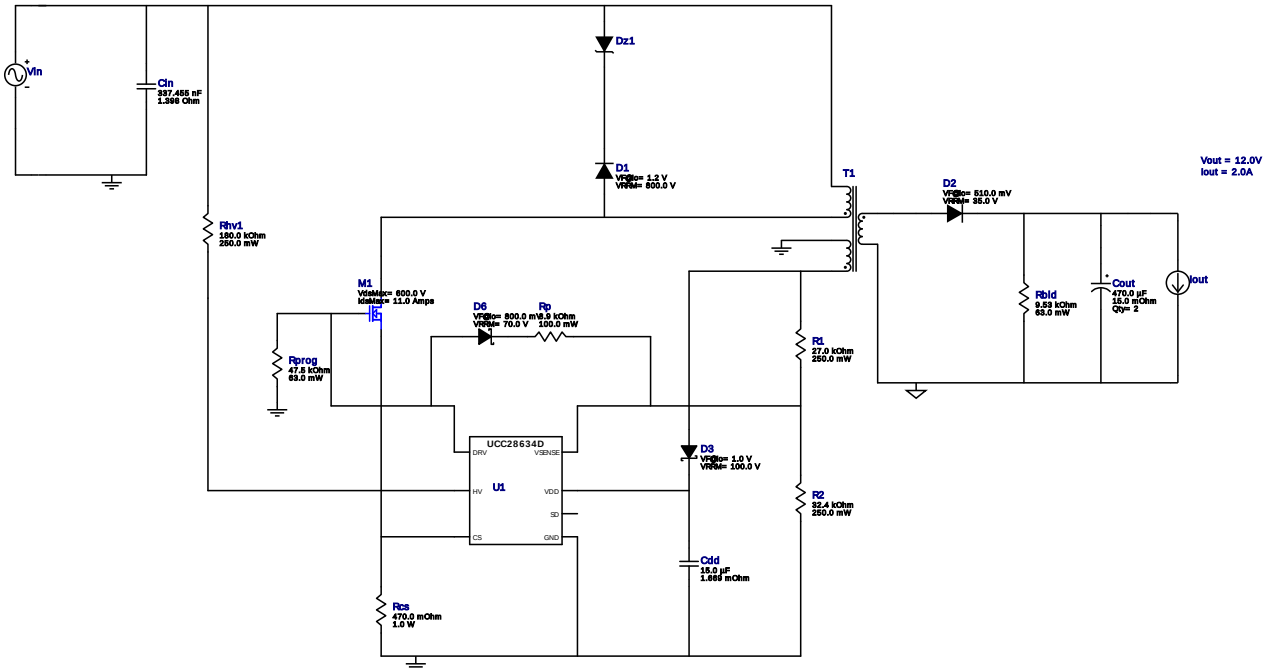


WEBENCH[®] Design Report

Design : 18 UCC28634DR
UCC28634DR 100V-160V to 12.00V @ 2A



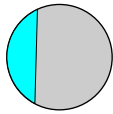
1. Rld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. For more information please click the design assistance button.
2. Device operates in peak power region. So user needs to ensure the safe operation of 'D2' diode by using Heat sink if required.
3. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

Design Alerts

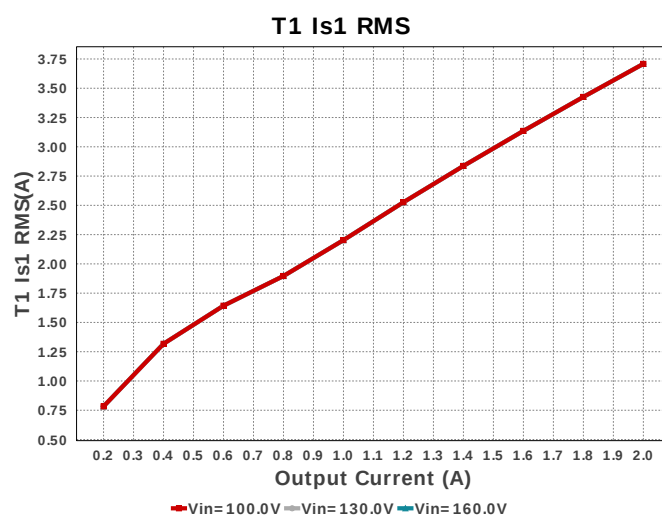
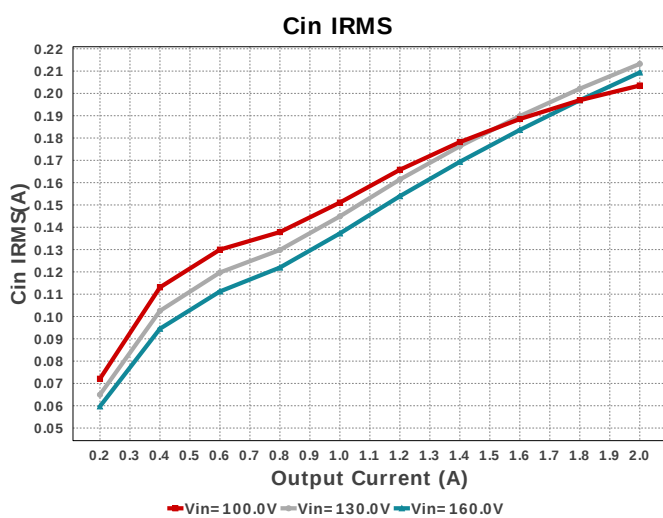
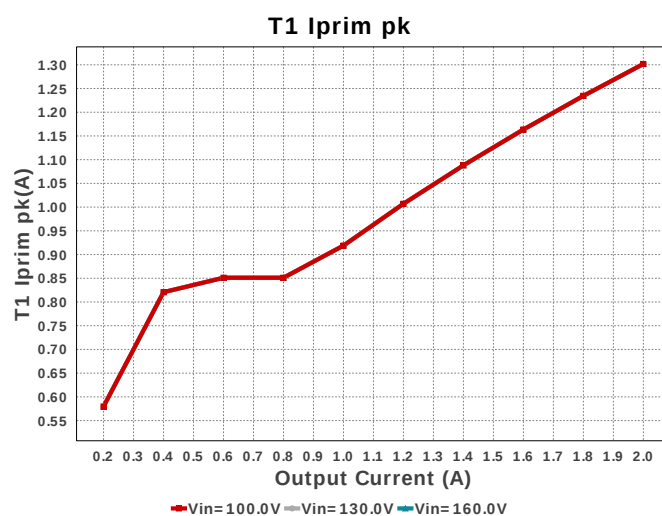
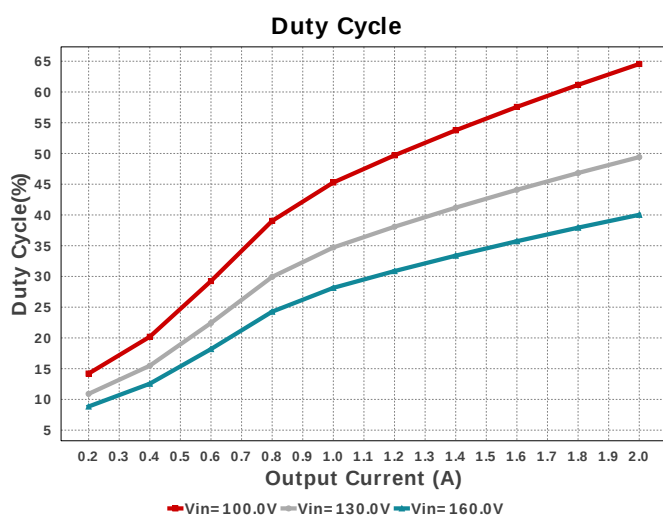
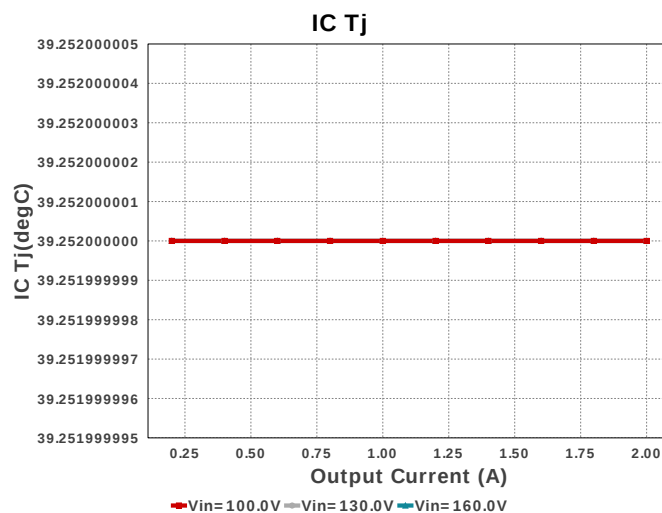
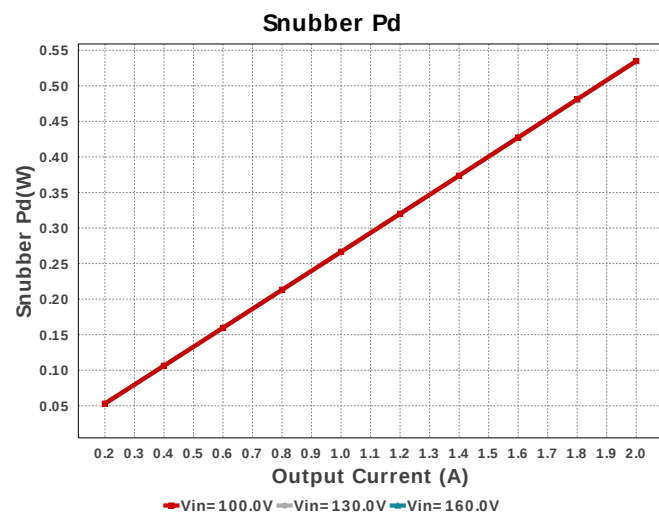
Component Selection Information

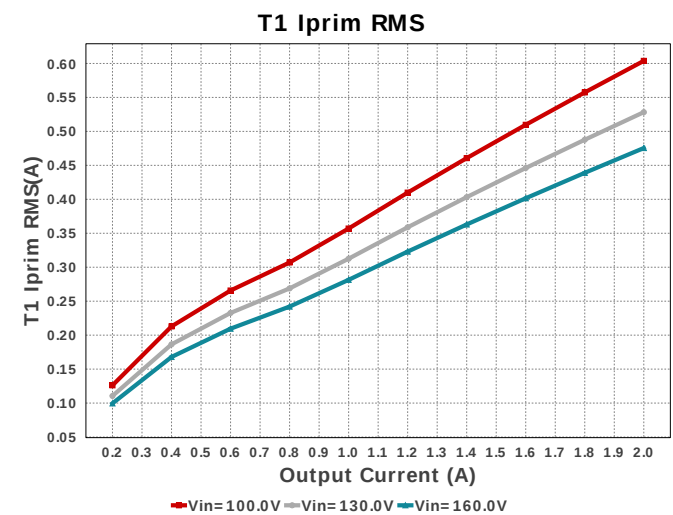
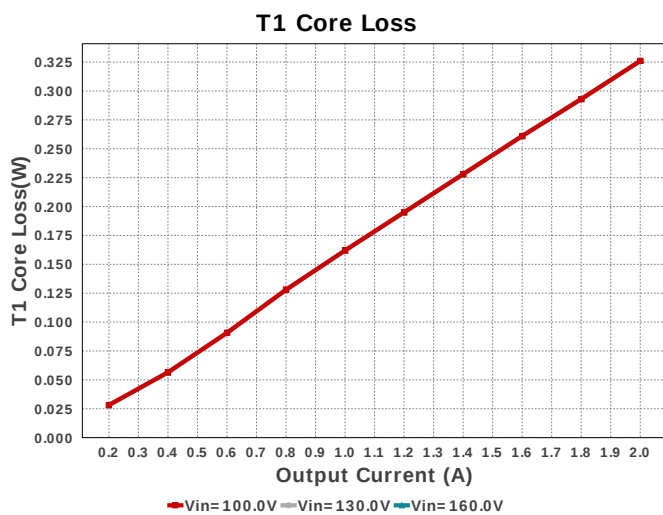
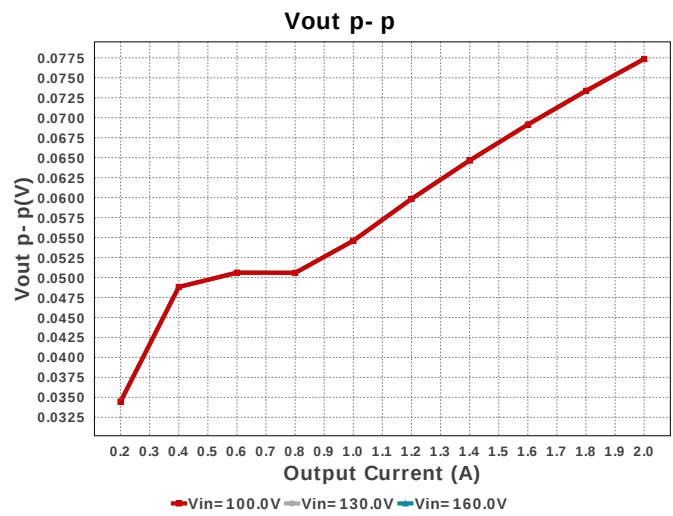
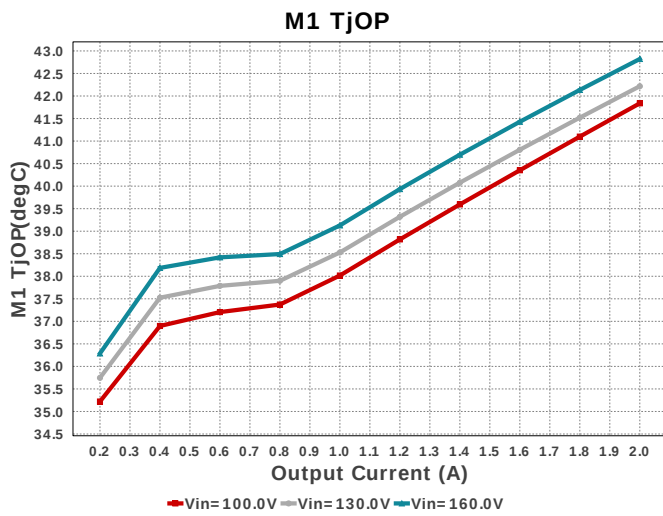
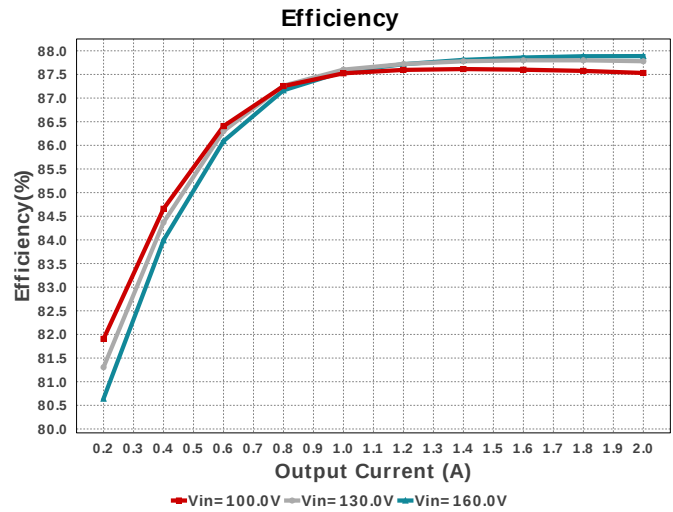
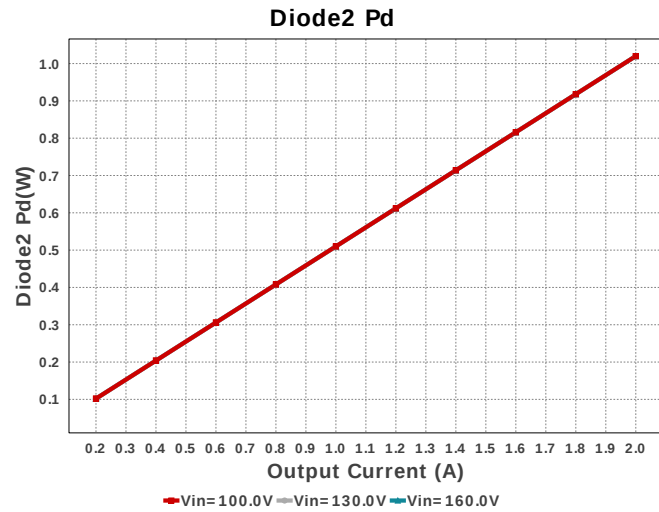
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

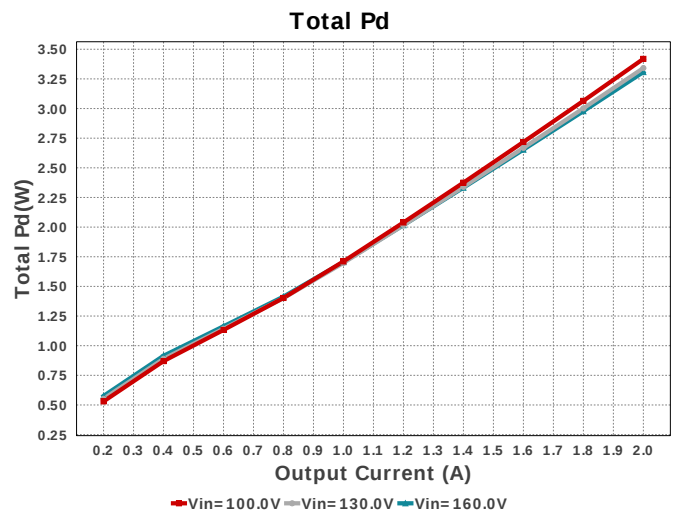
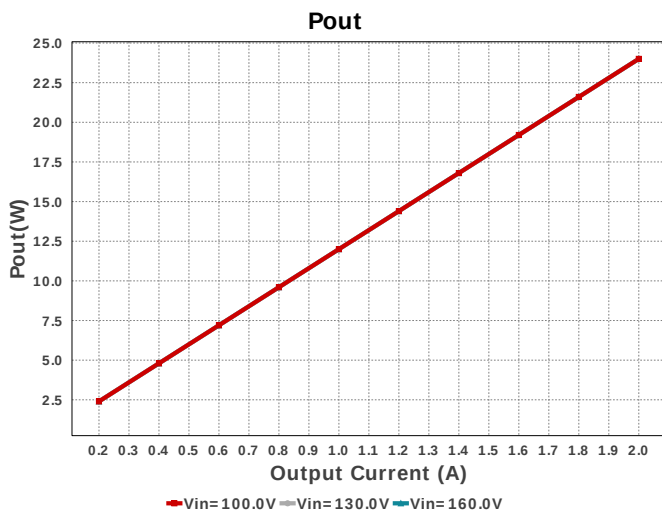
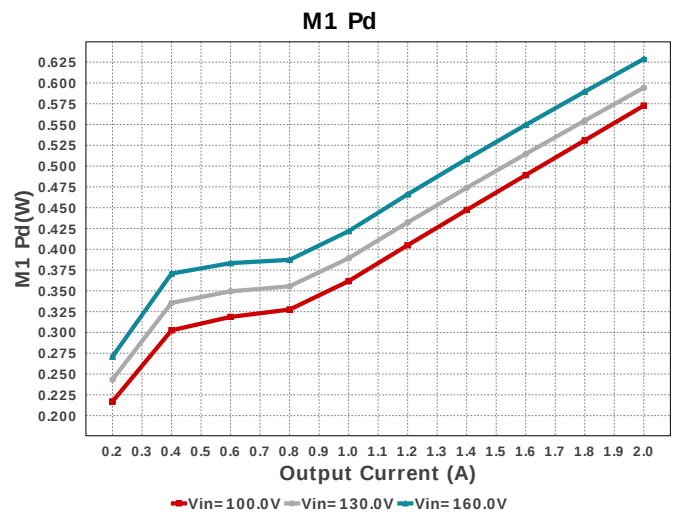
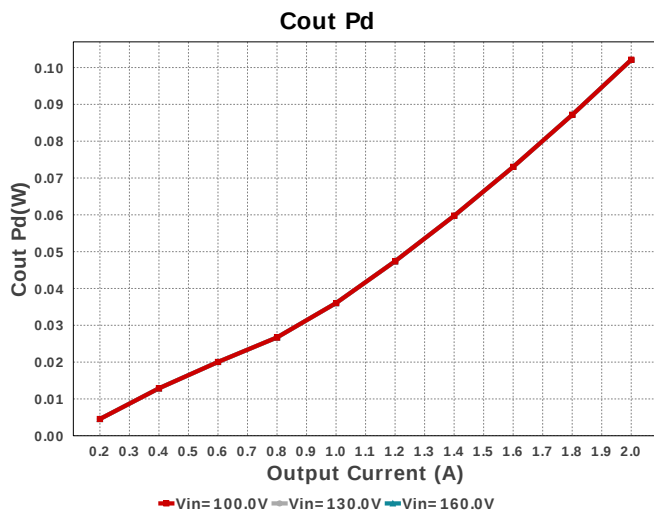
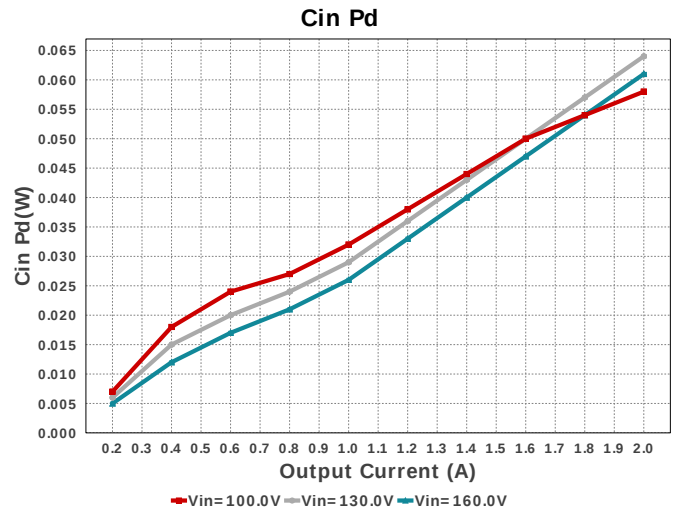
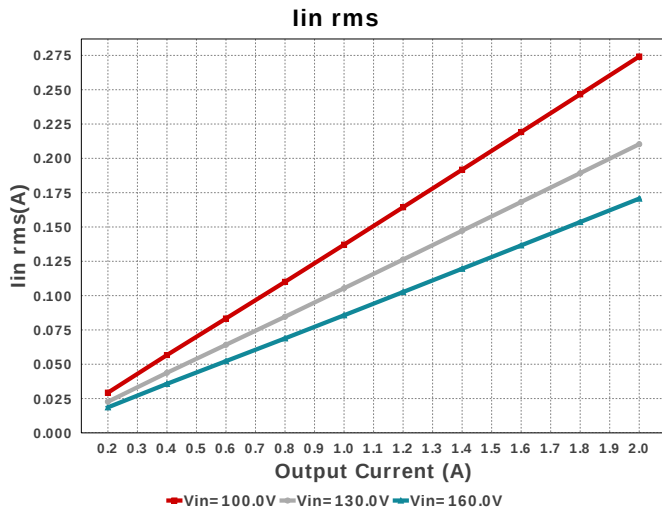
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cdd	TDK	C2012X5R1V156M125AC Series= X5R	Cap= 15.0 uF ESR= 1.669 mOhm VDC= 35.0 V IRMS= 5.0498 A	1	\$0.21	 0805 7 mm ²
Cin	CUSTOM	CUSTOM Series= ?	Cap= 337.455 nF ESR= 1.39822 Ohm VDC= 192.0 V IRMS= 392.73 mA	1	NA	CUSTOM 0 mm ²
Cout	Kemet	A750MS477M1EAAE015 Series= 3273	Cap= 470.0 uF ESR= 15.0 mOhm VDC= 25.0 V IRMS= 4.9 A	2	\$0.32	 A750_MS 144 mm ²
D1	Microsemi	UFS180JE3/TR13	VF@Io= 1.2 V VRRM= 800.0 V	1	\$0.73	 DO-214BA 42 mm ²

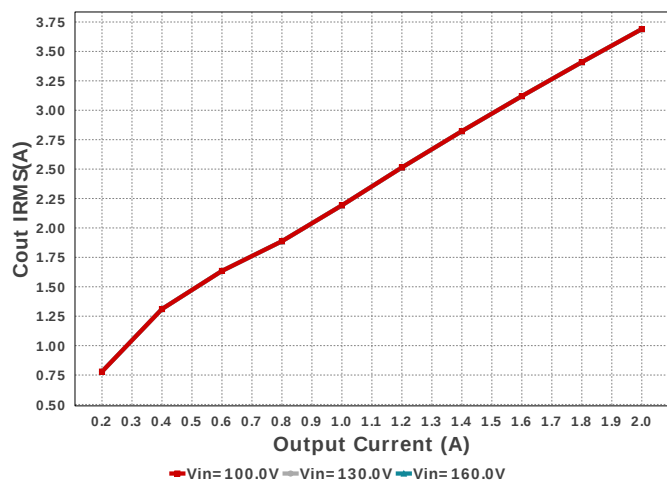
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D2	ON Semiconductor	MBRD835LT4G	VF@Io= 510.0 mV VRRM= 35.0 V	1	\$0.22	 DPAK 102 mm ²
D3	Comchip Technology	CDBW46-G	VF@Io= 1.0 V VRRM= 100.0 V	1	\$0.03	 SOD-123 13 mm ²
D6	Diodes Inc.	1N5711WS-7-F	VF@Io= 800.0 mV VRRM= 70.0 V	1	\$0.09	 SOD-323 9 mm ²
Dz1	Diodes Inc.	SMBJ150A-13-F	Zener	1	\$0.09	 SMB 44 mm ²
M1	STMicroelectronics	STF13NM60ND	VdsMax= 600.0 V IdsMax= 11.0 Amps	1	\$1.72	 TO-220FP 79 mm ²
R1	Yageo	RC1206FR-0727KL Series= ?	Res= 27.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm ²
R2	Vishay-Dale	CMF5032K400FHEB Series= CMF50	Res= 32.4 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.16	 CMF50 46 mm ²
Rbld	Vishay-Dale	CRCW04029K53FKED Series= CRCW...e3	Res= 9.53 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rcs	Vishay-Bccomponents	PAC100004707FA1000 Series= ?	Res= 470.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	\$0.34	 PAC01 113 mm ²
Rhv1	Yageo	RC1206FR-07180KL Series= ?	Res= 180.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm ²
Rp	Yageo	RC0603FR-073K9L Series= ?	Res= 3.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²
Rprog	Vishay-Dale	CRCW040247K5FKED Series= CRCW...e3	Res= 47.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
T1	Core=TDK , CoilFormer=TDK	Core=B66317G0000X187 , CoilFormer=B66208X1110T001	Lp= 526.0 µH Turns Ratio(Nas)= 8:7 Turns Ratio(Nps)= 57:7 Npri= 57.0 Naux= 8.0 Nsec= 7.0	1	\$0.22	 TDK_B66305 569 mm ²
U1	Texas Instruments	UCC28634DR	Switcher	1	\$0.66	 R-PDSO-G7 55 mm ²



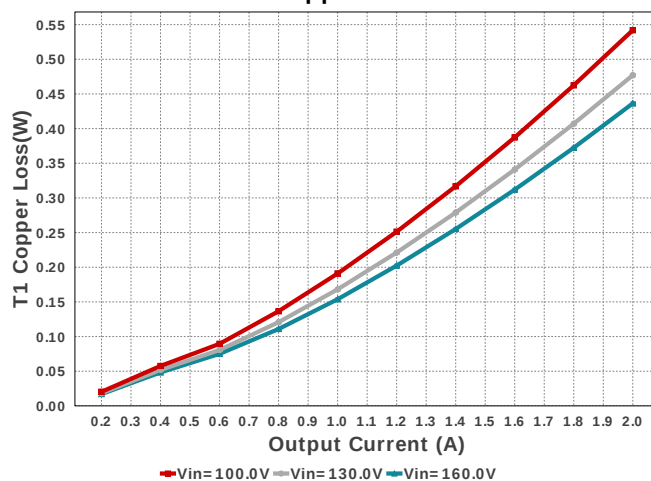




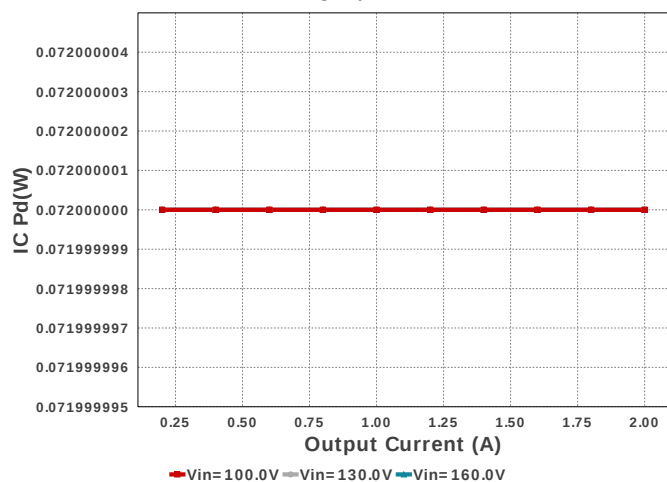
Cout IRMS



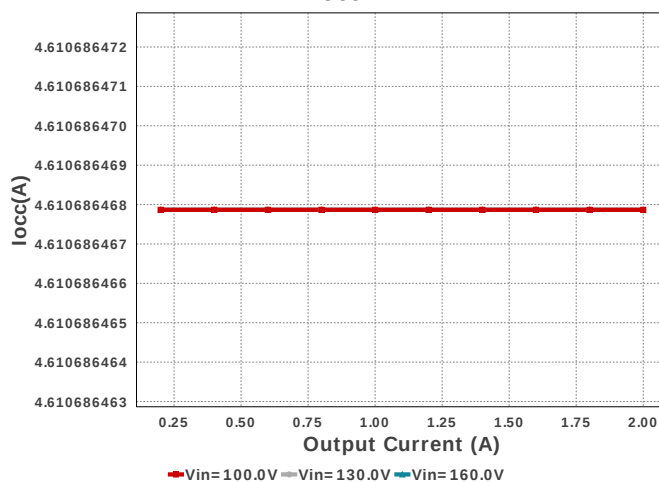
T1 Copper Loss



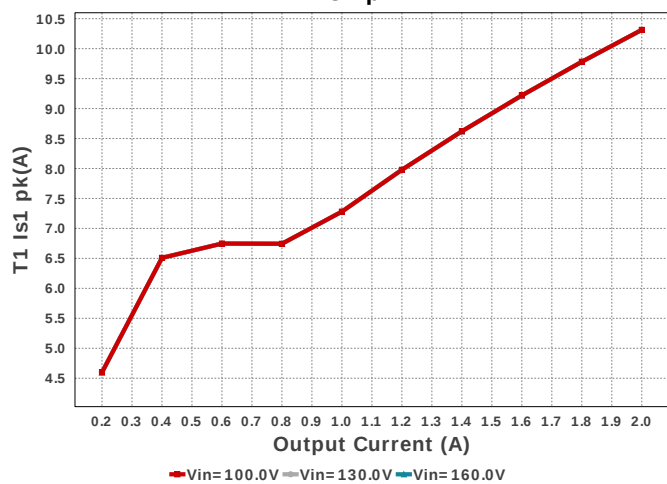
IC Pd



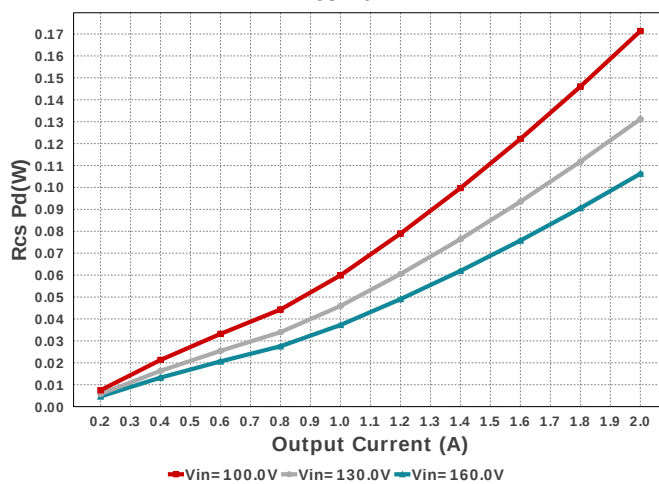
Iocc

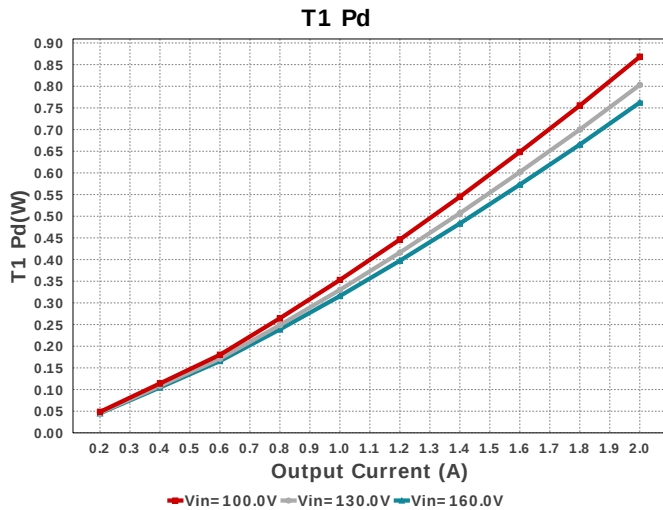


T1 Is1 pk



Rcs Pd





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	203.545 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	58.0 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	3.69 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	102.11 mW	Capacitor	Output capacitor power dissipation
5.	Diode2 Pd	1.02 W	Diode	Diode2 power dissipation
6.	IC Pd	72.0 mW	IC	IC power dissipation
7.	IC Tj	39.252 degC	IC	IC junction temperature
8.	ICThetaJA	128.5 degC/W	IC	IC junction-to-ambient thermal resistance
9.	M1 Pd	572.99 mW	Mosfet	M1 MOSFET total power dissipation
10.	M1 TjOP	41.838 degC	Mosfet	M1 MOSFET junction temperature
11.	Cin Pd	58.0 mW	Power	Input capacitor power dissipation
12.	Cout Pd	102.1 mW	Power	Output capacitor power dissipation
13.	Diode2 Pd	1.02 W	Power	Diode2 power dissipation
14.	IC Pd	72.0 mW	Power	IC power dissipation
15.	M1 Pd	572.66 mW	Power	M1 MOSFET total power dissipation
16.	Rcs Pd	171.36 mW	Power	Current Limit Sense Resistor Power Dissipation
17.	Snubber Pd	534.757 mW	Power	Snubber Power Dissipation
18.	T1 Copper Loss	542.0 mW	Power	Transformer Copper Loss Power Dissipation
19.	T1 Core Loss	326.0 mW	Power	Transformer Core Loss Power Dissipation
20.	T1 Pd	868.0 mW	Power	Estimated Losses in Transformer
21.	Total Pd	3.419 W	Power	Total Power Dissipation
22.	Rcs Pd	171.37 mW	Resistor	Current Limit Sense Resistor Power Dissipation
23.	BOM Count	19	System	Total Design BOM count
24.	Duty Cycle	64.553 %	Information	Duty cycle
25.	Efficiency	87.531 %	Information	Steady state efficiency
26.	FootPrint	1.499 k mm ²	Information	Total Foot Print Area of BOM components
27.	Frequency	60.0 kHz	Information	Switching frequency
28.	Iin rms	274.19 mA	Information	RMS Input Current
29.	Iocc	4.611 A	Information	Constant Current Limit
30.	Iout	2.0 A	Information	Iout operating point
31.	Mode	DCM	Information	Conduction Mode
32.	Pout	24.0 W	Information	Total output power
33.	Total BOM	NA	Information	Total BOM Cost
34.	Vin	100.0 V	Information	Vin operating point
35.	Vout	12.0 V	Information	Operational Output Voltage
36.	Vout p-p	77.351 mV	Information	Peak-to-peak output ripple voltage
37.	T1 Copper Loss	531.71 mW	Transformer	Transformer Copper Loss Power Dissipation
38.	T1 Core Loss	357.0 mW	Transformer	Transformer Core Loss Power Dissipation

#	Name	Value	Category	Description
39.	T1 Iprim RMS	603.821 mA	Transformer	Transformer Primary RMS Current
40.	T1 Iprim pk	1.302 A	Transformer	Transformer Primary Peak Current
41.	T1 Is1 RMS	3.708 A	Transformer	Transformer Secondary1 RMS Current
42.	T1 Is1 pk	10.313 A	Transformer	Transformer Secondary1 Peak Current
43.	T1 Pd	888.71 mW	Transformer	Estimated Losses in Transformer

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	160.0	Maximum input voltage
VinMin	100.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	UCC28634	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 C_{in} and C_{out} , 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

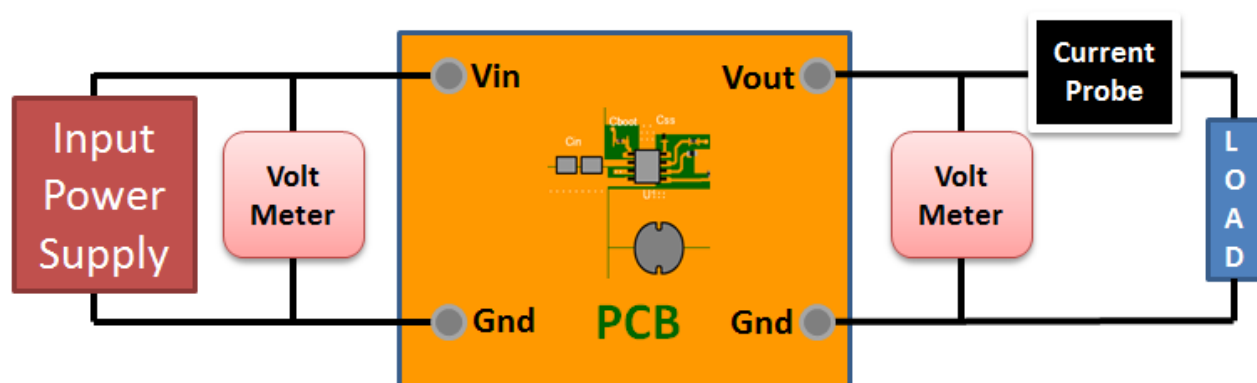
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down 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 100.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to V_{in} and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from V_{out} 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 V_{in} and GND, a load is connected between V_{out} and GND and a current meter is connected in series between V_{out} 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	B66317G0000X187
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66208X1110T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

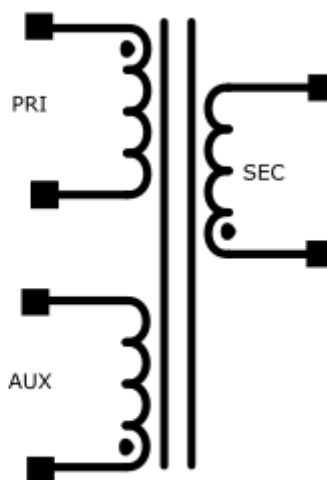
Turns	57.0
AWG	26.0
Layers	2.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Auxiliary

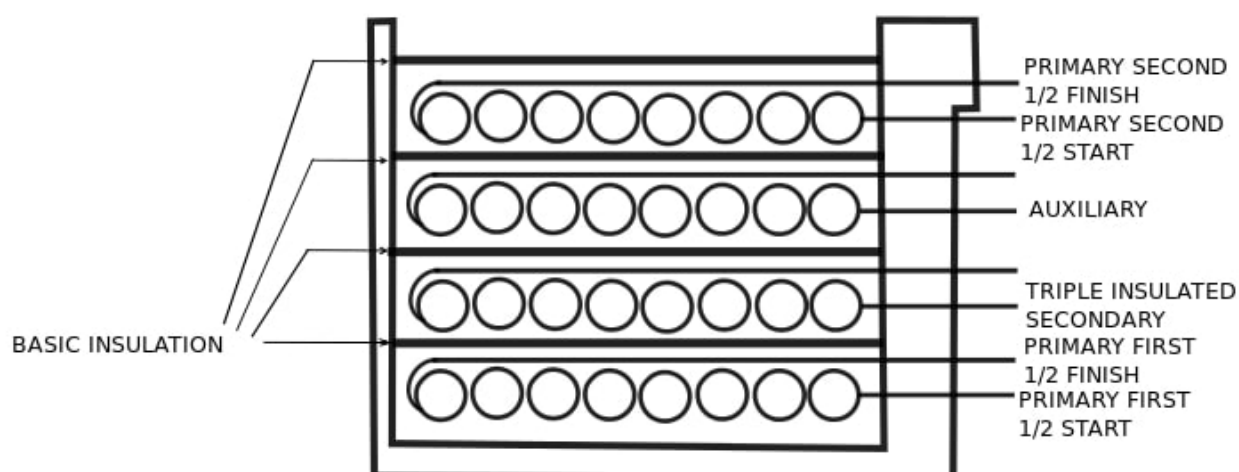
Turns	8.0
AWG	28.0
Layers	1.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	7.0
AWG	27.0
Layers	1.0
Strands	3.0
Insulation Type	Triple Insulated



Transformer Construction Diagram



Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	26.0	29	Clockwise

Winding	AWG	Turns	Winding Orientation
Triple Insulated Secondary	27.0	7.0	Counter Clockwise
Auxiliary	28.0	8.0	Counter Clockwise
Primary Second 1/2.0	26.0	28	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	5.26E-4H
2.	Inductance Factor(AI)	162.0nH
3.	Npri	57.0
4.	Nsec	7.0
5.	Naux	8.0
6.	Core Type	E25/13/7
7.	Core Material	N87
8.	Bmax	0.24T
9.	Switching Frequency	60.00kHz
10.	DMax	0.62
11.	Ipk(Primary)	1.36A
12.	Irms(Primary)	0.62A
13.	Ipk(Secondary)	11.1A
14.	Irms(Secondary)	3.93A

Design Assistance

1. Application Hints High Power Operation The UCC28630 allows a peak power delivery up to 200% the nominal rating with only a modest increase in peak current. The combination of up to 2x frequency increase and 1.25x peak current increase in CCM allows up to 2x peak power delivery capability for a given transformer size. Rbld Rbld is used to set a minimum load for the circuit, so that in standby the output voltage does not float up. The value chosen by WEBENCH should be a good starting point but may need to be adjusted to achieve minimum power dissipation at standby as well. Active X-Cap Discharge The X-capacitor discharge function discharges the X-capacitor to the SELV 60V level in 1 sec. When adjusting the components for the design, ensure that the bulk capacitance value is not too large for the power level desired, which ensures that the bulk capacitor discharge rate is fast enough to discharge the X-capacitor to meet the 1-second discharge target. The VSENSE terminal In order to protect the VSENSE terminal from excessive negative current, an additional series limiting resistor and clamping diode can be added on the VSENSE terminal. The DRV pull up diode can be combined with the clamping diode in a single package common-cathode diode to reduce the component count of the circuit (see Figure 24 in the datasheet for illustration). Magnetic Sense Resistor Network When adjusting components for the design, check that the equivalent Thevenin resistance (Rth) of the R1/R2 falls within the required range of 10kOhm and 20kOhm. If the Rth is outside of this range, it triggers the VSENSE terminal open or short terminal check at start-up. Peak Current Mode Control and the CS Terminal Depending on the PCB layout, an additional RC filter may be required on the CS terminal, as show in Figure 30 of the datasheet. The capacitor, Ccs, should be positioned as close as possible to terminals 3 and 4 and tracked directly to the terminals. Rcs2 should also be located close to terminal 3 to minimize noise, and should not exceed 20kOhms since larger values could be detected as a possible open circuit on the CS terminal during the start-up terminal checks. The time constant for this RC filter should no be excessive so that the filter does not reduce the measured peak current. Typical time values would fall between 100ns and 200ns. Primary-Side Overload Timer An internal overload timer tracks the power stage thermal stress and protects the power stage against output overload. The overload timer trip level and time constant are both selectable from a defined list of combinations (See Table 1 in datasheet for combinations), and is set using a pull-down resistance, Rprog, on the DRV terminal. The values of the Rprog resistor that corresponds to specific trip levels and time constants can also be seen in Table 1 in the datasheet. Please see the datasheet for further design guidance and recommendations. <http://www.ti.com/lit/ds/symlink/ucc28630.pdf>

2. Master key : 3C60701A999C10EB[v1]

3. **UCC28634** Product Folder : <http://www.ti.com/product/UCC28634> : contains the data sheet and other resources.

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