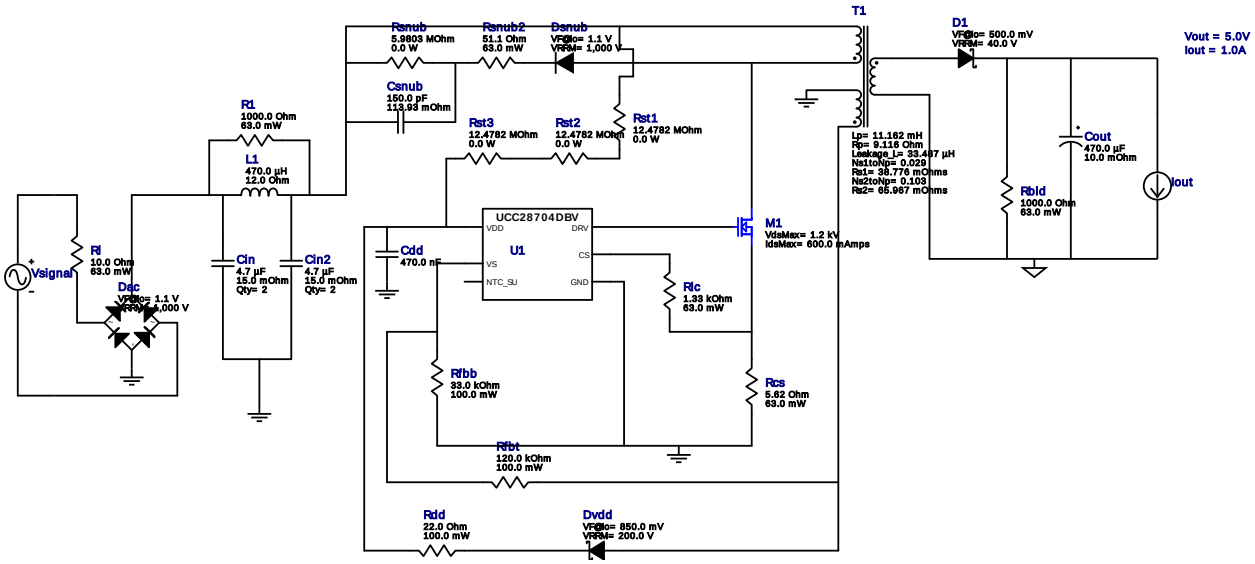
VinMin = 220.0V
VinMax = 330.0V
Vout = 5.0V
Iout = 1.0A

Device = UCC28704DBVR-1
Topology = Flyback
Created = 8/9/16 2:10:20 AM
BOM Cost = $0.00
BOM Count = 28
Total Pd = 1.02W

# WEBENCH® Design Report

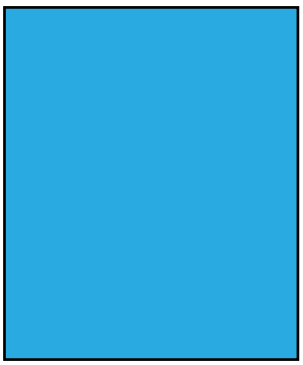
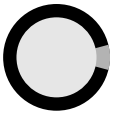
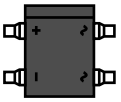
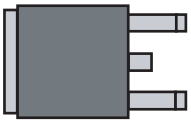
Design : 4352199/81 UCC28704DBVR-1
UCC28704DBVR-1 220.0V-330.0V to 5.66V @ 1.0A



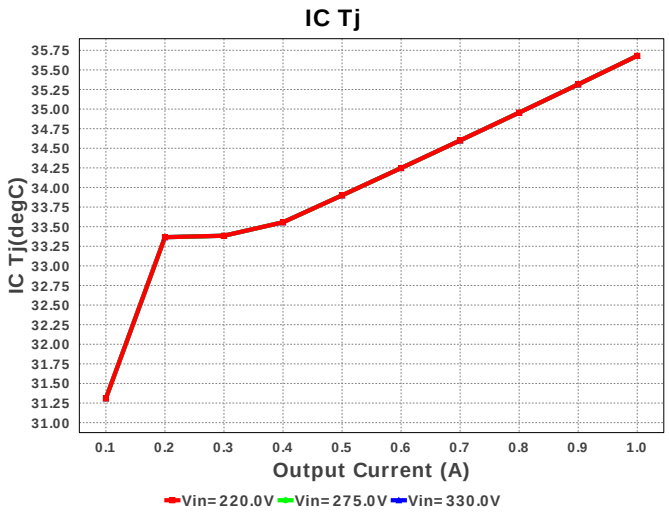

1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

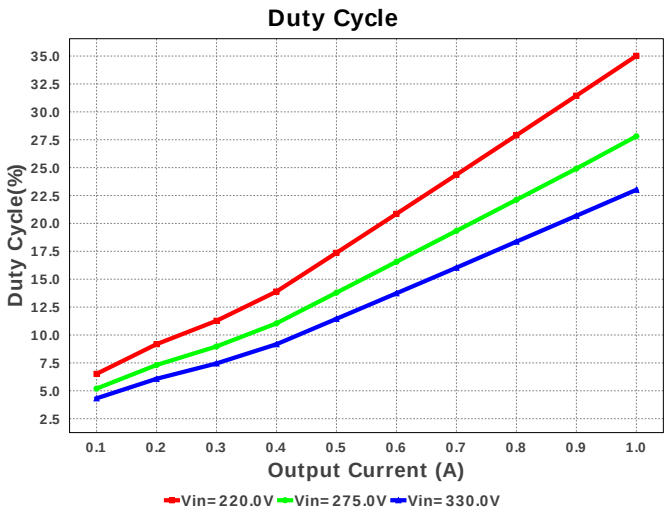
## Electrical BOM

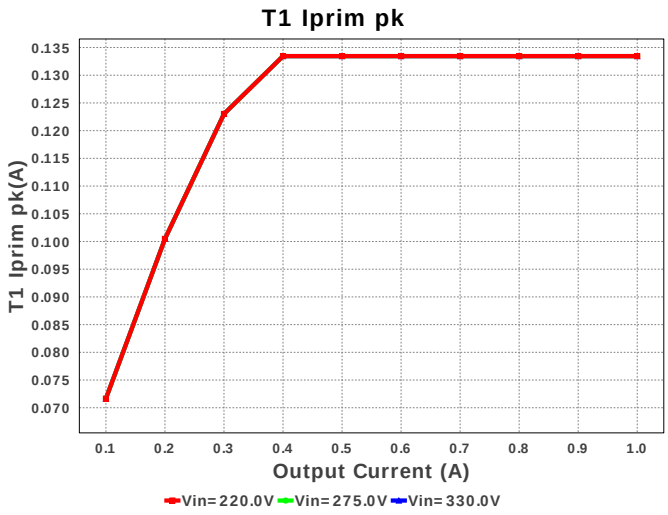
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cdd | Taiyo Yuden | TMK212BJ474KD-T<br>Series= X5R | Cap= 470.0 nF<br>VDC= 20.0 V<br>IRMS= 0.0 A | 1 | $0.02 | 0805 7 mm$^2$ |
| 2. | Cin | TDK | B32924C3475M<br>Series= B32924 | Cap= 4.7 uF<br>ESR= 15.0 mOhm<br>VDC= 630.0 V<br>IRMS= 457.0 mA | 2 | $1.11 | B32924_33mm 670 mm$^2$ |

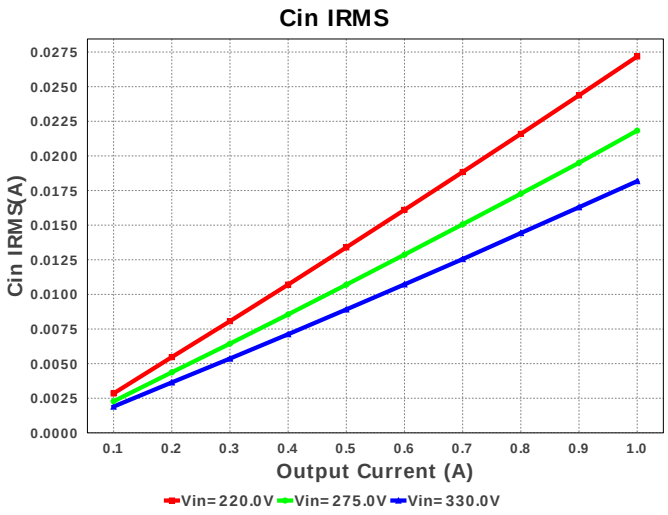
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 3. | Cin2 | TDK | B32924C3475M<br>Series= B32924 | Cap= 4.7 uF<br>ESR= 15.0 mOhm<br>VDC= 630.0 V<br>IRMS= 457.0 mA | 2 | $1.11 |  <br>B32924_33mm 670 mm$^2$ |
| 4. | Cout | Nichicon | RNU1C471MDN1PH<br>Series= ? | Cap= 470.0 uF<br>ESR= 10.0 mOhm<br>VDC= 16.0 V<br>IRMS= 6.1 A | 1 | $0.52 |  <br>NU_1000x1250 144 mm$^2$ |
| 5. | Csnub | TDK | C3216CH2J151J<br>Series= CH | Cap= 150.0 pF<br>ESR= 113.93 mOhm<br>VDC= 630.0 V<br>IRMS= 0.0 A | 1 | $0.03 |  <br>1206 11 mm$^2$ |
| 6. | D1 | Diodes Inc. | B340A-13-F | VF@Io= 500.0 mV<br>VRRM= 40.0 V | 1 | $0.11 |  <br>SMA 37 mm$^2$ |
| 7. | Dac | Vishay-Semiconductor | DF10SA | VF@Io= 1.1 V<br>VRRM= 1,000.0 V | 1 | $0.24 |  <br>DF-S 99 mm$^2$ |
| 8. | Dsnub | Fairchild Semiconductor | 1N4007 | VF@Io= 1.1 V<br>VRRM= 1,000.0 V | 1 | $0.03 |  <br>DO-41 43 mm$^2$ |
| 9. | Dvdd | Diodes Inc. | DFLS1200-7 | VF@Io= 850.0 mV<br>VRRM= 200.0 V | 1 | $0.21 |  <br>PowerDI123 13 mm$^2$ |
| 10. | L1 | NIC Components | NPI32C471MTRF | L= 470.0 µH<br>DCR= 12.0 Ohm | 1 | $0.08 |  <br>IND_NPI32C 21 mm$^2$ |
| 11. | M1 | IXYS | IXTA06N120P | VdsMax= 1.2 kV<br>IdsMax= 600.0 mAmps | 1 | $1.43 |  <br>DDPAK 210 mm$^2$ |
| 12. | R1 | Vishay-Dale | CRCW04021K00FKED<br>Series= CRCW..e3 | Res= 1000.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm$^2$ |
| 13. | Rbld | Vishay-Dale | CRCW04021K00FKED<br>Series= CRCW..e3 | Res= 1000.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm$^2$ |
| 14. | Rcs | Vishay-Dale | CRCW04025R62FKED<br>Series= CRCW..e3 | Res= 5.62 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm$^2$ |
| 15. | Rdd | Yageo America | RC0603FR-0722RL<br>Series= ? | Res= 22.0 Ohm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0603 5 mm$^2$ |
| 16. | Rfbb | Yageo America | RC0603FR-0733KL<br>Series= ? | Res= 33.0 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0603 5 mm$^2$ |
| 17. | Rfbt | Yageo America | RC0603FR-07120KL<br>Series= ? | Res= 120.0 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0603 5 mm$^2$ |

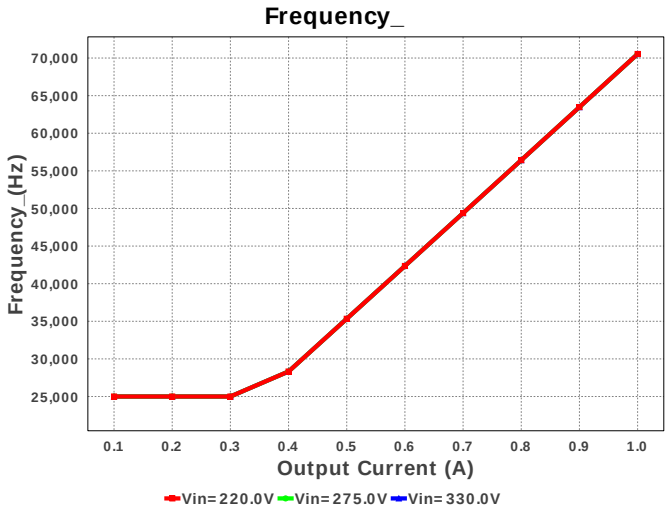
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 18. | Rl | Vishay-Dale | CRCW040210R0FKED<br>Series= CRCW..e3 | Res= 10.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 19. | Rlc | Vishay-Dale | CRCW04021K33FKED<br>Series= CRCW..e3 | Res= 1.33 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 20. | Rsnub | CUSTOM | CUSTOM<br>Series= ? | Res= 5.9803 MOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 21. | Rsnub2 | Vishay-Dale | CRCW040251R1FKED<br>Series= CRCW..e3 | Res= 51.1 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 22. | Rst1 | CUSTOM | CUSTOM<br>Series= ? | Res= 12.4782 MOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 23. | Rst2 | CUSTOM | CUSTOM<br>Series= ? | Res= 12.4782 MOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 24. | Rst3 | CUSTOM | CUSTOM<br>Series= ? | Res= 12.4782 MOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 25. | T1 | CUSTOM | CUSTOM | Lp= 11.162 mH<br>Rp= 9.116 Ohm<br>Leakage_L= 33.487 µH<br>Ns1toNp= 0.029<br>Rs1= 38.776 mOhms<br>Ns2toNp= 0.103<br>Rs2= 65.967 mOhms | 1 | NA | CUSTOM 0 mm² |
| 26. | U1 | Texas Instruments | UCC28704DBVR-1 | Switcher | 1 | $0.30 | SOT-23-6 15 mm² |

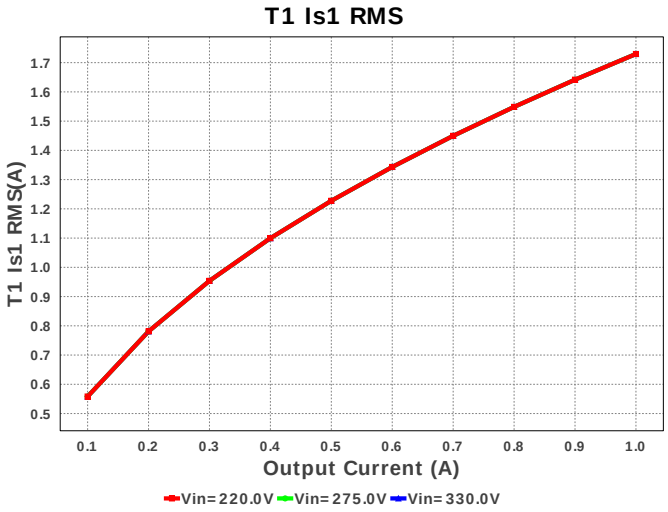


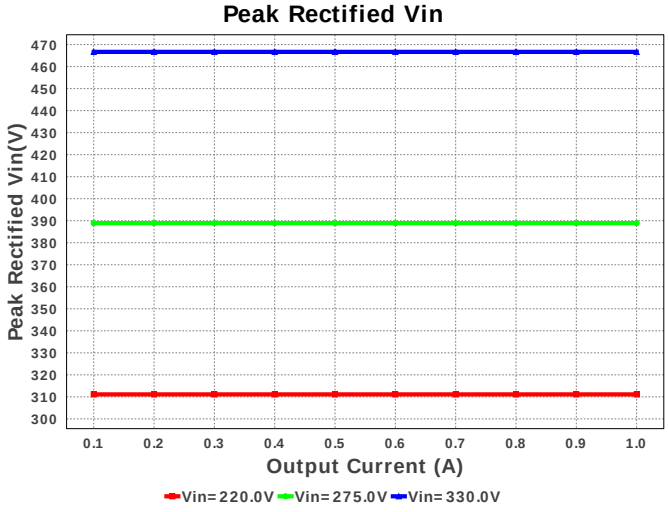



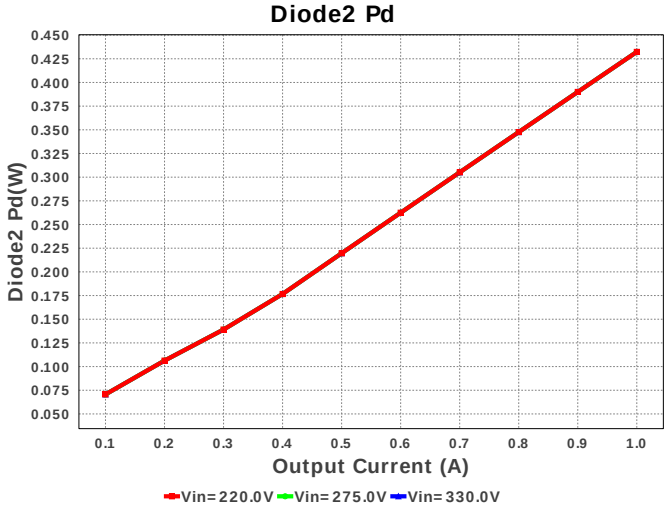


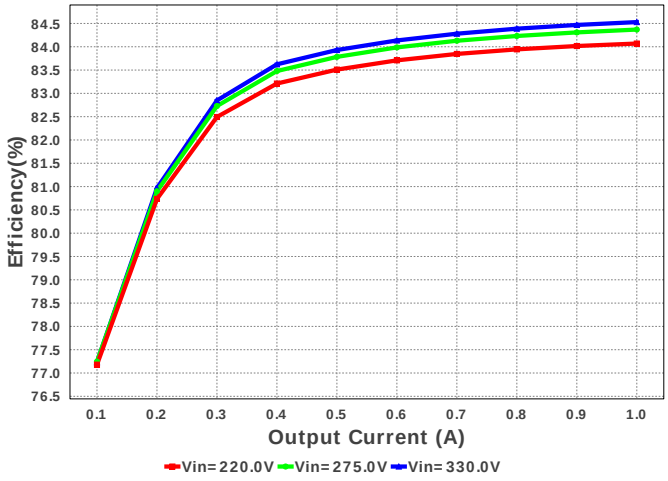



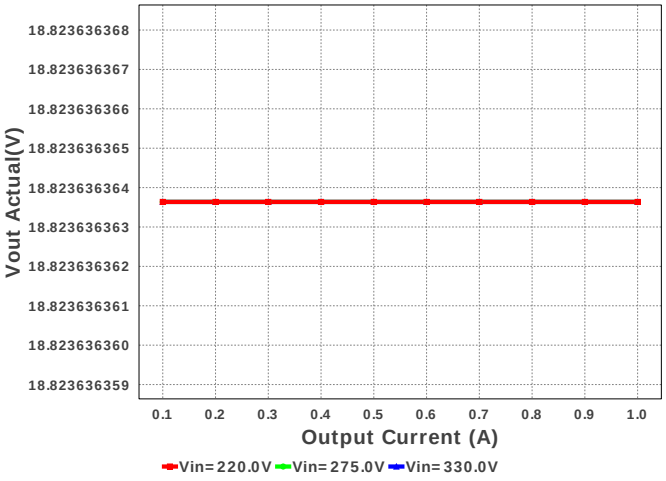



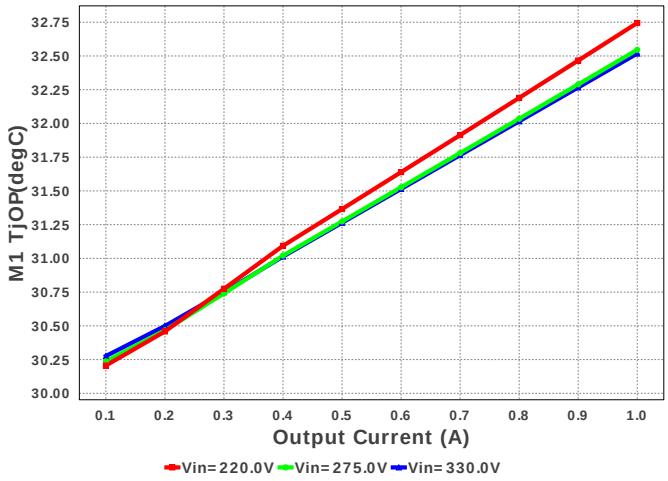
## Efficiency



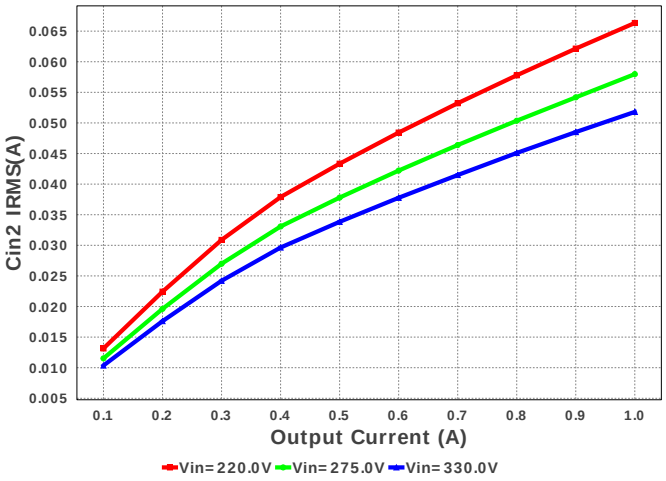

## Vout Actual



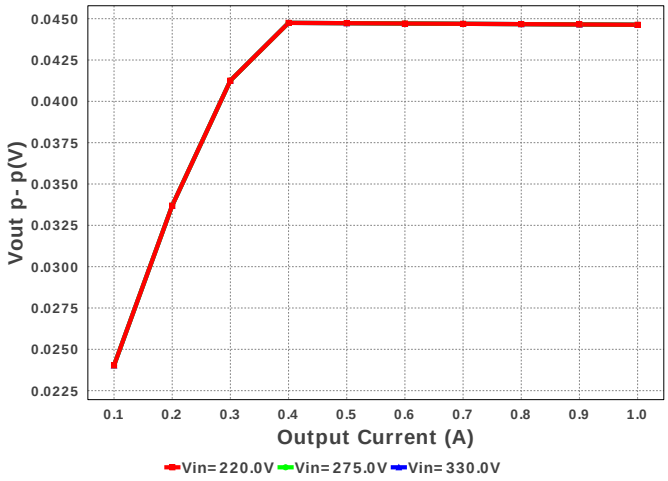

## M1 TjOP



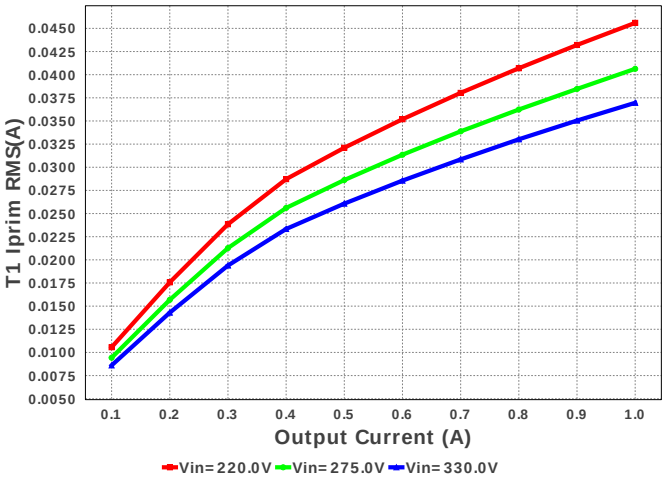

## Cin2 IRMS

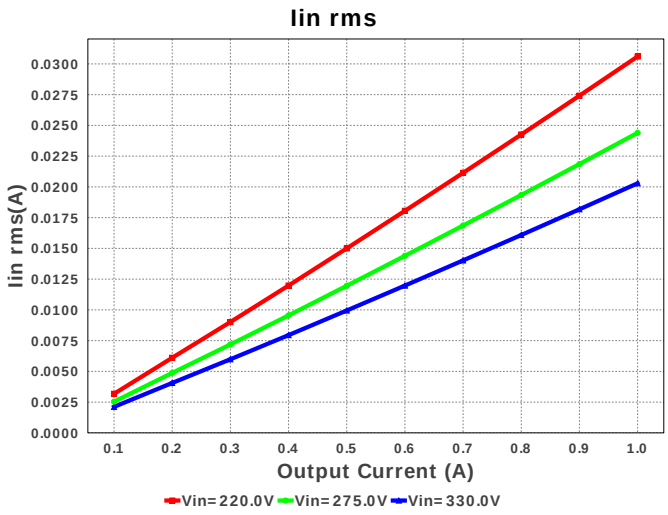


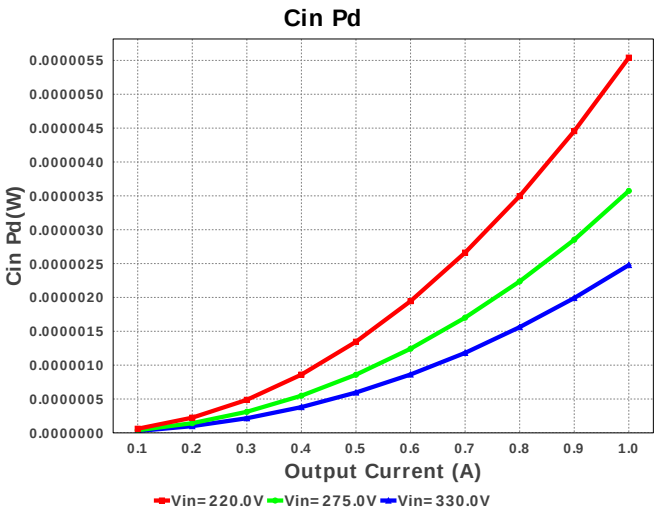

## Vout p-p

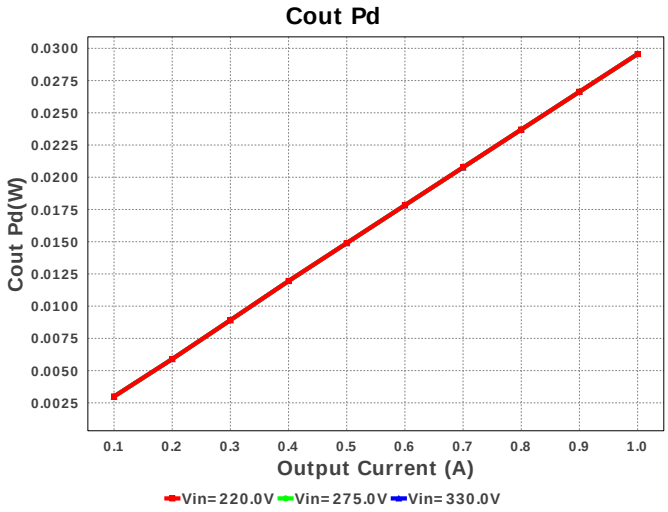


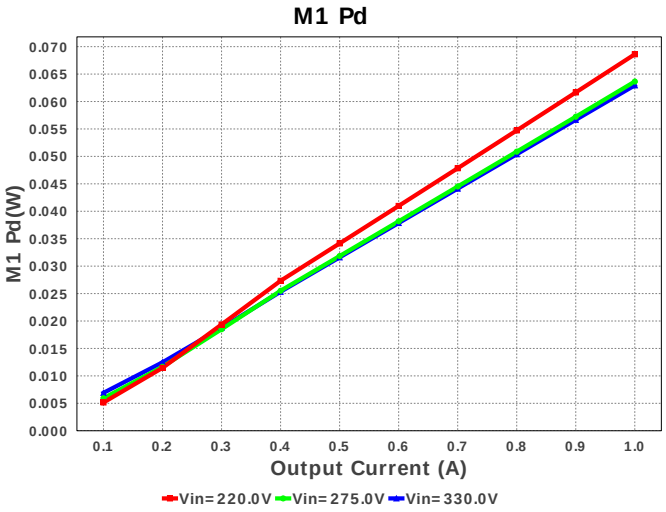

## T1 Iprim RMS

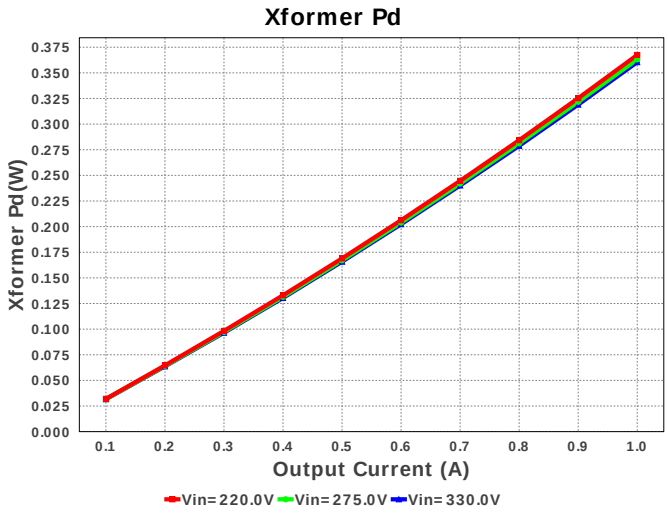


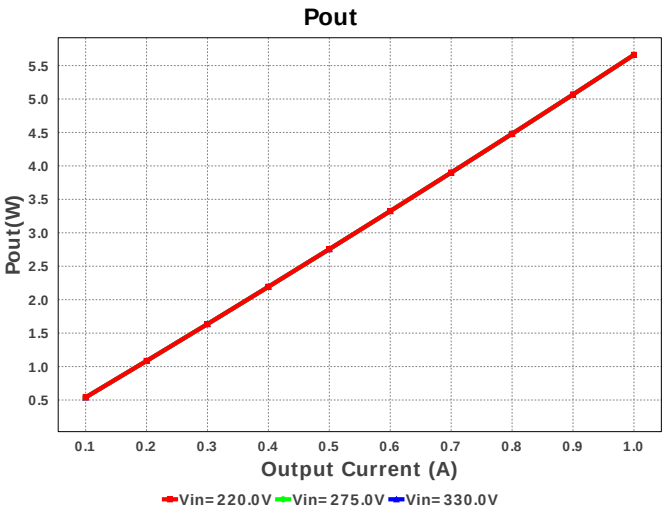


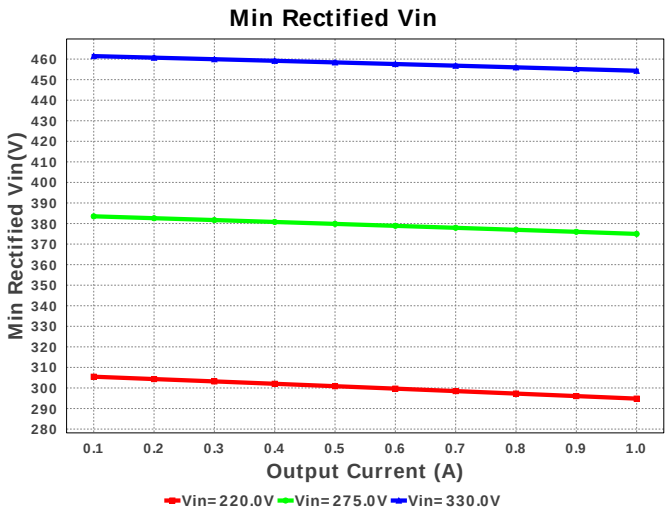



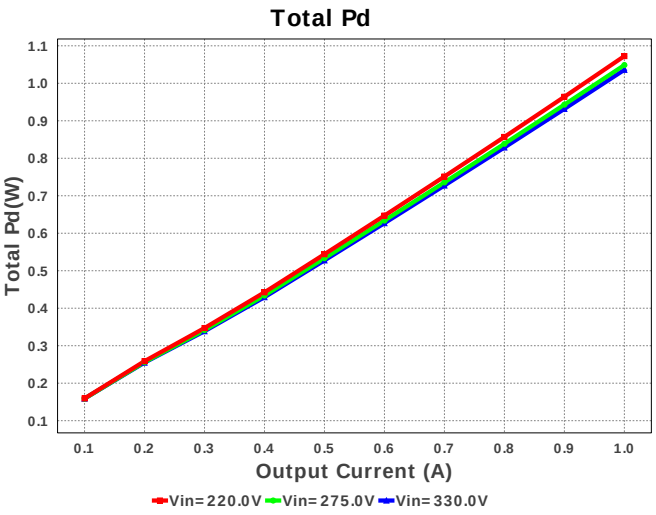



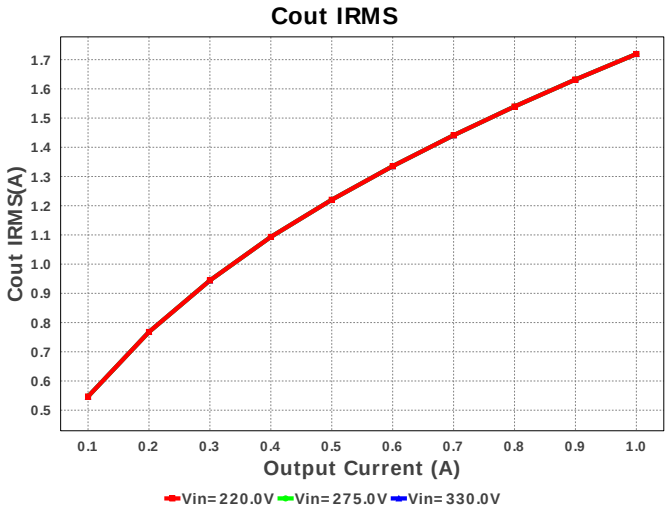



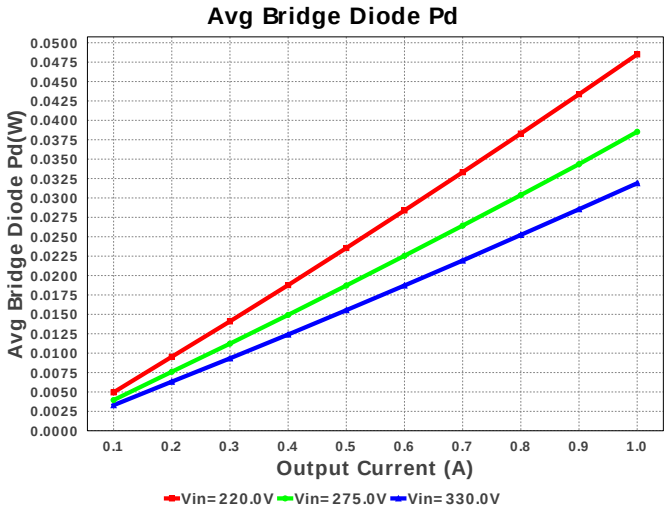



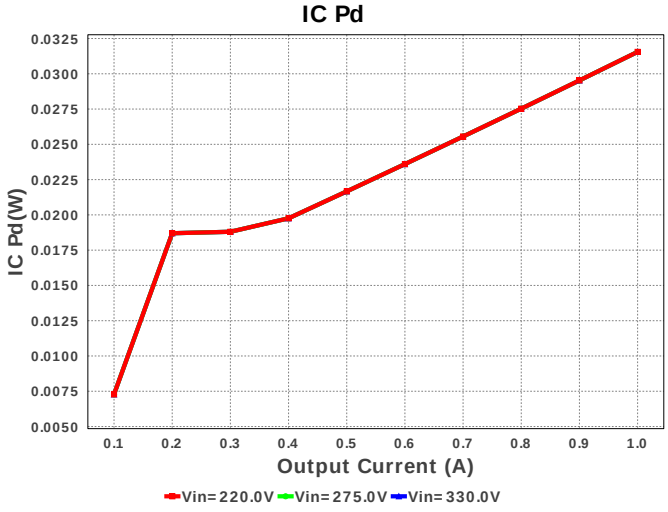



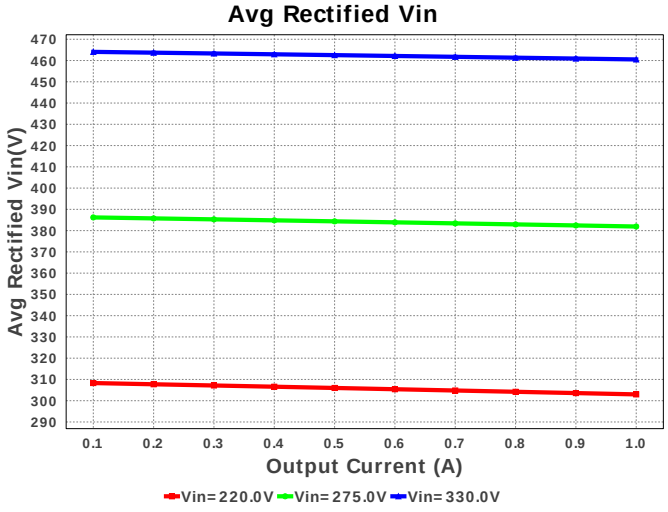


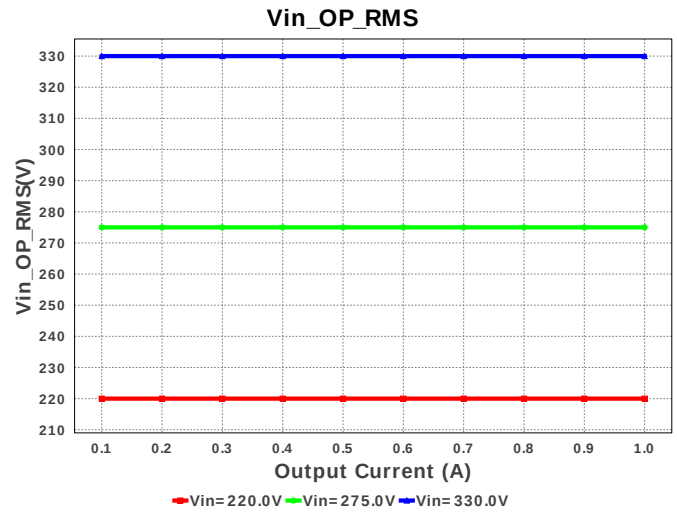



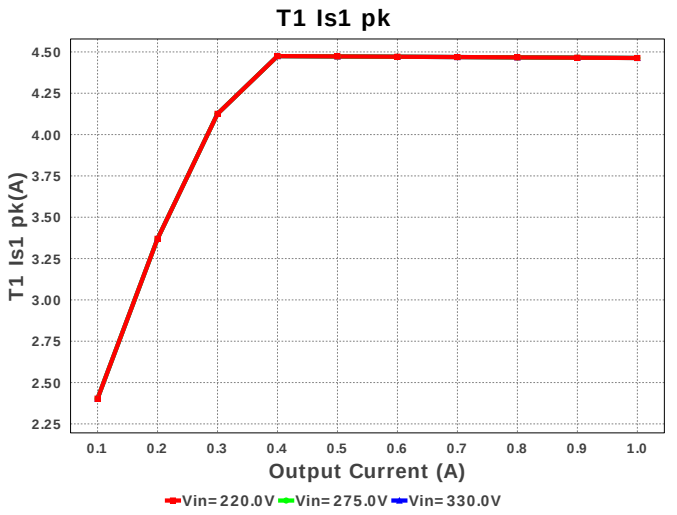



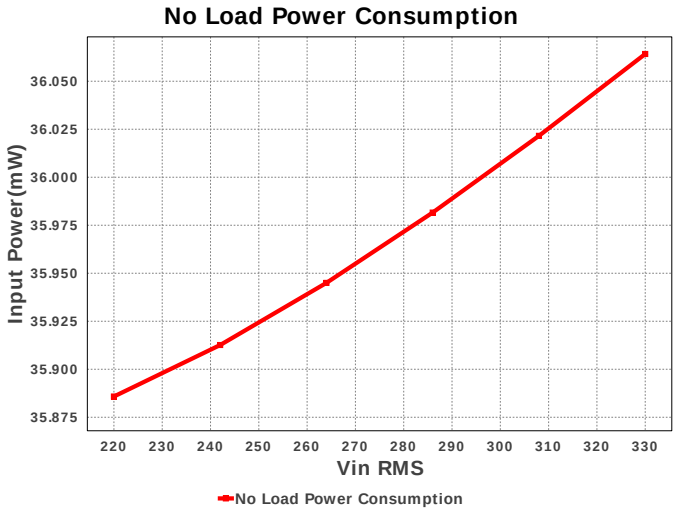



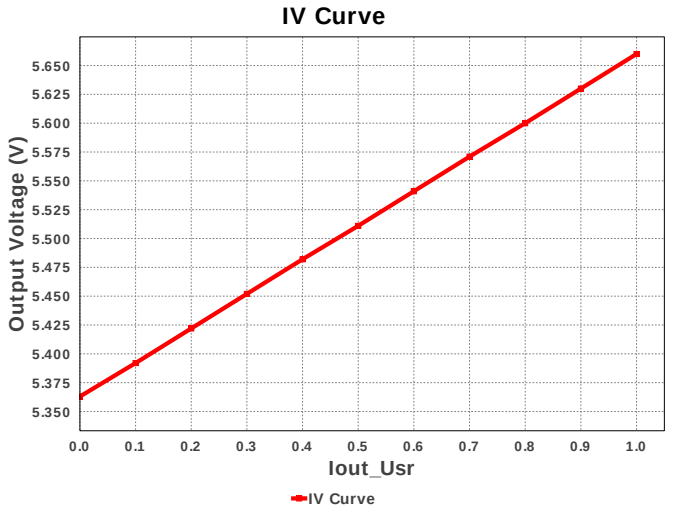






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 18.172 mA | Current | Input capacitor RMS ripple current |
| 2. | Cin2 IRMS | 51.755 mA | Current | Input Capacitor Cin2 RMS Ripple Current |
| 3. | Cout IRMS | 1.719 A | Current | Output capacitor RMS ripple current |
| 4. | Iin rms | 20.254 mA | Current | RMS Input Current |
| 5. | T1 Iprim RMS | 36.909 mA | Current | Transformer Primary RMS Current |
| 6. | T1 Iprim pk | 133.452 mA | Current | Transformer Primary Peak Current |
| 7. | T1 Is1 RMS | 1.73 A | Current | Transformer Secondary1 RMS Current |
| 8. | T1 Is1 pk | 4.463 A | Current | Transformer Secondary1 Peak Current |
| 9. | Avg Rectified Vin | 461.759 V | General | Average Rectified Voltage for the AC Line Period |
| 10. | BOM Count | 28 | General | Total Design BOM count |
| 11. | FootPrint | 3.336 k $mm^2$ | General | Total Foot Print Area of BOM components |
| 12. | Pout | 5.66 W | General | Total output power |
| 13. | Total BOM | $0.0 | General | Total BOM Cost |
| 14. | Vout Actual | 18.824 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 15. | Duty Cycle | 22.947 % | Op_point | Duty cycle |
| 16. | Efficiency | 84.681 % | Op_point | Steady state efficiency |
| 17. | Frequency_ | 70.531 kHz | Op_point | Switching frequency |
| 18. | IC Tj | 32.209 degC | Op_point | IC junction temperature |
| 19. | ICThetaJA | 70.0 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 20. | IOUT_OP | 1.0 A | Op_point | Iout operating point |
| 21. | M1 TjOP | 32.518 degC | Op_point | M1 MOSFET junction temperature |
| 22. | Min Rectified Vin | 456.832 V | Op_point | Minimum voltage seen at rectified input |
| 23. | Peak Rectified Vin | 466.686 V | Op_point | Peak voltage seen at rectified input |
| 24. | Vin_OP_RMS | 330.0 V | Op_point | AC Input RMS Voltage |
| 25. | Vout p-p | 44.634 mV | Op_point | Peak-to-peak output ripple voltage |
| 26. | Avg Bridge Diode Pd | 17.956 mW | Power | Average Power Dissipation in the Bridge Diode over the AC Line Period |
| 27. | Cin Pd | 2.477 µW | Power | Input capacitor power dissipation |
| 28. | Cout Pd | 29.563 mW | Power | Output capacitor power dissipation |
| 29. | Diode2 Pd | 432.302 mW | Power | Diode2 power dissipation |
| 30. | IC Pd | 31.551 mW | Power | IC power dissipation |
| 31. | M1 Pd | 62.958 mW | Power | M1 MOSFET total power dissipation |

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 32. | Total Pd | 1.024 W | Power | Total Power Dissipation |
| 33. | Xformer Pd | 360.424 mW | Power | Transformer power dissipation |
| 34. | Vout Tolerance | 1.785 % | | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 1.0 | Maximum Output Current |
| 2. | VinMax | 330.0 | Maximum input voltage |
| 3. | VinMin | 220.0 | Minimum input voltage |
| 4. | Vout | 5.0 | Output Voltage |
| 5. | acFrequency | 60.0 | Light Output in Lumen |
| 6. | base_pn | UCC28704 | Texas Instruments Base Part Number |
| 7. | source | AC | Input Source Type |
| 8. | ta | 30.0 | Ambient temperature |

## Design Assistance

1. Application Hints: T1: The transformer parameters assume that an RM6 core is used, and the DCR values are assumed values used only for efficiency estimates. Rbld: Rbld is used to 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 fined 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 acheived, but may need to be adjusted. Part Description: The UCC28704 Flyback power supply controller 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/ucc28704.pdf

2. UCC28704 Product Folder : http://www.ti.com/product/UCC28704 : contains the data sheet and other resources.