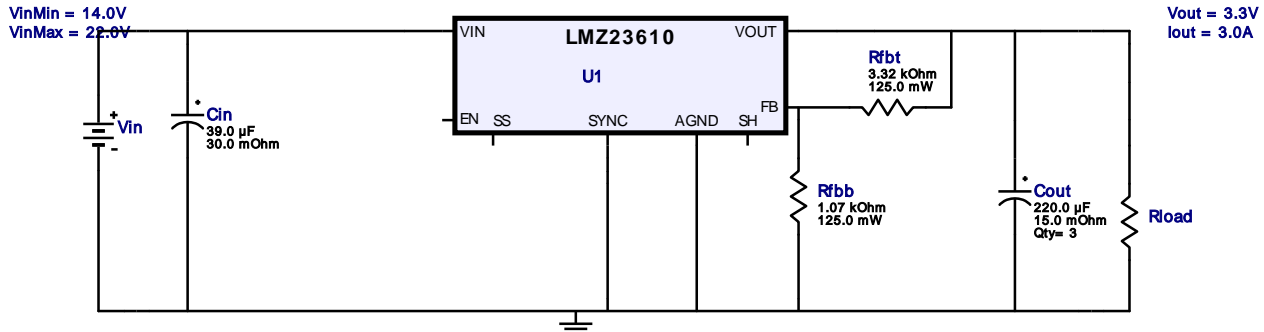
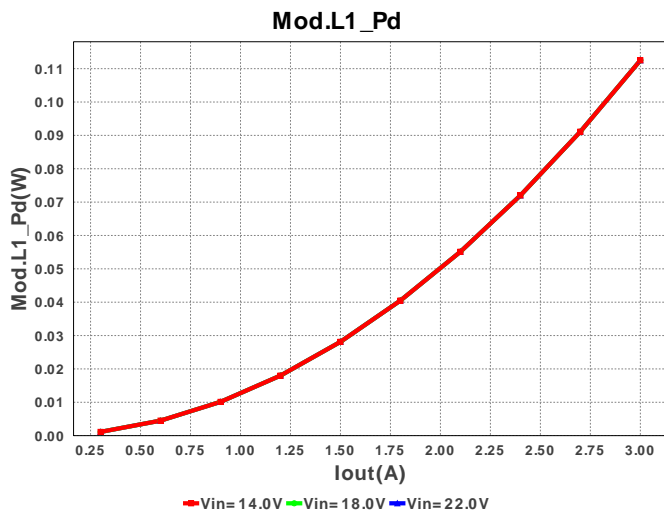
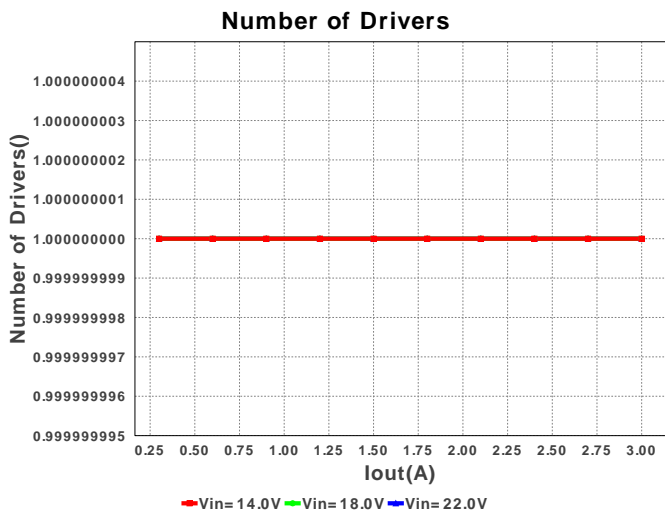
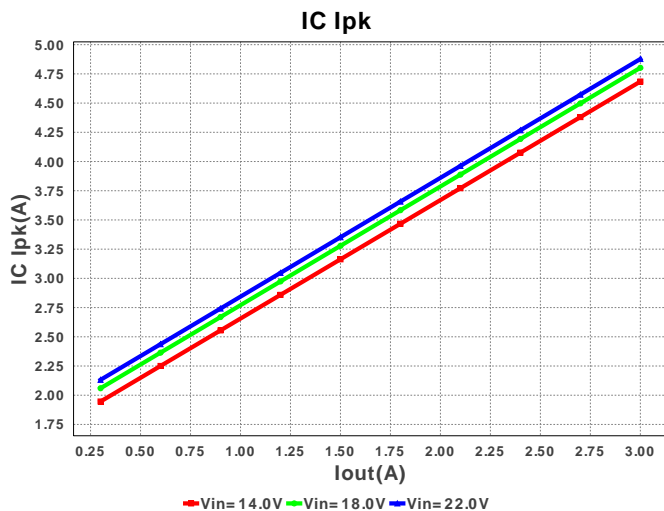
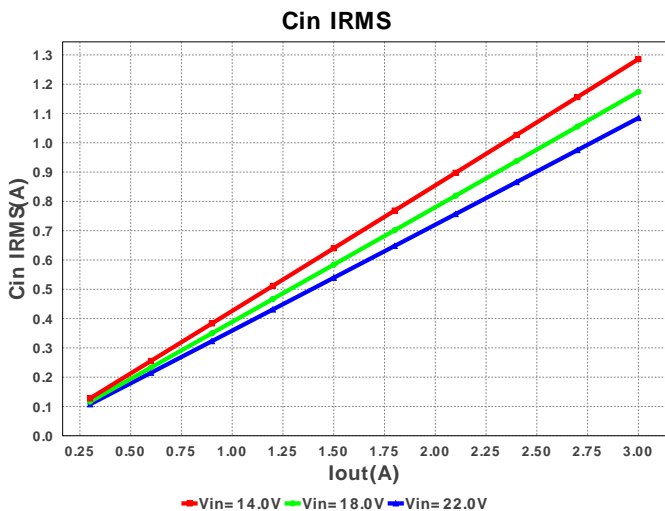
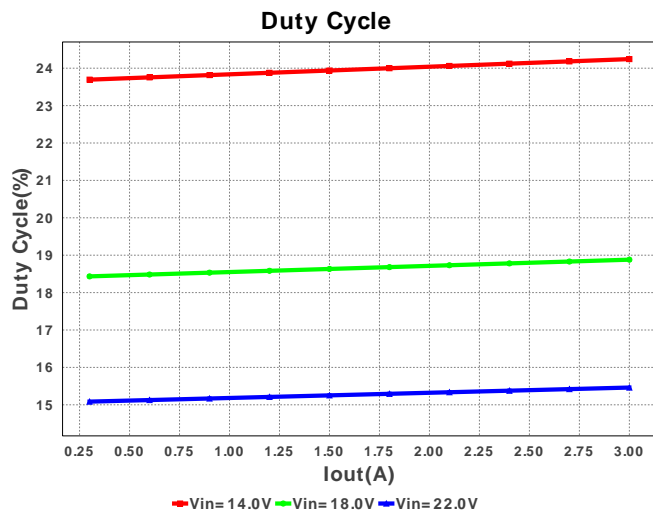
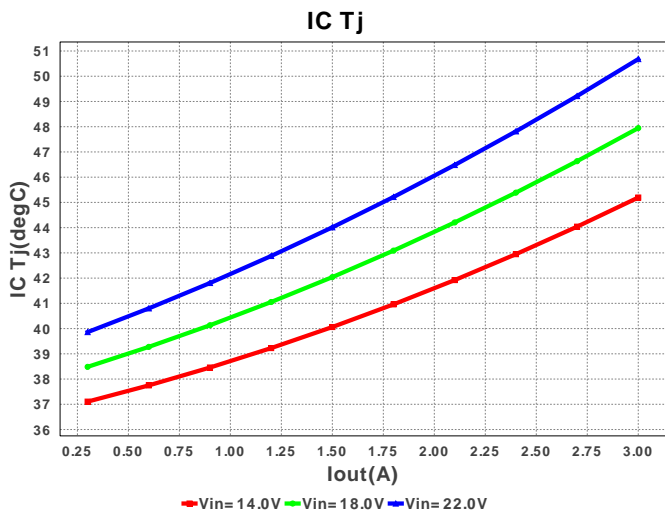
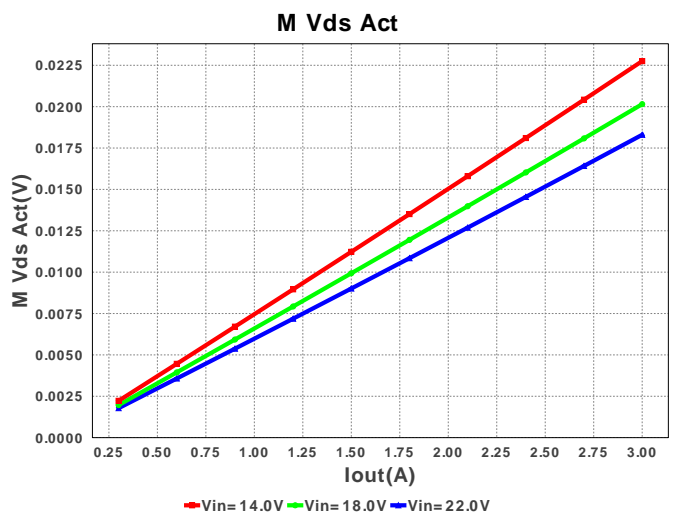
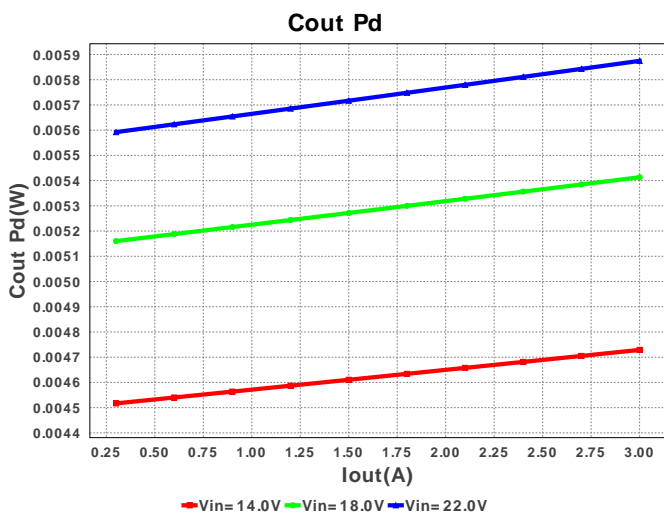
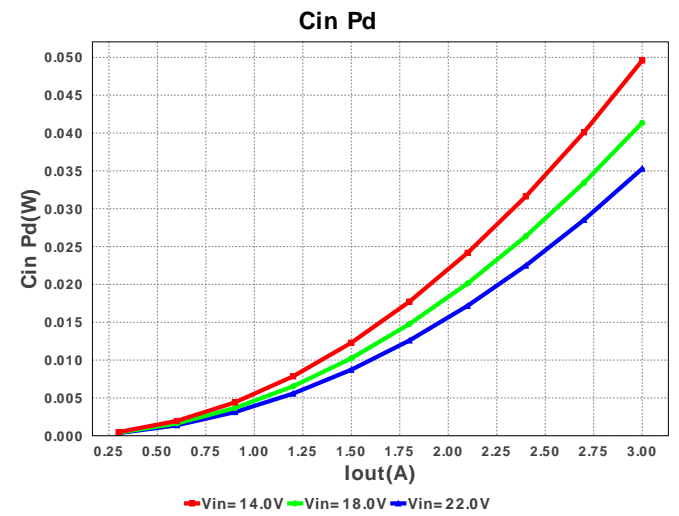
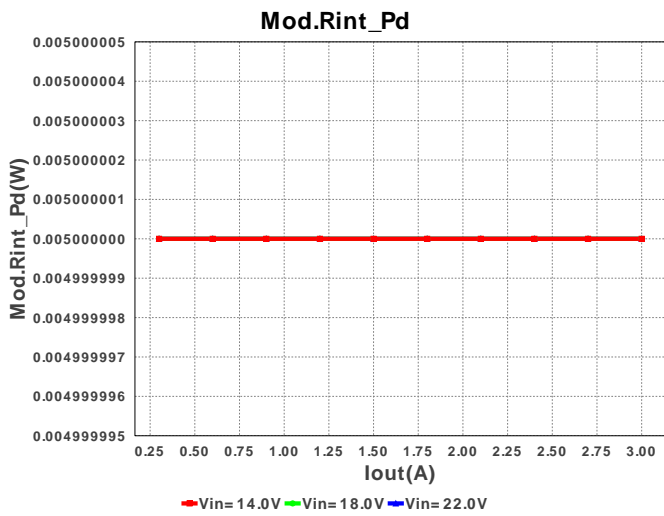
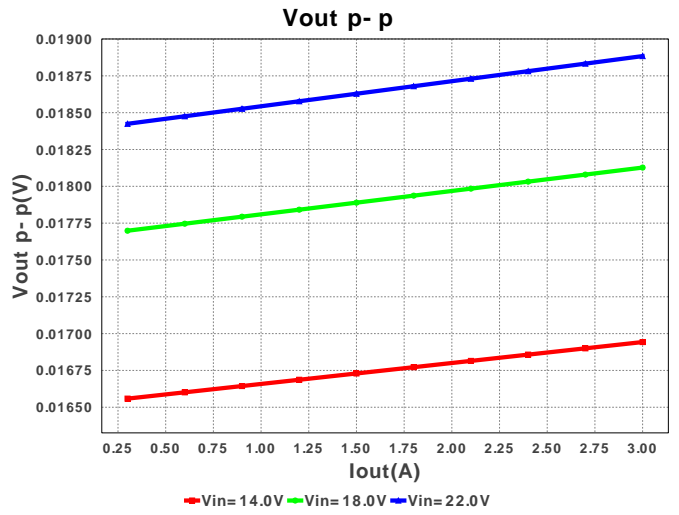
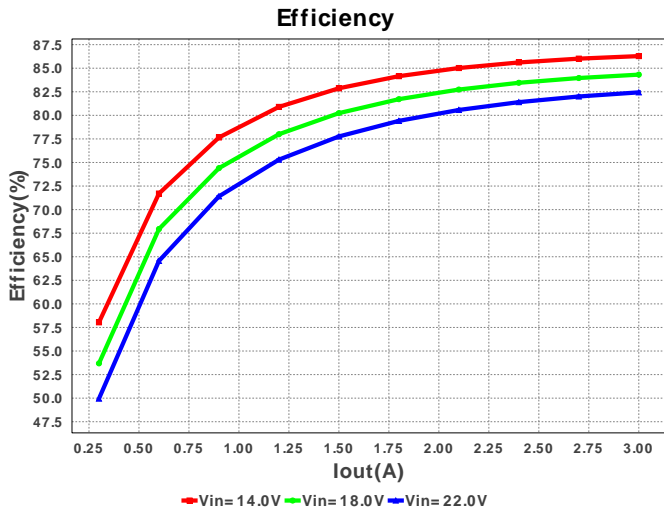


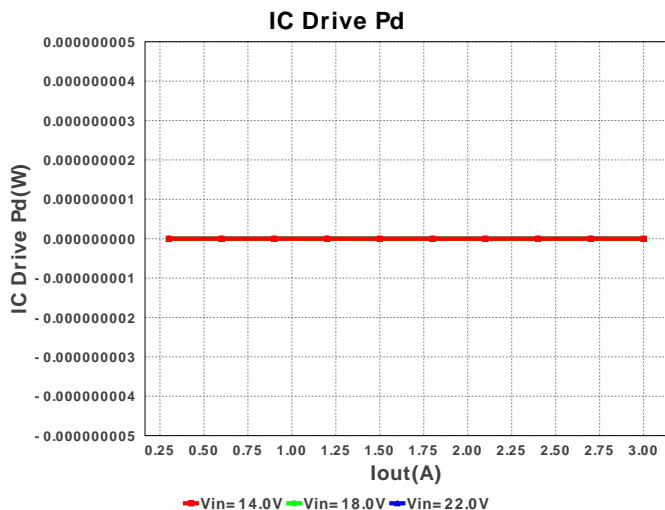
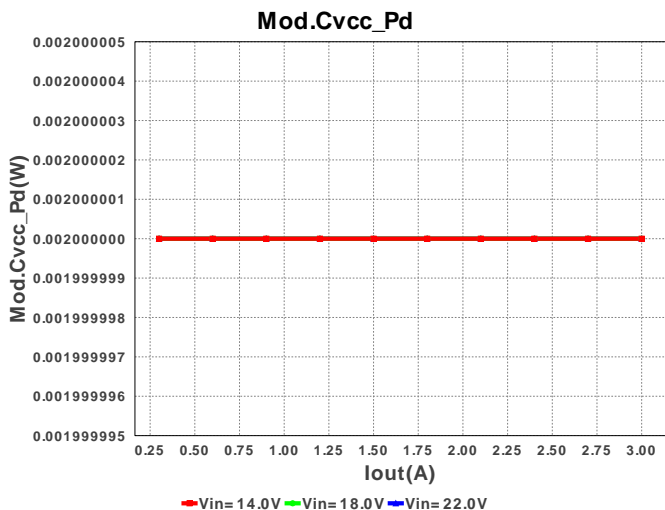
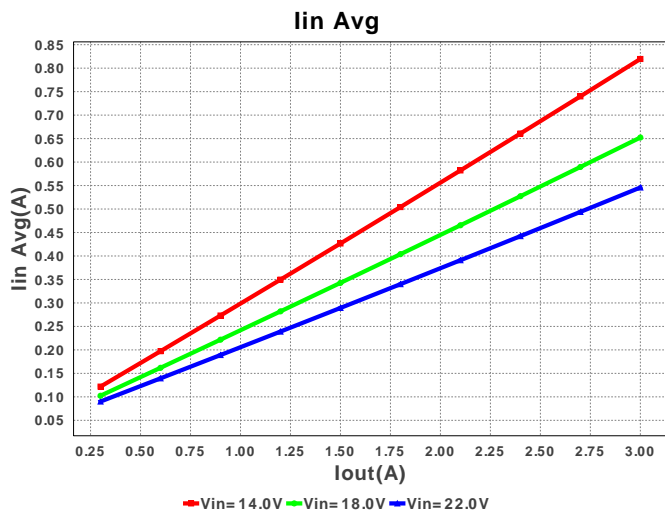
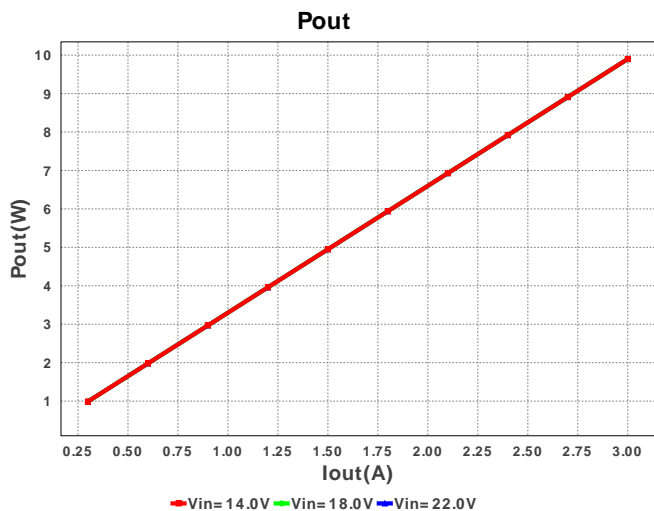
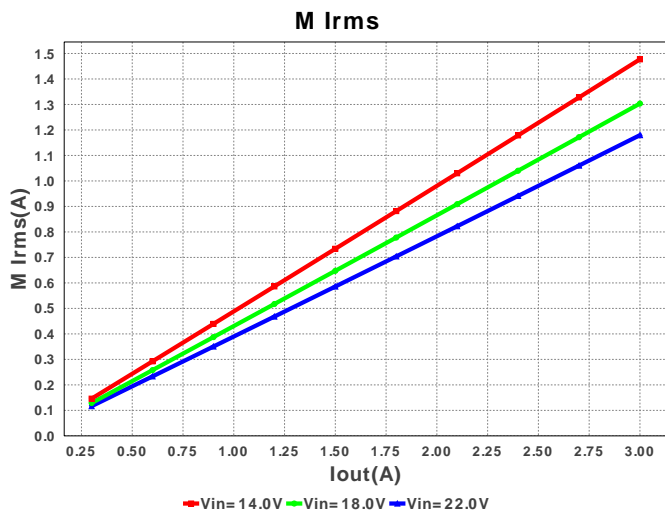
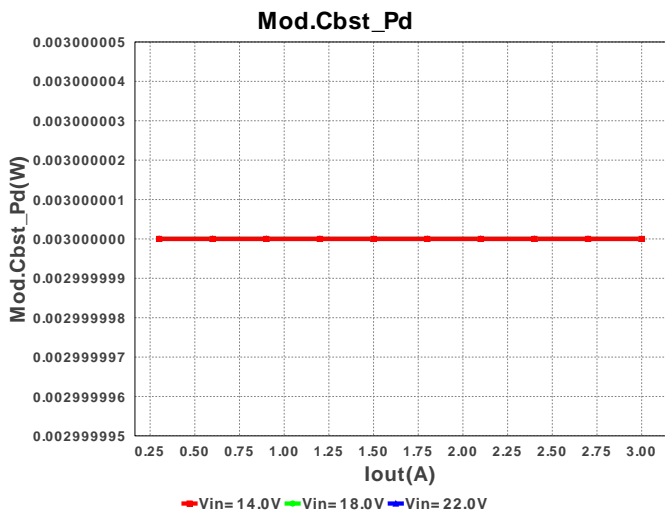
**WEBENCH<sup>®</sup> Design Report**

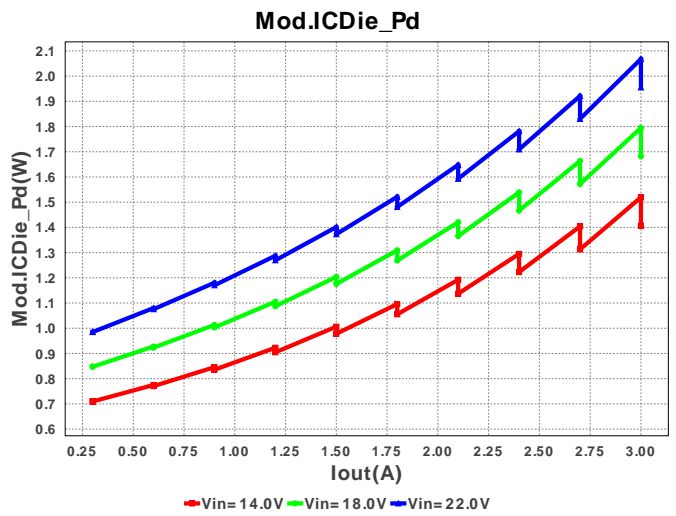
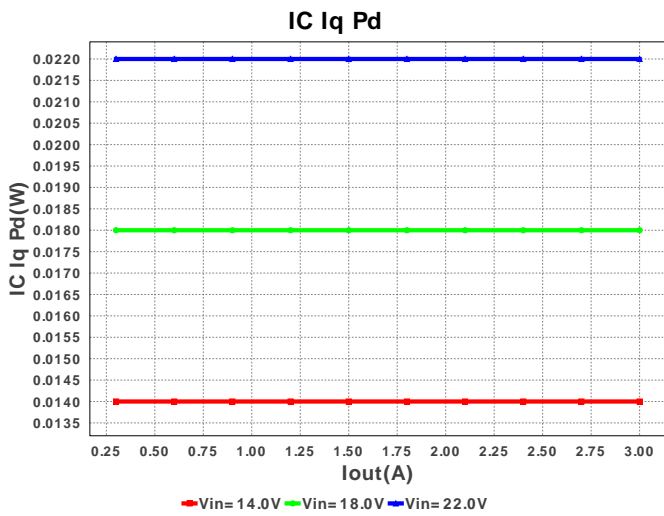
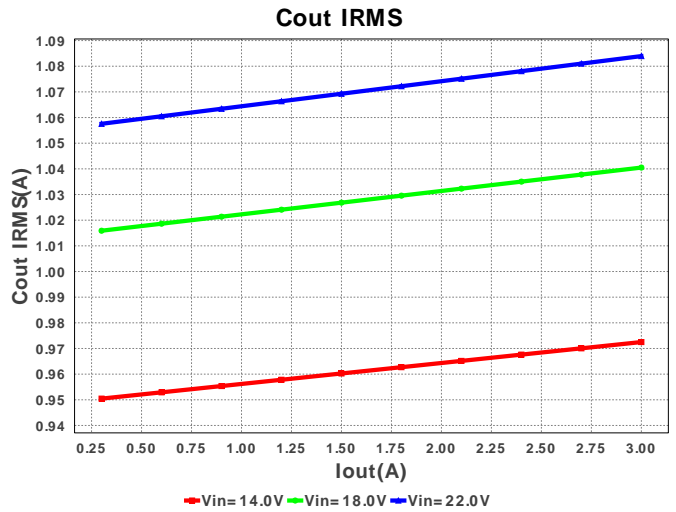
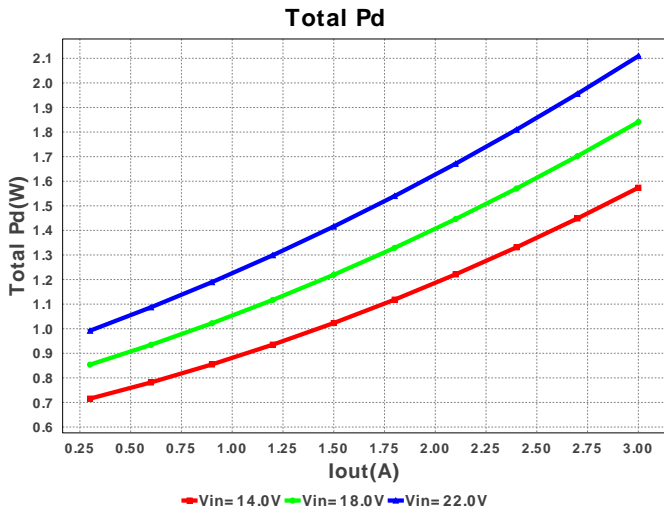
 Design : 3981718/220 LMZ23610TZ/NOPB  
 LMZ23610TZ/NOPB 14.0V-22.0V to 3.3V @ 3.0A

**Electrical BOM**

| #  | Name | Manufacturer      | Part Number                  | Properties  | Qty | Price   | Footprint  |
|----|------|-------------------|------------------------------|---|-----|---------|--|
| 1. | Cin  | Panasonic         | 35SVPF39M<br>Series= 1273    | Cap= 39.0 µF<br>ESR= 30.0 mOhm<br>VDC= 35.0 V<br>IRMS= 2.8 A  | 1   | \$0.50  | <br>CAPSMT_62_E7 106mm <sup>2</sup>   |
| 2. | Cout | Panasonic         | 6SVPE220MW<br>Series= 259    | Cap= 220.0 µF<br>ESR= 15.0 mOhm<br>VDC= 6.3 V<br>IRMS= 3.15 A | 3   | \$0.14  | <br>CAPSMT_62_E61 53mm <sup>2</sup> |
| 3. | Rfbb | Panasonic         | ERJ-6ENF1071V<br>Series= 225 | Res= 1.07 kOhm<br>Power= 125.0 mW<br>Tolerance= 1.0%          | 1   | \$0.01  | <br>0805 7mm <sup>2</sup>           |
| 4. | Rfht | Panasonic         | ERJ-6ENF3321V<br>Series= 225 | Res= 3.32 kOhm<br>Power= 125.0 mW<br>Tolerance= 1.0%          | 1   | \$0.01  | <br>0805 7mm <sup>2</sup>           |
| 5. | U1   | Texas Instruments | LMZ23610TZ/NOPB              | Switcher  | 1   | \$15.10 | <br>TZA011A 342mm <sup>2</sup>      |









### Operating Values

| #   | Name              | Value       | Category | Description                                |
|-----|-------------------|-------------|----------|--|
| 1.  | Cin IRMS          | 1.085 A     | Current  | Input capacitor RMS ripple current         |
| 2.  | Cout IRMS         | 1.084 A     | Current  | Output capacitor RMS ripple current        |
| 3.  | IC Ipk            | 4.877 A     | Current  | Peak switch current in IC                  |
| 4.  | Iin Avg           | 545.87 mA   | Current  | Average input current                      |
| 5.  | M Irms            | 1.18 A      | Current  | MOSFET RMS current                         |
| 6.  | BOM Count         | 7           | General  | Total Design BOM count                     |
| 7.  | FootPrint         | 621.0 mm2   | General  | Total Foot Print Area of BOM components    |
| 8.  | Frequency         | 350.0 kHz   | General  | Switching frequency                        |
| 9.  | IC Tolerance      | 20.0 mV     | General  | IC Feedback Tolerance                      |
| 10. | M Vds Act         | 18.3 mV     | General  | Voltage drop across the MosFET             |
| 11. | Pout              | 9.9 W       | General  | Total output power                         |
| 12. | Total BOM         | \$16.04     | General  | Total BOM Cost                             |
| 13. | Vout OP           | 3.3 V       | Op_Point | Operational Output Voltage                 |
| 14. | Cross Freq        | 9.175 kHz   | Op_point | Bode plot crossover frequency              |
| 15. | Duty Cycle        | 15.461 %    | Op_point | Duty cycle                                 |
| 16. | Efficiency        | 82.438 %    | Op_point | Steady state efficiency                    |
| 17. | IC Tj             | 50.679 degC | Op_point | IC junction temperature                    |
| 18. | ICThetaJA         | 10.0 degC/W | Op_point | IC junction-to-ambient thermal resistance  |
| 19. | IOUT_OP           | 3.0 A       | Op_point | Iout operating point                       |
| 20. | Phase Marg        | 50.178 deg  | Op_point | Bode Plot Phase Margin                     |
| 21. | VIN_OP            | 22.0 V      | Op_point | Vin operating point                        |
| 22. | Vout p-p          | 18.884 mV   | Op_point | Peak-to-peak output ripple voltage         |
| 23. | Cin Pd            | 35.291 mW   | Power    | Input capacitor power dissipation          |
| 24. | Cout Pd           | 5.875 mW    | Power    | Output capacitor power dissipation         |
| 25. | IC Drive Pd       | 0.0 W       | Power    | Driver power dissipation                   |
| 26. | IC Iq Pd          | 22.0 mW     | Power    | IC Iq Pd                                   |
| 27. | Total Pd          | 2.109 W     | Power    | Total Power Dissipation                    |
| 28. | Number of Drivers | 1.0         | Unknown  | Number of drivers in current sharing mode. |

### Design Inputs

| #  | Name    | Value     | Description                        |
|----|---------|-----------|------------------------------------|
| 1. | lout    | 3.0 A     | Maximum Output Current             |
| 2. | lout1   | 3.0 Amps  | Output Current #1                  |
| 3. | VinMax  | 22.0 V    | Maximum input voltage              |
| 4. | VinMin  | 14.0 V    | Minimum input voltage              |
| 5. | Vout    | 3.3 V     | Output Voltage                     |
| 6. | Vout1   | 3.3 Volt  | Output Voltage #1                  |
| 7. | base_pn | LMZ23610  | Texas Instruments Base Part Number |
| 8. | source  | DC        | Input Source Type                  |
| 9. | ta      | 30.0 degC | Ambient temperature                |

## Design Assistance

1. The Modules are very easy to use and just need a basic design using a resistor divider at the feedback and input and output caps to work. To design for UVLO you could click on the drop down menu in the 'Change Inputs' menu and select the 'UVLO Enabled Design'. The internal softstart time is set at 1.6mSec. If a longer softstart time is desired, you could change the preset to the desired amount and click on 'Submit'. Webench will then add an external softstartcap to the schematic. For designs requiring more than 10A of load current, multiple LMZ23610 ICs can be used by connecting their 'SH' pins together. The 'Master' LMZ23610 is set by connecting the resistor divider from feedback to the output. The slaves have their feedback pins open. Airflow There should be airflow of about 225LFM provided for the maximum input voltage of 36V and full load requirement. Without airflow the IC will heat up and has a chance of thermal failure.

2. LMZ23610 Product Folder : <http://www.ti.com/product/lmz23610> : contains the data sheet and other resources.

Texas Instruments' WEBENCH simulation tools attempt to recreate the performance of a substantially equivalent physical implementation of the design. Simulations are created using Texas Instruments' published specifications as well as the published specifications of other device manufacturers. While Texas Instruments does update this information periodically, this information may not be current at the time the simulation is built. Texas Instruments does not warrant the accuracy or completeness of the specifications or any information contained therein. Texas Instruments does not warrant that any designs or recommended parts will meet the specifications you entered, will be suitable for your application or fit for any particular purpose, or will operate as shown in the simulation in a physical implementation. Texas Instruments does not warrant that the designs are production worthy.

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

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