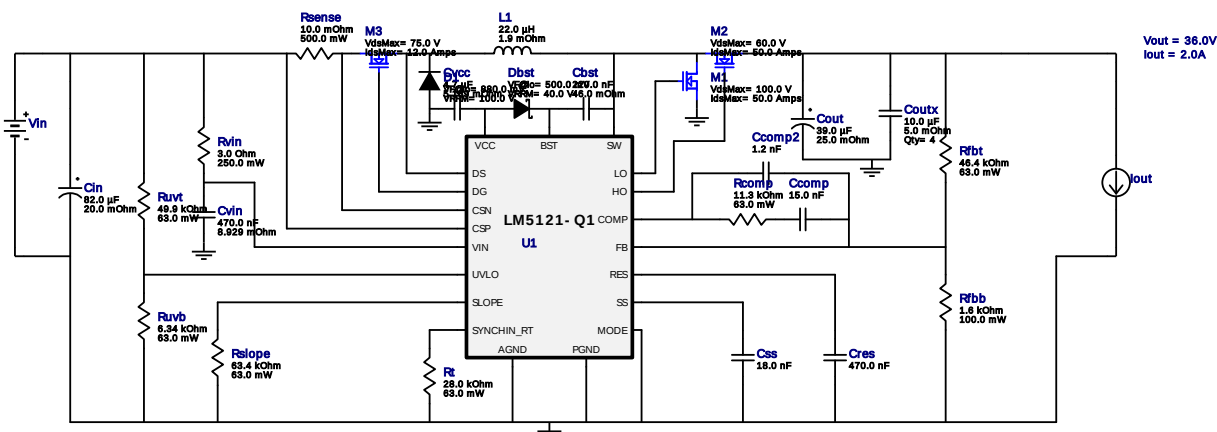


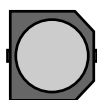
## WEBENCH® Design Report

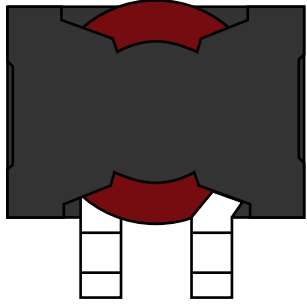
Design : 4802695/2 LM5121QMH/NOPB  
LM5121QMH/NOPB 14.0V-22.0V to 36.00V @ 2.0A



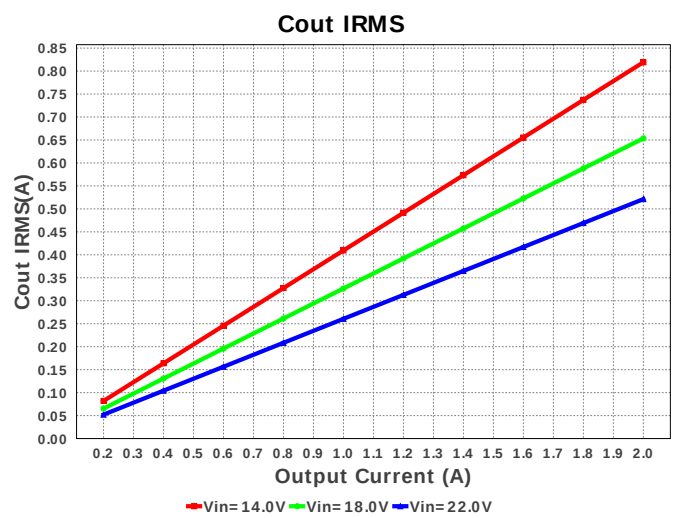
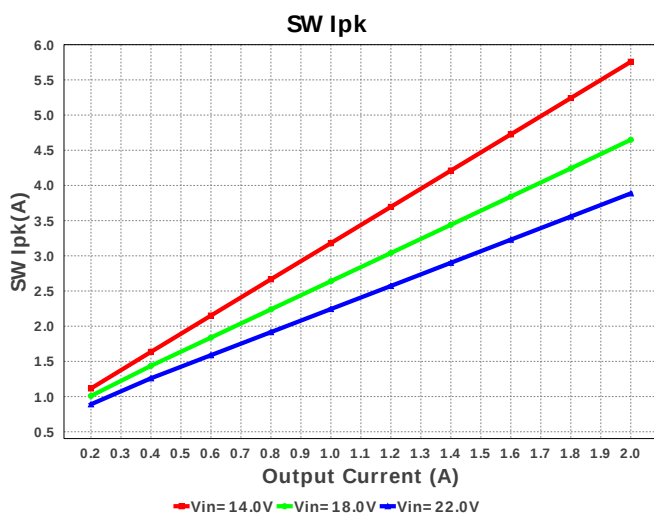
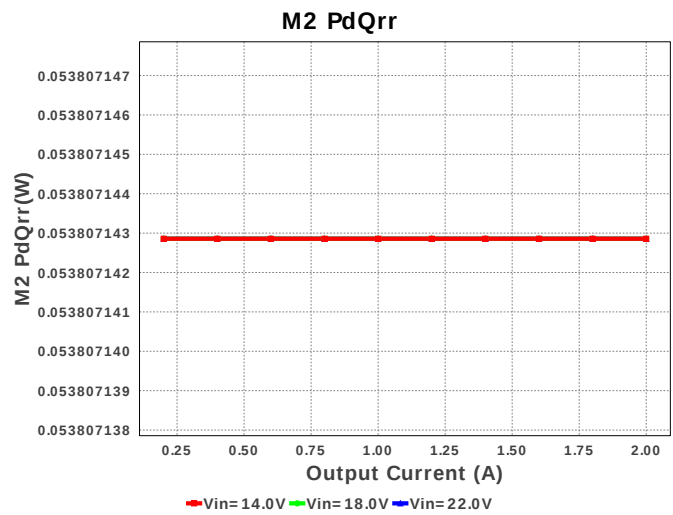
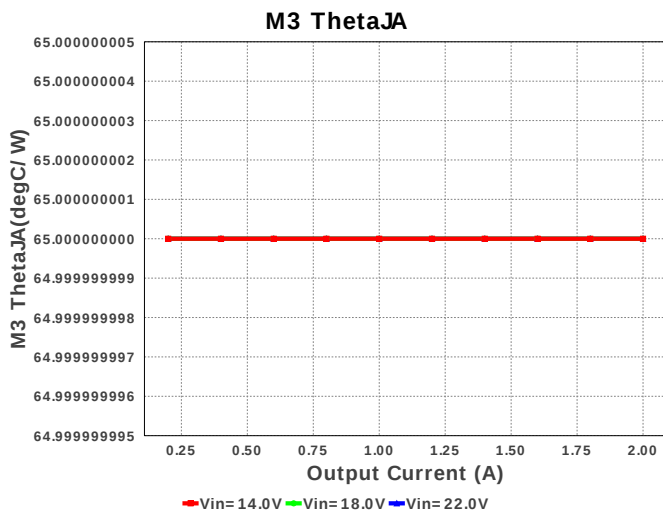
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer.

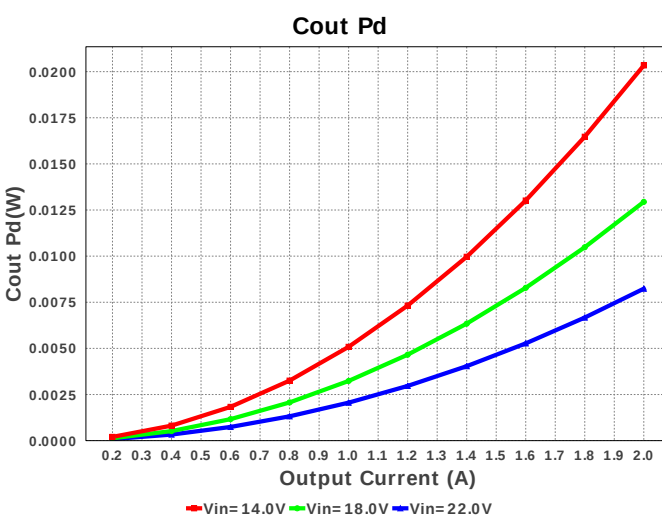
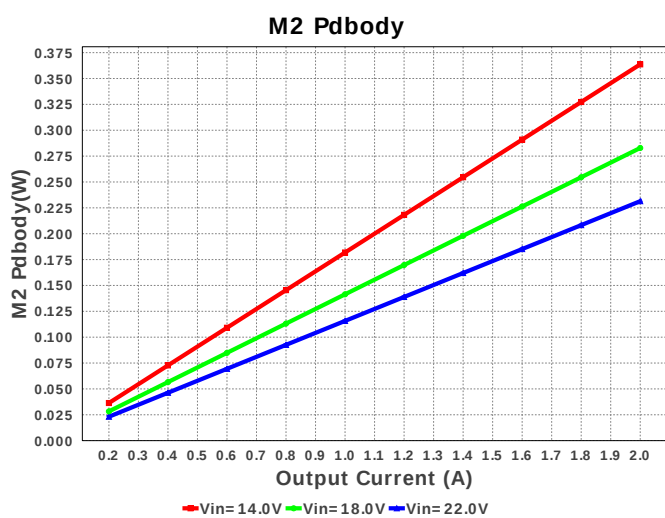
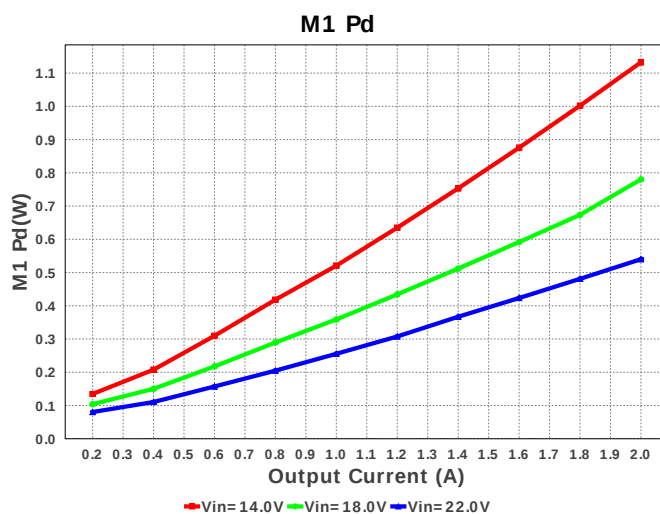
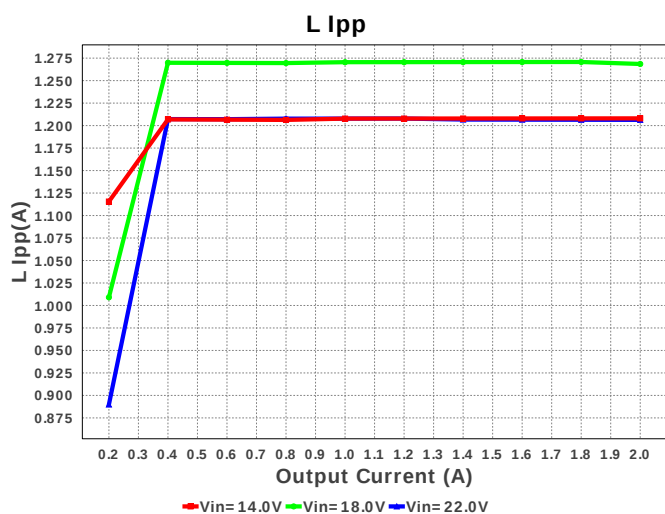
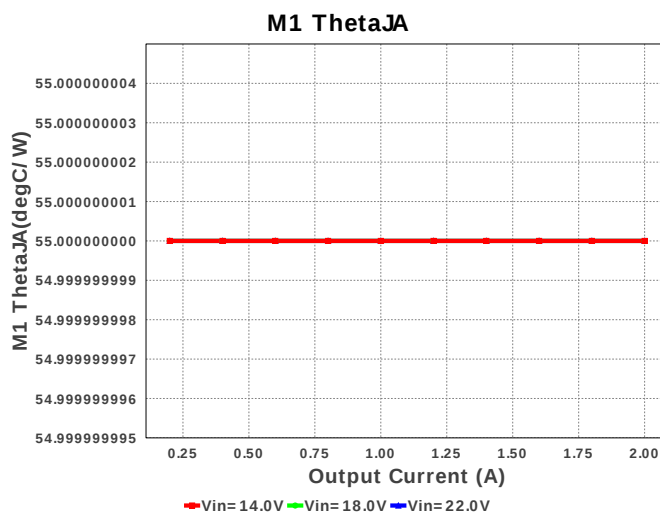
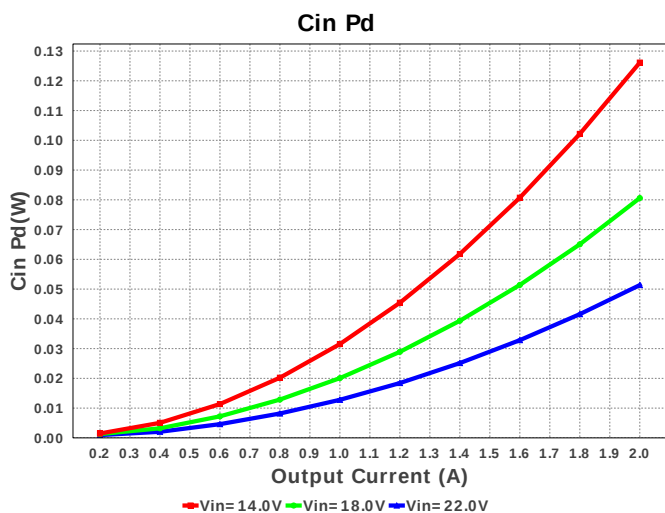
## Electrical BOM

| #  | Name   | Manufacturer              | Part Number                        | Properties                                                       | Qty | Price  | Footprint                                                                                                                  |
|----|--------|---------------------------|------------------------------------|------------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------------|
| 1. | Cbst   | 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 mm <sup>2</sup>                                                                                                     |
| 2. | Ccomp  | Yageo America             | CC0805KRX7R9BB153<br>Series= X7R   | Cap= 15.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | 0805 7 mm <sup>2</sup>                                                                                                     |
| 3. | Ccomp2 | Samsung Electro-Mechanics | CL21C122JBFNNWE<br>Series= C0G/NP0 | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | 0805 7 mm <sup>2</sup>                                                                                                     |
| 4. | Cin    | Panasonic                 | 35SVPF82M<br>Series= ?             | Cap= 82.0 uF<br>ESR= 20.0 mOhm<br>VDC= 35.0 V<br>IRMS= 4.0 A     | 1   | \$0.61 | <br>CAPSMT_62_E12 106 mm <sup>2</sup> |
| 5. | Cout   | Panasonic                 | 50SVPF39M<br>Series= ?             | Cap= 39.0 uF<br>ESR= 25.0 mOhm<br>VDC= 50.0 V<br>IRMS= 3.8 A     | 1   | \$0.72 | <br>CAPSMT_62_E12 106 mm <sup>2</sup> |
| 6. | Coutx  | TDK                       | C5750X7S2A106M230KB<br>Series= X7S | Cap= 10.0 uF<br>ESR= 5.0 mOhm<br>VDC= 100.0 V<br>IRMS= 6.45 A    | 4   | NA     | <br>2220 54 mm <sup>2</sup>           |
| 7. | Cres   | 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 <sup>2</sup>                                                                                                     |
| 8. | Css    | MuRata                    | GRM155R71E183KA61D<br>Series= X7R  | Cap= 18.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | 0402 3 mm <sup>2</sup>                                                                                                     |
| 9. | Cvcc   | 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>                                                                                                     |

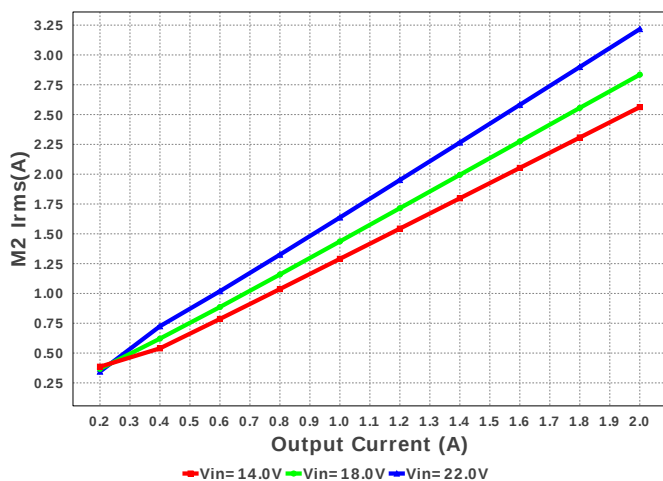
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                      | Qty | Price  | Footprint                                                                                                                  |
|-----|--------|---------------------------|--------------------------------------|-----------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------------|
| 10. | Cvin   | TDK                       | C3216JB2A474K<br>Series= JB          | Cap= 470.0 nF<br>ESR= 8.929 mOhm<br>VDC= 100.0 V<br>IRMS= 0.0 A | 1   | \$0.06 | <br>1206 11 mm <sup>2</sup>             |
| 11. | D1     | Vishay-Semiconductor      | SS10PH10-M3/86A                      | VF@Io= 880.0 mV<br>VRRM= 100.0 V                                | 1   | \$0.29 | <br>TO-277A 56 mm <sup>2</sup>          |
| 12. | Dbst   | Vishay-Semiconductor      | SS14-E3/61T                          | VF@Io= 500.0 mV<br>VRRM= 40.0 V                                 | 1   | \$0.08 | <br>SMA 37 mm <sup>2</sup>              |
| 13. | L1     | Coilcraft                 | SER2915H-223KL                       | L= 22.0 µH<br>DCR= 1.9 mOhm                                     | 1   | \$1.95 | <br>SER2915H 652 mm <sup>2</sup>        |
| 14. | M1     | Texas Instruments         | CSD19537Q3                           | VdsMax= 100.0 V<br>IdsMax= 50.0 Amps                            | 1   | \$0.50 | <br>DQG0008A 18 mm <sup>2</sup>         |
| 15. | M2     | Texas Instruments         | CSD18537NQ5A                         | VdsMax= 60.0 V<br>IdsMax= 50.0 Amps                             | 1   | \$0.31 | <br>TRANS_NexFET_Q5A 55 mm <sup>2</sup> |
| 16. | M3     | Vishay-Siliconix          | SI7148DP                             | VdsMax= 75.0 V<br>IdsMax= 12.0 Amps                             | 1   | NA     | <br>PowerPAK_SO-8 55 mm <sup>2</sup>  |
| 17. | Rcomp  | Vishay-Dale               | CRCW040211K3FKED<br>Series= CRCW..e3 | Res= 11.3 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 18. | Rfbb   | Yageo America             | RC0603FR-071K6L<br>Series= ?         | Res= 1.6 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0603 5 mm <sup>2</sup>            |
| 19. | Rfbt   | Vishay-Dale               | CRCW040246K4FKED<br>Series= CRCW..e3 | Res= 46.4 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 20. | Rsense | Stackpole Electronics Inc | CSR1206FK10L0<br>Series= ?           | Res= 10.0 mOhm<br>Power= 500.0 mW<br>Tolerance= 1.0%            | 1   | \$0.11 | <br>1206 11 mm <sup>2</sup>           |
| 21. | Rslope | Vishay-Dale               | CRCW040263K4FKED<br>Series= CRCW..e3 | Res= 63.4 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 22. | Rt     | Vishay-Dale               | CRCW040228K0FKED<br>Series= CRCW..e3 | Res= 28.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 23. | Ruvb   | Vishay-Dale               | CRCW04026K34FKED<br>Series= CRCW..e3 | Res= 6.34 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 24. | Ruvt   | Vishay-Dale               | CRCW040249K9FKED<br>Series= CRCW..e3 | Res= 49.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>            |
| 25. | Rvin   | Yageo America             | RC1206FR-073RL<br>Series= ?          | Res= 3.0 Ohm<br>Power= 250.0 mW<br>Tolerance= 1.0%              | 1   | \$0.01 | <br>1206 11 mm <sup>2</sup>           |

| #   | Name | Manufacturer      | Part Number    | Properties | Qty | Price  | Footprint                                                                                                        |
|-----|------|-------------------|----------------|------------|-----|--------|------------------------------------------------------------------------------------------------------------------|
| 26. | U1   | Texas Instruments | LM5121QMH/NOPB | Switcher   | 1   | \$2.76 | <br>MXA20A 71 mm <sup>2</sup> |

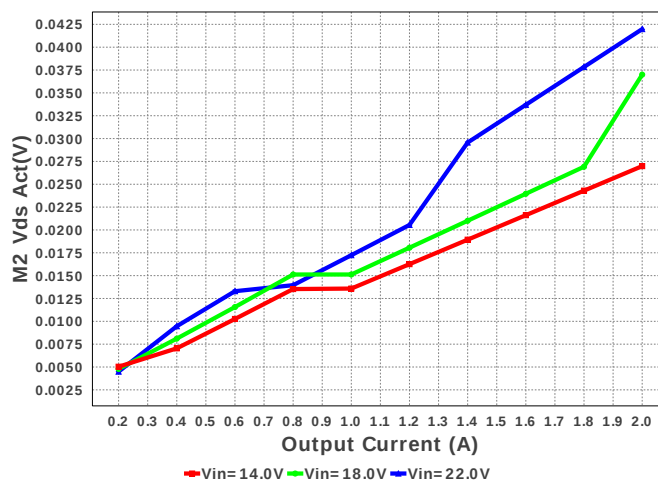




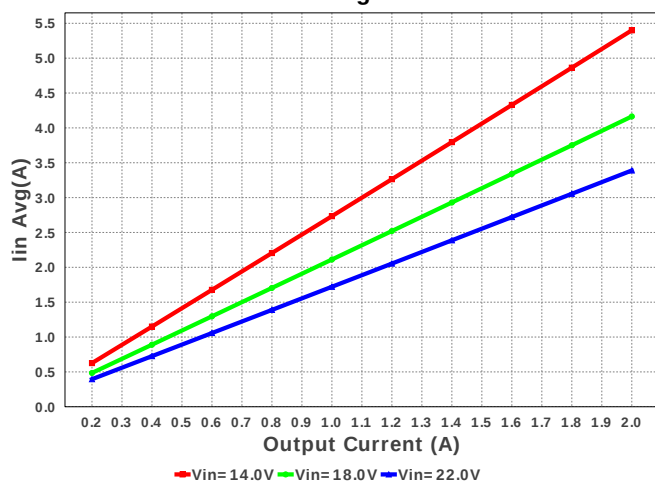
M2 Irms



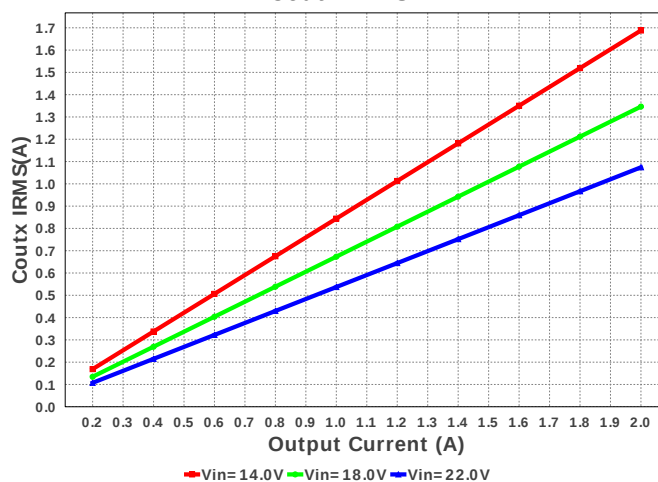
M2 Vds Act



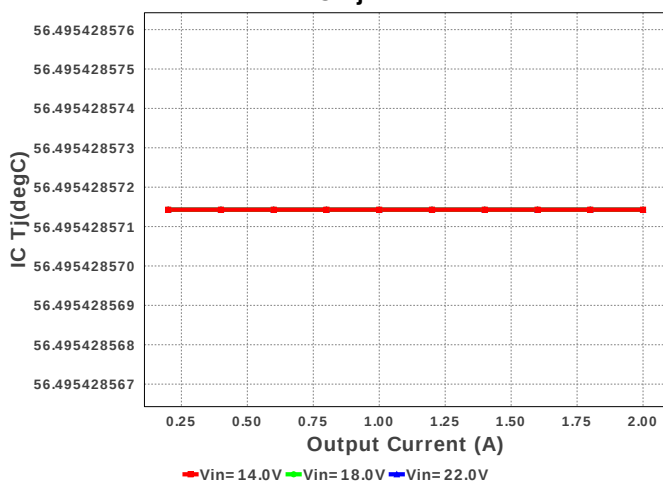
Iin Avg



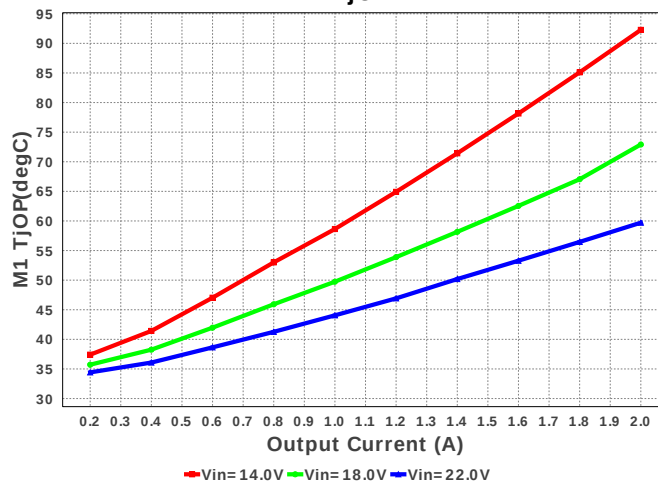
Coutx IRMS



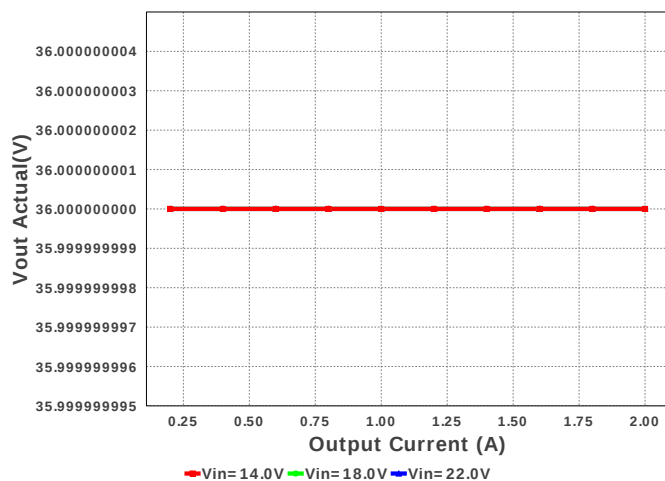
IC Tj



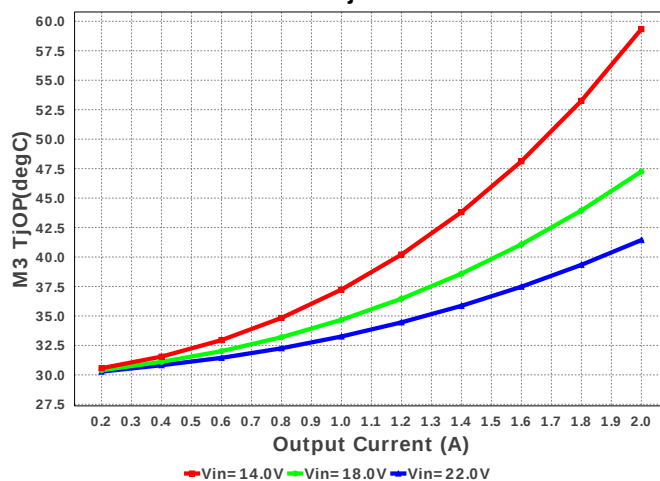
M1 TjOP



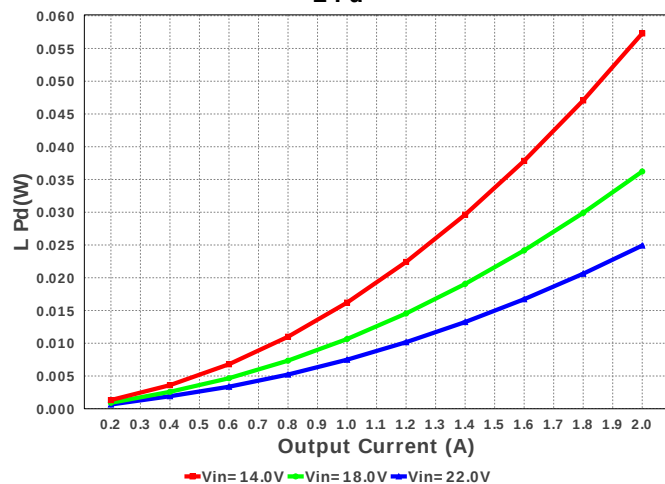
Vout Actual



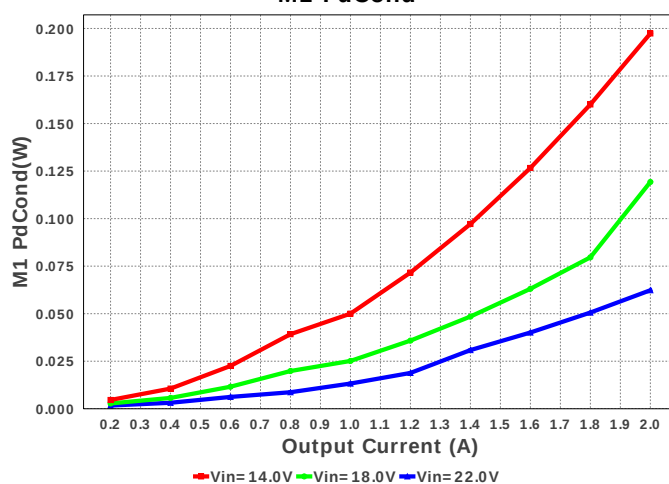
M3 TjOP



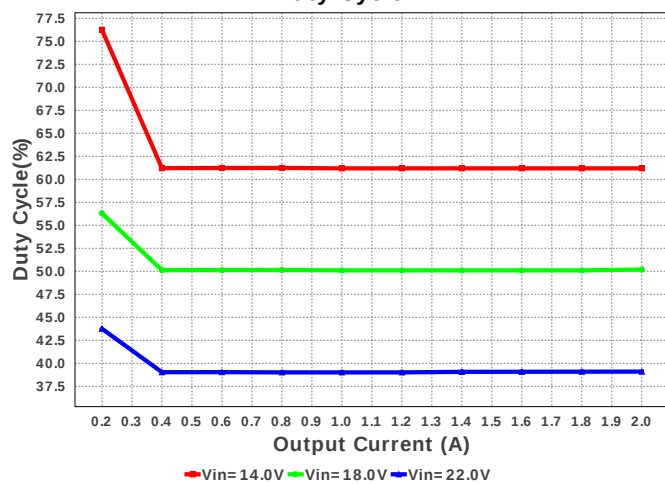
L Pd



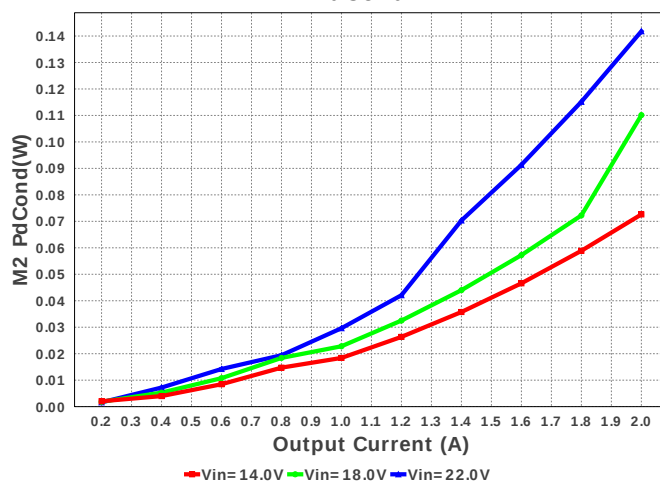
M1 PdCond

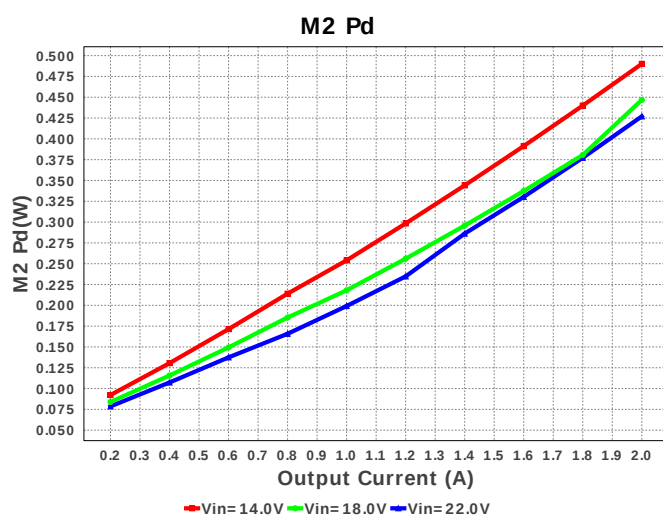
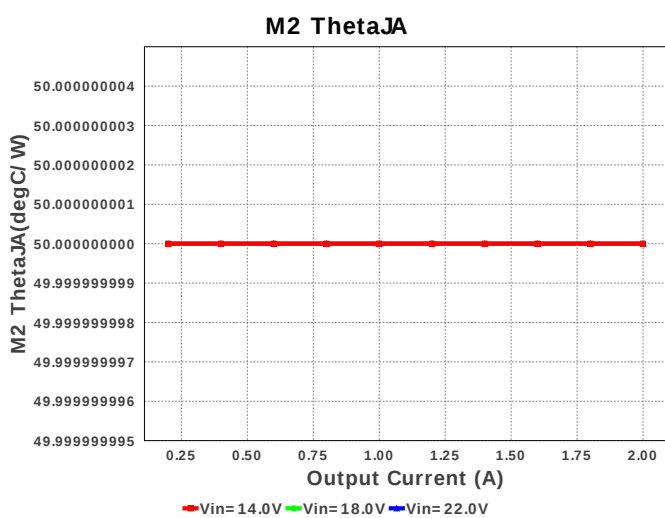
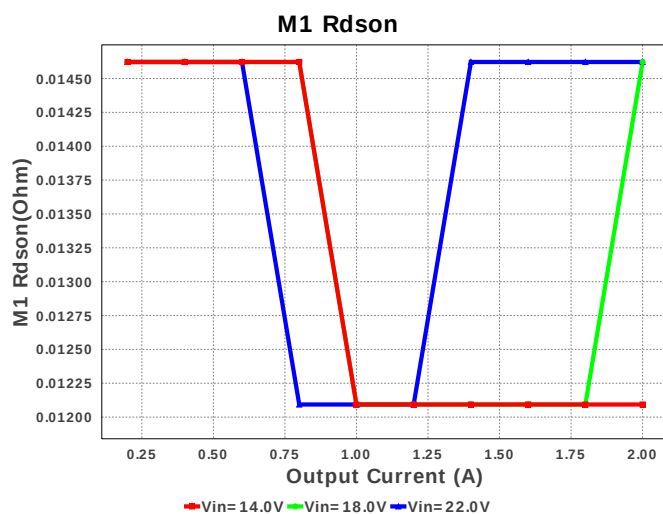
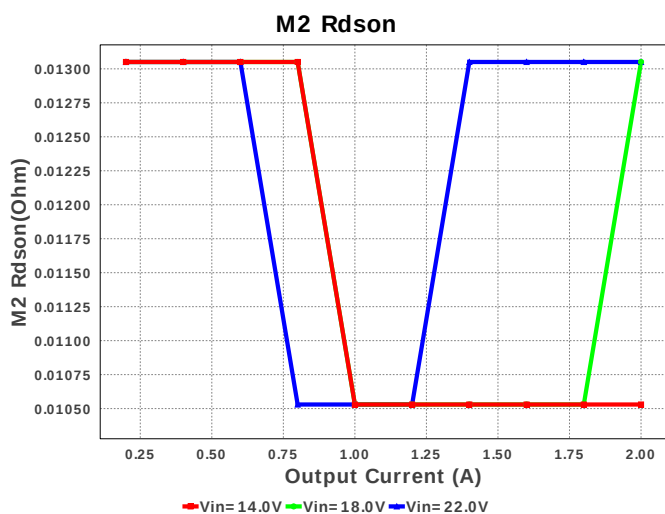
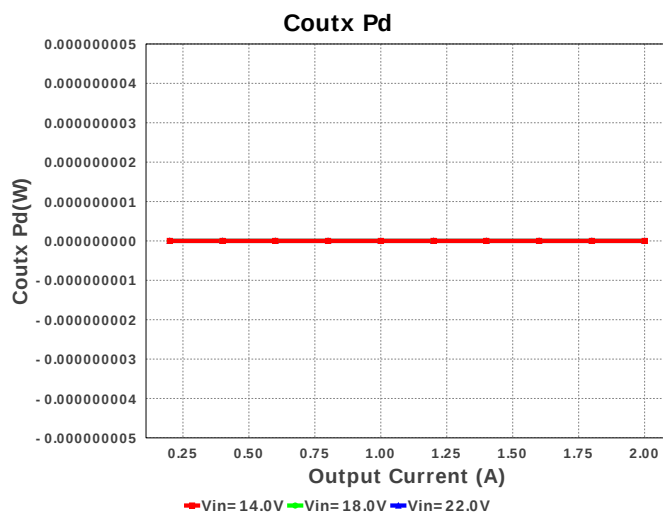
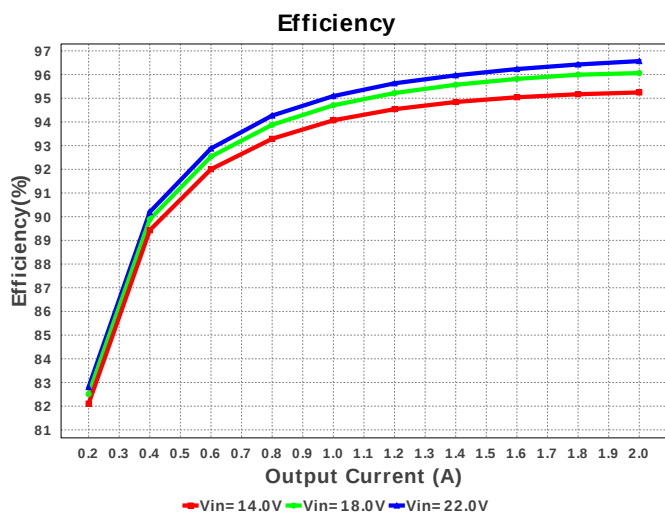


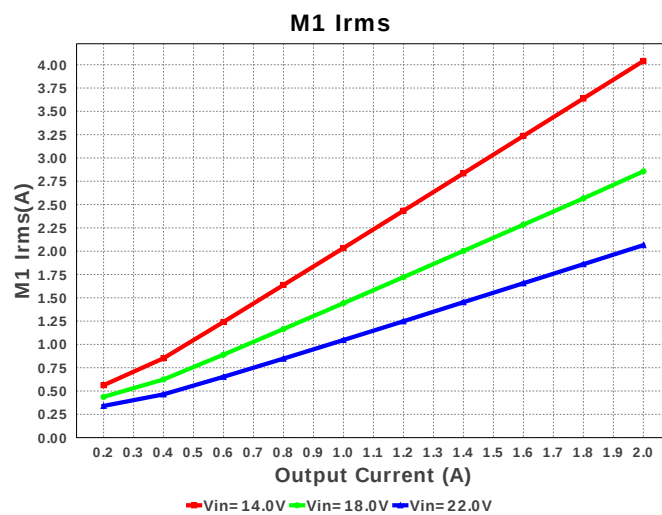
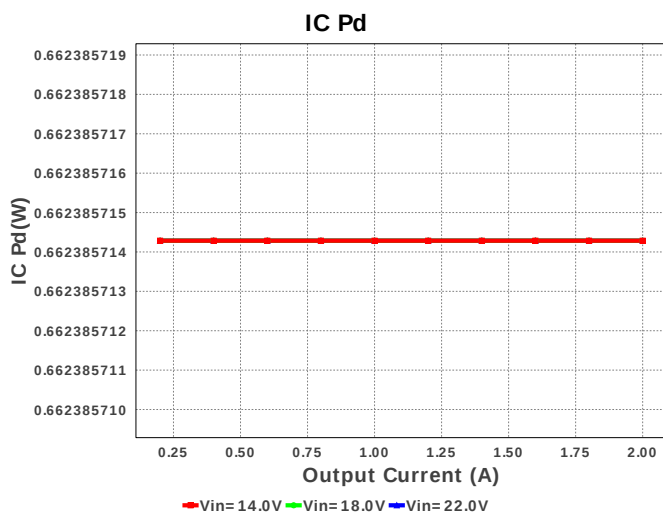
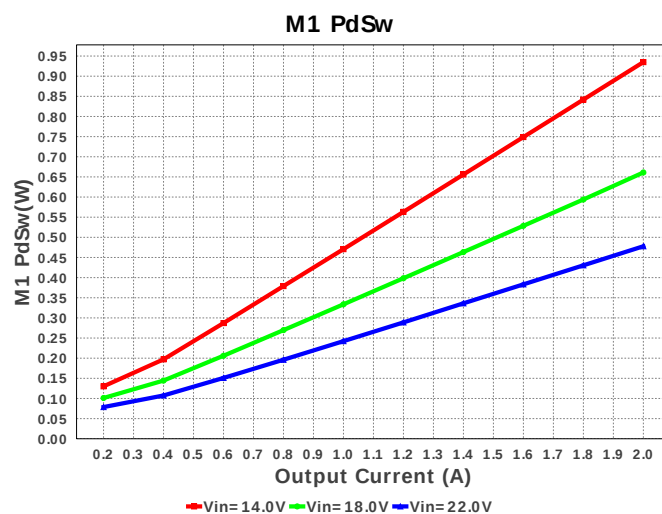
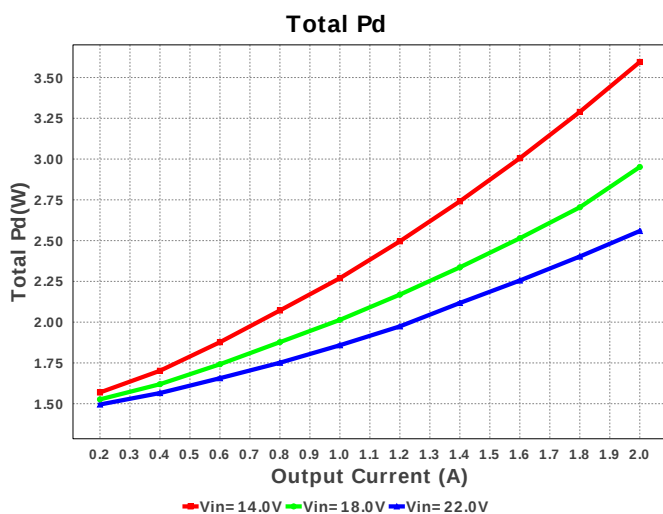
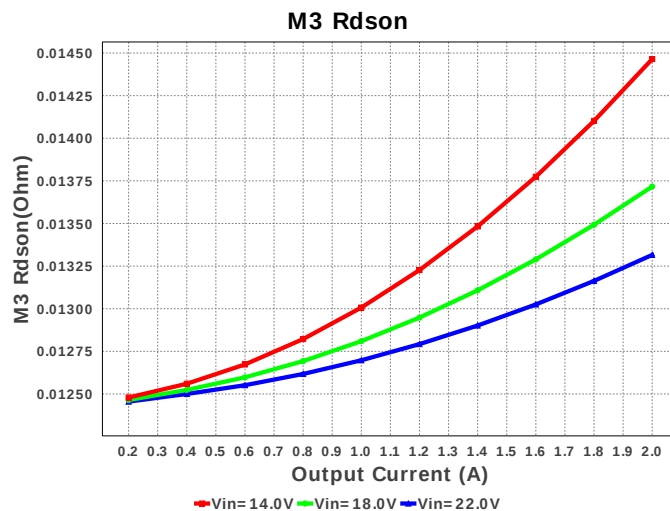
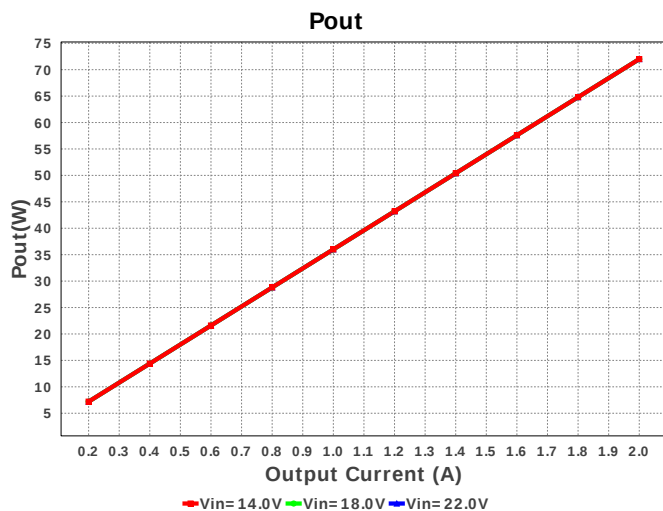
Duty Cycle

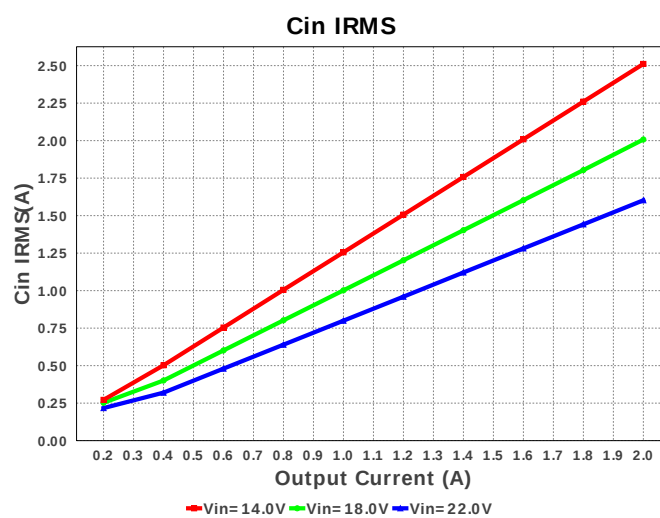
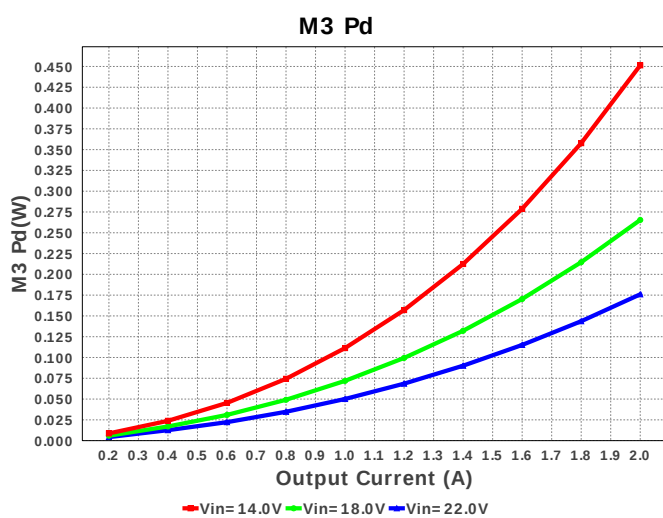
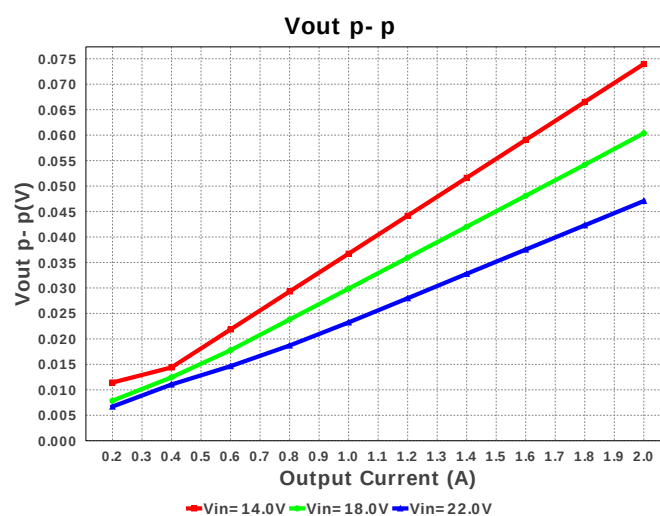
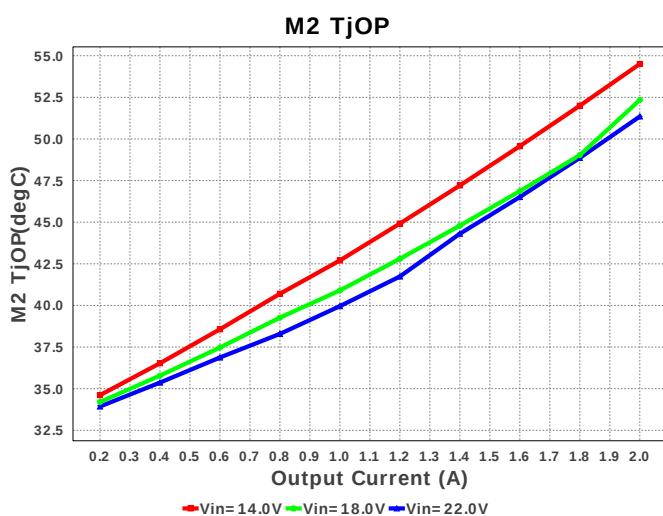
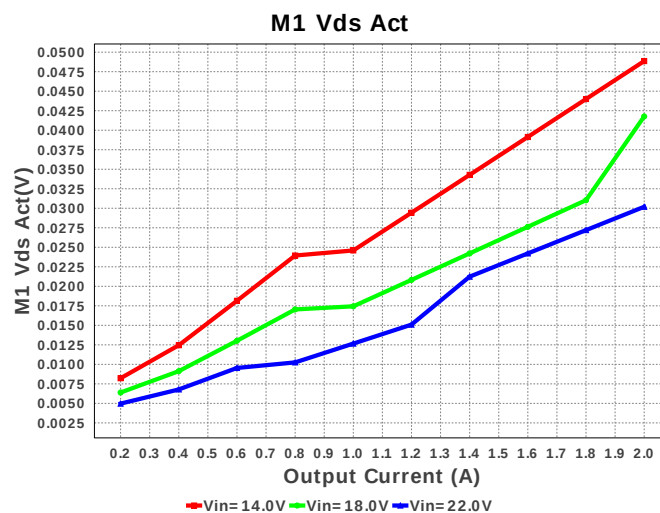
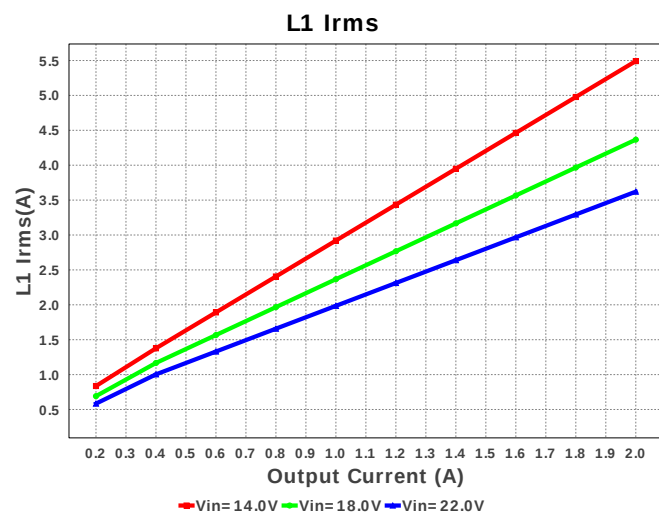


M2 PdCond









## Operating Values

| #   | Name       | Value                   | Category | Description                             |
|-----|------------|-------------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS   | 2.518 A                 | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS  | 770.561 mA              | Current  | Output capacitor RMS ripple current     |
| 3.  | Coutx IRMS | 1.737 A                 | Current  | Output capacitor_x RMS ripple current   |
| 4.  | Iin Avg    | 5.44 A                  | Current  | Average input current                   |
| 5.  | L Ipp      | 1.204 A                 | Current  | Peak-to-peak inductor ripple current    |
| 6.  | L1 Irms    | 5.49 A                  | Current  | Inductor ripple current                 |
| 7.  | M1 Irms    | 4.058 A                 | Current  | MOSFET RMS ripple current               |
| 8.  | M2 Irms    | 2.56 A                  | Current  | MOSFET RMS ripple current               |
| 9.  | SW Ipk     | 5.773 A                 | Current  | Peak switch current                     |
| 10. | BOM Count  | 29                      | General  | Total Design BOM count                  |
| 11. | FootPrint  | 1.465 k mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |

| #   | Name           | Value       | Category | Description                                                                                |
|-----|----------------|-------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Frequency      | 321.429 kHz | General  | Switching frequency                                                                        |
| 13. | IC Tolerance   | 18.0 mV     | General  | IC Feedback Tolerance                                                                      |
| 14. | M1 Rdson       | 12.093 mOhm | General  | Drain-Source On-resistance                                                                 |
| 15. | M1 ThetaJA     | 55.0 degC/W | General  | MOSFET junction-to-ambient thermal resistance                                              |
| 16. | M2 Rdson       | 10.53 mOhm  | General  | Drain-Source On-resistance                                                                 |
| 17. | M2 ThetaJA     | 50.0 degC/W | General  | MOSFET junction-to-ambient thermal resistance                                              |
| 18. | M2 Vds Act     | 26.954 mV   | General  | M Vds                                                                                      |
| 19. | Mode           | CCM         | General  | Conduction Mode                                                                            |
| 20. | Pout           | 72.0 W      | General  | Total output power                                                                         |
| 21. | Total BOM      | \$0.0       | General  | Total BOM Cost                                                                             |
| 22. | M3 TjOp        | 70.602 degC | Op_Point | M3 MOSFET junction temperature                                                             |
| 23. | Vout Actual    | 36.0 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 24. | Vout OP        | 36.0 V      | Op_Point | Operational Output Voltage                                                                 |
| 25. | Duty Cycle     | 61.323 %    | Op_point | Duty cycle                                                                                 |
| 26. | Efficiency     | 94.545 %    | Op_point | Steady state efficiency                                                                    |
| 27. | IC Tj          | 60.198 degC | Op_point | IC junction temperature                                                                    |
| 28. | ICThetaJA      | 40.0 degC/W | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 29. | IOUT_OP        | 2.0 A       | Op_point | Iout operating point                                                                       |
| 30. | M1 TjOP        | 92.614 degC | Op_point | M1 MOSFET junction temperature                                                             |
| 31. | M2 TjOP        | 54.496 degC | Op_point | MOSFET junction temperature                                                                |
| 32. | VIN_OP         | 14.0 V      | Op_point | Vin operating point                                                                        |
| 33. | Vout p-p       | 70.029 mV   | Op_point | Peak-to-peak output ripple voltage                                                         |
| 34. | Cin Pd         | 126.839 mW  | Power    | Input capacitor power dissipation                                                          |
| 35. | Cout Pd        | 18.614 mW   | Power    | Output capacitor power dissipation                                                         |
| 36. | Coutx Pd       | 0.0 W       | Power    | Output capacitor_x power loss                                                              |
| 37. | IC Pd          | 754.957 mW  | Power    | IC power dissipation                                                                       |
| 38. | L Pd           | 57.274 mW   | Power    | Inductor power dissipation                                                                 |
| 39. | M1 Pd          | 1.138 W     | Power    | MOSFET power dissipation                                                                   |
| 40. | M1 Pd          | 1.138 W     | Power    | MOSFET power dissipation                                                                   |
| 41. | M1 PdCond      | 199.186 mW  | Power    | M1 MOSFET conduction losses                                                                |
| 42. | M1 PdSw        | 939.246 mW  | Power    | M1 MOSFET switching losses                                                                 |
| 43. | M2 Pd          | 489.927 mW  | Power    | MOSFET power dissipation                                                                   |
| 44. | M2 PdCond      | 72.446 mW   | Power    | M2 MOSFET conduction losses                                                                |
| 45. | M2 PdQrr       | 53.807 mW   | Power    | Synchronous Boost High Side Reverse Recovery                                               |
| 46. | M2 Pdbody      | 363.673 mW  | Power    | Power dissipation through lower FET                                                        |
| 47. | M3 Pd          | 624.649 mW  | Power    | M3 MOSFET total power dissipation                                                          |
| 48. | M3 Rdson       | 19.595 mOhm | Power    | Drain-Source On-resistance                                                                 |
| 49. | Total Pd       | 4.154 W     | Power    | Total Power Dissipation                                                                    |
| 50. | M1 Vds Act     | 49.079 mV   |          | M Vds                                                                                      |
| 51. | M3 ThetaJA     | 65.0 degC/W |          | MOSFET junction-to-ambient thermal resistance                                              |
| 52. | Vout Tolerance | 3.482 %     |          | 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  | 22.0      | Maximum input voltage  |
| 3. | VinMin  | 14.0      | Minimum input voltage  |
| 4. | Vout    | 36.0      | Output Voltage         |
| 5. | base_pn | LM5121-Q1 | Base Product Number    |
| 6. | source  | DC        | Input Source Type      |
| 7. | Ta      | 30.0      | Ambient temperature    |

## Design Assistance

1. The LM5121 is a wide range boost controller which is operable in an ultra wide input range of 4.5 to 65V. A boost regulator can maintain regulation for input voltages lower than the output voltage.
2. Feature Highlights: Automotive Qualified Synchronous Boost Controller
3. The LM5121-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application
4. **LM5121-Q1** Product Folder : <http://www.ti.com/product/LM5121%2DQ1> : contains the data sheet and other resources.

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**You should completely validate and test your design implementation to confirm the system functionality for your application prior to production.**

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