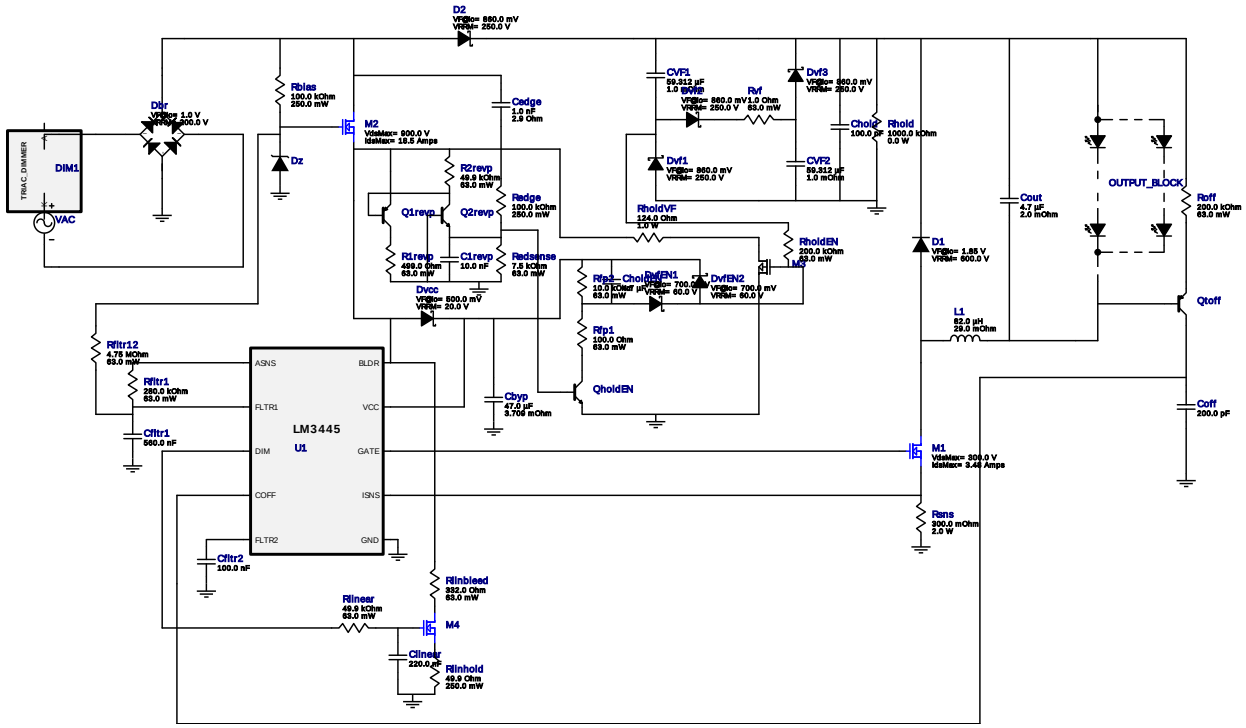
TEXAS INSTRUMENTS

# WEBENCH® Design Report

VinMin = 110.0V
VinMax = 130.0V
Vout = 9.8V
Iout = 2.1A

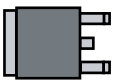
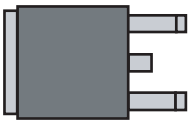
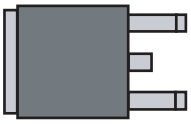
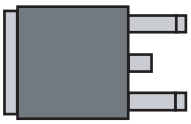
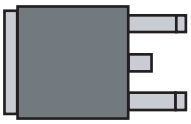
Device = LM3445MM/NOPB
Topology = Buck
Created = 8/10/16 11:46:17 PM
BOM Cost = $0.00
BOM Count = 134
Total Pd = 0.0W

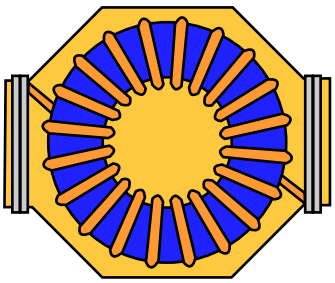
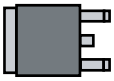
Design : 4765175/3 LM3445MM/NOPB
LM3445MM/NOPB 110.0V-130.0V to 9.80V @ 2.1A



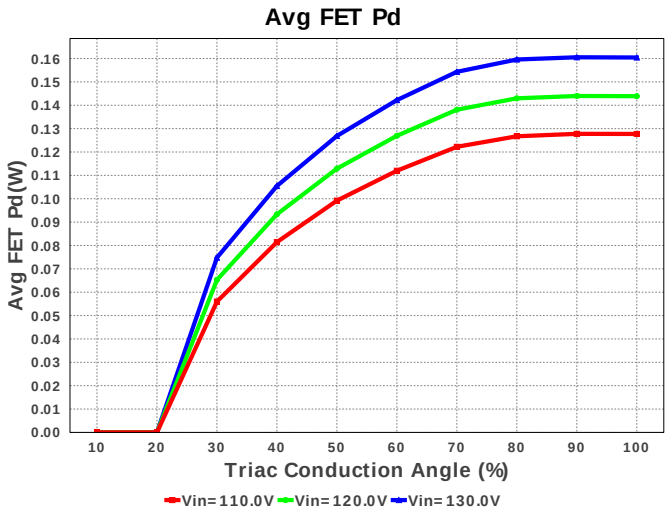

## Electrical BOM

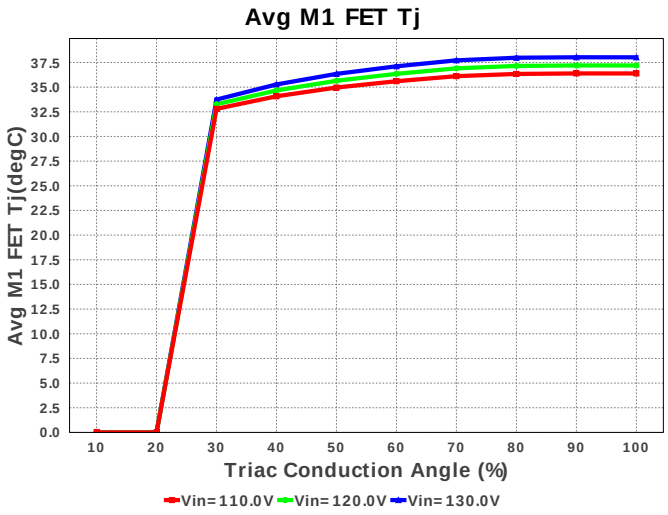
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | C1revp | MuRata | GRM216R71H103KA01D<br>Series= X7R | Cap= 10.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm$^2$ |
| 2. | CVF1 | CUSTOM | CUSTOM<br>Series= ? | Cap= 59.312 uF<br>ESR= 1.0 mOhm<br>VDC= 147.078 V<br>IRMS= 2.7299 A | 1 | NA | CUSTOM 0 mm$^2$ |
| 3. | CVF2 | CUSTOM | CUSTOM<br>Series= ? | Cap= 59.312 uF<br>ESR= 1.0 mOhm<br>VDC= 147.078 V<br>IRMS= 2.7299 A | 1 | NA | CUSTOM 0 mm$^2$ |
| 4. | Cbyp | MuRata | GRM31CR61A476KE15L<br>Series= X5R | Cap= 47.0 uF<br>ESR= 3.709 mOhm<br>VDC= 10.0 V<br>IRMS= 4.2862 A | 1 | $0.15 | 1206_190 11 mm$^2$ |
| 5. | Cedge | MuRata | GRM188R72E102KW07D<br>Series= X7R | Cap= 1.0 nF<br>ESR= 2.9 Ohm<br>VDC= 250.0 V<br>IRMS= 90.0 mA | 1 | $0.01 | 0603 5 mm$^2$ |
| 6. | Cfltr1 | MuRata | GRM155R61A564KE15D<br>Series= X5R | Cap= 560.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A | 1 | $0.03 | 0402 3 mm$^2$ |
| 7. | Cfltr2 | MuRata | GRM21BR71E104KA01L<br>Series= X7R | Cap= 100.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm$^2$ |

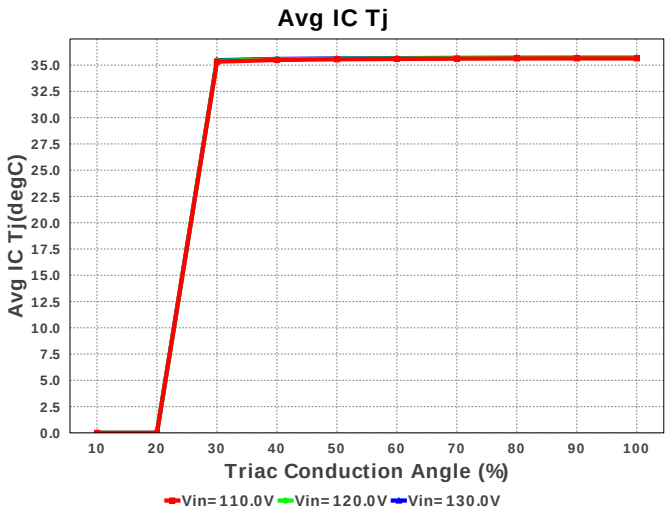
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 8. | Chold | MuRata | GRM31CR72E104KW03L<br>Series= X7R | Cap= 100.0 nF<br>VDC= 250.0 V<br>IRMS= 0.0 A | 1 | $0.06 |  <br>1206 11 mm² |
| 9. | CholdEN | Taiyo Yuden | LMK212BJ475KD-T<br>Series= X5R | Cap= 4.7 uF<br>VDC= 10.0 V<br>IRMS= 0.0 A | 1 | $0.03 | <br>0805 7 mm² |
| 10. | Clinear | MuRata | GRM155C80G224KE01D<br>Series= X6S | Cap= 220.0 nF<br>VDC= 4.0 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0402 3 mm² |
| 11. | Coff | Samsung Electro-Mechanics | CL21C201JBANNNC<br>Series= C0G/NP0 | Cap= 200.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0805 7 mm² |
| 12. | Cout | MuRata | GRM21BR61E475MA12L<br>Series= X5R | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 25.0 V<br>IRMS= 7.29 A | 1 | $0.02 | <br>0805 7 mm² |
| 13. | D1 | STMicroelectronics | STTH506B-TR | VF@Io= 1.85 V<br>VRRM= 600.0 V | 1 | $0.59 |  <br>DPAK 102 mm² |
| 14. | D2 | ON Semiconductor | MBRB40250TG | VF@Io= 860.0 mV<br>VRRM= 250.0 V | 1 | $0.94 |  <br>DDPAK 210 mm² |
| 15. | D_LED | CUSTOM | CUSTOM | LED | 84 | NA | CUSTOM 0 mm² |
| 16. | Dbr | Diodes Inc. | HD02-T | VF@Io= 1.0 V<br>VRRM= 200.0 V | 1 | $0.12 |  <br>MiniDIP 62 mm² |
| 17. | Dvcc | Vishay-Semiconductor | SS12-E3/61T | VF@Io= 500.0 mV<br>VRRM= 20.0 V | 1 | $0.08 |  <br>SMA 37 mm² |
| 18. | Dvf1 | ON Semiconductor | MBRB40250TG | VF@Io= 860.0 mV<br>VRRM= 250.0 V | 1 | $0.94 |  <br>DDPAK 210 mm² |
| 19. | Dvf2 | ON Semiconductor | MBRB40250TG | VF@Io= 860.0 mV<br>VRRM= 250.0 V | 1 | $0.94 |  <br>DDPAK 210 mm² |
| 20. | Dvf3 | ON Semiconductor | MBRB40250TG | VF@Io= 860.0 mV<br>VRRM= 250.0 V | 1 | $0.94 |  <br>DDPAK 210 mm² |
| 21. | DvfEN1 | Diodes Inc. | B260A-13-F | VF@Io= 700.0 mV<br>VRRM= 60.0 V | 1 | $0.09 |  <br>SMA 37 mm² |
| 22. | DvfEN2 | Diodes Inc. | B260A-13-F | VF@Io= 700.0 mV<br>VRRM= 60.0 V | 1 | $0.09 |  <br>SMA 37 mm² |
| 23. | Dz | ON Semiconductor | BZX84C15LT1G | Zener | 1 | $0.02 |  <br>SOT-23 14 mm² |

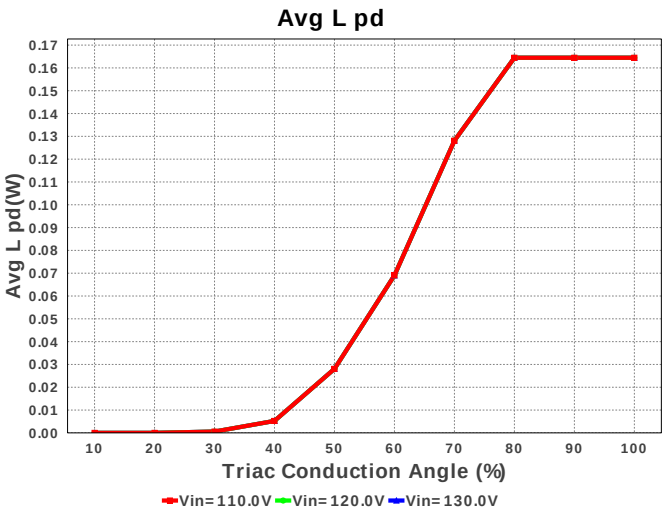
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 24. | L1 | Bourns | PM2110-820K-RC | L= 82.0 µH<br>DCR= 29.0 mOhm | 1 | $1.21 |  <br>PM2110 890 mm² |
| 25. | M1 | Fairchild Semiconductor | FQD7N30TM | VdsMax= 300.0 V<br>IdsMax= 3.48 Amps | 1 | $0.40 |  <br>DPAK 102 mm² |
| 26. | M2 | STMicroelectronics | STW21N90K5 | VdsMax= 900.0 V<br>IdsMax= 18.5 Amps | 1 | $3.94 |  <br>TO-247 123 mm² |
| 27. | M3 | unknown | | unknown | | NA | |
| 28. | M4 | unknown | | unknown | | NA | |
| 29. | Q1revp | Diodes Inc. | BC858C-7-F | Bipolar Transistor | 1 | $0.03 |  <br>SOT-23 14 mm² |
| 30. | Q2revp | Diodes Inc. | MMBT4401-7-F | Bipolar Transistor | 1 | $0.02 |  <br>SOT-23 14 mm² |
| 31. | QholdEN | Diodes Inc. | MMBT4401-7-F | Bipolar Transistor | 1 | $0.02 |  <br>SOT-23 14 mm² |
| 32. | Qtoff | Fairchild Semiconductor | MMBTA92 | Bipolar Transistor | 1 | $0.05 |  <br>SOT-23 14 mm² |
| 33. | R1revp | Vishay-Dale | CRCW0402499RFKED<br>Series= CRCW..e3 | Res= 499.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 34. | R2revp | 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 mm² |
| 35. | Rbias | Panasonic | ERJ-8ENF1003V<br>Series= ERJ-8E | Res= 100.0 kOhm<br>Power= 250.0 mW<br>Tolerance= 1.0% | 1 | $0.01 |  <br>1206 11 mm² |
| 36. | Redge | Panasonic | ERJ-8ENF1003V<br>Series= ERJ-8E | Res= 100.0 kOhm<br>Power= 250.0 mW<br>Tolerance= 1.0% | 1 | $0.01 |  <br>1206 11 mm² |
| 37. | Redsense | Vishay-Dale | CRCW04027K50FKED<br>Series= CRCW..e3 | Res= 7.5 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 38. | Rfltr1 | Vishay-Dale | CRCW0402280KFKED<br>Series= CRCW..e3 | Res= 280.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 39. | Rfltr12 | Vishay-Dale | CRCW04024M75FKED<br>Series= CRCW..e3 | Res= 4.75 MOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 40. | Rfp1 | Vishay-Dale | CRCW0402100RFKED<br>Series= CRCW..e3 | Res= 100.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 41. | Rfp2 | Vishay-Dale | CRCW040210K0FKED<br>Series= CRCW..e3 | Res= 10.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 42. | Rhold | CUSTOM | CUSTOM<br>Series= ? | Res= 1000.0 kOhm<br>Power= 0.0 W<br>Tolerance= 0.0% | 1 | NA | CUSTOM 0 mm² |

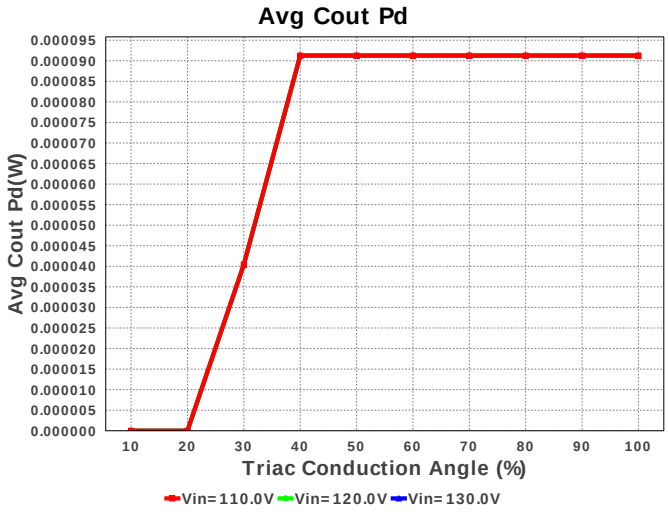
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 43. | RholdEN | Vishay-Dale | CRCW0402200KFKED<br>Series= CRCW..e3 | Res= 200.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 44. | RholdVF | Panasonic | ERJ-1TNF1240U<br>Series= ERJ-1T | Res= 124.0 Ohm<br>Power= 1.0 W<br>Tolerance= 1.0% | 1 | $0.13 | 2512 43 mm² |
| 45. | Rlinbleed | Vishay-Dale | CRCW0402332RFKED<br>Series= CRCW..e3 | Res= 332.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 46. | Rlinear | Vishay-Dale | CRCW040249K9FKED<br>Series= CRCW..e3 | Res= 49.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 47. | Rlinhold | Panasonic | ERJ-8ENF49R9V<br>Series= ERJ-8E | Res= 49.9 Ohm<br>Power= 250.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 1206 11 mm² |
| 48. | Roff | Vishay-Dale | CRCW0402200KFKED<br>Series= CRCW..e3 | Res= 200.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 49. | Rsns | Stackpole Electronics Inc | CSRN2512FKR300<br>Series= ? | Res= 300.0 mOhm<br>Power= 2.0 W<br>Tolerance= 1.0% | 1 | $0.13 | 2512 43 mm² |
| 50. | Rvf | Vishay-Dale | CRCW04021R00FKED<br>Series= CRCW..e3 | Res= 1.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 51. | U1 | Texas Instruments | LM3445MM/NOPB | Switcher | 1 | $0.40 | MUB10A 24 mm² |

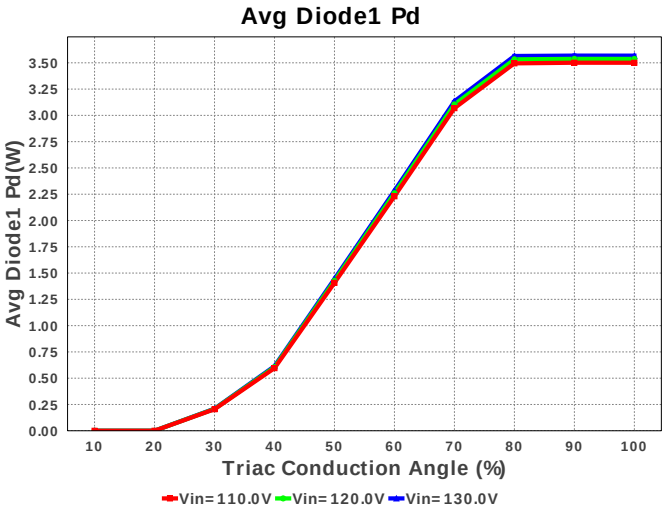


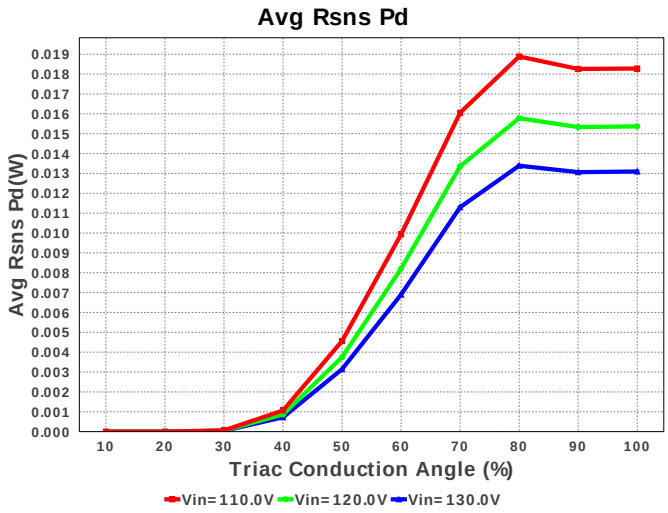



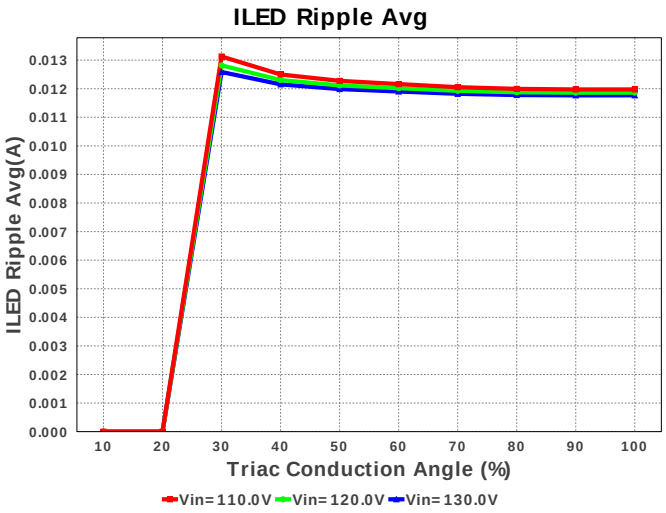


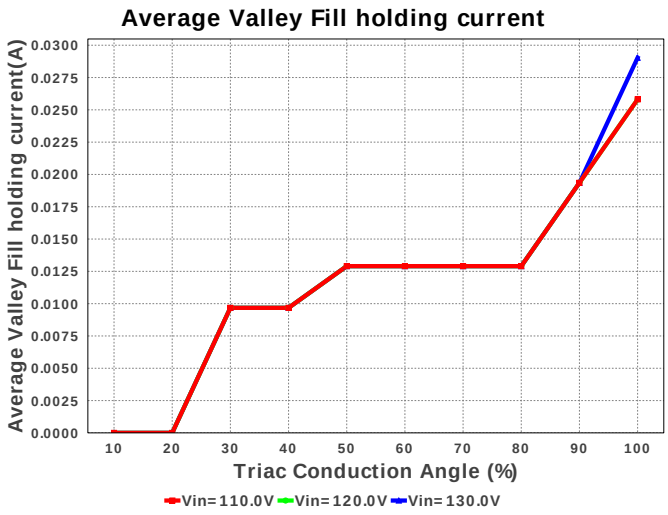



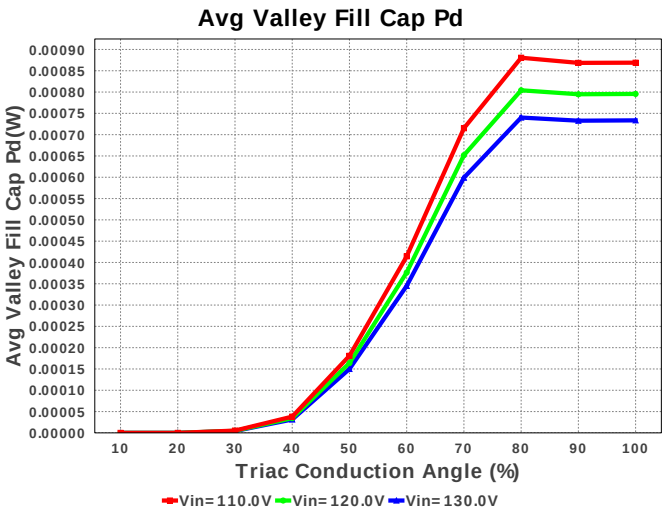



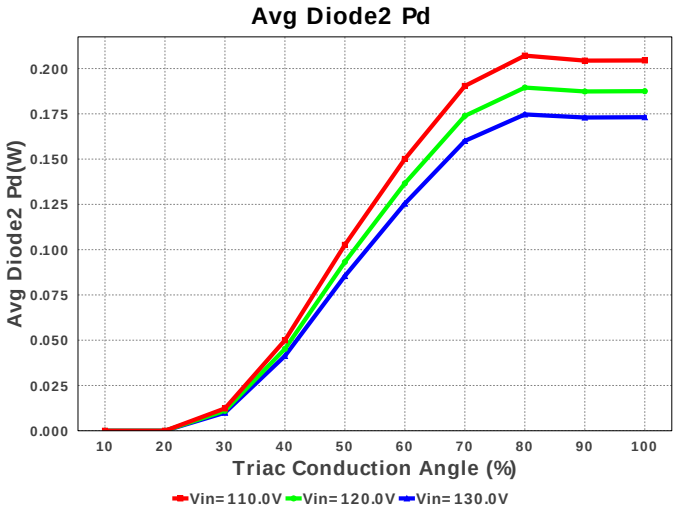



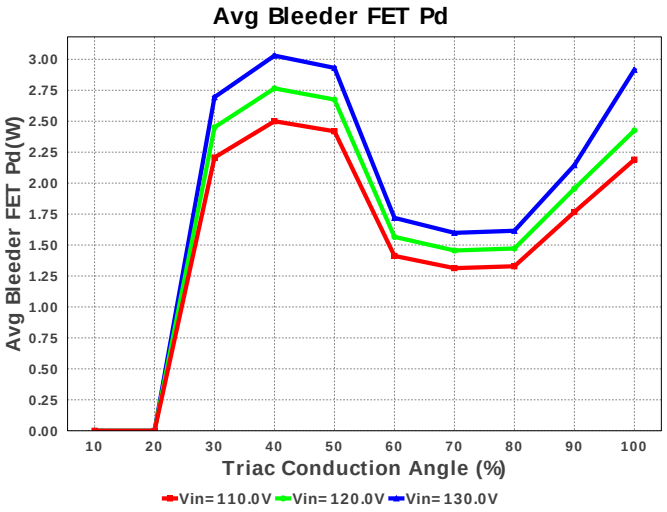



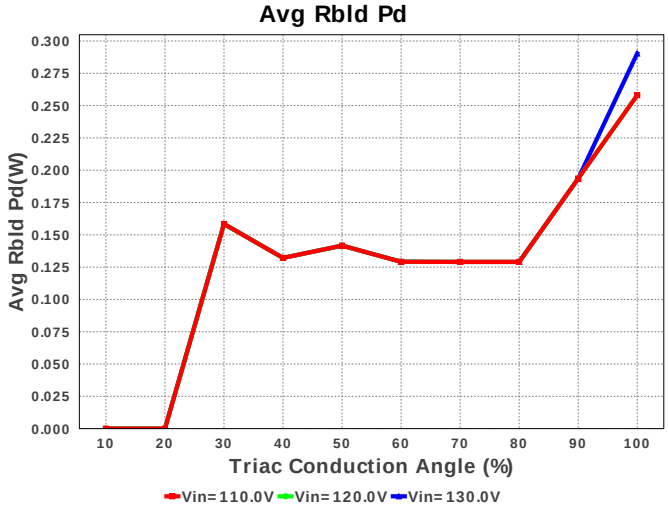



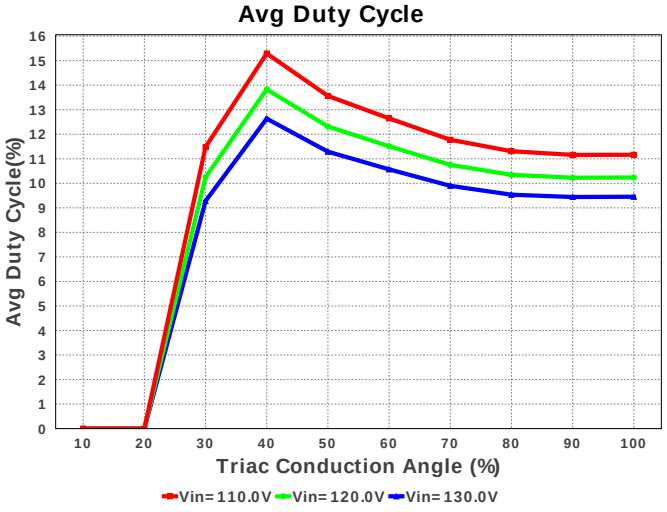


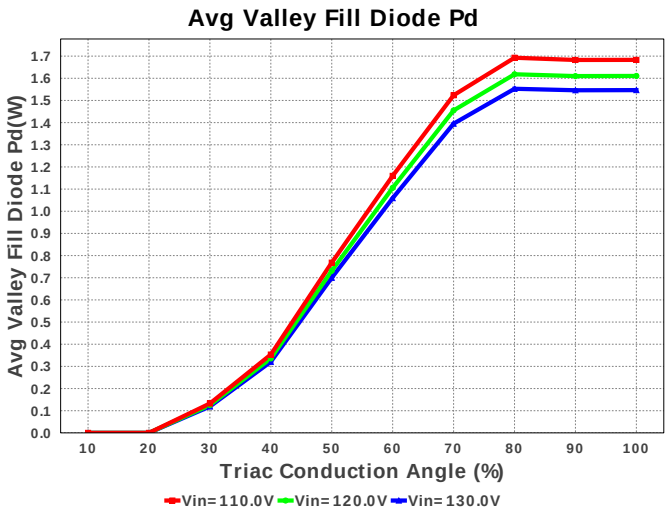



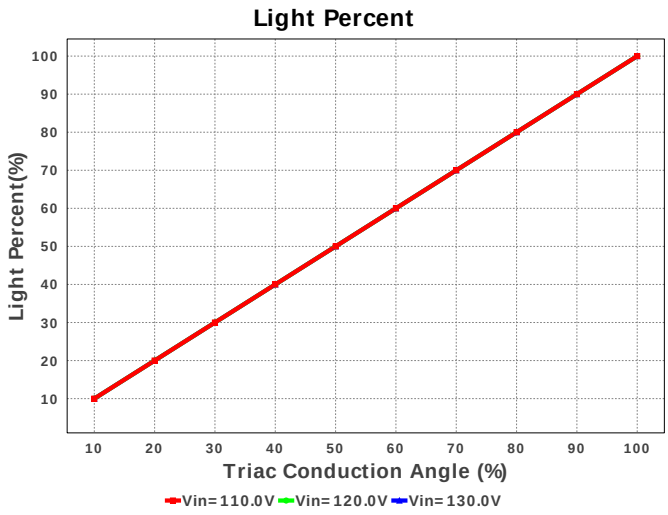



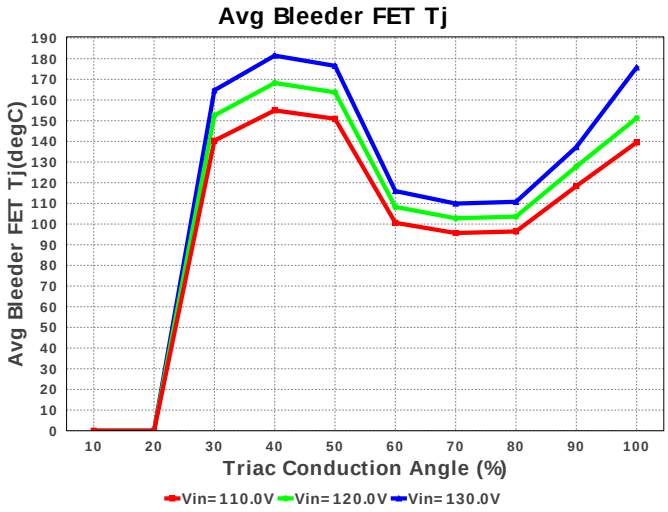



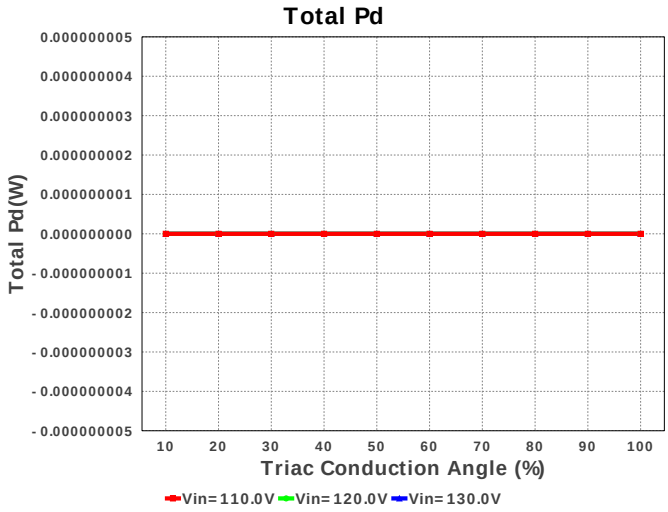



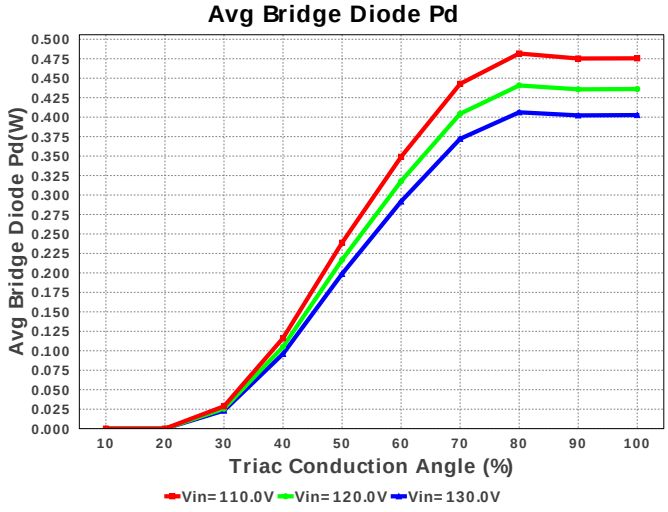



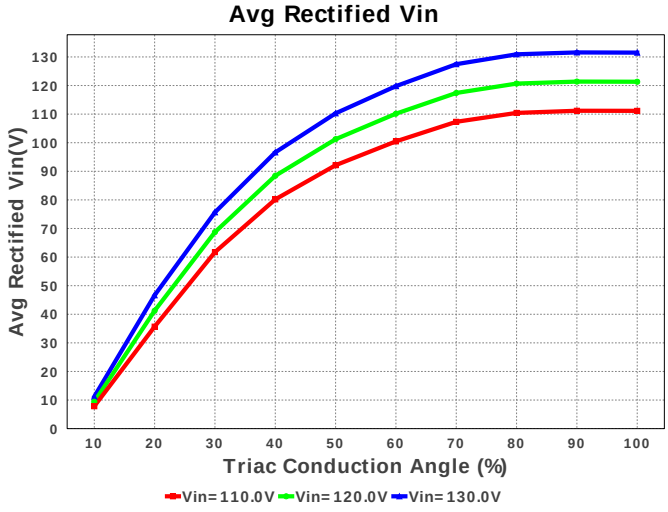


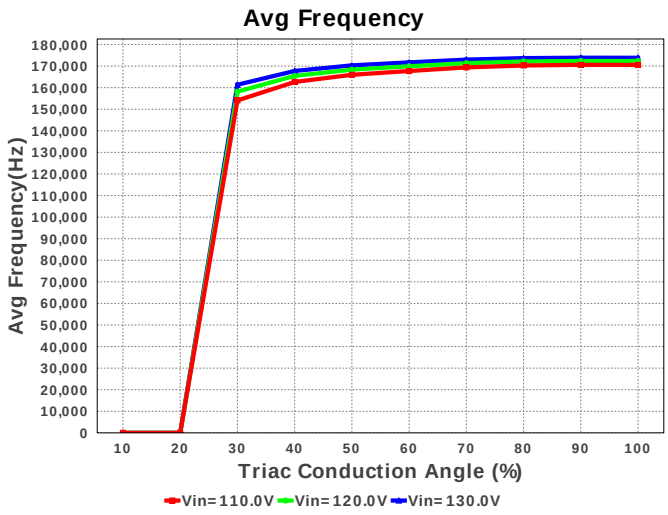



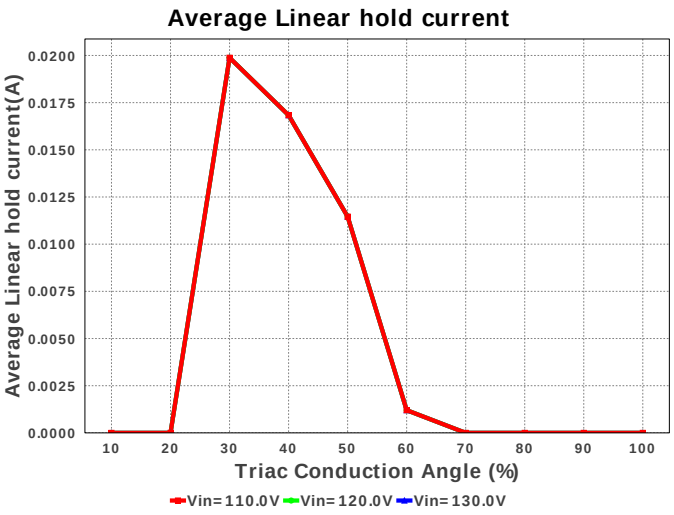



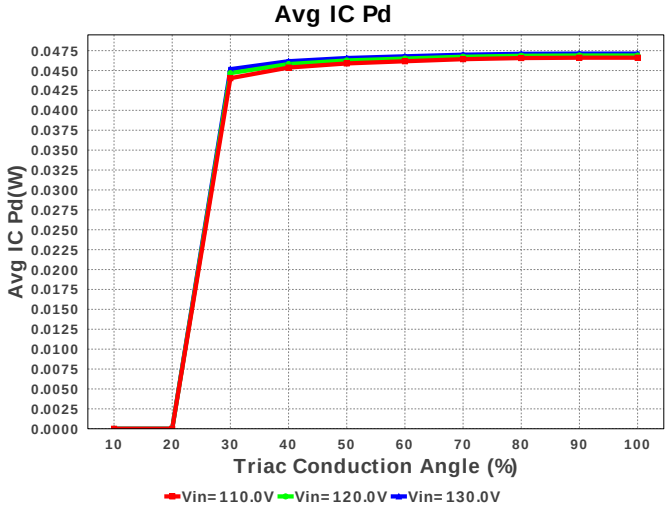



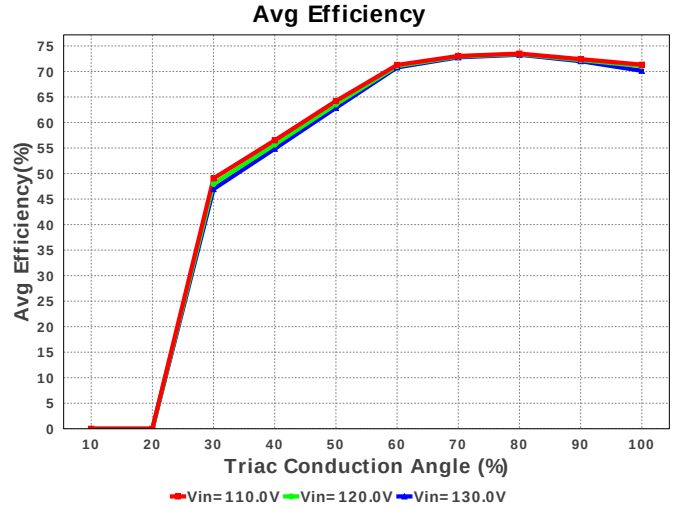



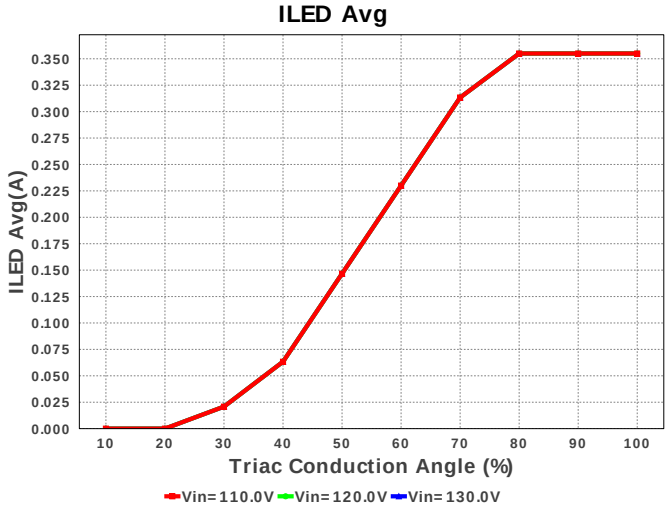






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | ILED Avg | 355.001 mA | Current | Average Current per LED for the AC line period |
| 2. | ILED Ripple Avg | 11.795 mA | Current | Average LED Ripple Current for the AC line period |
| 3. | Avg Rectified Vin | 129.77 V | General | Average Rectified Voltage for the AC Line Period |
| 4. | BOM Count | 134 | General | Total Design BOM count |
| 5. | FootPrint | 2.56 k $mm^2$ | General | Total Foot Print Area of BOM components |
| 6. | Total BOM | $0.0 | General | Total BOM Cost |
| 7. | Avg Bleeder FET Tj | 110.482 degC | Op_Point | Bleeder MOSFET average junction temperature over the AC Line Period |
| 8. | Avg M1 FET Tj | 37.893 degC | Op_Point | M1 MOSFET average junction temperature over the AC Line Period |
| 9. | Avg Duty Cycle | 9.669 % | Op_point | Average Duty Cycle over the AC Line Period |
| 10. | Avg Efficiency | 75.32 % | Op_point | Average Efficiency over the AC Line Period |

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 11. | Avg Frequency | 173.441 kHz | Op_point | Average Switching Frequency over the AC Line Period |
| 12. | Avg IC Tj | 35.694 degC | Op_point | Average IC junction temperature for the AC line period |
| 13. | VIN_OP | 130.0 V | Op_point | AC Input RMS Voltage |
| 14. | Avg Bleeder FET Pd | 1.61 W | Power | Average power dissipation in the bleeder FET over the AC line period |
| 15. | Avg Bridge Diode Pd | 310.591 mW | Power | Average Power Dissipation in the Bridge Diode over the AC Line Period |
| 16. | Avg Cout Pd | 91.252 µW | Power | Average Power Dissipation in the Output Capacitor over the AC Line Period |
| 17. | Avg Diode1 Pd | 3.559 W | Power | Average Power Dissipation in D1 over the AC Line Period |
| 18. | Avg Diode2 Pd | 107.195 mW | Power | Average Power Dissipation in D1 over the AC Line Period |
| 19. | Avg FET Pd | 157.866 mW | Power | Average power dissipation in the switching FET over the AC line period |
| 20. | Avg IC Pd | 47.057 mW | Power | Average Power Dissipation in the IC over the AC line period |
| 21. | Avg L pd | 164.463 mW | Power | Average Inductor power disspation over the AC line period |
| 22. | Avg Rbld Pd | 129.032 mW | Power | Average power dissipation in the bleeder resistor over the AC line period |
| 23. | Avg Rsns Pd | 13.816 mW | Power | Average power dissipation in the Current limit resistor over the AC line period |
| 24. | Avg Valley Fill Cap Pd | 750.772 µW | Power | Average Power Dissipation in the Valley Fill Capacitors over the AC Line Period |
| 25. | Avg Valley Fill Diode Pd | 953.096 mW | Power | Average Power Dissipation in the Valley Fill Diodes over the AC Line Period |
| 26. | Total Pd | 0.0 W | Power | Total Power Dissipation |
| 27. | Average Linear hold current | 0.0 A | | Average Linear hold current over the AC Line Period |
| 28. | Average Valley Fill holding current | 12.903 mA | | Average Valley Fill holding current over the AC Line Period |
| 29. | Light Percent | 75.0 % | | Percentage light from dimming |
| 30. | Vout Tolerance | 306.12 m% | | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 2.1 | Maximum Output Current |
| 2. | VinMax | 130.0 | Maximum input voltage |
| 3. | VinMin | 110.0 | Minimum input voltage |
| 4. | Vout | 9.8 | Output Voltage |
| 5. | acFrequency | 60.0 | Light Output in Lumen |
| 6. | application | LED_DRIVER | LED Application |
| 7. | base_pn | LM3445 | Texas Instruments Base Part Number |
| 8. | isLEDArchitect | N | LED Architect Project |
| 9. | ledparallel | 6.0 | Number of LED in parallel |
| 10. | ledpartnumber | ?? | LED Part number |
| 11. | ledseries | 14.0 | Number of LED in series |
| 12. | line_fsw | 60.0 | AC Line Frequency |
| 13. | source | AC | Input Source Type |
| 14. | ta | 30.0 | Ambient temperature |

## Design Assistance

1. LM3445 Product Folder : http://www.ti.com/product/LM3445 : contains the data sheet and other resources.