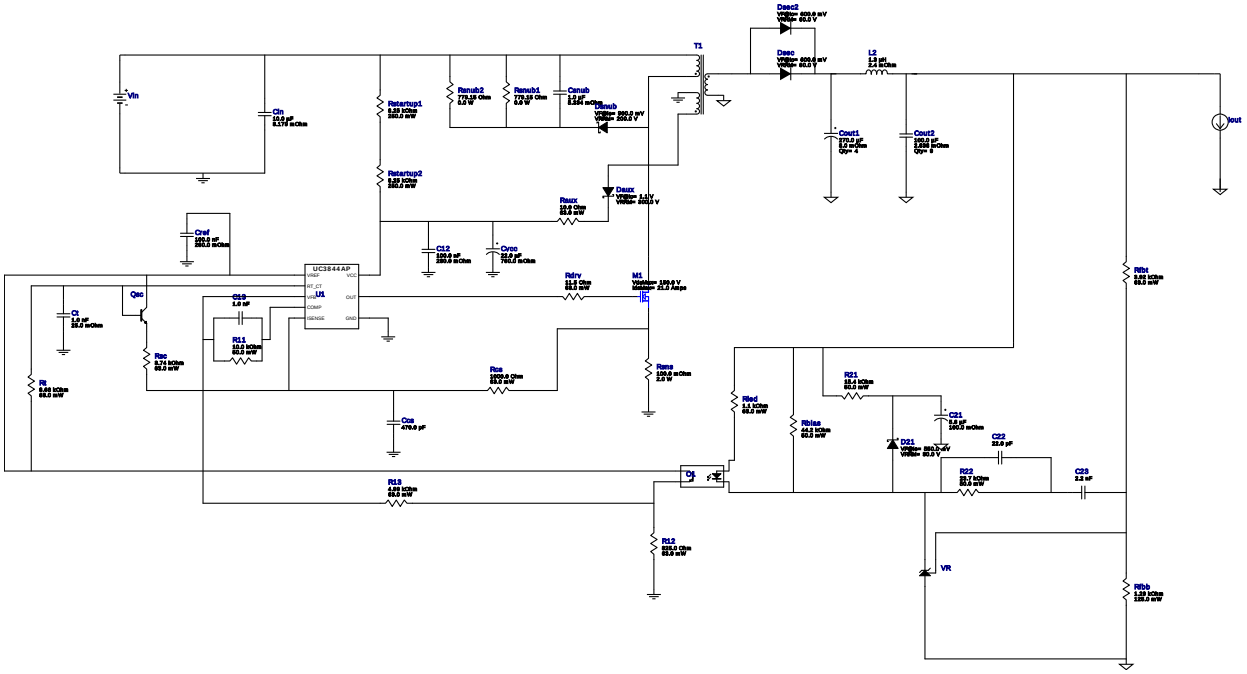
VinMin = 36.0V
VinMax = 72.0V
Vout = 5.0V
Iout = 9.0A

Device = UC3844AN
Topology = Flyback
Created = 2022-10-31 06:36:18.041
BOM Cost = NA
BOM Count = 55
Total Pd = 4.37W

WEBENCH® Design Report

Design : 33 UC3844AN
UC3844AN 36V-72V to 5.00V @ 9A

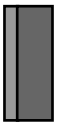
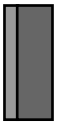


Design Alerts

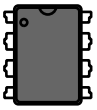
Component Selection Information
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

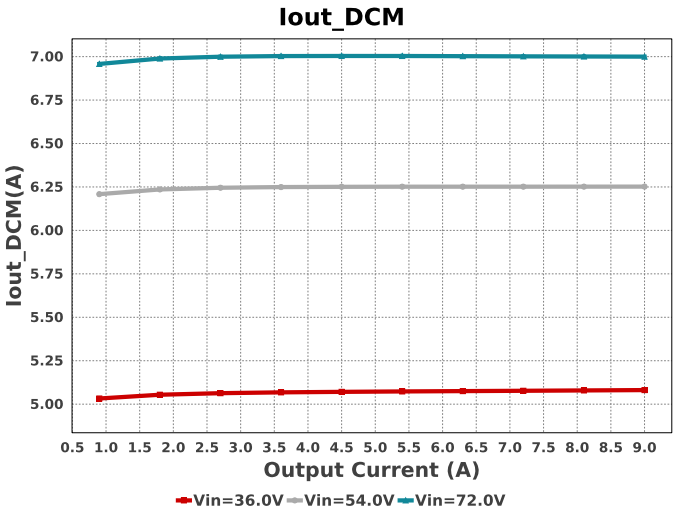
Electrical BOM

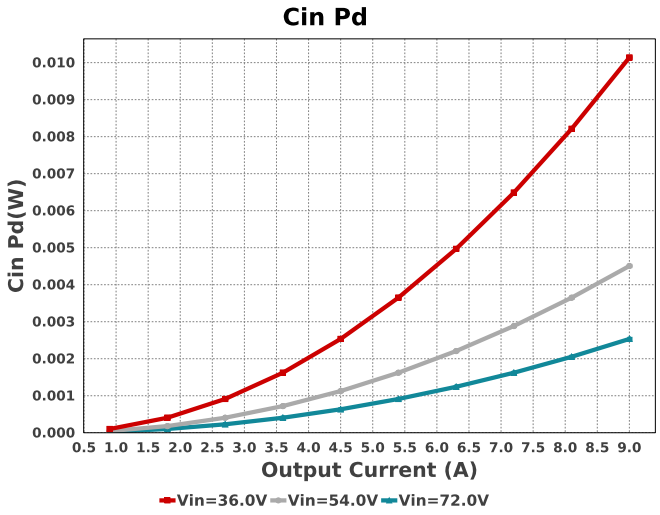
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
C13	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
C21	Panasonic	25TQC5R6M Series= TQC	Cap= 5.6 uF ESR= 100.0 mOhm VDC= 25.0 V IRMS= 800.0 mA	1	$0.75	3528-21 17 mm²
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 mm²
C23	Samsung Electro-Mechanics	CL21C222JBFNNNE Series= C0G/NP0	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
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 mm²
Cin	TDK	C5750X7S2A106K230KB Series= X7S	Cap= 10.0 uF ESR= 3.179 mOhm VDC= 100.0 V IRMS= 5.1199 A	1	$0.85	2220_250 54 mm²

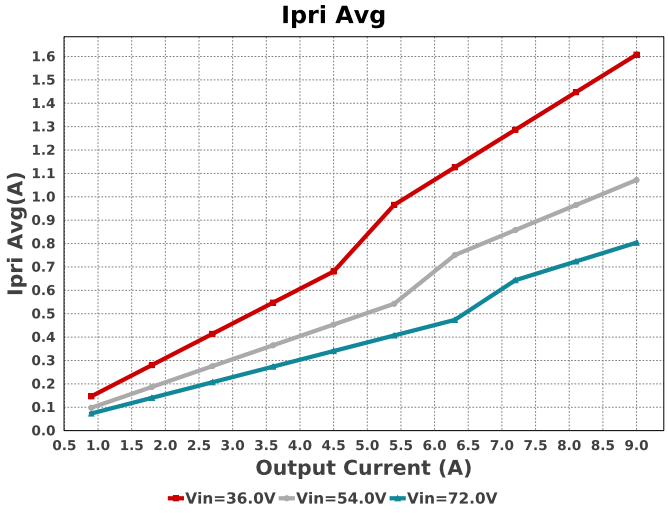
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cout1	Panasonic	16SVPG270M Series= SVPG	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	4	$0.97	 CAPSMT_62_C10 74 mm²
Cout2	TDK	C3216X5R1A107M160AC Series= X5R	Cap= 100.0 uF ESR= 2.838 mOhm VDC= 10.0 V IRMS= 4.3069 A	9	$0.46	 1206_190 11 mm²
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
Csnub	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
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 mm²
Cvcc	Nichicon	UUD1V220MCL1GS Series= uD	Cap= 22.0 uF ESR= 760.0 mOhm VDC= 35.0 V IRMS= 150.0 mA	1	$0.14	 SM_RADIAL_5MM 58 mm²
D21	Panasonic	DB2S31600L	VF@Io= 550.0 mV VRRM= 30.0 V	1	$0.03	 SOD-523 5 mm²
Daux	SMC Diode Solutions	ST1300ATR	VF@Io= 1.1 V VRRM= 300.0 V	1	$0.12	 SMA 37 mm²
Dsec	Diodes Inc.	STPS30M60	VF@Io= 600.0 mV VRRM= 60.0 V	1	$0.79	 TO-220AB 79 mm²
Dsec2	Diodes Inc.	STPS30M60	VF@Io= 600.0 mV VRRM= 60.0 V	1	$0.79	 TO-220AB 79 mm²
Dsnub	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.33	 SMB 44 mm²
L2	Coilcraft	MLC1250-132MLB	L= 1.3 µH 2.4 mOhm	1	$0.79	 MLC1250 165 mm²
M1	Infineon Technologies	BSZ520N15NS3 G	VdsMax= 150.0 V IdsMax= 21.0 Amps	1	$0.97	 PG-TSDSON-8 19 mm²
O1	Vishay-Semiconductor	TCMT1109	Optocoupler	1	$0.19	 SOP-4 44 mm²
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	$1.19	 TO-18 57 mm²
R11	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²

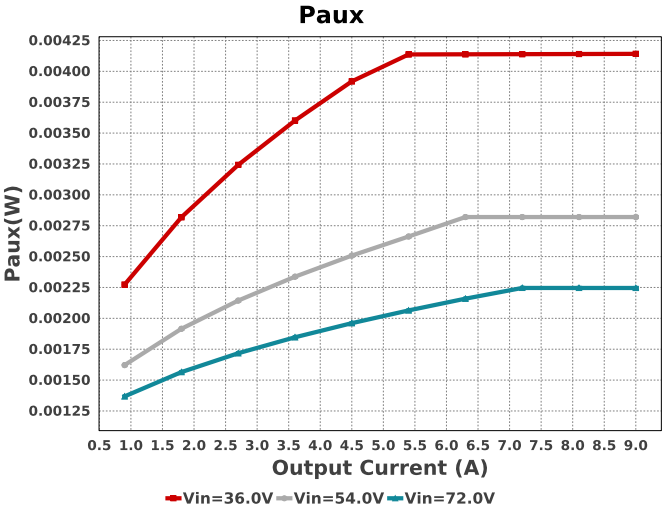
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
R12	Vishay-Dale	CRCW0402825RFKED Series= CRCW..e3	Res= 825.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
R21	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
R22	Yageo	RC0201FR-0723K7L Series= ?	Res= 23.7 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	CRCW020144K2FNED Series= ?	Res= 44.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rcs	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rdrv	Vishay-Dale	CRCW040211R5FKED Series= CRCW..e3	Res= 11.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Yageo	RT0805BRD071K29L Series= RT0805	Res= 1.29 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.06	0805 7 mm²
Rfbt	Vishay-Dale	CRCW04023K92FKED Series= CRCW..e3	Res= 3.92 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rled	Vishay-Dale	CRCW04021K10FKED Series= CRCW..e3	Res= 1.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsc	Vishay-Dale	CRCW04023K74FKED Series= CRCW..e3	Res= 3.74 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsns	Stackpole Electronics Inc	CSRN2512FKR100 Series= ?	Res= 100.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	$0.13	2512 43 mm²
Rsnub1	CUSTOM	CUSTOM Series= ?	Res= 779.15 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rsnub2	CUSTOM	CUSTOM Series= ?	Res= 779.15 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rstartup1	Vishay-Dale	CRCW12068K25FKEA Series= CRCW..e3	Res= 8.25 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rstartup2	Vishay-Dale	CRCW12068K25FKEA Series= CRCW..e3	Res= 8.25 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	Core=Wurth Elektronik , CoilFormer=Wurth Elektronik	Core=150-2623 , CoilFormer=070-2255	Lp= 21.0 µH Turns Ratio(Nas)= 12:4 Turns Ratio(Nps)= 11:4 Npri= 11.0 Naux= 12.0 Nsec= 4.0	1	NA	TDK_B65803 556 mm²

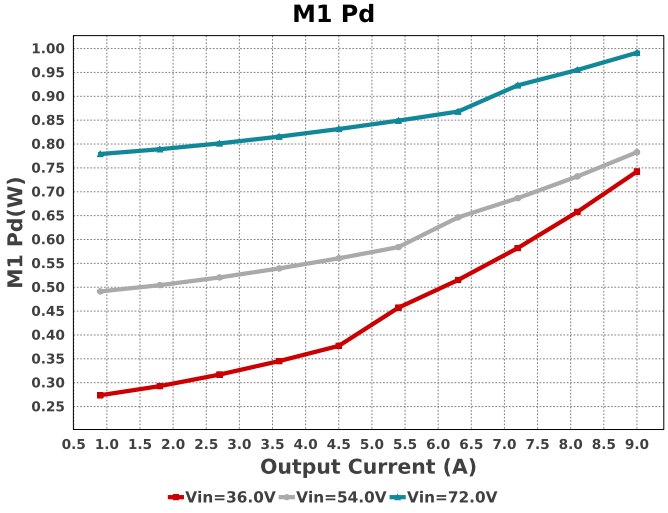
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	UC3844AN	Switcher	1	$0.43	 P0008A 116 mm²
VR	Texas Instruments	LMV431CM5/NOPB	Voltage References	1	$0.20	 R-PDSO-G3 16 mm²

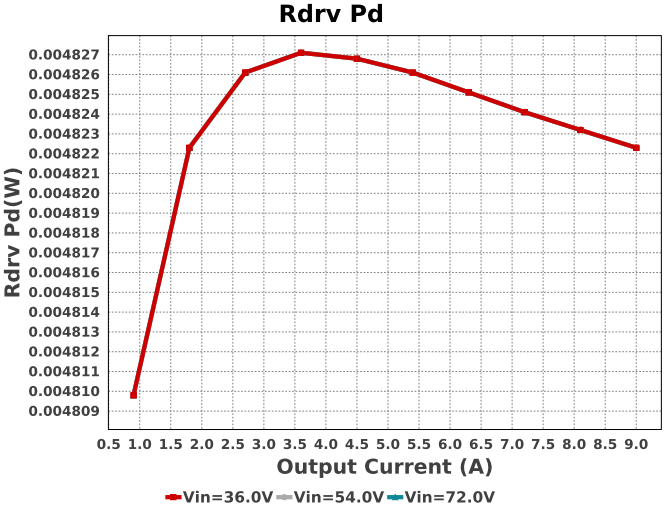


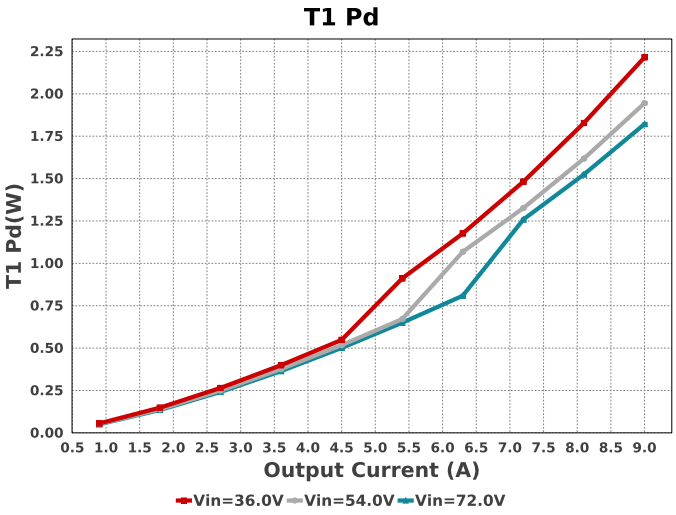


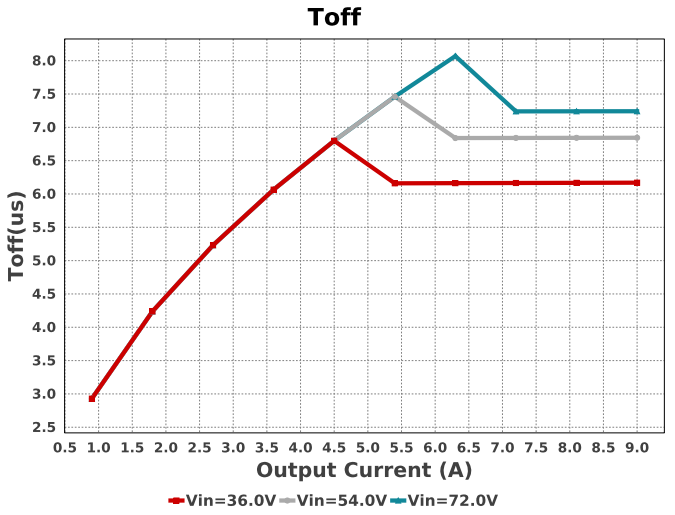


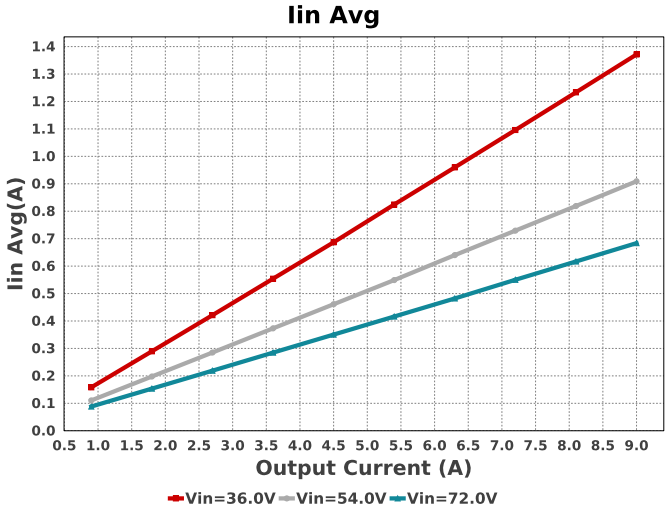


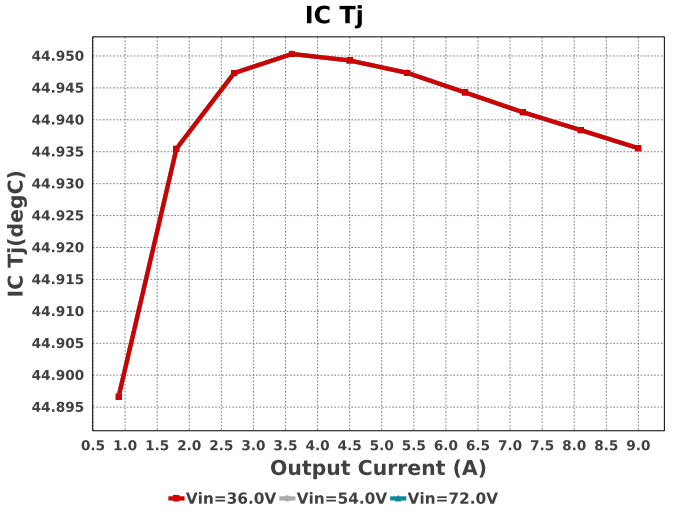


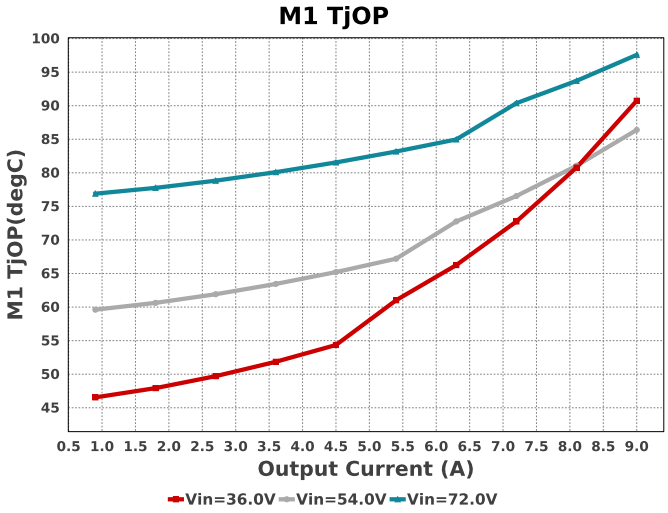


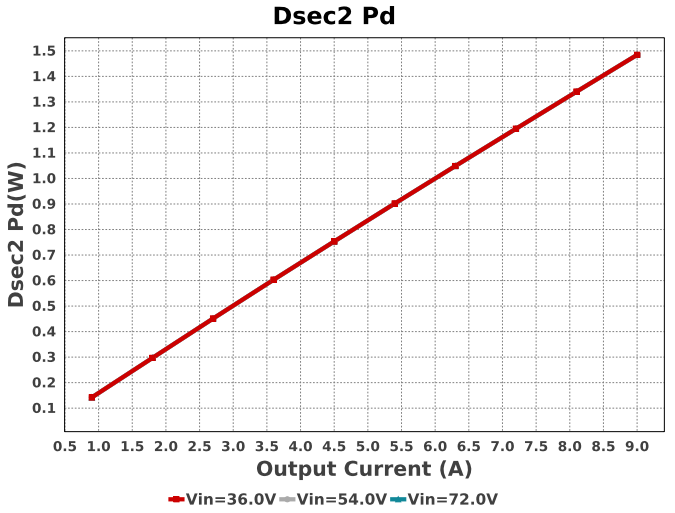


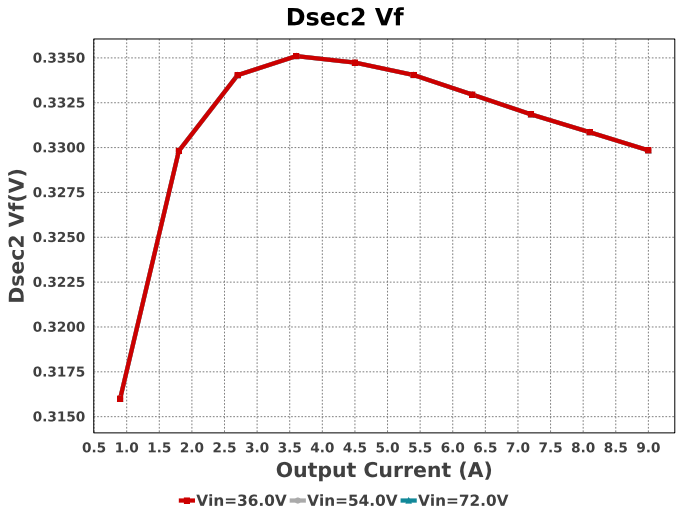


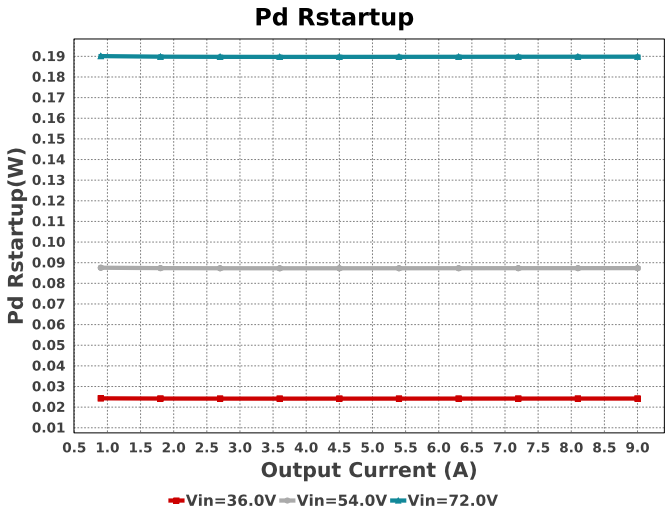


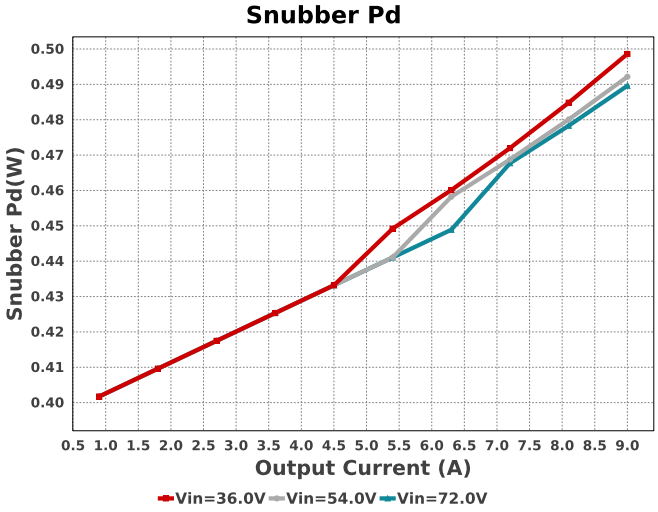


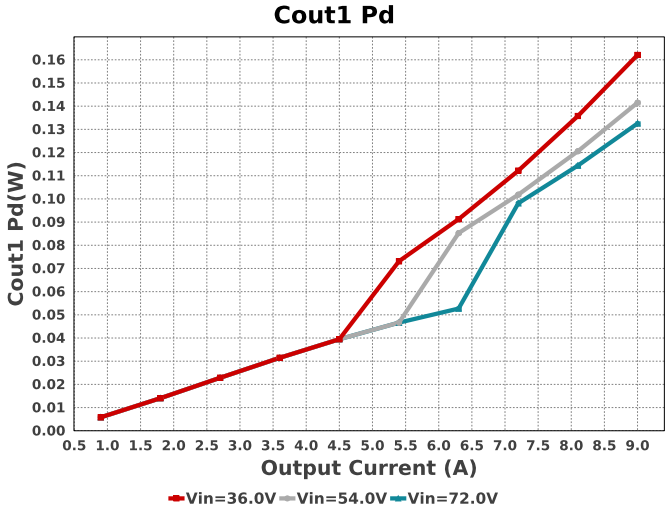


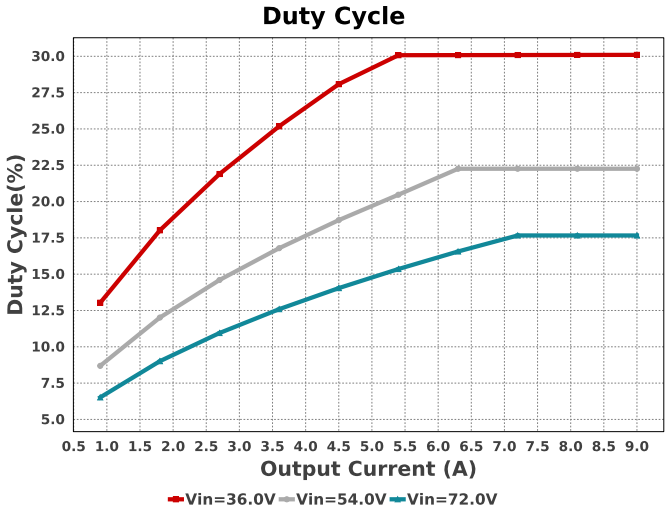


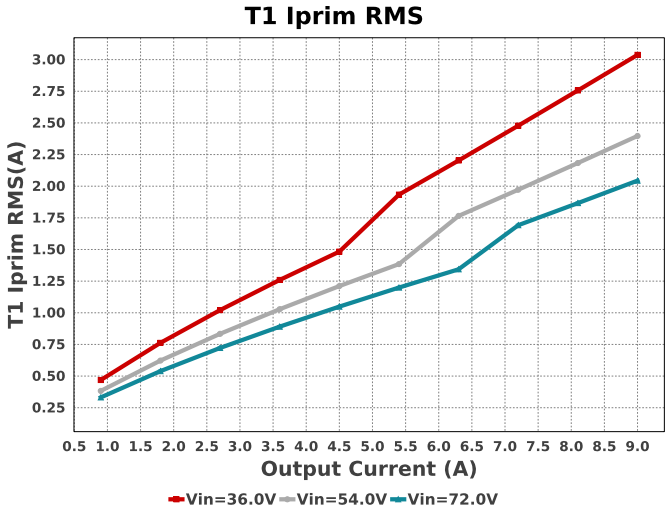


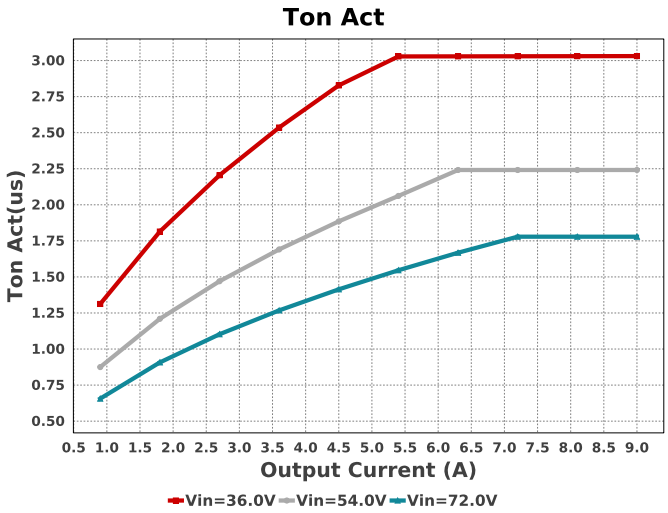


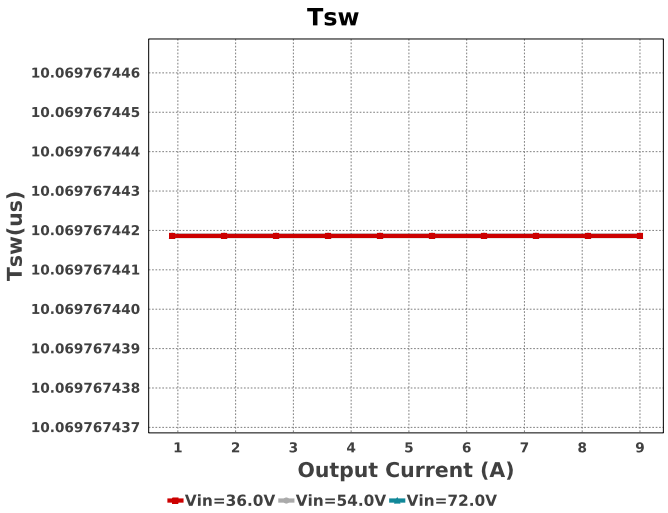


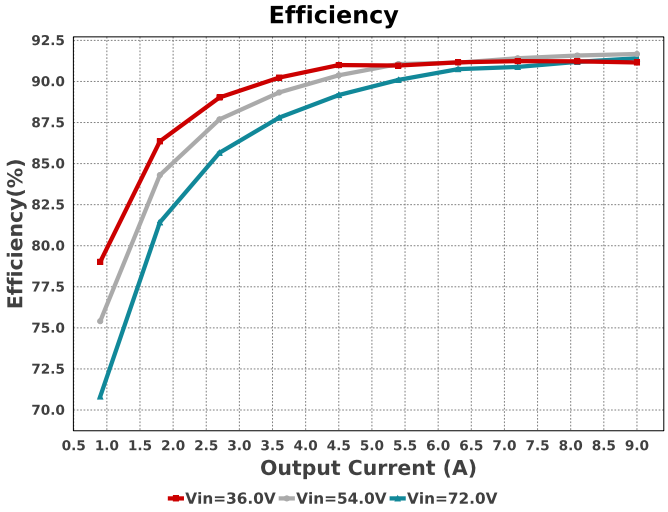


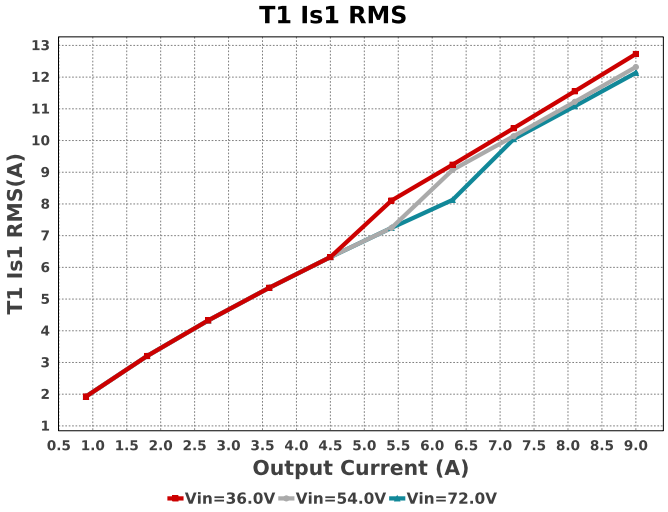


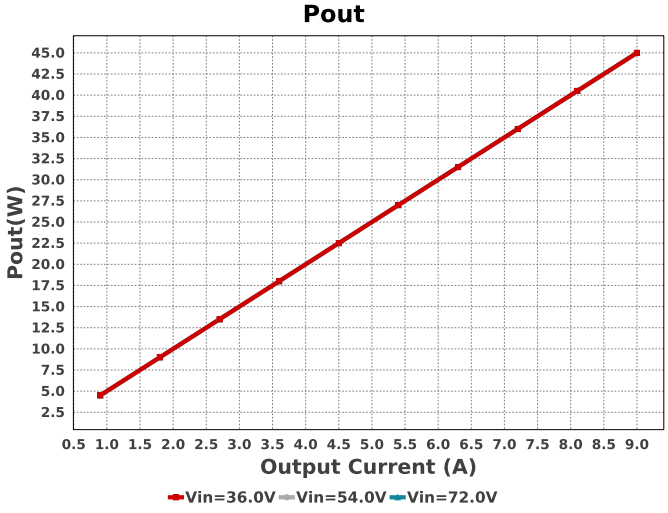


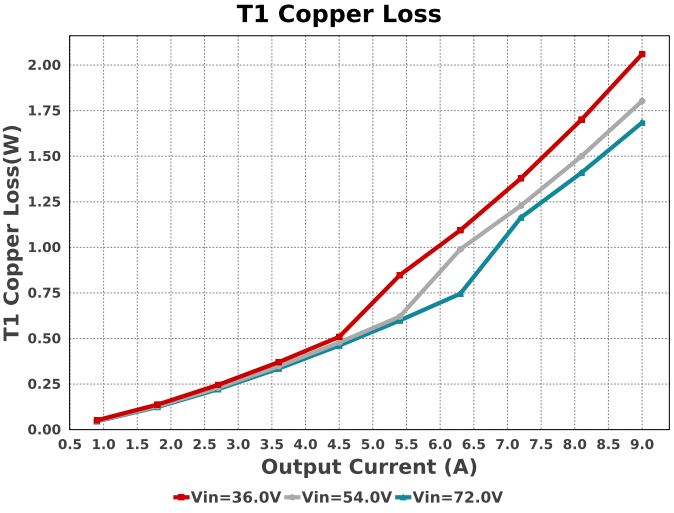


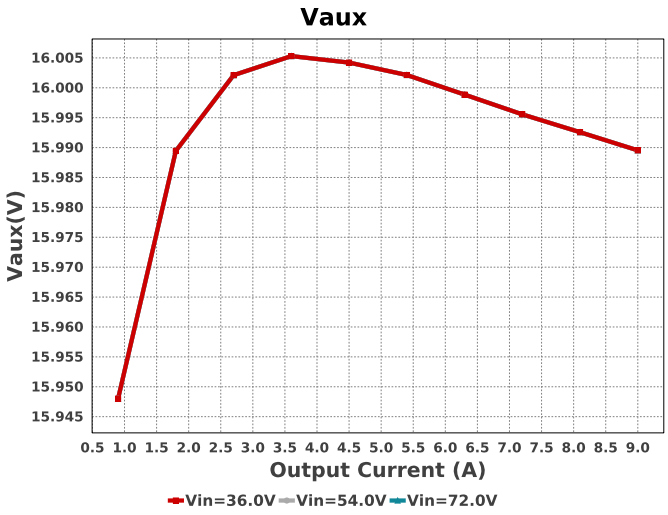


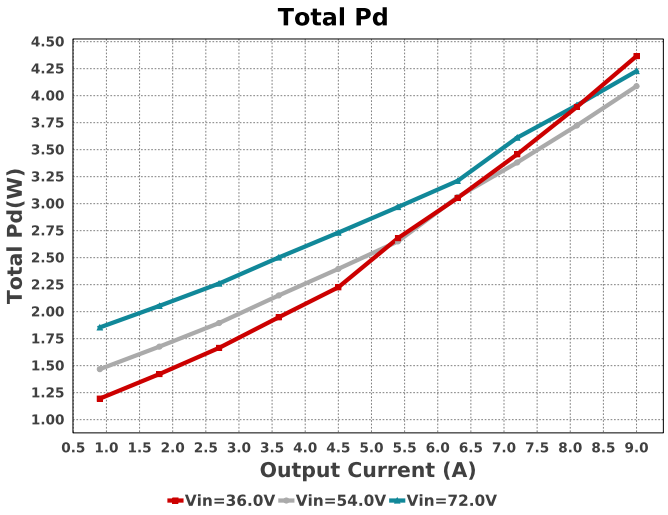


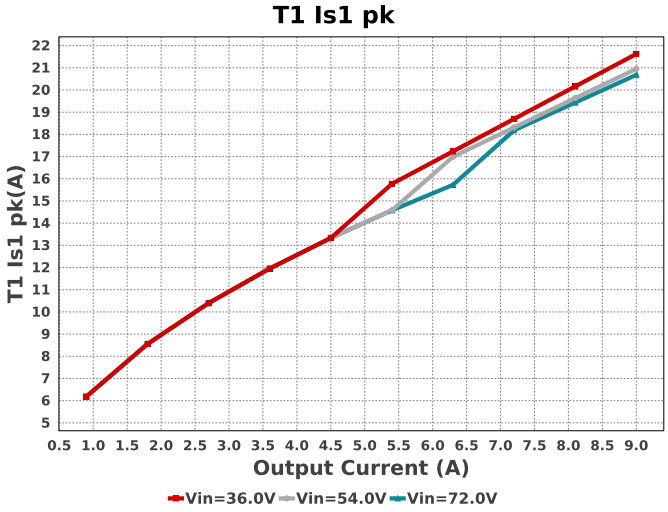


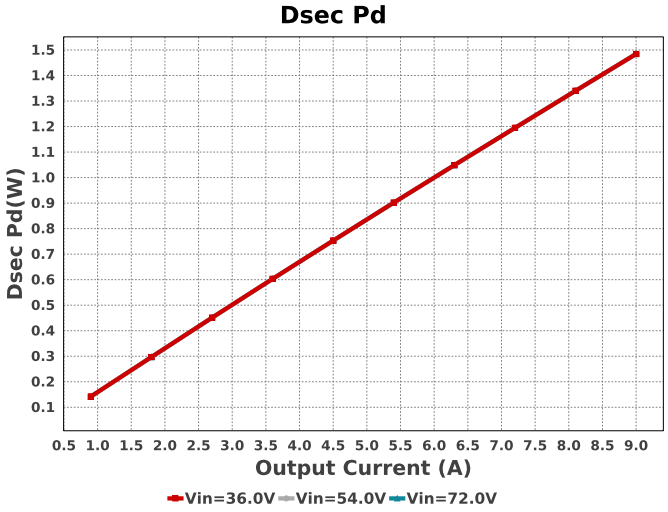


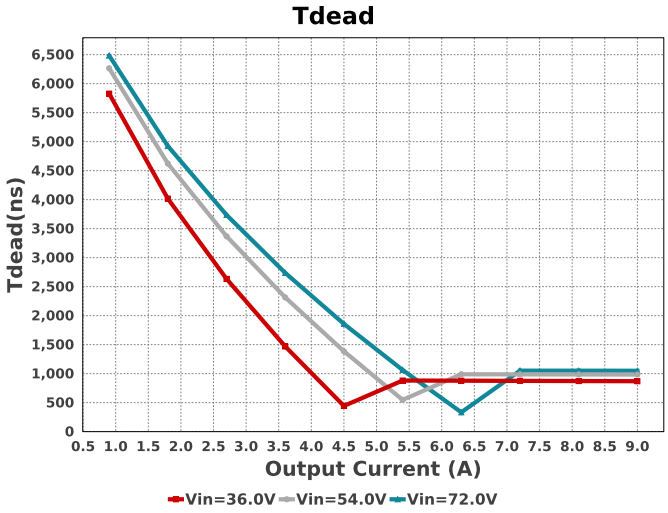


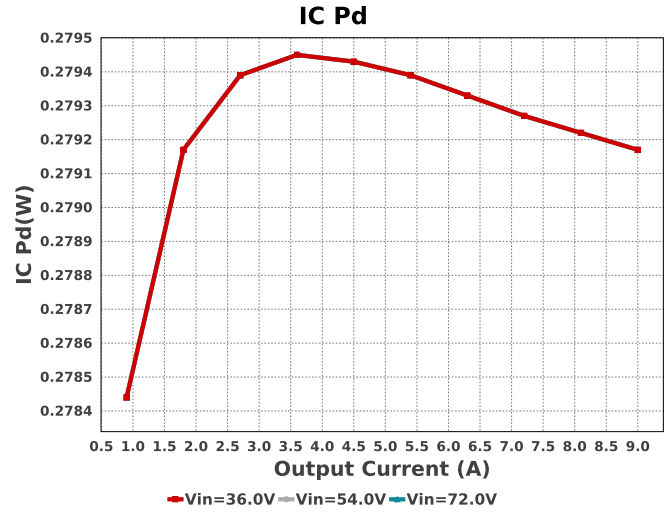


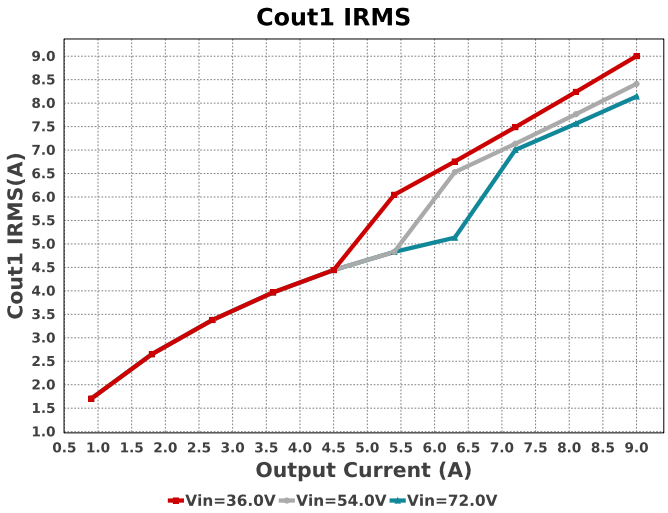


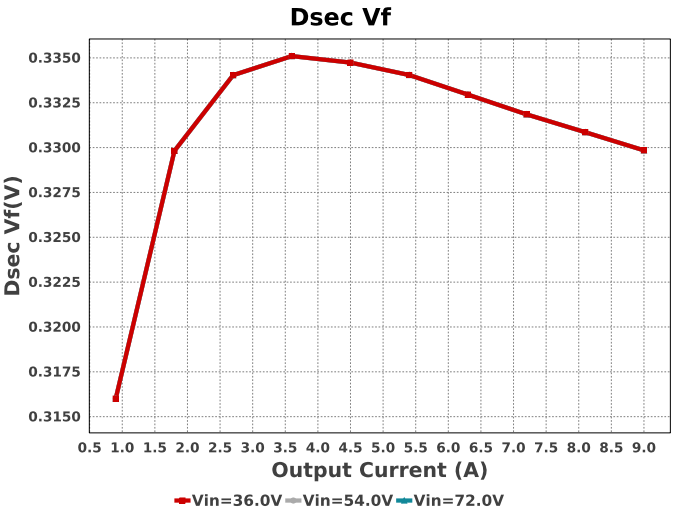


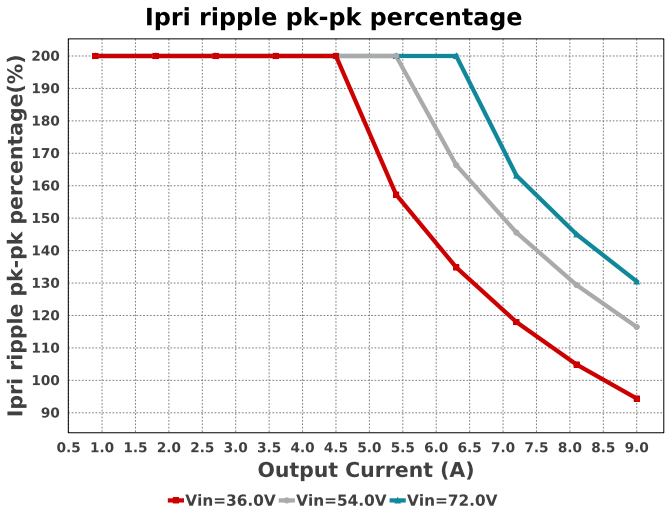


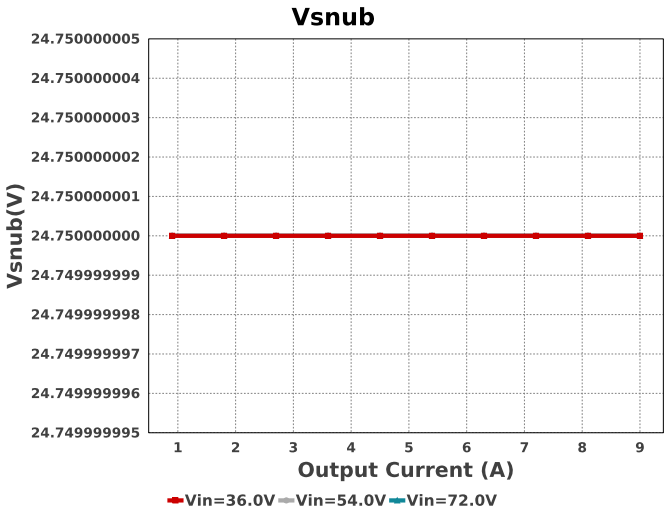


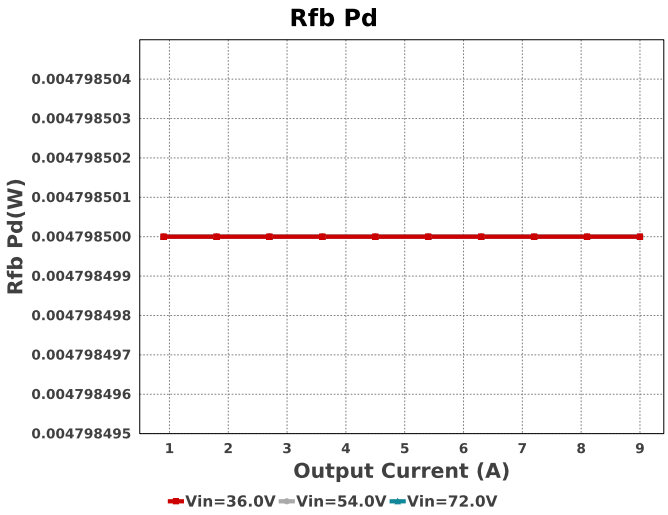


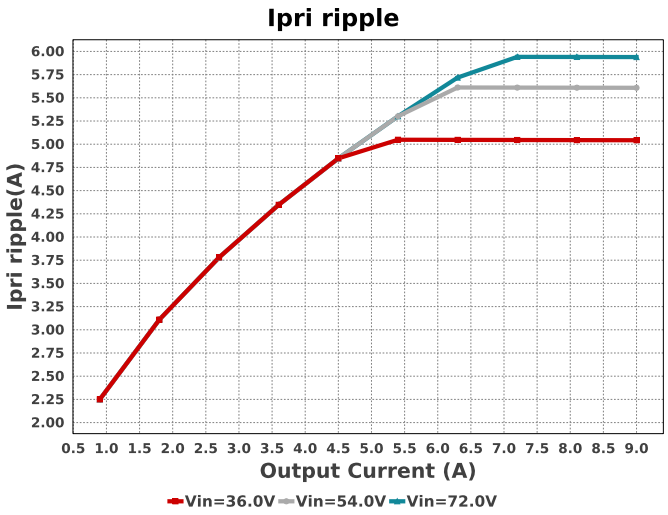


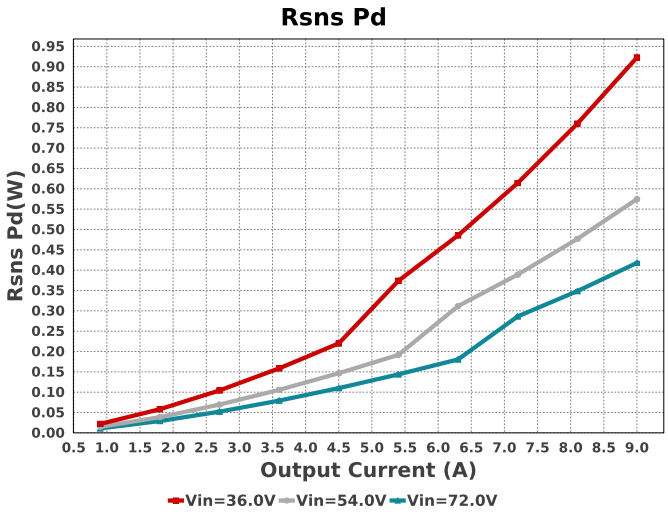


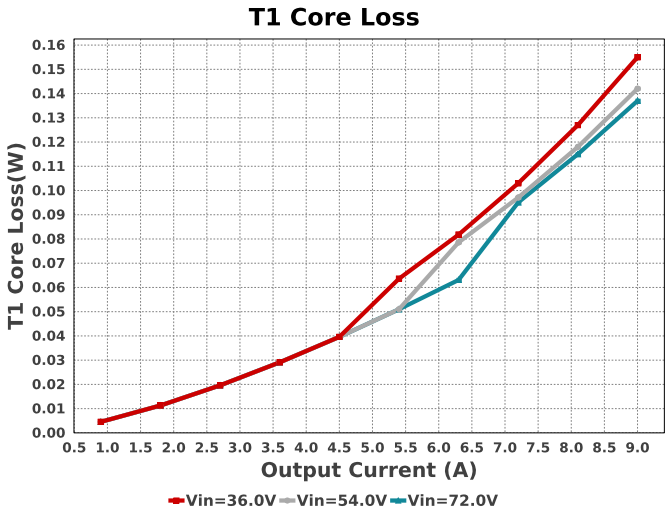


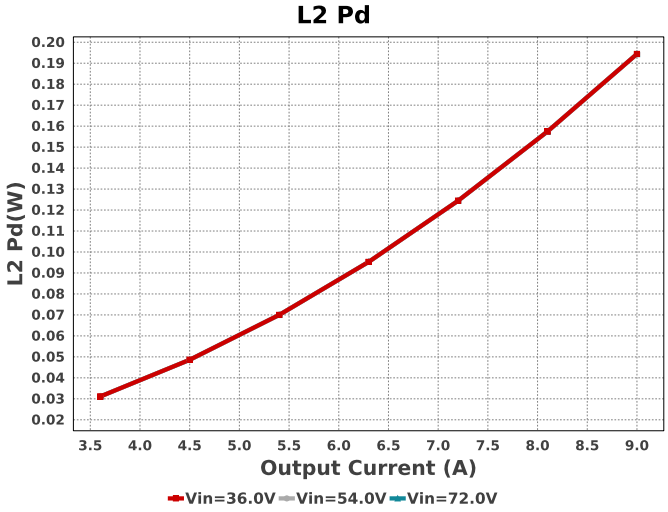


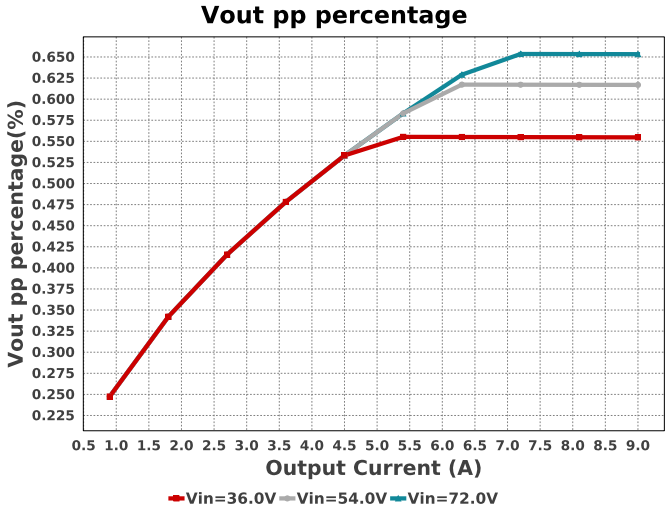


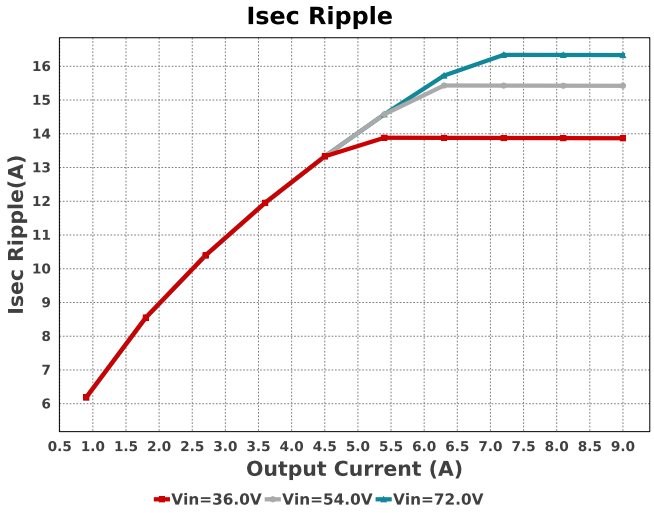


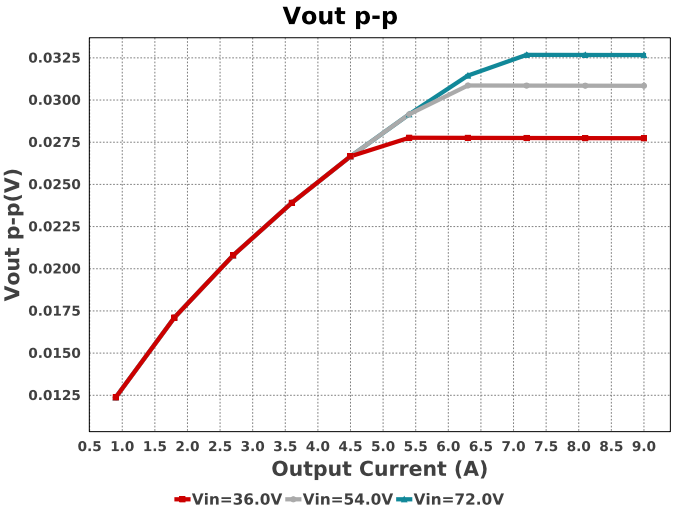


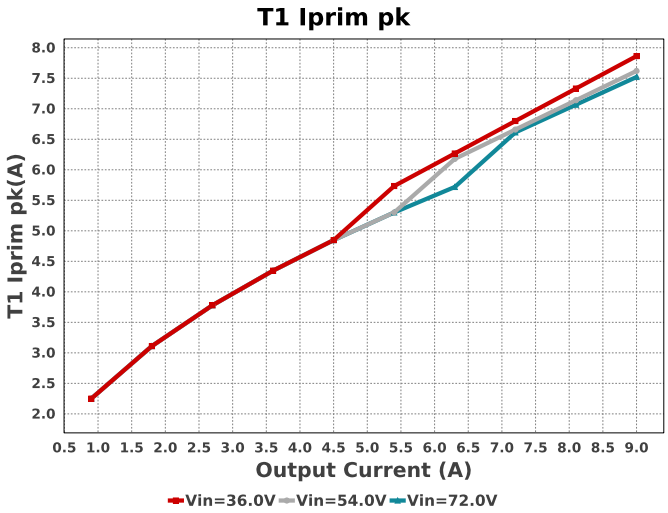












Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	10.137 mW	Capacitor	Input capacitor power dissipation
2.	Cout1 IRMS	9.002 A	Capacitor	Output capacitor1 RMS ripple current
3.	Cout1 Pd	162.08 mW	Capacitor	Output capacitor1 power dissipation
4.	Daux trr	35.0 ns	Diode	Auxiliary Diode Reverse Recovery Time
5.	Dsec Pd	1.484 W	Diode	Secondary Diode Power Dissipation
6.	Dsec Vf	329.845 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	1.484 W	Diode	Secondary Diode Power Dissipation
9.	Dsec2 Vf	329.845 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	279.17 mW	IC	IC power dissipation
12.	IC Tj	44.936 degC	IC	IC junction temperature
13.	ICThetaJA	53.5 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	1.371 A	IC	Average input current
15.	L2 Pd	194.4 mW	Inductor	Average Power Dissipation in the Inductor Over the AC Line Period
16.	M1 Pd	742.38 mW	Mosfet	M1 MOSFET total power dissipation
17.	M1 TjOP	90.742 degC	Mosfet	M1 MOSFET junction temperature
18.	Cin Pd	10.137 mW	Power	Input capacitor power dissipation
19.	Cout1 Pd	162.08 mW	Power	Output capacitor1 power dissipation
20.	Dsec Pd	1.484 W	Power	Secondary Diode Power Dissipation
21.	Dsec2 Pd	1.484 W	Power	Secondary Diode Power Dissipation
22.	IC Pd	279.17 mW	Power	IC power dissipation
23.	L2 Pd	194.4 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
24.	M1 Pd	742.38 mW	Power	M1 MOSFET total power dissipation
25.	Paux	4.142 mW	Power	Power Dissipation in Raux and Daux
26.	Pd Rstartup	24.164 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
27.	Rdrv Pd	4.822 mW	Power	Power Dissipation in Gate Drive Resistor
28.	Rfb Pd	4.798 mW	Power	Rfb Power Dissipation
29.	Rsns Pd	922.62 mW	Power	Current Limit Sense Resistor Power Dissipation
30.	Snubber Pd	498.591 mW	Power	Snubber Power Dissipation
31.	T1 Copper Loss	1.252 W	Power	Transformer Copper Loss Power Dissipation
32.	T1 Core Loss	121.0 mW	Power	Transformer Core Loss Power Dissipation
33.	T1 Pd	1.373 W	Power	Estimated Losses in Transformer
34.	Total Pd	4.366 W	Power	Total Power Dissipation
35.	Pd Rstartup	24.164 mW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
36.	Rdrv Pd	4.822 mW	Resistor	Power Dissipation in Gate Drive Resistor
37.	Rfb Pd	4.798 mW	Resistor	Rfb Power Dissipation
38.	Rsns Pd	922.62 mW	Resistor	Current Limit Sense Resistor Power Dissipation
39.	BOM Count	55	System Information	Total Design BOM count
40.	Duty Cycle	30.099 %	System Information	Duty cycle
41.	Efficiency	91.155 %	System Information	Steady state efficiency
42.	FootPrint	1.914 k mm^2	System Information	Total Foot Print Area of BOM components
43.	Frequency	99.307 kHz	System Information	Switching frequency
44.	Iout	9.0 A	System Information	Iout operating point
45.	Iout_DCM	5.081 A	System Information	Approximate Current below which DCM mode of operation will begin

#	Name	Value	Category	Description
46.	Mode	CCM	System Information	Conduction Mode
47.	Pout	45.0 W	System Information	Total output power
48.	Tdead	869.379 ns	System Information	Approximate Dead Time of the Regulator
49.	Toff	6.169 us	System Information	Approximate Converter Off Time
50.	Ton Act	3.031 us	System Information	Approximate Converter On Time
51.	Total BOM	NA	System Information	Total BOM Cost
52.	Tsw	10.07 us	System Information	Switching Time Period
53.	Vin	36.0 V	System Information	Vin operating point
54.	Vout	5.0 V	System Information	Operational Output Voltage
55.	Vout Actual	5.008 V	System Information	Vout Actual calculated based on selected voltage divider resistors
56.	Vout Tolerance	1.479 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
57.	Vout p-p	27.735 mV	System Information	Peak-to-peak output ripple voltage
58.	Vout pp percentage	554.699 m%	System Information	Output Voltage ripple percentage
59.	Vsnub	24.75 V	System Information	Voltage Across the Snubber
60.	Ipri Avg	1.608 A	Transformer	Average Current in Primary Winding over the complete Switching Period
61.	Ipri ripple	5.043 A	Transformer	Ripple Current in the Primary Winding
62.	Ipri ripple pk-pk percentage	94.403 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
63.	Isec Ripple	13.867 A	Transformer	Ripple Current in the Secondary Winding
64.	Paux	4.142 mW	Transformer	Power Dissipation in Raux and Daux
65.	T1 Copper Loss	1.252 W	Transformer	Transformer Copper Loss Power Dissipation
66.	T1 Core Loss	121.0 mW	Transformer	Transformer Core Loss Power Dissipation
67.	T1 Iprim RMS	3.037 A	Transformer	Transformer Primary RMS Current
68.	T1 Iprim pk	7.863 A	Transformer	Transformer Primary Peak Current
69.	T1 Is1 RMS	12.729 A	Transformer	Transformer Secondary1 RMS Current
70.	T1 Is1 pk	21.623 A	Transformer	Transformer Secondary1 Peak Current
71.	T1 Pd	1.373 W	Transformer	Estimated Losses in Transformer
72.	Vaux	15.99 V	Transformer	Auxiliary Voltage

Design Inputs

Name	Value	Description
Iout	9.0	Maximum Output Current
VinMax	72.0	Maximum input voltage
VinMin	36.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	UC3844A	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

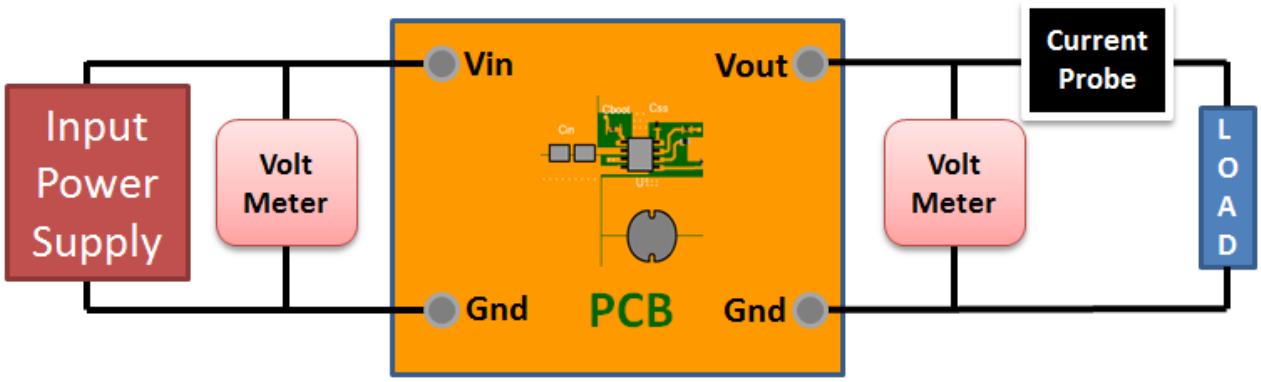
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 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	150-2623
2.	Core Manufacturer	Wurth Elektronik
3.	Coil Former Part Number	070-2255
4.	Coil Former Manufacturer	Wurth Elektronik

Transformer Electrical Diagram

Primary

Turns	11.0
AWG	28.0
Layers	2.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	4.0
AWG	27.0
Layers	1.0
Strands	3.0
Insulation Type	Triple Insulated

Auxiliary

Turns	12.0
AWG	28.0
Layers	1.0
Strands	2.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	28.0	6	Clockwise
Auxiliary	28.0	12.0	Counter Clockwise
Triple Insulated Secondary	27.0	4.0	Counter Clockwise
Primary Second 1/2.0	28.0	5	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	2.1E-5H
2.	Inductance Factor(Al)	173.0nH
3.	Npri	11.0
4.	Nsec	4.0
5.	Naux	12.0
6.	Core Type	RM8
7.	Core Material	TP4A

#	Name	Value
8.	Bmax	0.23T
9.	Switching Frequency	99.31kHz
10.	DMax	0.36
11.	Ipk(Primary)	7.23A
12.	Irms(Primary)	2.73A
13.	Ipk(Secondary)	19.9A
14.	Irms(Secondary)	10.0A

Design Assistance

1. Master key : 5A9DB1798243DBF8[v1]
2. **UC3844A** Product Folder : http://www.ti.com/product/UC3844A : contains the data sheet and other resources.