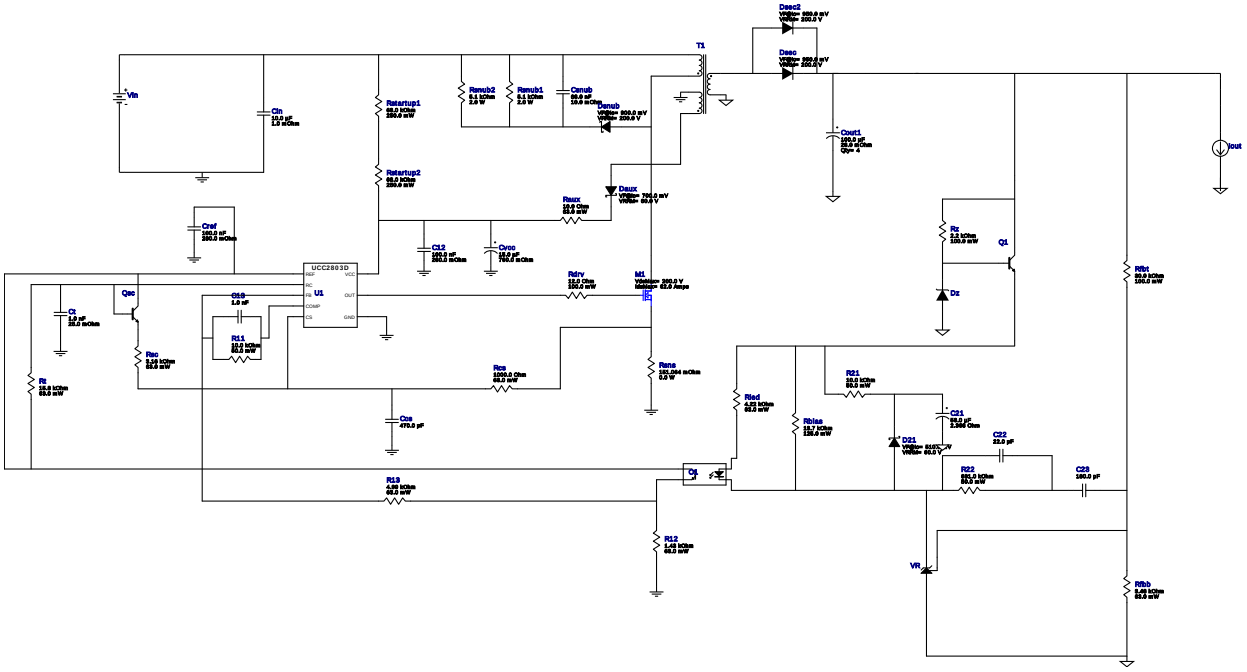
VinMin = 36.0V
VinMax = 60.0V
Vout = 24.0V
Iout = 2.0A

Device = UCC2803DTR
Topology = Flyback
Created = 2023-10-17 09:57:50.773
BOM Cost = NA
BOM Count = 48
Total Pd = 3.56W

WEBENCH® Design Report

Design : 221 UCC2803DTR
UCC2803DTR 36V-60V to 24.00V @ 2A

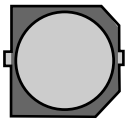
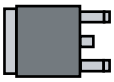
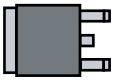
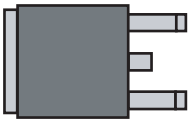


Design Alerts

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.

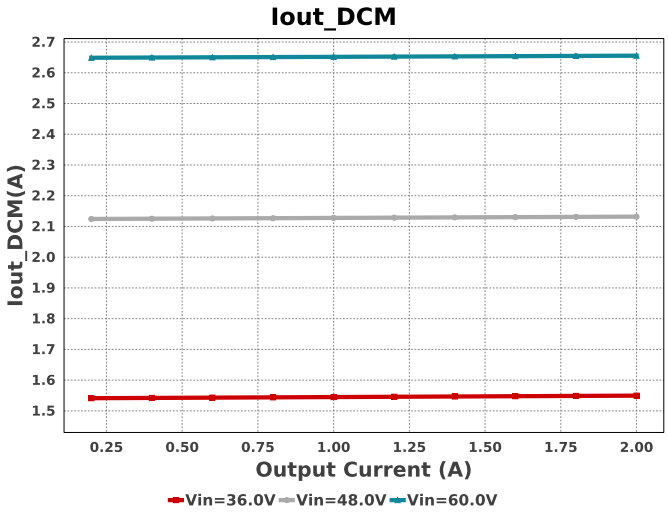
Electrical BOM

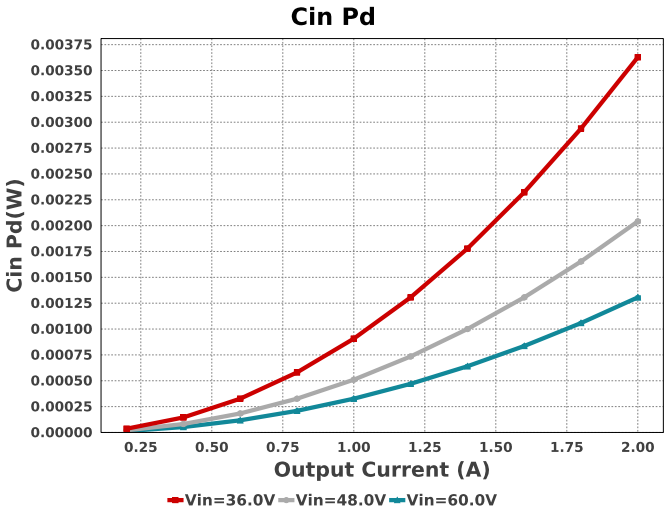
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
C13	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
C21	Chemi-Con	EKZE500ELL560MF11D Series= KZE	Cap= 56.0 uF ESR= 2.3681 Ohm VDC= 50.0 V IRMS= 385.0 mA	1	$0.13	Chemi-Con_630x1100 69 mm^2
C22	Samsung Electro-Mechanics	CL21C220JBANNNC Series= C0G/NP0	Cap= 22.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
C23	Kemet	C0805C181K5GACTU Series= C0G/NP0	Cap= 180.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ccs	Samsung Electro-Mechanics	CL21C471JBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2

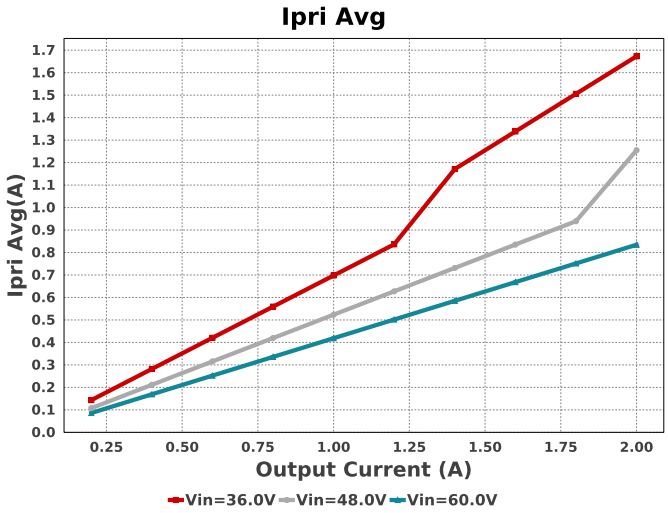
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	CKG57NX7R2A106M500JH Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 4.22 A	1	$1.80	 CKG57N 56 mm^2
Cout1	Panasonic	EEHZA1H101P Series= ZA	Cap= 100.0 uF ESR= 28.0 mOhm VDC= 50.0 V IRMS= 2.0 A	4	$1.43	 SM_RADIAL_10BMM 160 mm^2
Cref	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm^2
Csnub	MuRata	GRM31MR72A683KA01L Series= X7R	Cap= 68.0 nF ESR= 10.0 mOhm VDC= 100.0 V IRMS= 800.0 mA	1	$0.07	 1206 11 mm^2
Ct	Kemet	C0805C102J5GACTU Series= C0G/NP0	Cap= 1.0 nF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 1.71 A	1	$0.02	 0805 7 mm^2
Cvcc	Nichicon	UUD1V150MCL1GS Series= uD	Cap= 15.0 uF ESR= 760.0 mOhm VDC= 35.0 V IRMS= 150.0 mA	1	$0.14	 SM_RADIAL_5MM 58 mm^2
D21	ON Semiconductor	MBRA160T3G	VF@Io= 510.0 mV VRRM= 60.0 V	1	$0.13	 SMA 37 mm^2
Daux	Fairchild Semiconductor	SS26FL	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.11	 SOD-123F 12 mm^2
Dsec	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.18	 DPAK 102 mm^2
Dsec2	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.18	 DPAK 102 mm^2
Dsnub	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.33	 SMB 44 mm^2
Dz	Micro Commercial Components	3SMAJ5932B-TP	Zener	1	$0.13	 SMA 37 mm^2
M1	International Rectifier	IRFS4227PBF	VdsMax= 200.0 V IdsMax= 62.0 Amps	1	$1.91	 DDPAK 210 mm^2
O1	Vishay-Semiconductor	TCMT1107	Optocoupler	1	$0.19	 SOP-4 44 mm^2
Q1	Diodes Inc.	MMBT3904-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm^2
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	$1.19	 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

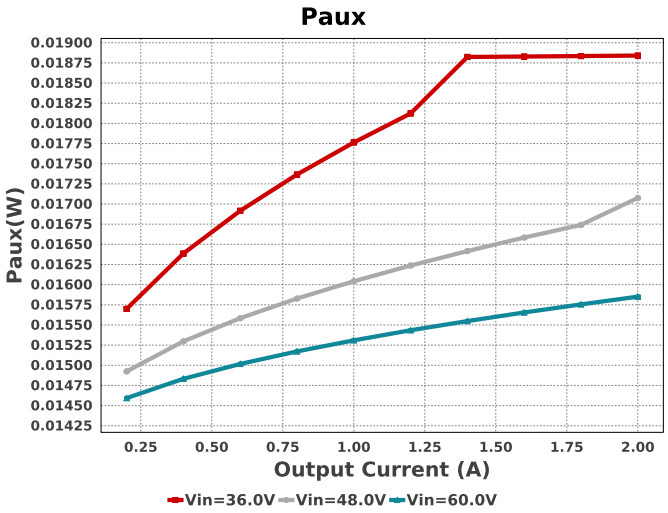
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R12	Vishay-Dale	CRCW04021K43FKED Series= CRCW..e3	Res= 1.43 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
R21	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
R22	Yageo	RC0201FR-07681KL Series= ?	Res= 681.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rbias	Vishay-Dale	CRCW080513K7FKEA Series= CRCW..e3	Res= 13.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 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	Yageo	RC0603FR-0712RL Series= ?	Res= 12.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbb	Vishay-Dale	CRCW04023K48FKED Series= CRCW..e3	Res= 3.48 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rled	Vishay-Dale	CRCW04024K22FKED Series= CRCW..e3	Res= 4.22 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsc	Vishay-Dale	CRCW04023K16FKED Series= CRCW..e3	Res= 3.16 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsns	CUSTOM	CUSTOM Series= ?	Res= 151.064 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rsnub1	Vishay-Bccomponents	PR02000205101JR500 Series= ?	Res= 5.1 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.06	PR02 117 mm²
Rsnub2	Vishay-Bccomponents	PR02000205101JR500 Series= ?	Res= 5.1 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.06	PR02 117 mm²
Rstartup1	Yageo	RC1206FR-0768KL Series= ?	Res= 68.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rstartup2	Yageo	RC1206FR-0768KL Series= ?	Res= 68.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt	Vishay-Dale	CRCW040215K8FKED Series= CRCW..e3	Res= 15.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rz	Yageo	RC0603FR-072K2L Series= ?	Res= 2.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²

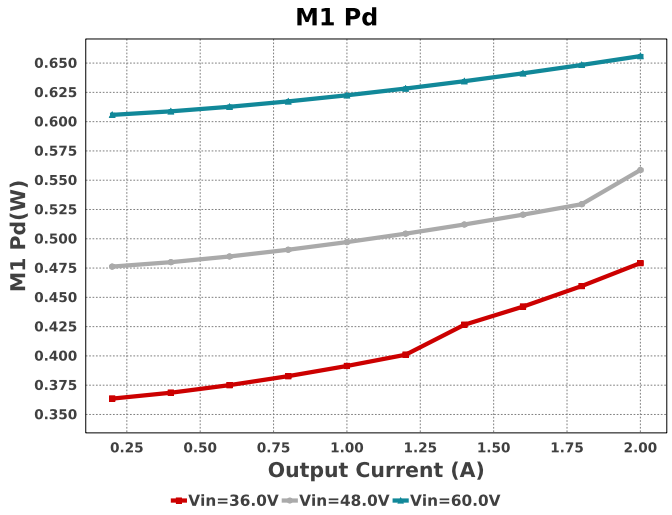
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
T1	Core=TDK , CoilFormer=TDK	Core=B66229G0000X187 , CoilFormer=B66230A1114T001	Lp= 88.0 µH Turns Ratio(Nas)= 5:11 Turns Ratio(Nps)= 22:11 Npri= 22.0 Naux= 5.0 Nsec= 11.0	1	$1.83	 1462 mm²
U1	Texas Instruments	UCC2803DTR	Switcher	1	$0.72	 D0008A 57 mm²
VR	Texas Instruments	TL431IDBVR	Voltage References	1	$0.05	 R-PDSO-G3 16 mm²

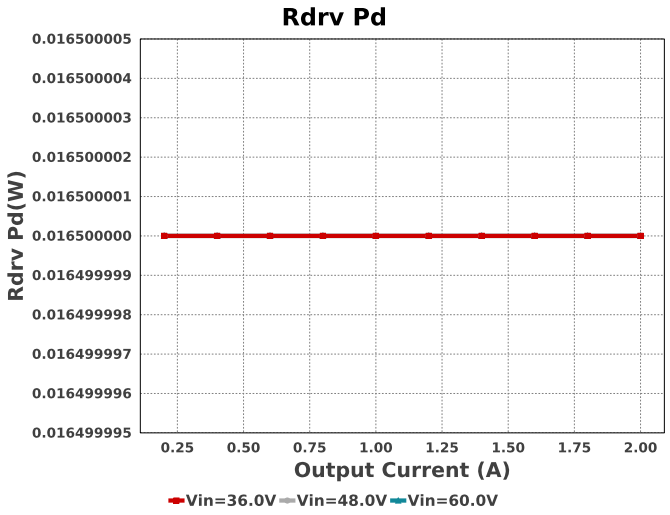


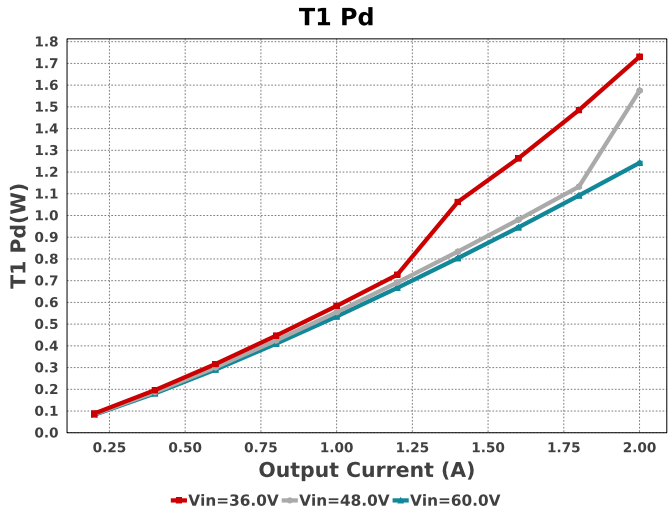


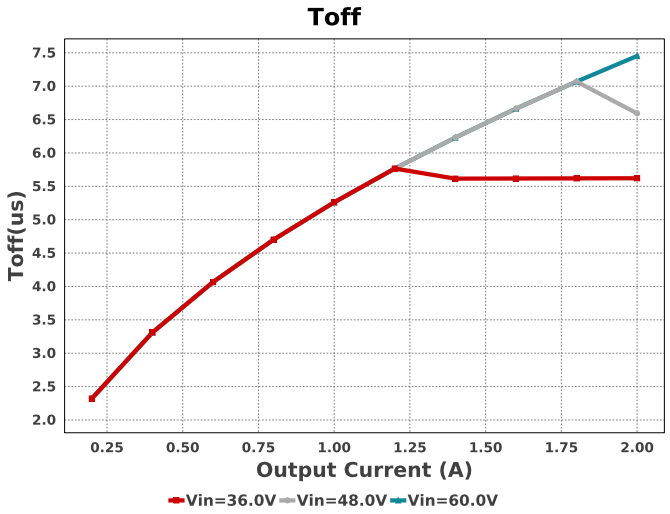


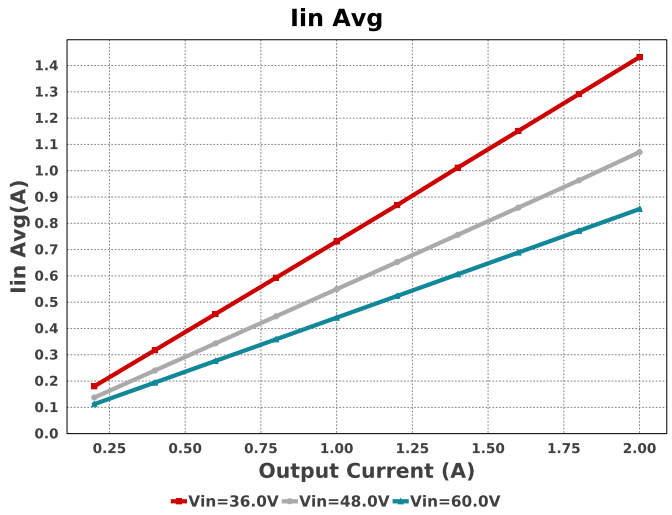


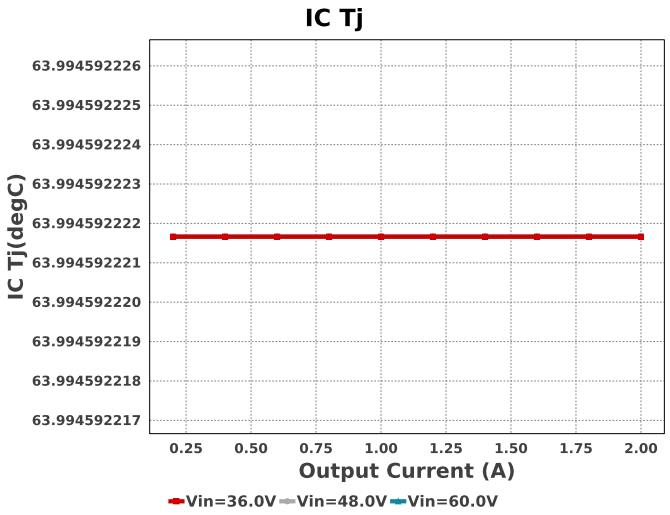


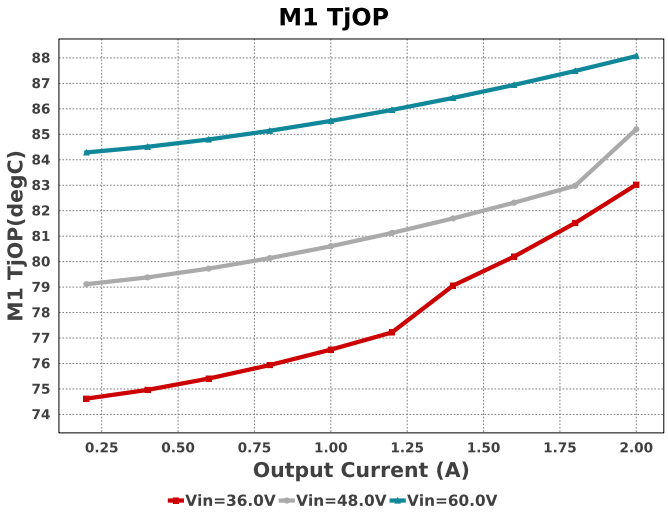


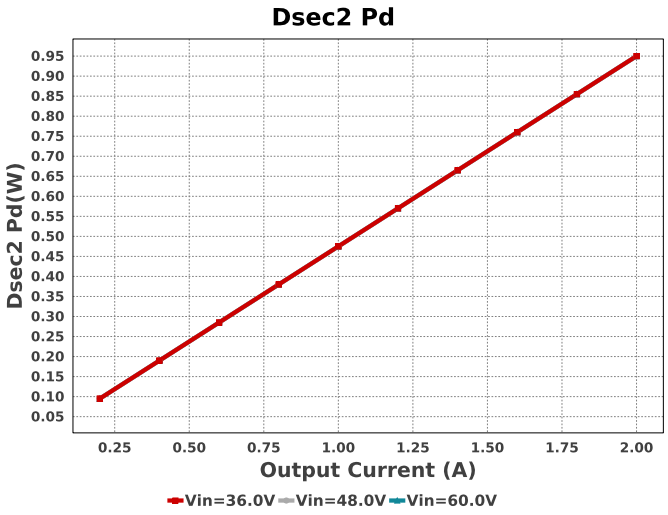


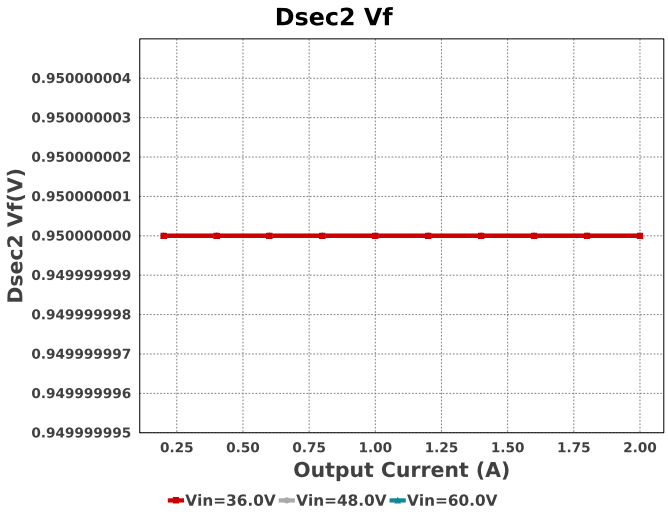


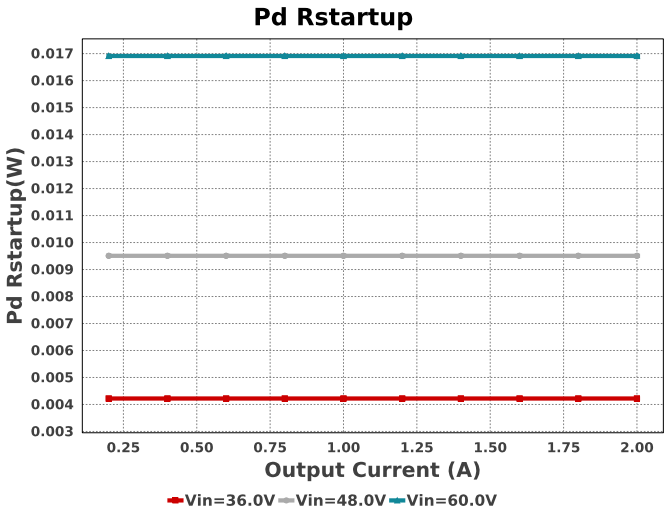


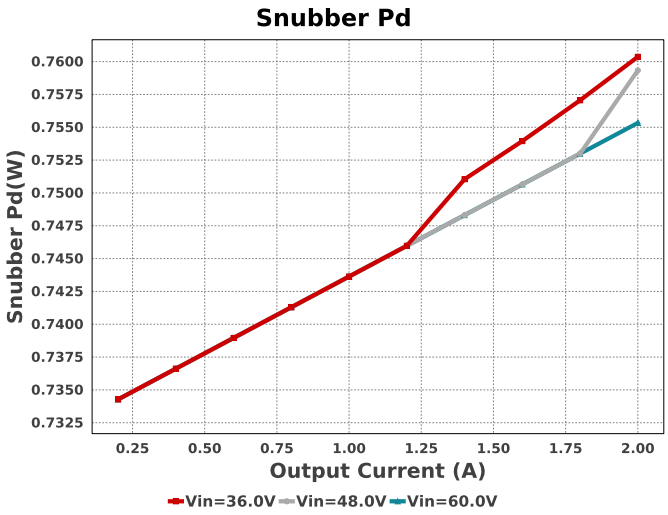


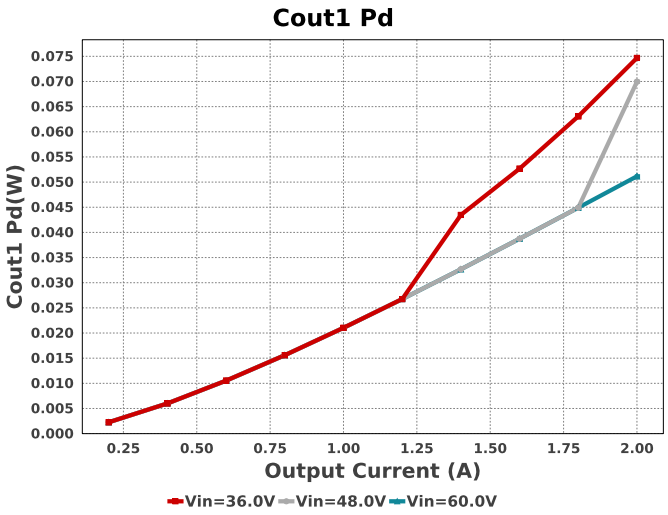


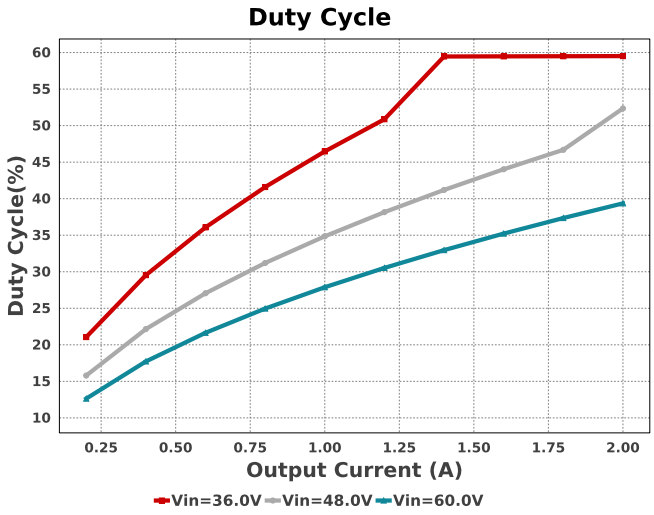


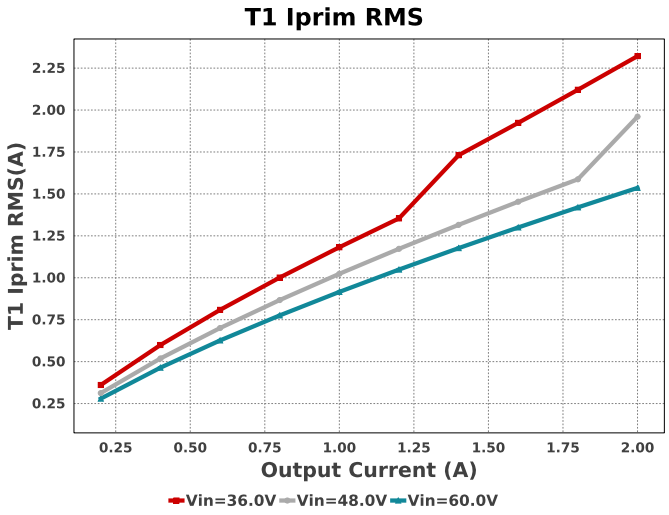


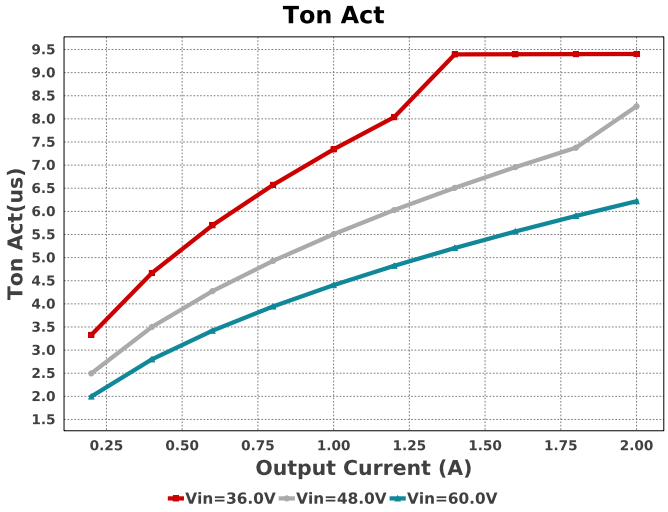


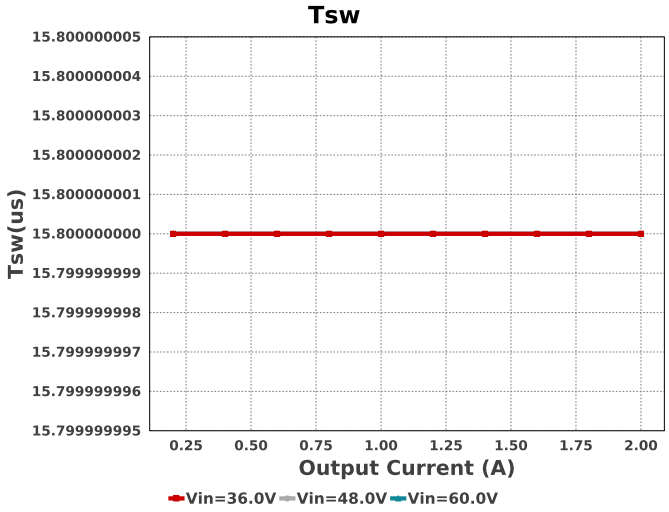


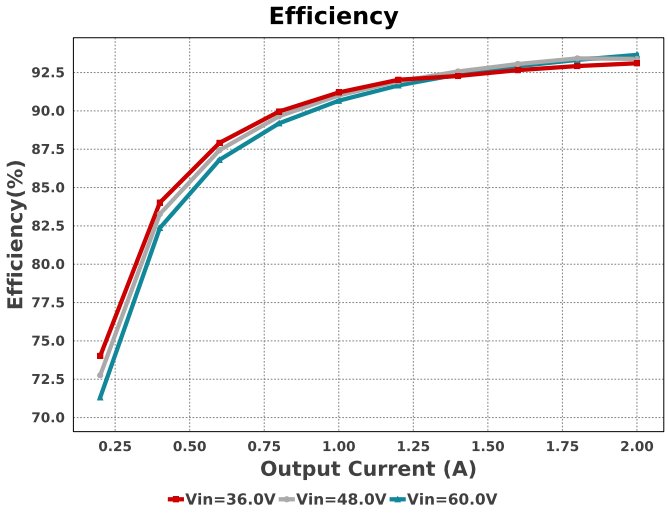


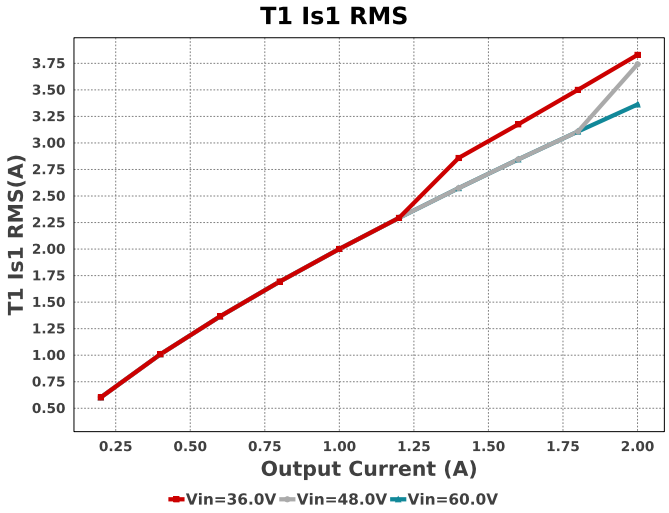


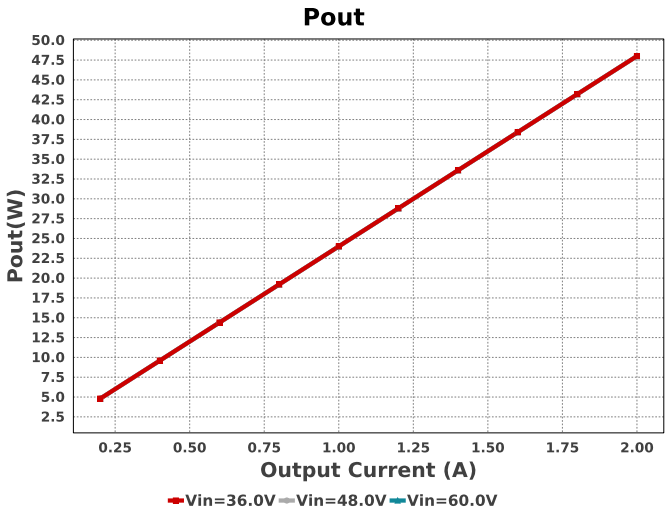


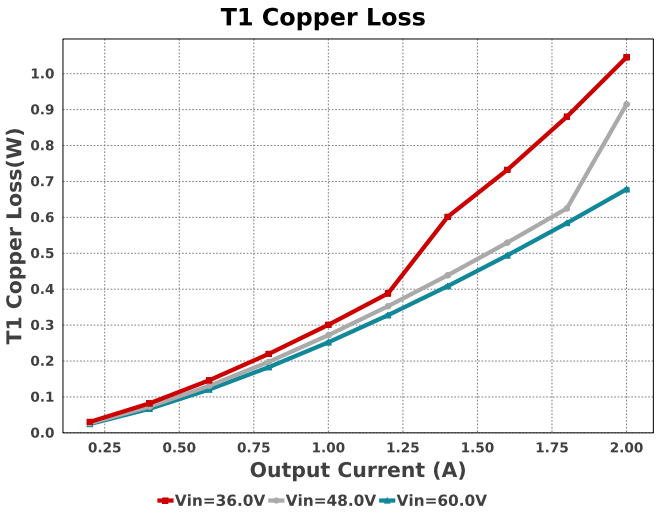


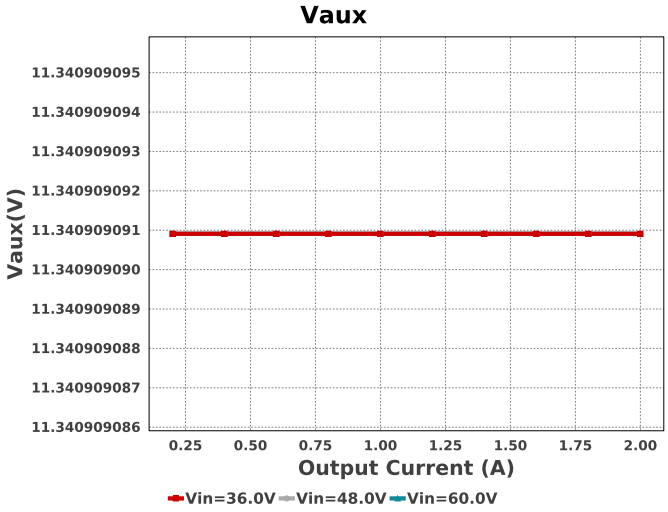


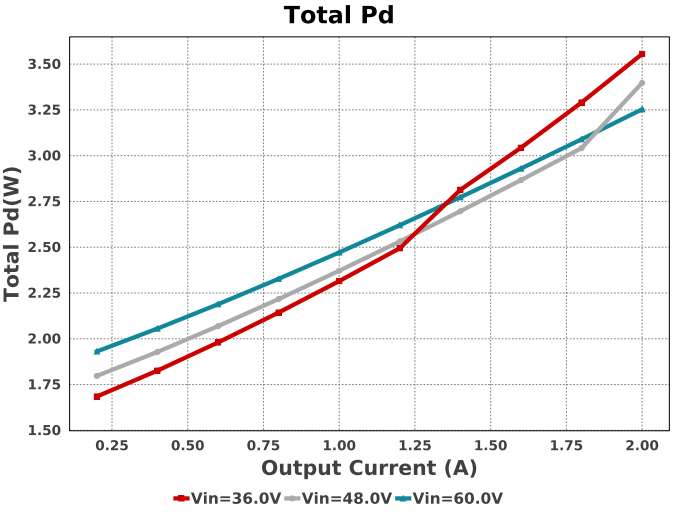


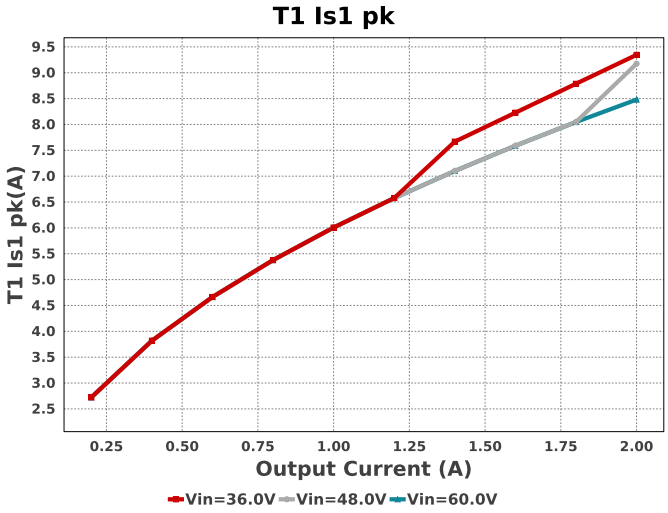


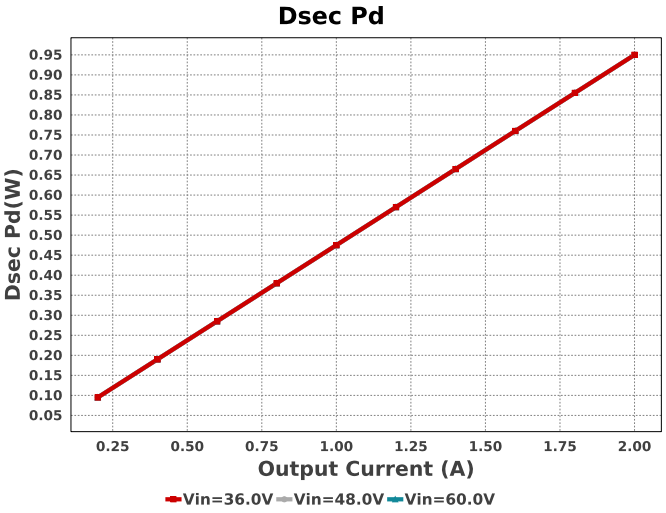


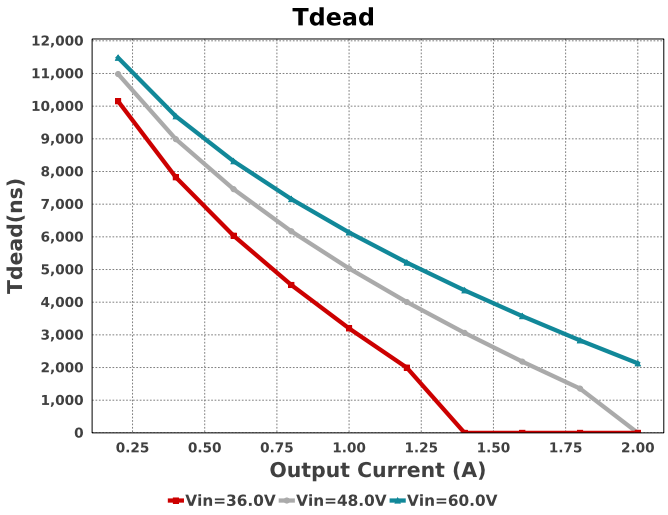


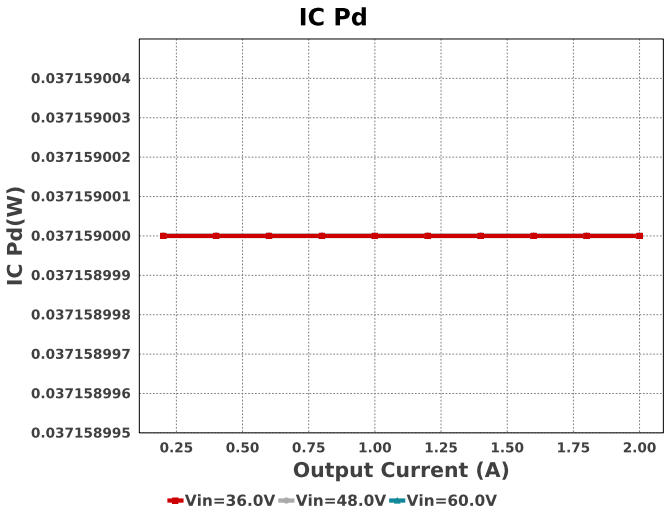


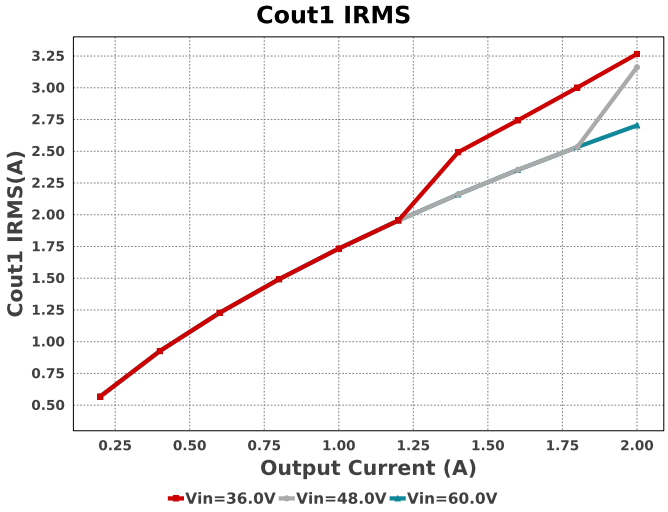


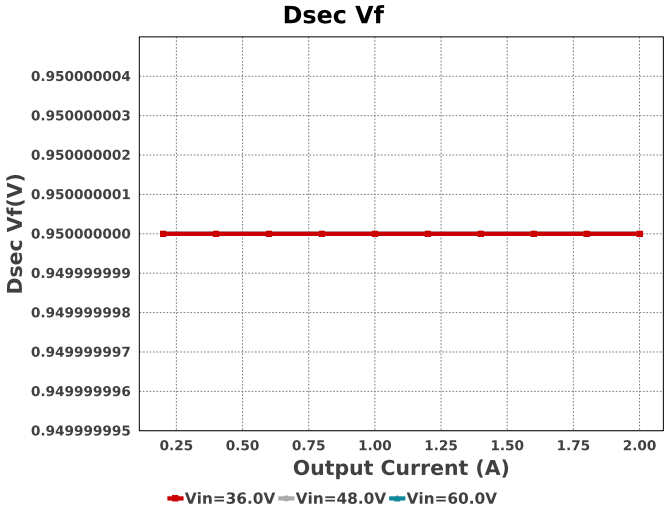


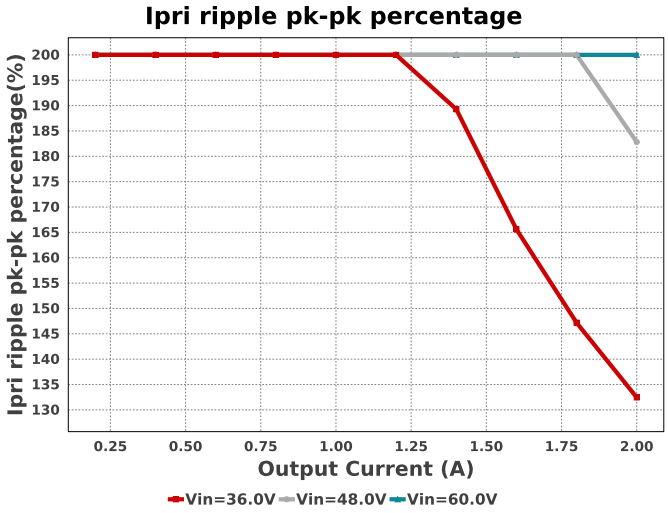


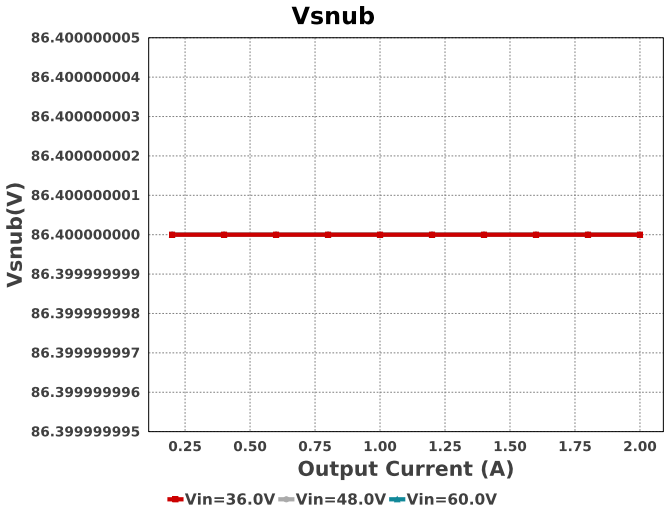


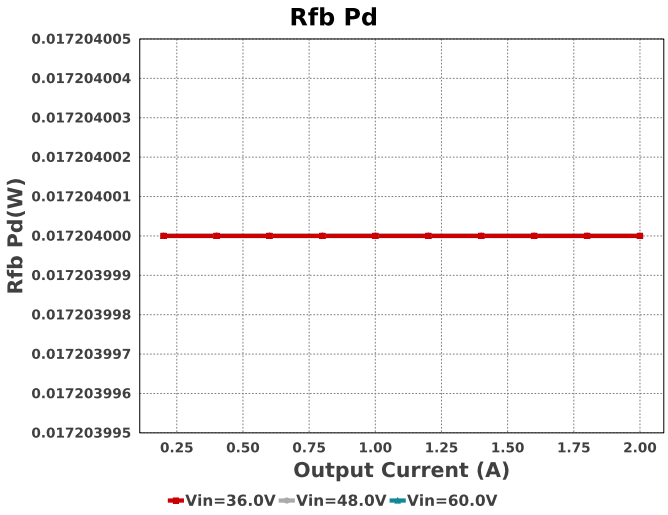


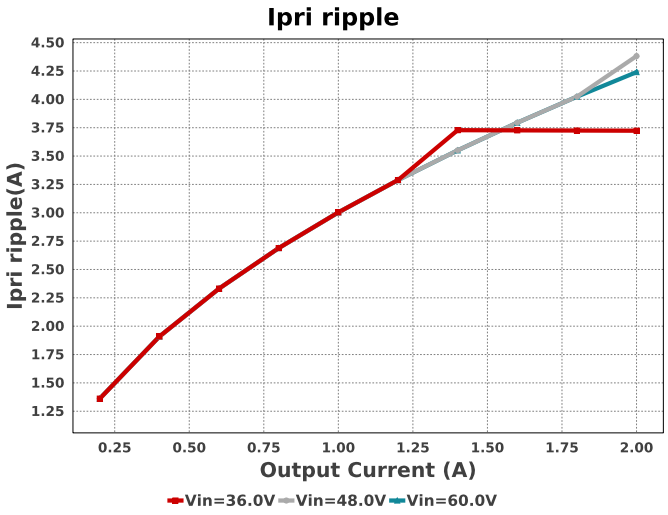


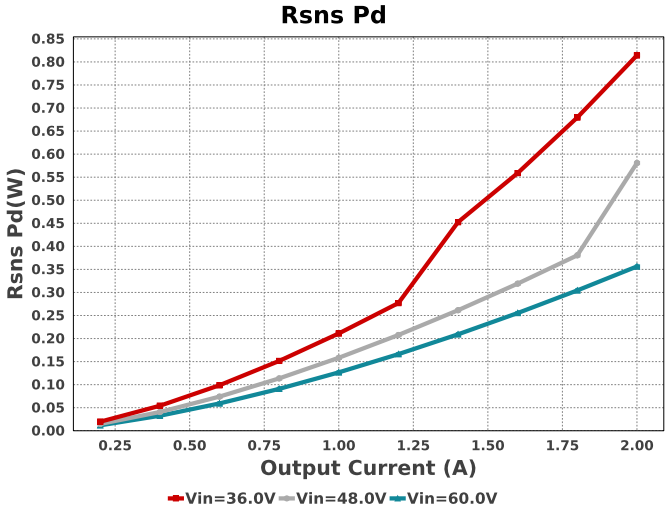


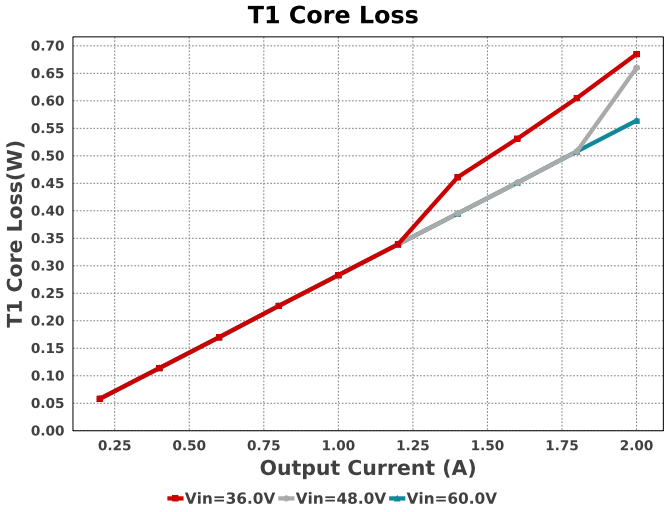


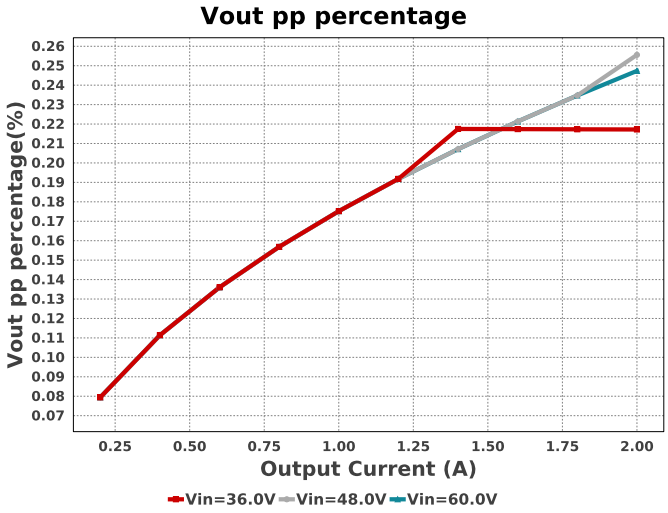


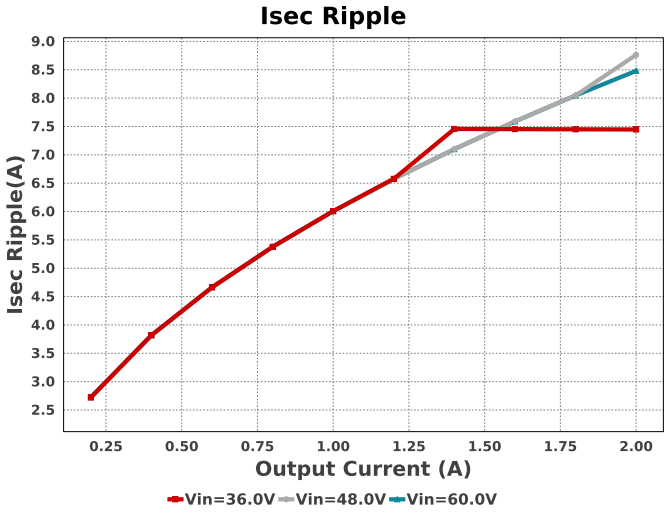


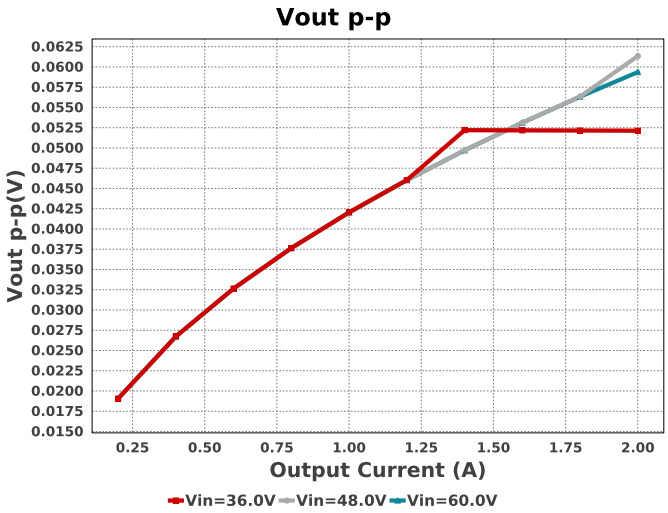


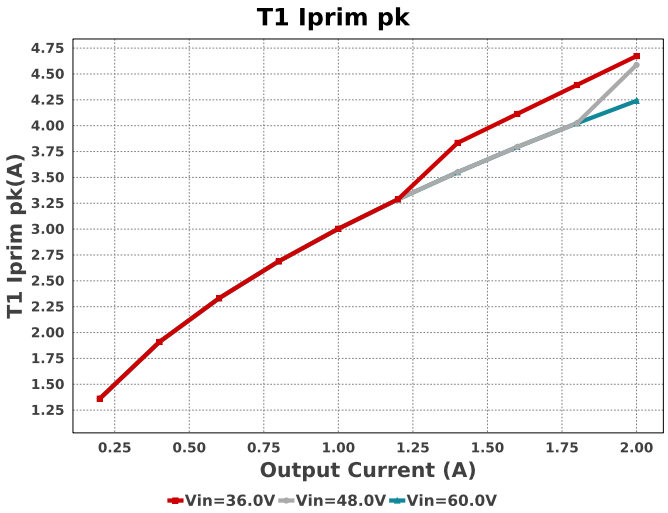












Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	3.628 mW	Capacitor	Input capacitor power dissipation
2.	Cout1 IRMS	3.266 A	Capacitor	Output capacitor1 RMS ripple current
3.	Cout1 Pd	74.675 mW	Capacitor	Output capacitor1 power dissipation
4.	Daux trr	8.26 ns	Diode	Auxiliary Diode Reverse Recovery Time
5.	Dsec Pd	950.0 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	950.0 mW	Diode	Secondary Diode Power Dissipation
9.	Dsec2 Vf	950.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
10.	Dsnub trr	30.0 ns	Diode	Snubber Diode Reverse Recovery Time
11.	IC Pd	37.159 mW	IC	IC power dissipation
12.	IC Tj	63.995 degC	IC	IC junction temperature
13.	ICThetaJA	107.5 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	1.432 A	IC	Average input current
15.	M1 Pd	479.25 mW	Mosfet	M1 MOSFET total power dissipation
16.	M1 TjOP	83.023 degC	Mosfet	M1 MOSFET junction temperature
17.	Cin Pd	3.628 mW	Power	Input capacitor power dissipation
18.	Cout1 Pd	74.675 mW	Power	Output capacitor1 power dissipation
19.	Dsec Pd	950.0 mW	Power	Secondary Diode Power Dissipation
20.	Dsec2 Pd	950.0 mW	Power	Secondary Diode Power Dissipation
21.	IC Pd	37.159 mW	Power	IC power dissipation
22.	M1 Pd	479.25 mW	Power	M1 MOSFET total power dissipation
23.	Paux	18.841 mW	Power	Power Dissipation in Raux and Daux
24.	Pd Rstartup	4.221 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
25.	Rdrv Pd	16.5 mW	Power	Power Dissipation in Gate Drive Resistor
26.	Rfb Pd	17.204 mW	Power	Rfb Power Dissipation
27.	Rsns Pd	814.26 mW	Power	Current Limit Sense Resistor Power Dissipation
28.	Snubber Pd	760.362 mW	Power	Snubber Power Dissipation
29.	T1 Copper Loss	997.09 mW	Power	Transformer Copper Loss Power Dissipation
30.	T1 Core Loss	652.0 mW	Power	Transformer Core Loss Power Dissipation
31.	T1 Pd	1.649 W	Power	Estimated Losses in Transformer
32.	Total Pd	3.555 W	Power	Total Power Dissipation
33.	Pd Rstartup	4.221 mW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
34.	Rdrv Pd	16.5 mW	Resistor	Power Dissipation in Gate Drive Resistor
35.	Rfb Pd	17.204 mW	Resistor	Rfb Power Dissipation
36.	Rsns Pd	814.26 mW	Resistor	Current Limit Sense Resistor Power Dissipation
37.	BOM Count	48	System Information	Total Design BOM count
38.	Duty Cycle	59.513 %	System Information	Duty cycle
39.	Efficiency	93.104 %	System Information	Steady state efficiency
40.	FootPrint	3.382 k mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	63.291 kHz	System Information	Switching frequency
42.	Iout	2.0 A	System Information	Iout operating point
43.	Iout_DCM	1.55 A	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	48.0 W	System Information	Total output power
46.	Tdead	0.0 ns	System Information	Approximate Dead Time of the Regulator
47.	Toff	5.621 us	System Information	Approximate Converter Off Time
48.	Ton Act	9.403 us	System Information	Approximate Converter On Time
49.	Total BOM	NA	System Information	Total BOM Cost
50.	Tsw	15.8 us	System Information	Switching Time Period
51.	Vin	36.0 V	System Information	Vin operating point
52.	Vout	24.0 V	System Information	Operational Output Voltage
53.	Vout Actual	24.004 V	System Information	Vout Actual calculated based on selected voltage divider resistors
54.	Vout Tolerance	2.137 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
55.	Vout p-p	52.129 mV	System Information	Peak-to-peak output ripple voltage
56.	Vout pp percentage	217.206 m%	System Information	Output Voltage ripple percentage
57.	Vsnub	86.4 V	System Information	Voltage Across the Snubber
58.	Ipri Avg	1.673 A	Transformer	Average Current in Primary Winding over the complete Switching Period
59.	Ipri ripple	3.724 A	Transformer	Ripple Current in the Primary Winding
60.	Ipri ripple pk-pk percentage	132.463 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
61.	Isec Ripple	7.447 A	Transformer	Ripple Current in the Secondary Winding
62.	Paux	18.841 mW	Transformer	Power Dissipation in Raux and Daux
63.	T1 Copper Loss	997.09 mW	Transformer	Transformer Copper Loss Power Dissipation
64.	T1 Core Loss	652.0 mW	Transformer	Transformer Core Loss Power Dissipation
65.	T1 Iprim RMS	2.322 A	Transformer	Transformer Primary RMS Current
66.	T1 Iprim pk	4.673 A	Transformer	Transformer Primary Peak Current
67.	T1 Is1 RMS	3.83 A	Transformer	Transformer Secondary1 RMS Current
68.	T1 Is1 pk	9.346 A	Transformer	Transformer Secondary1 Peak Current
69.	T1 Pd	1.649 W	Transformer	Estimated Losses in Transformer
70.	Vaux	11.341 V	Transformer	Auxiliary Voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	60.0	Maximum input voltage
VinMin	36.0	Minimum input voltage
Vout	24.0	Output Voltage
base_pn	UCC2803	Base Product Number
source	DC	Input Source Type
Ta	60.0	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

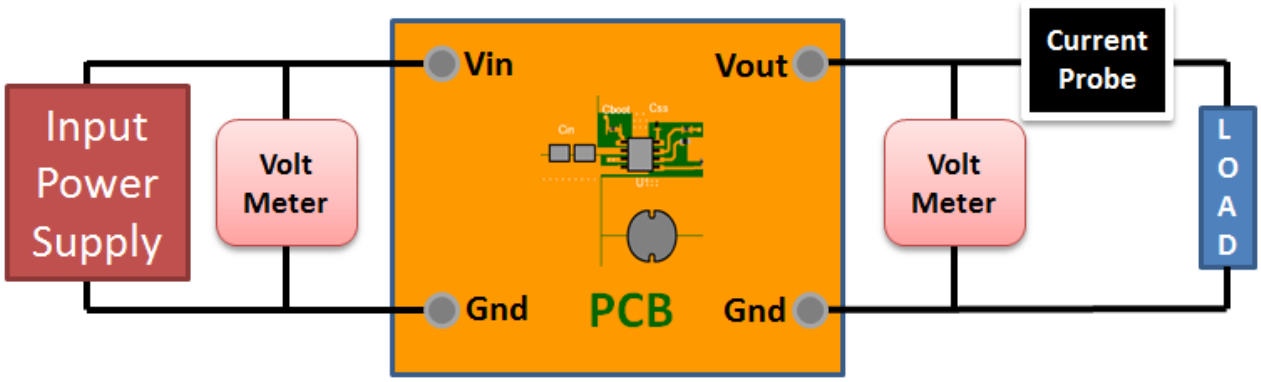
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 36.0V 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	B66229G0000X187
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66230A1114T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	22.0
AWG	25.0
Layers	2.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	11.0
AWG	24.0
Layers	1.0
Strands	2.0
Insulation Type	Triple Insulated

Auxiliary

Turns	5.0
AWG	28.0
Layers	1.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	25.0	11	Clockwise
Auxiliary	28.0	5.0	Counter Clockwise
Triple Insulated Secondary	24.0	11.0	Counter Clockwise
Primary Second 1/2.0	25.0	11	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	8.8E-5H
2.	Inductance Factor(Al)	181.0nH
3.	Npri	22.0
4.	Nsec	11.0
5.	Naux	5.0
6.	Core Type	E32/16/9
7.	Core Material	N87

#	Name	Value
8.	Bmax	0.22T
9.	Switching Frequency	63.29kHz
10.	DMax	0.6
11.	Ipk(Primary)	4.58A
12.	Irms(Primary)	2.24A
13.	Ipk(Secondary)	9.17A
14.	Irms(Secondary)	3.67A

Design Assistance

1. Master key : E659BA289C4D766A[v1]
2. **UCC2803** Product Folder : http://www.ti.com/product/UCC2803 : contains the data sheet and other resources.