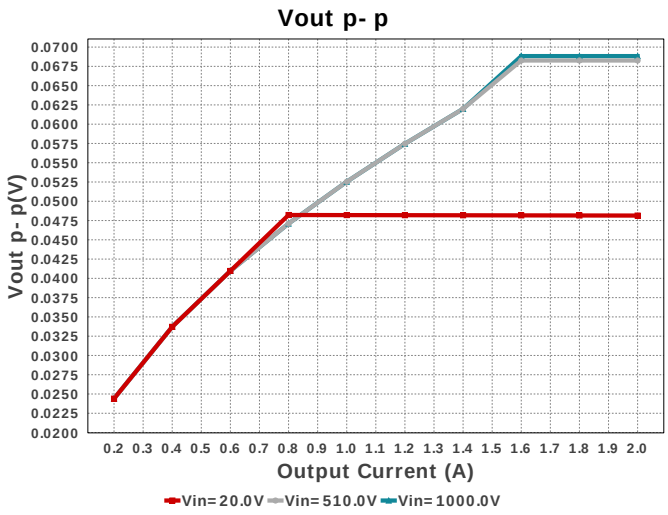


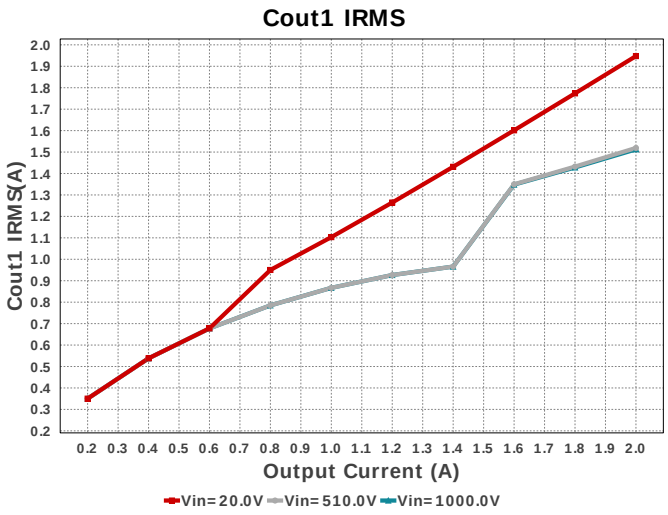


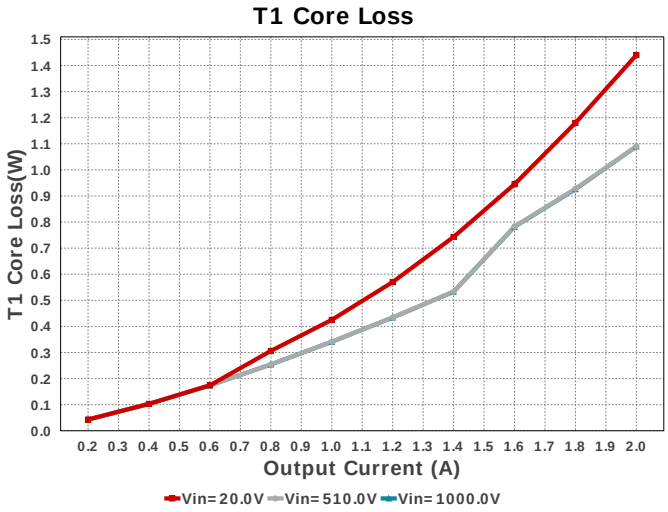


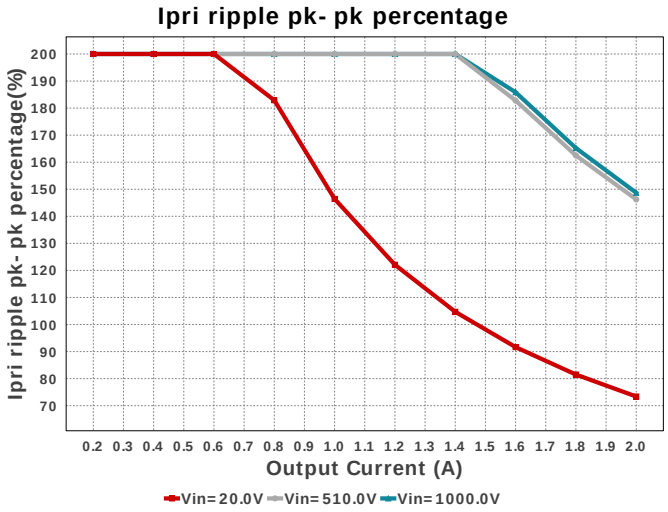


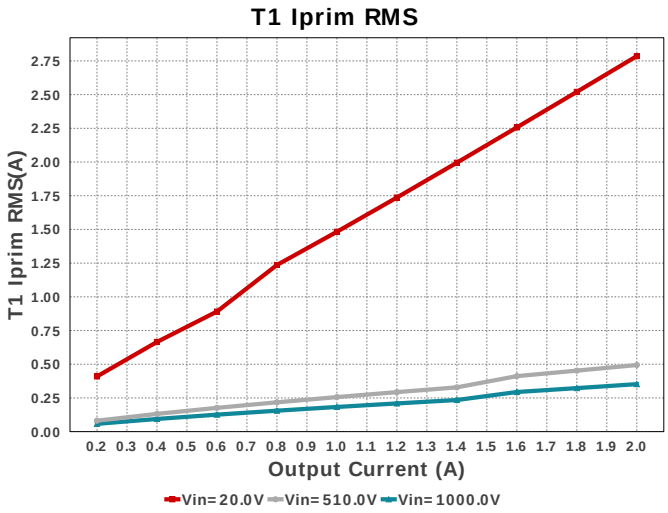


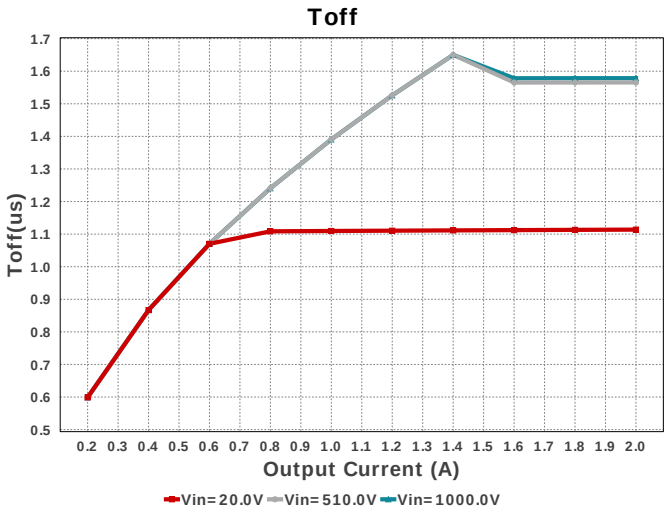


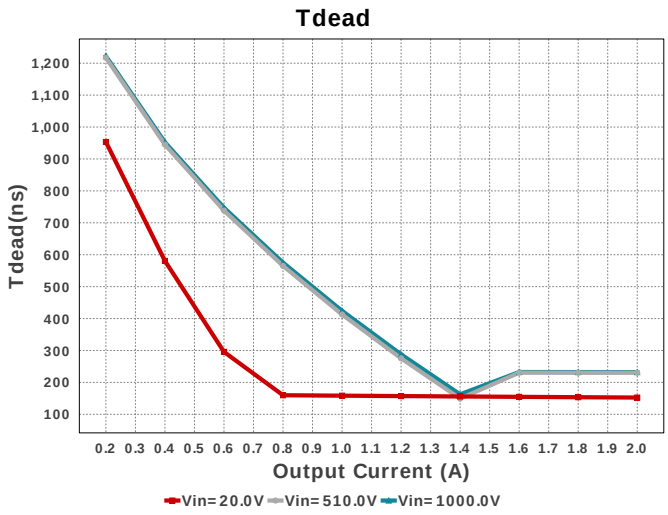


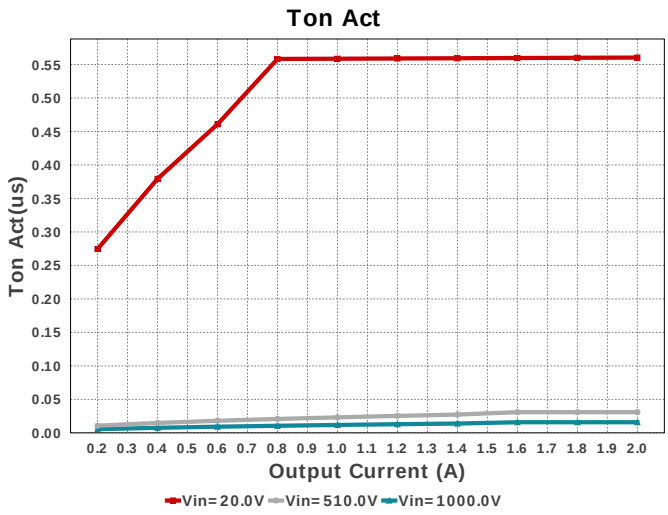


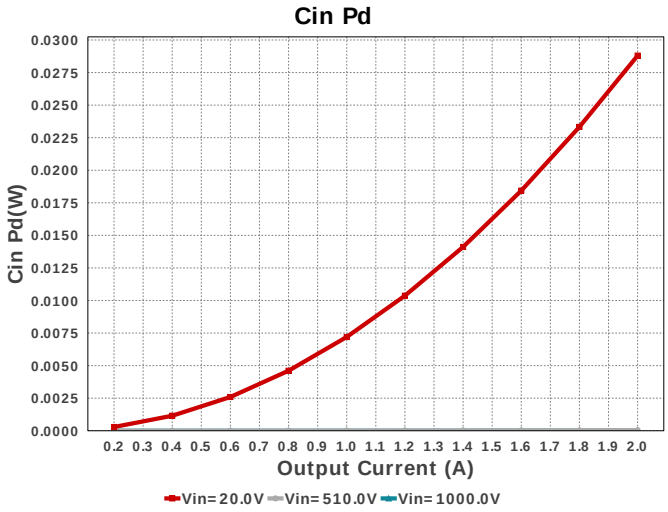


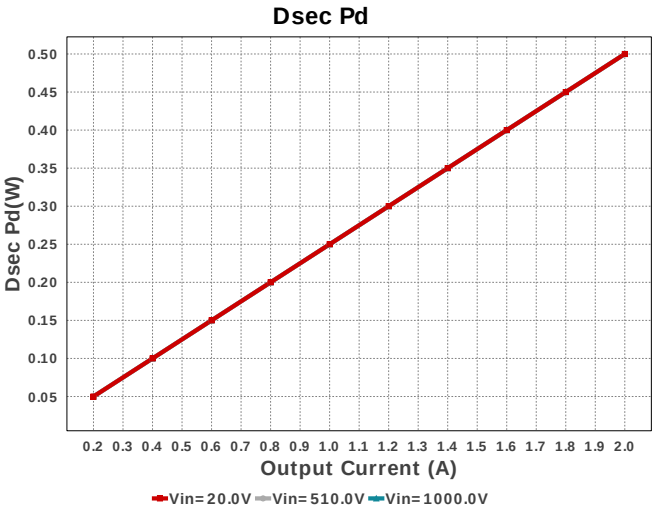


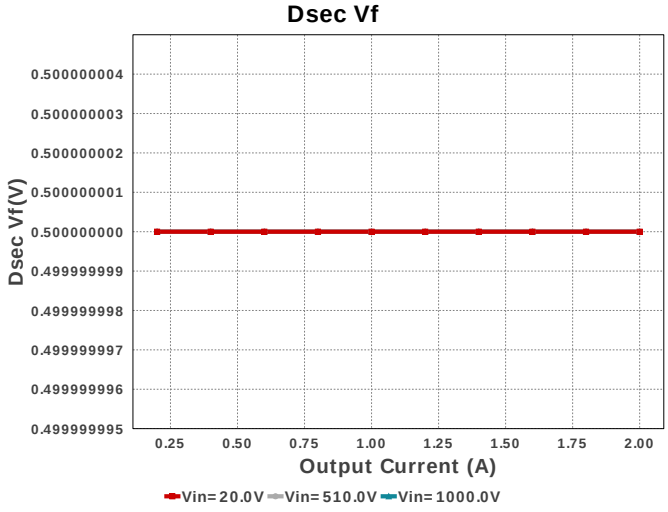


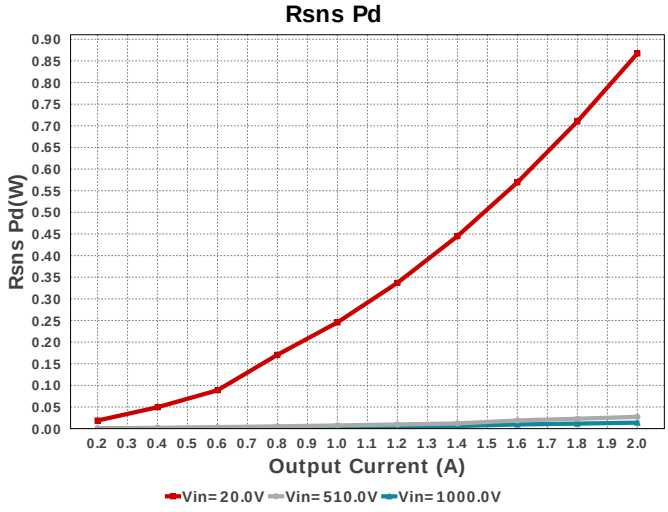


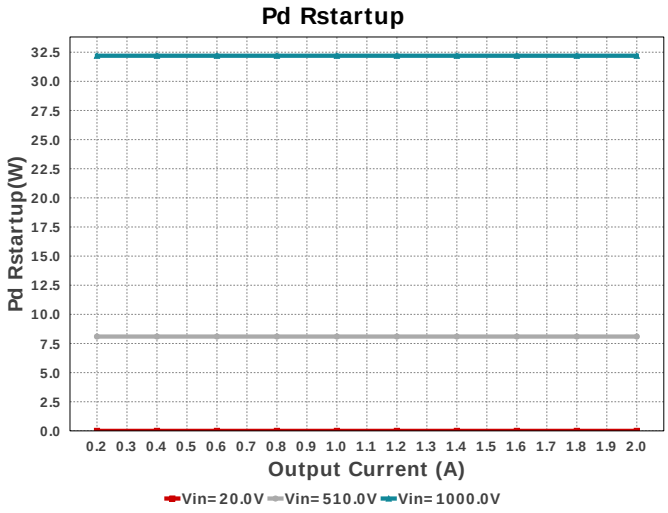


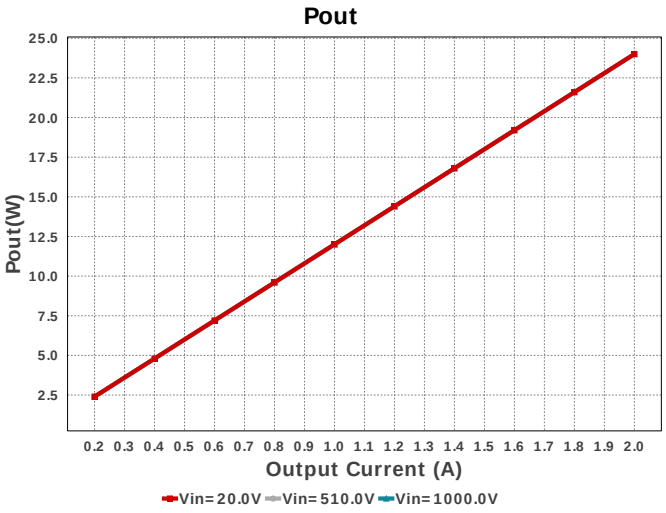


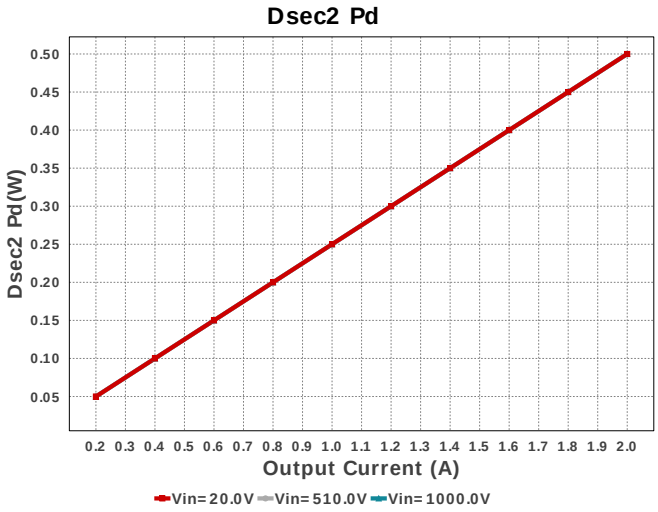


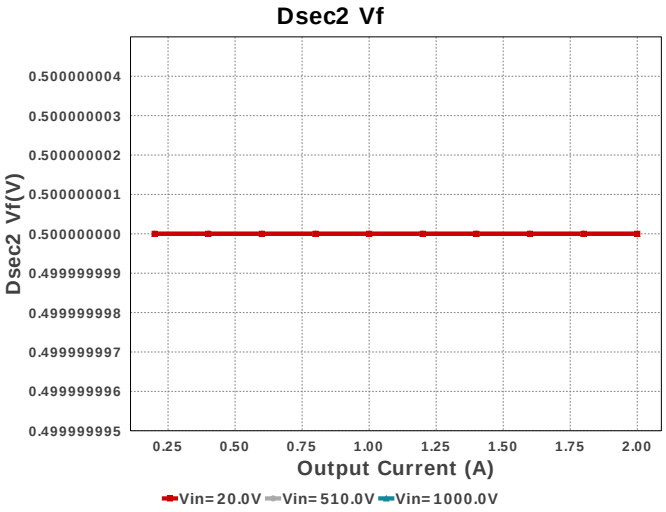


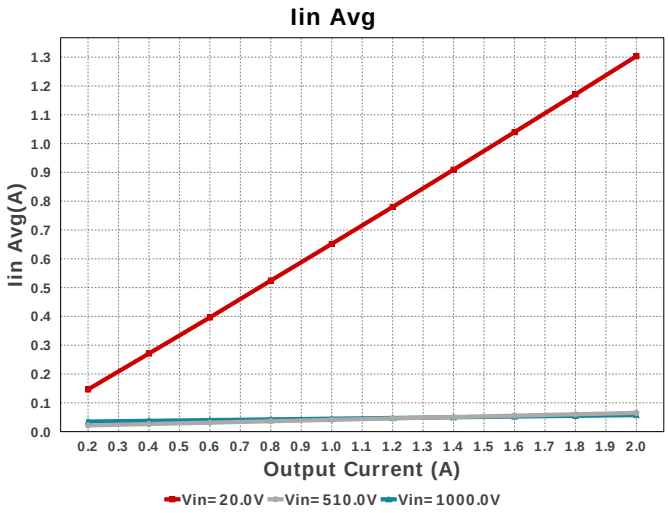


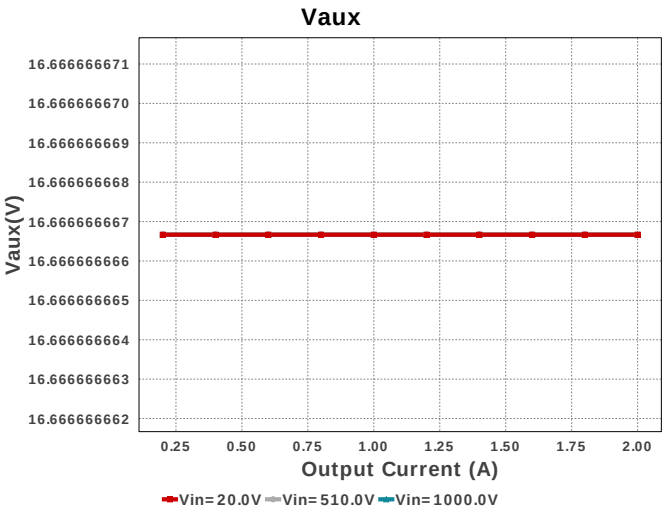


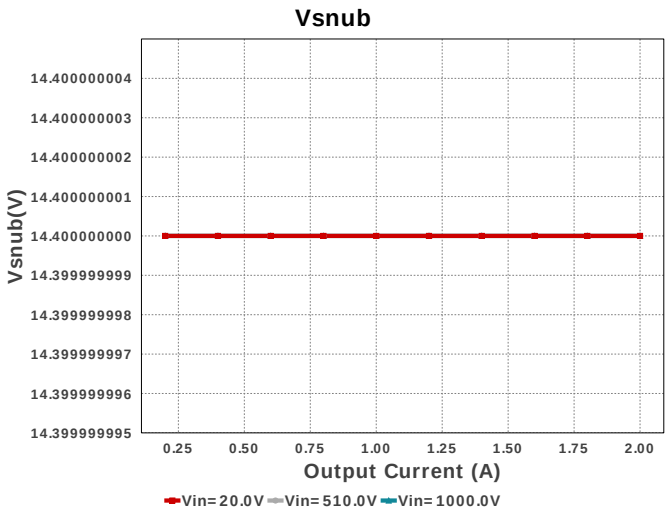


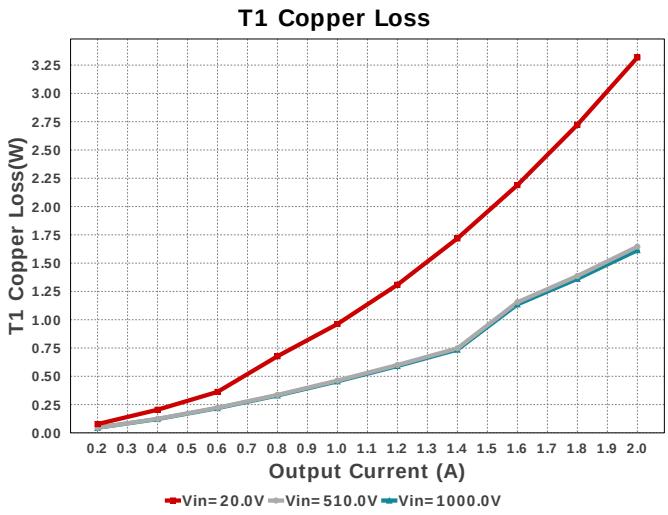


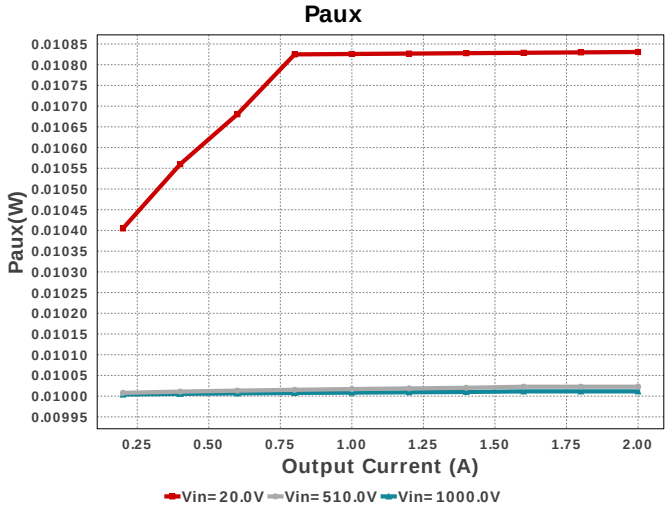


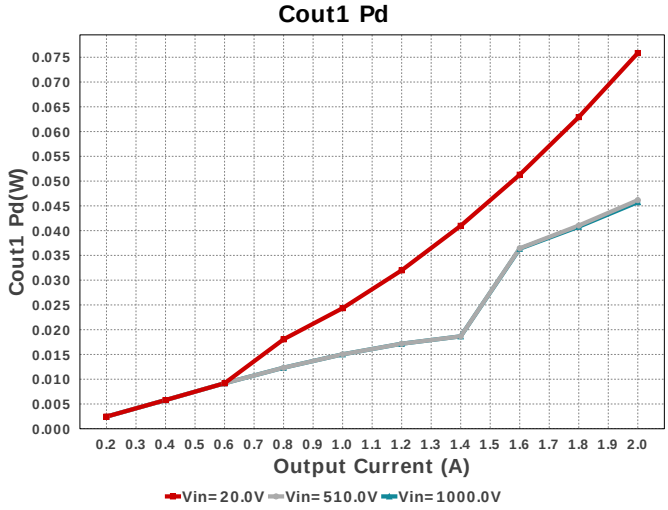


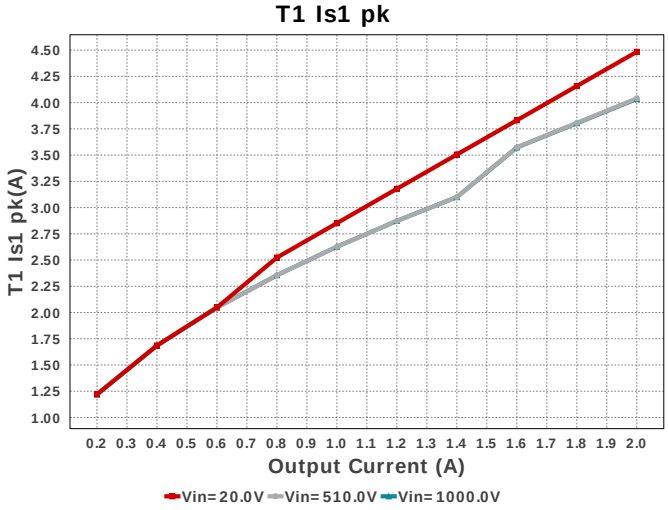


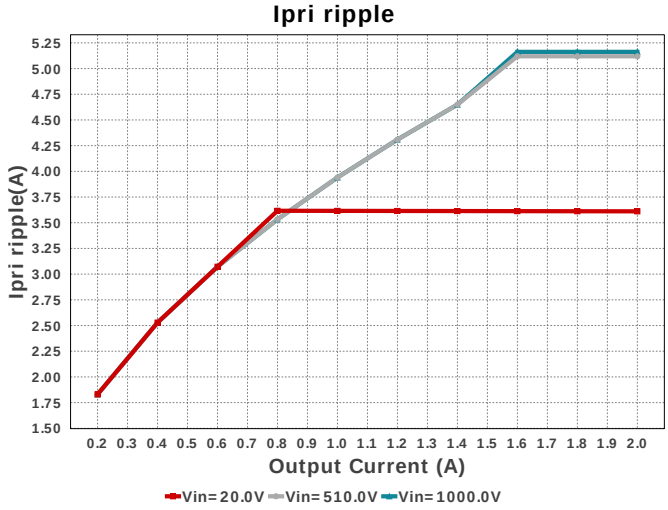


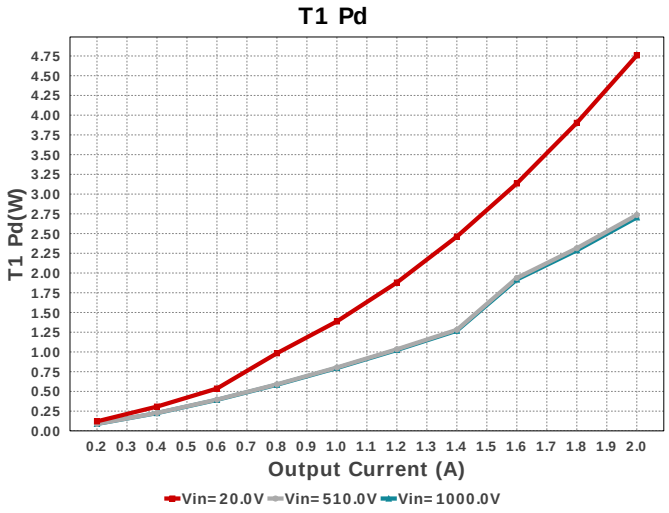












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	1.947 A	Current	Output capacitor1 RMS ripple current
2.	Iin Avg	1.322 A	Current	Average input current
3.	Iout_DCM	861.913 mA	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	1.509 A	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	3.611 A	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	73.393 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	2.407 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	2.786 A	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	6.725 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	2.792 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	4.484 A	Current	Transformer Secondary1 Peak Current
12.	BOM Count	46	General	Total Design BOM count
13.	Daux trr	0.0 ns	General	Auxiliary Diode Reverse Recovery Time
14.	Dsec Vf	500.0 mV	General	Effective Forward Voltage Drop at the Operating Current
15.	Dsec trr	0.0 ns	General	Output Diode Reverse Recovery Time
16.	Dsec2 Vf	500.0 mV	General	Effective Forward Voltage Drop at the Operating Current
17.	Dsnub trr	0.0 ns	General	Snubber Diode Reverse Recovery Time
18.	FootPrint	2.091 k mm^2	General	Total Foot Print Area of BOM components
19.	Frequency	547.445 kHz	General	Switching frequency
20.	Mode	CCM	General	Conduction Mode
21.	Pout	24.0 W	General	Total output power
22.	Tdead	152.467 ns	General	Approximate Dead Time of the Regulator
23.	Toff	1.114 us	General	Approximate Converter Off Time
24.	Ton Act	560.369 mus	General	Approximate Converter On Time
25.	Total BOM	$0.0	General	Total BOM Cost
26.	Tsw	1.827 us	General	Switching Time Period
27.	Vaux	16.667 V	General	Auxiliary Voltage
28.	Vsnub	14.4 V	General	Voltage Across the Snubber
29.	Duty Cycle	30.677 %	Op Point	Duty cycle
30.	ICThetaJA	107.5 degC/W	Op Point	IC junction-to-ambient thermal resistance
31.	IOUT_OP	2.0 A	Op Point	Iout operating point
32.	VIN_OP	20.0 V	Op Point	Vin operating point
33.	Vout Actual	11.99 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
34.	Vout OP	12.0 V	Op Point	Operational Output Voltage
35.	Vout Tolerance	1.926 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	48.145 mV	Op Point	Peak-to-peak output ripple voltage
37.	Cin Pd	28.8 mW	Power	Input capacitor power dissipation
38.	Cout1 Pd	75.853 mW	Power	Output capacitor1 power dissipation
39.	Dsec Pd	500.0 mW	Power	Secondary Diode Power Dissipation
40.	Dsec2 Pd	500.0 mW	Power	Secondary Diode Power Dissipation
41.	Paux	10.831 mW	Power	Power Dissipation in Raux and Daux
42.	Pd Rstartup	267.593 µW	Power	Power Dissipation in Rstartup1 and Rstartup2
43.	Rfb Pd	8.324 mW	Power	Rfb Power Dissipation
44.	Rsns Pd	867.172 mW	Power	Current Limit Sense Resistor Power Dissipation
45.	Snubber Pd	312.8 mW	Power	Snubber Power Dissipation
46.	T1 Pd	2.572 W	Power	Estimated Losses in Transformer
47.	T1 Copper Loss	1.64 W		
48.	T1 Core Loss	932.0 mW		
49.	Vout pp percentage	401.21 m%		Output Voltage ripple percentage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	1,000.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	UCC2813-4	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

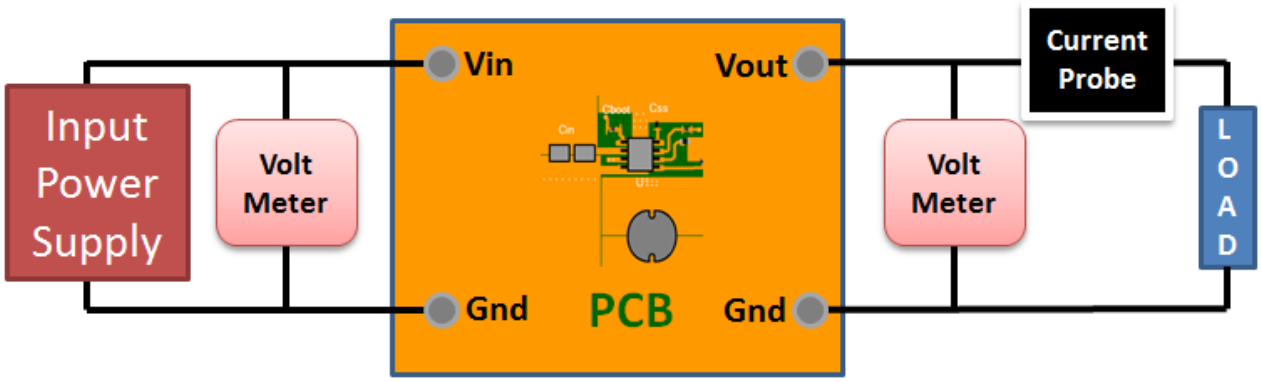
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 20.0V 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	B65807P0000R049
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B65808E1508T001
4.	Coil Former Manufacturer	TDK

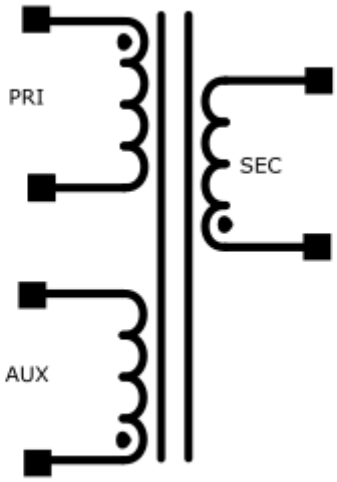
Transformer Electrical Diagram

Primary

Turns	2.0
AWG	34.0
Layers	2.0
Strands	29.0
Insulation Type	Heavy Insulated Magnet Wire

Auxiliary

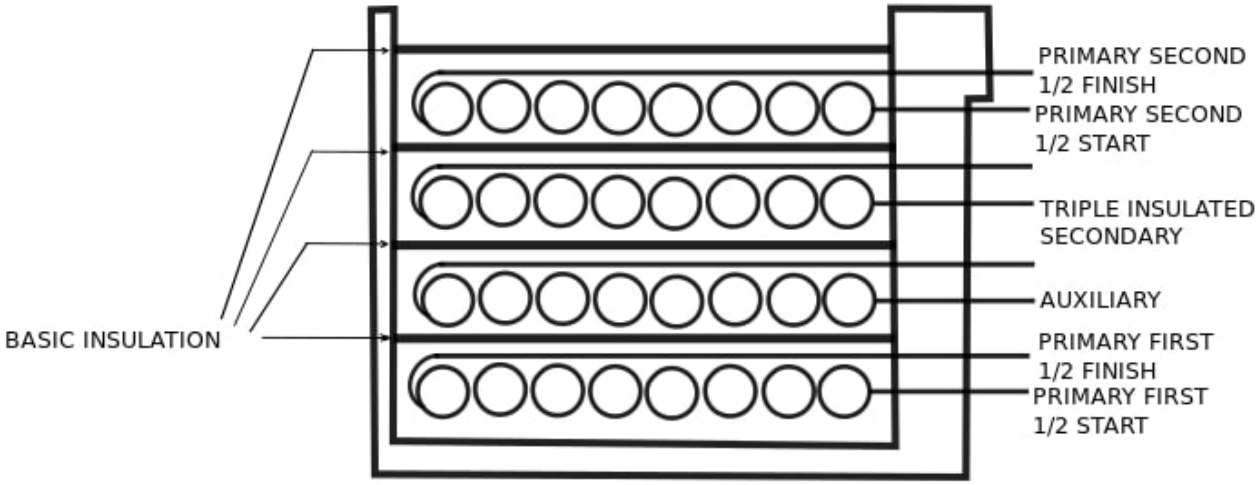
Turns	4.0
AWG	28.0
Layers	1.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire



Secondary

Turns	3.0
AWG	39.0
Layers	1.0
Strands	5.0
Insulation Type	Triple Insulated

Transformer Construction Diagram



Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	34.0	1	Clockwise

Winding	AWG	Turns	Winding Orientation
Auxiliary	28.0	4.0	Counter Clockwise
Triple Insulated Secondary	39.0	3.0	Counter Clockwise
Primary Second 1/2.0	34.0	1	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	3.0E-12H
2.	Inductance Factor(Al)	693.0nH
3.	Npri	2.0
4.	Nsec	3.0
5.	Naux	4.0
6.	Core Type	RM6 LP
7.	Core Material	N49
8.	Bmax	0.23T
9.	Switching Frequency	0.55kHz
10.	DMax	0.4
11.	Ipk(Primary)	6.19A
12.	Irms(Primary)	2.48A
13.	Ipk(Secondary)	4.13A
14.	Irms(Secondary)	2.02A

Design Assistance

1. Master key : A7CBDCE6C75BBC17[v1]
2. **UCC2813-4** Product Folder : http://www.ti.com/product/UCC2813%2D4 : contains the data sheet and other resources.