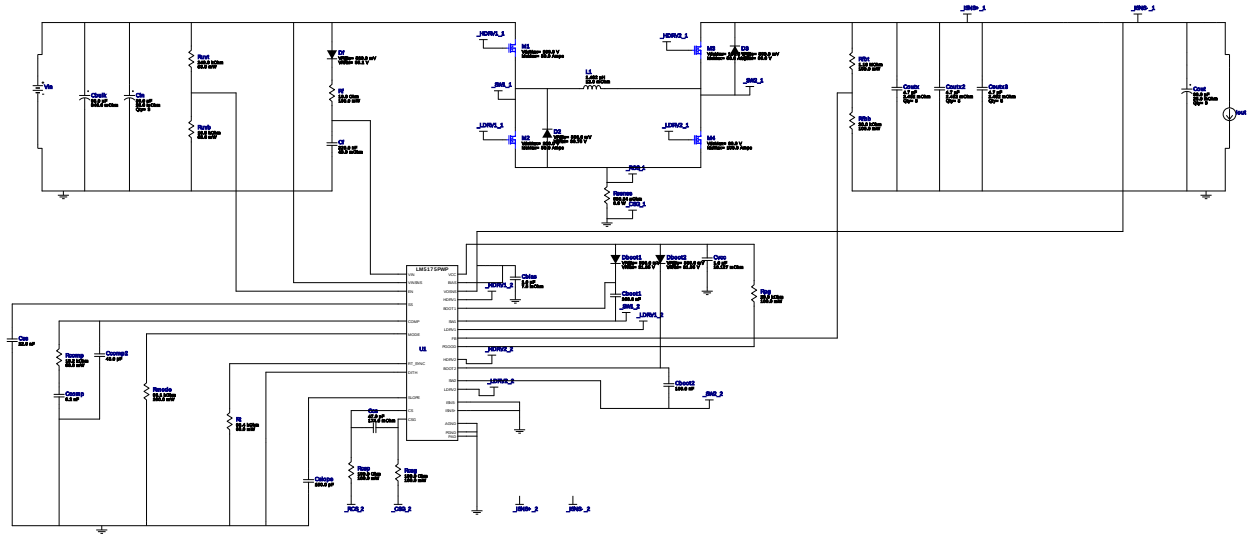
# WEBENCH® Design Report

VinMin = 20.0V
VinMax = 27.0V
Vout = 48.0V
Iout = 20.0A

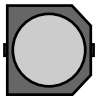
Device = LM5175PWPR
Topology = Buck_Boost
Created = 7/28/16 11:13:11 PM
BOM Cost = $0.00
BOM Count = 61
Total Pd = 43.98W

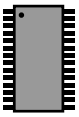
Design : 4681306/6 LM5175PWPR
LM5175PWPR 20.0V-27.0V to 48.00V @ 20.0A

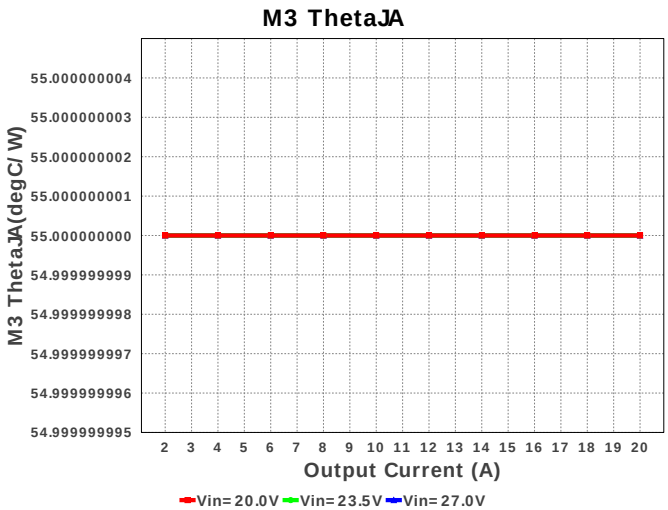


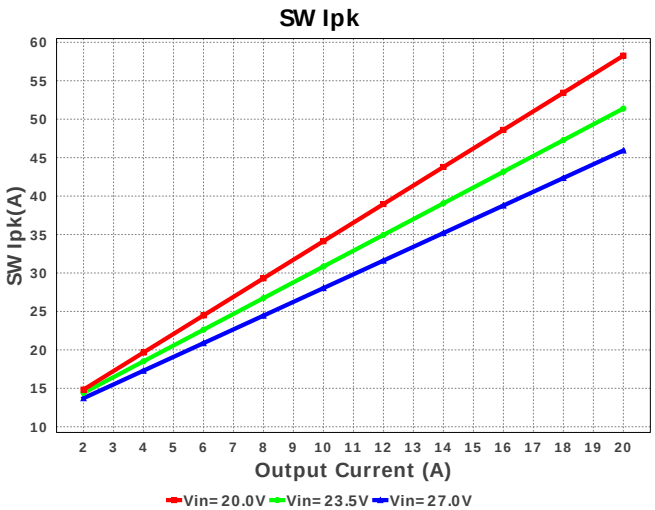
## Electrical BOM

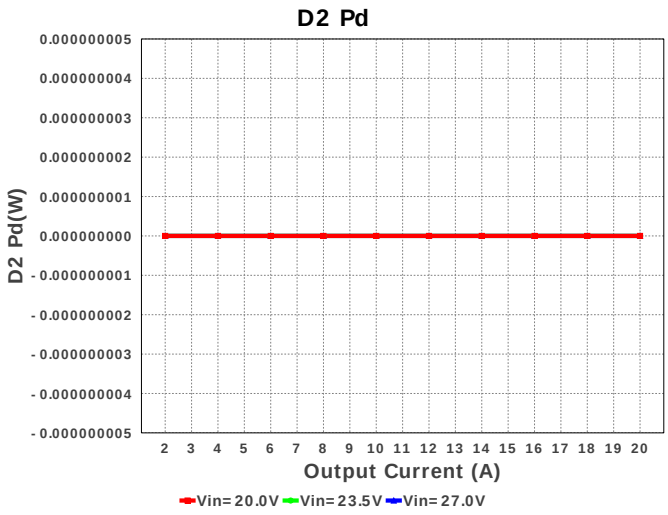
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cbias | TDK | C3216X7R2A105M160AA<br>Series= X7R | Cap= 1.0 uF<br>ESR= 7.5 mOhm<br>VDC= 100.0 V<br>IRMS= 5.9235 A | 1 | $0.11 | 1206 11 mm² |
| 2. | Cboot1 | Kemet | C0603C104K3RACTU<br>Series= X7R | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0603 5 mm² |
| 3. | Cboot2 | Kemet | C0603C104K3RACTU<br>Series= X7R | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0603 5 mm² |
| 4. | Cbulk | Chemi-Con | EMVY350ADA680MF80G<br>Series= MVY | Cap= 68.0 uF<br>ESR= 340.0 mOhm<br>VDC= 35.0 V<br>IRMS= 280.0 mA | 1 | $0.13 | CAPSMT_62_F80 74 mm² |
| 5. | Ccomp | MuRata | GRM033R61A822KA01D<br>Series= X5R | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0201 2 mm² |
| 6. | Ccomp2 | Samsung Electro-Mechanics | CL21C430JBANNNC<br>Series= C0G/NP0 | Cap= 43.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 7. | Ccs | AVX | 06035A470JAT2A<br>Series= C0G/NP0 | Cap= 47.0 pF<br>ESR= 174.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0603 5 mm² |
| 8. | Cf | Kemet | C0805C224K5RACTU<br>Series= X7R | Cap= 220.0 nF<br>ESR= 46.0 mOhm<br>VDC= 50.0 V<br>IRMS= 2.65 A | 1 | $0.02 | 0805 7 mm² |
| 9. | Cin | Panasonic | 50SVPF39M<br>Series= ? | Cap= 39.0 uF<br>ESR= 25.0 mOhm<br>VDC= 50.0 V<br>IRMS= 3.8 A | 3 | $0.72 | CAPSMT_62_E12 106 mm² |

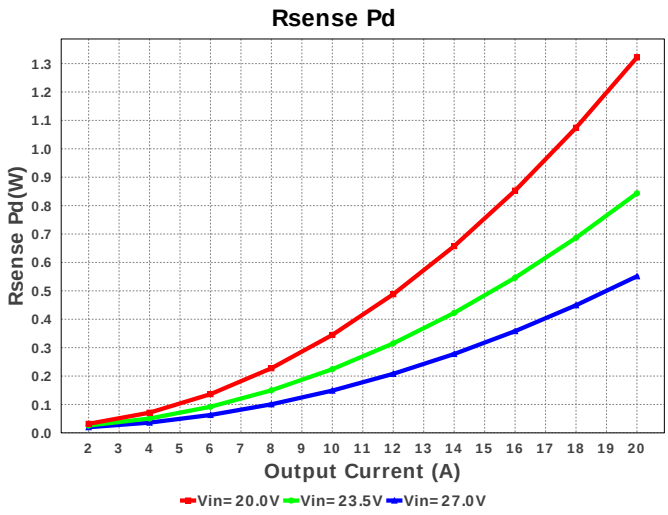
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 10. | Cout | Panasonic | 63SXV33M<br>Series= ? | Cap= 33.0 uF<br>ESR= 25.0 mOhm<br>VDC= 63.0 V<br>IRMS= 2.95 A | 9 | $1.25 |  <br>CAPSMT_62_E12 106 mm² |
| 11. | Coutx | TDK | C5750X5R2A475K<br>Series= X5R | Cap= 4.7 uF<br>ESR= 2.482 mOhm<br>VDC= 100.0 V<br>IRMS= 0.0 A | 5 | $0.37 |  <br>2220 54 mm² |
| 12. | Coutx2 | TDK | C5750X5R2A475K<br>Series= X5R | Cap= 4.7 uF<br>ESR= 2.482 mOhm<br>VDC= 100.0 V<br>IRMS= 0.0 A | 5 | $0.37 |  <br>2220 54 mm² |
| 13. | Coutx3 | TDK | C5750X5R2A475K<br>Series= X5R | Cap= 4.7 uF<br>ESR= 2.482 mOhm<br>VDC= 100.0 V<br>IRMS= 0.0 A | 5 | $0.37 |  <br>2220 54 mm² |
| 14. | Cslope | Kemet | C0603C151K3GACTU<br>Series= C0G/NP0 | Cap= 150.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0603 5 mm² |
| 15. | Css | Kemet | C0603C223K3RACTU<br>Series= X7R | Cap= 22.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0603 5 mm² |
| 16. | Cvcc | MuRata | GRM188R61C105KA93D<br>Series= X5R | Cap= 1.0 uF<br>ESR= 10.127 mOhm<br>VDC= 16.0 V<br>IRMS= 994.63 mA | 1 | $0.01 | <br>0603 5 mm² |
| 17. | D2 | CUSTOM | CUSTOM | VF@Io= 500.0 mV<br>VRRM= 33.75 V | 1 | NA | CUSTOM 0 mm² |
| 18. | D3 | CUSTOM | CUSTOM | VF@Io= 500.0 mV<br>VRRM= 60.0 V | 1 | NA | CUSTOM 0 mm² |
| 19. | Dboot1 | CUSTOM | CUSTOM | VF@Io= 500.0 mV<br>VRRM= 31.05 V | 1 | NA | CUSTOM 0 mm² |
| 20. | Dboot2 | CUSTOM | CUSTOM | VF@Io= 500.0 mV<br>VRRM= 31.05 V | 1 | NA | CUSTOM 0 mm² |
| 21. | Df | CUSTOM | CUSTOM | VF@Io= 500.0 mV<br>VRRM= 35.1 V | 1 | NA | CUSTOM 0 mm² |
| 22. | L1 | CUSTOM | CUSTOM | L= 1.482 µH<br>DCR= 12.0 mOhm | 1 | NA | CUSTOM 0 mm² |
| 23. | M1 | Texas Instruments | CSD19537Q3 | VdsMax= 100.0 V<br>IdsMax= 50.0 Amps | 1 | $0.75 |  <br>TRANS_NexFET_Q3 18 mm² |
| 24. | M2 | Texas Instruments | CSD19537Q3 | VdsMax= 100.0 V<br>IdsMax= 50.0 Amps | 1 | $0.75 |  <br>TRANS_NexFET_Q3 18 mm² |
| 25. | M3 | Texas Instruments | CSD19534Q5A | VdsMax= 100.0 V<br>IdsMax= 50.0 Amps | 1 | $0.68 |  <br>TRANS_NexFET_Q5A 55 mm² |
| 26. | M4 | Texas Instruments | CSD18563Q5A | VdsMax= 60.0 V<br>IdsMax= 100.0 Amps | 1 | $0.68 |  <br>TRANS_NexFET_Q5A 55 mm² |
| 27. | Rcomp | Vishay-Dale | CRCW040218K2FKED<br>Series= CRCW..e3 | Res= 18.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 28. | Rcsg | Vishay-Dale | CRCW0603100RFKEA<br>Series= CRCW..e3 | Res= 100.0 Ohm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0603 5 mm² |

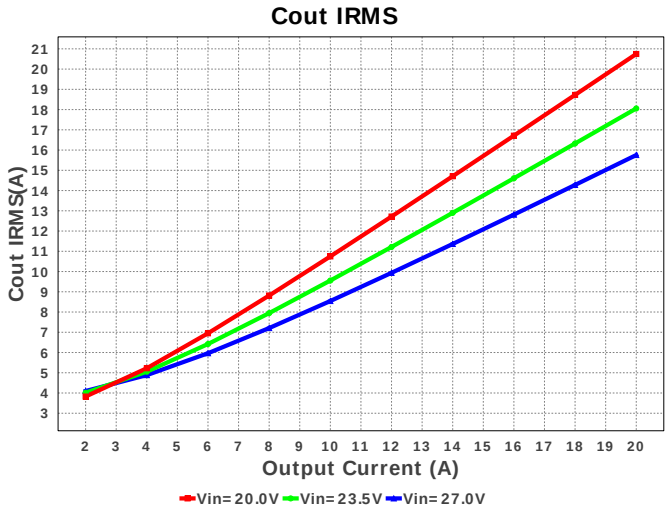
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 29. | Rcsp | Vishay-Dale | CRCW0603100RFKEA<br>Series= CRCW..e3 | Res= 100.0 Ohm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 30. | Rf | Vishay-Dale | CRCW060310R0FKEA<br>Series= CRCW..e3 | Res= 10.0 Ohm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 31. | Rfbb | Vishay-Dale | CRCW060320K0FKEA<br>Series= CRCW..e3 | Res= 20.0 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 32. | Rfbt | Vishay-Dale | CRCW06031M18FKEA<br>Series= CRCW..e3 | Res= 1.18 MOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 33. | Rmode | Vishay-Dale | CRCW060393K1FKEA<br>Series= CRCW..e3 | Res= 93.1 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 34. | Rpg | Vishay-Dale | CRCW060320K0FKEA<br>Series= CRCW..e3 | Res= 20.0 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 35. | Rsense | CUSTOM | CUSTOM<br>Series= ? | Res= 966.34 uOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |
| 36. | Rt | Vishay-Dale | CRCW040263K4FKED<br>Series= CRCW..e3 | Res= 63.4 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 37. | Ruvb | Vishay-Dale | CRCW040216K5FKED<br>Series= CRCW..e3 | Res= 16.5 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 38. | Ruvt | Vishay-Dale | CRCW0402249KFKED<br>Series= CRCW..e3 | Res= 249.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 39. | U1 | Texas Instruments | LM5175PWPR | Switcher | 1 | $3.10 |  PWP0028F_N 98 mm² |

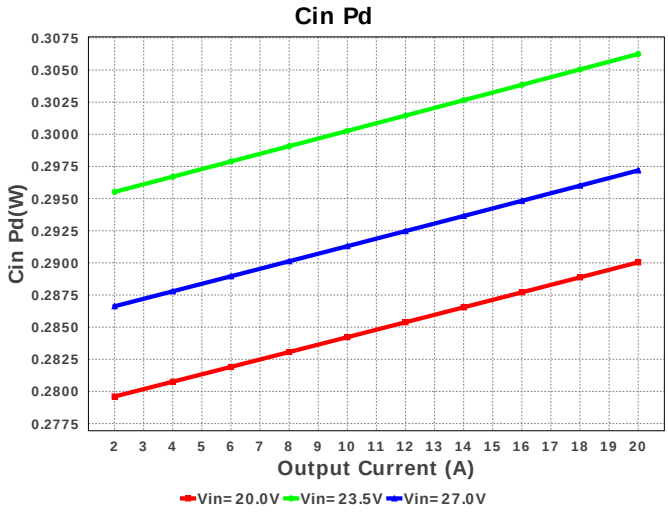


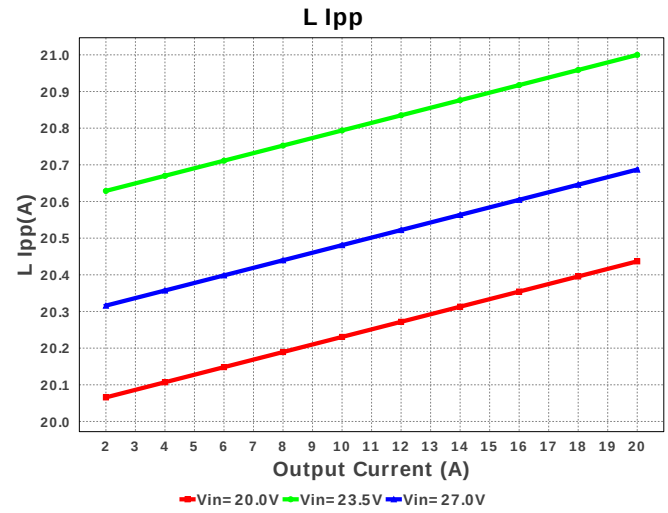



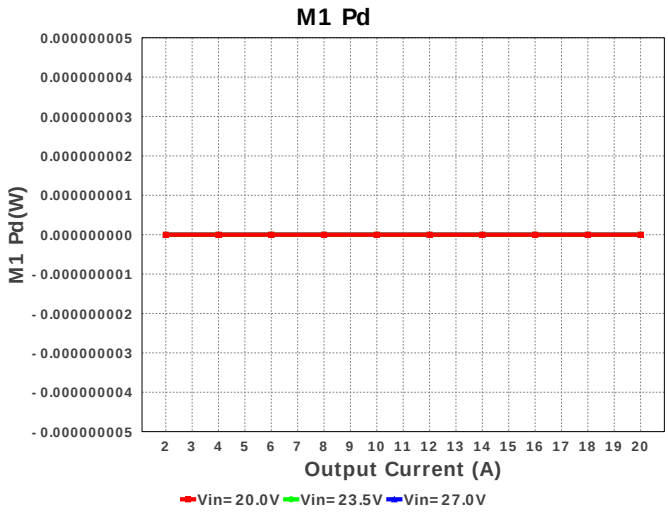


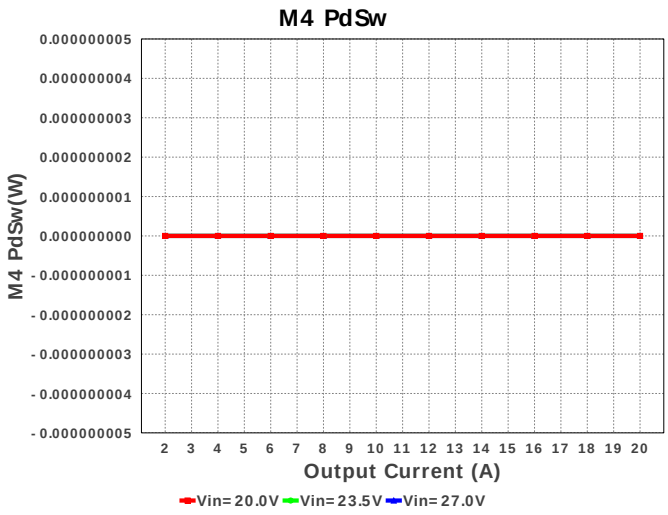



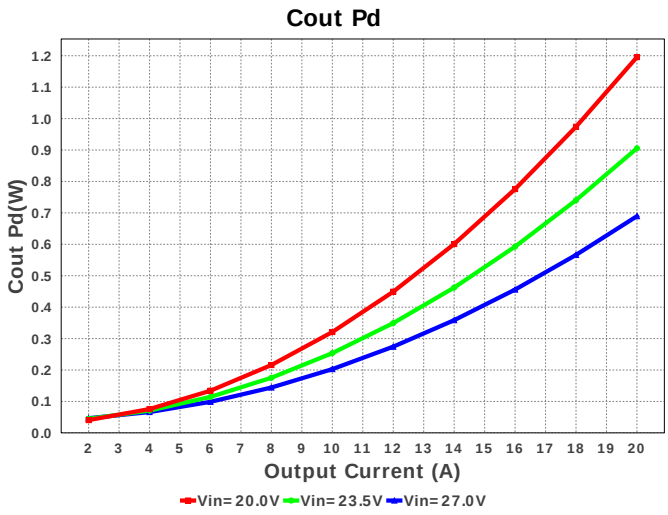



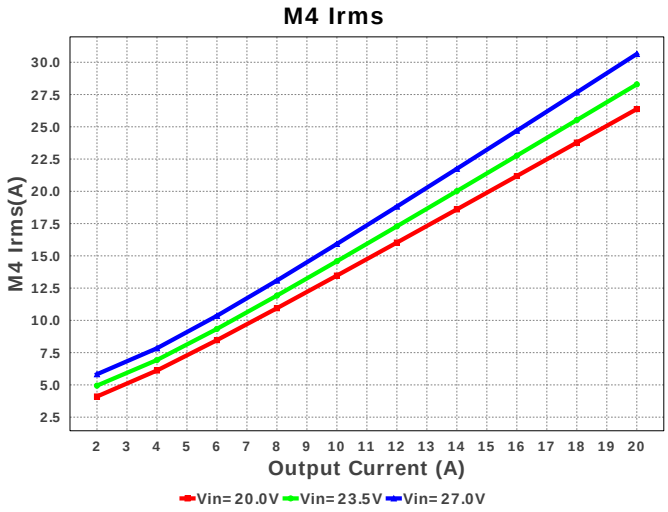



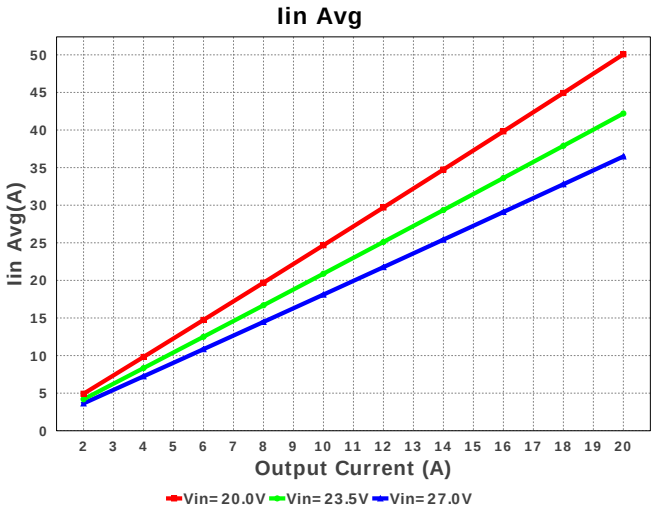



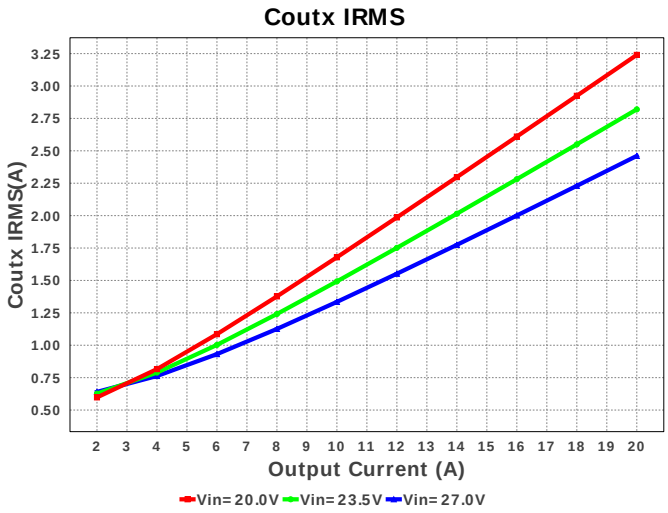



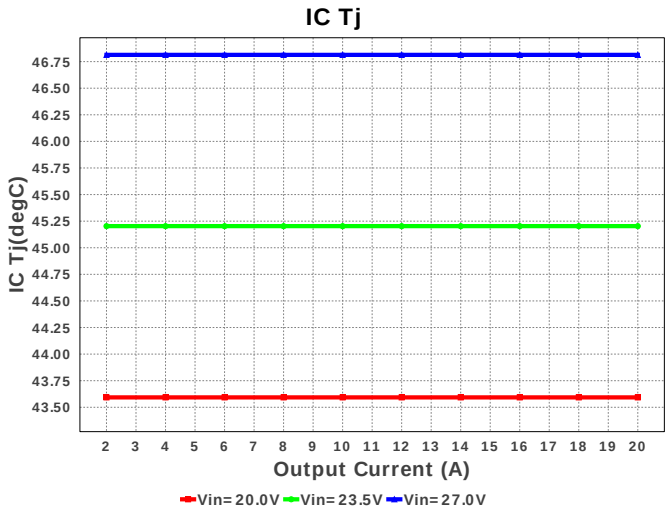


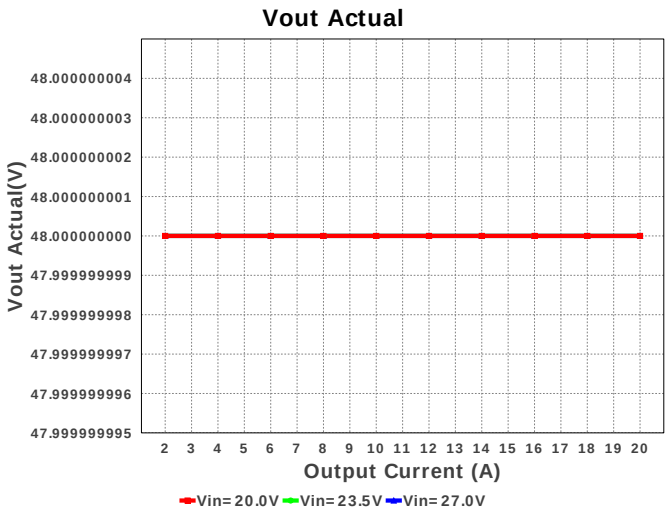



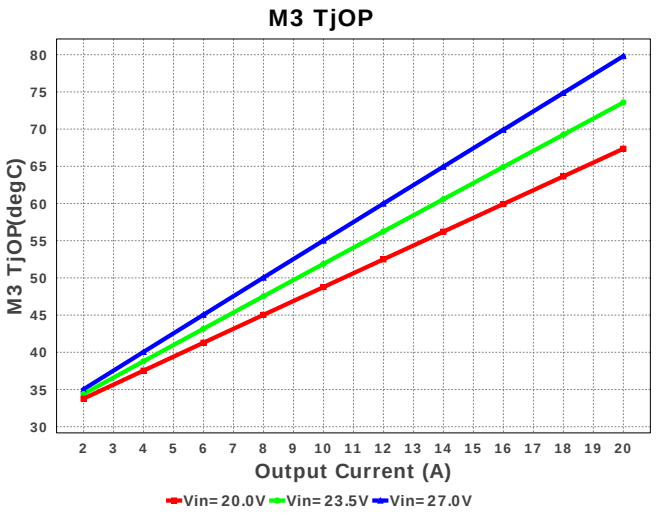



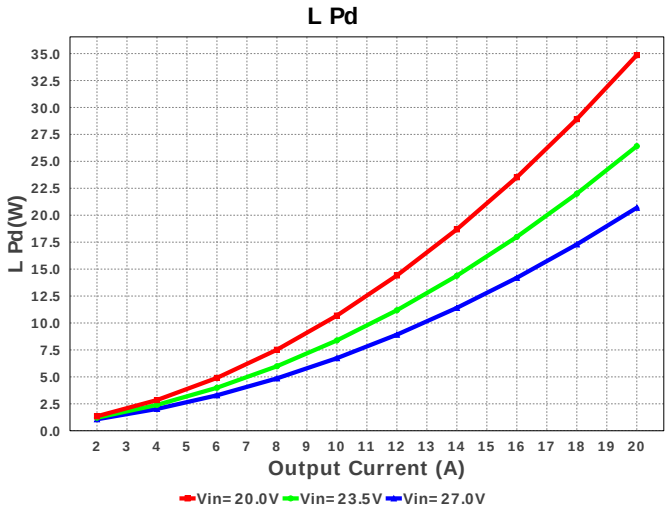



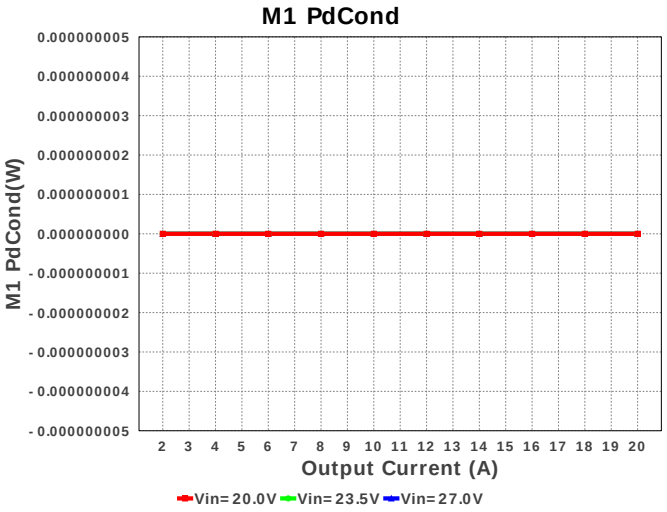



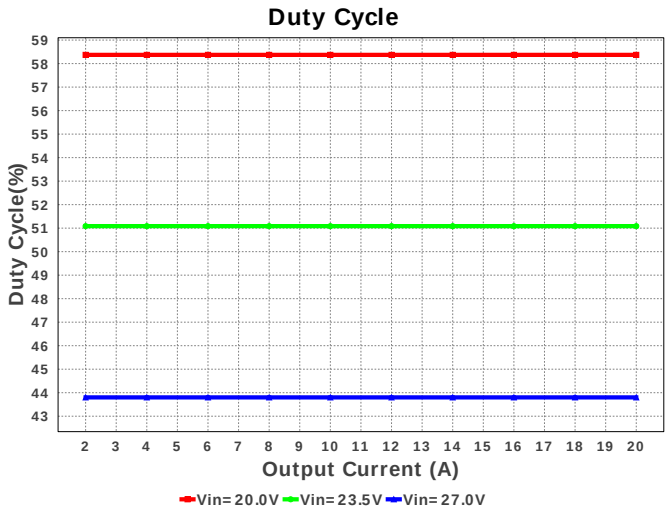



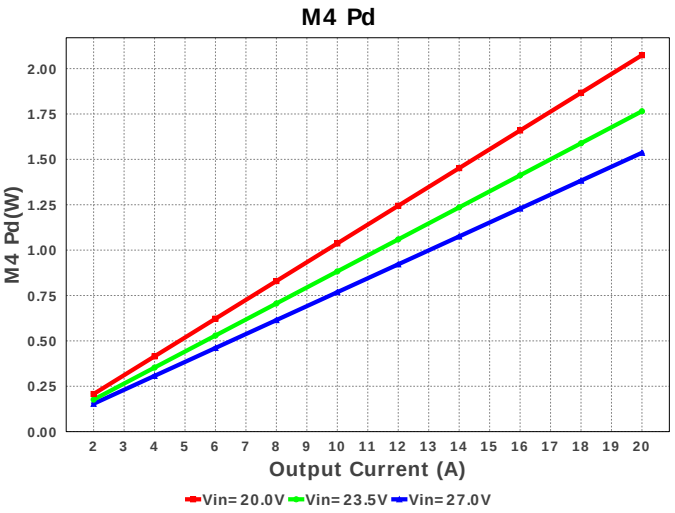


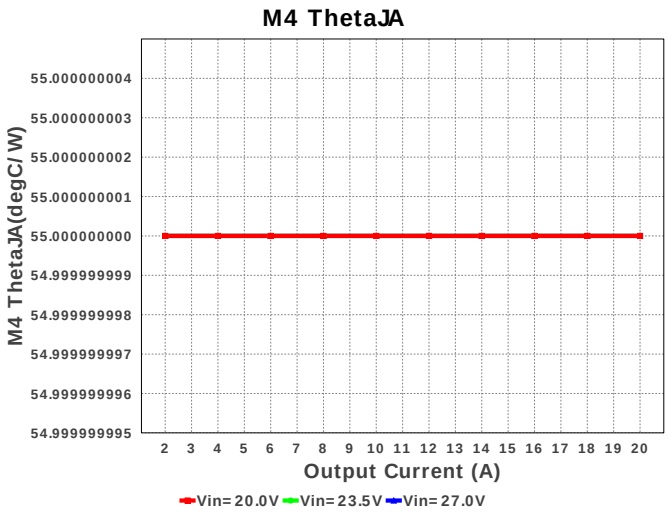



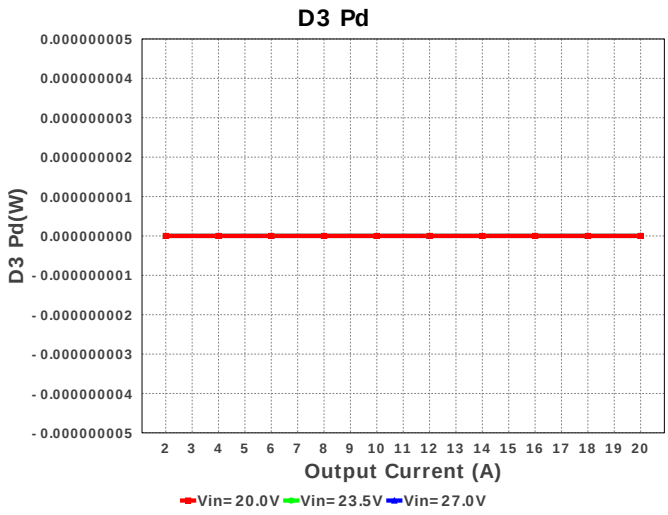



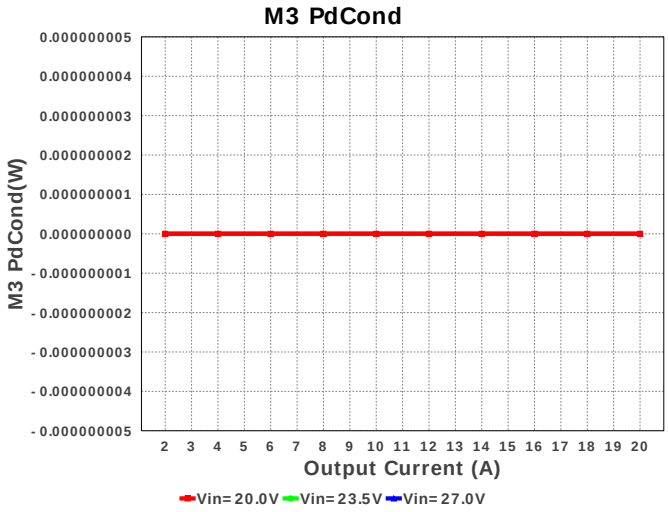



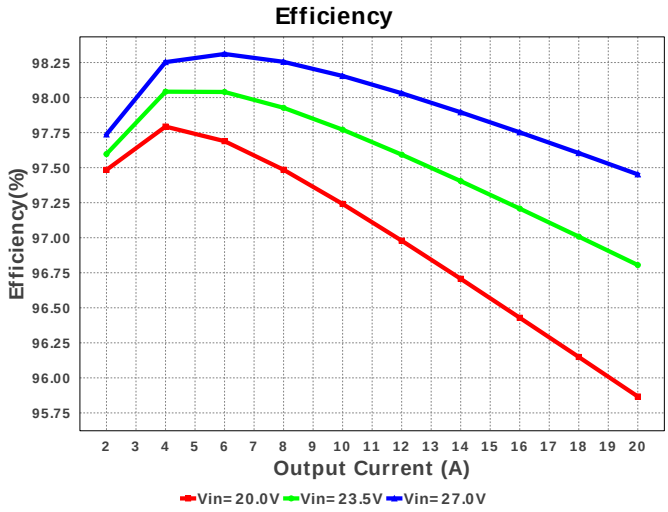



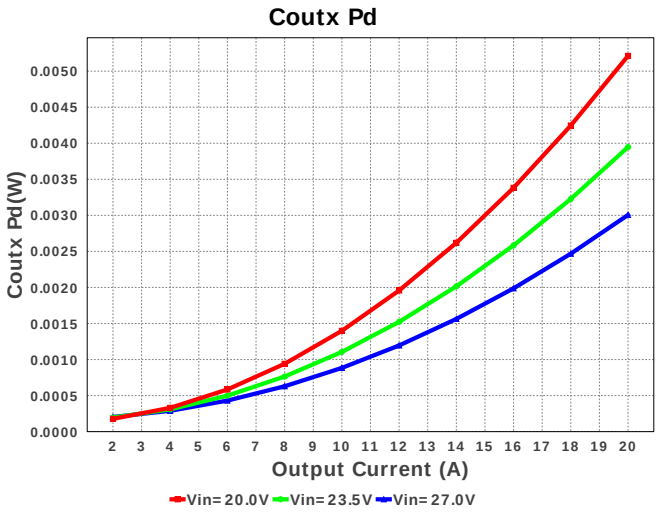



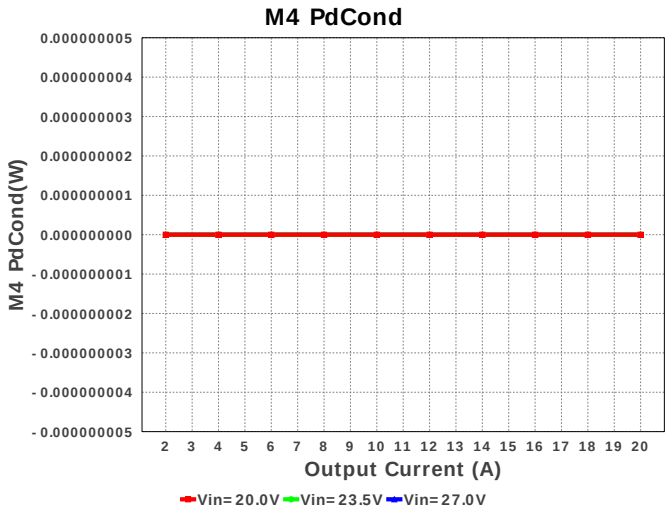


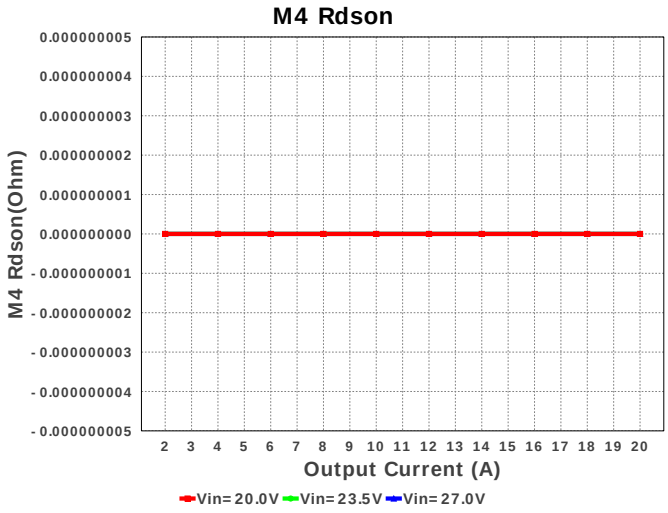



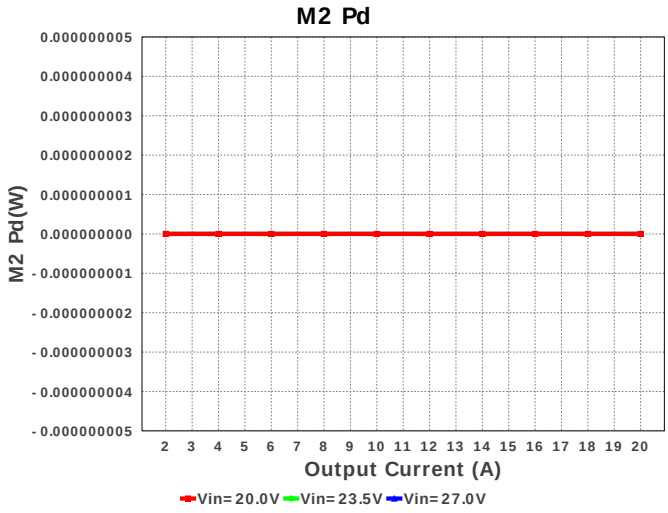



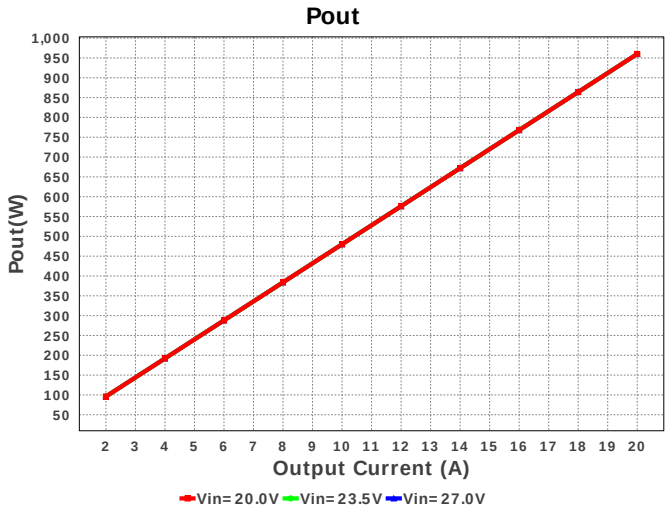



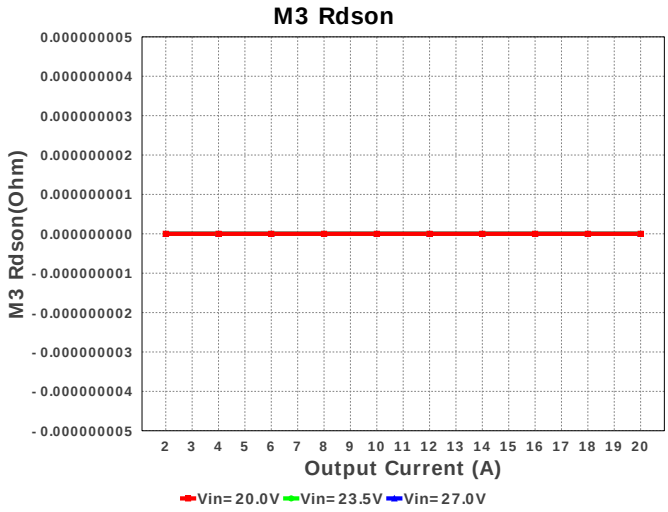



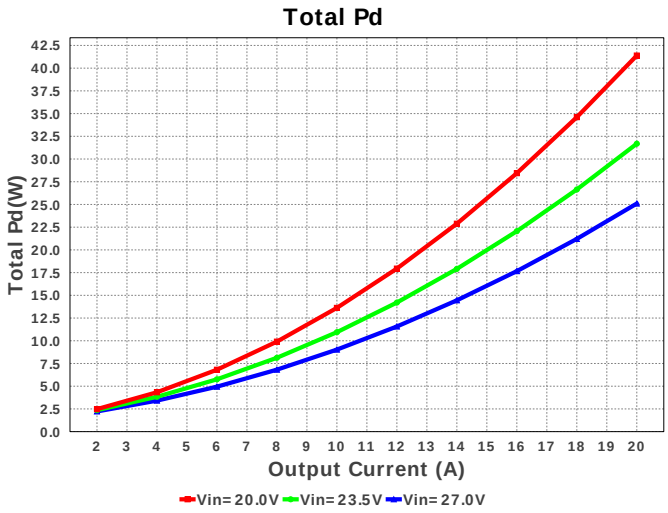



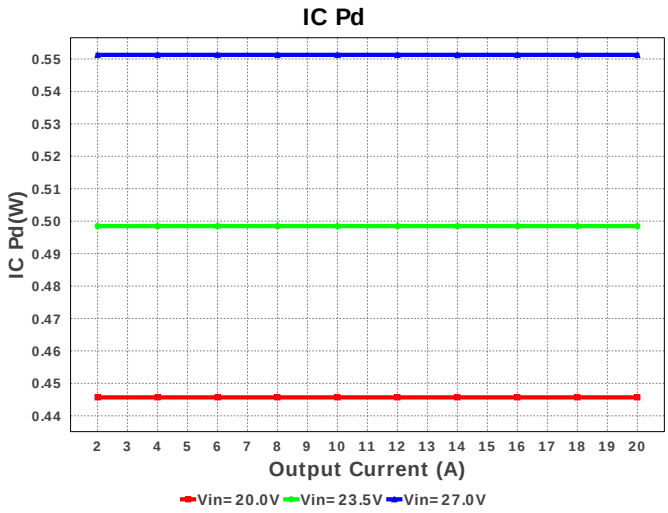


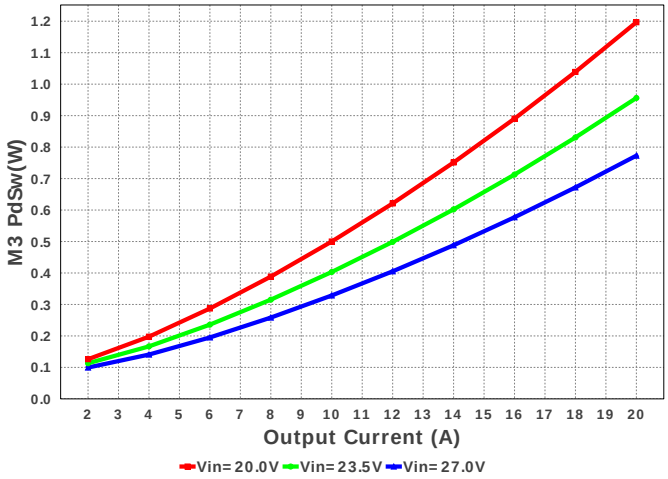



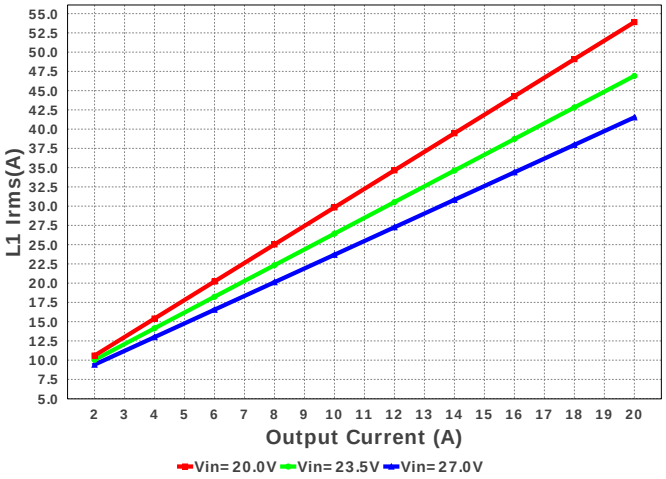



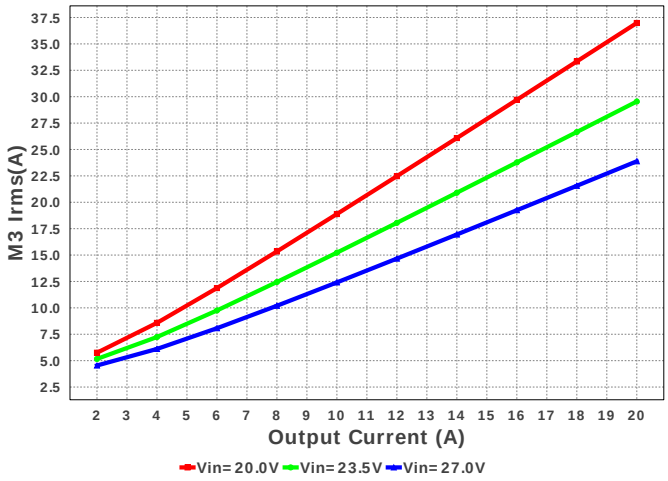
### M3 PdSw



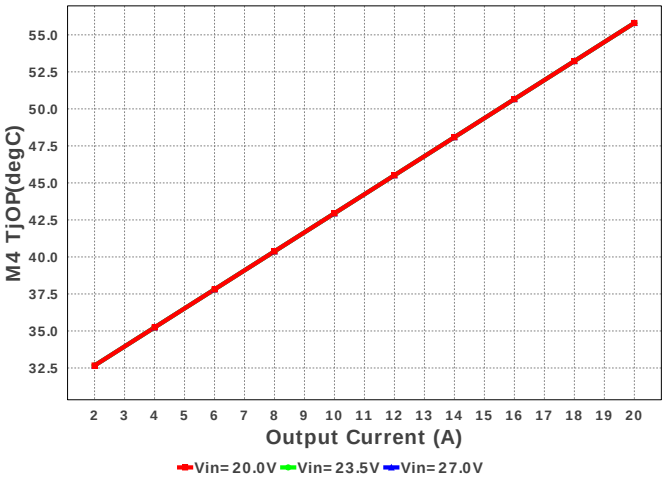

### L1 Irms



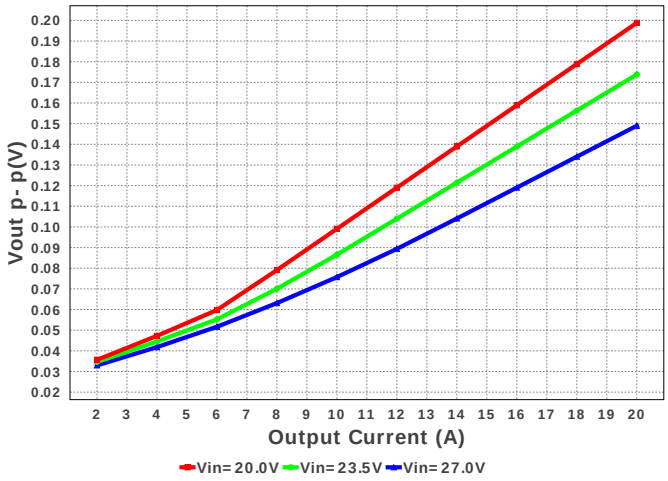

### M3 Irms



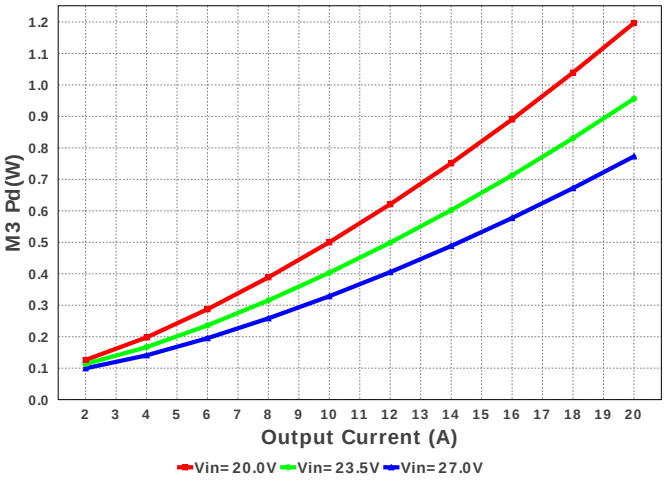

### M4 TjOP

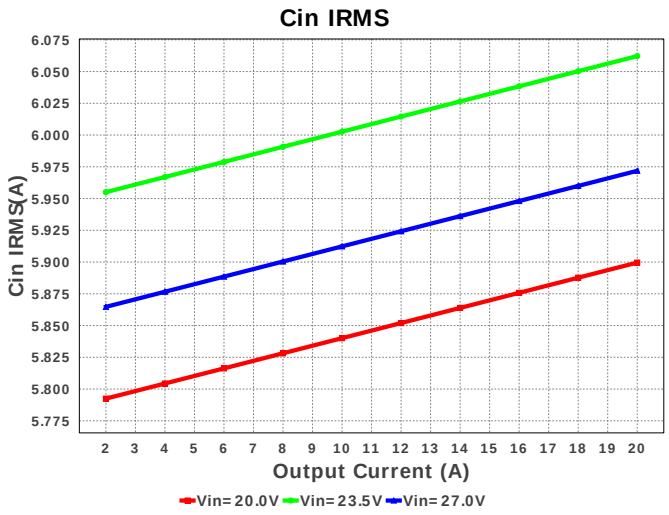


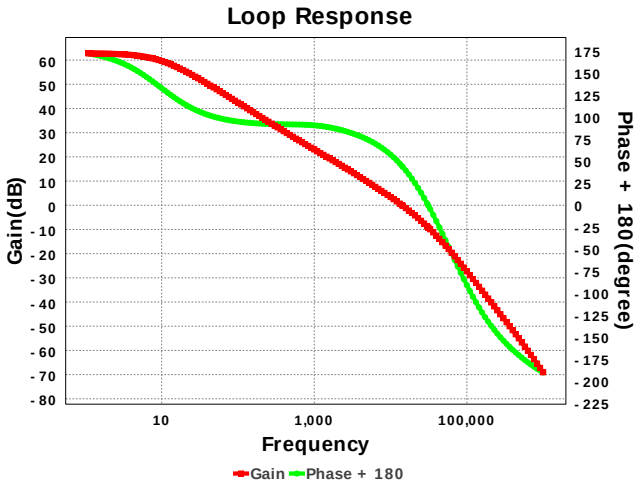

### Vout p- p




### M3 Pd






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 7.923 A | Current | Input capacitor RMS ripple current |
| 2. | Cout IRMS | 16.112 A | Current | Output capacitor RMS ripple current |
| 3. | Coutx IRMS | 2.516 A | Current | Output capacitor_x RMS ripple current |
| 4. | Iin Avg | 50.199 A | Current | Average input current |
| 5. | L Ipp | 27.445 A | Current | Peak-to-peak inductor ripple current |
| 6. | L1 Irms | 55.923 A | Current | Inductor ripple current |
| 7. | M3 Irms | 37.604 A | Current | MOSFET RMS ripple current |
| 8. | M4 Irms | 26.819 A | Current | MOSFET RMS ripple current |
| 9. | SW Ipk | 49.31 A | Current | Peak switch current |
| 10. | BOM Count | 61 | General | Total Design BOM count |
| 11. | FootPrint | 3.521 k $mm^2$ | General | Total Foot Print Area of BOM components |
| 12. | Frequency | 392.804 kHz | General | Switching frequency |
| 13. | IC Tolerance | 0.0 V | General | IC Feedback Tolerance |
| 14. | Pout | 960.0 W | General | Total output power |
| 15. | Total BOM | $0.0 | General | Total BOM Cost |
| 16. | Low Freq Gain | 62.755 dB | Op_Point | Gain at 10Hz |
| 17. | M3 TjOP | 79.811 degC | Op_Point | MOSFET junction temperature |
| 18. | M4 TjOP | 55.801 degC | Op_Point | MOSFET junction temperature |
| 19. | Vout Actual | 48.0 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 20. | Vout OP | 48.0 V | Op_Point | Operational Output Voltage |
| 21. | Cross Freq | 14.129 kHz | Op_point | Bode plot crossover frequency |
| 22. | Duty Cycle | 43.801 % | Op_point | Duty cycle |
| 23. | Efficiency | 95.619 % | Op_point | Steady state efficiency |
| 24. | Gain Marg | -9.251 dB | Op_point | Bode Plot Gain Margin |
| 25. | IC Tj | 46.813 degC | Op_point | IC junction temperature |
| 26. | ICThetaJA | 30.5 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 27. | IOUT_OP | 20.0 A | Op_point | Iout operating point |
| 28. | Phase Marg | 45.346 deg | Op_point | Bode Plot Phase Margin |
| 29. | VIN_OP | 20.0 V | Op_point | Vin operating point |
| 30. | Vout p-p | 148.747 mV | Op_point | Peak-to-peak output ripple voltage |
| 31. | Cin Pd | 523.086 mW | Power | Input capacitor power dissipation |
| 32. | Cout Pd | 721.12 mW | Power | Output capacitor power dissipation |
| 33. | Coutx Pd | 3.144 mW | Power | Output capacitor_x power loss |
| 34. | D2 Pd | 0.0 W | Power | Diode power dissipation |
| 35. | D3 Pd | 0.0 W | Power | Diode power dissipation |
| 36. | IC Pd | 551.259 mW | Power | IC power dissipation |
| 37. | L Pd | 37.528 W | Power | Inductor power dissipation |
| 38. | M1 Pd | 0.0 W | Power | M1 MOSFET total power dissipation |
| 39. | M1 PdCond | 0.0 W | Power | M1 MOSFET conduction losses |
| 40. | M2 Pd | 0.0 W | Power | M2 MOSFET total power dissipation |
| 41. | M3 Pd | 1.217 W | Power | MOSFET power dissipation |
| 42. | M3 PdCond | 0.0 W | Power | M1 MOSFET conduction losses |
| 43. | M3 PdSw | 1.217 W | Power | M1 MOSFET switching losses |
| 44. | M3 Rdson | 0.0 Ohm | Power | Drain-Source On-resistance |
| 45. | M4 Pd | 2.074 W | Power | MOSFET power dissipation |
| 46. | M4 PdCond | 0.0 W | Power | M2 MOSFET conduction losses |
| 47. | M4 PdSw | 0.0 W | Power | M2 MOSFET switching losses |
| 48. | M4 Rdson | 0.0 Ohm | Power | Drain-Source On-resistance |
| 49. | Rsense Pd | 1.366 W | Power | LED Current Rsns Power Dissipation |
| 50. | Total Pd | 43.984 W | Power | Total Power Dissipation |
| 51. | M3 ThetaJA | 55.0 degC/W | | MOSFET junction-to-ambient thermal resistance |
| 52. | M4 ThetaJA | 55.0 degC/W | | MOSFET junction-to-ambient thermal resistance |

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 53. | Vout Tolerance | 1.987 % | | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 20.0 | Maximum Output Current |
| 2. | VinMax | 27.0 | Maximum input voltage |
| 3. | VinMin | 20.0 | Minimum input voltage |
| 4. | Vout | 48.0 | Output Voltage |
| 5. | base_pn | LM5175 | Base Product Number |
| 6. | source | DC | Input Source Type |
| 7. | Ta | 30.0 | Ambient temperature |

## Design Assistance

1. Tip: Snubbers and/or gate resistors may be required to limit the SW1,2 node switching spikes below the IC and FET abs max ratings.

2. Tip: Slope Capacitor: smaller slope capacitors provide better transition region behavior.

3. **LM5175** Product Folder : http://www.ti.com/product/LM5175 : contains the data sheet and other resources.