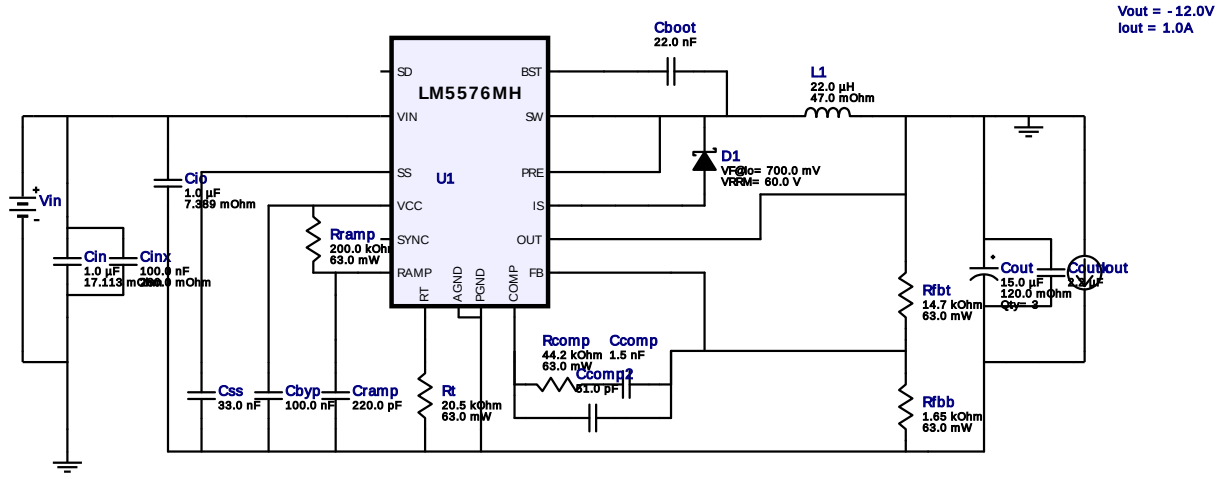
TEXAS INSTRUMENTS

# WEBENCH® Design Report

VinMin = 12.0V
VinMax = 15.0V
Vout = -12.0V
Iout = 1.0A

Device = LM5576MHX/NOPB
Topology = Inverting_Buck_Boost
Created = 8/28/16 7:31:44 AM
BOM Cost = $4.46
BOM Count = 21
Total Pd = 1.61W

Design : 4009018/129 LM5576MHX/NOPB
LM5576MHX/NOPB 12.0V-15.0V to -12.00V @ 1.0A




## Electrical BOM

| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cboot | MuRata | GRM155R71E223KA61D<br>Series= X7R | Cap= 22.0 nF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 mm² |
| 2. | Cbyp | MuRata | GRM155R61A104KA01D<br>Series= X5R | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 mm² |
| 3. | Ccomp | Yageo America | CC0805KRX7R9BB152<br>Series= X7R | Cap= 1.5 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 4. | Ccomp2 | Samsung Electro-Mechanics | CL21C510JBANNNC<br>Series= C0G/NP0 | Cap= 51.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 5. | Cin | MuRata | GRM188R61E105KA12D<br>Series= X5R | Cap= 1.0 uF<br>ESR= 17.113 mOhm<br>VDC= 25.0 V<br>IRMS= 979.39 mA | 1 | $0.01 | 0603 5 mm² |
| 6. | Cinx | AVX | 08053C104KAT2A<br>Series= X7R | Cap= 100.0 nF<br>ESR= 280.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |
| 7. | Cio | MuRata | GRM31MR71H105KA88L<br>Series= X7R | Cap= 1.0 uF<br>ESR= 7.389 mOhm<br>VDC= 50.0 V<br>IRMS= 979.22 mA | 1 | $0.03 | 1206 11 mm² |
| 8. | Cout | Panasonic | 16SVP15M<br>Series= SVP | Cap= 15.0 uF<br>ESR= 120.0 mOhm<br>VDC= 16.0 V<br>IRMS= 1.02 A | 3 | $0.38 | SM_RADIAL_5MM 58 mm² |
| 9. | Coutx | Taiyo Yuden | TMK212BJ225KG-T<br>Series= X5R | Cap= 2.2 uF<br>VDC= 20.0 V<br>IRMS= 0.0 A | 1 | $0.04 | 0805 7 mm² |
| 10. | Cramp | Yageo America | CC0805JRNPO9BN221<br>Series= C0G/NP0 | Cap= 220.0 pF<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm² |

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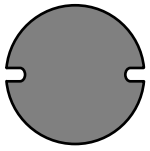
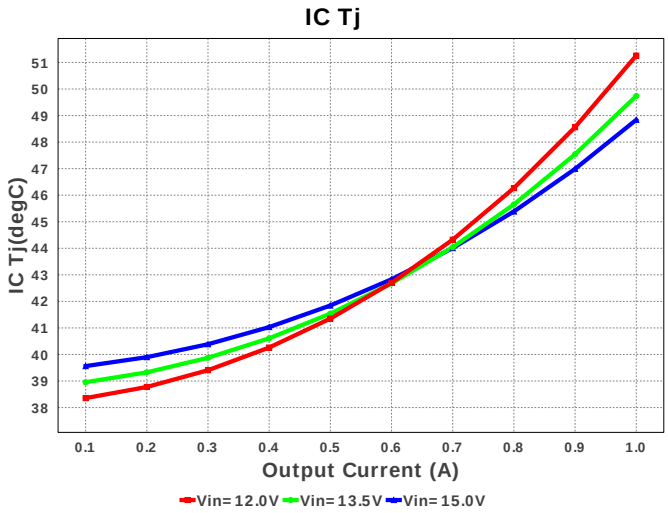
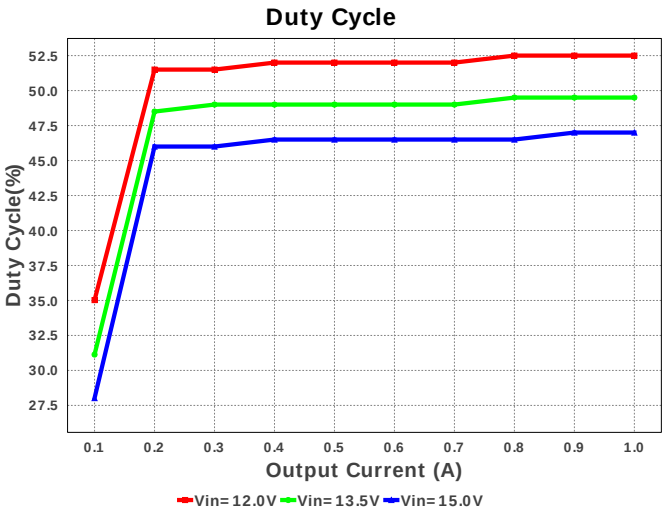
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 11. | Css | MuRata | GRM033R60J333KE01D<br>Series= X5R | Cap= 33.0 nF<br>VDC= 6.3 V<br>IRMS= 0.0 A | 1 | $0.01 | <br>0201 2 mm² |
| 12. | D1 | Diodes Inc. | B560C-13-F | VF@Io= 700.0 mV<br>VRRM= 60.0 V | 1 | $0.17 |  <br>SMC 83 mm² |
| 13. | L1 | Bourns | SDR1307-220ML | L= 22.0 µH<br>DCR= 47.0 mOhm | 1 | $0.35 |  <br>SDR1307 227 mm² |
| 14. | Rcomp | Vishay-Dale | CRCW040244K2FKED<br>Series= CRCW..e3 | Res= 44.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 15. | Rfbb | Vishay-Dale | CRCW04021K65FKED<br>Series= CRCW..e3 | Res= 1.65 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 16. | Rfbt | Vishay-Dale | CRCW040214K7FKED<br>Series= CRCW..e3 | Res= 14.7 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 17. | Rramp | Vishay-Dale | CRCW0402200KFKED<br>Series= CRCW..e3 | Res= 200.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 18. | Rt | Vishay-Dale | CRCW040220K5FKED<br>Series= CRCW..e3 | Res= 20.5 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | <br>0402 3 mm² |
| 19. | U1 | Texas Instruments | LM5576MHX/NOPB | Switcher | 1 | $2.60 |  <br>MXA20A 71 mm² |

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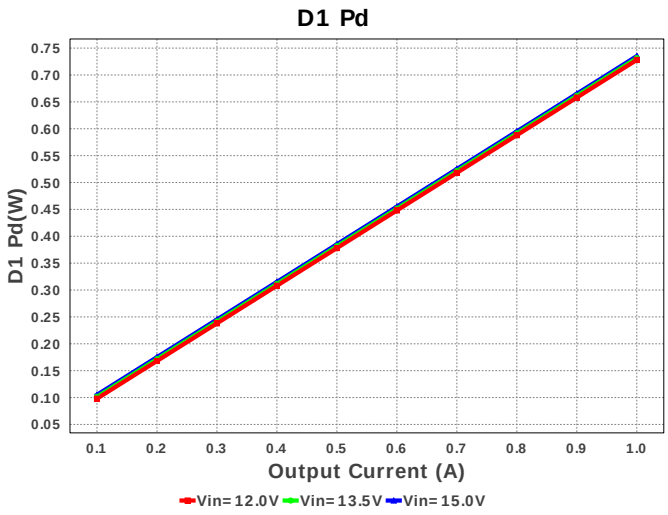


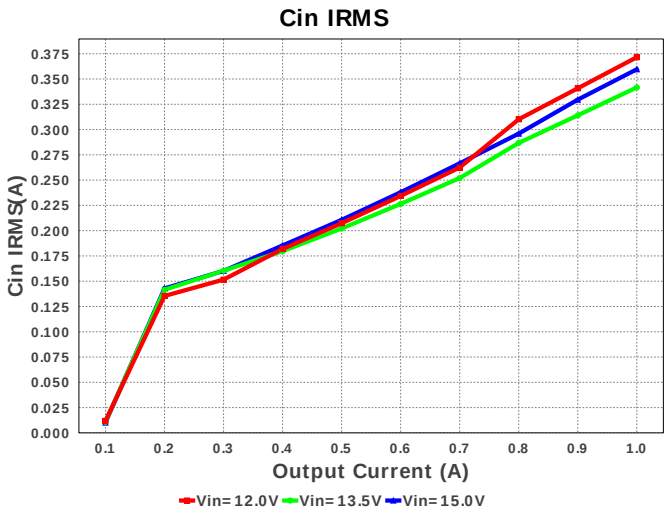


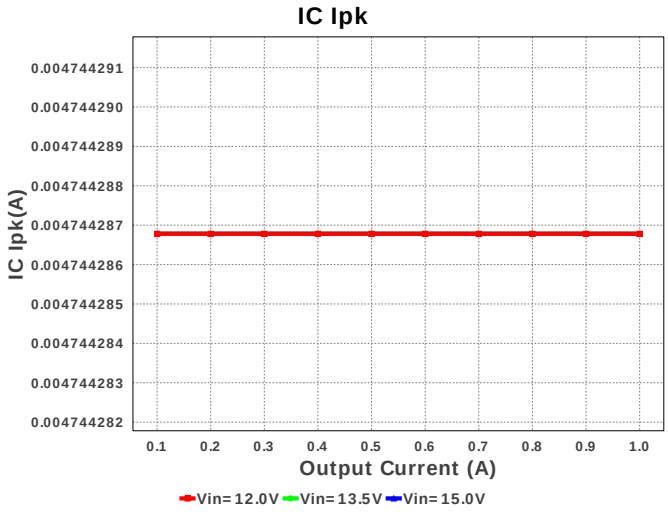


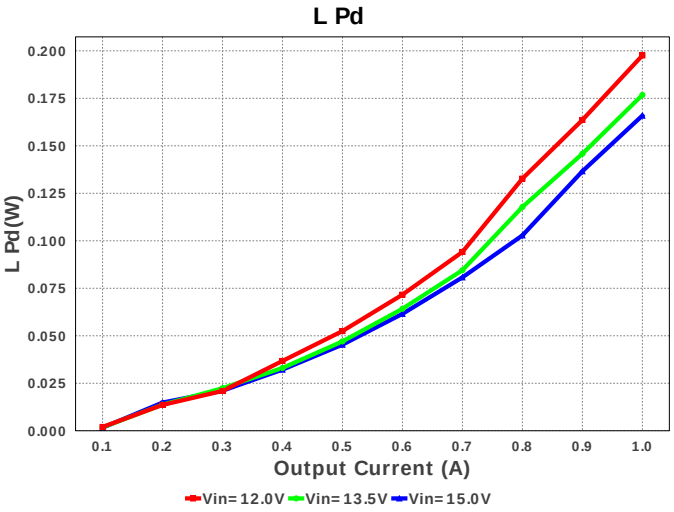


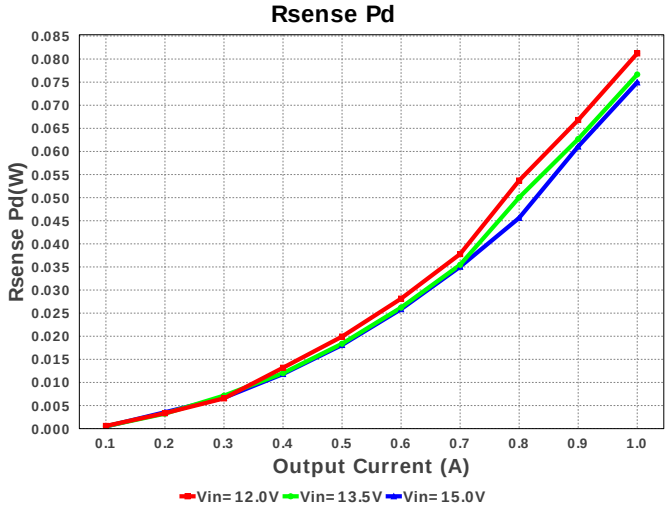


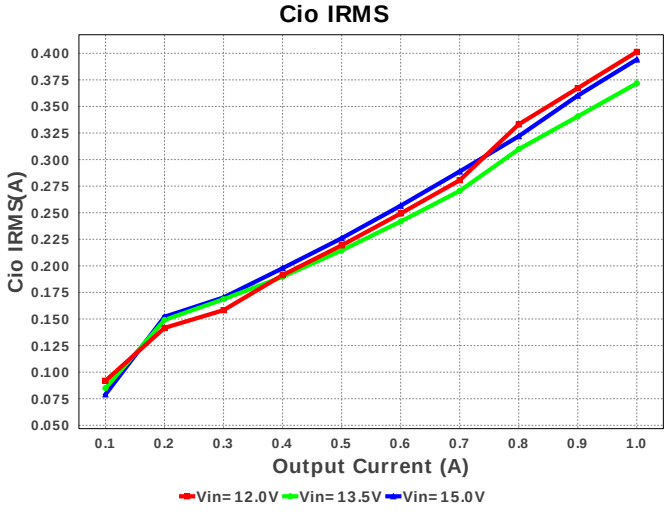


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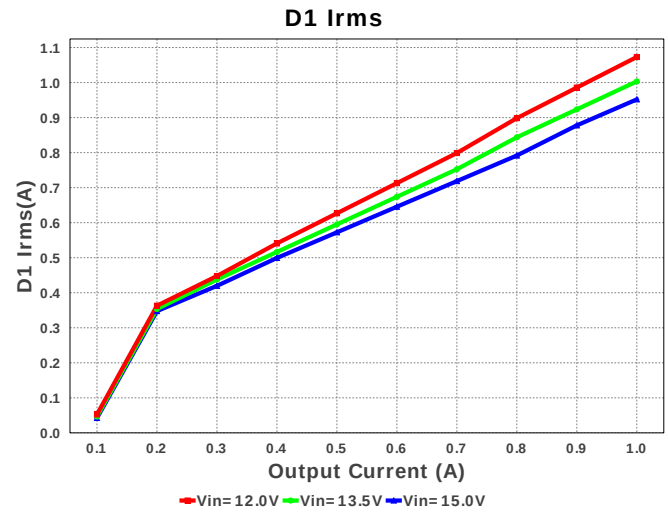


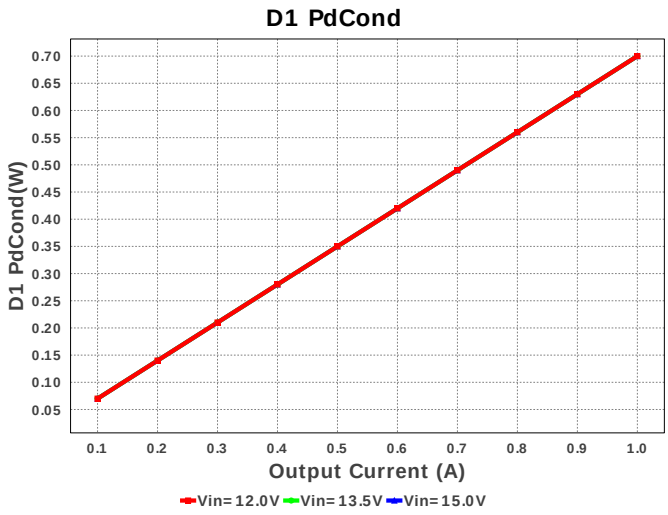


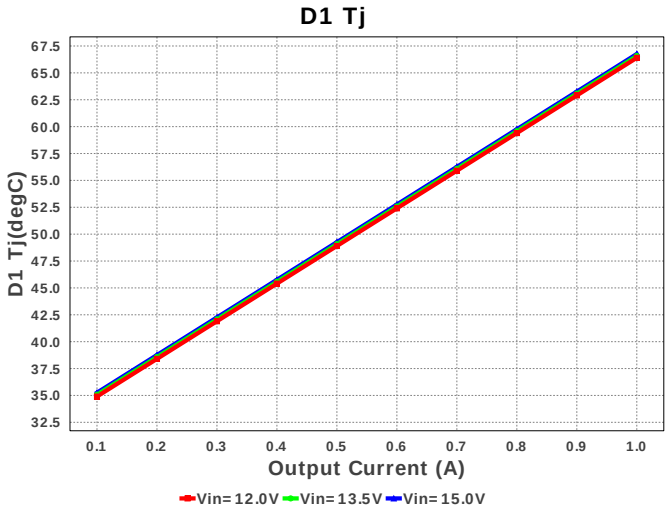


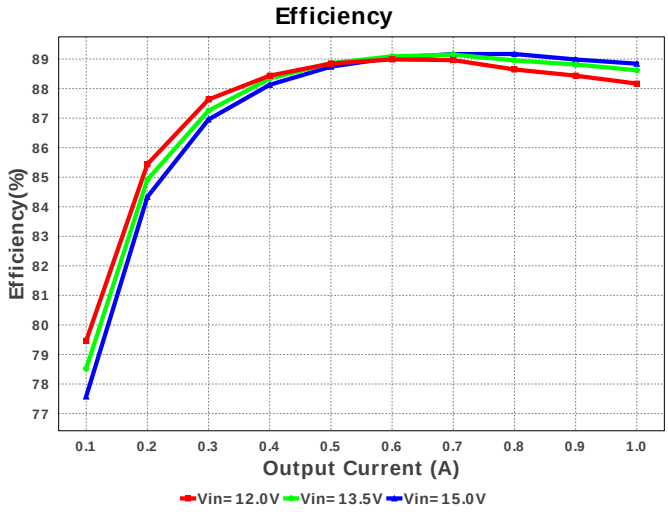


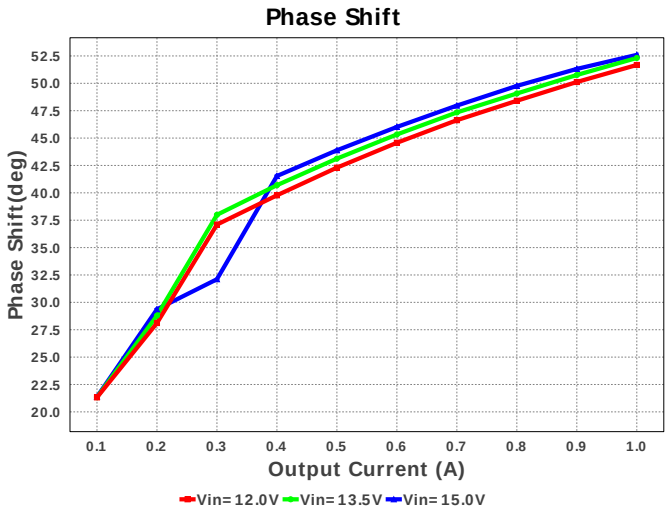


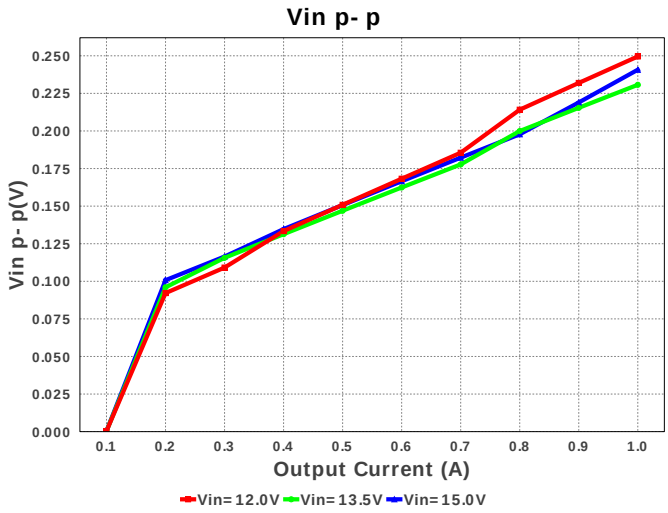


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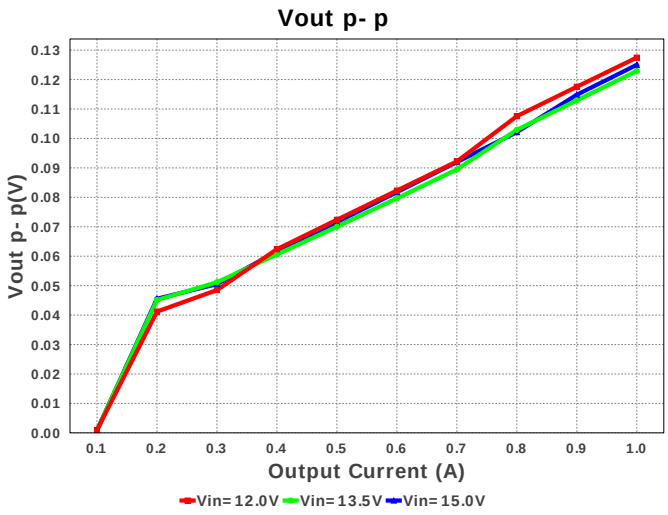


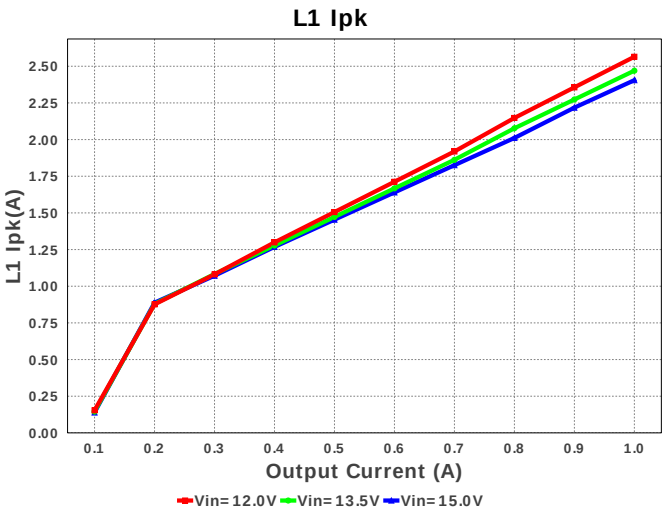


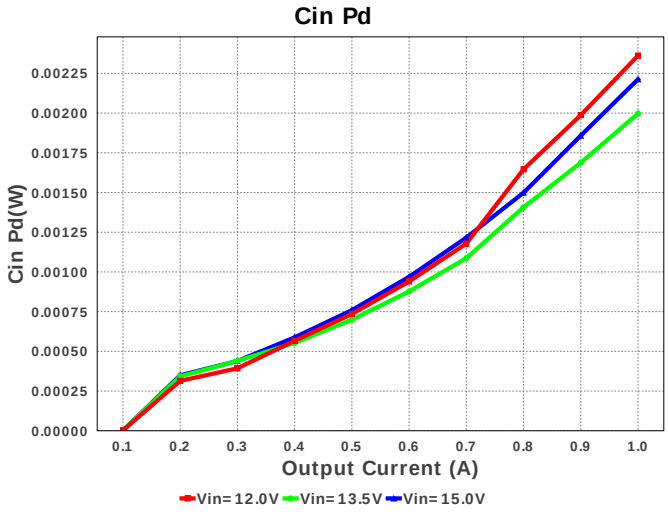


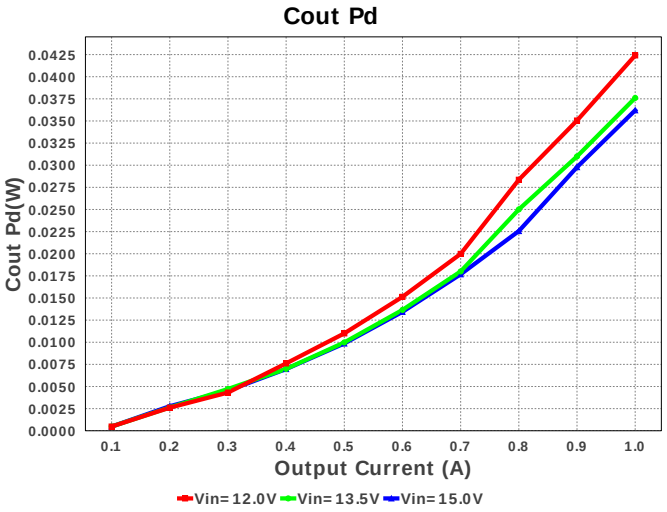


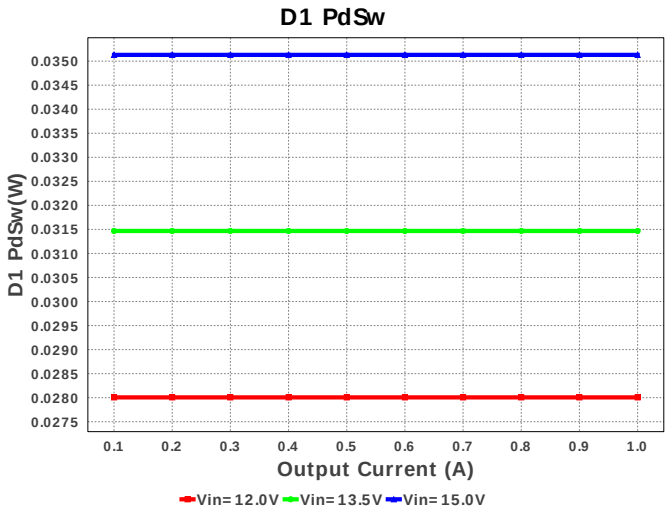


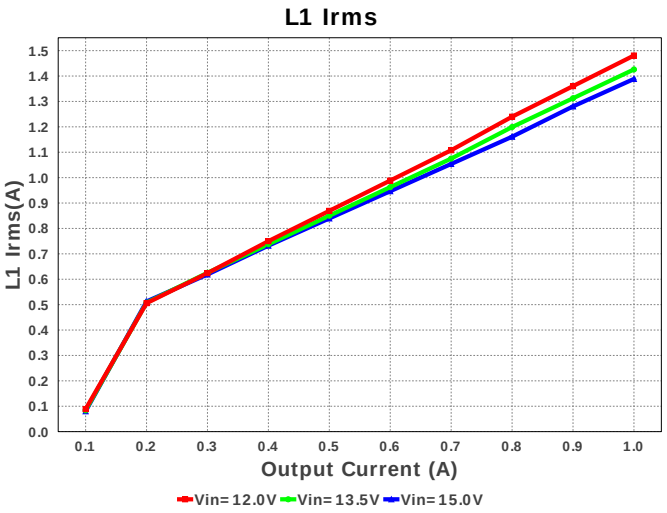


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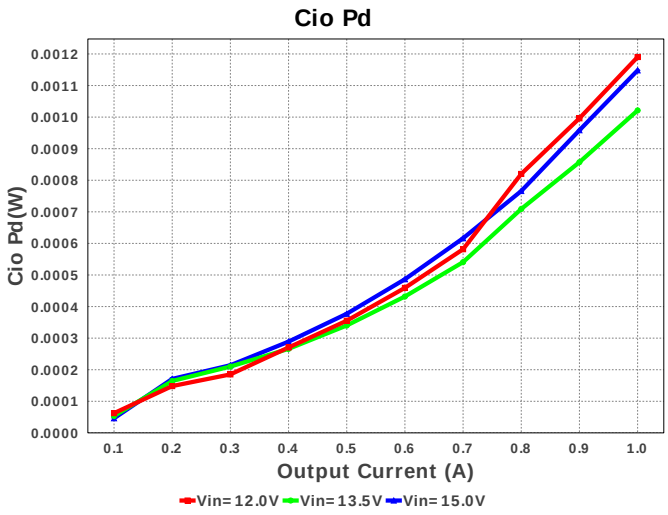


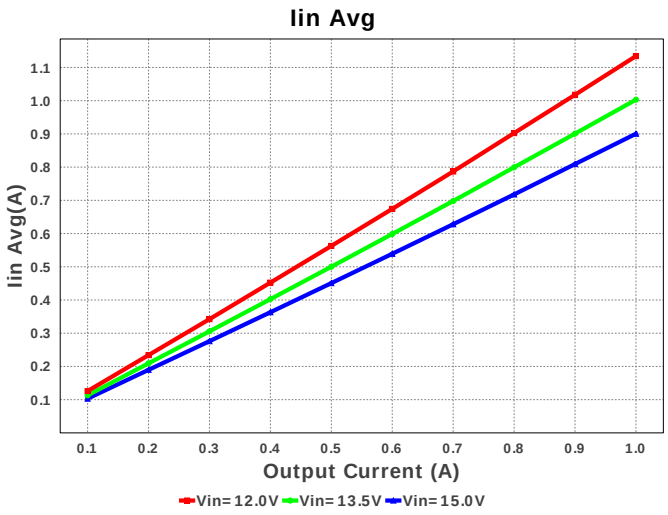


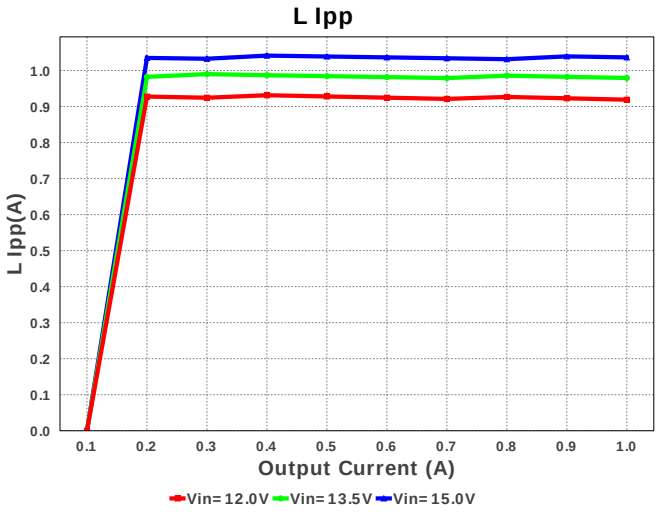


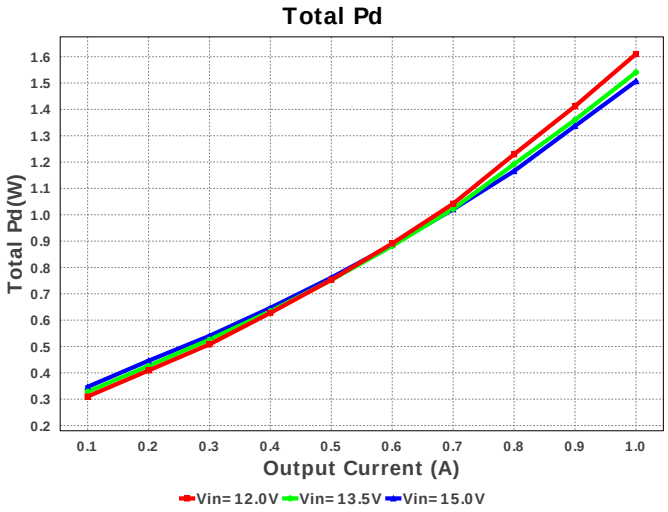


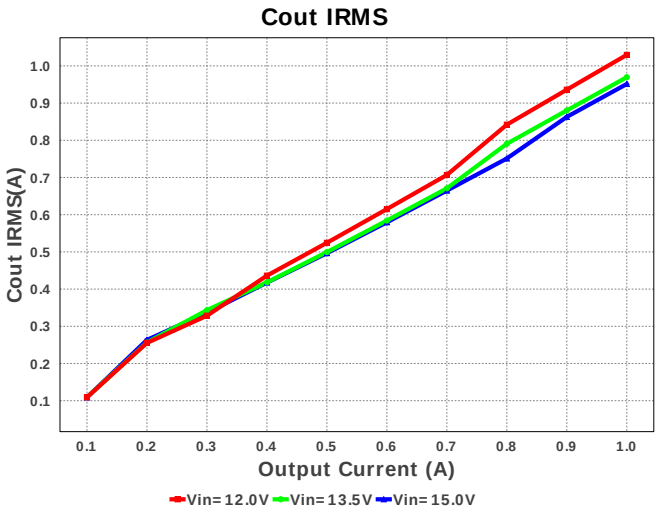


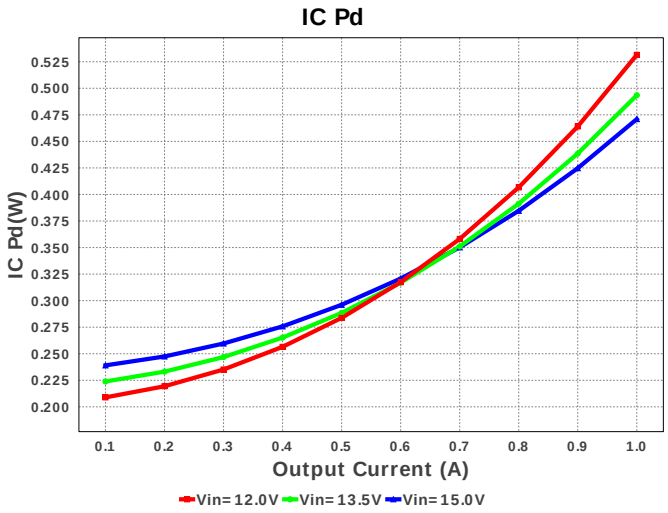


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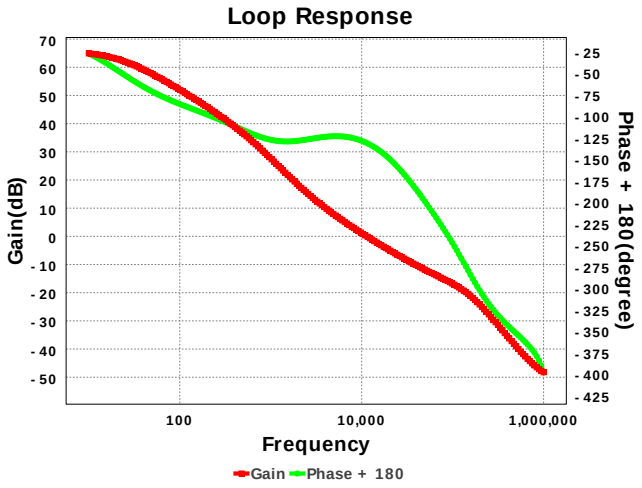


## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 371.415 mA | Current | Input capacitor RMS ripple current |
| 2. | Cio IRMS | 401.789 mA | Current | Input to output capacitor RMS ripple current |
| 3. | Cout IRMS | 1.03 A | Current | Output capacitor RMS ripple current |
| 4. | D1 Irms | 1.072 A | Current | D1 Irms |
| 5. | IC Ipk | 4.75 mA | Current | Peak switch current in IC |
| 6. | Iin Avg | 1.134 A | Current | Average input current |
| 7. | L Ipp | 915.075 mA | Current | Peak-to-peak output inductor ripple current |
| 8. | L1 Ipk | 2.563 A | Current | Inductor peak current |
| 9. | L1 Irms | 1.48 A | Current | Inductor ripple current |
| 10. | BOM Count | 21 | General | Total Design BOM count |
| 11. | FootPrint | 629.0 $mm^2$ | General | Total Foot Print Area of BOM components |
| 12. | Frequency | 300.0 kHz | General | Switching frequency |
| 13. | IC Tolerance | 18.0 mV | General | IC Feedback Tolerance |
| 14. | Mode | DCM | General | Conduction Mode |
| 15. | Total BOM | $4.46 | General | Total BOM Cost |
| 16. | D1 Tj | 66.406 degC | Op_Point | D1 junction temperature |
| 17. | Vin p-p | 247.968 mV | Op_Point | Peak-to-peak input voltage |
| 18. | Cross Freq | 10.97 kHz | Op_point | Bode plot crossover frequency |
| 19. | Duty Cycle | 52.5 % | Op_point | Duty cycle |
| 20. | Efficiency | 88.163 % | Op_point | Steady state efficiency |
| 21. | Gain Marg | 10.106 db | Op_point | Bode Plot Gain Margin |
| 22. | IC Tj | 51.277 degC | Op_point | IC junction temperature |
| 23. | IOUT_OP | 1.0 A | Op_point | Iout operating point |
| 24. | Phase Marg | 50.59 deg | Op_point | Bode Plot Phase Margin |
| 25. | Phase Shift | 51.665 deg | Op_point | Bode Plot Phase Shift |
| 26. | VIN_OP | 12.0 V | Op_point | Vin operating point |
| 27. | Vout p-p | 126.974 mV | Op_point | Peak-to-peak output ripple voltage |
| 28. | Cin Pd | 2.361 mW | Power | Input capacitor power dissipation |
| 29. | Cio Pd | 1.193 mW | Power | Input to output capacitor power dissipation |
| 30. | Cout Pd | 42.464 mW | Power | Output capacitor power dissipation |
| 31. | D1 Pd | 728.125 mW | Power | Diode power dissipation |
| 32. | D1 PdCond | 700.0 mW | Power | Diode conduction losses |
| 33. | D1 PdSw | 28.125 mW | Power | Diode switching losses |
| 34. | IC Pd | 531.927 mW | Power | IC power dissipation |
| 35. | L Pd | 197.605 mW | Power | Inductor power dissipation |
| 36. | Rsense Pd | 81.255 mW | Power | Rsense Power Dissipation |
| 37. | Total Pd | 1.611 W | Power | Total Power Dissipation |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 1.0 | Maximum Output Current |
| 2. | VinMax | 15.0 | Maximum input voltage |
| 3. | VinMin | 12.0 | Minimum input voltage |
| 4. | Vout | -12.0 | Output Voltage |
| 5. | base_pn | LM5576 | Texas Instruments Base Part Number |
| 6. | source | DC | Input Source Type |
| 7. | ta | 30.0 | Ambient temperature |

## Design Assistance

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1. LM5576 Product Folder : http://www.ti.com/product/LM5576 : contains the data sheet and other resources.

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