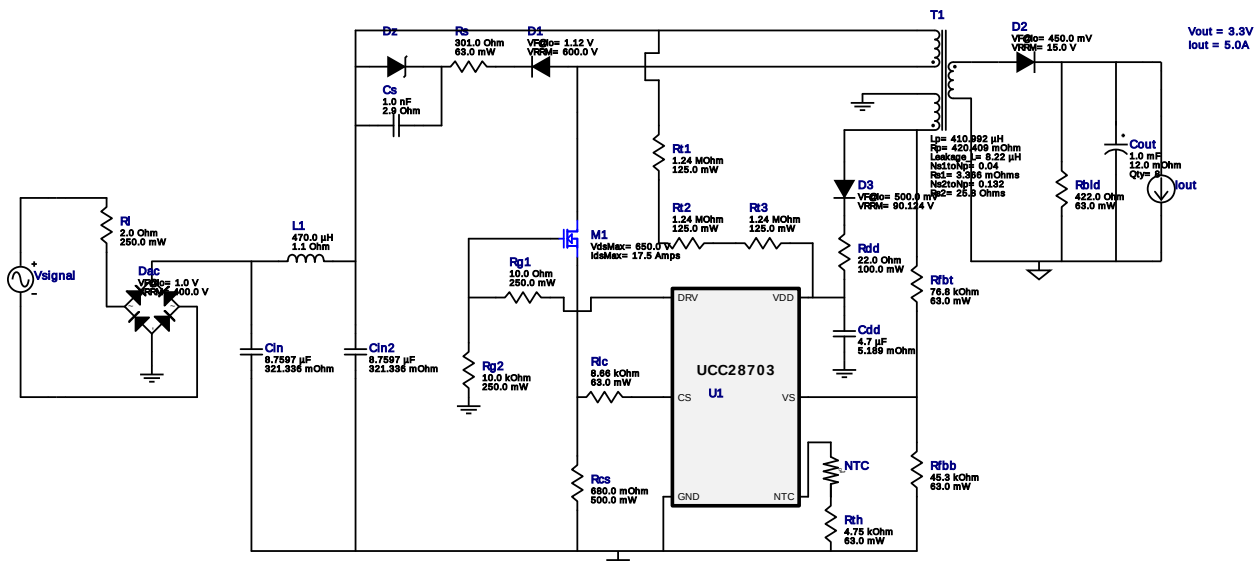


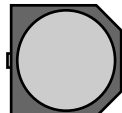
## WEBENCH® Design Report

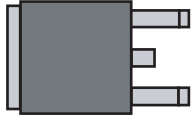
Design : 4755129/5 UCC28703DBVR  
UCC28703DBVR 110.0V-130.0V to 3.30V @ 5.0A



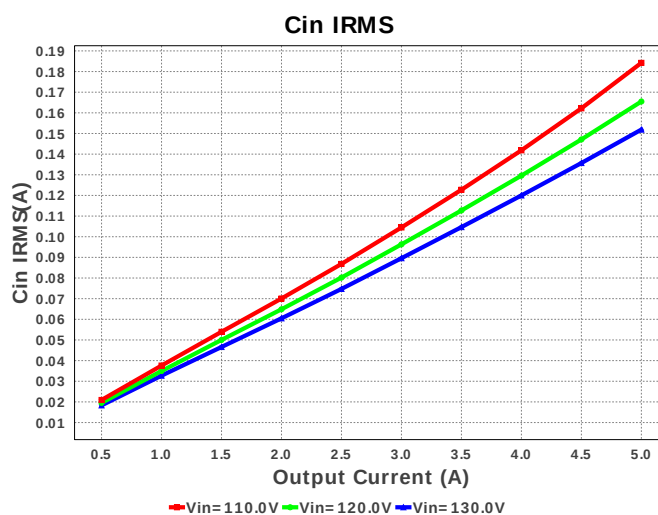
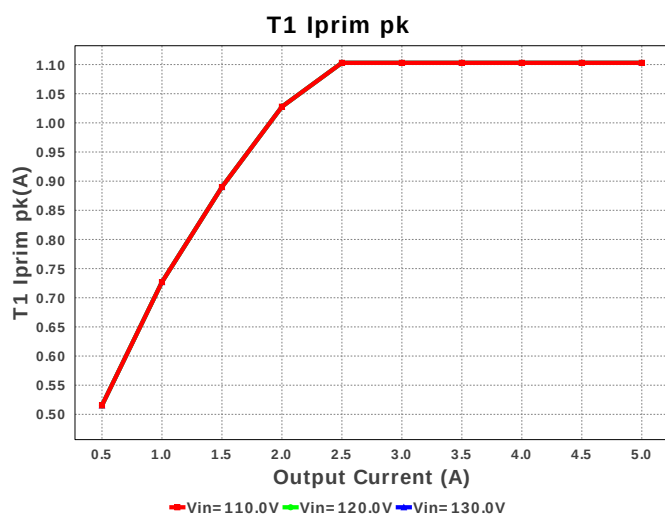
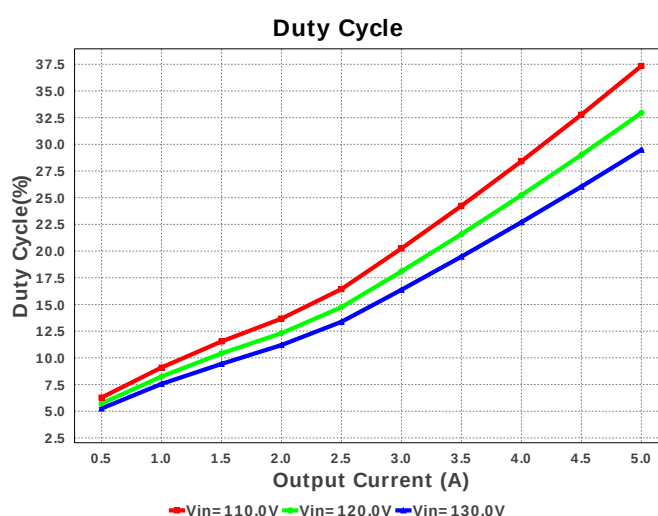
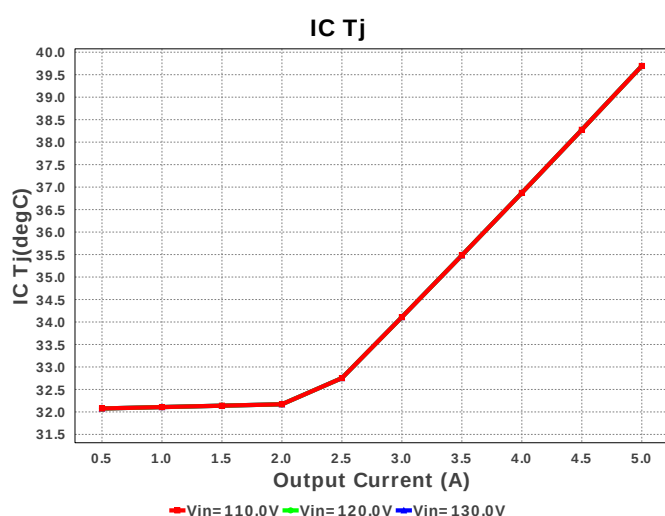
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

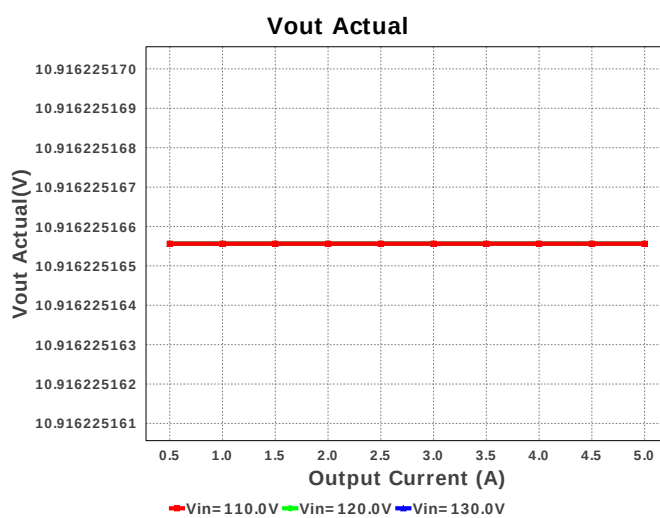
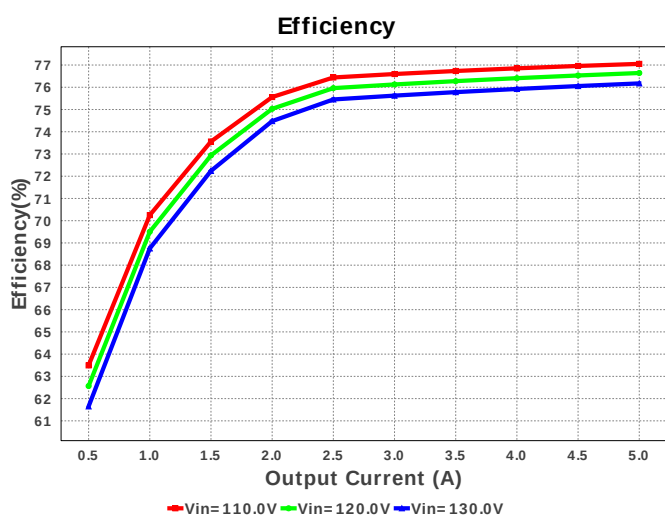
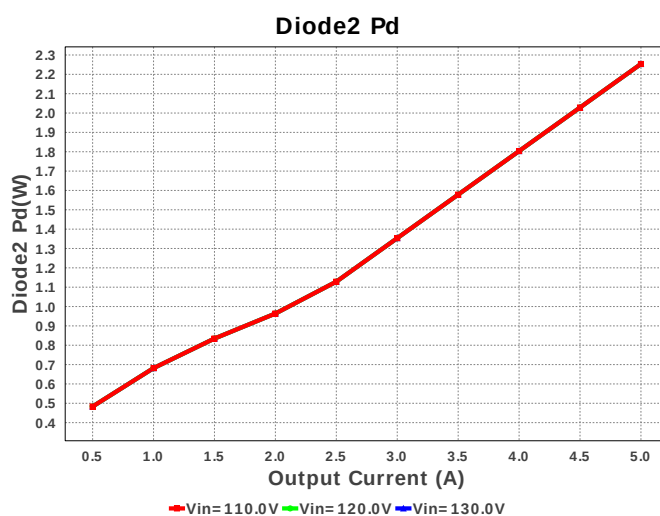
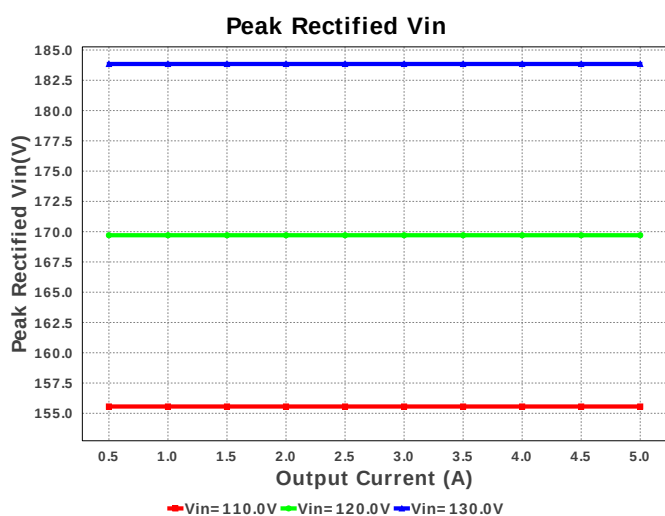
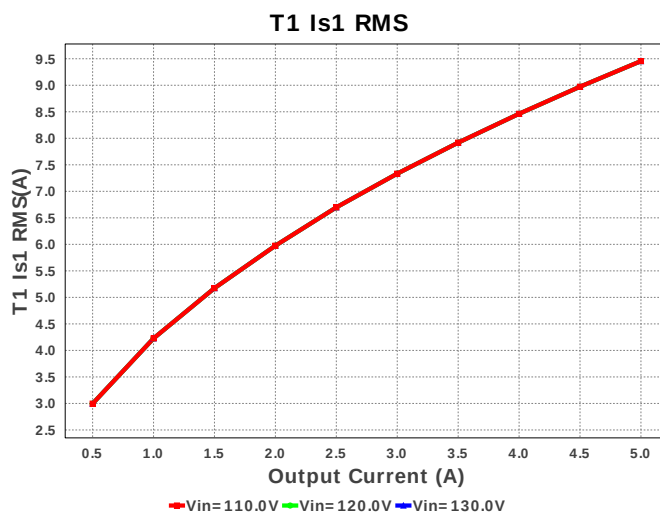
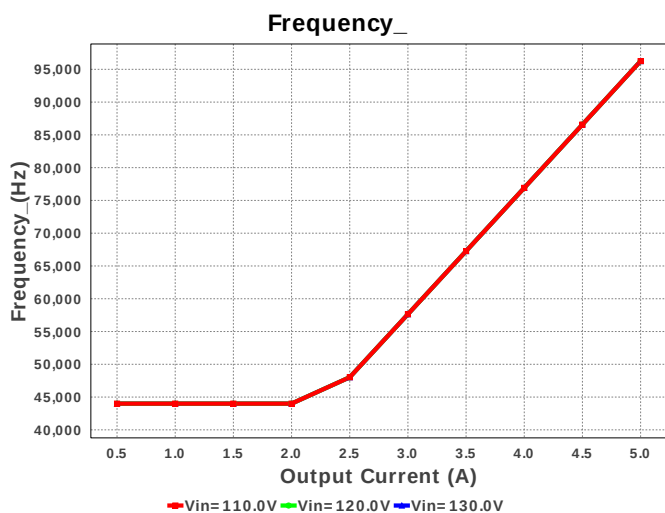
### Electrical BOM

| #  | Name | Manufacturer | Part Number                       | Properties                                                               | Qty | Price  | Footprint                                                                                                                  |
|----|------|--------------|-----------------------------------|--------------------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------------|
| 1. | Cdd  | MuRata       | GRM21BR61E475KA12L<br>Series= X5R | Cap= 4.7 uF<br>ESR= 5.189 mOhm<br>VDC= 25.0 V<br>IRMS= 2.03531 A         | 1   | \$0.02 | 0805 7 mm <sup>2</sup>                                                                                                     |
| 2. | Cin  | CUSTOM       | CUSTOM<br>Series= ?               | Cap= 8.7597 uF<br>ESR= 321.336 mOhm<br>VDC= 275.769 V<br>IRMS= 699.24 mA | 1   | NA     | CUSTOM 0 mm <sup>2</sup>                                                                                                   |
| 3. | Cin2 | CUSTOM       | CUSTOM<br>Series= ?               | Cap= 8.7597 uF<br>ESR= 321.336 mOhm<br>VDC= 275.769 V<br>IRMS= 699.24 mA | 1   | NA     | CUSTOM 0 mm <sup>2</sup>                                                                                                   |
| 4. | Cout | Panasonic    | 16SVPF1000M<br>Series= ?          | Cap= 1.0 mF<br>ESR= 12.0 mOhm<br>VDC= 16.0 V<br>IRMS= 5.4 A              | 8   | \$0.74 | <br>CAPSMT_62_F12 151 mm <sup>2</sup> |
| 5. | Cs   | MuRata       | GRM188R72E102KW07D<br>Series= X7R | Cap= 1.0 nF<br>ESR= 2.9 Ohm<br>VDC= 250.0 V<br>IRMS= 90.0 mA             | 1   | \$0.01 | 0603 5 mm <sup>2</sup>                                                                                                     |
| 6. | D1   | Bourns       | CD214C-F3600                      | VF@Io= 1.12 V<br>VRRM= 600.0 V                                           | 1   | \$0.18 | <br>SMC 83 mm <sup>2</sup>            |

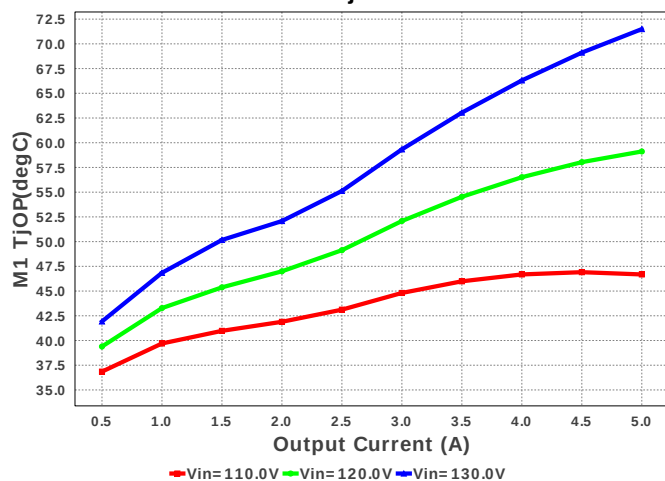
| #   | Name | Manufacturer          | Part Number                          | Properties                                            | Qty | Price  | Footprint                                                                                                         |
|-----|------|-----------------------|--------------------------------------|-------------------------------------------------------|-----|--------|-------------------------------------------------------------------------------------------------------------------|
| 7.  | D2   | ON Semiconductor      | MBRB2515LT4G                         | VF@Io= 450.0 mV<br>VRRM= 15.0 V                       | 1   | \$1.00 | <br>DDPAK 210 mm <sup>2</sup>  |
| 8.  | D3   | CUSTOM                | CUSTOM                               | VF@Io= 500.0 mV<br>VRRM= 90.124 V                     | 1   | NA     | CUSTOM 0 mm <sup>2</sup>                                                                                          |
| 9.  | Dac  | Diodes Inc.           | HD04-T                               | VF@Io= 1.0 V<br>VRRM= 400.0 V                         | 1   | \$0.12 | <br>MiniDIP 62 mm <sup>2</sup> |
| 10. | Dz   | ON Semiconductor      | MMBZ5270BLT1G                        | Zener                                                 | 1   | \$0.03 | <br>SOT-23 14 mm <sup>2</sup>  |
| 11. | L1   | Bourns                | SRR7045-471M                         | L= 470.0 µH<br>DCR= 1.1 Ohm                           | 1   | \$0.26 | <br>SRR7045 81 mm <sup>2</sup> |
| 12. | M1   | Infineon Technologies | IPP65R190CFD                         | VdsMax= 650.0 V<br>IdsMax= 17.5 Amps                  | 1   | \$2.34 | TO-220 0 mm <sup>2</sup>                                                                                          |
| 13. | Rbld | Vishay-Dale           | CRCW0402422RFKED<br>Series= CRCW..e3 | Res= 422.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>     |
| 14. | Rcs  | Rohm                  | MCR25JZHFLR680<br>Series= MCR25      | Res= 680.0 mOhm<br>Power= 500.0 mW<br>Tolerance= 1.0% | 1   | \$0.03 | <br>1210 15 mm <sup>2</sup>    |
| 15. | Rdd  | Yageo America         | RC0603FR-0722RL<br>Series= ?         | Res= 22.0 Ohm<br>Power= 100.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0603 5 mm <sup>2</sup>    |
| 16. | Rfbb | Vishay-Dale           | CRCW040245K3FKED<br>Series= CRCW..e3 | Res= 45.3 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>   |
| 17. | Rfbt | Vishay-Dale           | CRCW040276K8FKED<br>Series= CRCW..e3 | Res= 76.8 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>   |
| 18. | Rg1  | Panasonic             | ERJ-8ENF10R0V<br>Series= ERJ-8E      | Res= 10.0 Ohm<br>Power= 250.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>1206 11 mm <sup>2</sup>  |
| 19. | Rg2  | Panasonic             | ERJ-8ENF1002V<br>Series= ERJ-8E      | Res= 10.0 kOhm<br>Power= 250.0 mW<br>Tolerance= 1.0%  | 1   | \$0.01 | <br>1206 11 mm <sup>2</sup>  |
| 20. | RI   | Vishay-Dale           | CRCW12062R00FKEA<br>Series= CRCW..e3 | Res= 2.0 Ohm<br>Power= 250.0 mW<br>Tolerance= 1.0%    | 1   | \$0.01 | <br>1206 11 mm <sup>2</sup>  |
| 21. | Rlc  | Vishay-Dale           | CRCW04028K66FKED<br>Series= CRCW..e3 | Res= 8.66 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>   |
| 22. | Rs   | Vishay-Dale           | CRCW0402301RFKED<br>Series= CRCW..e3 | Res= 301.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>   |
| 23. | Rt1  | Vishay-Dale           | CRCW08051M24FKEA<br>Series= CRCW..e3 | Res= 1.24 MOhm<br>Power= 125.0 mW<br>Tolerance= 1.0%  | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>   |
| 24. | Rt2  | Vishay-Dale           | CRCW08051M24FKEA<br>Series= CRCW..e3 | Res= 1.24 MOhm<br>Power= 125.0 mW<br>Tolerance= 1.0%  | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>   |
| 25. | Rt3  | Vishay-Dale           | CRCW08051M24FKEA<br>Series= CRCW..e3 | Res= 1.24 MOhm<br>Power= 125.0 mW<br>Tolerance= 1.0%  | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>   |
| 26. | Rth  | Vishay-Dale           | CRCW04024K75FKED<br>Series= CRCW..e3 | Res= 4.75 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%   | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>   |

| #   | Name | Manufacturer      | Part Number  | Properties                                                                                                                                  | Qty | Price  | Footprint                                                                                                       |
|-----|------|-------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------------------|
| 27. | T1   | CUSTOM            | CUSTOM       | Lp= 410.992 $\mu$ H<br>Rp= 420.409 mOhm<br>Leakage_L= 8.22 $\mu$ H<br>Ns1toNp= 0.04<br>Rs1= 3.366 mOhms<br>Ns2toNp= 0.132<br>Rs2= 25.8 Ohms | 1   | NA     | CUSTOM 0 mm <sup>2</sup>                                                                                        |
| 28. | U1   | Texas Instruments | UCC28703DBVR | Switcher                                                                                                                                    | 1   | \$0.35 |  SOT-23-6 15 mm <sup>2</sup> |

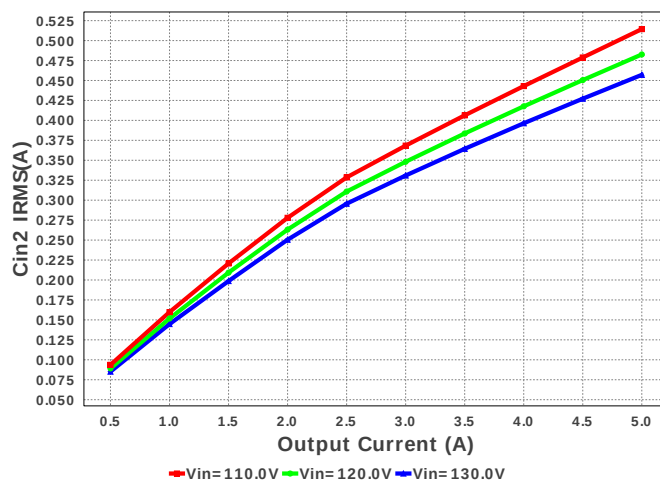




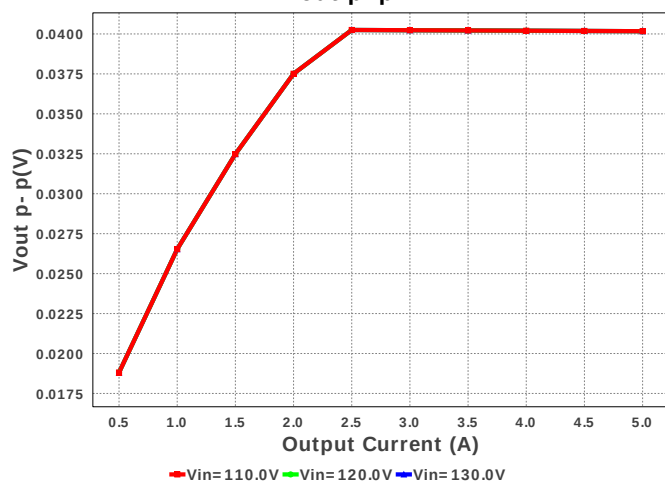
M1 TjOP



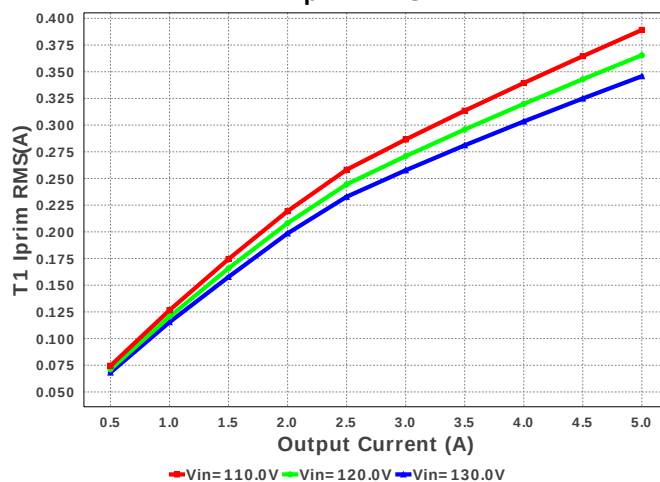
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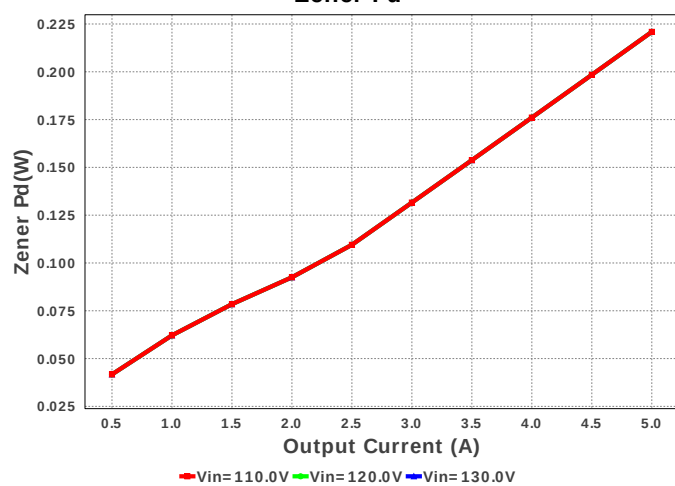
Vout p- p



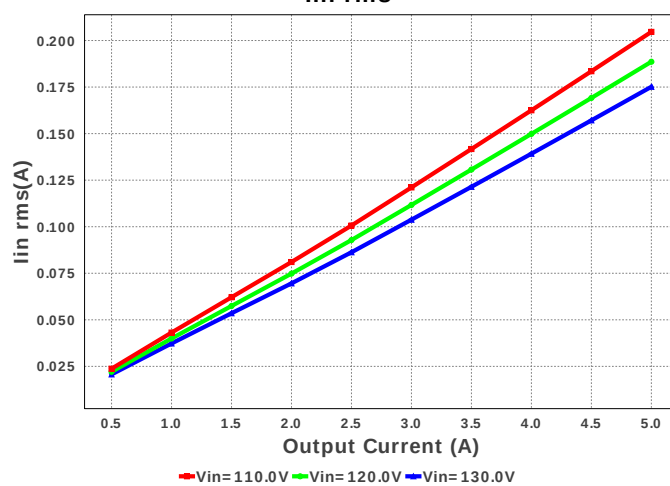
T1 Iprim RMS

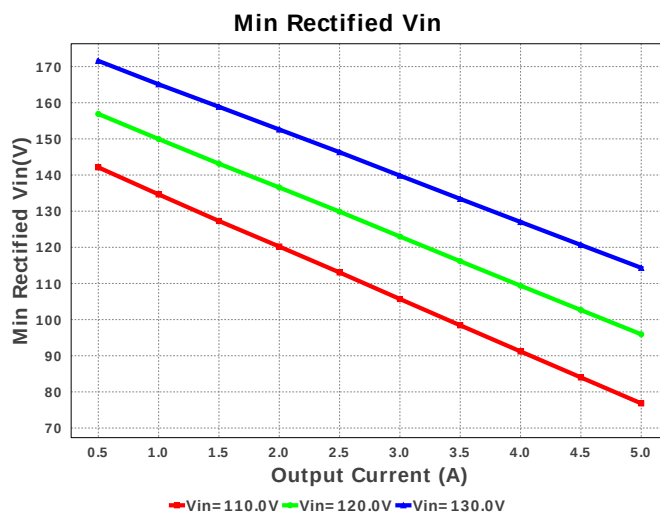
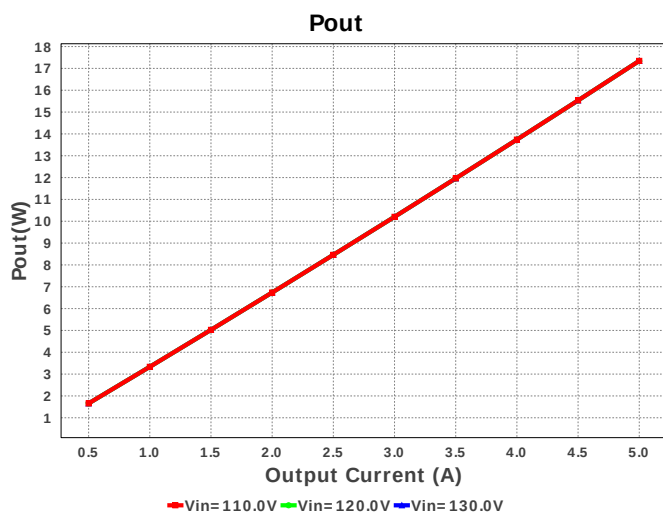
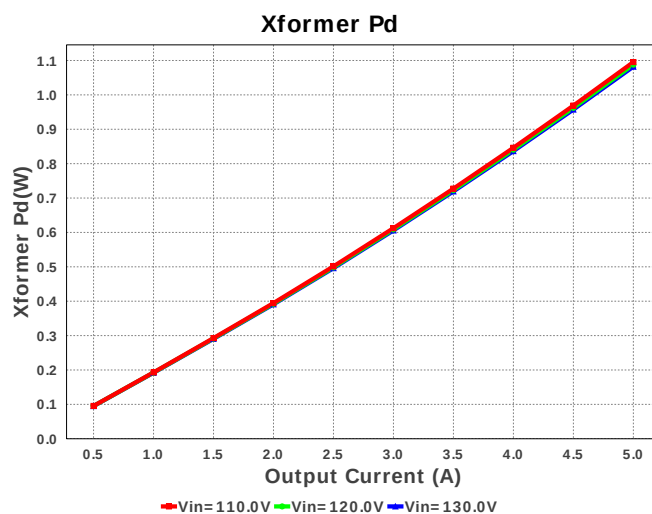
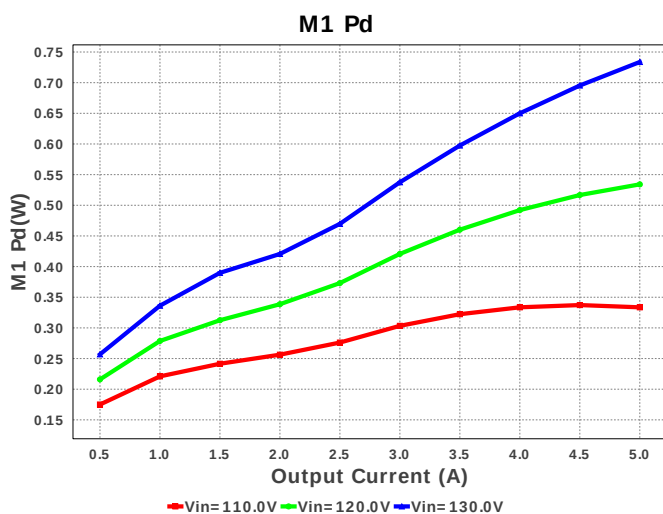
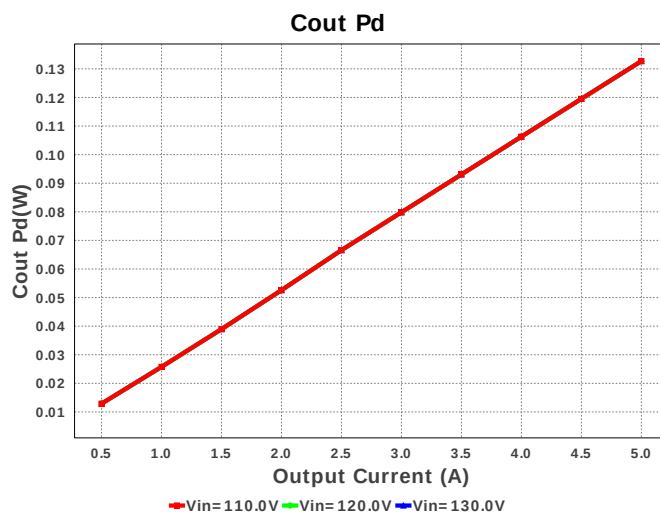
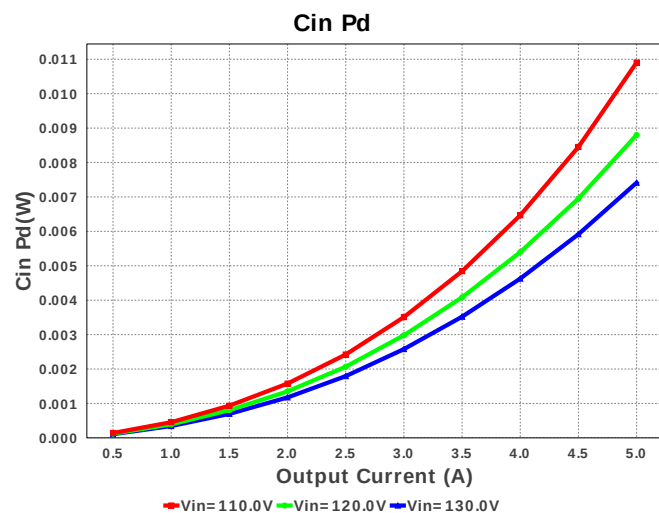


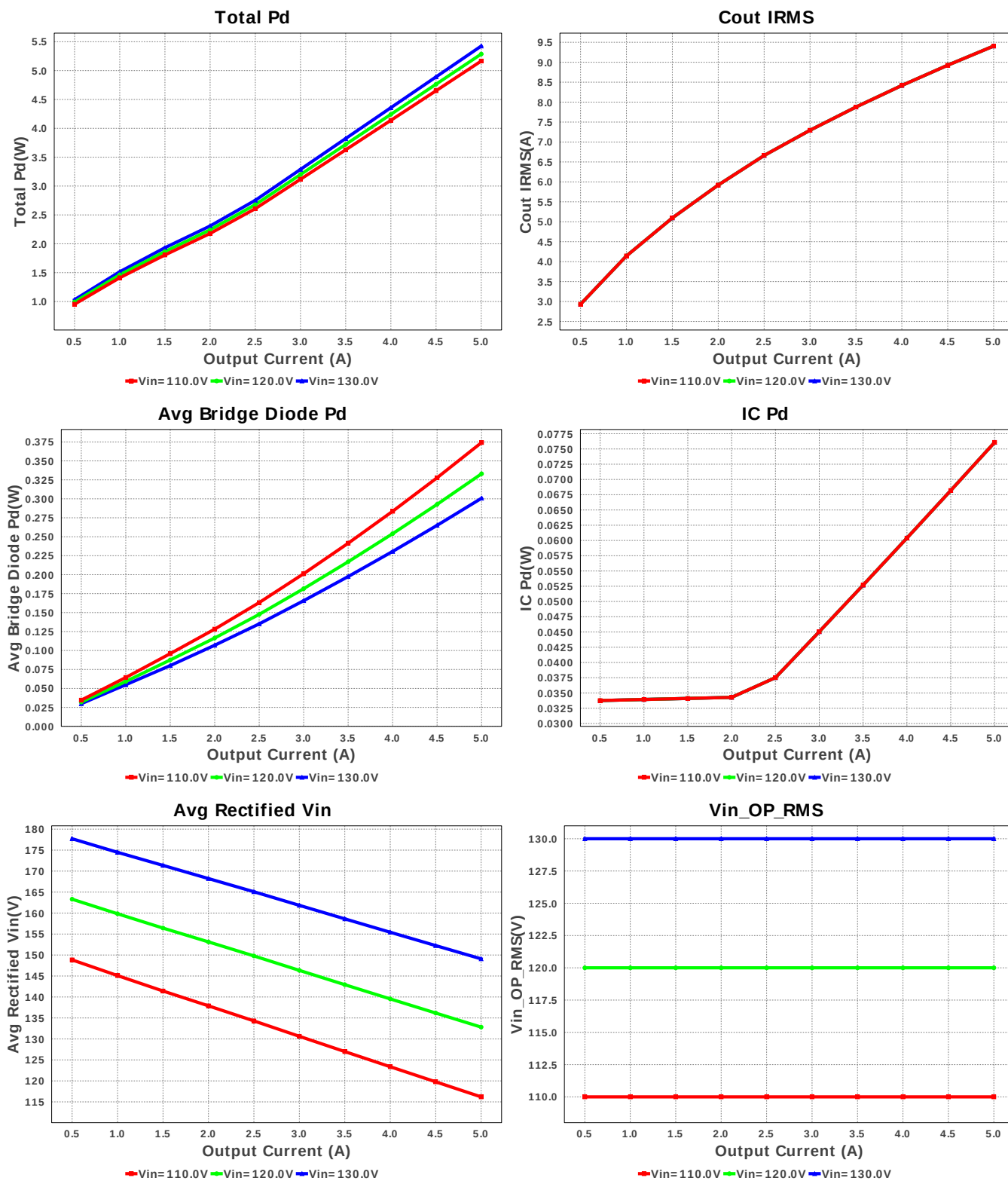
Zener Pd



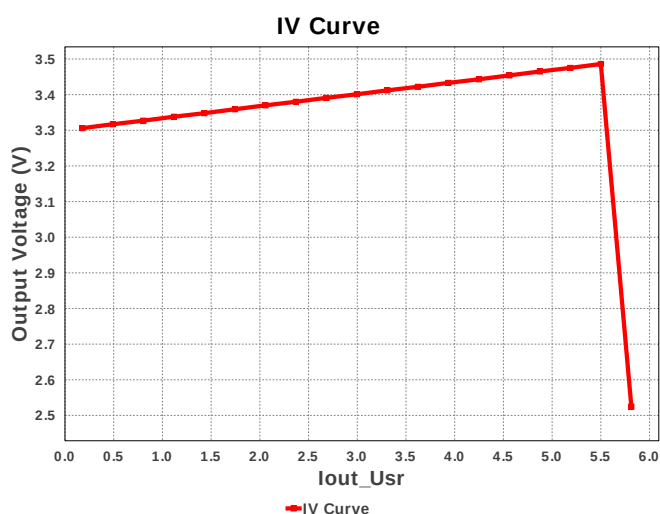
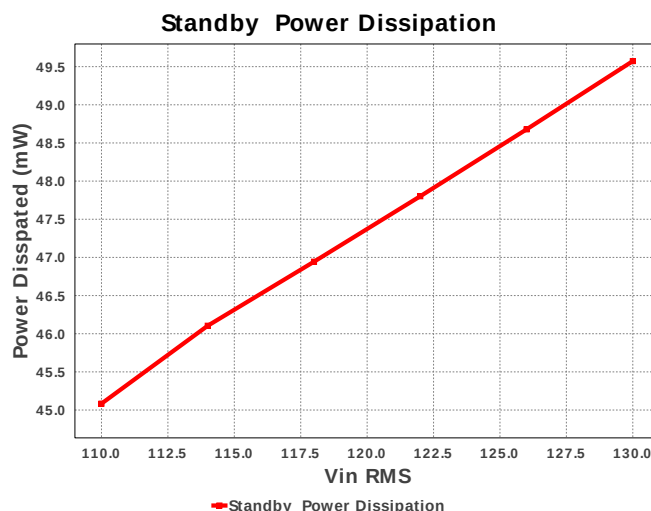
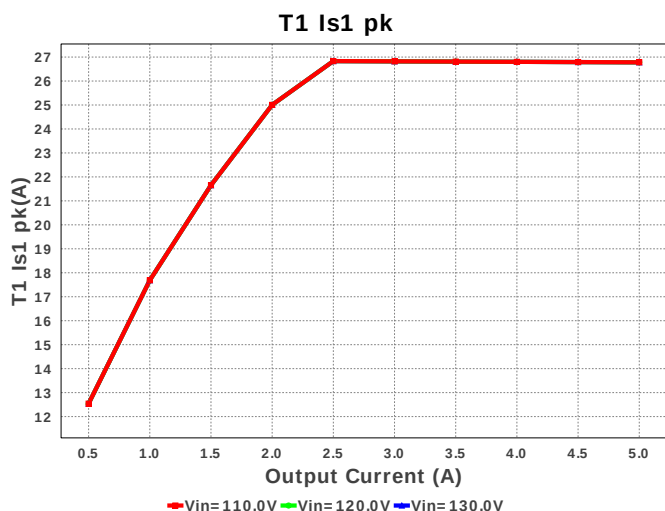
lin rms











## Operating Values

| #   | Name                | Value                   | Category | Description                                                           |
|-----|---------------------|-------------------------|----------|-----------------------------------------------------------------------|
| 1.  | Cin IRMS            | 141.283 mA              | Current  | Input capacitor RMS ripple current                                    |
| 2.  | Cin2 IRMS           | 433.618 mA              | Current  | Input Capacitor Cin2 RMS Ripple Current                               |
| 3.  | Cout IRMS           | 9.448 A                 | Current  | Output capacitor RMS ripple current                                   |
| 4.  | Iin rms             | 163.79 mA               | Current  | RMS Input Current                                                     |
| 5.  | T1 Iprim RMS        | 326.187 mA              | Current  | Transformer Primary RMS Current                                       |
| 6.  | T1 Iprim pk         | 1.103 A                 | Current  | Transformer Primary Peak Current                                      |
| 7.  | T1 Is1 RMS          | 9.498 A                 | Current  | Transformer Secondary1 RMS Current                                    |
| 8.  | T1 Is1 pk           | 27.022 A                | Current  | Transformer Secondary1 Peak Current                                   |
| 9.  | Avg Rectified Vin   | 157.131 V               | General  | Average Rectified Voltage for the AC Line Period                      |
| 10. | BOM Count           | 36                      | General  | Total Design BOM count                                                |
| 11. | FootPrint           | 2.053 k mm <sup>2</sup> | General  | Total Foot Print Area of BOM components                               |
| 12. | Pout                | 17.345 W                | General  | Total output power                                                    |
| 13. | Total BOM           | \$0.0                   | General  | Total BOM Cost                                                        |
| 14. | Vout Actual         | 10.916 V                | Op_Point | Vout Actual calculated based on selected voltage divider resistors    |
| 15. | Vout OP             | 3.469 V                 | Op_Point | Operational Output Voltage                                            |
| 16. | Duty Cycle          | 26.239 %                | Op_point | Duty cycle                                                            |
| 17. | Efficiency          | 81.461 %                | Op_point | Steady state efficiency                                               |
| 18. | Frequency           | 89.802 kHz              | Op_point | Switching frequency                                                   |
| 19. | IC Tj               | 30.973 degC             | Op_point | IC junction temperature                                               |
| 20. | ICThetaJA           | 70.0 degC/W             | Op_point | IC junction-to-ambient thermal resistance                             |
| 21. | IOUT_OP             | 5.0 A                   | Op_point | Iout operating point                                                  |
| 22. | M1 TJOP             | 77.235 degC             | Op_point | M1 MOSFET junction temperature                                        |
| 23. | Min Rectified Vin   | 130.415 V               | Op_point | Minimum voltage seen at rectified input                               |
| 24. | Peak Rectified Vin  | 183.846 V               | Op_point | Peak voltage seen at rectified input                                  |
| 25. | Vin_OP_RMS          | 130.0 V                 | Op_point | AC Input RMS Voltage                                                  |
| 26. | Vout p-p            | 40.533 mV               | Op_point | Peak-to-peak output ripple voltage                                    |
| 27. | Avg Bridge Diode Pd | 196.663 mW              | Power    | Average Power Dissipation in the Bridge Diode over the AC Line Period |
| 28. | Cin Pd              | 6.414 mW                | Power    | Input capacitor power dissipation                                     |
| 29. | Cout Pd             | 133.91 mW               | Power    | Output capacitor power dissipation                                    |
| 30. | Diode2 Pd           | 1.292 W                 | Power    | Diode2 power dissipation                                              |
| 31. | IC Pd               | 71.044 mW               | Power    | IC power dissipation                                                  |



| #   | Name           | Value      | Category | Description                                                                                |
|-----|----------------|------------|----------|--------------------------------------------------------------------------------------------|
| 32. | M1 Pd          | 826.373 mW | Power    | M1 MOSFET total power dissipation                                                          |
| 33. | Total Pd       | 3.947 W    | Power    | Total Power Dissipation                                                                    |
| 34. | Xformer Pd     | 1.034 W    | Power    | Transformer power dissipation                                                              |
| 35. | Zener Pd       | 55.846 mW  | Power    | Zener power dissipation                                                                    |
| 36. | Vout Tolerance | 1.471 %    |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name     | Value    | Description            |
|----|----------|----------|------------------------|
| 1. | Iout     | 5.0      | Maximum Output Current |
| 2. | VinMax   | 130.0    | Maximum input voltage  |
| 3. | VinMin   | 110.0    | Minimum input voltage  |
| 4. | Vout     | 3.3      | Output Voltage         |
| 5. | line_fsw | 60.0     | Light Output in Lumen  |
| 6. | base_pn  | UCC28703 | Base Product Number    |
| 7. | source   | AC       | Input Source Type      |
| 8. | Ta       | 26.0     | Ambient temperature    |

## Design Assistance

1. Application Hints 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. Rlc Rlc provides the function of feed-forward line compensation to eliminate change in IPP due to change in di/dt and the propagation delay of the internal comparator and MOSFET turn-off time. For best results the chosen value may need to be adjusted based on board, FET and transformer parasitics. Rfbt & Rfbb The feedback resistors will set the output voltage of the circuit. The values chosen may need to be fine tuned based on the final Transformer turns ratios and the voltage across the output diode at close to zero current. Cdd Cdd supplies the device operating current until the output of the converter reaches the target minimum operating voltage. The value calculated by WEBENCH for Cdd is a good starting point since it assumes that the output current of the Flyback is available to charge the output capacitance until the minimum output voltage is achieved, but may need to be adjusted. Part Description The UCC28700 family of flyback power supply controllers provides Constant-Voltage (CV) and Constant-Current (CC) output regulation. Primary-Side Regulation (PSR) eliminates the use of an Opto-Coupler. Please see the datasheet for further design guidance. <http://www.ti.com/lit/ds/symlink/ucc28700.pdf>

2. **UCC28703 Product Folder** : <http://www.ti.com/product/UCC28703> : contains the data sheet and other resources.

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