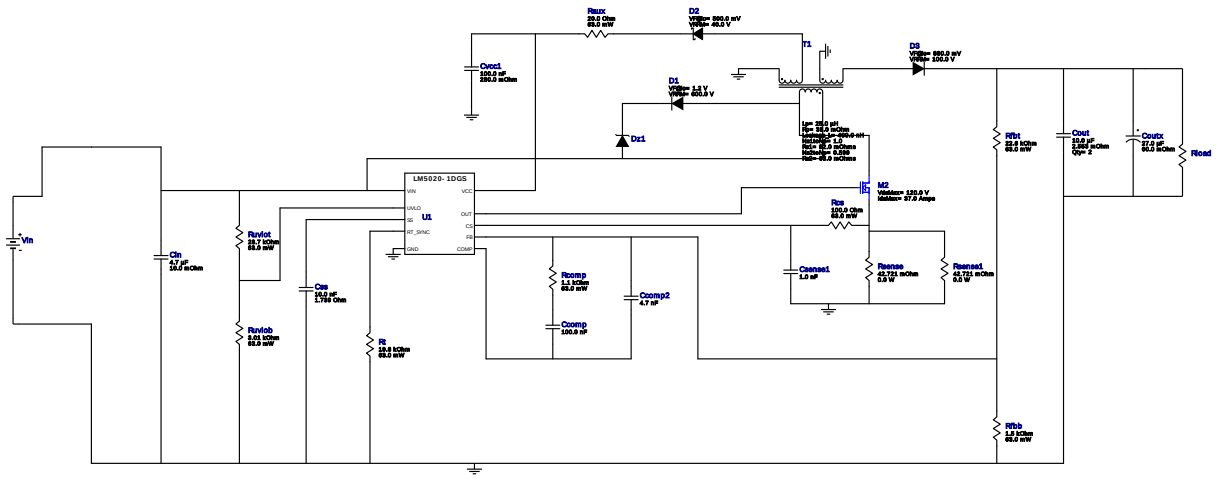
# WEBENCH® Design Report

VinMin = 14.0V
VinMax = 22.0V
Vout = 20.0V
Iout = 2.0A

Device = LM5020MM-1/NOPB
Topology = Flyback
Created = 7/13/16 12:48:56 AM
BOM Cost = $0.00
BOM Count = 26
Total Pd = 8.95W

Design : 4738744/1 LM5020MM-1/NOPB
LM5020MM-1/NOPB 14.0V-22.0V to 20.00V @ 2.0A

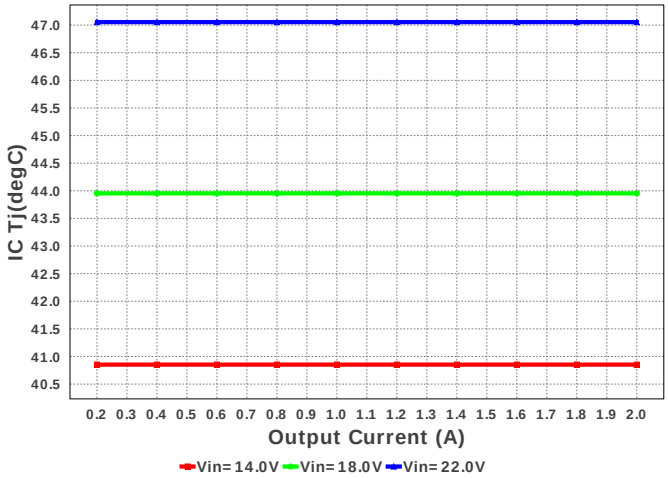



## Electrical BOM

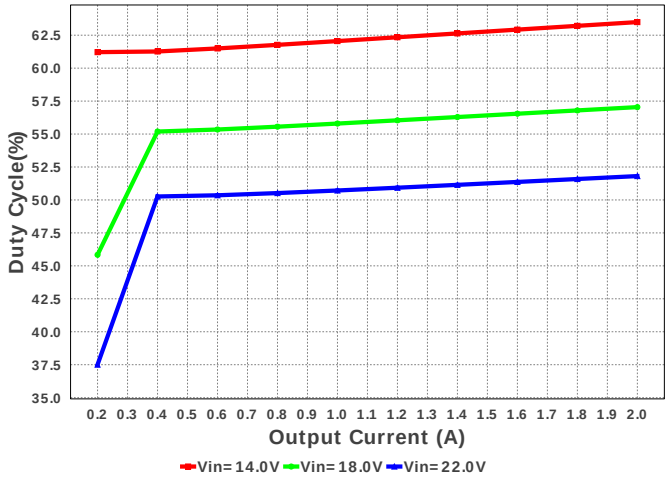
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Ccomp | MuRata | GRM21BR71E104KA01L<br>Series= X7R | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 2. | Ccomp2 | Yageo America | CC0805KRX7R9BB472<br>Series= X7R | Cap= 4.7 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 3. | Cin | AVX | 12063D475MAT2A<br>Series= X5R | Cap= 4.7 uF<br>ESR= 10.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.11 | 1206 11 mm² |
| 4. | Cout | TDK | C3216X6S1V106K<br>Series= X6S | Cap= 10.0 uF<br>ESR= 2.553 mOhm<br>VDC= 35.0 V<br>IRMS= 0.0 A | 2 | $0.14 | 1206 11 mm² |
| 5. | Coutx | Panasonic | EEHZA1V270P<br>Series= ? | Cap= 27.0 uF<br>ESR= 60.0 mOhm<br>VDC= 35.0 V<br>IRMS= 1.3 A | 1 | $0.66 | SM_RADIAL_6.3AMM 80 mm² |
| 6. | Csense1 | MuRata | GRM033R71C102KA01D<br>Series= X7R | Cap= 1.0 nF<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0201 2 mm² |
| 7. | Css | Kemet | C0805C103K5RACTU<br>Series= X7R | Cap= 10.0 nF<br>ESR= 1.739 Ohm<br>VDC= 50.0 V<br>IRMS= 411.0 mA | 1 | $0.01 | 0805 7 mm² |
| 8. | Cvcc1 | AVX | 08053C104KAT2A<br>Series= X7R | Cap= 100.0 nF<br>ESR= 280.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 9. | D1 | Bourns | CD214B-F3600 | VF@Io= 1.2 V<br>VRRM= 600.0 V | 1 | $0.14 | SMB 44 mm² |

| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 10. | D2 | Vishay-Semiconductor | SS14-E3/61T | VF@Io= 500.0 mV<br>VRRM= 40.0 V | 1 | $0.08 |  <br>SMA 37 mm² |
| 11. | D3 | Vishay-Semiconductor | SS10PH10-M3/86A | VF@Io= 880.0 mV<br>VRRM= 100.0 V | 1 | $0.29 |  <br>TO-277A 56 mm² |
| 12. | Dz1 | ON Semiconductor | BZX84C24LT1G | Zener | 1 | $0.02 |  <br>SOT-23 14 mm² |
| 13. | M2 | Infineon Technologies | BSC240N12NS3 G | VdsMax= 120.0 V<br>IdsMax= 37.0 Amps | 1 | NA |  <br>PG-TDSON-8 55 mm² |
| 14. | Raux | Vishay-Dale | CRCW040220R0FKED<br>Series= CRCW..e3 | Res= 20.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 15. | Rcomp | Vishay-Dale | CRCW04021K10FKED<br>Series= CRCW..e3 | Res= 1.1 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 16. | Rcs | Vishay-Dale | CRCW0402100RFKED<br>Series= CRCW..e3 | Res= 100.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 17. | Rfbb | Vishay-Dale | CRCW04021K50FKED<br>Series= CRCW..e3 | Res= 1.5 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 18. | Rfbt | Vishay-Dale | CRCW040222K6FKED<br>Series= CRCW..e3 | Res= 22.6 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 19. | Rsense | CUSTOM | CUSTOM<br>Series= ? | Res= 42.721 mOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 20. | Rsense1 | CUSTOM | CUSTOM<br>Series= ? | Res= 42.721 mOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 21. | Rt | Vishay-Dale | CRCW040219K6FKED<br>Series= CRCW..e3 | Res= 19.6 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 22. | Ruvlob | Vishay-Dale | CRCW04023K01FKED<br>Series= CRCW..e3 | Res= 3.01 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 23. | Ruvlot | Vishay-Dale | CRCW040228K7FKED<br>Series= CRCW..e3 | Res= 28.7 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 24. | T1 | Wurth Elektronik | 750315445 | Lp= 25.0 µH<br>Rp= 38.0 mOhm<br>Leakage_L= 400.0 nH<br>Ns1toNp= 1.0<br>Rs1= 92.0 mOhms<br>Ns2toNp= 0.599<br>Rs2= 63.0 mOhms | 1 | NA | Wurth_750315445 0 mm² |
| 25. | U1 | Texas Instruments | LM5020MM-1/NOPB | Switcher | 1 | $0.80 | mpds035b 35 mm² |

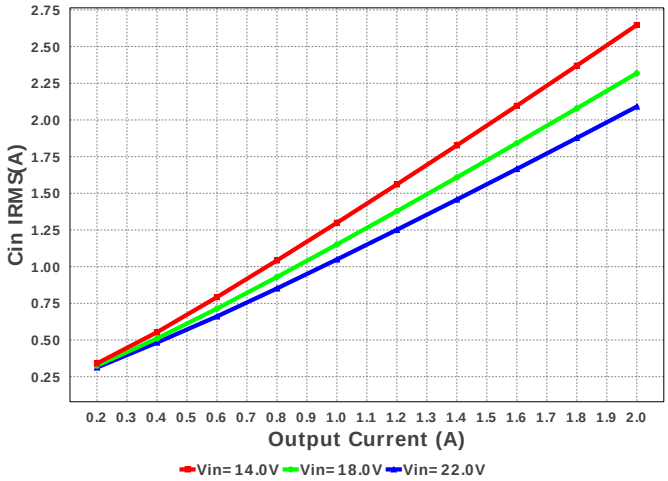
## IC Tj



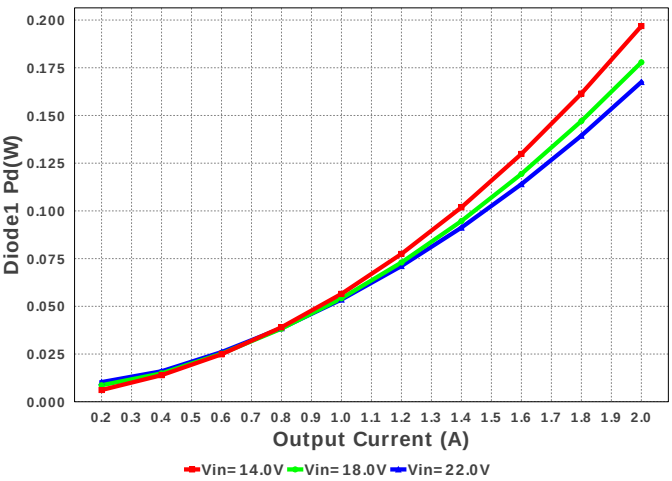

## Duty Cycle



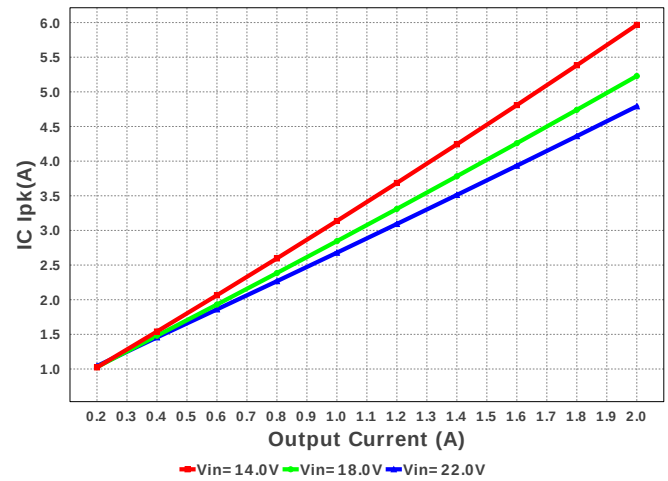

## Cin IRMS



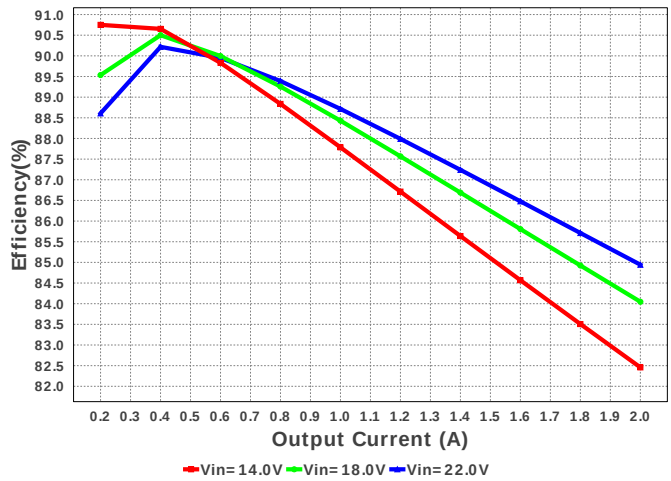

## Diode1 Pd

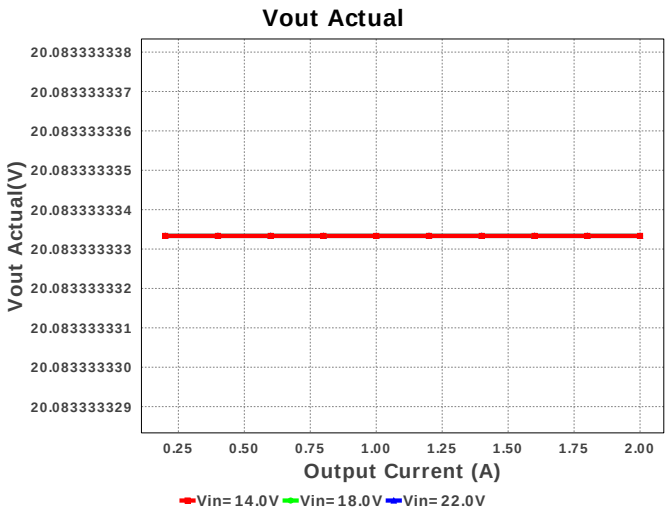


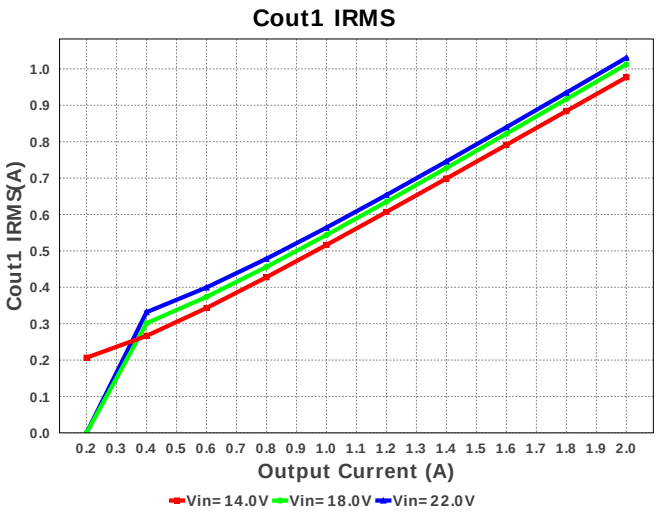

## IC Ipk

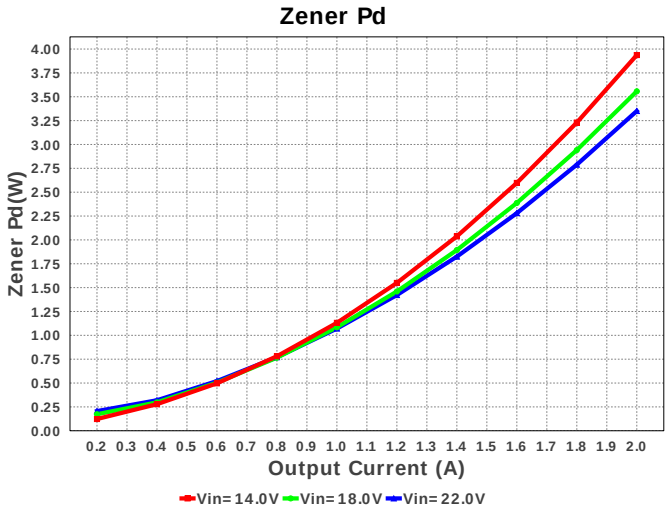


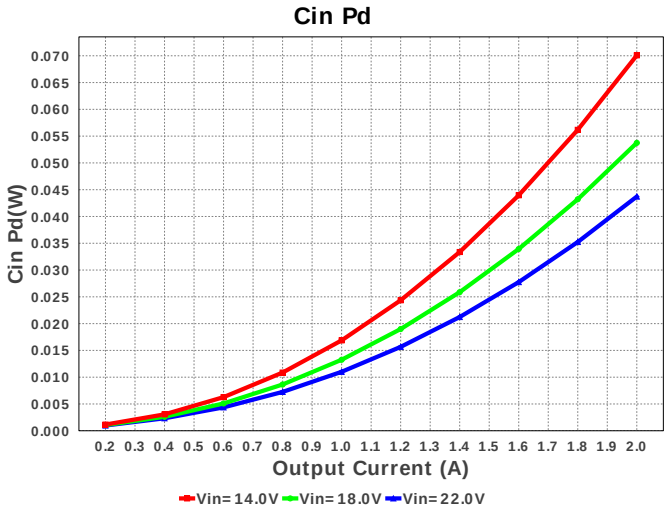

## Efficiency

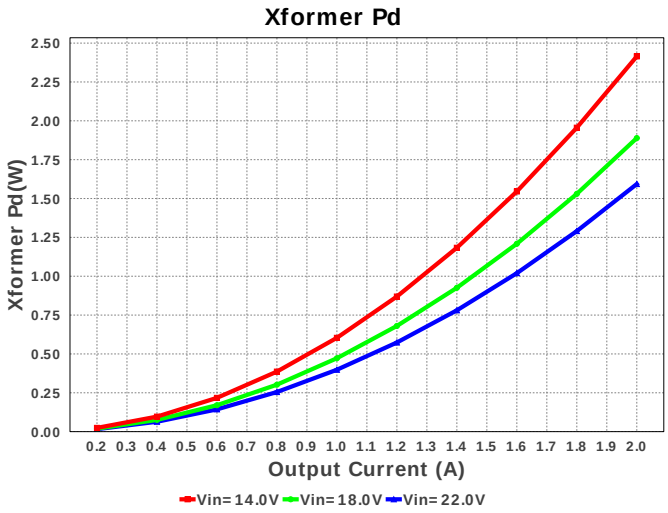


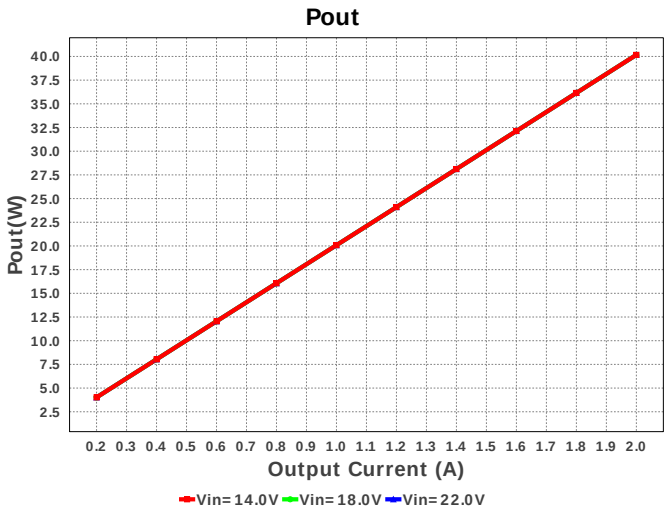


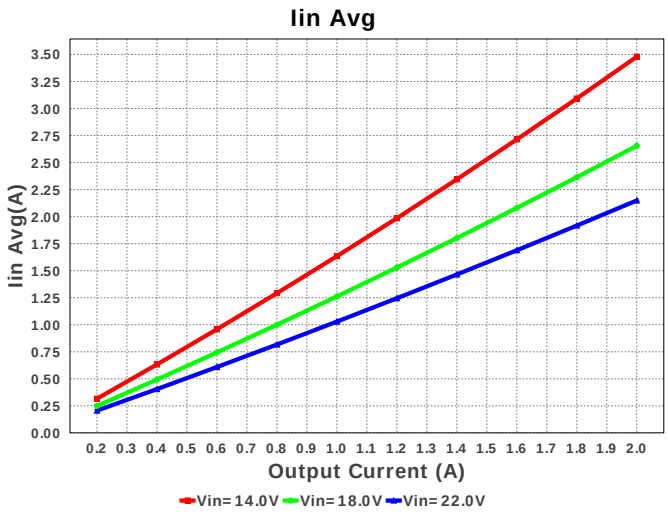



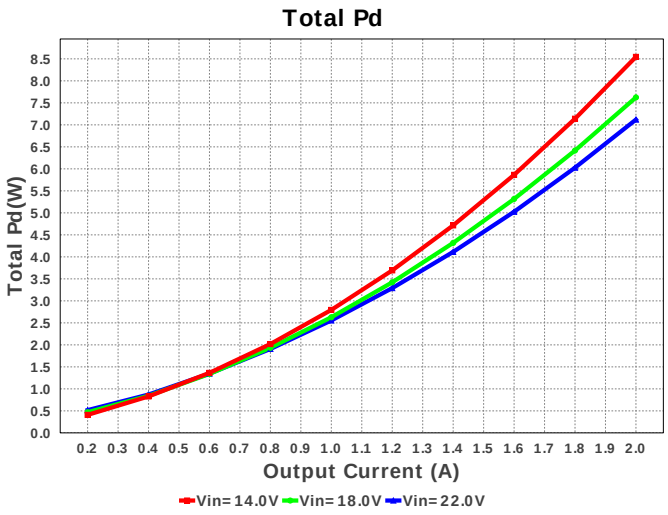



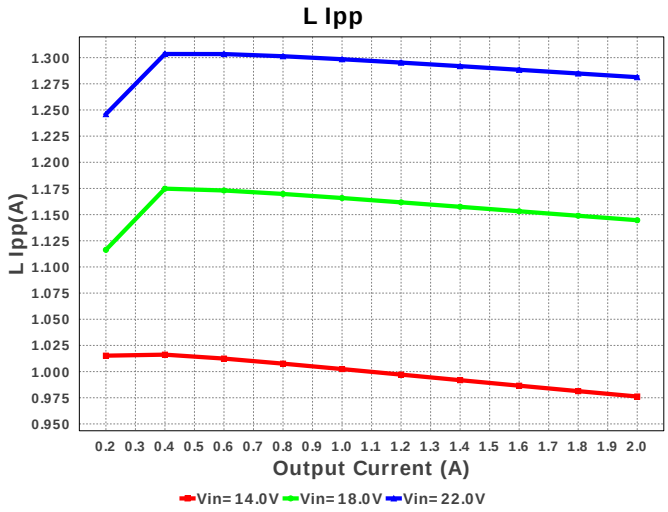



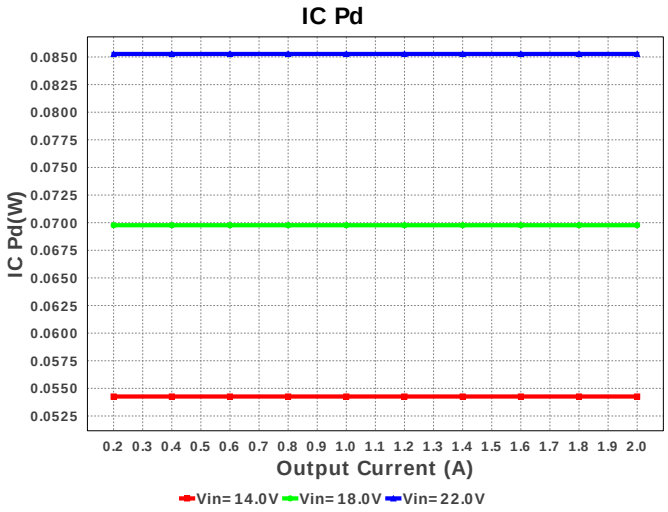



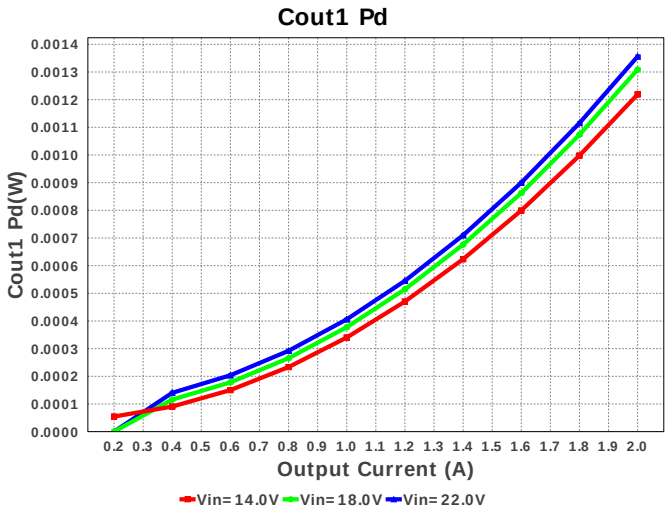



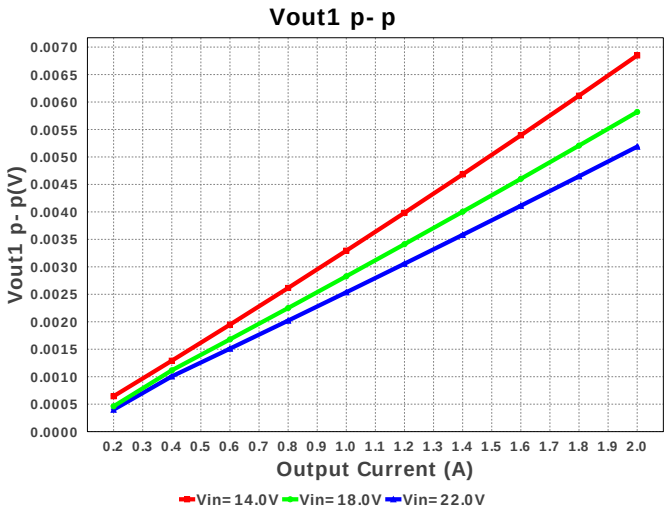


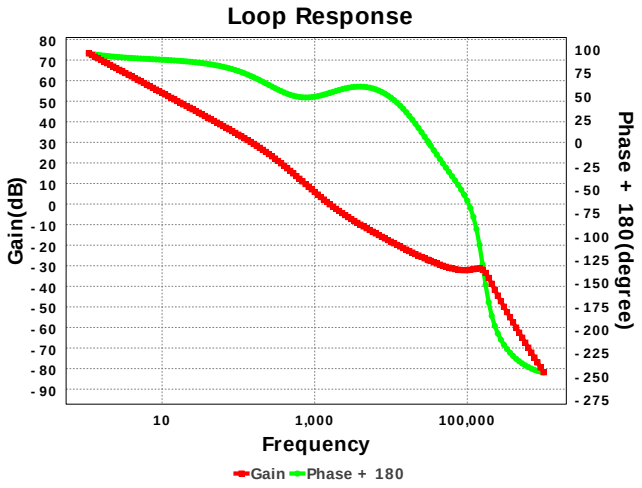






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 2.658 A | Current | Input capacitor RMS ripple current |
| 2. | Cout1 IRMS | 2.41 A | Current | Output capacitor1 RMS ripple current |
| 3. | IC Ipk | 5.989 A | Current | Peak switch current |
| 4. | Iin Avg | 3.509 A | Current | Average input current |
| 5. | L Ipp | 965.08 mA | Current | Peak-to-peak inductor ripple current |
| 6. | BOM Count | 26 | General | Total Design BOM count |
| 7. | FootPrint | 423.0 $mm^2$ | General | Total Foot Print Area of BOM components |
| 8. | Frequency | 325.0 kHz | General | Switching frequency |
| 9. | IC Tolerance | 25.0 mV | General | IC Feedback Tolerance |
| 10. | Pout | 40.167 W | General | Total output power |
| 11. | Total BOM | $0.0 | General | Total BOM Cost |
| 12. | Low Freq Gain | 70.771 dB | Op_Point | Gain at 10Hz |
| 13. | Vout Actual | 20.083 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 14. | Cross Freq | 1.297 kHz | Op_point | Bode plot crossover frequency |
| 15. | Duty Cycle | 63.681 % | Op_point | Duty cycle |
| 16. | Efficiency | 81.773 % | Op_point | Steady state efficiency |
| 17. | Gain Marg | -23.113 dB | Op_point | Bode Plot Gain Margin |
| 18. | IC Tj | 40.923 degC | Op_point | IC junction temperature |
| 19. | ICThetaJA | 200.0 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 20. | IOUT_OP | 2.0 A | Op_point | Iout operating point |
| 21. | Phase Marg | 48.765 deg | Op_point | Bode Plot Phase Margin |
| 22. | VIN_OP | 14.0 V | Op_point | Vin operating point |
| 23. | Vout1 OP | 20.083 V | Op_point | Operational Voltage 1 |
| 24. | Vout1 p-p | 6.883 mV | Op_point | Peak-to-peak output1 ripple voltage |
| 25. | Cin Pd | 70.629 mW | Power | Input capacitor power dissipation |
| 26. | Cout1 Pd | 7.415 mW | Power | Output capacitor1 power dissipation |
| 27. | Cout1 Pd | 7.415 mW | Power | Output capacitor1 power dissipation |
| 28. | Diode1 Pd | 198.606 mW | Power | Diode1 power dissipation |
| 29. | IC Pd | 54.614 mW | Power | IC power dissipation |
| 30. | Total Pd | 8.953 W | Power | Total Power Dissipation |
| 31. | Xformer Pd | 2.488 W | Power | Transformer power dissipation |
| 32. | Zener Pd | 3.972 W | Power | Zener power dissipation |
| 33. | Vout Tolerance | 3.932 % | | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 2.0 | Maximum Output Current |
| 2. | Iout1 | 2.0 | Output Current #1 |
| 3. | Iout2 | 1.0 | Output Current #2 |
| 4. | Iout3 | 1.0 | Output Current #3 |
| 5. | VinMax | 22.0 | Maximum input voltage |
| 6. | VinMin | 14.0 | Minimum input voltage |
| 7. | Vout | 20.0 | Output Voltage |
| 8. | Vout1 | 20.0 | Output Voltage #1 |
| 9. | Vout2 | 3.0 | Output Voltage #2 |
| 10. | Vout3 | 4.0 | Output Voltage #3 |
| 11. | base_pn | LM5020-1 | Base Product Number |
| 12. | source | DC | Input Source Type |
| 13. | Ta | 30.0 | Ambient temperature |

## Design Assistance

1. **LM5020-1** Product Folder : http://www.ti.com/product/LM5020-1 : contains the data sheet and other resources.