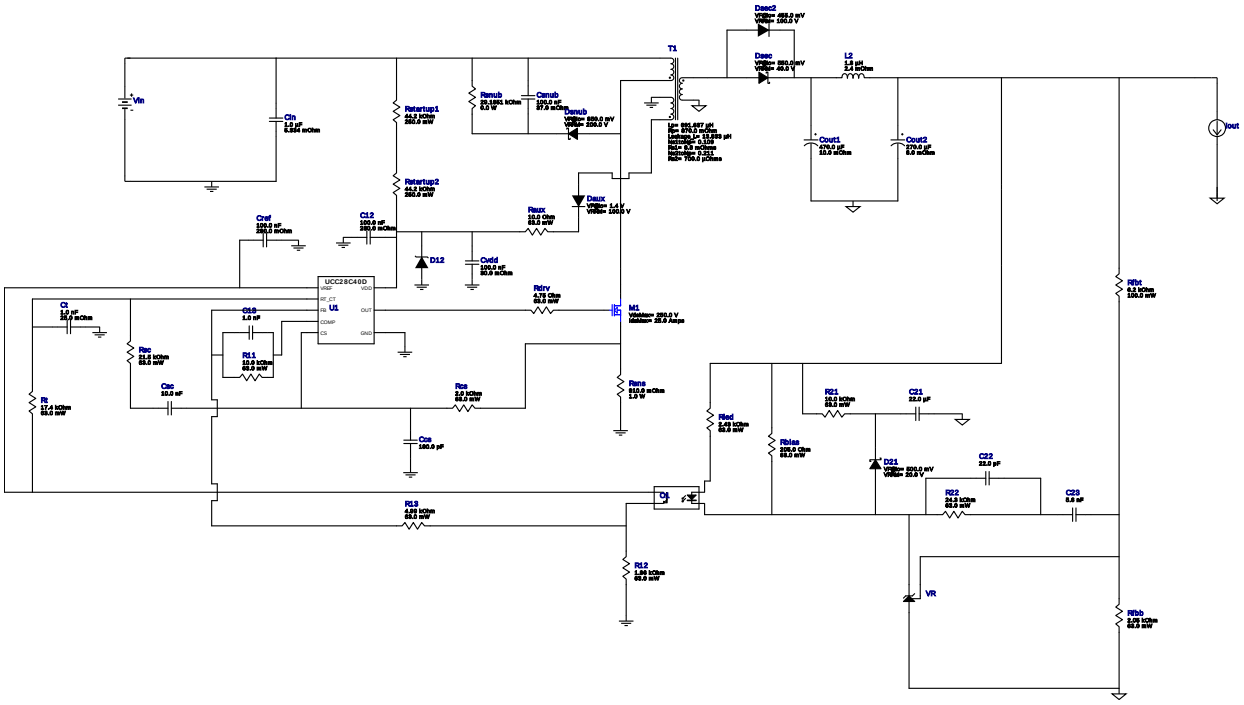
WEBENCH® Design Report

VinMin = 36.0V
VinMax = 72.0V
Vout = 5.0V
Iout = 2.0A

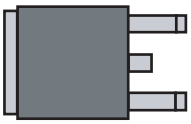
Device = UCC28C40DR
Topology = Flyback
Created = 7/8/16 12:07:20 AM
BOM Cost = $0.00
BOM Count = 44
Total Pd = 0.0W

Design : 4733566/1 UCC28C40DR
UCC28C40DR 36.0V-72.0V to 5.00V @ 2.0A



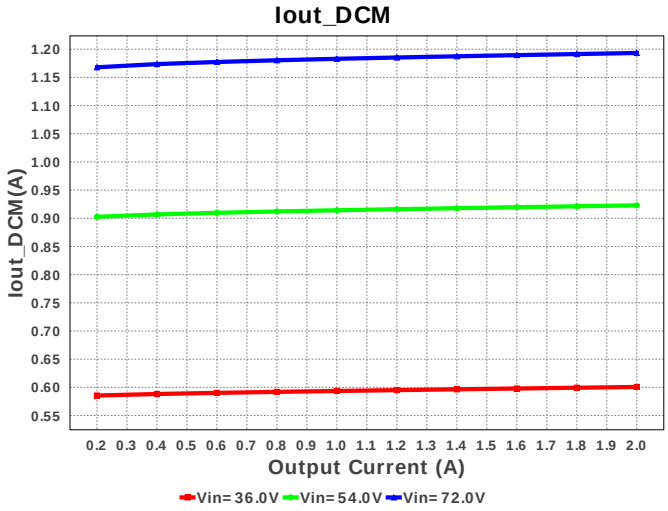
Electrical BOM

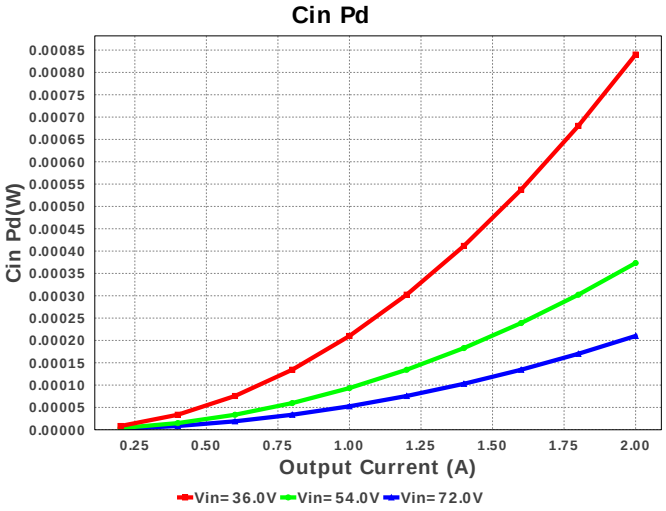
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
2.	C13	Samsung Electro-Mechanics	CL21C102JBCNFNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
3.	C21	Taiyo Yuden	LMK212BJ226MG-T Series= X5R	Cap= 22.0 uF VDC= 10.0 V IRMS= 0.0 A	1	$0.12	0805 7 mm²
4.	C22	Kemet	C0805C220K3GACTU Series= C0G/NP0	Cap= 22.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
5.	C23	Yageo America	CC0805KRX7R9BB562 Series= X7R	Cap= 5.6 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
6.	Ccs	Kemet	C0805C181K5GACTU Series= C0G/NP0	Cap= 180.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
7.	Cin	MuRata	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	$0.11	1206_190 11 mm²
8.	Cout1	Nichicon	RNU1C471MDN1PH Series= ?	Cap= 470.0 uF ESR= 10.0 mOhm VDC= 16.0 V IRMS= 6.1 A	1	$0.52	NU_1000x1250 144 mm²

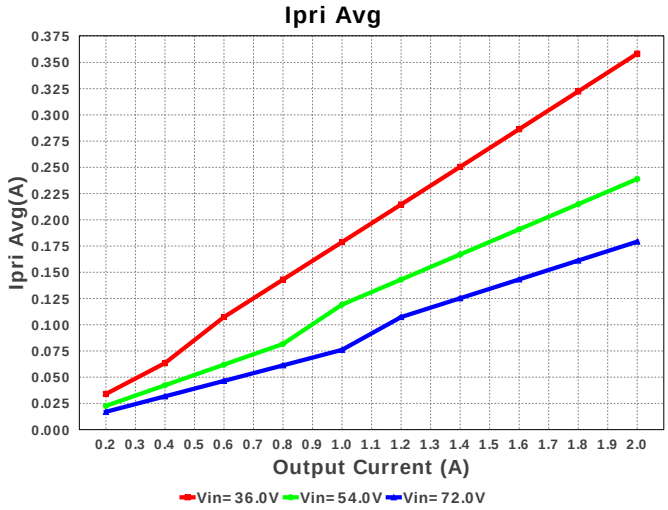
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cout2	Panasonic	16SVPG270M Series= ?	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	$0.70	 CAPSMT_62_C10 74 mm²
10.	Cref	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
11.	Csc	MuRata	GRM216R71H103KA01D Series= X7R	Cap= 10.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
12.	Csnub	AVX	12061C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 37.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.03	 1206 11 mm²
13.	Ct	Kemet	C0805C102J5GACTU Series= C0G/NP0	Cap= 1.0 nF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 1.71 A	1	$0.01	 0805 7 mm²
14.	Cvdd	MuRata	GRM188R71C104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 16.0 V IRMS= 1.7 A	1	$0.01	 0603 5 mm²
15.	D12	Diodes Inc.	MMSZ5248B-7-F	Zener	1	$0.04	 SOD-123 13 mm²
16.	D21	Vishay-Semiconductor	SS12-E3/61T	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMA 37 mm²
17.	Daux	NXP Semiconductor	BAS316,115	VF@Io= 1.4 V VRRM= 100.0 V	1	$0.02	 SOD-323 9 mm²
18.	Dsec	Diodes Inc.	B540C-13-F	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.17	 SMC 83 mm²
19.	Dsec2	STMicroelectronics	STPS20M100SG-TR	VF@Io= 455.0 mV VRRM= 100.0 V	1	$1.33	 DDPAK 210 mm²
20.	Dsnub	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	$0.21	 PowerDI123 13 mm²
21.	L2	Coilcraft	SER1360-182KLB	L= 1.8 µH DCR= 2.4 mOhm	1	$0.72	 SER1360 225 mm²
22.	M1	Infineon Technologies	BSC600N25NS3 G	VdsMax= 250.0 V IdsMax= 25.0 Amps	1	$1.41	 PG-TDSON-8 55 mm²
23.	O1	Vishay-Semiconductor	TCMT1109	Optocoupler	1	$0.21	 SOP-4 44 mm²
24.	R11	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	R12	Vishay-Dale	CRCW04021K96FKED Series= CRCW..e3	Res= 1.96 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

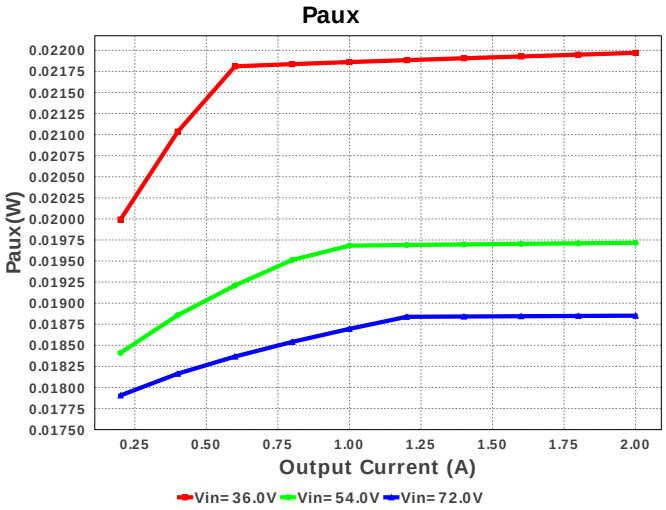
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
27.	R21	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
28.	R22	Vishay-Dale	CRCW040224K3FKED Series= CRCW..e3	Res= 24.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
29.	Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
30.	Rbias	Vishay-Dale	CRCW0402205RFKED Series= CRCW..e3	Res= 205.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	Rcs	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rdrv	Vishay-Dale	CRCW04024R75FKED Series= CRCW..e3	Res= 4.75 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
33.	Rfbb	Vishay-Dale	CRCW04022K05FKED Series= CRCW..e3	Res= 2.05 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
34.	Rfbt	Yageo America	RC0603FR-076K2L Series= ?	Res= 6.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
35.	Rled	Vishay-Dale	CRCW04022K43FKED Series= CRCW..e3	Res= 2.43 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
36.	Rsc	Vishay-Dale	CRCW040221K5FKED Series= CRCW..e3	Res= 21.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
37.	Rsns	Bourns	CRM2010-FX-R910ELF Series= ?	Res= 910.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.09	2010 32 mm²
38.	Rsnub	CUSTOM	CUSTOM Series= ?	Res= 29.1651 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
39.	Rstartup1	Panasonic	ERJ-8ENF4422V Series= ERJ-8E	Res= 44.2 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
40.	Rstartup2	Panasonic	ERJ-8ENF4422V Series= ERJ-8E	Res= 44.2 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
41.	Rt	Vishay-Dale	CRCW040217K4FKED Series= CRCW..e3	Res= 17.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
42.	T1	CUSTOM	CUSTOM	Lp= 691.637 µH Rp= 870.0 mOhm Leakage_L= 13.833 µH Ns1toNp= 0.109 Rs1= 8.6 mOhms Ns2toNp= 0.211 Rs2= 700.0 µOhms	1	NA	CUSTOM 0 mm²
43.	U1	Texas Instruments	UCC28C40DR	Switcher	1	$0.75	D0008A 57 mm²

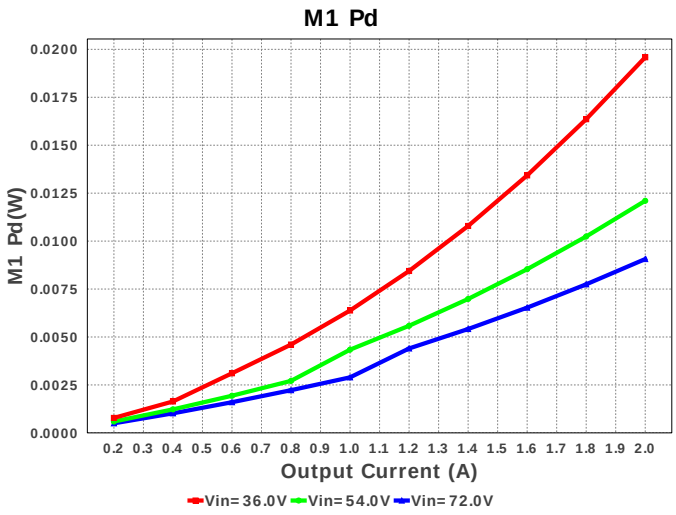
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
44.	VR	Texas Instruments	LMV431CM5/NOPB	Voltage References	1	$0.16	R-PDSO-G3 16 mm²

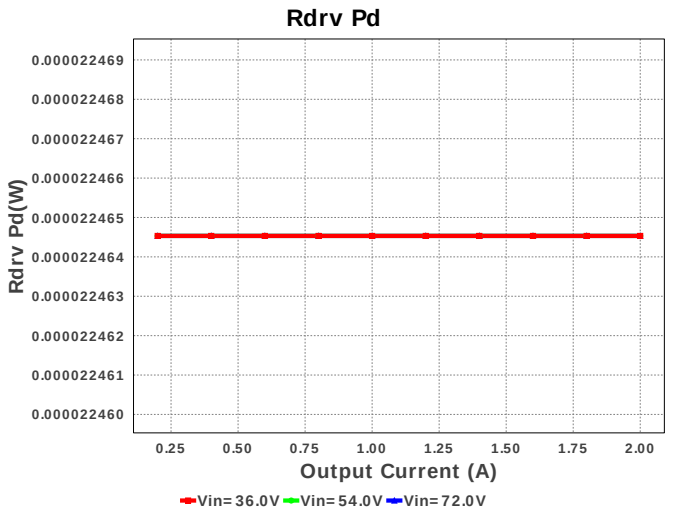


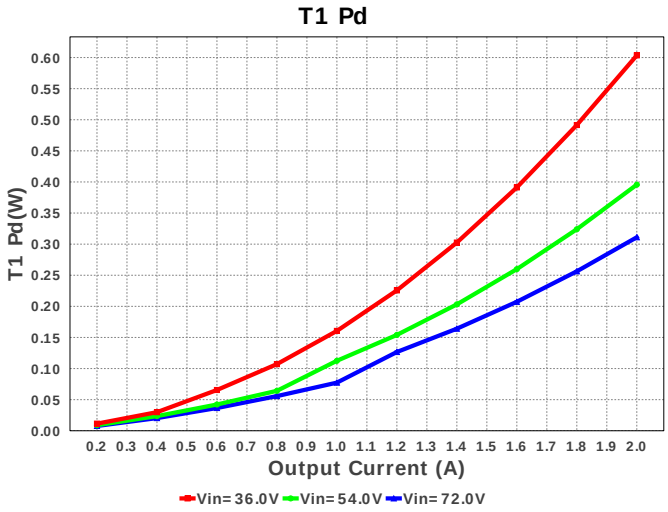


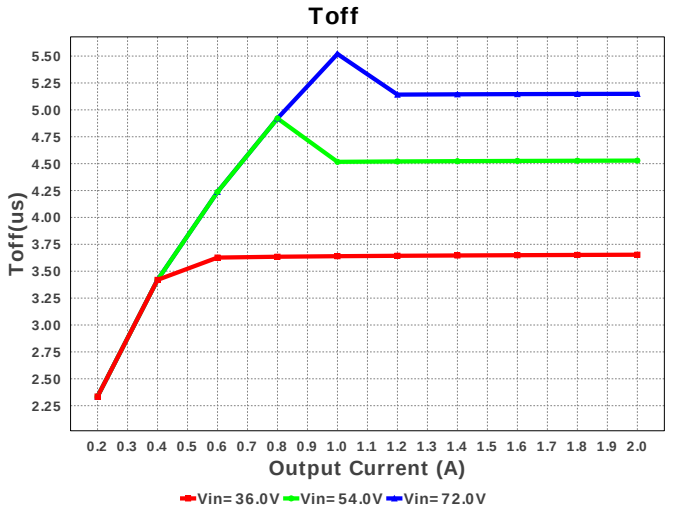


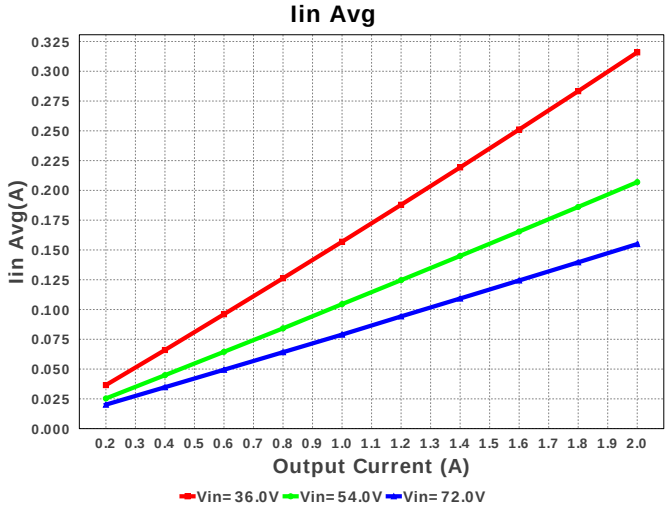


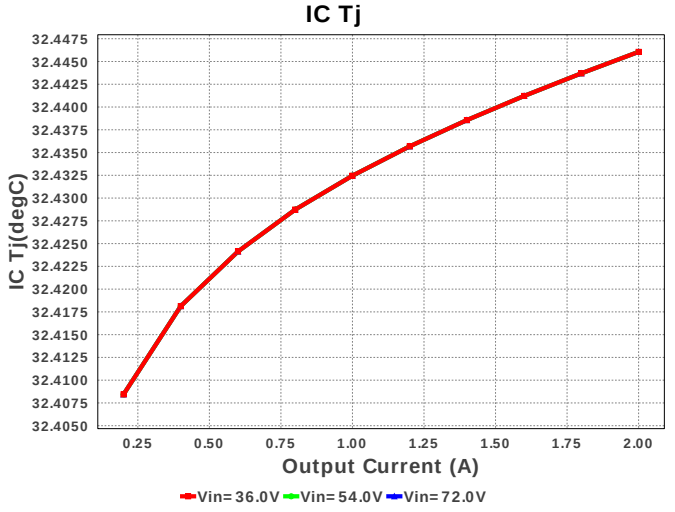


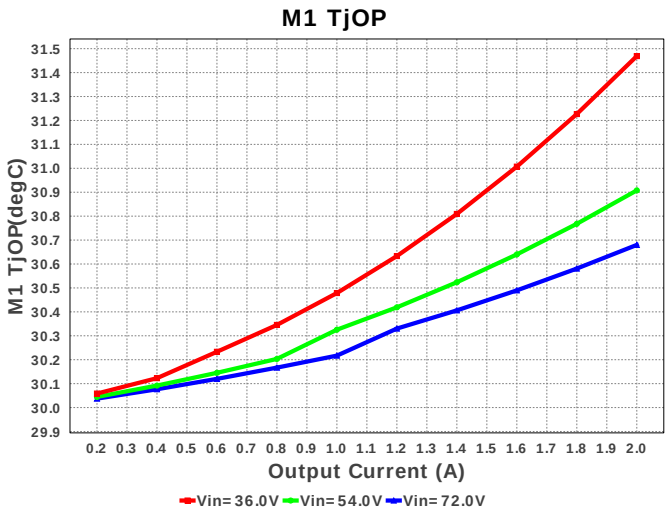


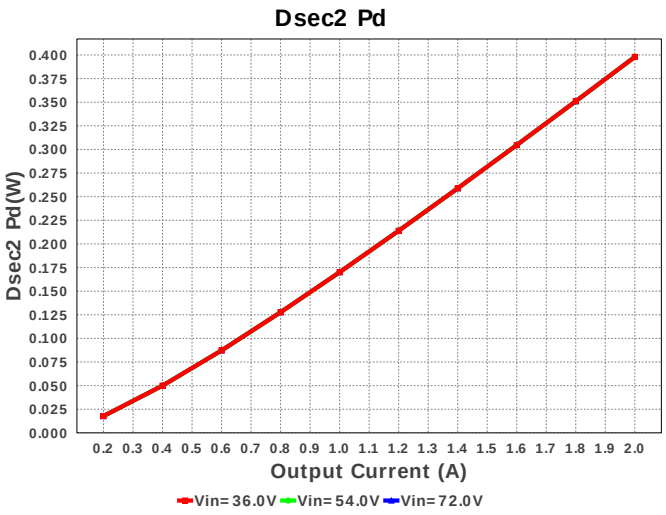


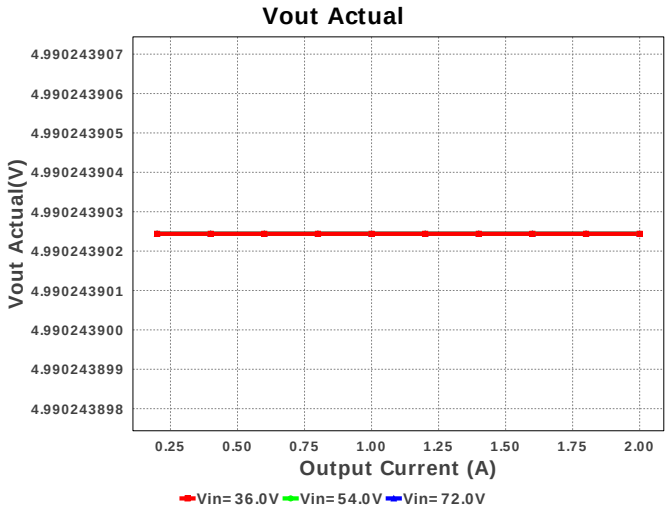


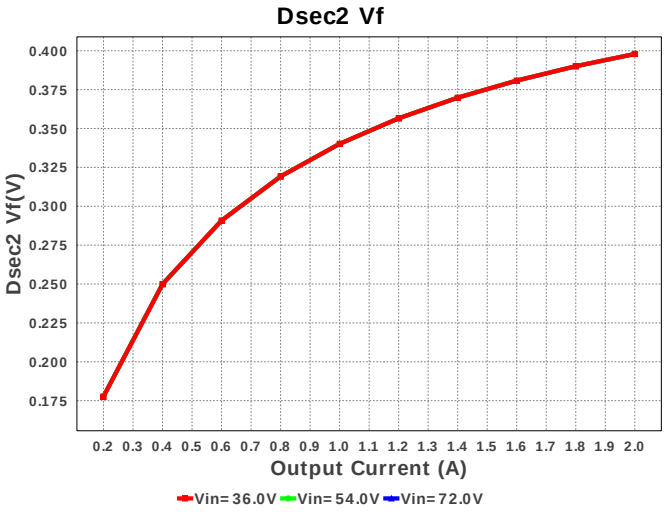


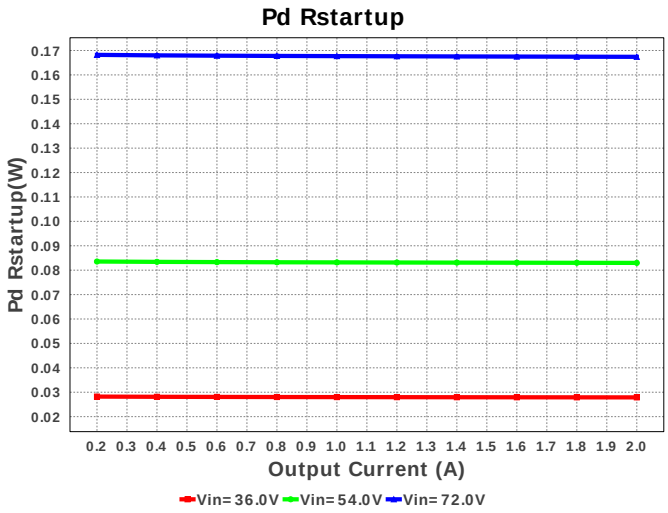


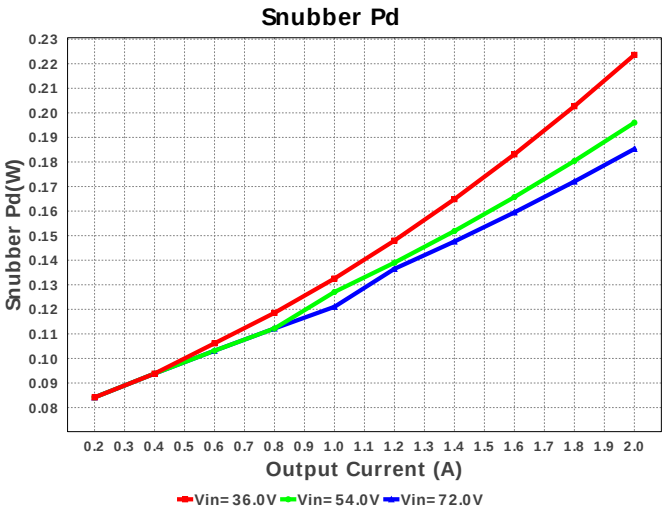


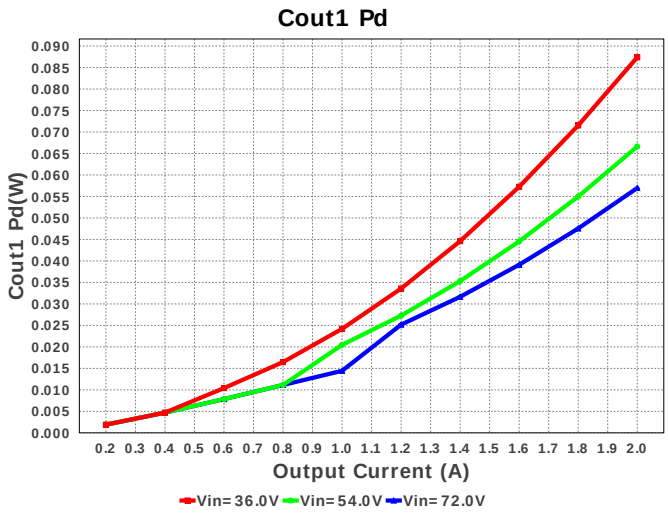


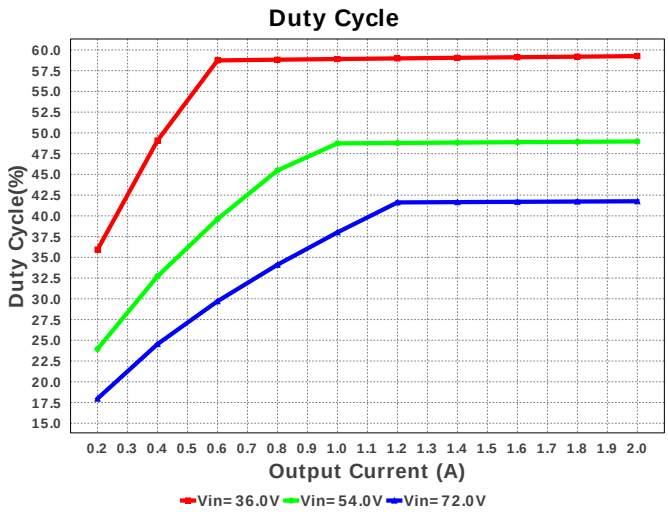


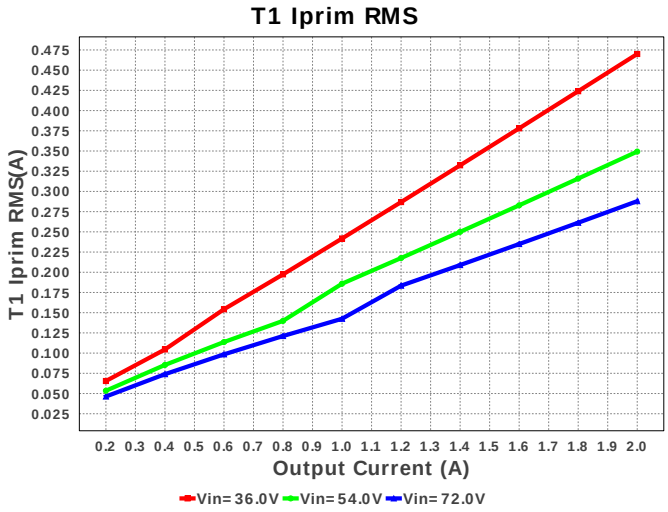


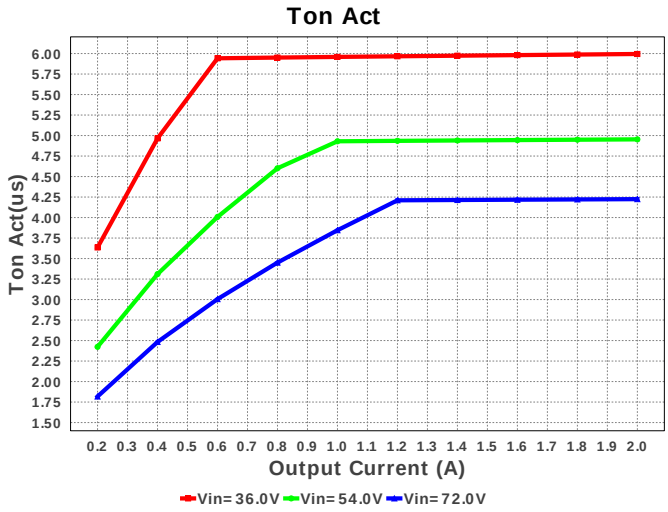


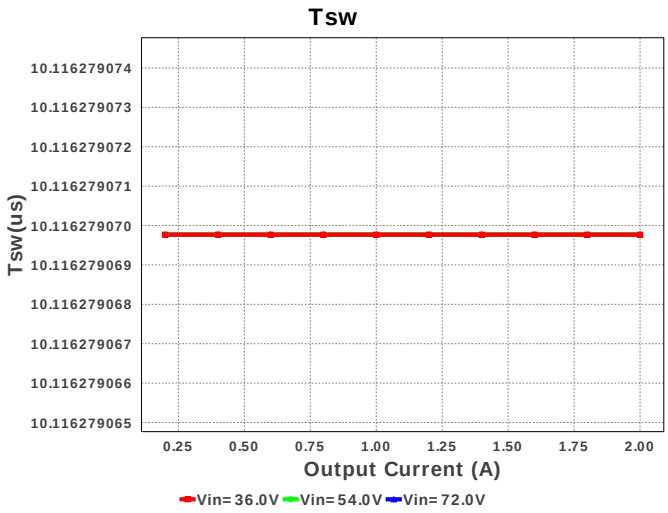


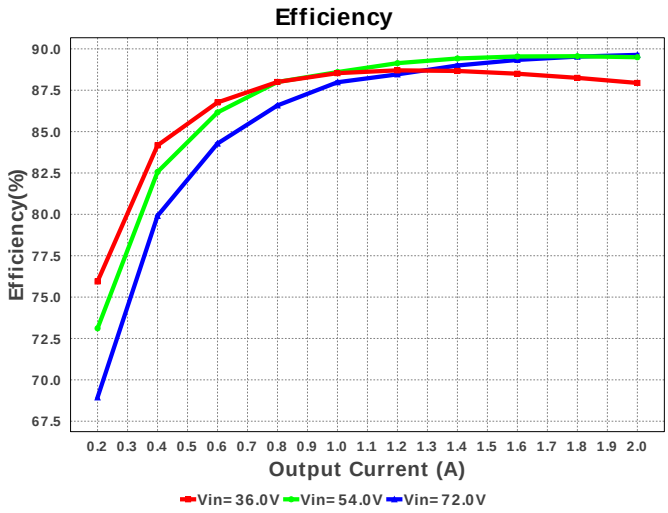


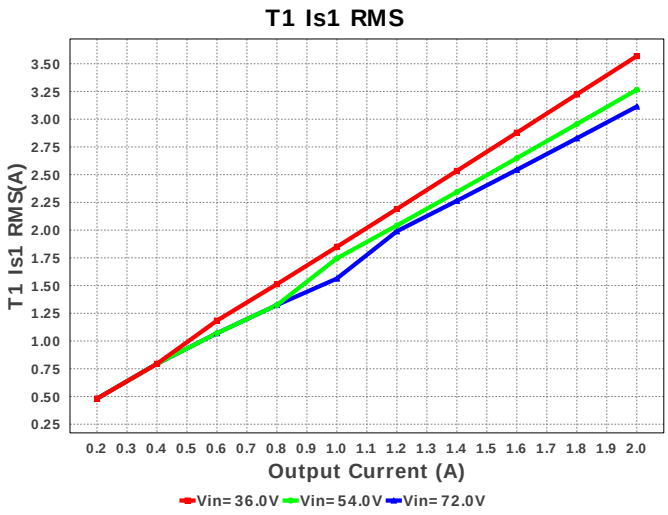


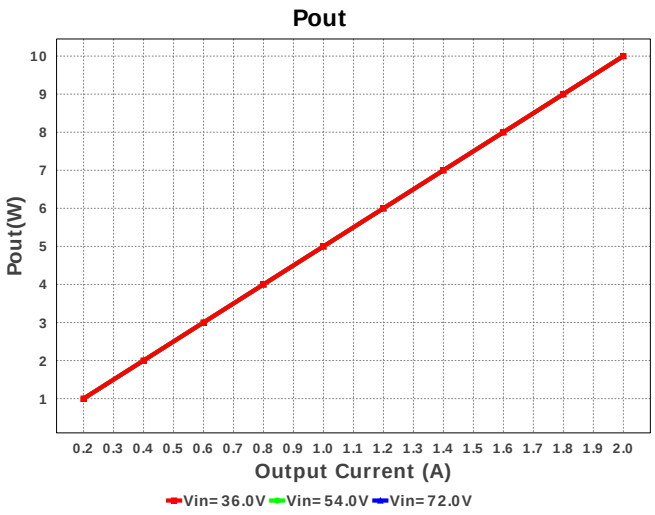


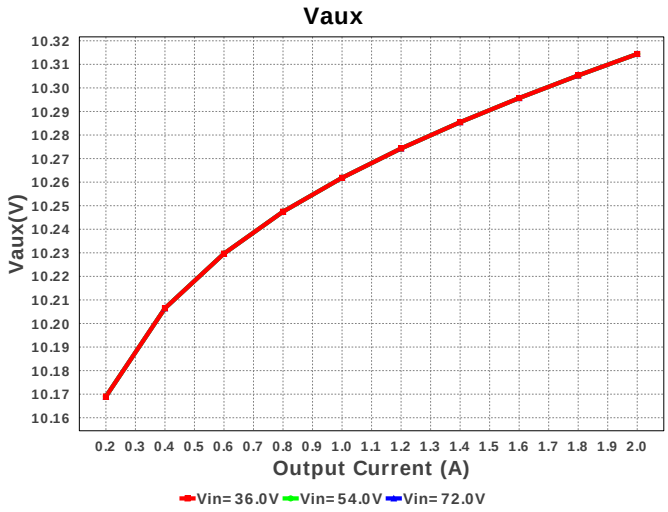


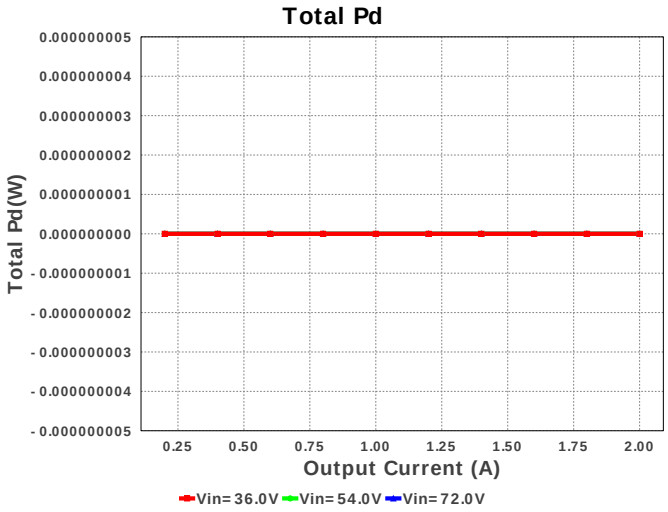


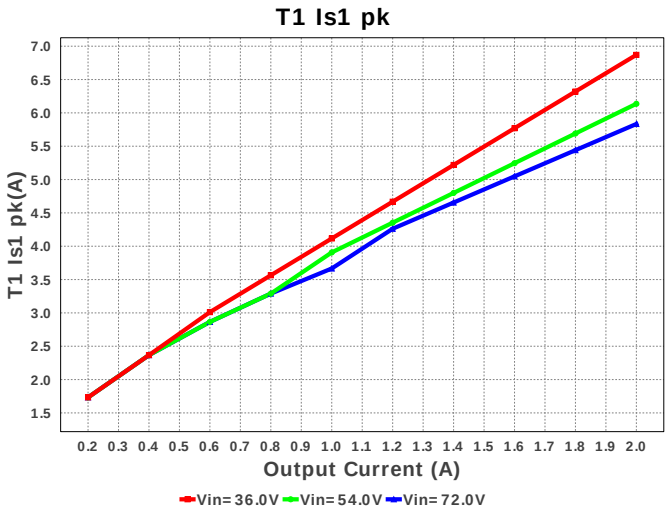


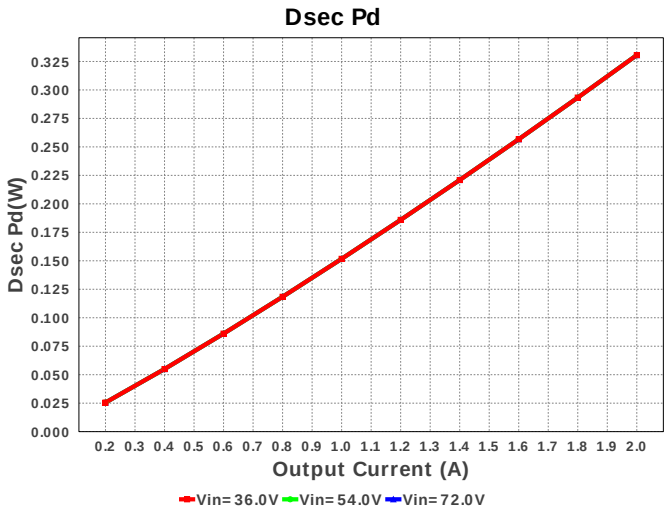


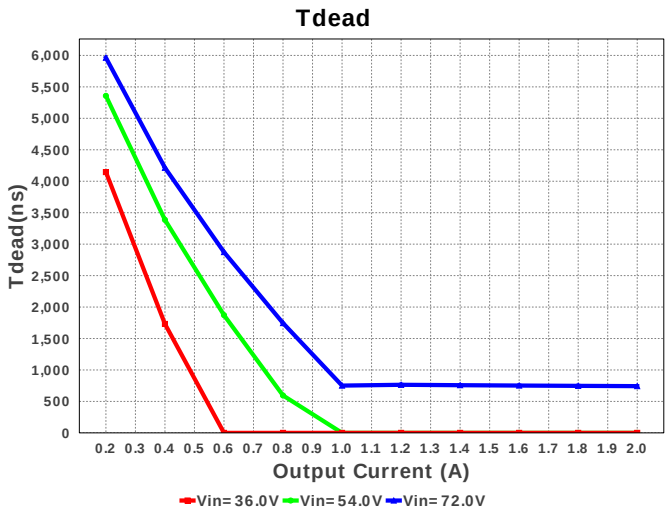


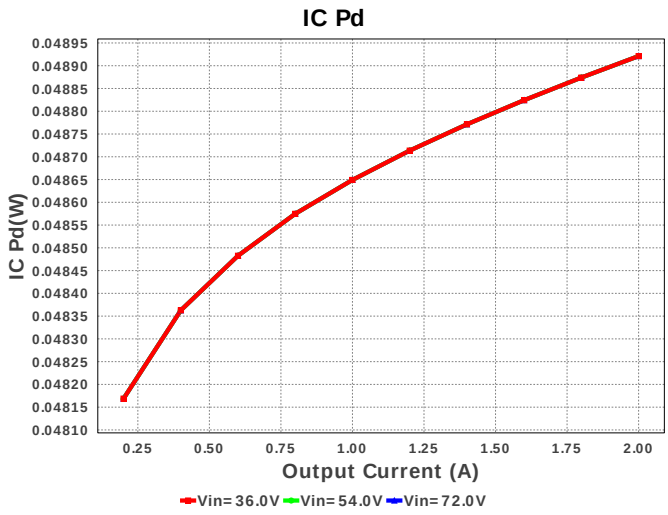


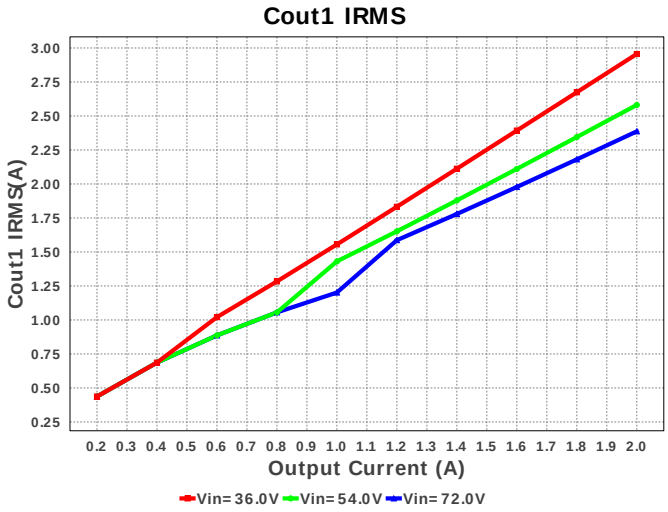


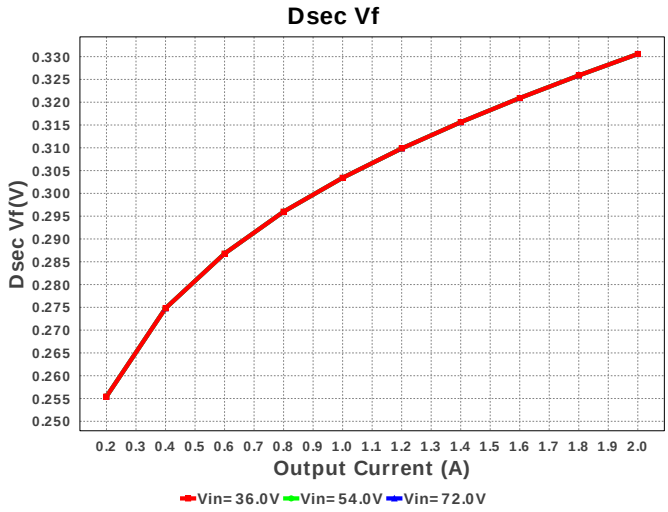


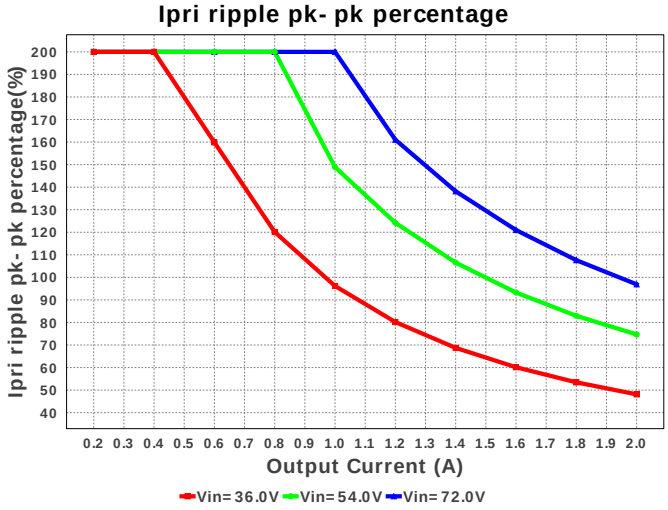


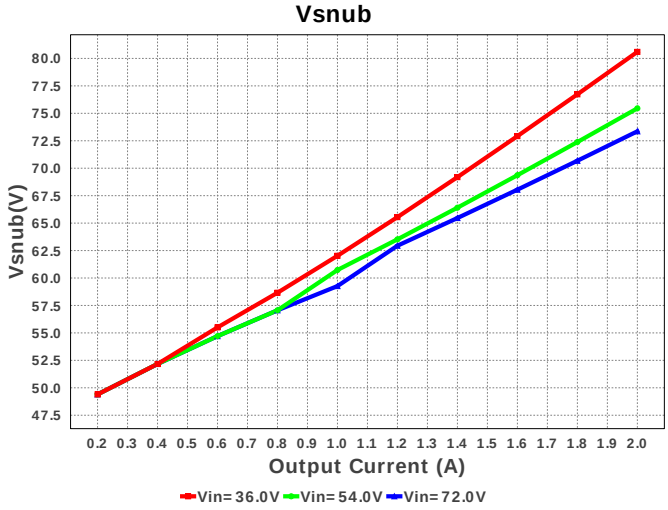


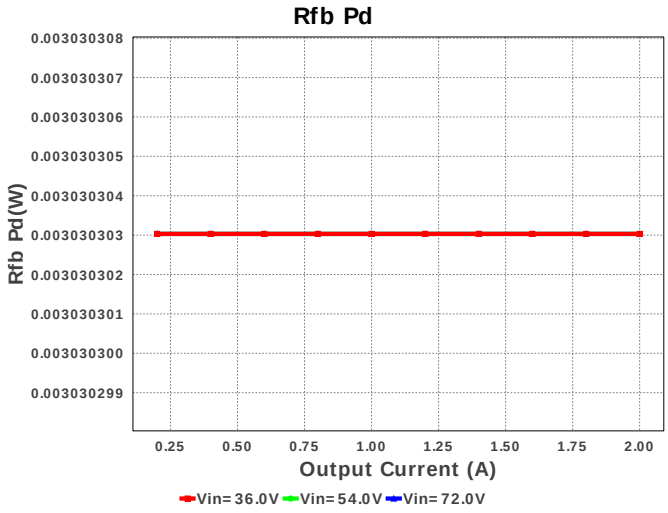


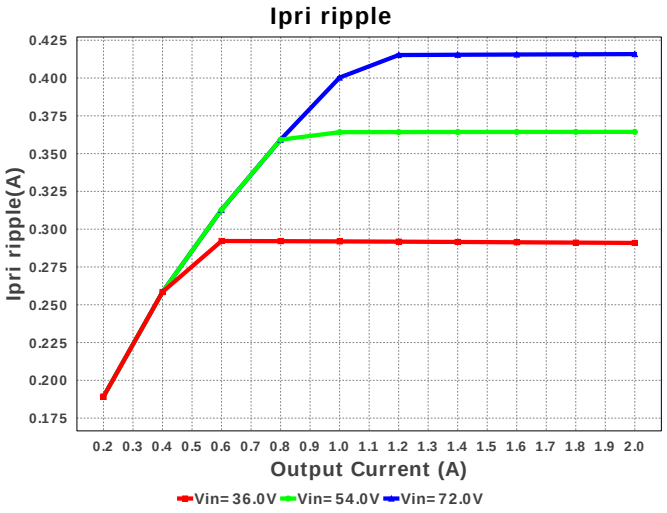


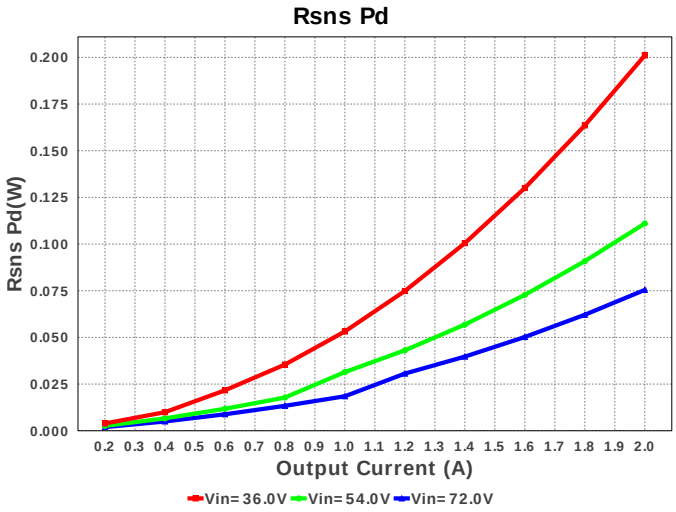


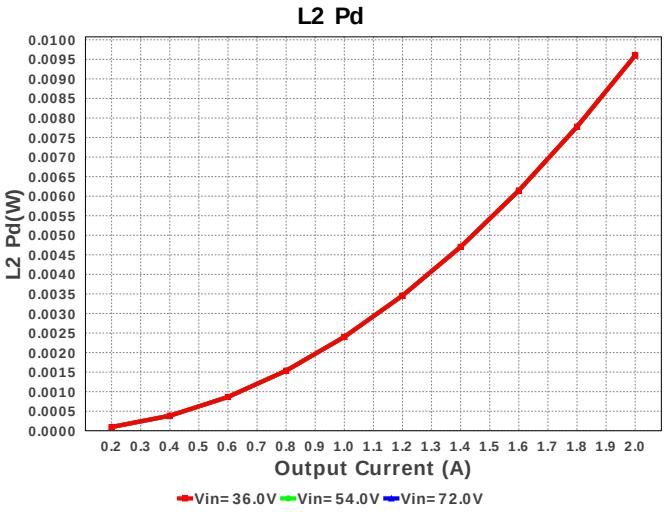


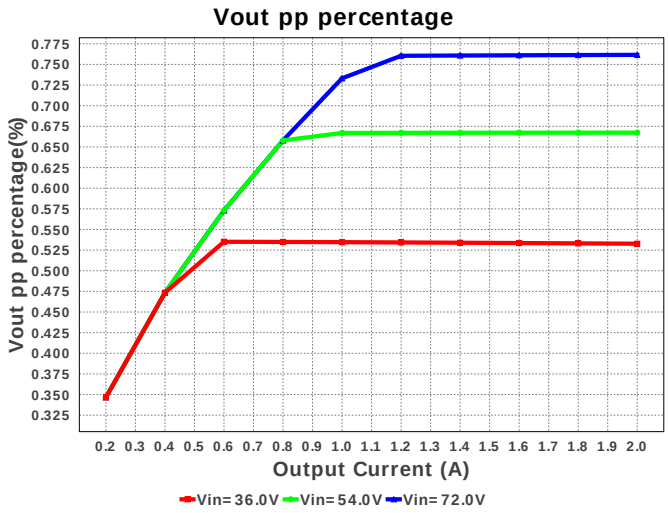


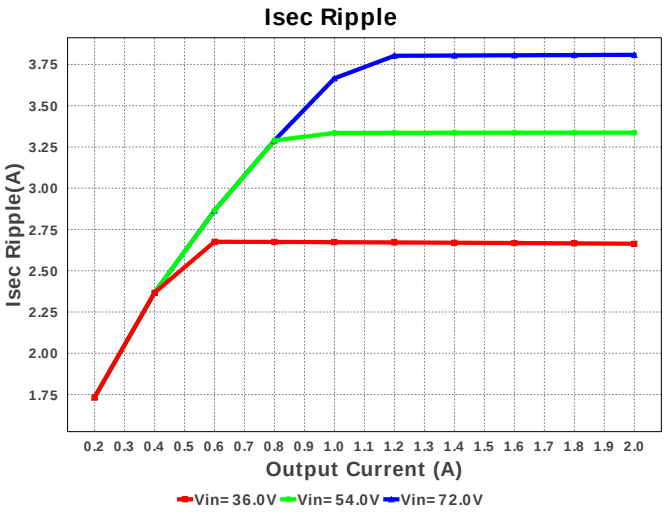

Rfb Pd
Rfb Pd(W)
0.003030308
0.003030307
0.003030306
0.003030305
0.003030304
0.003030303
0.003030302
0.003030301
0.003030300
0.003030299
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V

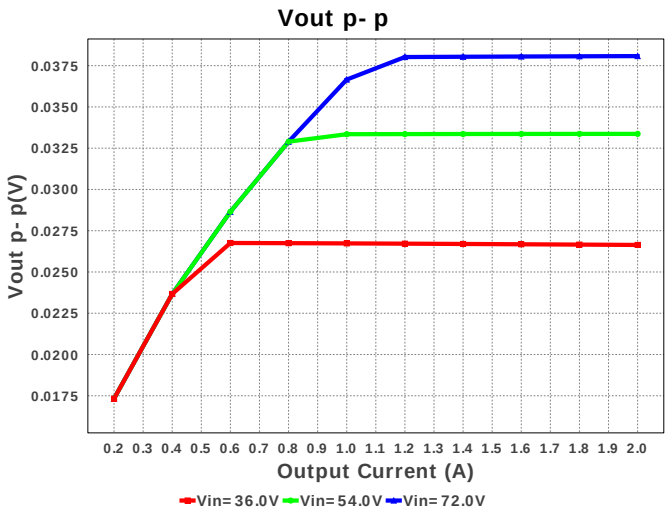

Ipri ripple
Ipri ripple(A)
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V

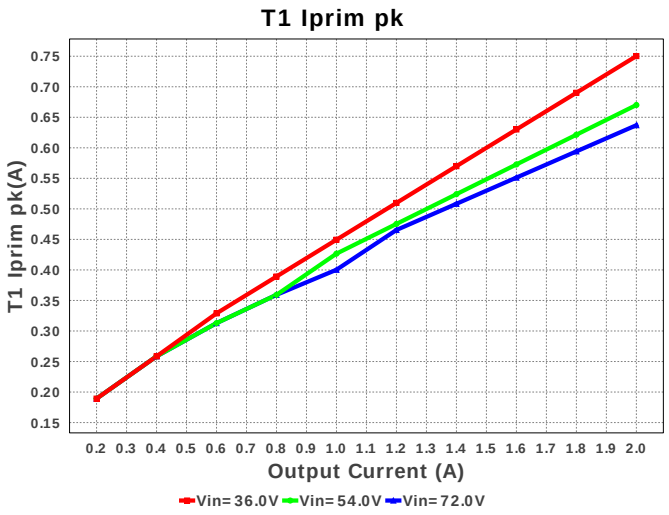

Rsns Pd
Rsns Pd(W)
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V


L2 Pd
L2 Pd(W)
0.0100
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
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V


Vout pp percentage
Vout pp percentage(%)
0.775
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V


Isec Ripple
Isec Ripple(A)
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin= 36.0V Vin= 54.0V Vin= 72.0V





Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	2.956 A	Current	Output capacitor1 RMS ripple current
2.	Iin Avg	315.872 mA	Current	Average input current
3.	Iout_DCM	600.728 mA	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	358.375 mA	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	290.893 mA	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	48.099 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	2.664 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	470.016 mA	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	750.224 mA	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	3.569 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	6.87 A	Current	Transformer Secondary1 Peak Current
12.	BOM Count	44	General	Total Design BOM count
13.	Daux trr	4.0 ns	General	Auxiliary Diode Reverse Recovery Time
14.	Dsec Vf	330.58 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	397.923 mV	General	Effective Forward Voltage Drop at the Operating Current
17.	Dsnub trr	0.0 ns	General	Snubber Diode Reverse Recovery Time
18.	FootPrint	1.174 k mm^2	General	Total Foot Print Area of BOM components
19.	Frequency	98.851 kHz	General	Switching frequency
20.	Pout	10.0 W	General	Total output power
21.	Tdead	0.0 ns	General	Approximate Dead Time of the Regulator
22.	Toff	3.653 us	General	Approximate Converter Off Time
23.	Ton Act	5.995 us	General	Approximate Converter On Time
24.	Total BOM	$0.0	General	Total BOM Cost
25.	Tsw	10.116 us	General	Switching Time Period
26.	Vaux	10.314 V	General	Auxiliary Voltage
27.	Vsnub	80.598 V	General	Voltage Across the Snubber
28.	Vout Actual	4.99 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
29.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
30.	Duty Cycle	59.257 %	Op_point	Duty cycle
31.	Efficiency	87.94 %	Op_point	Steady state efficiency
32.	IC Tj	32.446 degC	Op_point	IC junction temperature
33.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
34.	IOUT_OP	2.0 A	Op_point	Iout operating point
35.	M1 TjOP	31.469 degC	Op_point	M1 MOSFET junction temperature
36.	Vout p-p	26.638 mV	Op_point	Peak-to-peak output ripple voltage
37.	Cin Pd	839.947 µW	Power	Input capacitor power dissipation
38.	Cout1 Pd	87.37 mW	Power	Output capacitor1 power dissipation
39.	Dsec Pd	330.58 mW	Power	Secondary Diode Power Dissipation
40.	Dsec2 Pd	397.923 mW	Power	Secondary Diode Power Dissipation
41.	IC Pd	48.921 mW	Power	IC power dissipation
42.	L2 Pd	9.6 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
43.	M1 Pd	19.586 mW	Power	M1 MOSFET total power dissipation
44.	Paux	21.97 mW	Power	Power Dissipation in Raux and Daux
45.	Pd Rstartup	27.886 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
46.	Rdrv Pd	22.465 µW	Power	Power Dissipation in Gate Drive Resistor
47.	Rfb Pd	3.03 mW	Power	Rfb Power Dissipation
48.	Rsns Pd	201.033 mW	Power	Current Limit Sense Resistor Power Dissipation
49.	Snubber Pd	223.611 mW	Power	Snubber Power Dissipation
50.	T1 Pd	603.469 mW	Power	Estimated Losses in Transformer

#	Name	Value	Category	Description
51.	Total Pd	0.0 W	Power	Total Power Dissipation
52.	Vout Tolerance	2.173 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
53.	Vout pp percentage	532.757 m%		Output Voltage ripple percentage

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	VinMax	72.0	Maximum input voltage
3.	VinMin	36.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	base_pn	UCC28C40	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

Design Assistance

1. **UCC28C40** Product Folder : http://www.ti.com/product/UCC28C40 : contains the data sheet and other resources.