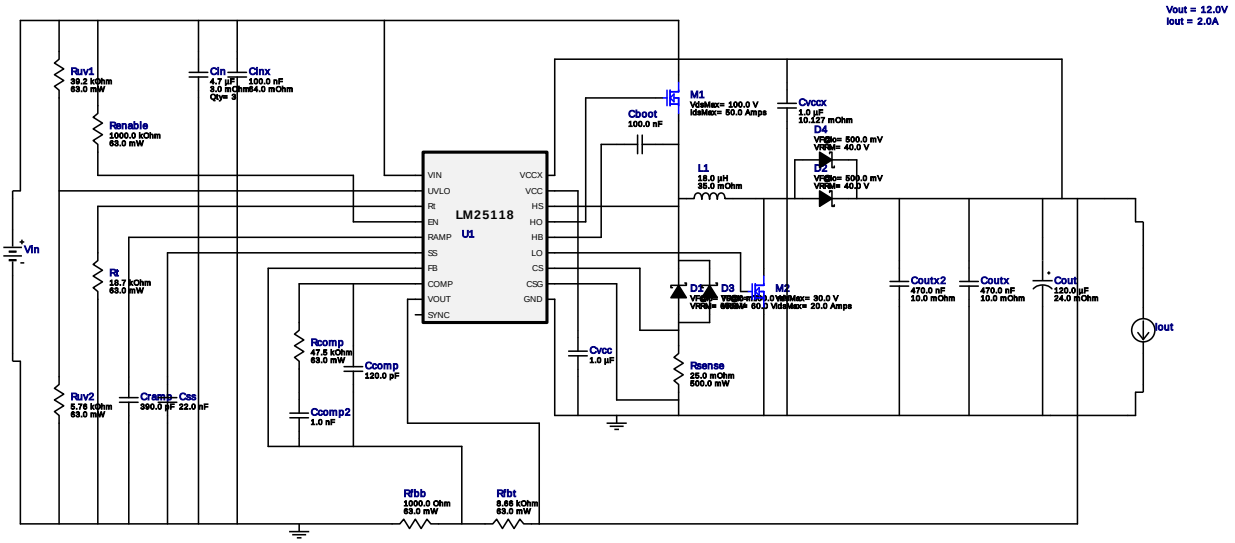
TEXAS INSTRUMENTS

# WEBENCH® Design Report

VinMin = 12.0V
VinMax = 36.0V
Vout = 12.0V
Iout = 2.0A

Device = LM25118MH/NOPB
Topology = Buck_Boost
Created = 8/11/16 5:20:52 AM
BOM Cost = $5.23
BOM Count = 30
Total Pd = 2.08W

Design : 4085315/5 LM25118MH/NOPB
LM25118MH/NOPB 12.0V-36.0V to 12.00V @ 2.0A

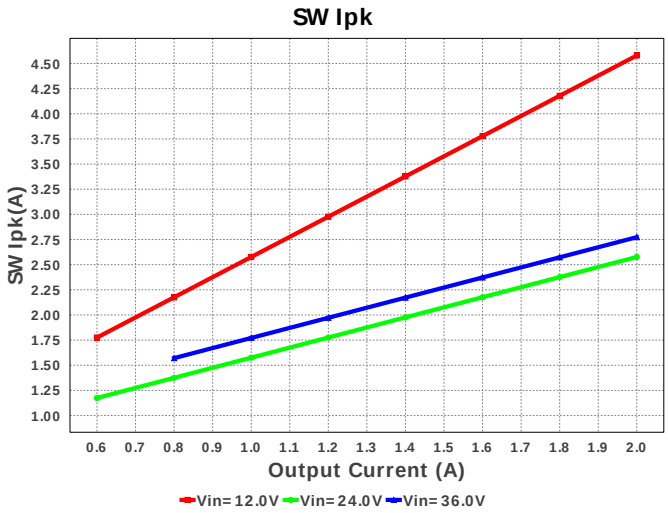


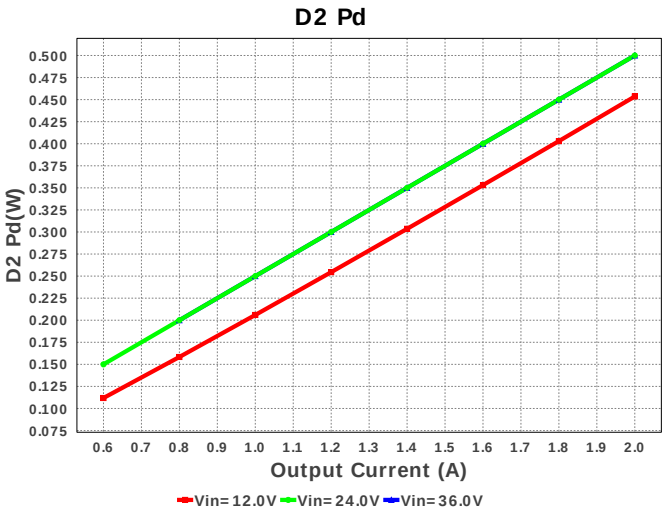

## Electrical BOM

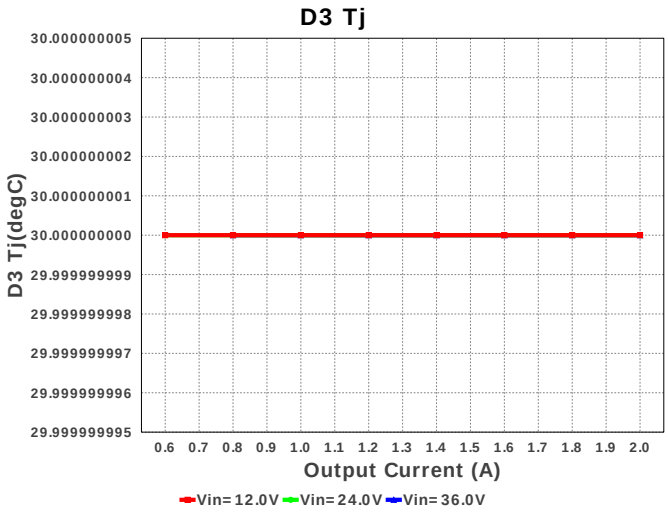
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cboot | MuRata | GRM21BR71E104KA01L<br>Series= X7R | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 2. | Ccomp | Samsung Electro-Mechanics | CL21C121JB61PNC<br>Series= C0G/NP0 | Cap= 120.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 3. | Ccomp2 | Samsung Electro-Mechanics | CL21C102JBCNFNC<br>Series= C0G/NP0 | Cap= 1.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 4. | Cin | MuRata | GRM31CR71H475KA12L<br>Series= X7R | Cap= 4.7 uF<br>ESR= 3.0 mOhm<br>VDC= 50.0 V<br>IRMS= 4.98 A | 3 | $0.07 | 1206 11 mm² |
| 5. | Cinx | Kemet | C0805C104K5RACTU<br>Series= X7R | Cap= 100.0 nF<br>ESR= 64.0 mOhm<br>VDC= 50.0 V<br>IRMS= 1.64 A | 1 | $0.01 | 0805 7 mm² |
| 6. | Cout | Chemi-Con | APXE160ARA121MH70G<br>Series= PXE | Cap= 120.0 uF<br>ESR= 24.0 mOhm<br>VDC= 16.0 V<br>IRMS= 3.01 A | 1 | $0.63 | CAPSMT_62_H70 110 mm² |
| 7. | Coutx | MuRata | GRM188R71C474KA88D<br>Series= X7R | Cap= 470.0 nF<br>ESR= 10.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.02 | 0603 5 mm² |
| 8. | Coutx2 | MuRata | GRM188R71C474KA88D<br>Series= X7R | Cap= 470.0 nF<br>ESR= 10.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.02 | 0603 5 mm² |
| 9. | Cramp | Yageo America | CC0805KRX7R9BB391<br>Series= X7R | Cap= 390.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |

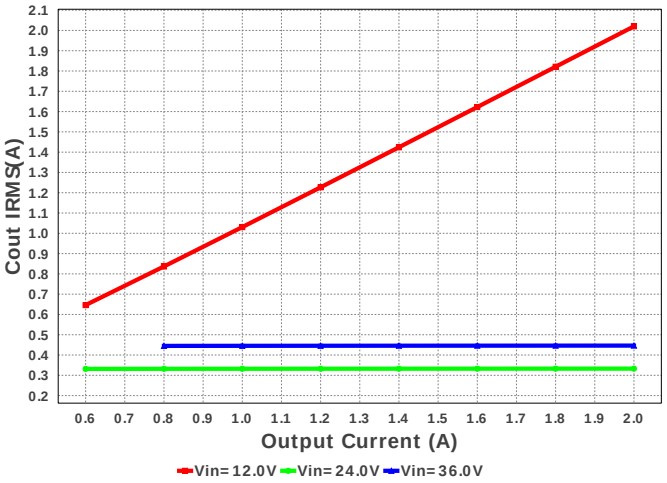
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 10. | Css | Yageo America | CC0805KRX7R9BB223<br>Series= X7R | Cap= 22.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0805 7 mm² |
| 11. | Cvcc | Taiyo Yuden | EMK212B7105KG-T<br>Series= X7R | Cap= 1.0 uF<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.02 | <br>0805 7 mm² |
| 12. | Cvccx | 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 |
| 13. | D1 | Diodes Inc. | B560C-13-F | VF@Io= 700.0 mV<br>VRRM= 60.0 V | 1 | $0.17 |  <br>SMC 83 mm² |
| 14. | D2 | Diodes Inc. | B340A-13-F | VF@Io= 500.0 mV<br>VRRM= 40.0 V | 1 | $0.11 |  <br>SMA 37 mm² |
| 15. | D3 | Diodes Inc. | B560C-13-F | VF@Io= 700.0 mV<br>VRRM= 60.0 V | 1 | $0.17 |  <br>SMC 83 mm² |
| 16. | D4 | Diodes Inc. | B340A-13-F | VF@Io= 500.0 mV<br>VRRM= 40.0 V | 1 | $0.11 |  <br>SMA 37 mm² |
| 17. | L1 | Bourns | SRR1210-180M | L= 18.0 µH<br>DCR= 35.0 mOhm | 1 | $0.44 |  <br>SRR1210 196 mm² |
| 18. | M1 | Texas Instruments | CSD19537Q3 | VdsMax= 100.0 V<br>IdsMax= 50.0 Amps | 1 | $0.50 |  <br>TRANS_NexFET_Q3 18 mm² |
| 19. | M2 | Texas Instruments | CSD17579Q3A | VdsMax= 30.0 V<br>IdsMax= 20.0 Amps | 1 | $0.19 |  <br>TRANS_NexFET_Q3A 18 mm² |
| 20. | Rcomp | Vishay-Dale | CRCW040247K5FKED<br>Series= CRCW..e3 | Res= 47.5 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 21. | Renable | Vishay-Dale | CRCW04021M00FKED<br>Series= CRCW..e3 | Res= 1000.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 22. | Rfbb | 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 mm² |
| 23. | Rfbt | 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 mm² |
| 24. | Rsense | Stackpole Electronics Inc | CSR1206FK25L0<br>Series= ? | Res= 25.0 mOhm<br>Power= 500.0 mW<br>Tolerance= 1.0% | 1 | $0.10 |  <br>1206 11 mm² |
| 25. | Rt | Vishay-Dale | CRCW040218K7FKED<br>Series= CRCW..e3 | Res= 18.7 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 26. | Ruv1 | Vishay-Dale | CRCW040239K2FKED<br>Series= CRCW..e3 | Res= 39.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 27. | Ruv2 | Vishay-Dale | CRCW04025K76FKED<br>Series= CRCW..e3 | Res= 5.76 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |

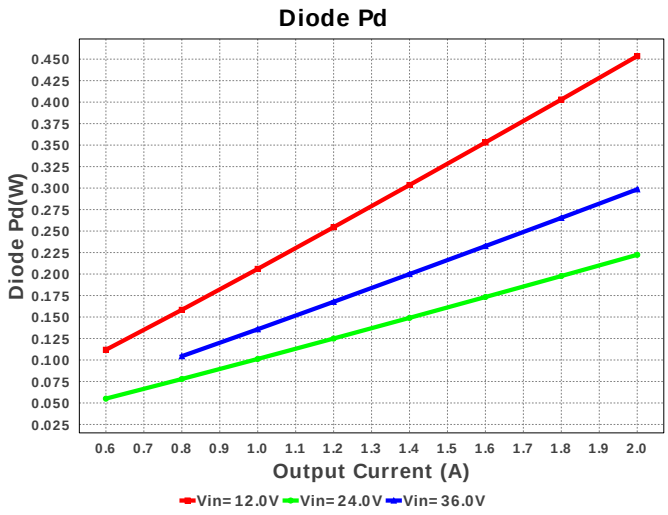
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 28. | U1 | Texas Instruments | LM25118MH/NOPB | Switcher | 1 | $2.40 |  MXA20A 71 mm² |

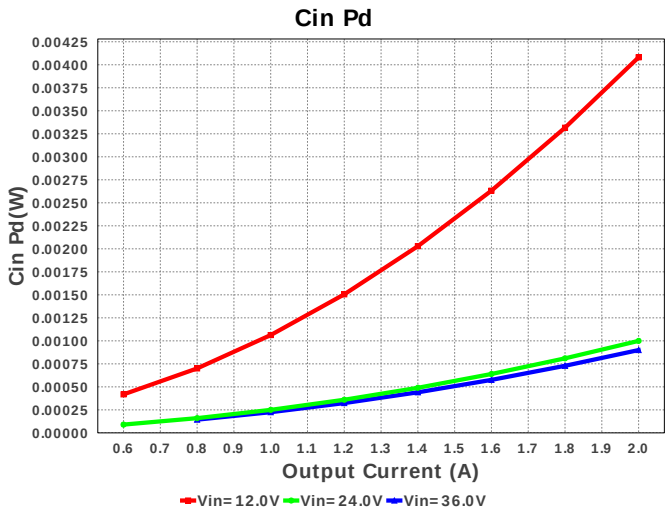


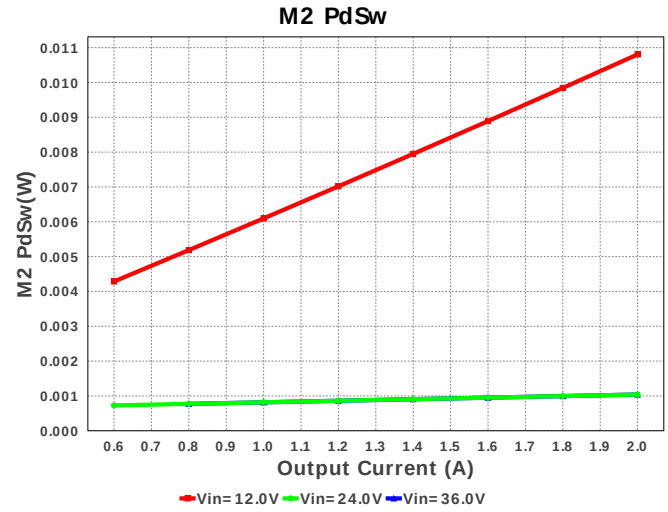



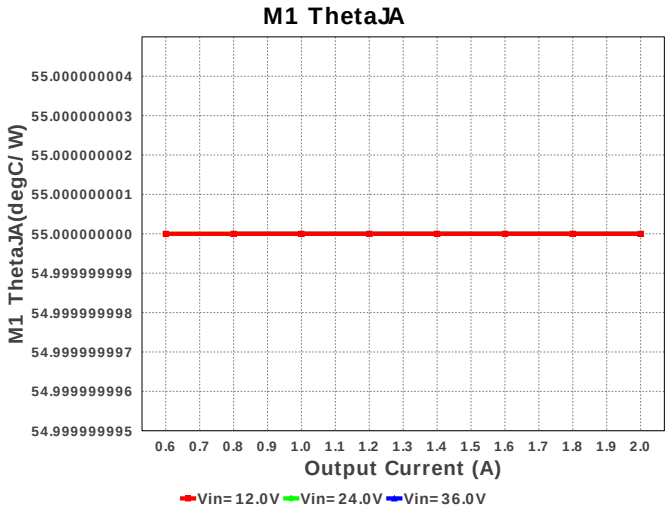



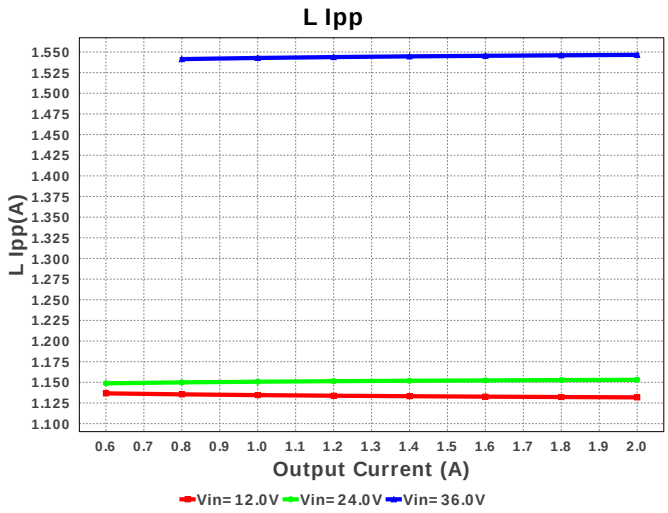



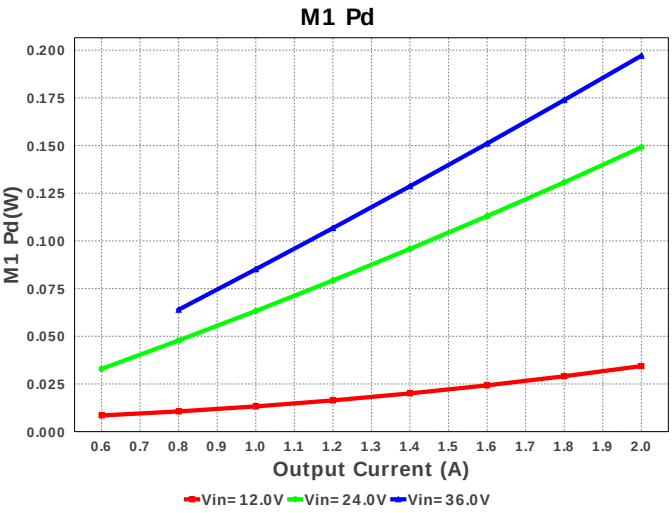


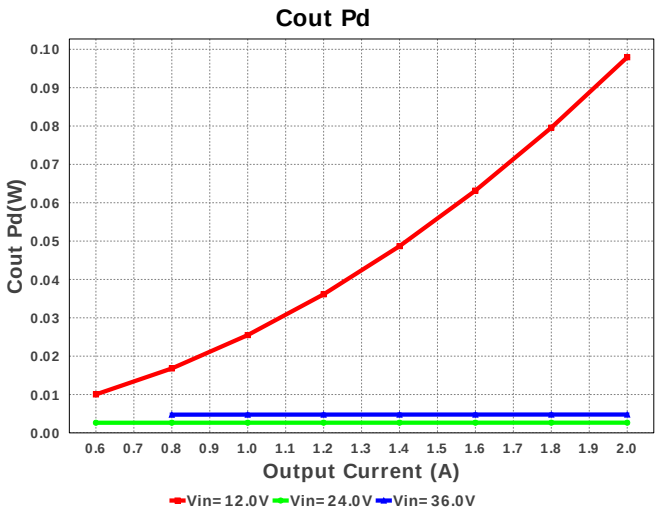



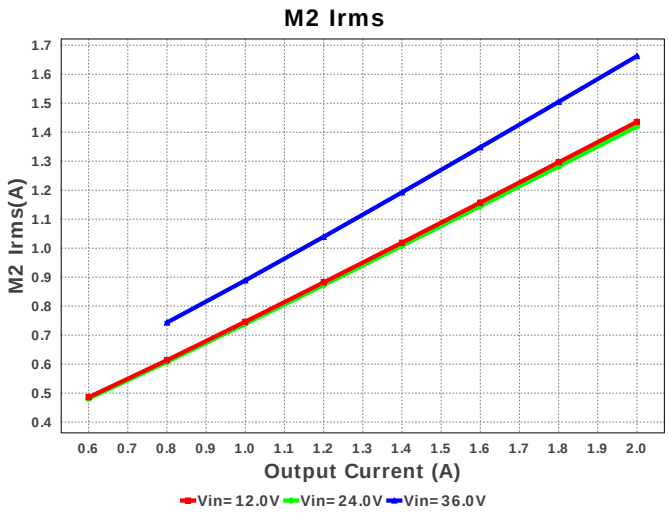



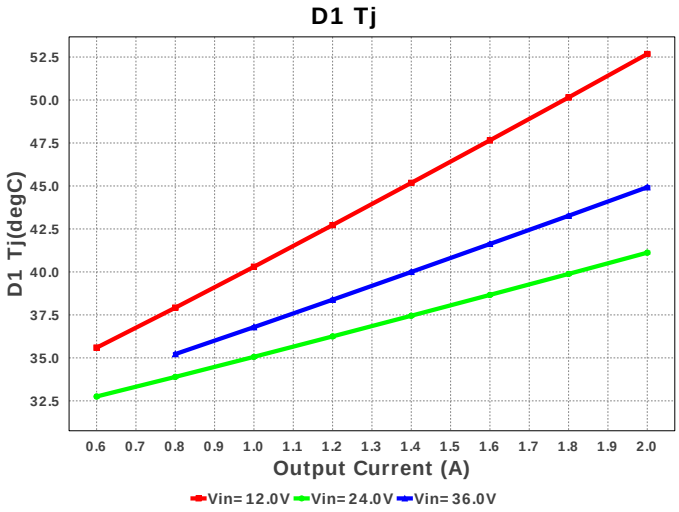



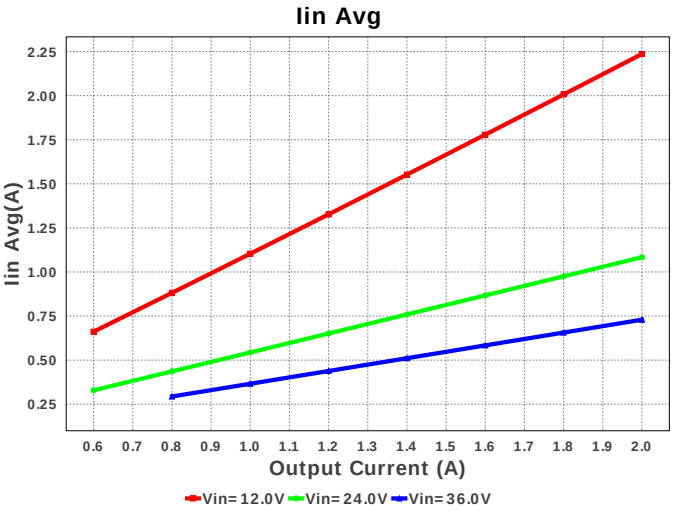



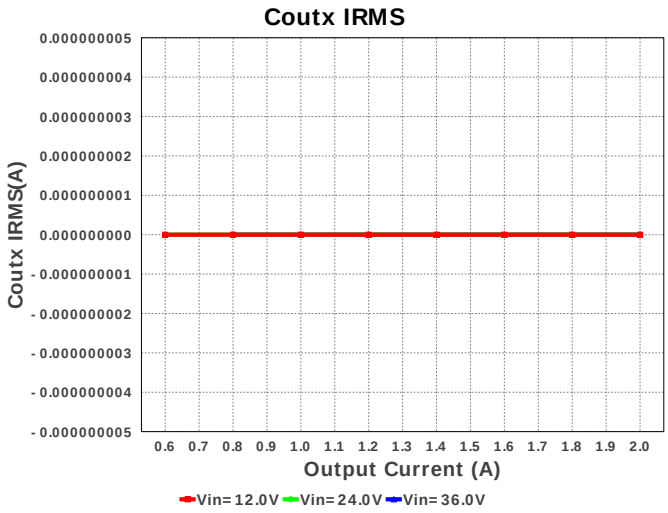



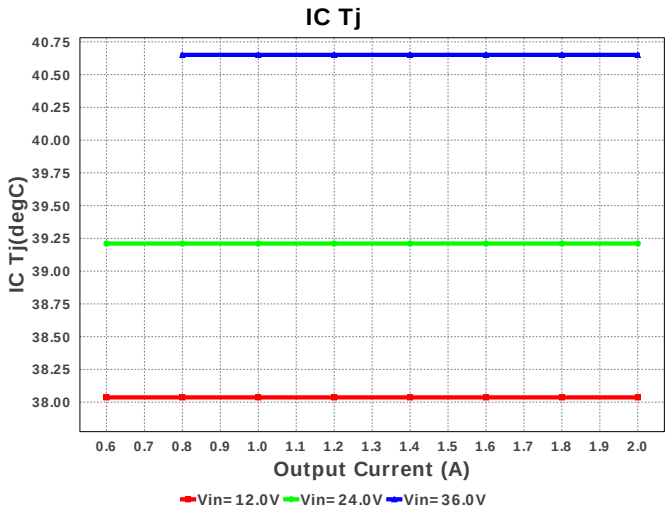


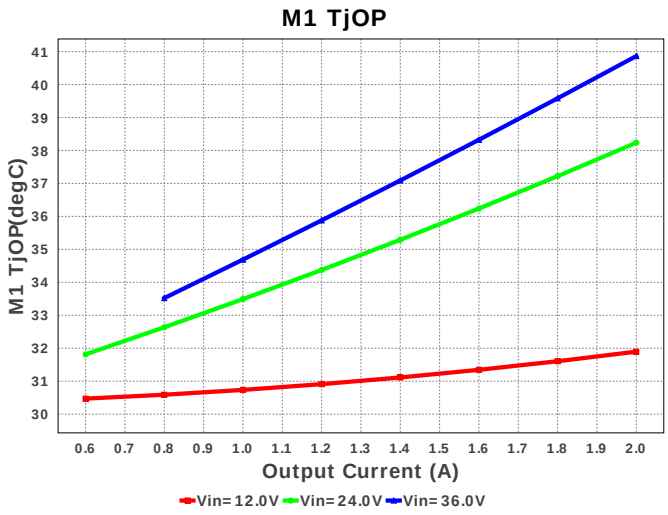



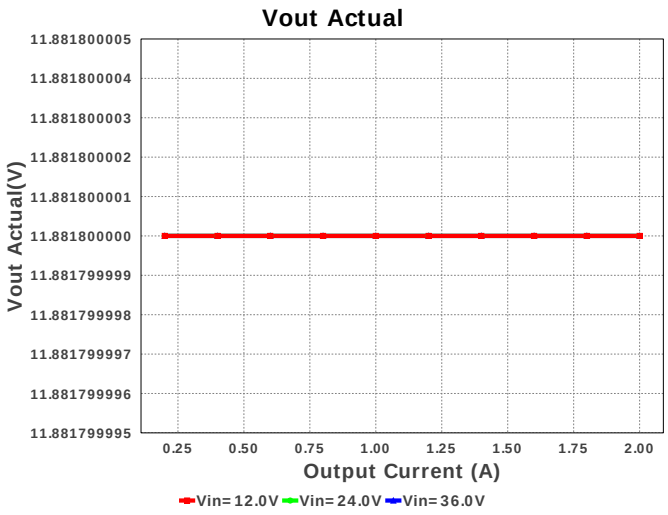



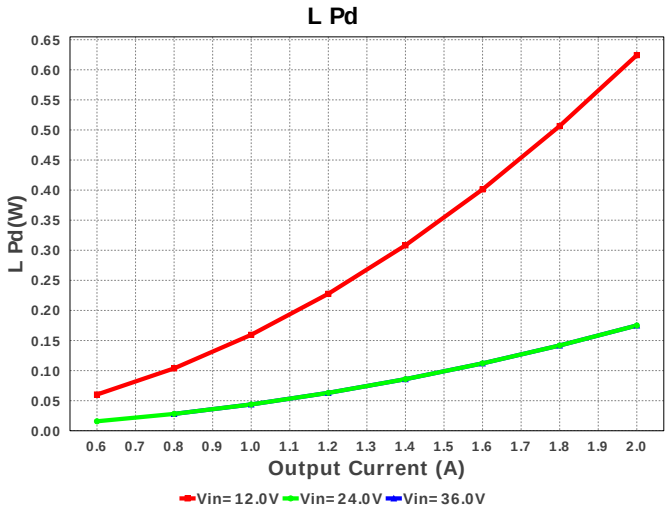



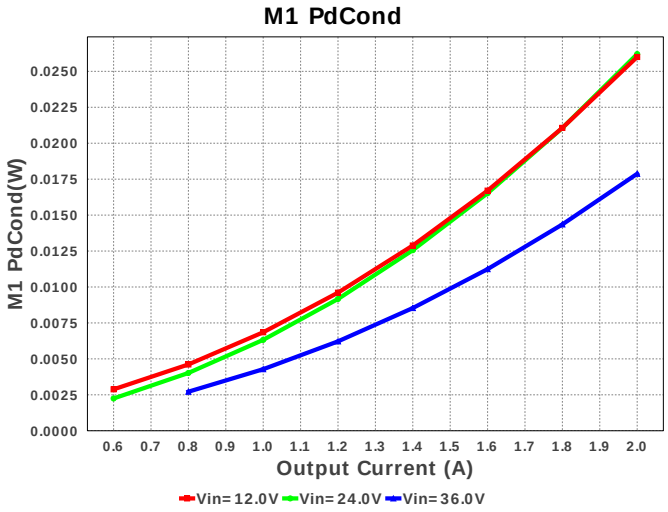



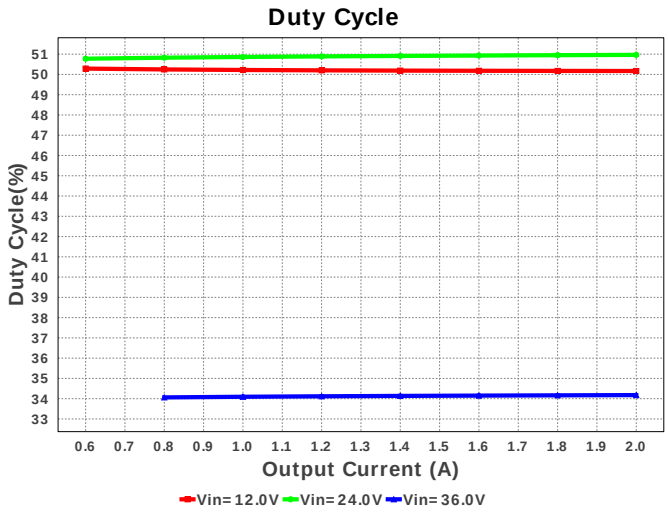



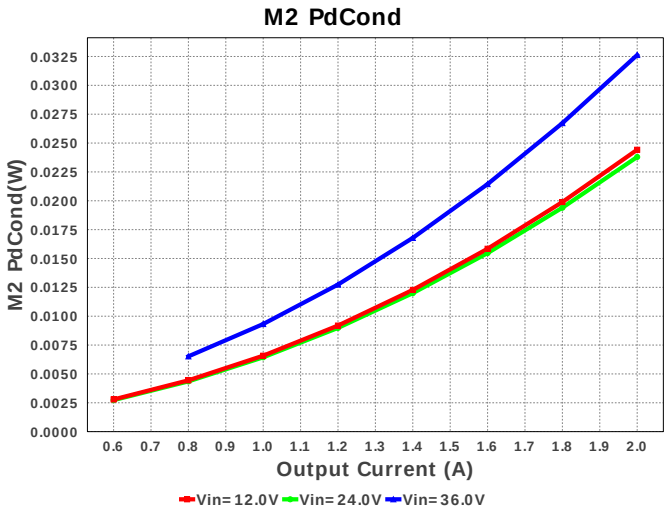


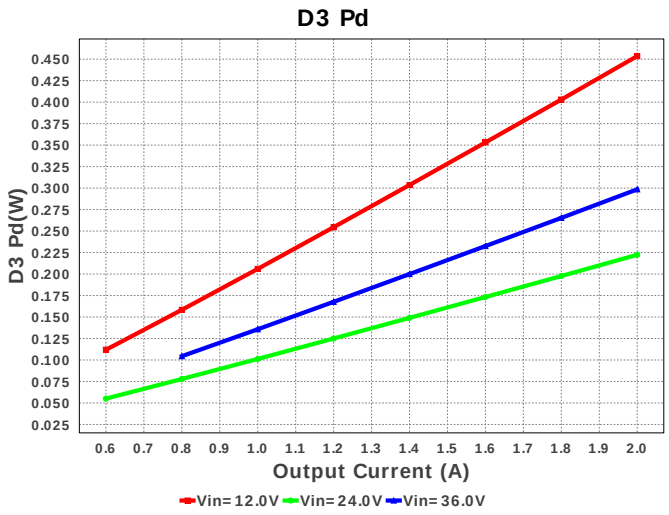



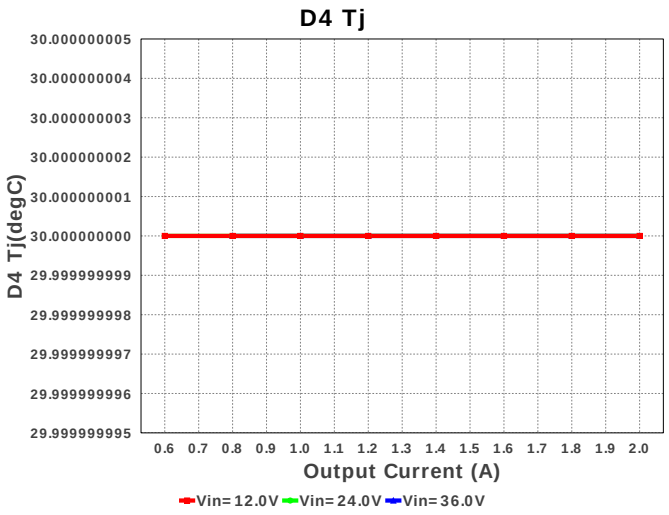



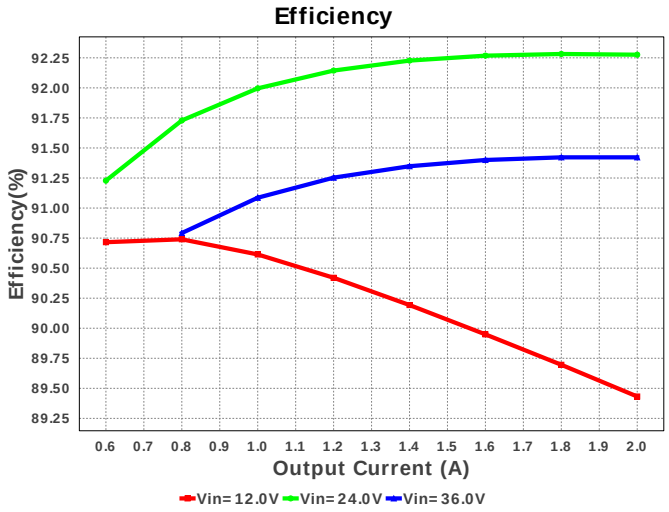



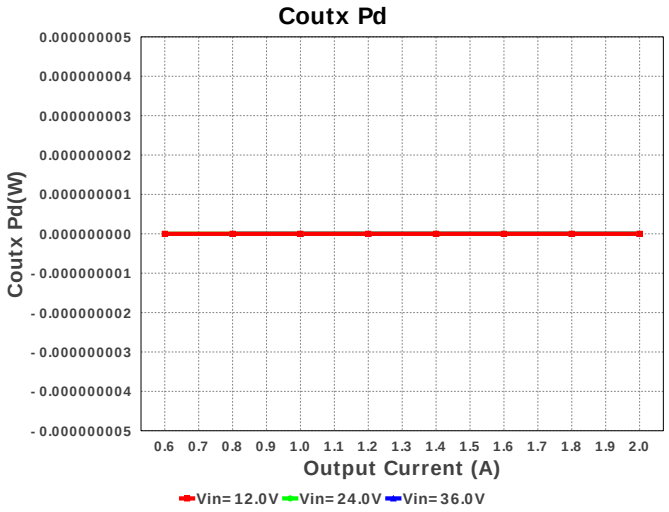



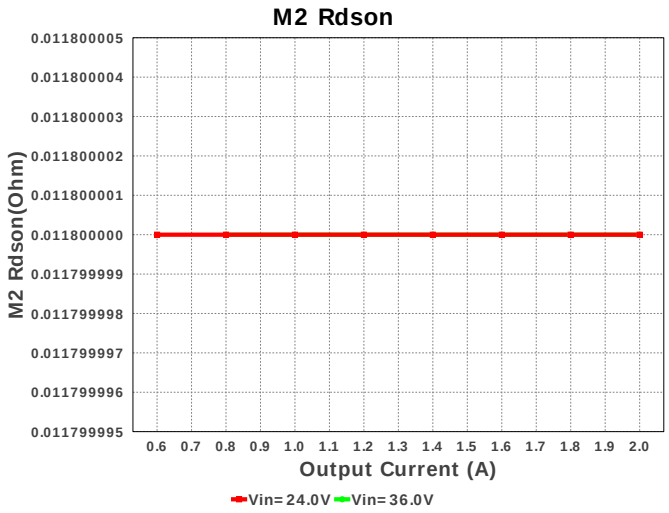



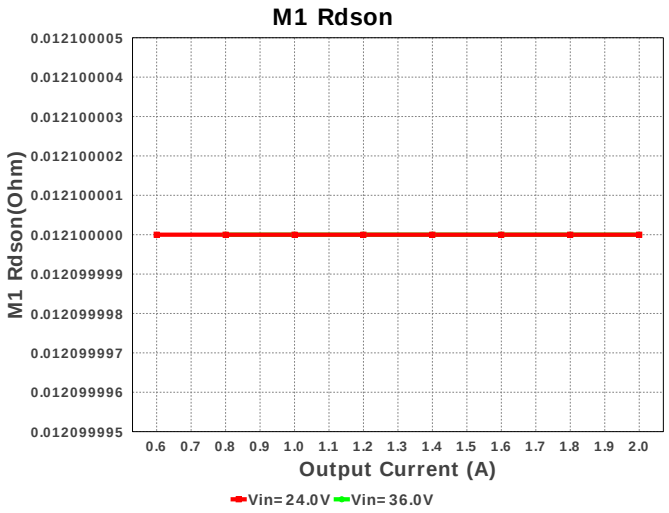


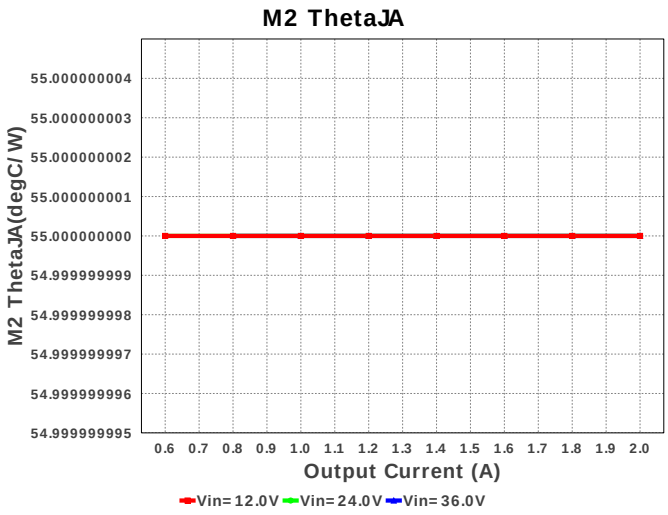



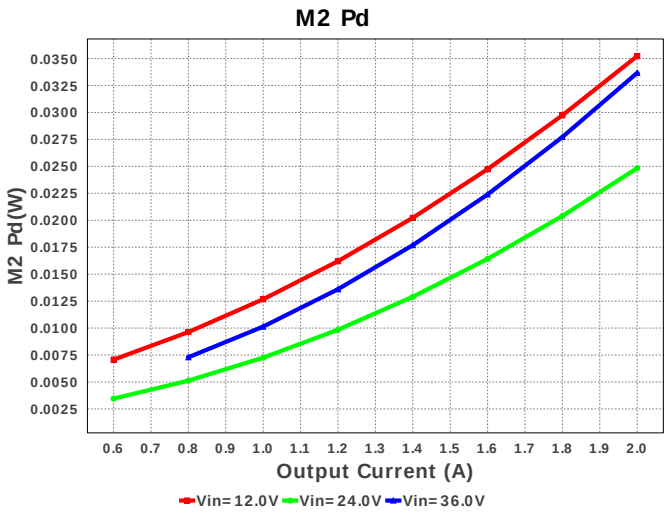



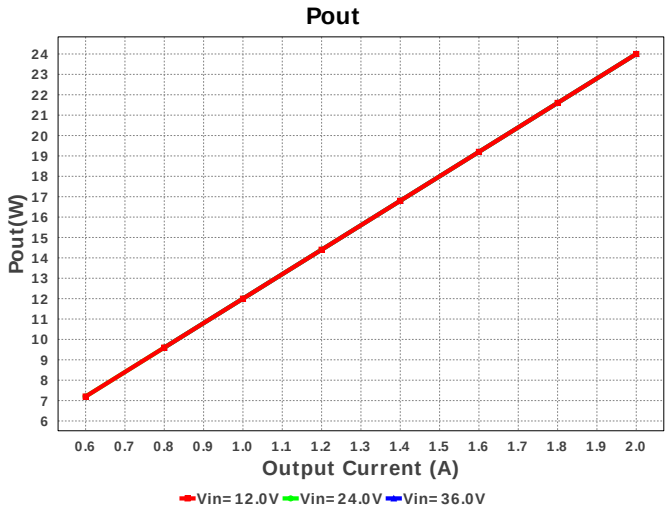



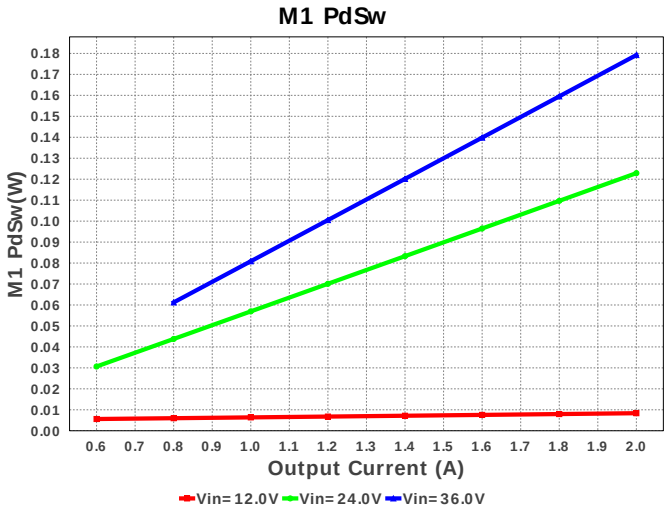



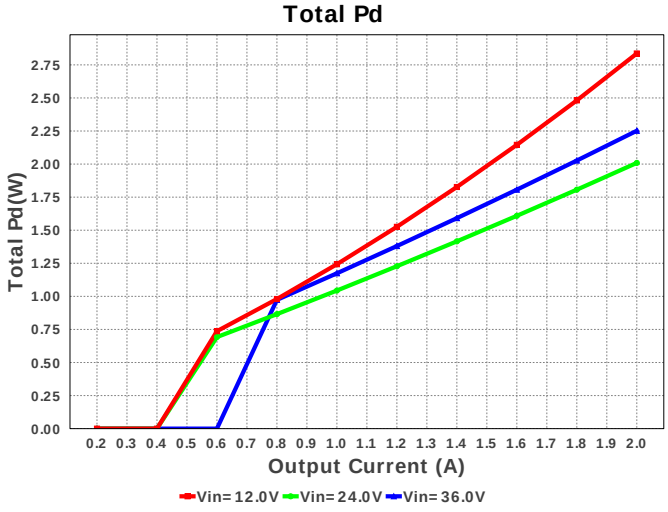



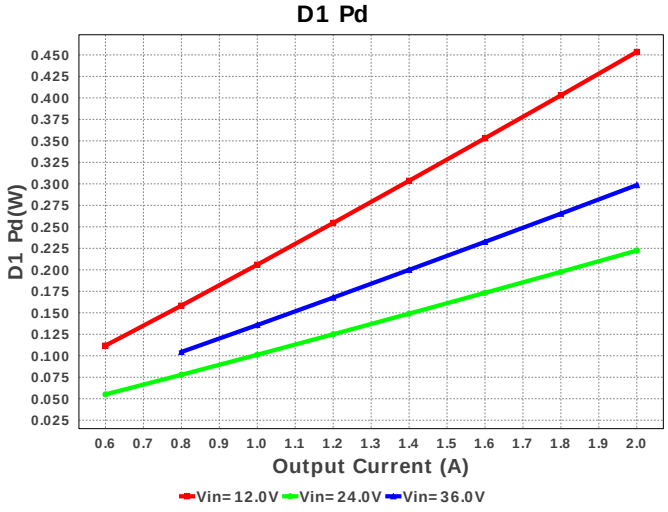


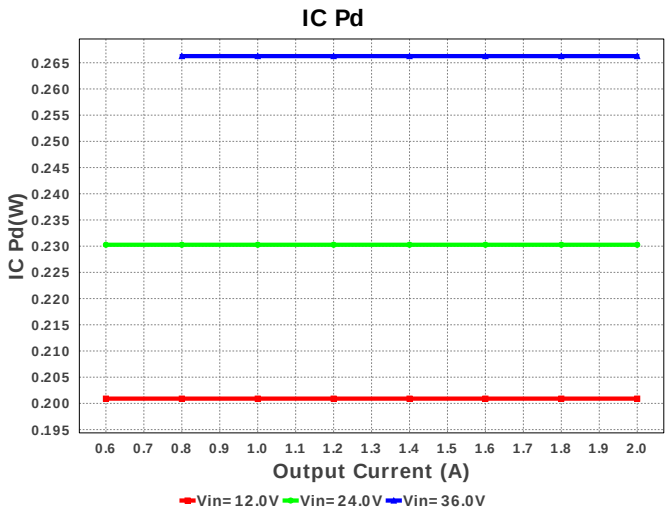



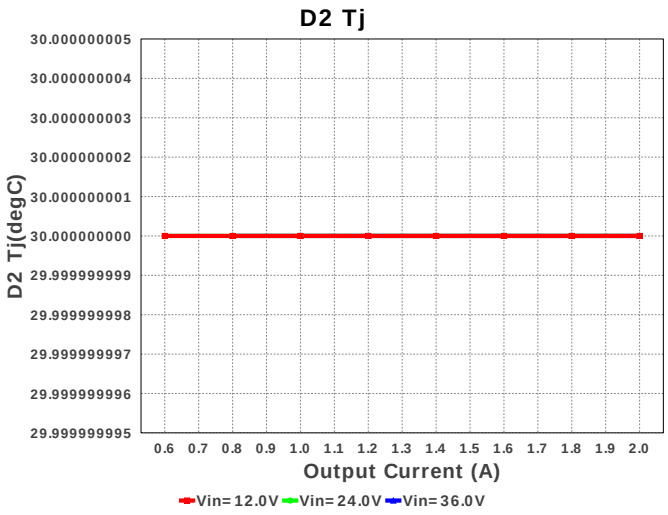



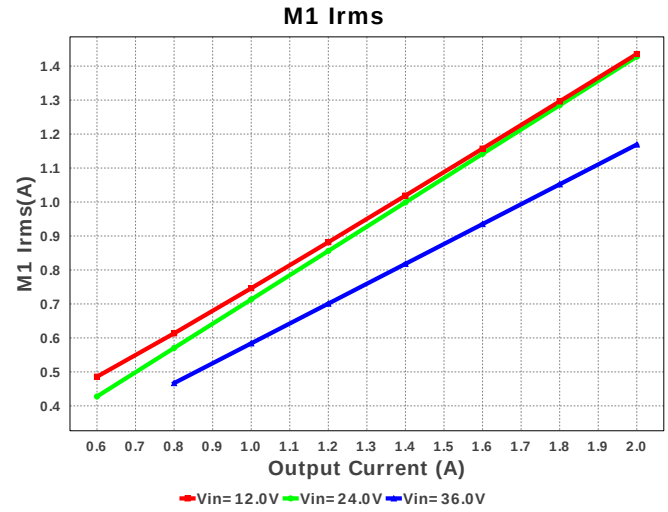



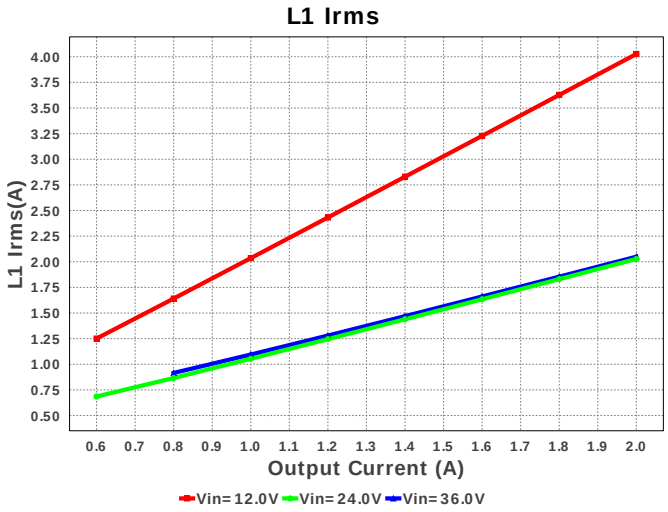



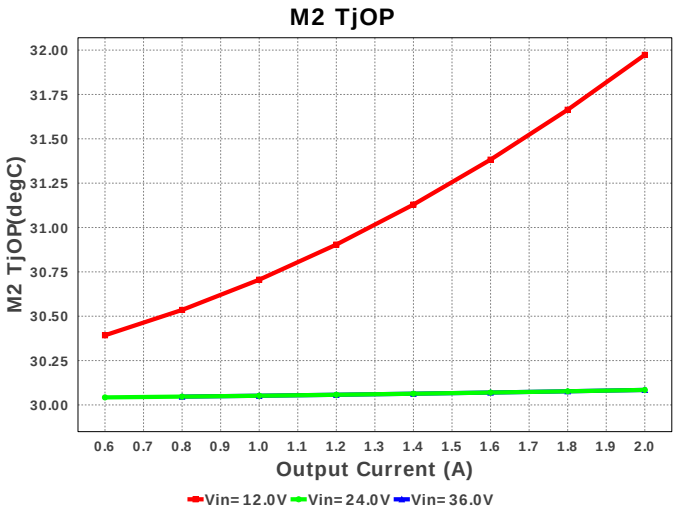



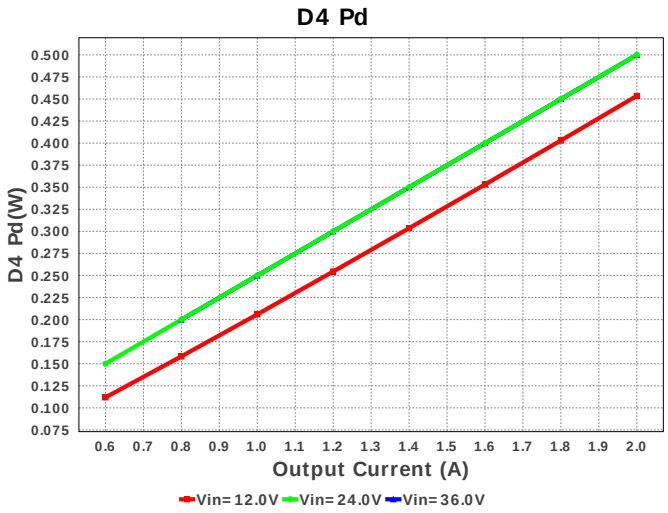


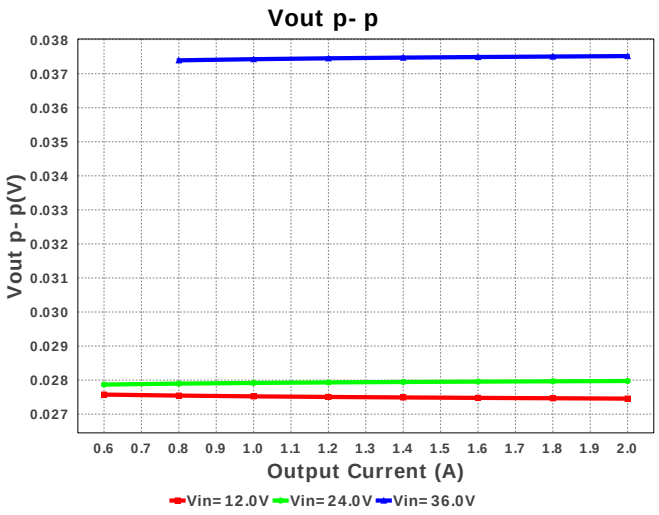



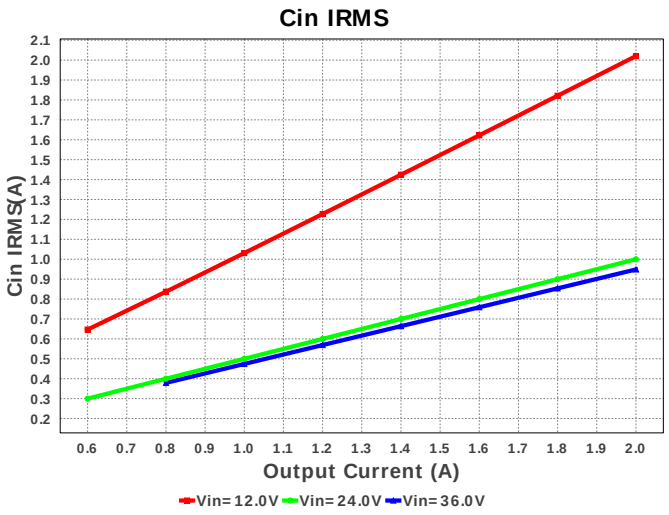



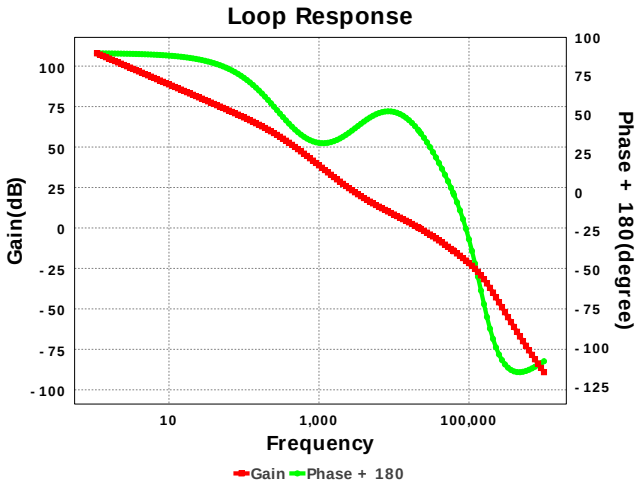






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 948.619 mA | Current | Input capacitor RMS ripple current |
| 2. | Cout IRMS | 446.465 mA | Current | Output capacitor RMS ripple current |
| 3. | Coutx IRMS | 0.0 A | Current | Output capacitor_x RMS ripple current |
| 4. | Iin Avg | 724.33 mA | Current | Average input current |
| 5. | L Ipp | 1.547 A | Current | Peak-to-peak inductor ripple current |
| 6. | L1 Irms | 2.049 A | Current | Inductor ripple current |
| 7. | M1 Irms | 1.169 A | Current | MOSFET RMS ripple current |
| 8. | M2 Irms | 1.663 A | Current | MOSFET RMS ripple current |
| 9. | SW Ipk | 2.773 A | Current | Peak switch current |
| 10. | BOM Count | 30 | General | Total Design BOM count |
| 11. | FootPrint | 782.0 $mm^2$ | General | Total Foot Print Area of BOM components |
| 12. | Frequency | 294.659 kHz | General | Switching frequency |
| 13. | IC Tolerance | 18.0 mV | General | IC Feedback Tolerance |
| 14. | M1 Rdson | 12.1 mOhm | General | Drain-Source On-resistance |
| 15. | M1 ThetaJA | 55.0 degC/W | General | MOSFET junction-to-ambient thermal resistance |
| 16. | M2 Rdson | 11.8 mOhm | General | Drain-Source On-resistance |
| 17. | M2 ThetaJA | 55.0 degC/W | General | MOSFET junction-to-ambient thermal resistance |
| 18. | Mode | CCM | General | Conduction Mode |
| 19. | Pout | 24.0 W | General | Total output power |
| 20. | Total BOM | $5.23 | General | Total BOM Cost |
| 21. | D1 Tj | 44.926 degC | Op_Point | D1 junction temperature |
| 22. | D1 Tj | 44.926 degC | Op_Point | D1 junction temperature |
| 23. | D2 Tj | 71.078 degC | Op_Point | D2 junction temperature |
| 24. | D3 Tj | 44.926 degC | Op_Point | D3 junction temperature |
| 25. | D4 Tj | 71.078 degC | Op_Point | D4 junction temperature |
| 26. | Low Freq Gain | 107.906 dB | Op_Point | Gain at 10Hz |
| 27. | Vout Actual | 11.882 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 28. | Vout OP | 12.0 V | Op_Point | Operational Output Voltage |
| 29. | Cross Freq | 21.669 kHz | Op_point | Bode plot crossover frequency |
| 30. | Duty Cycle | 34.179 % | Op_point | Duty cycle |
| 31. | Efficiency | 92.039 % | Op_point | Steady state efficiency |

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 32. | Gain Marg | -13.929 dB | Op_point | Bode Plot Gain Margin |
| 33. | IC Tj | 40.651 degC | Op_point | IC junction temperature |
| 34. | ICThetaJA | 40.0 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 35. | IOUT_OP | 2.0 A | Op_point | Iout operating point |
| 36. | M1 TjOP | 40.863 degC | Op_point | MOSFET junction temperature |
| 37. | M2 TjOP | 35.968 degC | Op_point | MOSFET junction temperature |
| 38. | Operating Topology | Buck | Op_point | The current operating topology of the device |
| 39. | Phase Marg | 39.618 deg | Op_point | Bode Plot Phase Margin |
| 40. | VIN_OP | 36.0 V | Op_point | Vin operating point |
| 41. | Vout p-p | 37.519 mV | Op_point | Peak-to-peak output ripple voltage |
| 42. | Cin Pd | 899.878 µW | Power | Input capacitor power dissipation |
| 43. | Cout Pd | 4.784 mW | Power | Output capacitor power dissipation |
| 44. | Coutx Pd | 0.0 W | Power | Output capacitor_x power loss |
| 45. | D1 Pd | 298.529 mW | Power | Diode power dissipation |
| 46. | D2 Pd | 410.776 mW | Power | Diode2 power dissipation |
| 47. | D3 Pd | 298.529 mW | Power | Diode3 power dissipation |
| 48. | D4 Pd | 410.776 mW | Power | Diode4 power dissipation |
| 49. | Diode Pd | 298.529 mW | Power | Diode power dissipation |
| 50. | IC Pd | 266.268 mW | Power | IC power dissipation |
| 51. | L Pd | 175.0 mW | Power | Inductor power dissipation |
| 52. | M1 Pd | 199.418 mW | Power | MOSFET power dissipation |
| 53. | M1 PdCond | 20.195 mW | Power | M1 MOSFET conduction losses |
| 54. | M1 PdSw | 179.223 mW | Power | M1 MOSFET switching losses |
| 55. | M2 Pd | 41.01 mW | Power | MOSFET power dissipation |
| 56. | M2 PdCond | 33.472 mW | Power | M2 MOSFET conduction losses |
| 57. | M2 PdSw | 7.539 mW | Power | M2 MOSFET switching losses |
| 58. | Total Pd | 2.076 W | Power | Total Power Dissipation |
| 59. | Vout Tolerance | 3.301 % | | 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. | VinMax | 36.0 | Maximum input voltage |
| 3. | VinMin | 12.0 | Minimum input voltage |
| 4. | Vout | 12.0 | Output Voltage |
| 5. | base_pn | LM25118 | Texas Instruments Base Part Number |
| 6. | source | DC | Input Source Type |
| 7. | ta | 30.0 | Ambient temperature |

## Design Assistance

1. The LM25118 is a wide range buck-boost controller which is operable in an ultra wide input range of 3 to 75V. A buck-boost regulator can maintain regulation for input voltages either higher or lower than the output voltage. The challenge is that buck-boost power converters are not as efficient as buck regulators. The LM5118 has been designed as a dual mode controller whereby the power converter acts as a buck regulator while the input voltage is above the output. As the input voltage approaches the output voltage, a gradual transition to the buck-boost mode occurs. This gradual transition between modes eliminates disturbances at the output during transitions.

2. LM25118 Product Folder : http://www.ti.com/product/LM25118 : contains the data sheet and other resources.