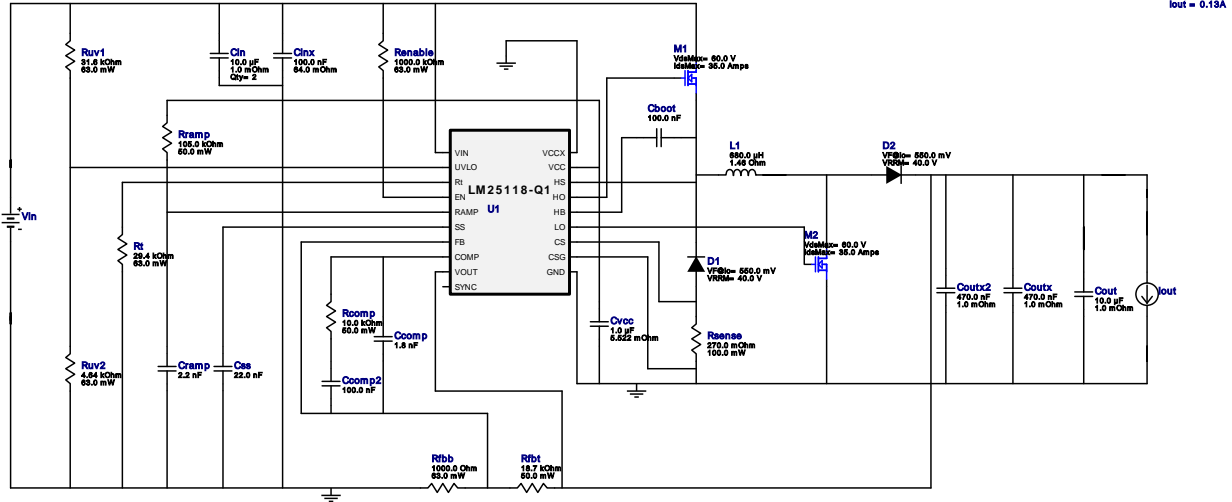


VinMin = 12.0V  
 VinMax = 29.0V  
 Vout = 24.0V  
 Iout = 0.13A

Device = LM25118Q1MH/NOPB  
 Topology = Buck\_Boost  
 Created = 2023-12-25 23:52:53.625  
 BOM Cost = \$6.06  
 BOM Count = 27  
 Total Pd = 0.45W

# WEBENCH® Design Report

Design : 5 LM25118Q1MH/NOPB  
 LM25118Q1MH/NOPB 12V-29V to 24.00V @ 0.2A



## Design Alerts

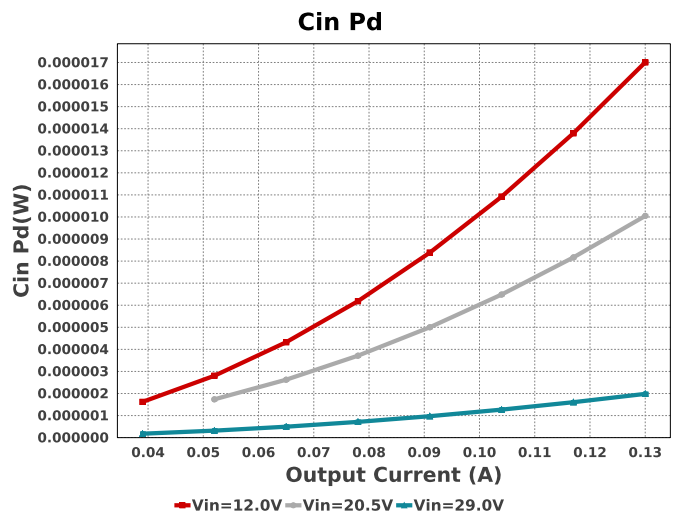
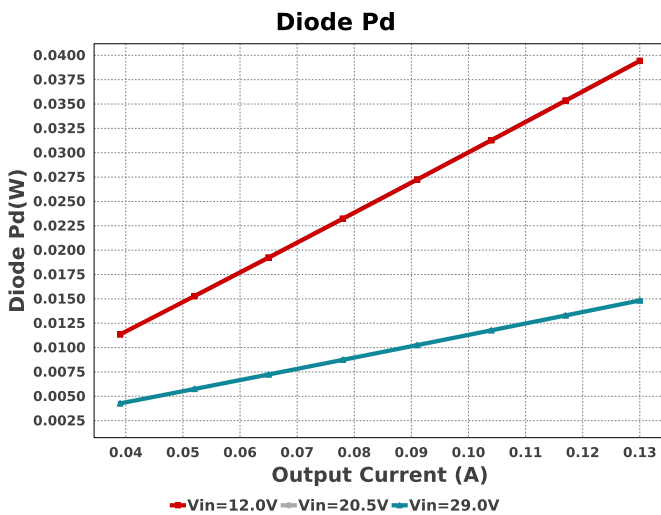
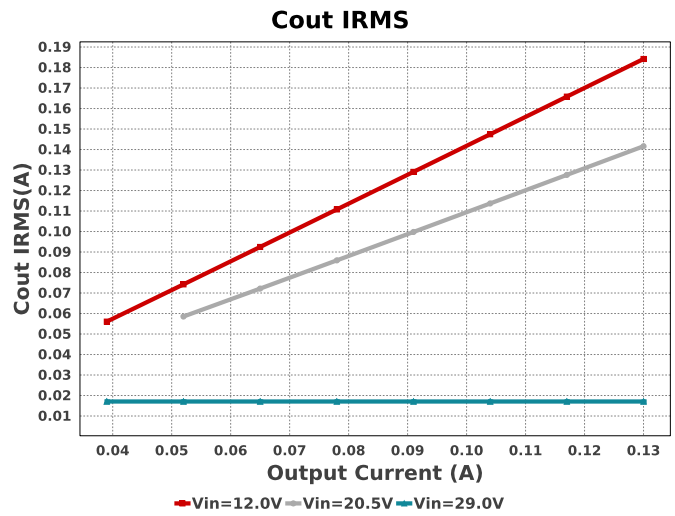
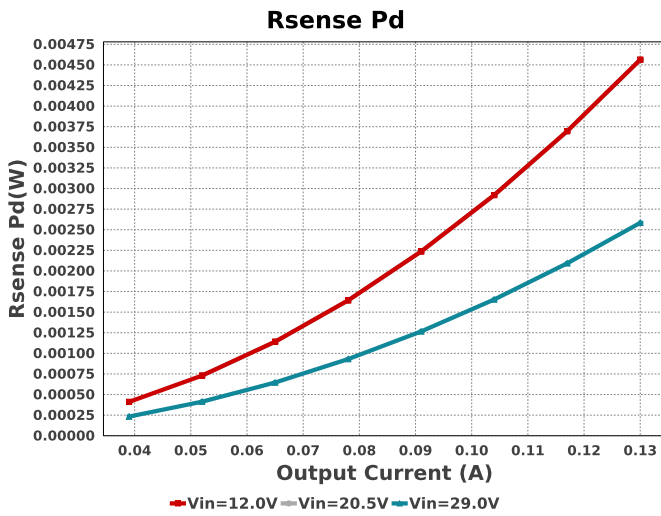
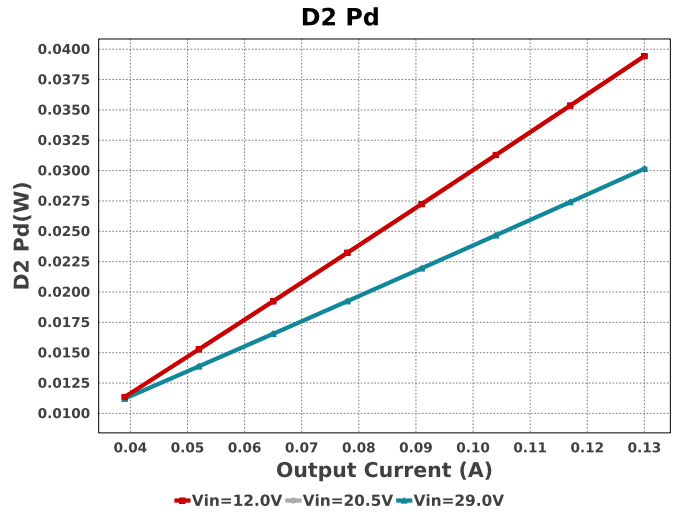
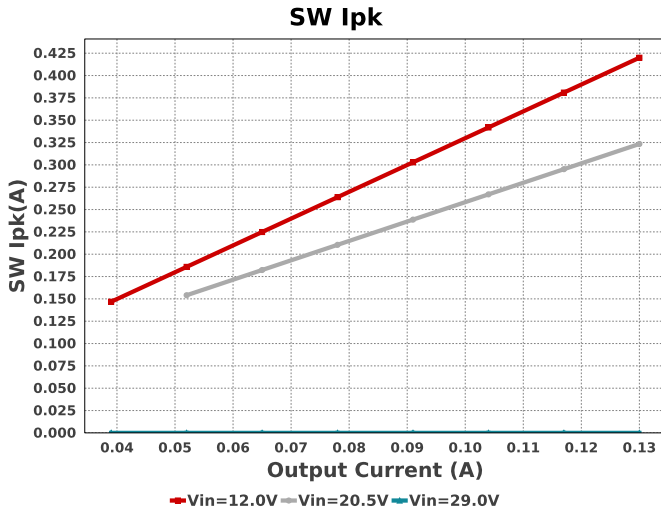
### Component Selection Information

Tool Tip for Keep selected FETs during Redesign Configuration Option: By Default if you hit REDESIGN button, Webench re-designs all the external components including Fets. But if we have checked this configuration option, currently selected fets in schematic will get locked and re-design happens for only other external components. This helps to update the desing by keeping Fets unchanged.

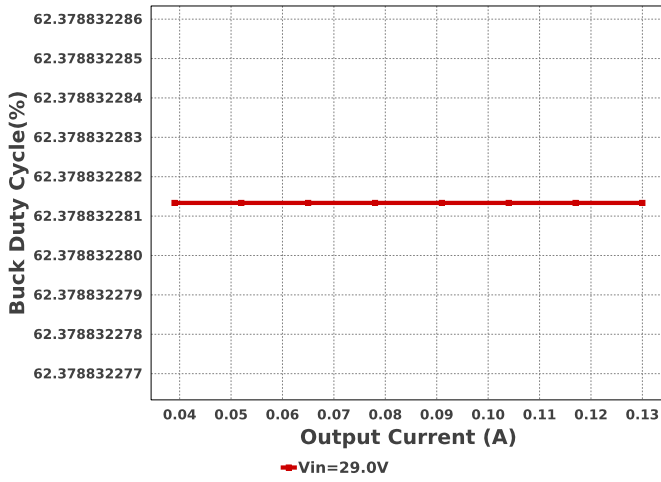
## Electrical BOM

| Name   | Manufacturer              | Part Number                        | Properties   | Qty | Price  | Footprint                   |
|--------|---------------------------|------------------------------------|--|-----|--------|-----------------------------|
| Cboot  | AVX                       | 08053C104JAZ2A<br>Series= X7R      | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A                    | 1   | \$0.07 | 0805 7 mm <sup>2</sup>      |
| Ccomp  | Samsung Electro-Mechanics | CL21C182JBF1PNE<br>Series= C0G/NP0 | Cap= 1.8 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                      | 1   | \$0.02 | 0805 7 mm <sup>2</sup>      |
| Ccomp2 | AVX                       | 08053C104JAZ2A<br>Series= X7R      | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A                    | 1   | \$0.07 | 0805 7 mm <sup>2</sup>      |
| Cin    | MuRata                    | GRM32ER71J106KA12L<br>Series= X7R  | Cap= 10.0 uF<br>ESR= 1.0 mOhm<br>VDC= 63.0 V<br>IRMS= 6.0 A    | 2   | \$0.30 | 1210_280 15 mm <sup>2</sup> |
| Cinx   | Kemet                     | C0805C104M5RACTU<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 mm <sup>2</sup>      |
| Cout   | TDK                       | C3225X7R1H106M250AC<br>Series= X7R | Cap= 10.0 uF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.0 A    | 1   | \$0.27 | 1210 15 mm <sup>2</sup>     |
| Coutx  | MuRata                    | GRM21BR71H474KA88L<br>Series= X7R  | Cap= 470.0 nF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A   | 1   | \$0.05 | 0805 7 mm <sup>2</sup>      |

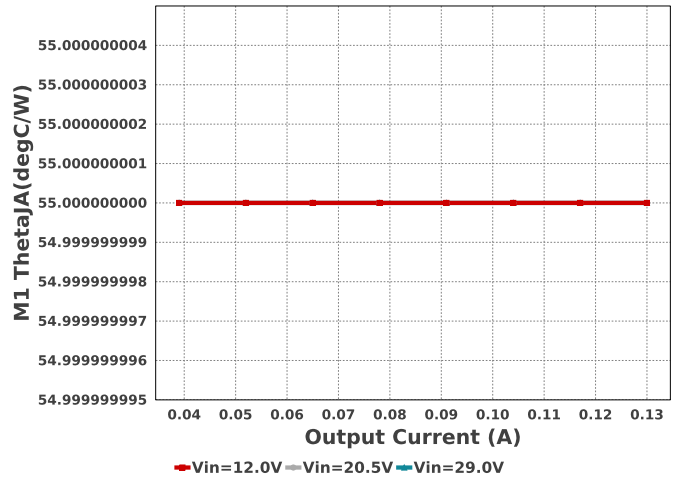
| Name    | Manufacturer              | Part Number                             | Properties  | Qty | Price  | Footprint  |
|---------|---------------------------|---|---|-----|--------|--|
| Coutx2  | MuRata                    | GRM21BR71H474KA88L<br>Series= X7R       | Cap= 470.0 nF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A    | 1   | \$0.05 |  0805 7 mm <sup>2</sup>         |
| Cramp   | Samsung Electro-Mechanics | CL21C222JBFNNE<br>Series= C0G/NP0       | Cap= 2.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                       | 1   | \$0.02 |  0805 7 mm <sup>2</sup>         |
| Css     | TDK                       | CGA4J2C0G1H223J125AA<br>Series= C0G/NP0 | Cap= 22.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                      | 1   | \$0.07 |  0805 7 mm <sup>2</sup>         |
| Cvcc    | TDK                       | C1608X5R1H105K080AB<br>Series= X5R      | Cap= 1.0 uF<br>ESR= 5.522 mOhm<br>VDC= 50.0 V<br>IRMS= 2.2162 A | 1   | \$0.03 |  0603 5 mm <sup>2</sup>         |
| D1      | ON Semiconductor          | MBR140SFT1G                             | VF@Io= 550.0 mV<br>VRRM= 40.0 V                                 | 1   | \$0.12 |  SOD-123FL 12 mm <sup>2</sup>   |
| D2      | ON Semiconductor          | MBR140SFT1G                             | VF@Io= 550.0 mV<br>VRRM= 40.0 V                                 | 1   | \$0.12 |  SOD-123FL 12 mm <sup>2</sup>   |
| L1      | Würth Elektronik          | 744770268                               | L= 680.0 uH<br>1.46 Ohm   | 1   | \$1.33 |  WE-PD_1280 196 mm <sup>2</sup> |
| M1      | Texas Instruments         | CSD18543Q3A                             | VdsMax= 60.0 V<br>IdsMax= 35.0 Amps                             | 1   | \$0.23 |  DNH0008A 18 mm <sup>2</sup>    |
| M2      | Texas Instruments         | CSD18543Q3A                             | VdsMax= 60.0 V<br>IdsMax= 35.0 Amps                             | 1   | \$0.23 |  DNH0008A 18 mm <sup>2</sup>  |
| Rcomp   | Yageo                     | RC0201FR-0710KL<br>Series= ?            | Res= 10.0 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 |  0201 2 mm <sup>2</sup>       |
| Renable | Vishay-Dale               | CRCW04021M00FKED<br>Series= CRCW..e3    | Res= 1000.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%           | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| Rfbb    | Vishay-Dale               | CRCW04021K00FKED<br>Series= CRCW..e3    | Res= 1000.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%            | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| Rfbt    | Yageo                     | RC0201FR-0718K7L<br>Series= ?           | Res= 18.7 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 |  0201 2 mm <sup>2</sup>       |
| Rramp   | Yageo                     | RC0201FR-07105KL<br>Series= ?           | Res= 105.0 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0%            | 1   | \$0.01 |  0201 2 mm <sup>2</sup>       |
| Rsense  | Panasonic                 | ERJ-3RQFR27V<br>Series= ERJ-3R          | Res= 270.0 mOhm<br>Power= 100.0 mW<br>Tolerance= 1.0%           | 1   | \$0.02 |  0603 5 mm <sup>2</sup>       |
| Rt      | Vishay-Dale               | CRCW040229K4FKED<br>Series= CRCW..e3    | Res= 29.4 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| Ruv1    | Vishay-Dale               | CRCW040231K6FKED<br>Series= CRCW..e3    | Res= 31.6 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| Ruv2    | Vishay-Dale               | CRCW04024K64FKED<br>Series= CRCW..e3    | Res= 4.64 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%             | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| U1      | Texas Instruments         | LM25118Q1MH/NOPB                        | Switcher  | 1   | \$2.67 |  MXA20A 71 mm <sup>2</sup>    |



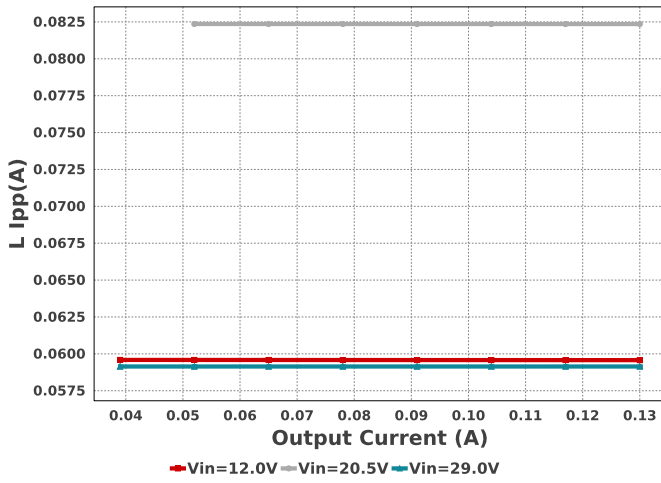
**Buck Duty Cycle**



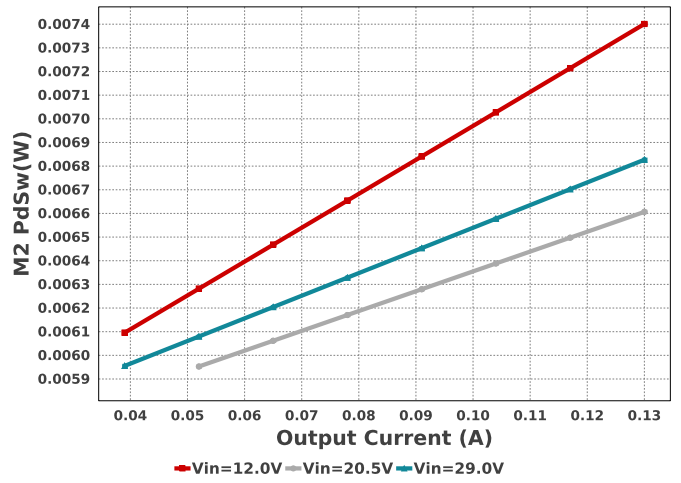
**M1 ThetaJA**



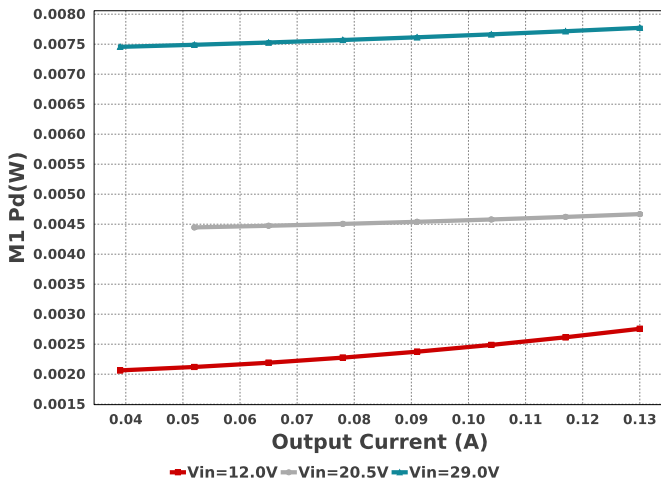
**L Ipp**



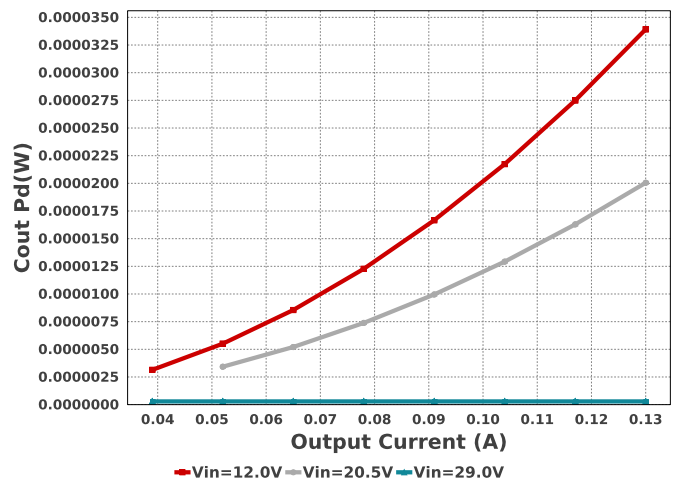
**M2 PdSw**

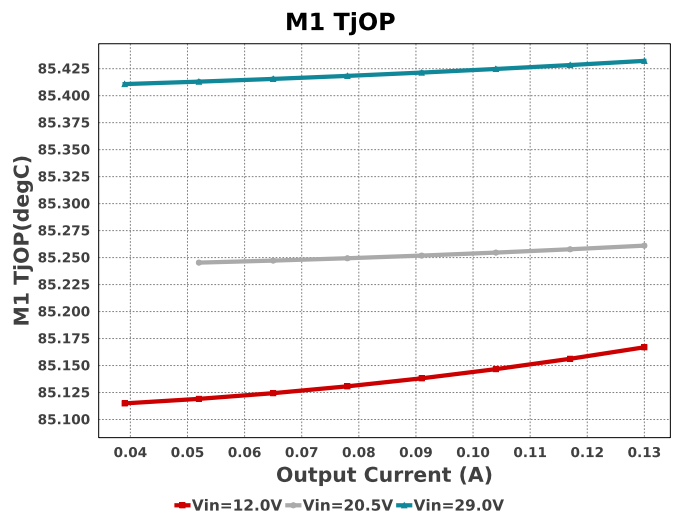
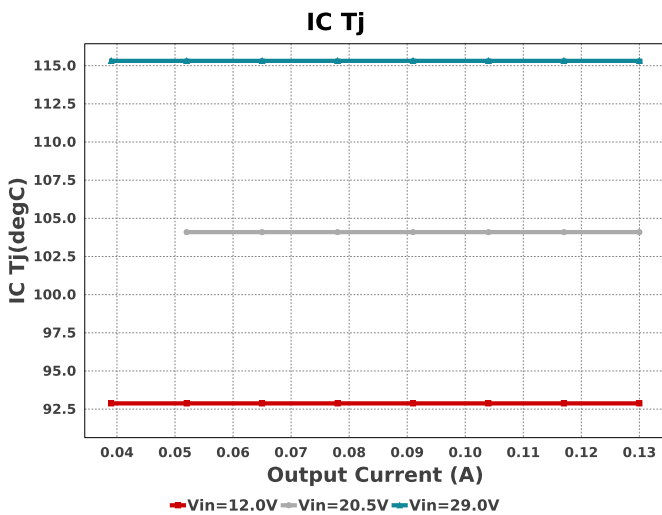
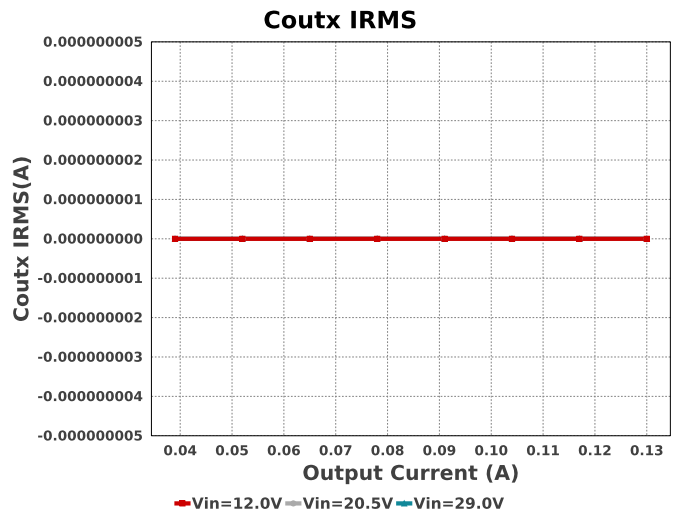
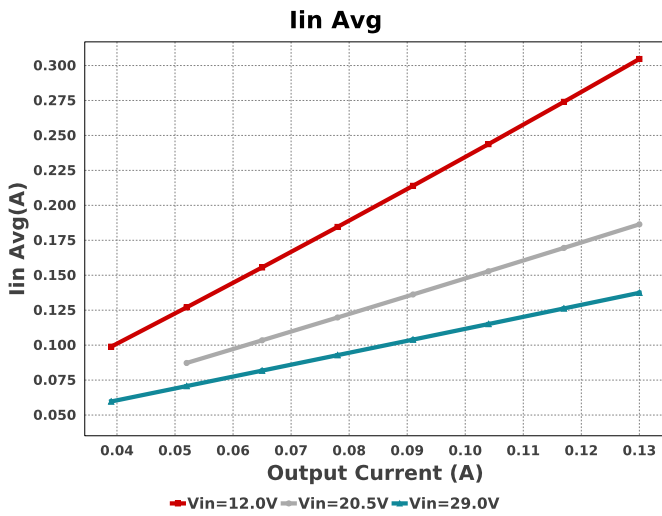
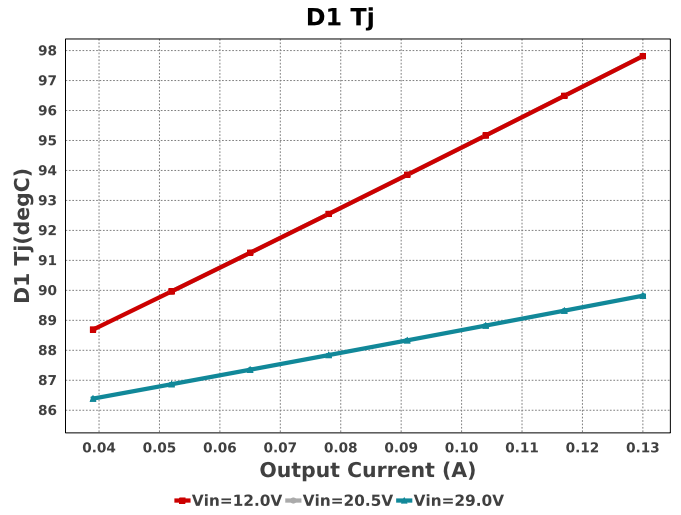
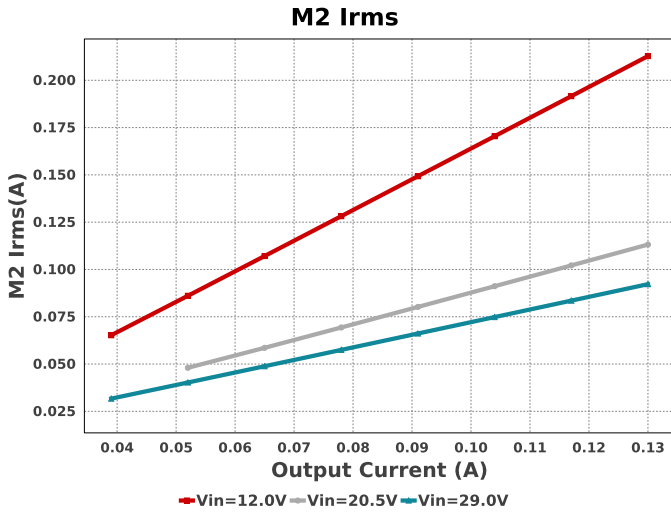


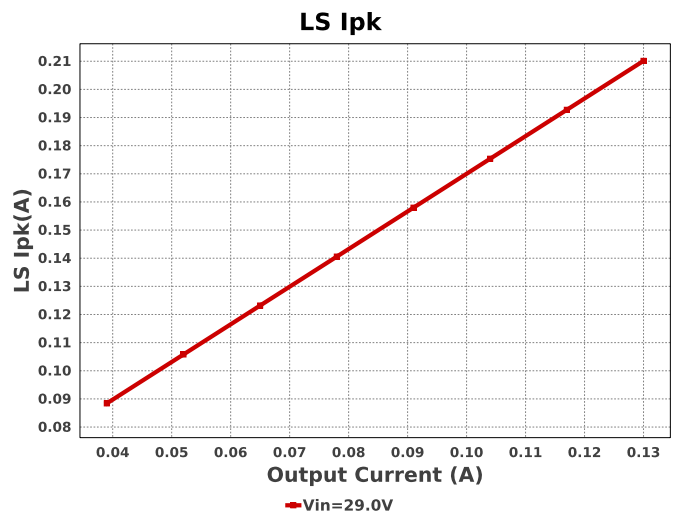
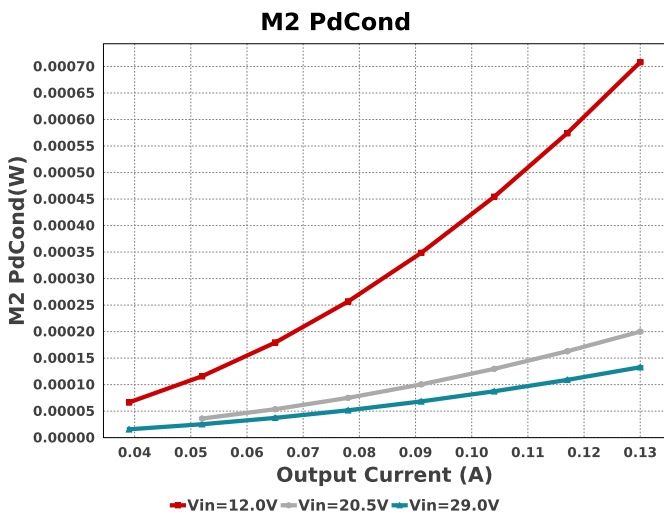
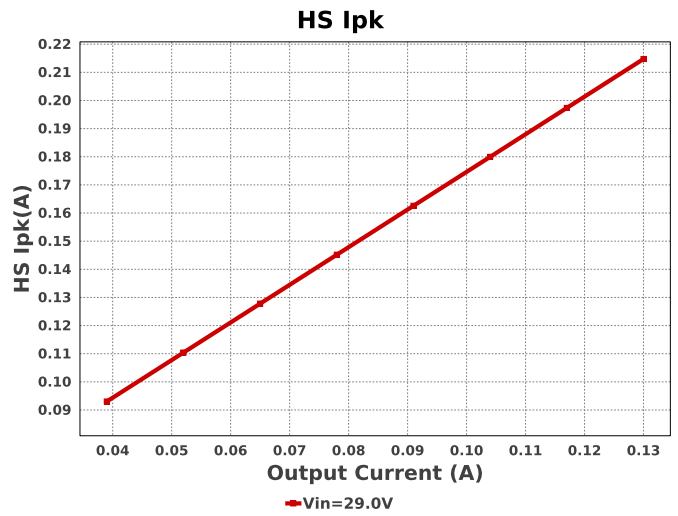
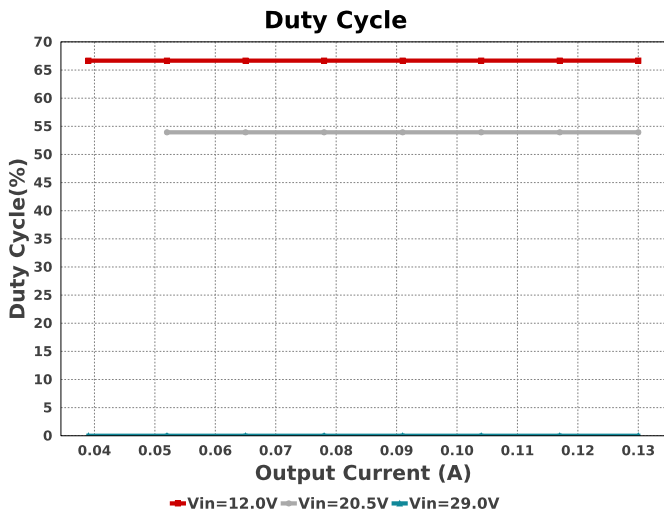
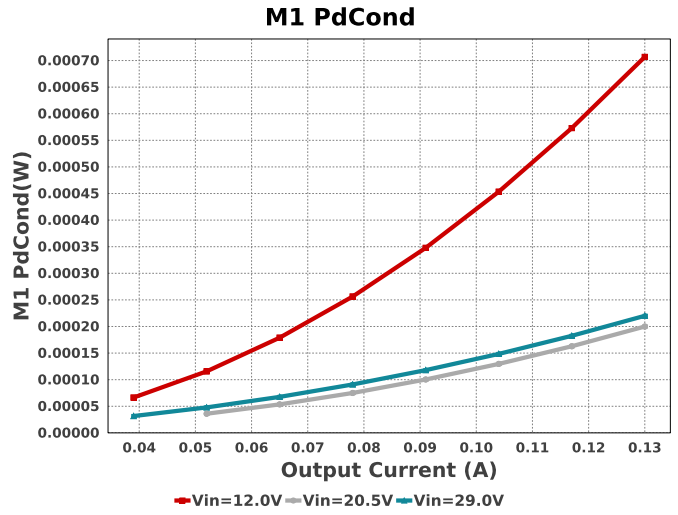
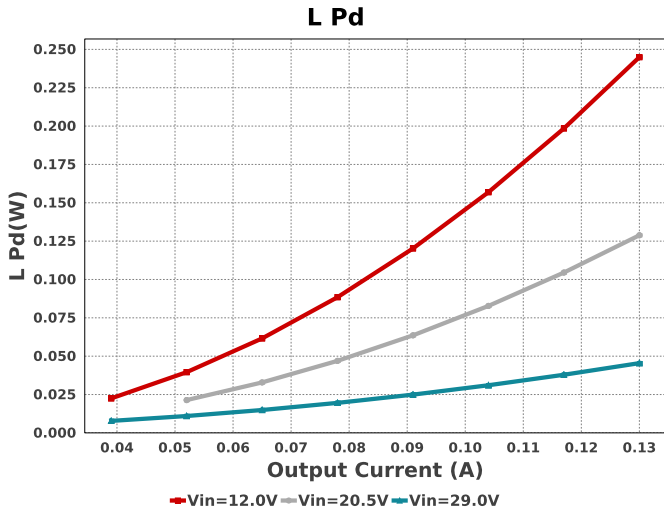
**M1 Pd**

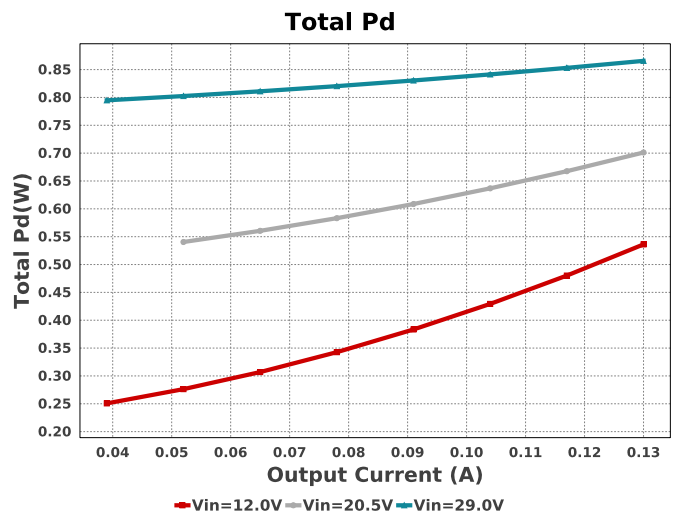
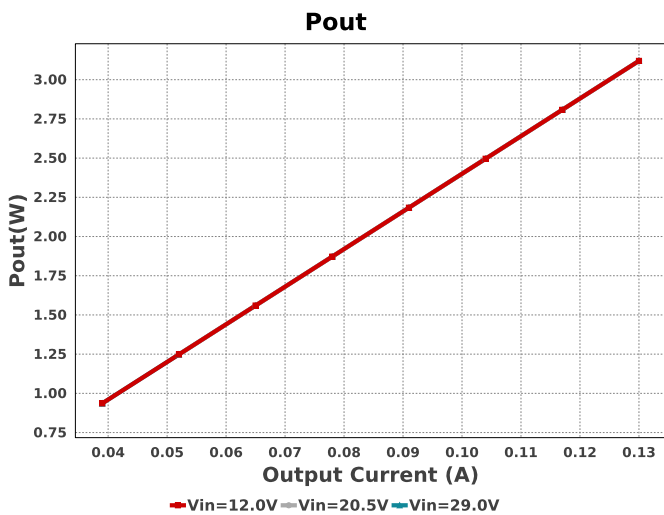
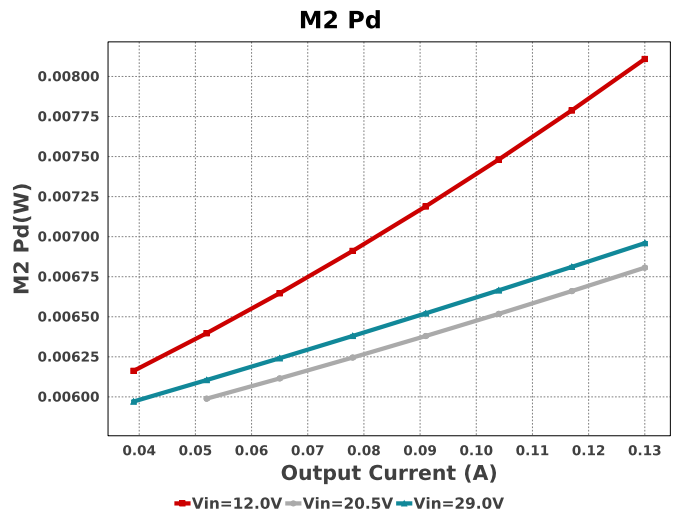
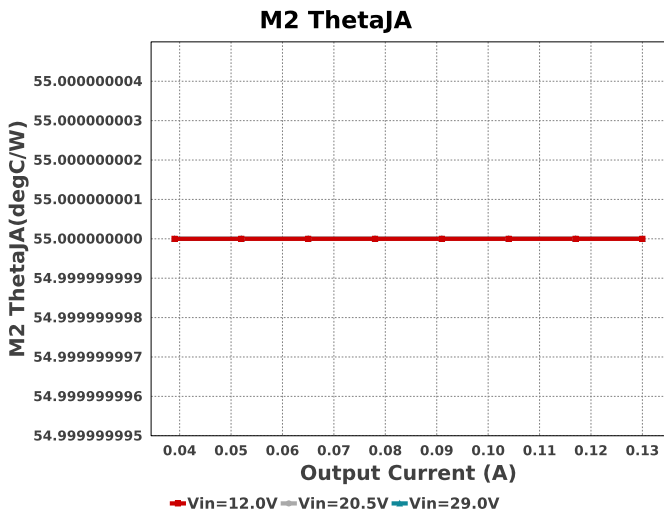
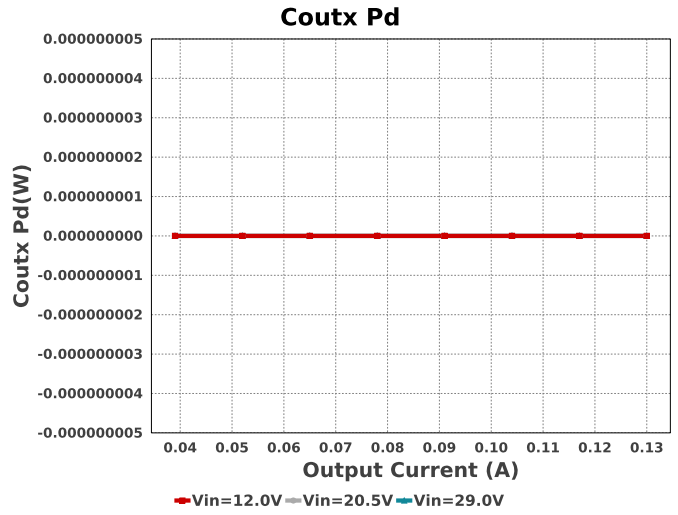
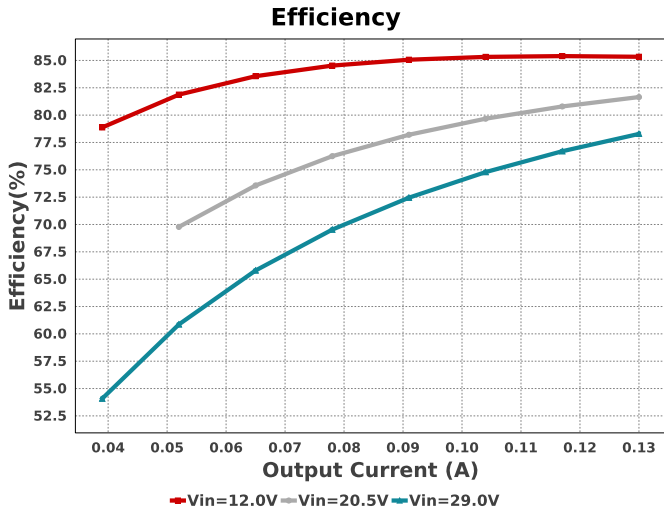


**Cout Pd**

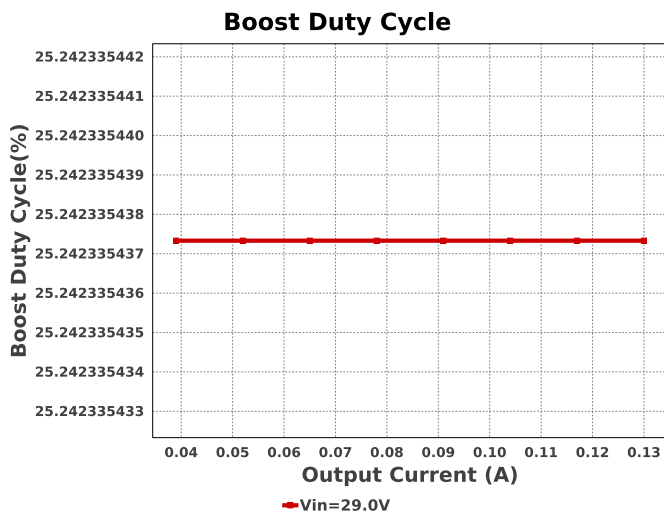
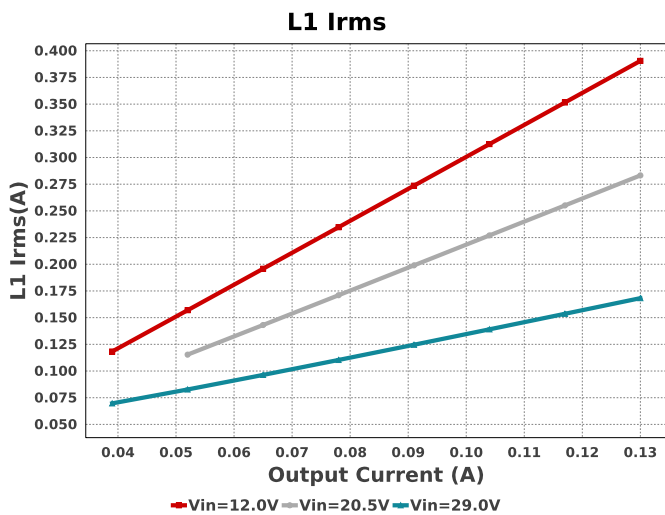
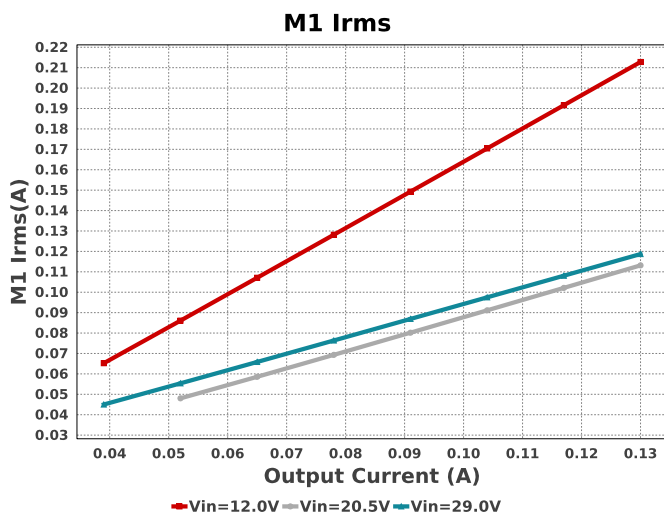
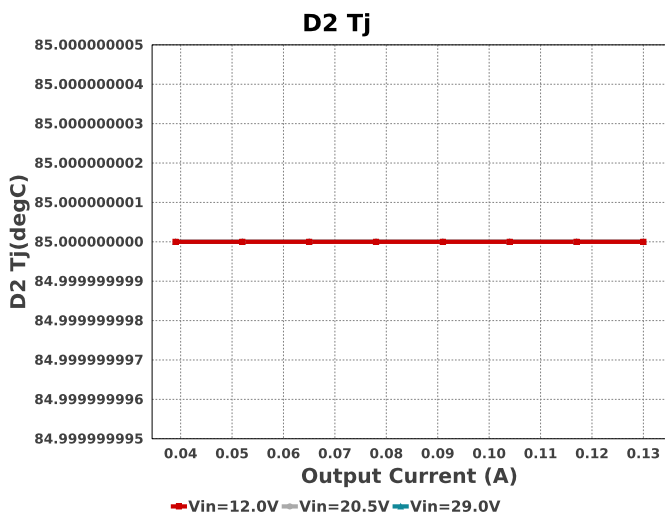
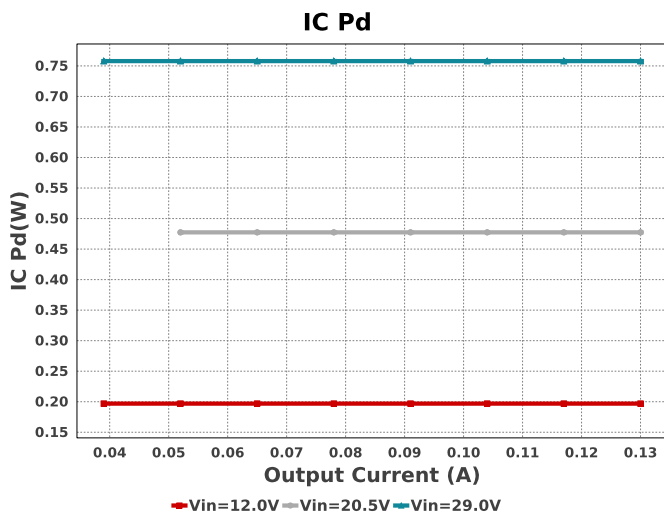
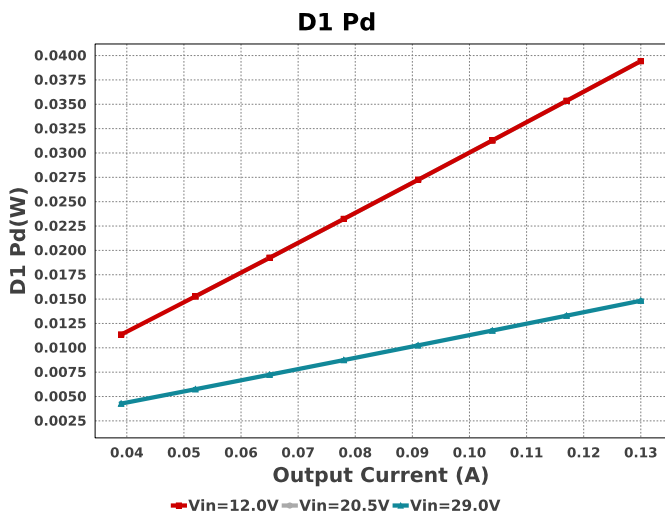




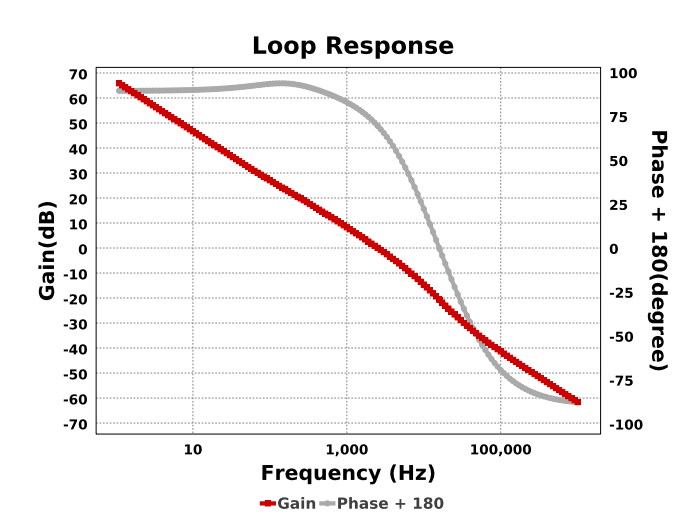
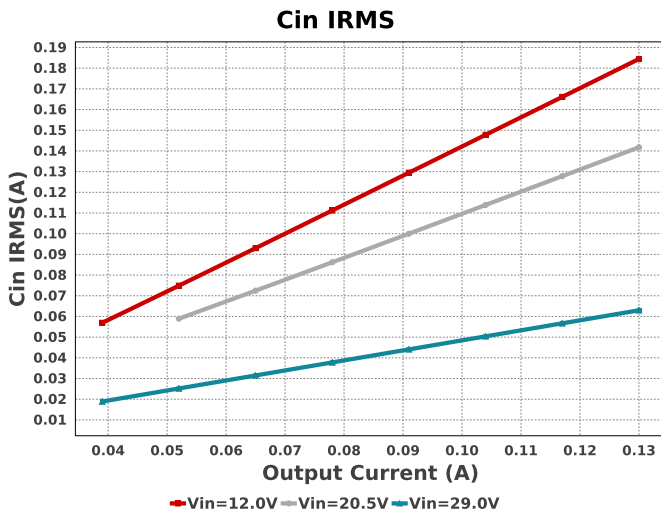
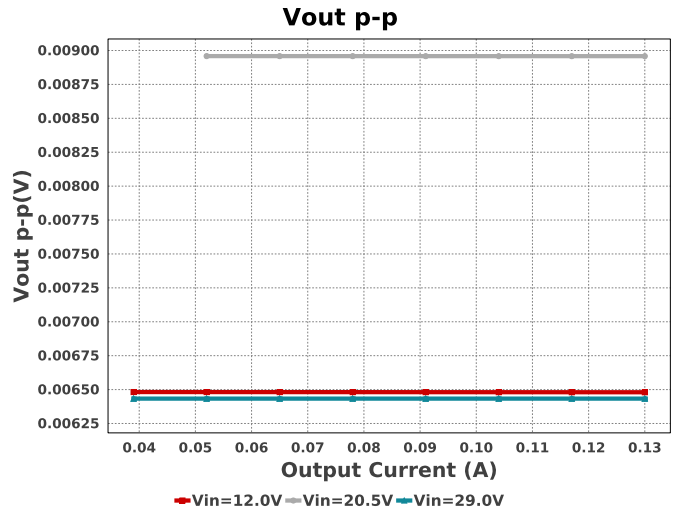
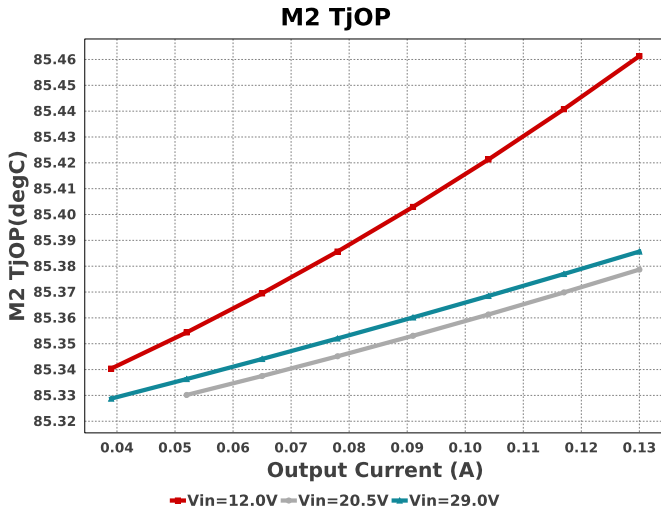












Operating Values

| #   | Name         | Value        | Category  | Description                                   |
|-----|--------------|--------------|-----------|---|
| 1.  | BOM Count    | 27           |           | Total Design BOM count                        |
| 2.  | Total BOM    | \$6.062      |           | Total BOM Cost                                |
| 3.  | Cin IRMS     | 184.434 mA   | Capacitor | Input capacitor RMS ripple current            |
| 4.  | Cin Pd       | 17.008 μW    | Capacitor | Input capacitor power dissipation             |
| 5.  | Cout IRMS    | 184.166 mA   | Capacitor | Output capacitor RMS ripple current           |
| 6.  | Cout Pd      | 33.917 μW    | Capacitor | Output capacitor power dissipation            |
| 7.  | Coutx IRMS   | 0.0 A        | Capacitor | Output capacitor_x RMS ripple current         |
| 8.  | Coutx Pd     | 0.0 W        | Capacitor | Output capacitor_x power loss                 |
| 9.  | D1 Pd        | 39.431 mW    | Diode     | Diode power dissipation                       |
| 10. | D1 Tj        | 97.815 degC  | Diode     | D1 junction temperature                       |
| 11. | D1 Tj        | 97.815 degC  | Diode     | D1 junction temperature                       |
| 12. | D2 Pd        | 39.431 mW    | Diode     | Diode2 power dissipation                      |
| 13. | Diode Pd     | 39.431 mW    | Diode     | Diode power dissipation                       |
| 14. | IC Pd        | 757.89 mW    | IC        | IC power dissipation                          |
| 15. | IC Tj        | 115.315 degC | IC        | IC junction temperature                       |
| 16. | IC Tolerance | 18.0 mV      | IC        | IC Feedback Tolerance                         |
| 17. | ICThetaJA    | 40.0 degC/W  | IC        | IC junction-to-ambient thermal resistance     |
| 18. | Iin Avg      | 145.42 mA    | IC        | Average input current                         |
| 19. | L Ipp        | 59.574 mA    | Inductor  | Peak-to-peak inductor ripple current          |
| 20. | L Pd         | 244.93 mW    | Inductor  | Inductor power dissipation                    |
| 21. | L1 Irms      | 390.523 mA   | Inductor  | Inductor ripple current                       |
| 22. | M1 Irms      | 212.788 mA   | Mosfet    | MOSFET RMS ripple current                     |
| 23. | M1 Pd        | 2.757 mW     | Mosfet    | MOSFET power dissipation                      |
| 24. | M1 PdCond    | 707.21 μW    | Mosfet    | M1 MOSFET conduction losses                   |
| 25. | M1 ThetaJA   | 55.0 degC/W  | Mosfet    | MOSFET junction-to-ambient thermal resistance |
| 26. | M1 TjOP      | 85.167 degC  | Mosfet    | MOSFET junction temperature                   |
| 27. | M2 Irms      | 212.788 mA   | Mosfet    | MOSFET RMS ripple current                     |
| 28. | M2 Pd        | 8.109 mW     | Mosfet    | MOSFET power dissipation                      |
| 29. | M2 PdCond    | 708.26 μW    | Mosfet    | M2 MOSFET conduction losses                   |
| 30. | M2 PdSw      | 7.401 mW     | Mosfet    | M2 MOSFET switching losses                    |
| 31. | M2 ThetaJA   | 55.0 degC/W  | Mosfet    | MOSFET junction-to-ambient thermal resistance |
| 32. | M2 TjOP      | 85.461 degC  | Mosfet    | MOSFET junction temperature                   |

| #   | Name               | Value                 | Category | Description  |
|-----|--------------------|-----------------------|----------|--|
| 33. | Cin Pd             | 17.008 $\mu$ W        | Power    | Input capacitor power dissipation  |
| 34. | Cout Pd            | 33.917 $\mu$ W        | Power    | Output capacitor power dissipation   |
| 35. | Coutx Pd           | 0.0 W                 | Power    | Output capacitor_x power loss  |
| 36. | D1 Pd              | 39.431 mW             | Power    | Diode power dissipation  |
| 37. | D2 Pd              | 39.431 mW             | Power    | Diode2 power dissipation   |
| 38. | Diode Pd           | 39.431 mW             | Power    | Diode power dissipation  |
| 39. | IC Pd              | 757.89 mW             | Power    | IC power dissipation   |
| 40. | L Pd               | 244.93 mW             | Power    | Inductor power dissipation   |
| 41. | M1 Pd              | 2.757 mW              | Power    | MOSFET power dissipation   |
| 42. | M1 PdCond          | 707.21 $\mu$ W        | Power    | M1 MOSFET conduction losses  |
| 43. | M2 Pd              | 8.109 mW              | Power    | MOSFET power dissipation   |
| 44. | M2 PdCond          | 708.26 $\mu$ W        | Power    | M2 MOSFET conduction losses  |
| 45. | M2 PdSw            | 7.401 mW              | Power    | M2 MOSFET switching losses   |
| 46. | Rsense Pd          | 4.563 mW              | Power    | LED Current Rsns Power Dissipation   |
| 47. | Total Pd           | 454.007 mW            | Power    | Total Power Dissipation  |
| 48. | Rsense Pd          | 4.563 mW              | Resistor | LED Current Rsns Power Dissipation   |
| 49. | Cross Freq         | 2.534 kHz             | System   | Bode plot crossover frequency  |
| 50. | D2 Tj              | 85.0 degC             | System   | D2 junction temperature  |
| 51. | Duty Cycle         | 66.679 %              | System   | Duty cycle   |
| 52. | Efficiency         | 73.983 %              | System   | Steady state efficiency  |
| 53. | FootPrint          | 457.0 mm <sup>2</sup> | System   | Total Foot Print Area of BOM components  |
| 54. | Frequency          | 197.409 kHz           | System   | Switching frequency  |
| 55. | Gain Marg          | -20.785 dB            | System   | Bode Plot Gain Margin  |
| 56. | Iout               | 130.0 mA              | System   | Iout operating point   |
| 57. | Low Freq Gain      | 65.861 dB             | System   | Gain at 1Hz  |
| 58. | Mode               | CCM                   | System   | Conduction Mode  |
| 59. | Operating Topology | Buck-Boost            | System   | The current operating topology of the device   |
| 60. | Phase Marg         | 69.995 deg            | System   | Bode Plot Phase Margin   |
| 61. | Pout               | 3.12 W                | System   | Total output power   |
| 62. | SW Ipk             | 419.931 mA            | System   | Peak switch current  |
| 63. | Vin                | 12.0 V                | System   | Vin operating point  |
| 64. | Vout               | 24.0 V                | System   | Operational Output Voltage   |
| 65. | Vout Actual        | 24.231 V              | System   | Vout Actual calculated based on selected voltage divider resistors                         |
| 66. | Vout Tolerance     | 3.409 %               | System   | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |
| 67. | Vout p-p           | 6.48 mV               | System   | Peak-to-peak output ripple voltage   |

## Design Inputs

| Name    | Value      | Description            |
|---------|------------|------------------------|
| Iout    | 130.0 m    | Maximum Output Current |
| VinMax  | 29.0       | Maximum input voltage  |
| VinMin  | 12.0       | Minimum input voltage  |
| Vout    | 24.0       | Output Voltage         |
| base_pn | LM25118-Q1 | Base Product Number    |
| source  | DC         | Input Source Type      |
| Ta      | 85.0       | Ambient temperature    |

## WEBENCH® Assembly

### Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of  $C_{in}$  and  $C_{out}$ , and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

### Soldering Component to Board

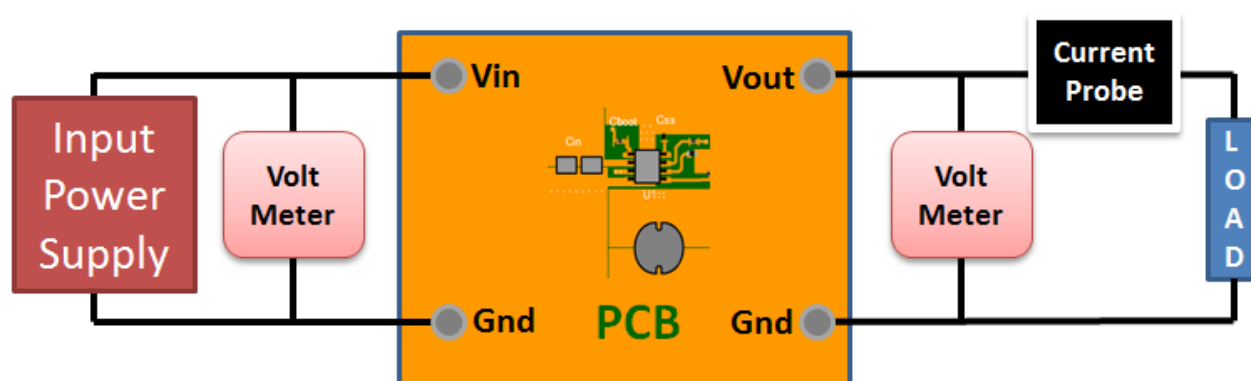
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

### Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 12.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to  $V_{in}$  and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from  $V_{out}$  and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

### Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between  $V_{in}$  and GND, a load is connected between  $V_{out}$  and GND and a current meter is connected in series between  $V_{out}$  and the load. The load must be able to handle at least rated output power + 50% ( 7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



### Design Assistance

1. The LM25118-Q1 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. Master key : 4B75C236C8D913C5ABBE984106C70346[v1]

3. **LM25118-Q1** Product Folder : <http://www.ti.com/product/LM25118%2DQ1> : contains the data sheet and other resources.

#### Important Notice and Disclaimer

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with TI products.