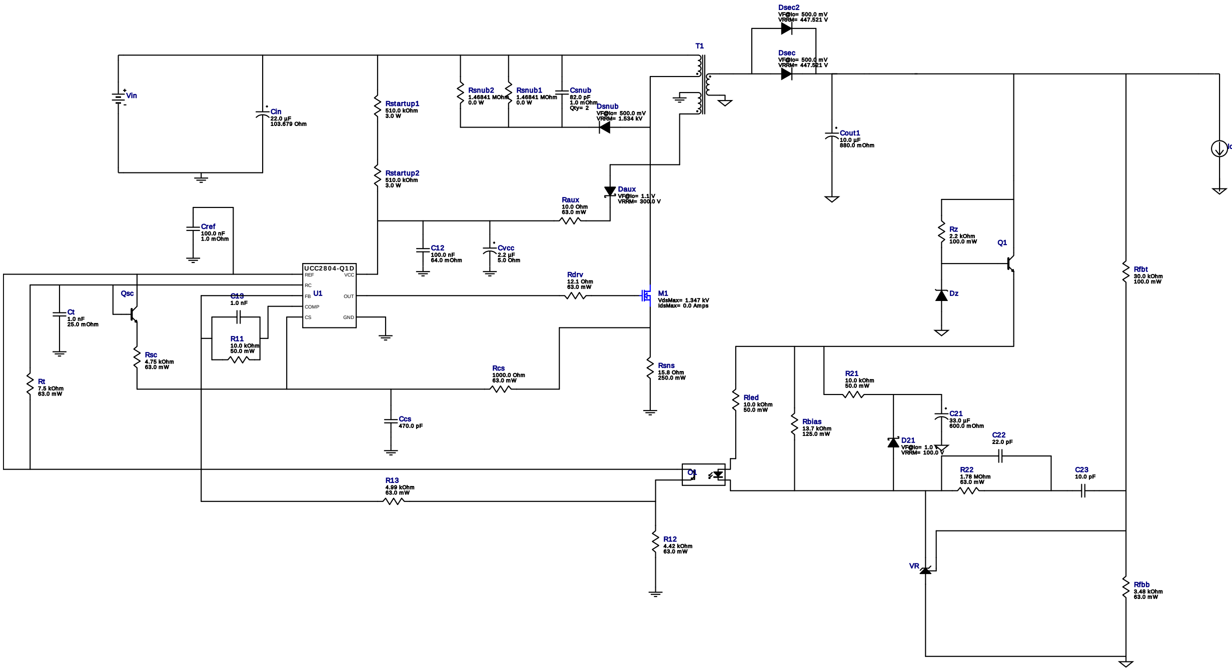
VinMin = 250.0V
VinMax = 1000.0V
Vout = 24.0V
Iout = 0.08A

Device = UCC2804QDRQ1
Topology = Flyback
Created = 2022-05-02 08:22:43.475
BOM Cost = NA
BOM Count = 46
Total Pd =

WEBENCH ® Design Report

Design : 35 UCC2804QDRQ1
UCC2804QDRQ1 250V-1000V to 24.00V @ 0.08A



Design Alerts

Component Selection Information

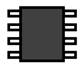
The UCC2804-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin. With the current design condition, suitable FET could not be found in the current database. Hence, this design is created using an ideal FET. Please note that the resulting FET parameters are ideal, so the efficiency/loss values have been disabled. Also, the schematic/PCB export and Thermal simulations will not work with the ideal FET.

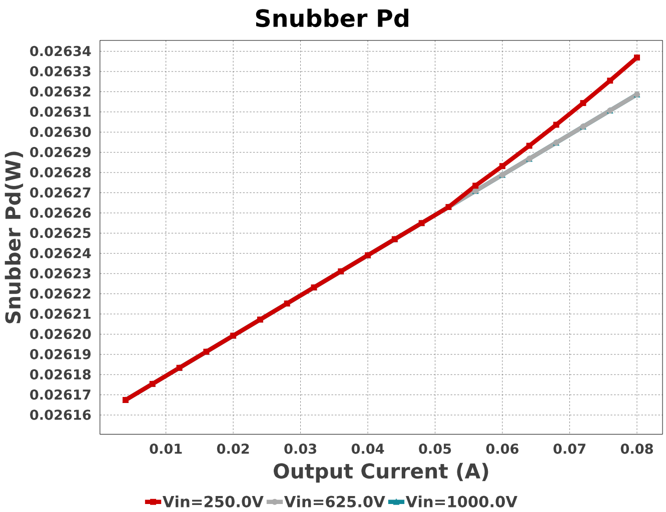
Electrical BOM

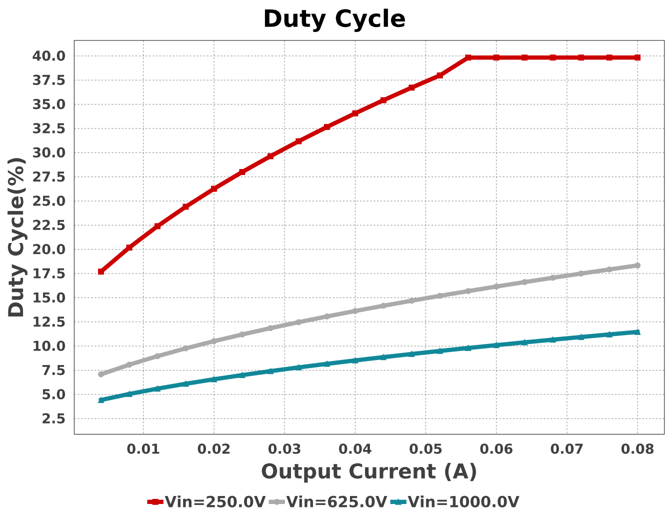
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
C13	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
C21	Chemi-Con	EMVY500ADA330MF80G Series= MVY	Cap= 33.0 uF ESR= 600.0 mOhm VDC= 50.0 V IRMS= 170.0 mA	1	$0.13	CAPSMT_62_F80 74 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	Samsung Electro-Mechanics	CL21C100JBANNNC Series= C0G/NP0	Cap= 10.0 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

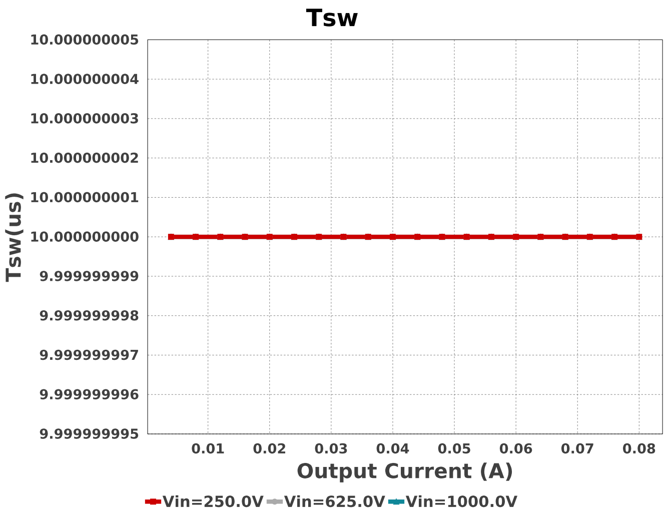
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	CUSTOM	CUSTOM Series= ?	Cap= 22.0 uF ESR= 103.679 Ohm VDC= 1.2 kV IRMS= 16.4571 mA	1	NA	CUSTOM 0 mm^2
Cout1	Nichicon	UUD1H100MCL1GS Series= uD	Cap= 10.0 uF ESR= 880.0 mOhm VDC= 50.0 V IRMS= 165.0 mA	1	$0.11	SM_RADIAL_6.3AMM 80 mm^2
Cref	MuRata	GRM155R71C104KA88D Series= X7R	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	GRM42A7U3F820JW31L Series= U2J	Cap= 82.0 pF ESR= 1.0 mOhm VDC= 3.15 kV IRMS= 0.0 A	2	$0.21	1808 16 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	Panasonic	EEE-FC1H2R2R Series= FC	Cap= 2.2 uF ESR= 5.0 Ohm VDC= 50.0 V IRMS= 30.0 mA	1	$0.05	SM_RADIAL_B 47 mm^2
D21	Comchip Technology	CDBW46-G	VF@Io= 1.0 V VRRM= 100.0 V	1	$0.03	SOD-123 13 mm^2
Daux	SMC Diode Solutions	ST1300ATR	VF@Io= 1.1 V VRRM= 300.0 V	1	$0.07	SMA 37 mm^2
Dsec	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 447.521 V	1	NA	CUSTOM 0 mm^2
Dsec2	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 447.521 V	1	NA	CUSTOM 0 mm^2
Dsnub	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 1.534 kV	1	NA	CUSTOM 0 mm^2
Dz	Diodes Inc.	MMSZ5250B-7-F	Zener	1	$0.03	SOD-123 13 mm^2
M1	NA	IdealFET	VdsMax= 1.347 kV IdsMax= 0.0 Amps	1	NA	NA 0 mm^2
O1	Fairchild Semiconductor	FOD817A	Optocoupler	1	$0.11	DIP-4 71 mm^2
Q1	ON Semiconductor	BC846BLT1G	Bipolar Transistor	1	$0.02	SOT-23 14 mm^2
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	$1.11	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	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 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

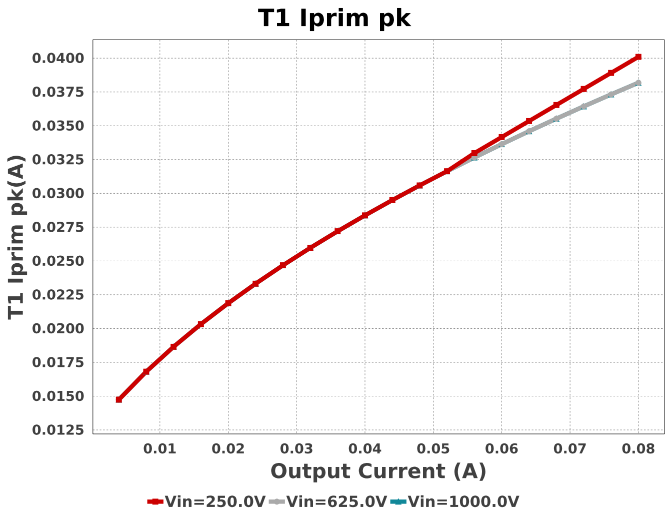
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R22	Vishay-Dale	CRCW04021M78FKED Series= CRCW..e3	Res= 1.78 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rbias	Vishay-Dale	CRCW080513K7FKEA Series= CRCW..e3	Res= 13.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rcs	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 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	Vishay-Dale	CRCW04023K48FKED Series= CRCW..e3	Res= 3.48 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rled	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsc	Vishay-Dale	CRCW04024K75FKED Series= CRCW..e3	Res= 4.75 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsns	Vishay-Dale	CMF5015R800FHEB Series= CMF50	Res= 15.8 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.20	CMF50 46 mm^2
Rsnub1	CUSTOM	CUSTOM Series= ?	Res= 1.46841 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rsnub2	CUSTOM	CUSTOM Series= ?	Res= 1.46841 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rstartup1	Vishay-Bccomponents	PR03000205103JAC00 Series= ?	Res= 510.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.17	PR03 197 mm^2
Rstartup2	Vishay-Bccomponents	PR03000205103JAC00 Series= ?	Res= 510.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.17	PR03 197 mm^2
Rt	Vishay-Dale	CRCW04027K50FKED Series= CRCW..e3	Res= 7.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rz	Yageo	RC0603FR-072K2L Series= ?	Res= 2.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
T1	Core=Wurth Elektronik , CoilFormer=Wurth Elektronik	Core=150-3262 , CoilFormer=070-6389	Lp= 30.018 mH Turns Ratio(Nas)= 18:29 Turns Ratio(Nps)= 186:29 Npri= 186.0 Naux= 18.0 Nsec= 29.0	1	NA	EPQ13 323 mm^2

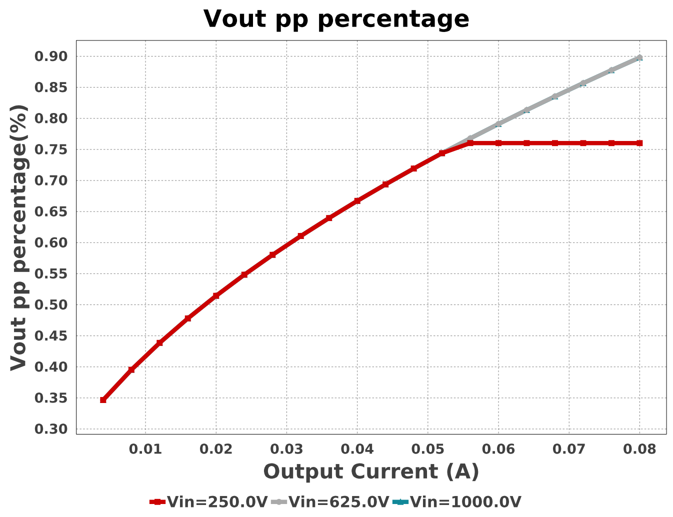
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	UCC2804QDRQ1	Switcher	1	$1.15	 D0008A 57 mm^2
VR	Texas Instruments	TL431IDBVR	Voltage References	1	$0.09	 R-PDSO-G3 16 mm^2

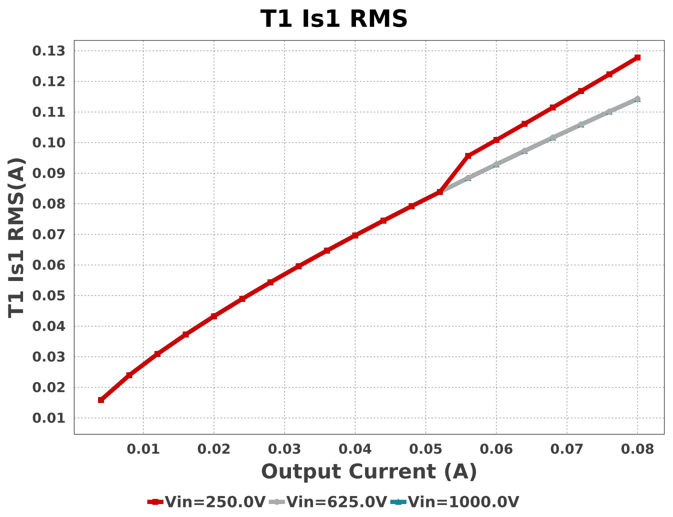


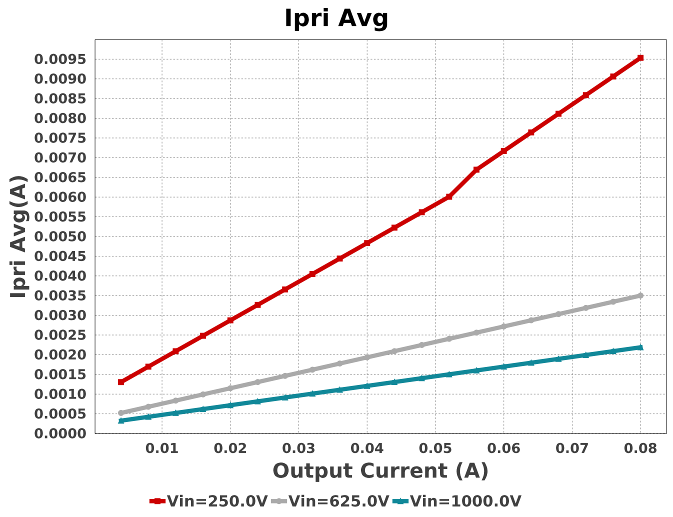


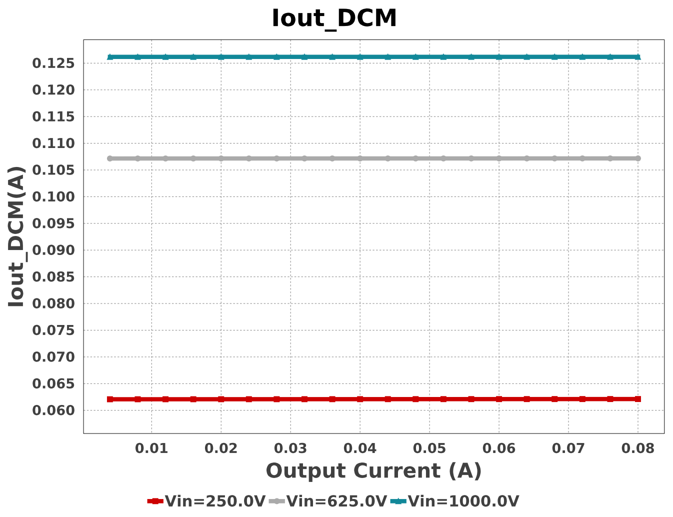


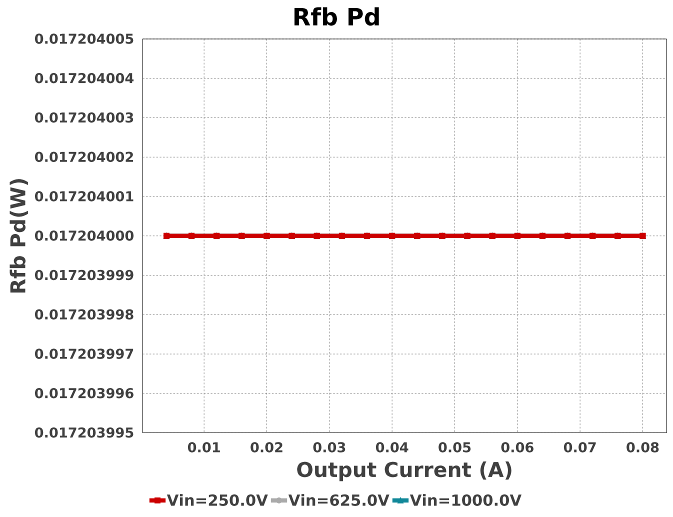


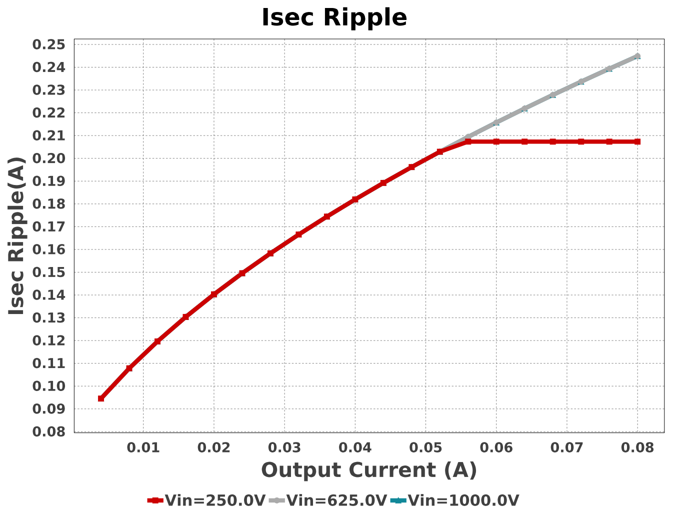

Vout pp percentage
Vout pp percentage(%)
0.90 0.85 0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V


T1 Is1 RMS
T1 Is1 RMS(A)
0.13 0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V

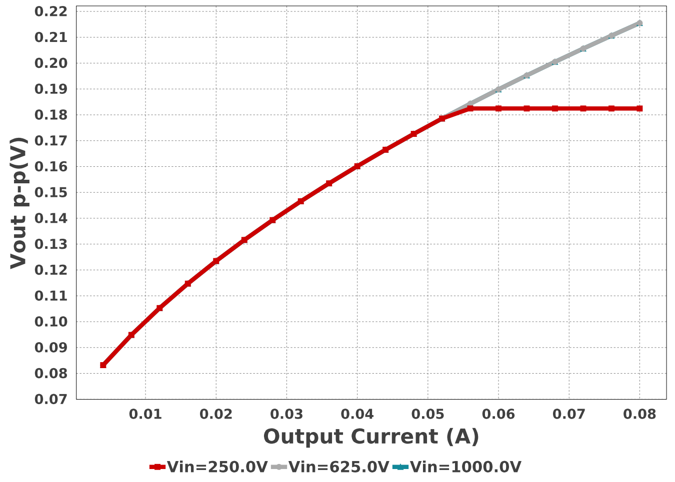

Ipri Avg
Ipri Avg(A)
0.0095 0.0090 0.0085 0.0080 0.0075 0.0070 0.0065 0.0060 0.0055 0.0050 0.0045 0.0040 0.0035 0.0030 0.0025 0.0020 0.0015 0.0010 0.0005 0.0000
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V


Iout_DCM
Iout_DCM(A)
0.125 0.120 0.115 0.110 0.105 0.100 0.095 0.090 0.085 0.080 0.075 0.070 0.065 0.060
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V

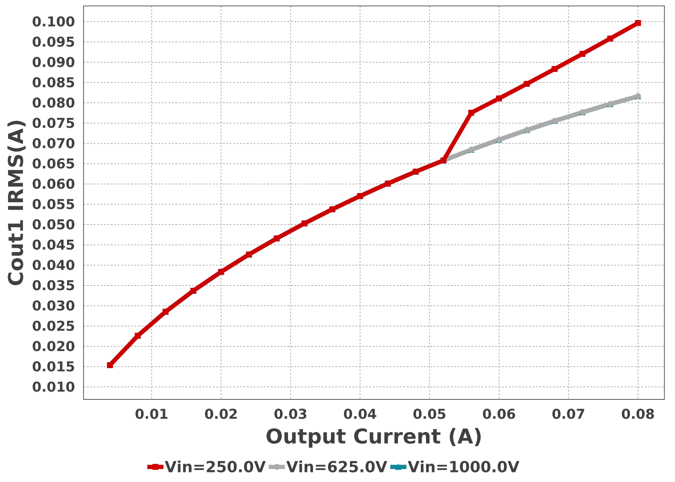

Rfb Pd
Rfb Pd(W)
0.017204005 0.017204004 0.017204003 0.017204002 0.017204001 0.017204000 0.017203999 0.017203998 0.017203997 0.017203996 0.017203995
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V


Isec Ripple
Isec Ripple(A)
0.25 0.24 0.23 0.22 0.21 0.20 0.19 0.18 0.17 0.16 0.15 0.14 0.13 0.12 0.11 0.10 0.09 0.08
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
Output Current (A)
Vin=250.0V Vin=625.0V Vin=1000.0V

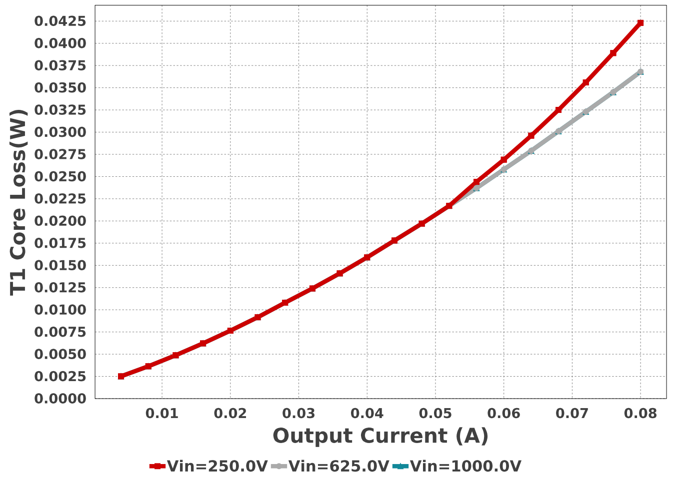
Vout p-p



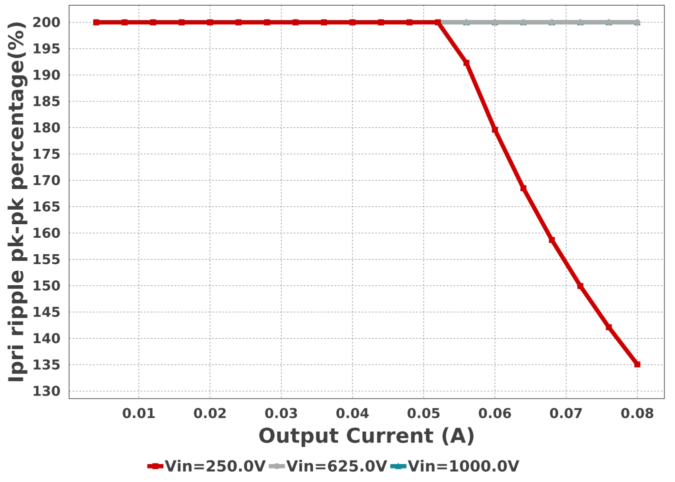
Cout1 IRMS



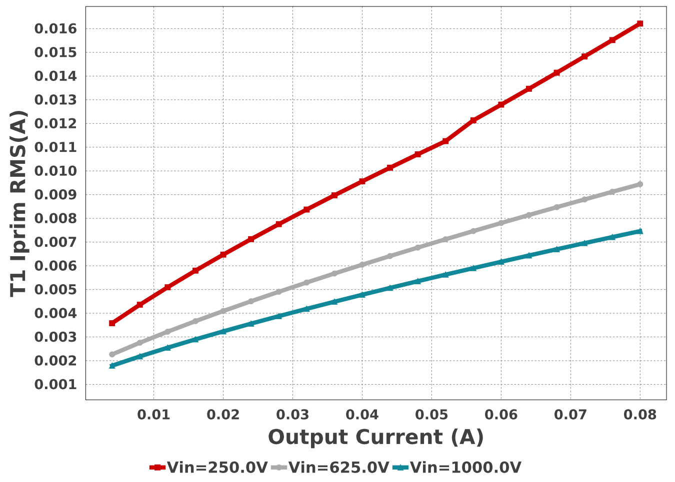
T1 Core Loss



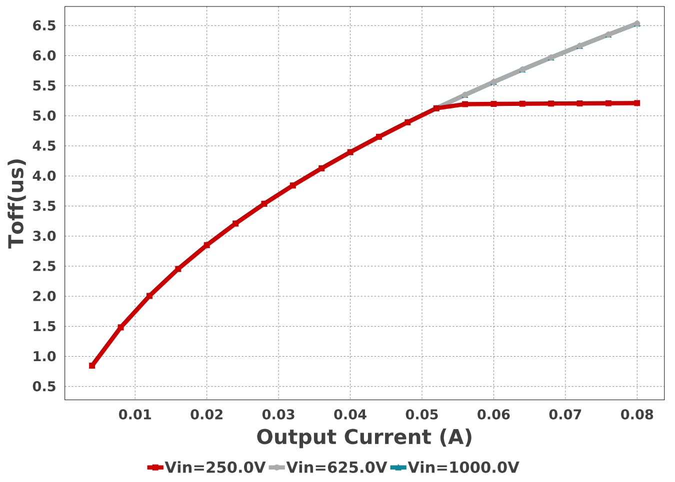
Ipri ripple pk-pk percentage



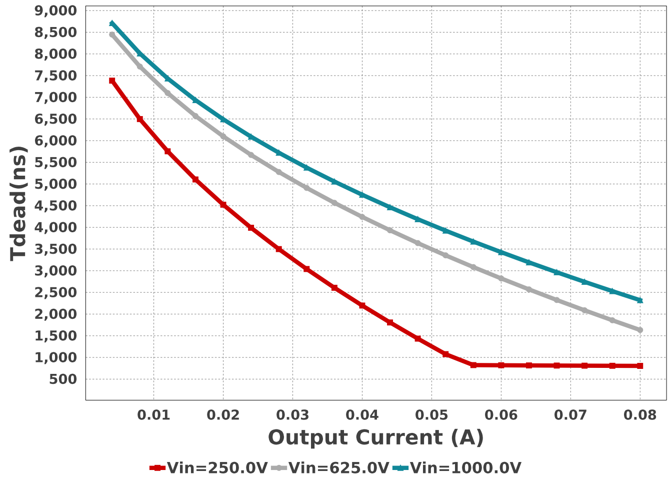
T1 Iprim RMS



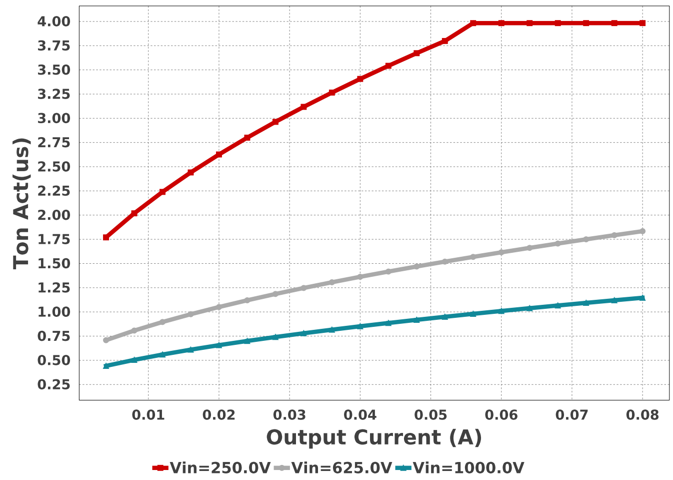
Toff



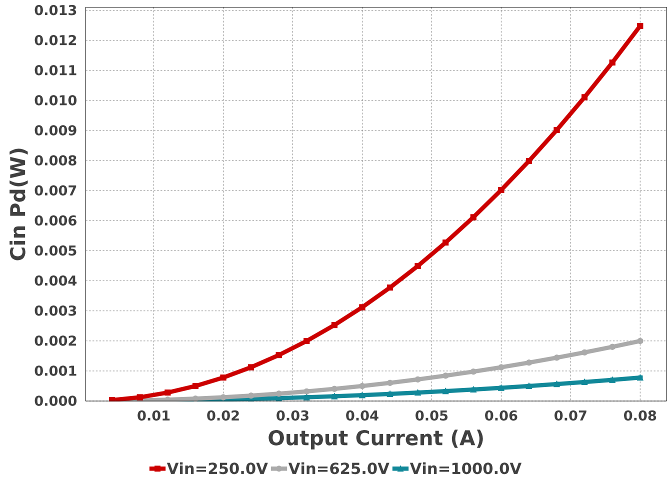
Tdead



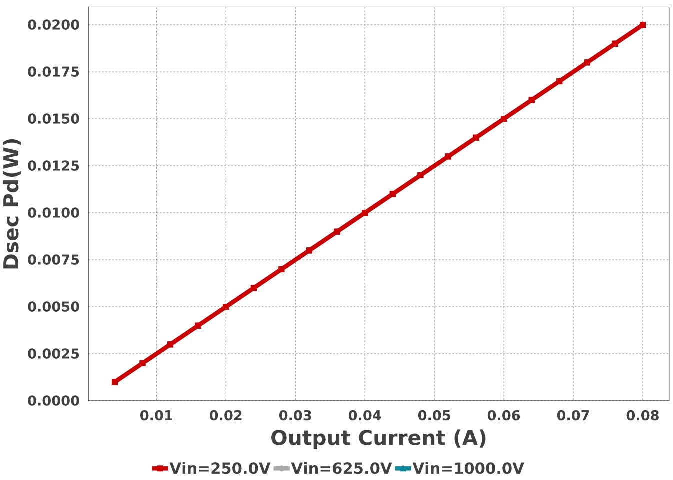
Ton Act



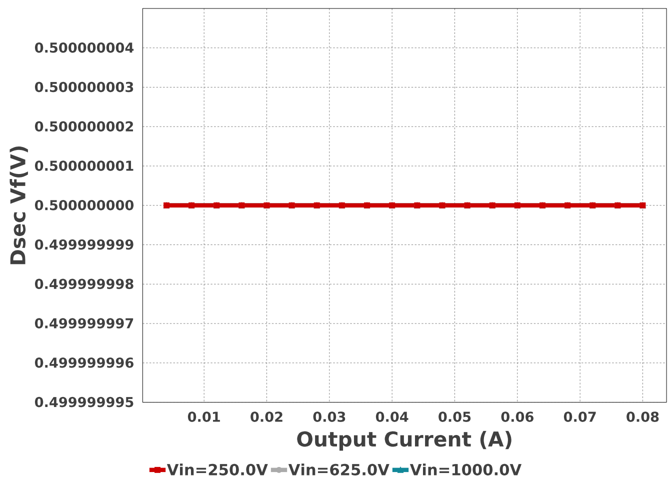
Cin Pd



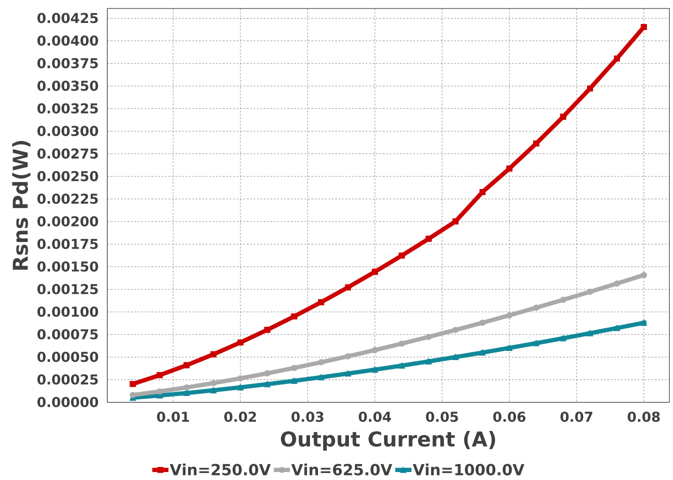
Dsec Pd



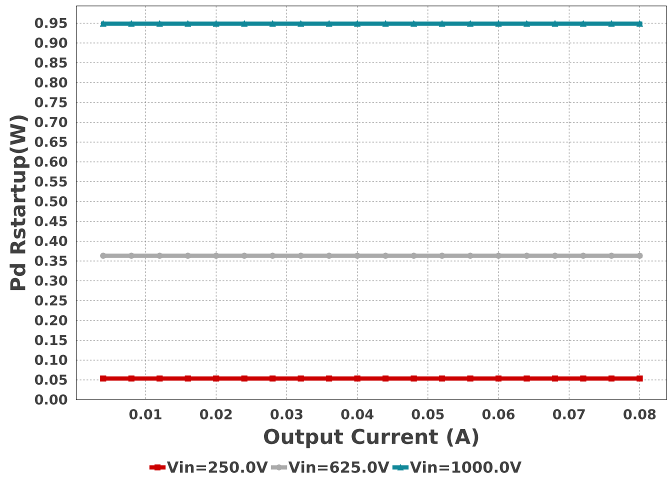
Dsec Vf



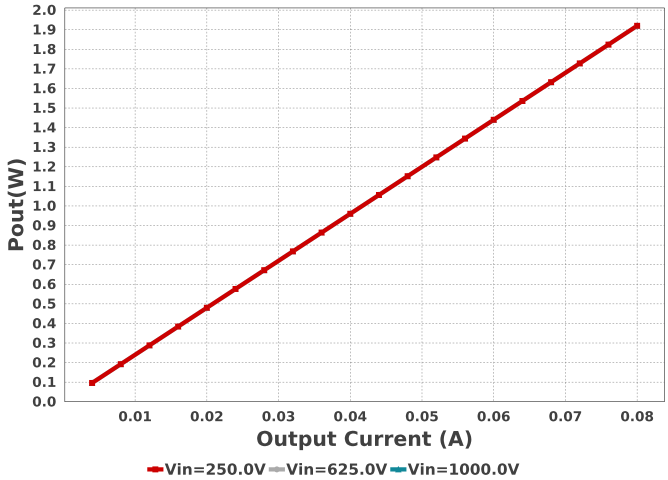
Rsns Pd



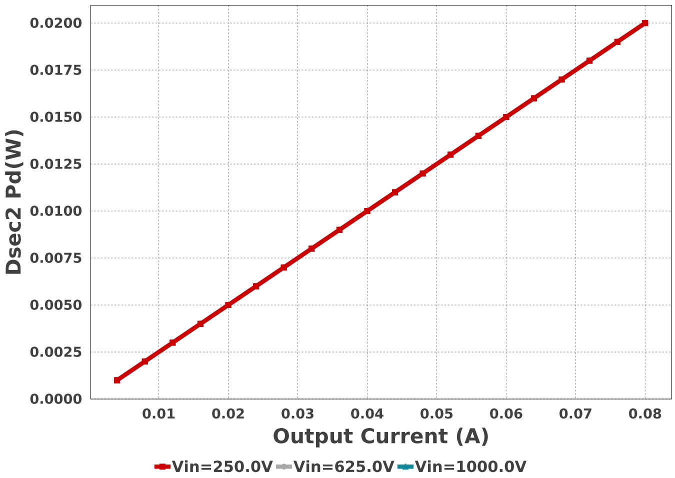
Pd Rstartup



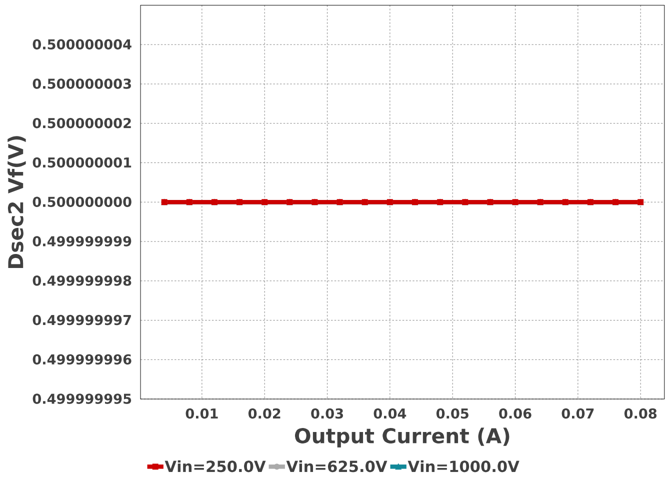
Pout



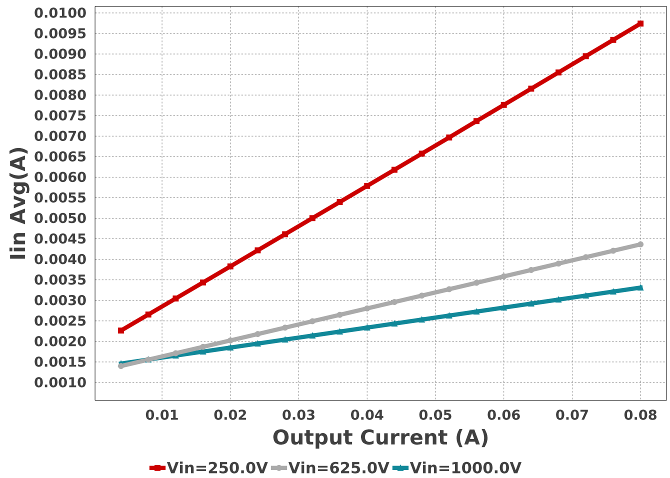
Dsec2 Pd



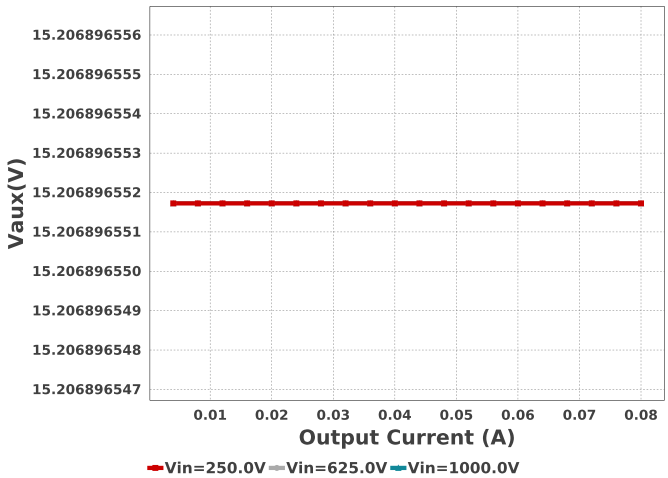
Dsec2 Vf



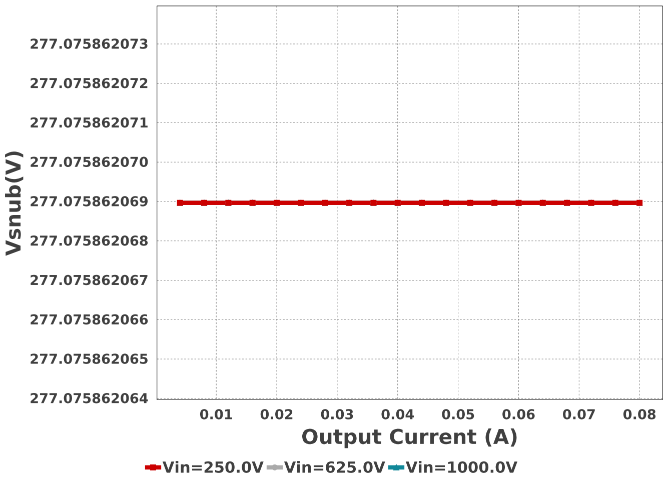
Iin Avg



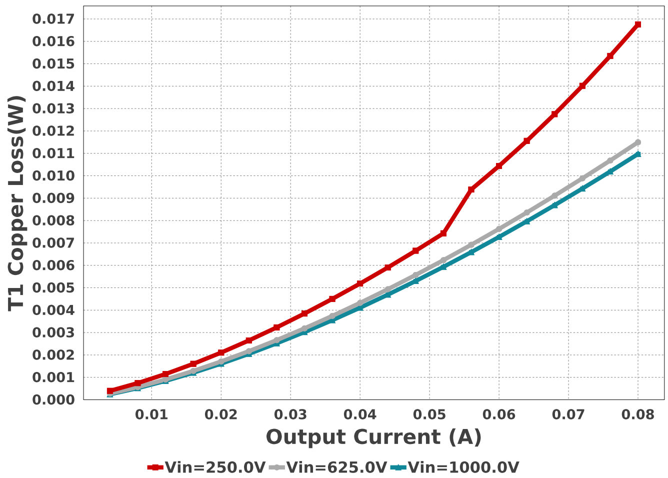
Vaux



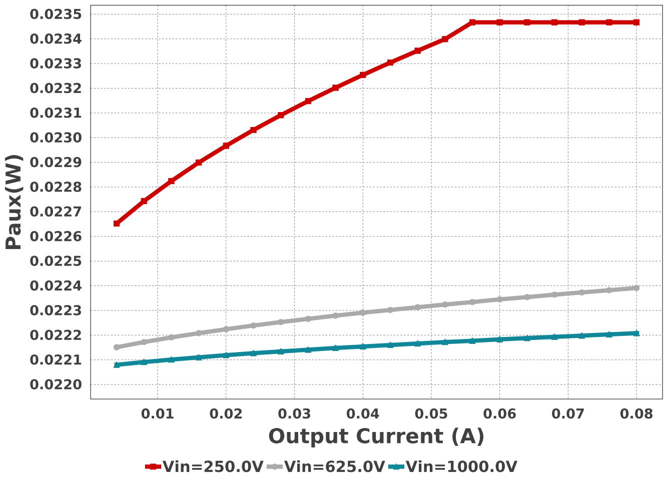
Vsnub



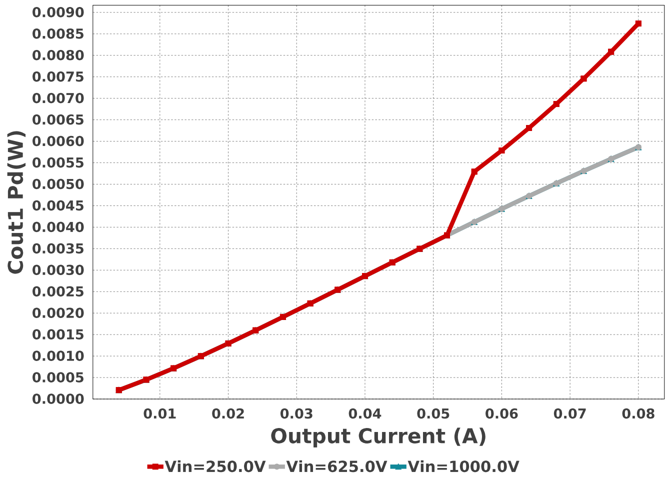
T1 Copper Loss



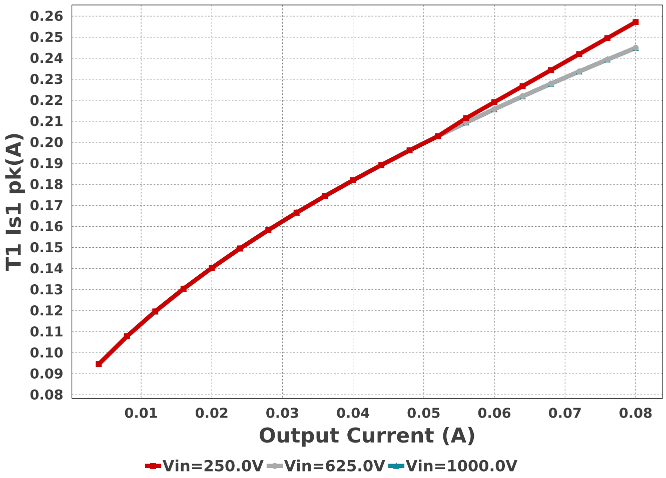
Paux



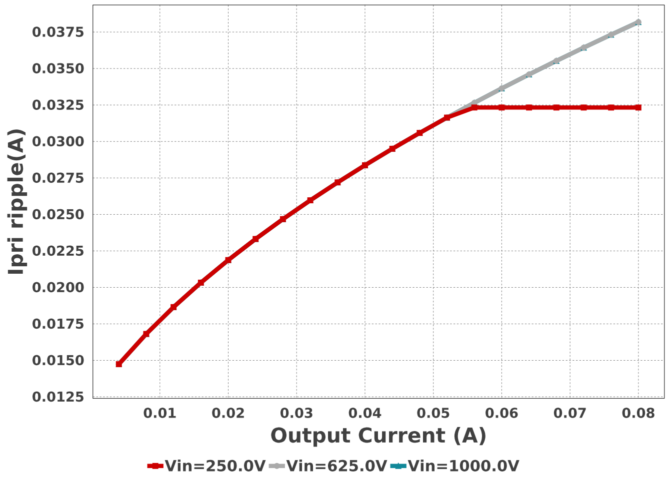
Cout1 Pd

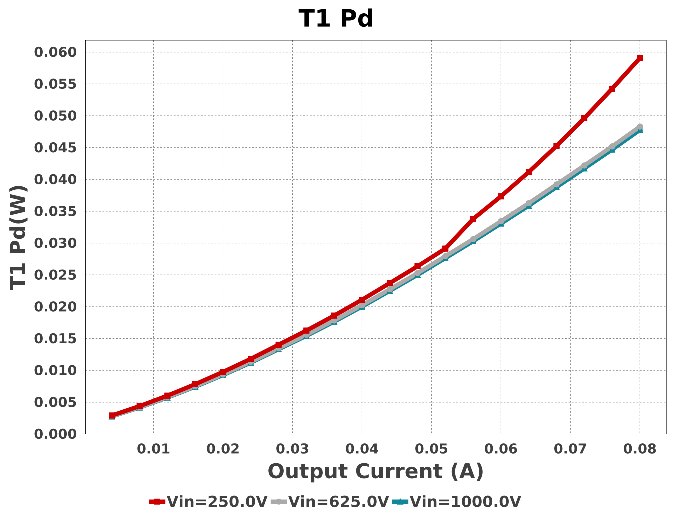


T1 Is1 pk



Ipri ripple





Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	12.48 mW	Capacitor	Input capacitor power dissipation
2.	Cout1 IRMS	99.661 mA	Capacitor	Output capacitor1 RMS ripple current
3.	Cout1 Pd	8.74 mW	Capacitor	Output capacitor1 power dissipation
4.	Daux trr	35.0 ns	Diode	Auxiliary Diode Reverse Recovery Time
5.	Dsec Pd	20.0 mW	Diode	Secondary Diode Power Dissipation
6.	Dsec Vf	500.0 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	20.0 mW	Diode	Secondary Diode Power Dissipation
9.	Dsec2 Vf	500.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
10.	Dsnub trr	0.0 ns	Diode	Snubber Diode Reverse Recovery Time
11.	ICThetaJA	107.5 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	10.794 mA	IC	Average input current
13.	Cin Pd	12.48 mW	Power	Input capacitor power dissipation
14.	Cout1 Pd	8.74 mW	Power	Output capacitor1 power dissipation
15.	Dsec Pd	20.0 mW	Power	Secondary Diode Power Dissipation
16.	Dsec2 Pd	20.0 mW	Power	Secondary Diode Power Dissipation
17.	Paux	23.467 mW	Power	Power Dissipation in Raux and Daux
18.	Pd Rstartup	53.542 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
19.	Rfb Pd	17.204 mW	Power	Rfb Power Dissipation
20.	Rsns Pd	4.153 mW	Power	Current Limit Sense Resistor Power Dissipation
21.	Snubber Pd	26.337 mW	Power	Snubber Power Dissipation
22.	T1 Copper Loss	16.372 mW	Power	Transformer Copper Loss Power Dissipation
23.	T1 Core Loss	40.8 mW	Power	Transformer Core Loss Power Dissipation
24.	T1 Pd	57.172 mW	Power	Estimated Losses in Transformer
25.	Pd Rstartup	53.542 mW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
26.	Rfb Pd	17.204 mW	Resistor	Rfb Power Dissipation
27.	Rsns Pd	4.153 mW	Resistor	Current Limit Sense Resistor Power Dissipation
28.	BOM Count	46	System Information	Total Design BOM count
29.	Duty Cycle	39.833 %	System Information	Duty cycle
30.	FootPrint	1.521 k mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	100.0 kHz	System Information	Switching frequency
32.	Iout	80.0 mA	System Information	Iout operating point
33.	Iout_DCM	62.116 mA	System Information	Approximate Current below which DCM mode of operation will begin
34.	Mode	CCM	System Information	Conduction Mode
35.	Pout	1.92 W	System Information	Total output power
36.	Tdead	805.019 ns	System Information	Approximate Dead Time of the Regulator
37.	Toff	5.212 us	System Information	Approximate Converter Off Time
38.	Ton Act	3.983 us	System Information	Approximate Converter On Time
39.	Total BOM	NA	System Information	Total BOM Cost

#	Name	Value	Category	Description
40.	Tsw	10.0 us	System Information	Switching Time Period
41.	Vin	250.0 V	System Information	Vin operating point
42.	Vout	24.0 V	System Information	Operational Output Voltage
43.	Vout Actual	24.004 V	System Information	Vout Actual calculated based on selected voltage divider resistors
44.	Vout Tolerance	2.137 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
45.	Vout p-p	182.448 mV	System Information	Peak-to-peak output ripple voltage
46.	Vout pp percentage	760.202 m%	System Information	Output Voltage ripple percentage
47.	Vsnub	277.076 V	System Information	Voltage Across the Snubber
48.	Ipri Avg	9.533 mA	Transformer	Average Current in Primary Winding over the complete Switching Period
49.	Ipri ripple	32.325 mA	Transformer	Ripple Current in the Primary Winding
50.	Ipri ripple pk-pk percentage	135.065 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
51.	Isec Ripple	207.328 mA	Transformer	Ripple Current in the Secondary Winding
52.	Paux	23.467 mW	Transformer	Power Dissipation in Raux and Daux
53.	T1 Copper Loss	16.372 mW	Transformer	Transformer Copper Loss Power Dissipation
54.	T1 Core Loss	40.8 mW	Transformer	Transformer Core Loss Power Dissipation
55.	T1 Iprim RMS	16.213 mA	Transformer	Transformer Primary RMS Current
56.	T1 Iprim pk	40.096 mA	Transformer	Transformer Primary Peak Current
57.	T1 Is1 RMS	127.798 mA	Transformer	Transformer Secondary1 RMS Current
58.	T1 Is1 pk	257.167 mA	Transformer	Transformer Secondary1 Peak Current
59.	T1 Pd	57.172 mW	Transformer	Estimated Losses in Transformer
60.	Vaux	15.207 V	Transformer	Auxiliary Voltage

Design Inputs

Name	Value	Description
Iout	80.0 m	Maximum Output Current
VinMax	1,000.0	Maximum input voltage
VinMin	250.0	Minimum input voltage
Vout	24.0	Output Voltage
base_pn	UCC2804-Q1	Base Product Number
source	DC	Input Source Type
Ta	85.0	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

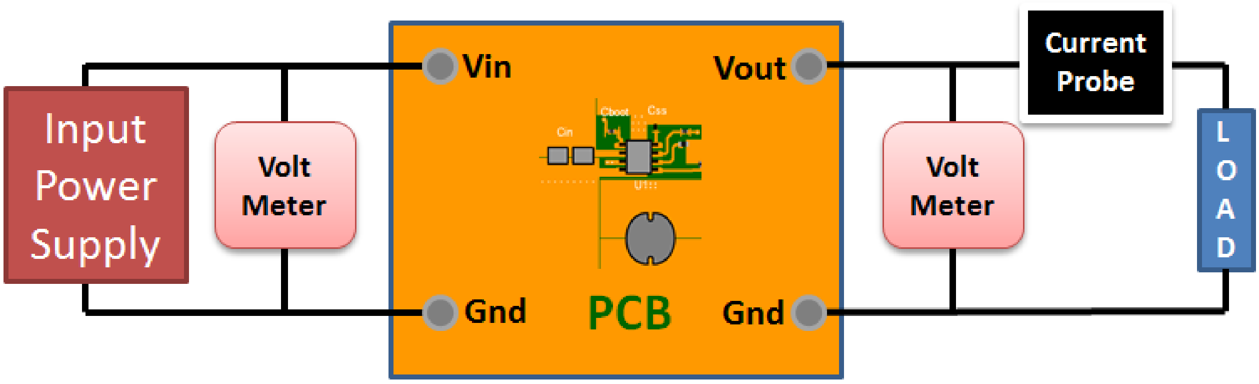
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 250.0V 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	150-3262
2.	Core Manufacturer	Wurth Elektronik
3.	Coil Former Part Number	070-6389
4.	Coil Former Manufacturer	Wurth Elektronik

Transformer Electrical Diagram

Primary

Turns	186.0
AWG	39.0
Layers	3.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	29.0
AWG	34.0
Layers	2.0
Strands	1.0
Insulation Type	Triple Insulated

Auxiliary

Turns	18.0
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 2/3.0	39.0	124	Clockwise
Auxiliary	28.0	18.0	Counter Clockwise
Triple Insulated Secondary	34.0	29.0	Counter Clockwise
Primary Second 1/3.0	39.0	62	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	0.03H
2.	Inductance Factor(Al)	868.0nH
3.	Npri	186.0
4.	Nsec	29.0
5.	Naux	18.0
6.	Core Type	EPQ13
7.	Core Material	TP4A

#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	100.00kHz
10.	DMax	0.4
11.	Ipk(Primary)	0.04A
12.	Irms(Primary)	0.02A
13.	Ipk(Secondary)	0.25A
14.	Irms(Secondary)	0.13A

Design Assistance

1. Feature Highlights: This device provides the features that are necessary to implement off-line or dc-to-dc fixed-frequency current-mode control schemes, with a minimum number of external components.

2. The UCC2804-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

3. Master key : 4252A3B24B4CB103[v1]

4. **UCC2804-Q1** Product Folder : http://www.ti.com/product/UCC2804%2DQ1 : contains the data sheet and other resources.