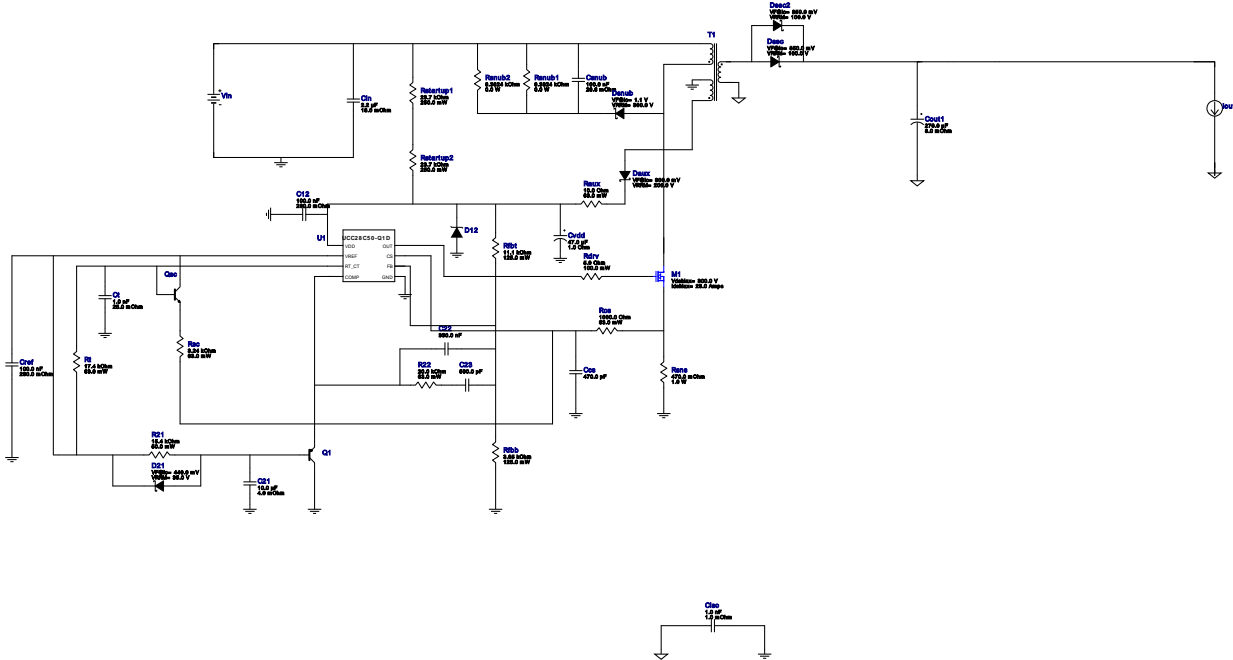


VinMin = 21.0V  
 VinMax = 150.0V  
 Vout = 6.0V  
 Iout = 1.5A

Device = UCC28C50QDRQ1  
 Topology = Flyback  
 Created = 2023-12-06 05:46:57.730  
 BOM Cost = NA  
 BOM Count = 37  
 Total Pd = 2.2W

# WEBENCH<sup>®</sup> Design Report

Design : 14733 UCC28C50QDRQ1  
 UCC28C50QDRQ1 21V-150V to 6.00V @ 1.5A



1. This regulator device 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. View WEBENCH(R) Disclaimer.

## Design Alerts














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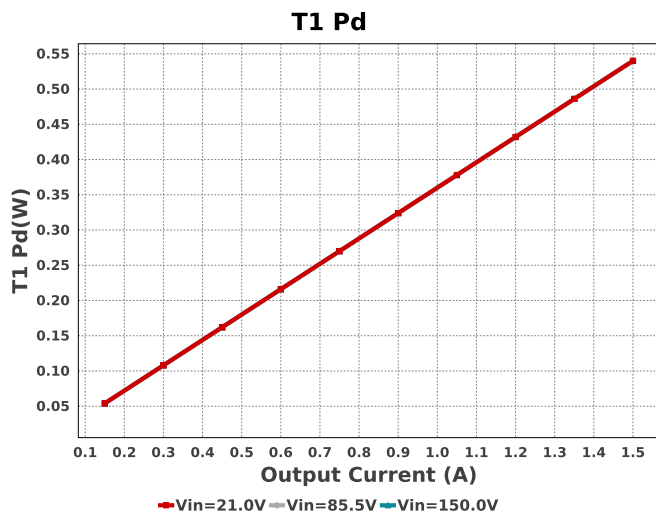
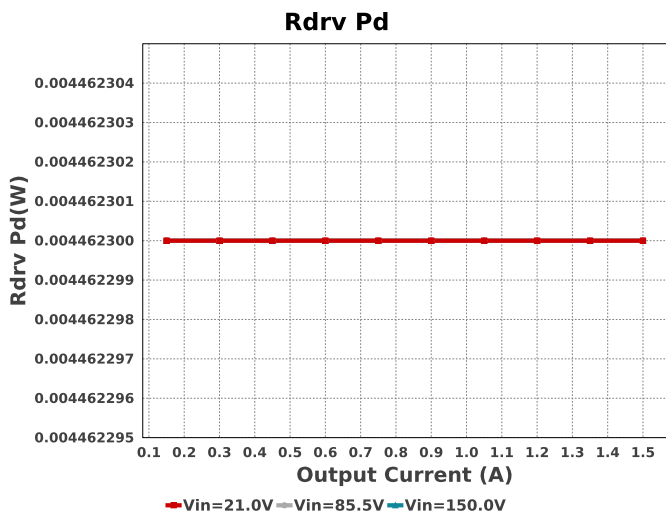
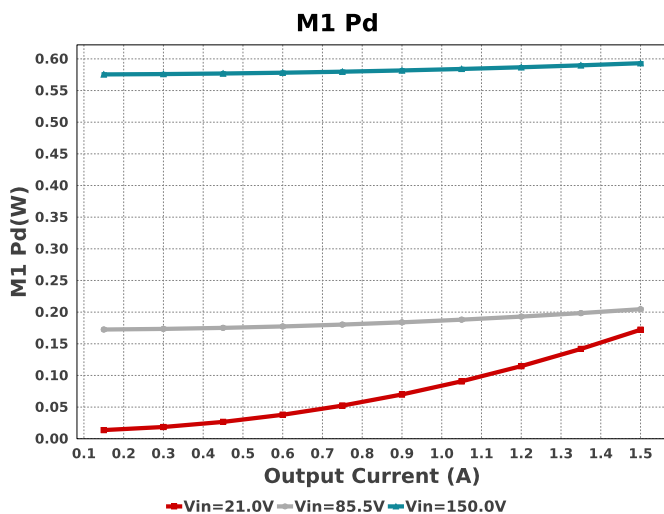
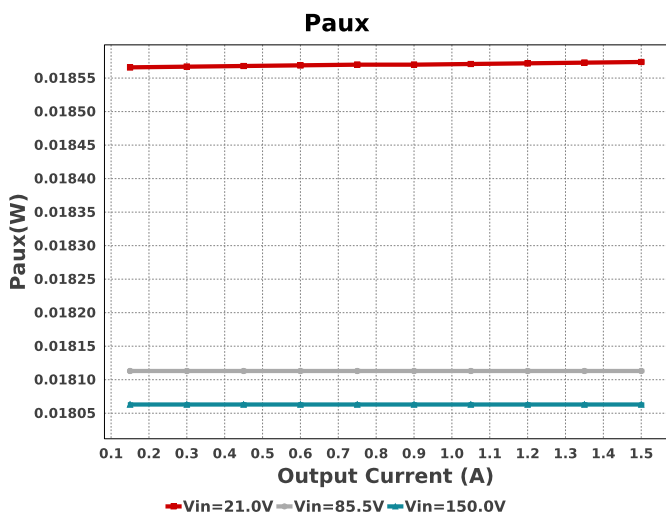
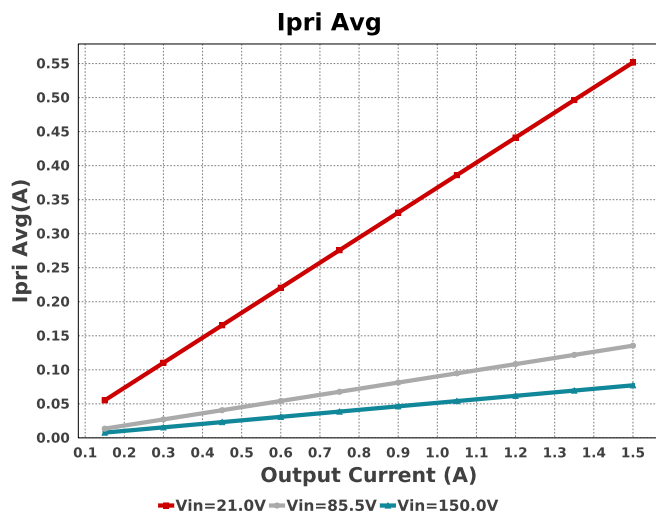
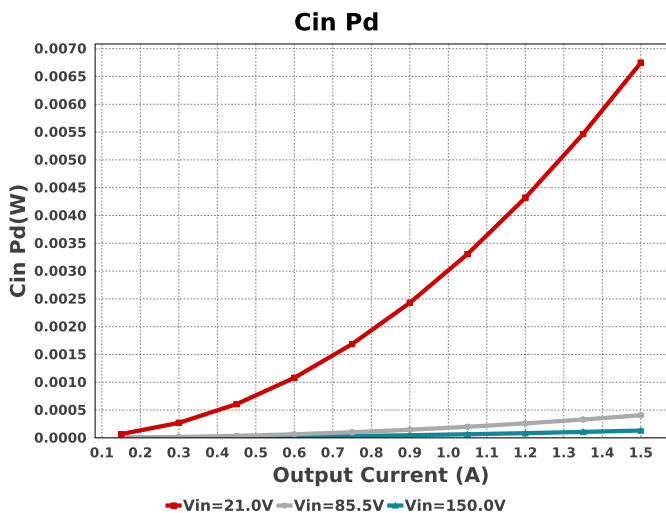
The UCC28C50-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

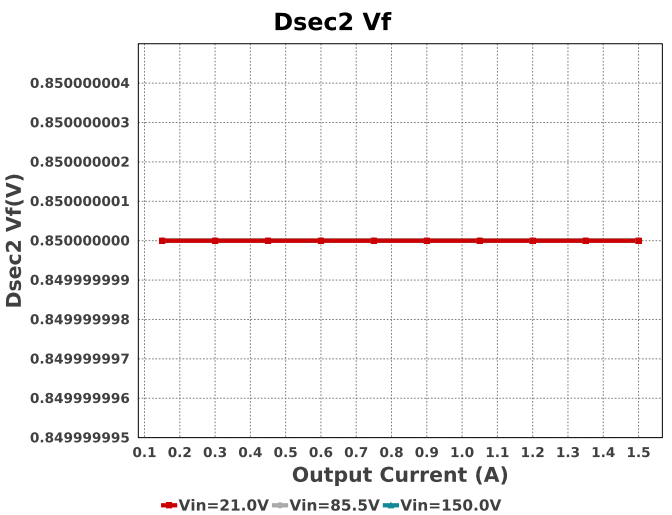
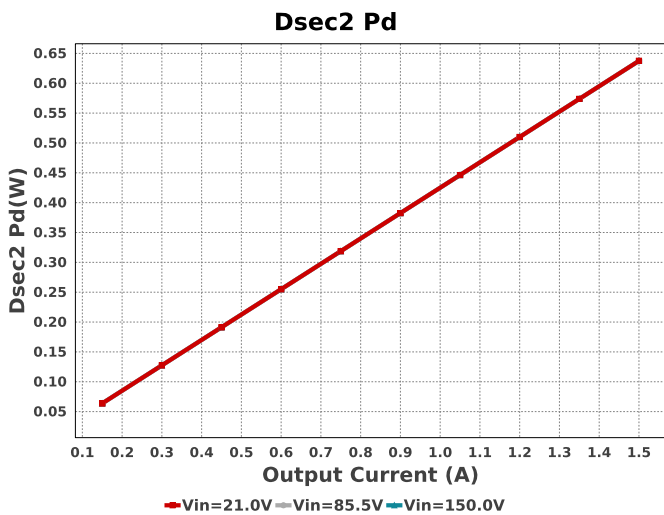
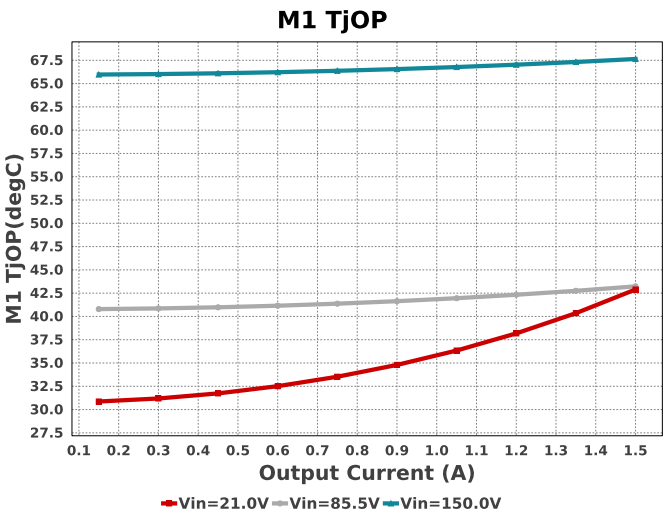
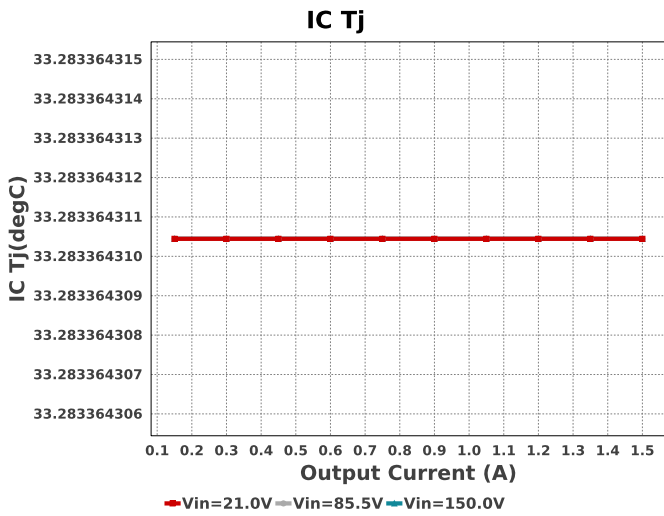
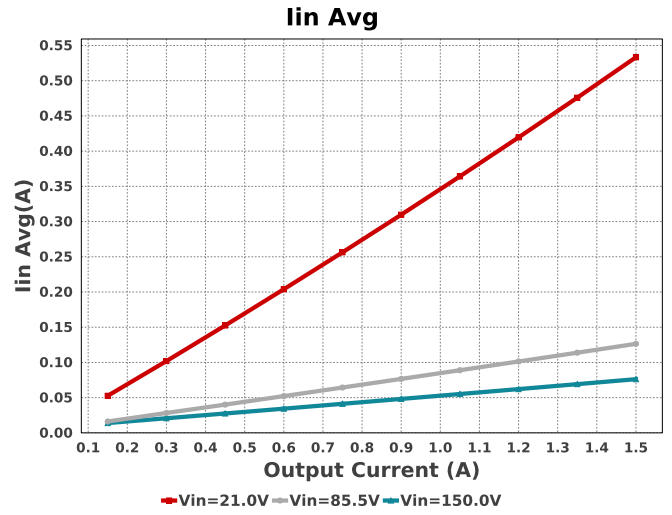
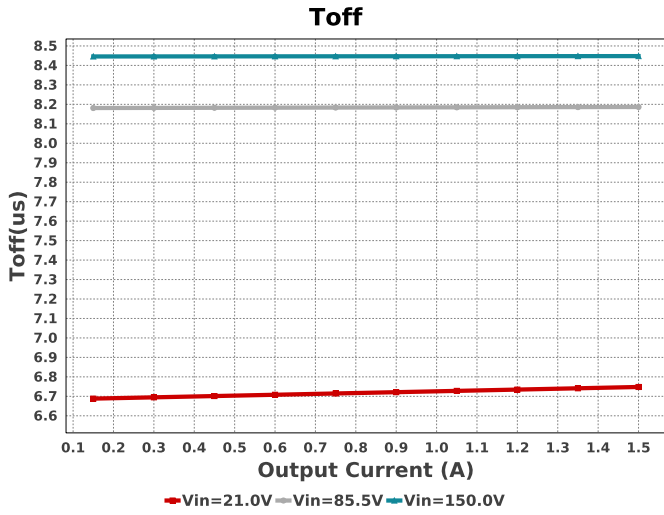
## Electrical BOM

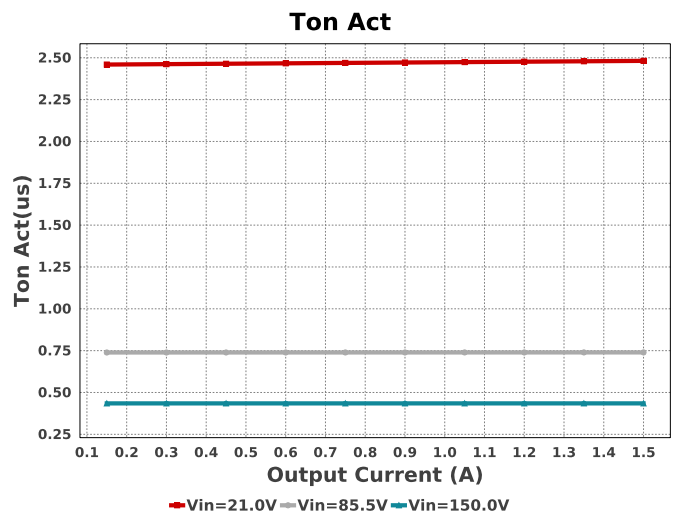
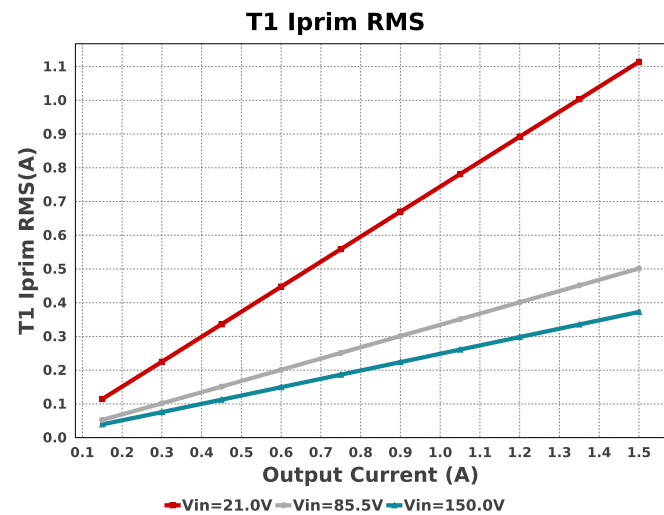
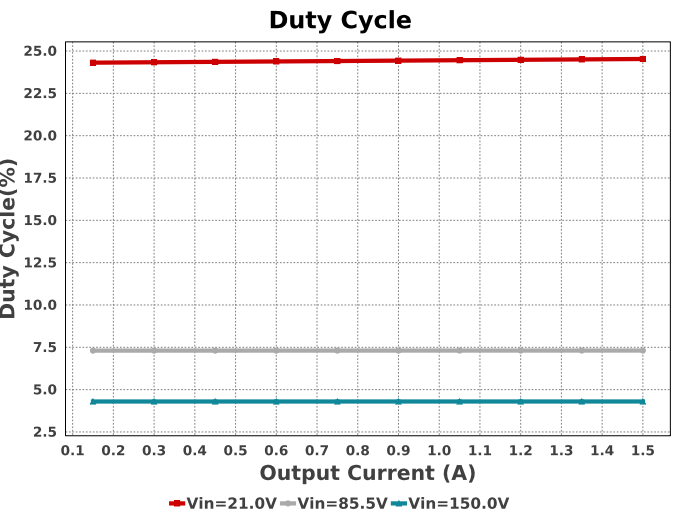
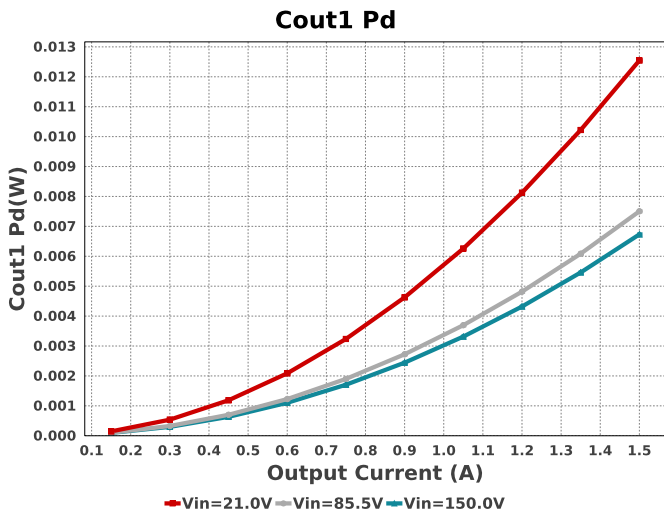
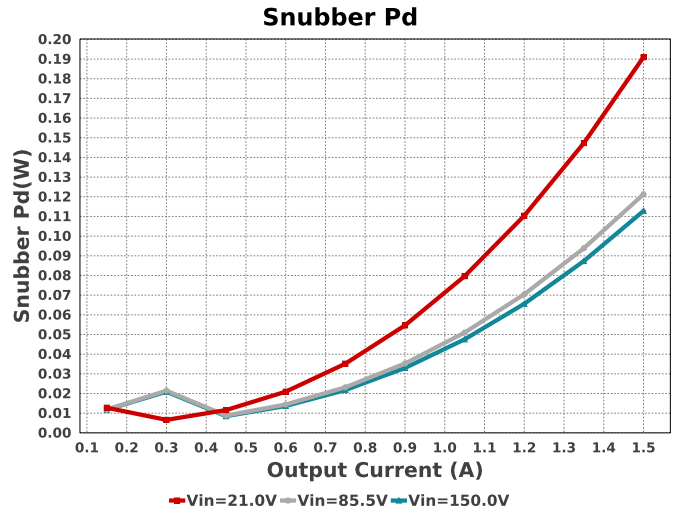
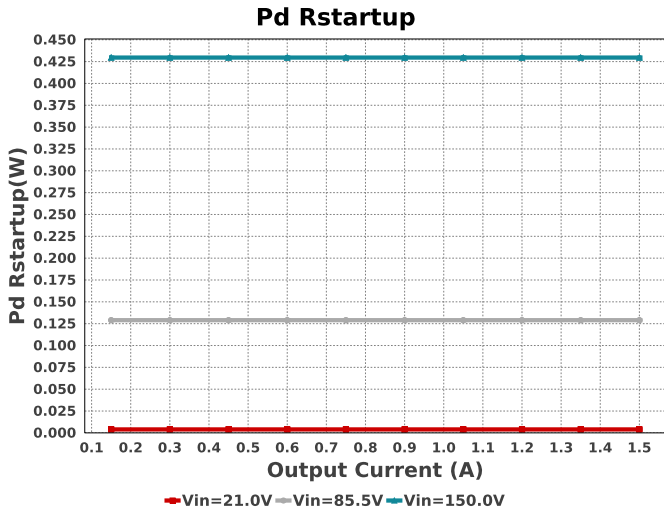
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm <sup>2</sup>
C21	MuRata	GRM21BR61E106MA73L Series= X5R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 2.8 A	1	\$0.04	0805 7 mm <sup>2</sup>
C22	Panasonic	EPCU1C334MA5 Series= EPCU(A)	Cap= 330.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.23	1206 11 mm <sup>2</sup>
C23	MuRata	GRM1555C1H561JA01J Series= C0G/NP0	Cap= 560.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
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 <sup>2</sup>

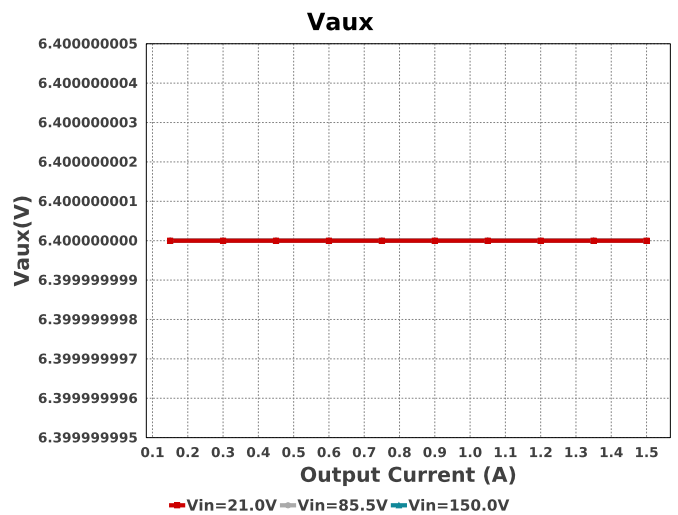
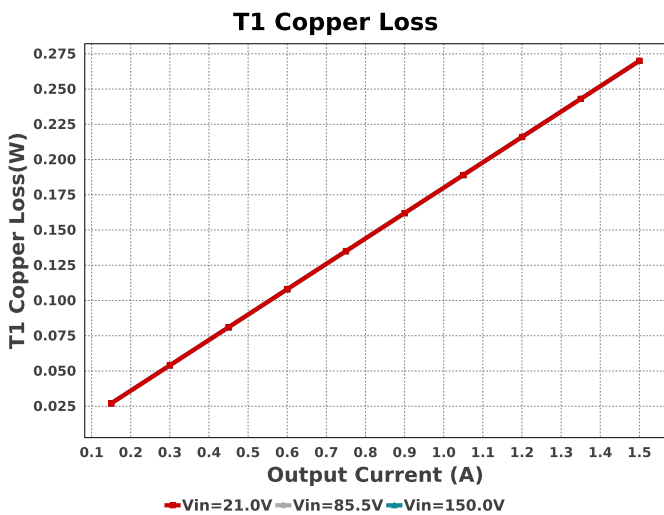
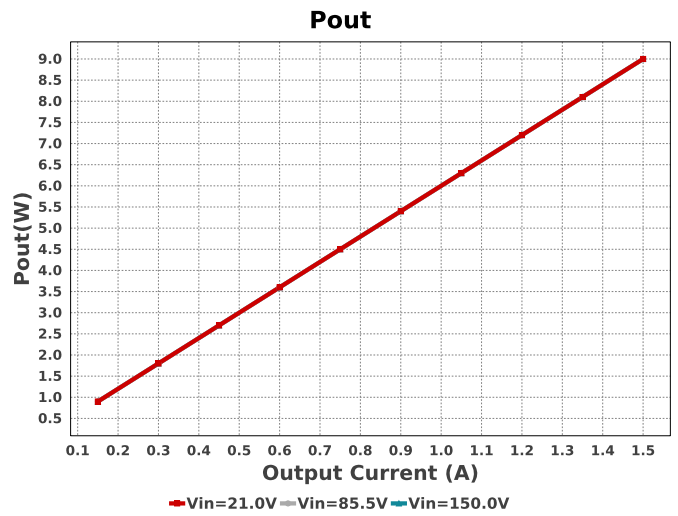
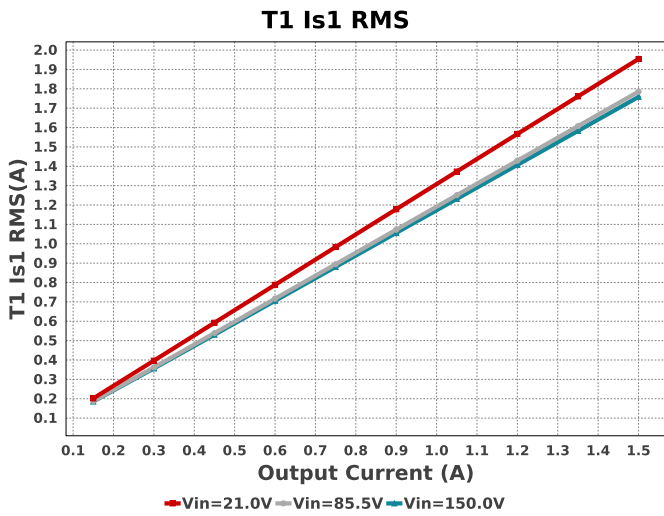
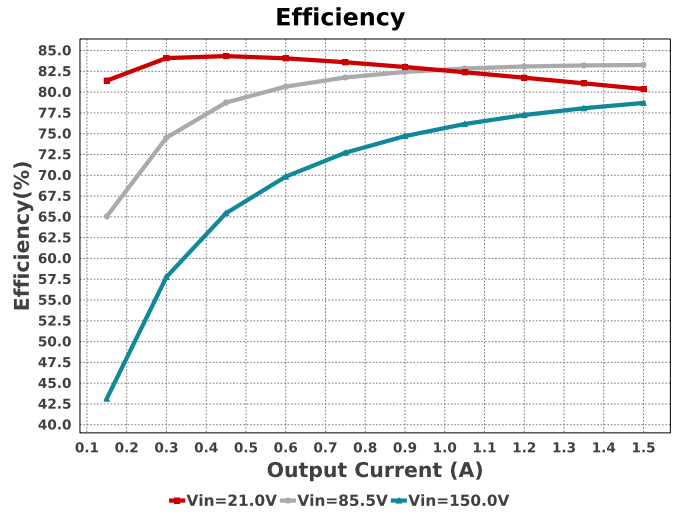
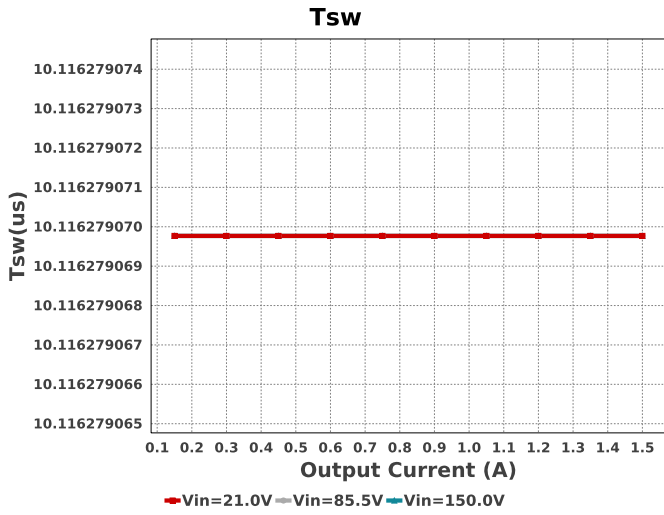
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Cin	TDK	B32674D3225K Series= B32674	Cap= 2.2 uF ESR= 18.0 mOhm VDC= 300.0 V IRMS= 5.0 A	1	\$0.92	 B32674_3150x1900x1100 436 mm <sup>2</sup>
Ciso	Johanson Technology	202R18W102KV4E Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 2.0 kV IRMS= 0.0 A	1	\$0.06	 1206_190 11 mm <sup>2</sup>
Cout1	Panasonic	16SVPG270M Series= SVPG	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	\$0.97	 CAPSMT_62_C10 74 mm <sup>2</sup>
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 <sup>2</sup>
Csub	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	\$0.01	 0603 5 mm <sup>2</sup>
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 <sup>2</sup>
Cvdd	Chemi-Con	EMVY250ADA470MF55G Series= MVY	Cap= 47.0 uF ESR= 1.0 Ohm VDC= 25.0 V IRMS= 140.0 mA	1	\$0.13	 CAPSMT_62_F55 77 mm <sup>2</sup>
D12	Diodes Inc.	MMSZ5250B-7-F	Zener	1	\$0.04	 SOD-123 13 mm <sup>2</sup>
D21	Bourns	CD0603-B0130L	VF@Io= 440.0 mV VRRM= 35.0 V	1	\$0.09	 Diode_0603 5 mm <sup>2</sup>
Daux	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	\$0.33	 SMB 44 mm <sup>2</sup>
Dsec	Comchip Technology	CDBC5100-G	VF@Io= 850.0 mV VRRM= 100.0 V	1	\$0.27	 SMC 83 mm <sup>2</sup>
Dsec2	Comchip Technology	CDBC5100-G	VF@Io= 850.0 mV VRRM= 100.0 V	1	\$0.27	 SMC 83 mm <sup>2</sup>
Dsub	SMC Diode Solutions	ST1300ATR	VF@Io= 1.1 V VRRM= 300.0 V	1	\$0.12	 SMA 37 mm <sup>2</sup>
M1	Panasonic	FDB28N30TM	VdsMax= 300.0 V IdsMax= 28.0 Amps	1	\$1.17	 DDPAK 210 mm <sup>2</sup>
Q1	Diodes Inc.	BC856A-7-F	Bipolar Transistor	1	\$0.04	 SOT-23 14 mm <sup>2</sup>
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	\$1.19	 TO-18 57 mm <sup>2</sup>

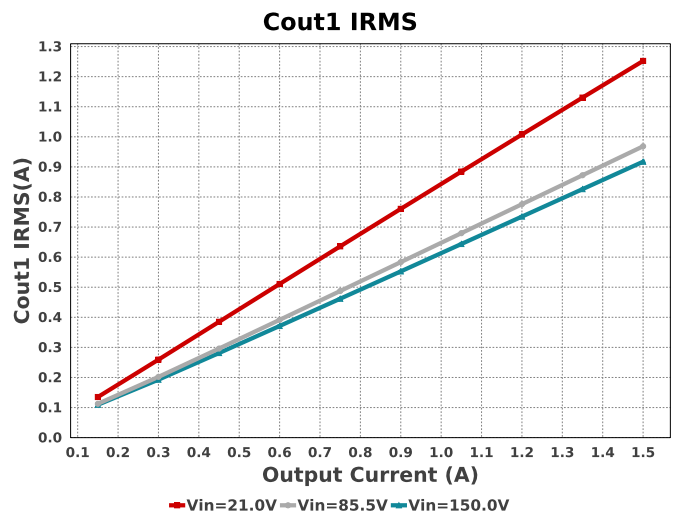
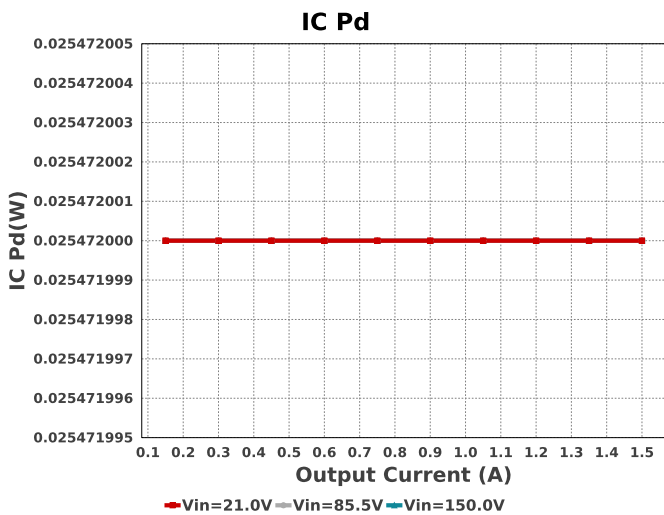
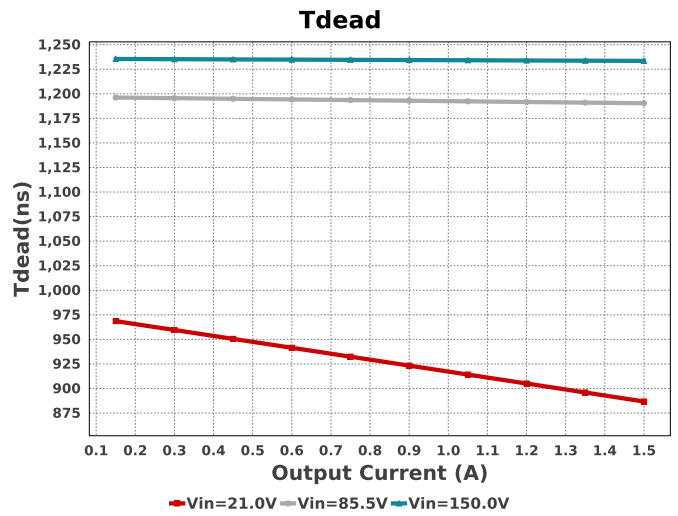
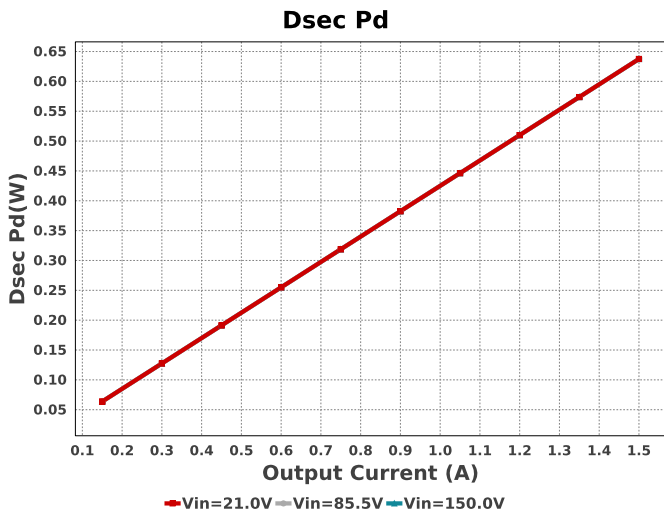
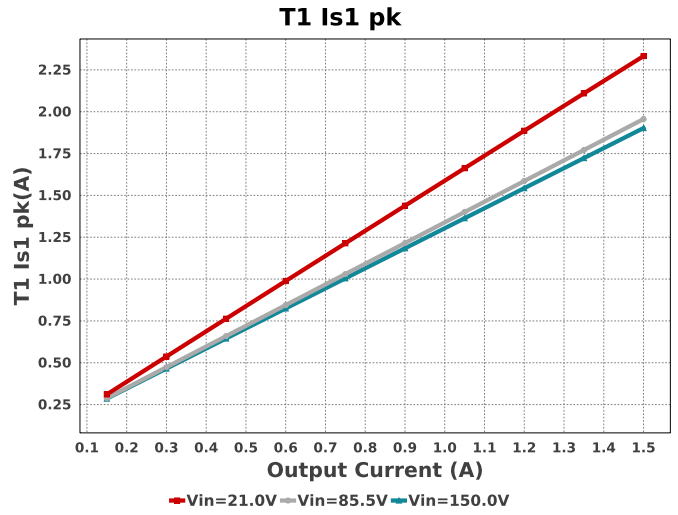
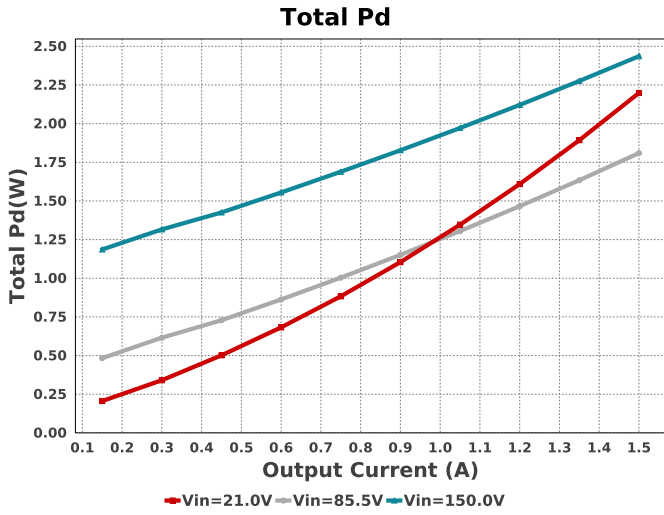
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R21	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	 0201 2 mm <sup>2</sup>
R22	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
Rcs	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
Rdrv	Vishay-Dale	CRCW06035R90FKEA Series= CRCW..e3	Res= 5.9 Ohm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm <sup>2</sup>
Rfbb	Panasonic	ERJ-6ENF3651V Series= ERJ-6E	Res= 3.65 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm <sup>2</sup>
Rfbt	Yageo	RT0805BRD0711K1L Series= ?	Res= 11.1 kOhm Power= 125.0 mW Tolerance= 0.1%	1	\$0.05	 0805 7 mm <sup>2</sup>
Rsc	Vishay-Dale	CRCW04023K24FKED Series= CRCW..e3	Res= 3.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
Rsns	Stackpole Electronics Inc	RSF1FTR470 Series= ?	Res= 470.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	\$0.05	 RSF1 150 mm <sup>2</sup>
Rsub1	CUSTOM	CUSTOM Series= ?	Res= 9.3824 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm <sup>2</sup>
Rsub2	CUSTOM	CUSTOM Series= ?	Res= 9.3824 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm <sup>2</sup>
Rstartup1	Vishay-Dale	CRCW120623K7FKEA Series= CRCW..e3	Res= 23.7 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm <sup>2</sup>
Rstartup2	Vishay-Dale	CRCW120623K7FKEA Series= CRCW..e3	Res= 23.7 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm <sup>2</sup>
Rt	Vishay-Dale	CRCW040217K4FKED Series= CRCW..e3	Res= 17.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
T1	CUSTOM	CUSTOM	Lp= 300.0 µH	1	NA	CUSTOM 0 mm <sup>2</sup>
U1	Texas Instruments	UCC28C50QDRQ1	Switcher	1	\$0.67	 D0008A 57 mm <sup>2</sup>



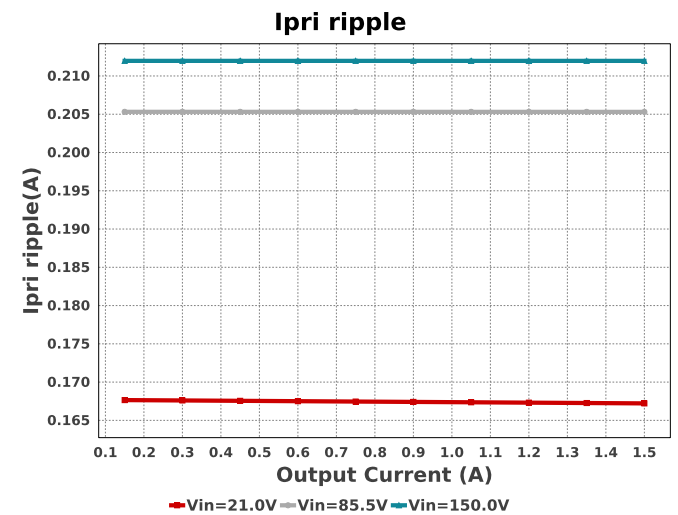
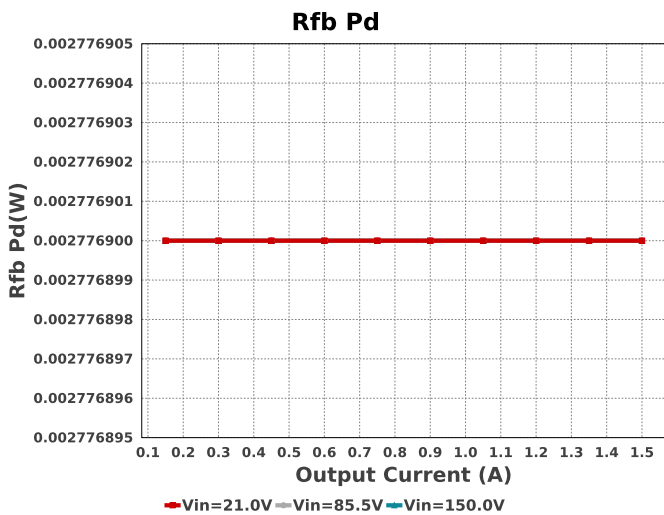
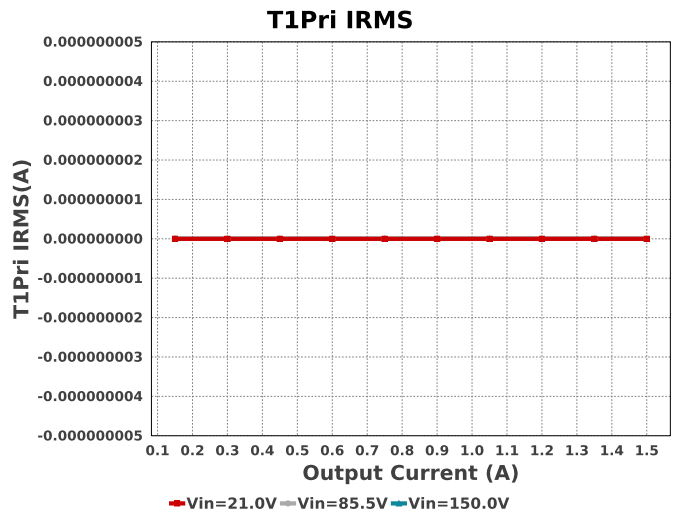
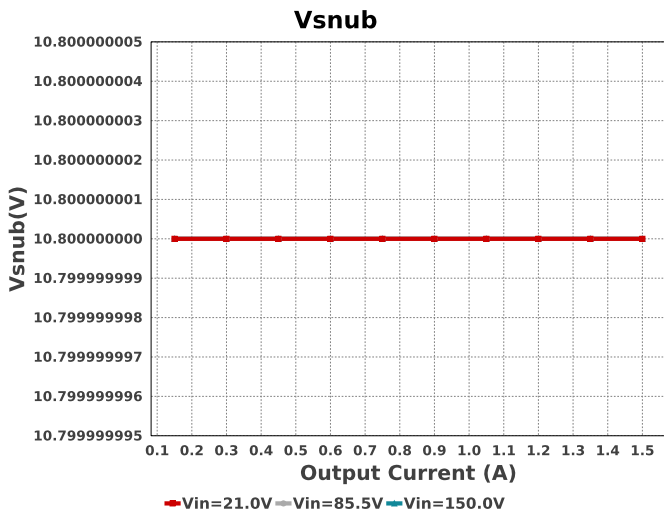
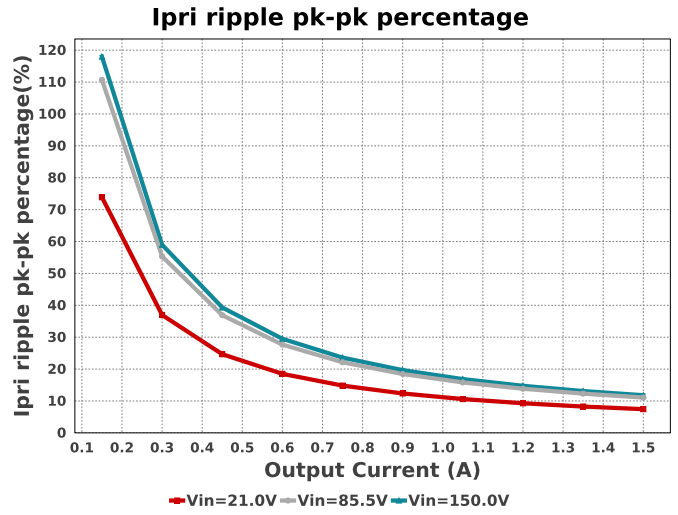
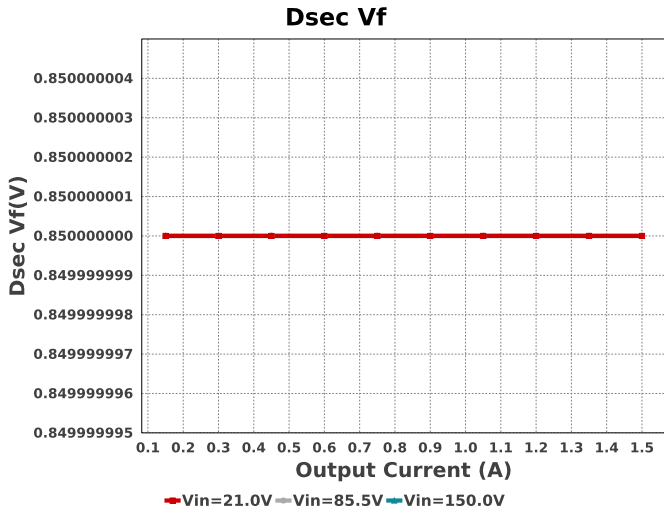


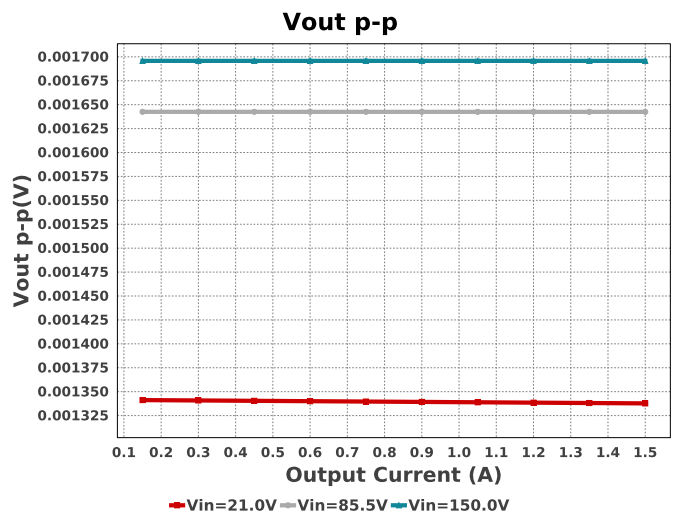
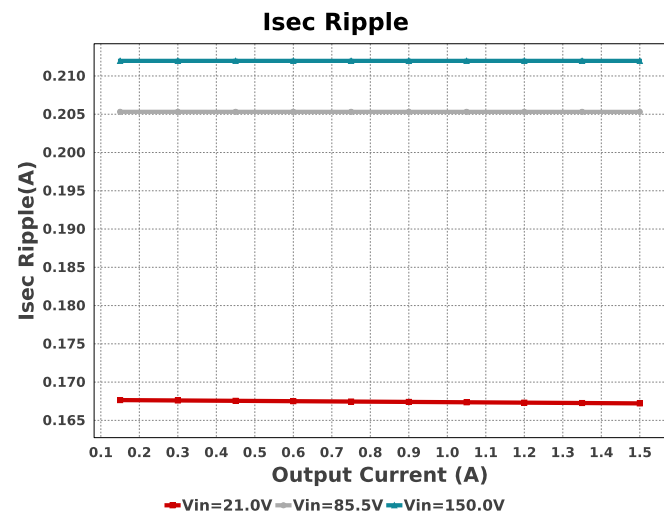
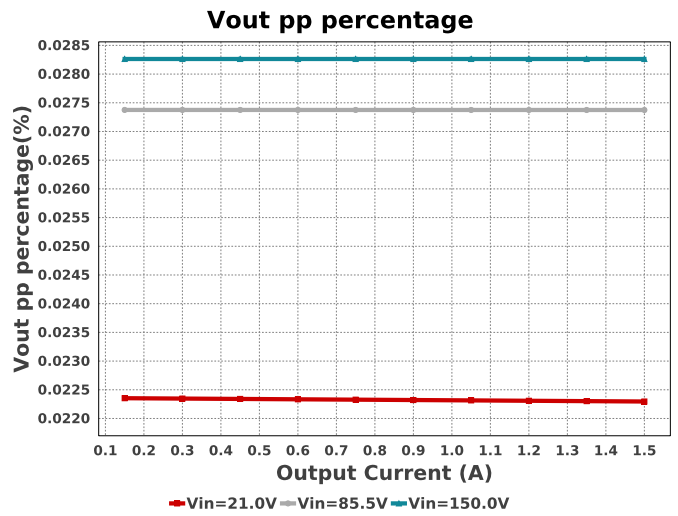
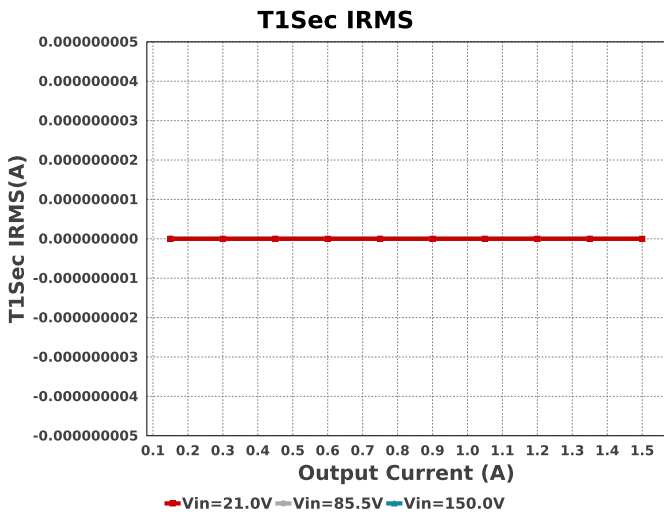
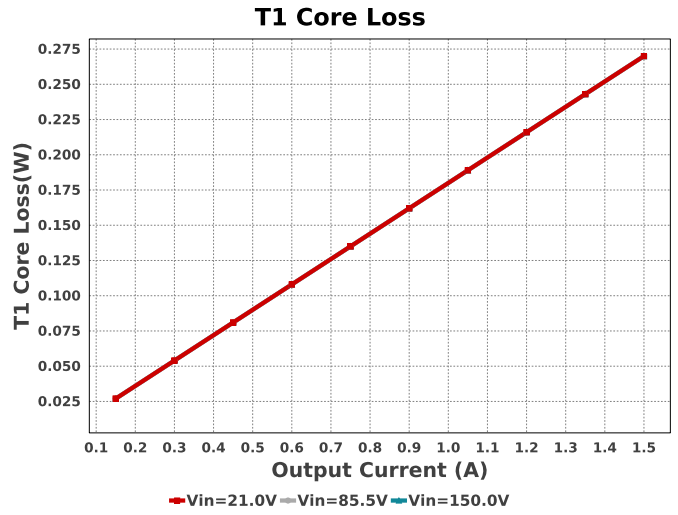
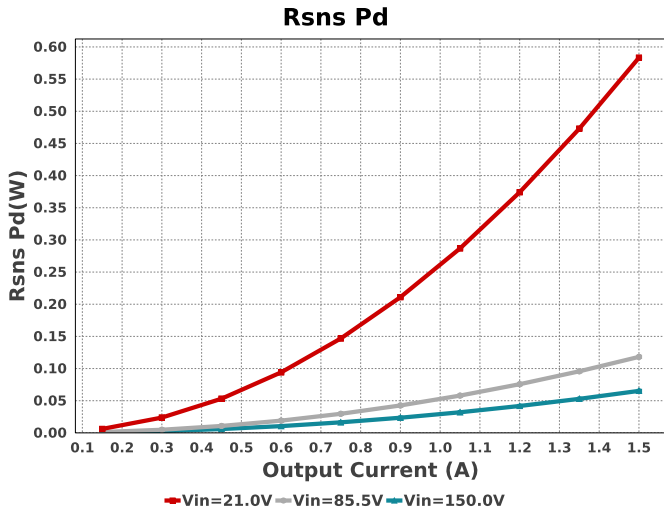


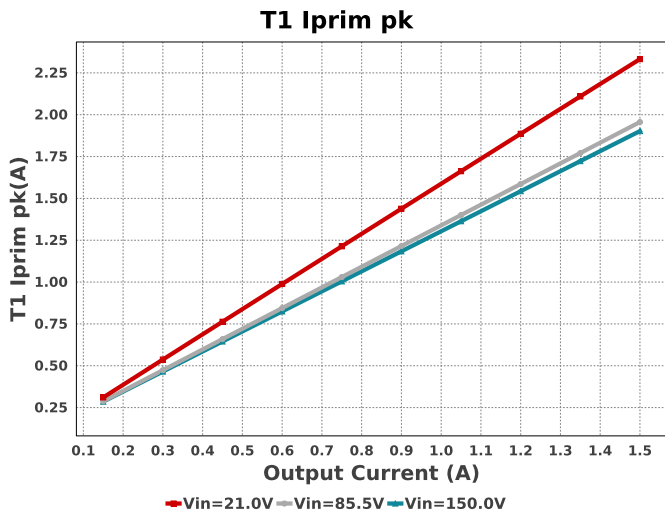












## Operating Values

#	Name	Value	Category	Description
1.	BOM Count	37		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin Pd	6.747 mW	Capacitor	Input capacitor power dissipation
4.	Cout1 IRMS	1.252 A	Capacitor	Output capacitor1 RMS ripple current
5.	Cout1 Pd	12.545 mW	Capacitor	Output capacitor1 power dissipation
6.	Dsec Pd	637.5 mW	Diode	Secondary Diode Power Dissipation
7.	Dsec Vf	850.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
8.	Dsec2 Pd	637.5 mW	Diode	Secondary Diode Power Dissipation
9.	Dsec2 Vf	850.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
10.	IC Pd	25.472 mW	IC	IC power dissipation
11.	IC Tj	33.283 degC	IC	IC junction temperature
12.	ICThetaJA	128.9 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	533.26 mA	IC	Average input current
14.	M1 Pd	172.13 mW	Mosfet	M1 MOSFET total power dissipation
15.	M1 TjOP	42.892 degC	Mosfet	M1 MOSFET junction temperature
16.	Cin Pd	6.747 mW	Power	Input capacitor power dissipation
17.	Cout1 Pd	12.545 mW	Power	Output capacitor1 power dissipation
18.	Dsec Pd	637.5 mW	Power	Secondary Diode Power Dissipation
19.	Dsec2 Pd	637.5 mW	Power	Secondary Diode Power Dissipation
20.	IC Pd	25.472 mW	Power	IC power dissipation
21.	M1 Pd	172.13 mW	Power	M1 MOSFET total power dissipation
22.	Paux	18.574 mW	Power	Power Dissipation in Raux and Daux
23.	Pd Rstartup	3.96 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
24.	Rdrv Pd	4.462 mW	Power	Power Dissipation in Gate Drive Resistor
25.	Rfb Pd	2.777 mW	Power	Rfb Power Dissipation
26.	Rsns Pd	583.26 mW	Power	Current Limit Sense Resistor Power Dissipation
27.	Snubber Pd	190.99 mW	Power	Snubber Power Dissipation
28.	T1 Copper Loss	270.0 mW	Power	Transformer Copper Loss Power Dissipation
29.	T1 Core Loss	270.0 mW	Power	Transformer Core Loss Power Dissipation
30.	T1 Pd	540.0 mW	Power	Estimated Losses in Transformer
31.	Total Pd	2.198 W	Power	Total Power Dissipation
32.	Pd Rstartup	3.96 mW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
33.	Rdrv Pd	4.462 mW	Resistor	Power Dissipation in Gate Drive Resistor
34.	Rfb Pd	2.777 mW	Resistor	Rfb Power Dissipation
35.	Rsns Pd	583.26 mW	Resistor	Current Limit Sense Resistor Power Dissipation
36.	Duty Cycle	24.53 %	System	Duty cycle
37.	Efficiency	80.369 %	System	Steady state efficiency
38.	FootPrint	1.477 k mm <sup>2</sup>	System	Total Foot Print Area of BOM components
39.	Frequency	98.851 kHz	System	Switching frequency
40.	Iout	1.5 A	System	Iout operating point
41.	Mode	CCM	System	Conduction Mode
42.	Pout	9.0 W	System	Total output power
43.	Tdead	886.747 ns	System	Approximate Dead Time of the Regulator

#	Name	Value	Category	Description
44.	Toff	6.748 us	System Information	Approximate Converter Off Time
45.	Ton Act	2.482 us	System Information	Approximate Converter On Time
46.	Tsw	10.116 us	System Information	Switching Time Period
47.	Vin	21.0 V	System Information	Vin operating point
48.	Vout	6.0 V	System Information	Operational Output Voltage
49.	Vout p-p	1.338 mV	System Information	Peak-to-peak output ripple voltage
50.	Vout pp percentage	22.296 m%	System Information	Output Voltage ripple percentage
51.	Vsnub	10.8 V	System Information	Voltage Across the Snubber
52.	Ipri Avg	551.605 mA	Transformer	Average Current in Primary Winding over the complete Switching Period
53.	Ipri ripple	167.218 mA	Transformer	Ripple Current in the Primary Winding
54.	Ipri ripple pk-pk percentage	7.436 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
55.	Isec Ripple	167.218 mA	Transformer	Ripple Current in the Secondary Winding
56.	Paux	18.574 mW	Transformer	Power Dissipation in Raux and Daux
57.	T1 Copper Loss	270.0 mW	Transformer	Transformer Copper Loss Power Dissipation
58.	T1 Core Loss	270.0 mW	Transformer	Transformer Core Loss Power Dissipation
59.	T1 Iprim RMS	1.114 A	Transformer	Transformer Primary RMS Current
60.	T1 Iprim pk	2.332 A	Transformer	Transformer Primary Peak Current
61.	T1 Is1 RMS	1.954 A	Transformer	Transformer Secondary1 RMS Current
62.	T1 Is1 pk	2.332 A	Transformer	Transformer Secondary1 Peak Current
63.	T1 Pd	540.0 mW	Transformer	Estimated Losses in Transformer
64.	T1Pri IRMS	0.0 A	Transformer	Transformer Primary RMS Current
65.	T1Sec IRMS	0.0 A	Transformer	Transformer Secondary RMS Current
66.	Vaux	6.4 V	Transformer	Auxiliary Voltage

## Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	150.0	Maximum input voltage
VinMin	21.0	Minimum input voltage
Vout	6.0	Output Voltage
base_pn	UCC28C50-Q1	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

## WEBENCH® Assembly

## WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B65805P0000R049
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B65806P1008D001
4.	Coil Former Manufacturer	TDK

### Transformer Electrical Diagram

#### Primary

Turns	26.0
AWG	33.0
Layers	4.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

#### Secondary

Turns	6.0
AWG	26.0
Layers	1.0
Strands	1.0
Insulation Type	Triple Insulated

#### Auxiliary

Turns	11.0
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 2/4.0	33.0	13	Clockwise
Triple Insulated Secondary	26.0	6.0	Counter Clockwise
Auxiliary	28.0	11.0	Counter Clockwise
Primary Second 2/4.0	33.0	13	Clockwise

#### Transformer Parameters

#	Name	Value
1.	Lpri	9.9E-5H
2.	Inductance Factor(AI)	147.0nH
3.	Npri	26.0
4.	Nsec	6.0
5.	Naux	11.0
6.	Core Type	RM5
7.	Core Material	N49

#	Name	Value
8.	Bmax	0.23T
9.	Switching Frequency	98.85kHz
10.	DMax	0.6
11.	Ipk(Primary)	1.49A
12.	Irms(Primary)	0.72A
13.	Ipk(Secondary)	6.45A
14.	Irms(Secondary)	2.56A

## 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 UCC28C50-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 : 9323268074580801[v1]

4. **UCC28C50-Q1** Product Folder : <https://www.ti.com/product/UCC28C50%2DQ1> : contains the data sheet and other resources.

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