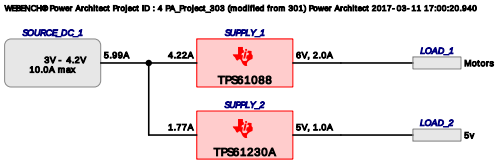
# WEBENCH® Power Architect




## Project Report

Project : 4653448/4 : PA_Project_303 (modified from 301)
Created : 2017-03-11 17:00:20.940
Optimize project optFactor=3

Project Summary

| | | |
|---|---|---|
| 1. | Total System Efficiency | 94.599 % |
| 2. | Total System BOM Count | 24.0 |
| 3. | Total System Footprint | 354.0 mm2 |
| 4. | Total System BOM Cost | $3.76 |
| 5. | Total System Power Dissipation | 970.6 mW |

--> Launch WEBENCH Power Architect.

### My Comments

No comments

### Sequencer Flag Table

| Supply | Sequencer Flag | Load | Load Name |
|---|---|---|---|
| SUPPLY_1 | 0 | LOAD_1 | Motors |
| SUPPLY_2 | 0 | LOAD_2 | 5v |

### Power Supplies

| # | Name | NSID | Description | Vout | Iout | Efficiency | Foot-print | Cost | Design | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | SUPPLY_1 | TPS61088 | Switcher : TPS61088 10-A Fully-Integrated Synchronous Boost Converter | 6 V | 2.0 A | 94.9% | 189 | $2.64 | 31 | 4 |
| 2. | SUPPLY_2 | TPS61230A | Switcher : High Efficiency Boost Converter | 5 V | 1.0 A | 93.9% | 165 | $1.12 | 32 | 10 |

### Power Loads

| # | Name | VLoad | ILoad | Description |
|---|---|---|---|---|
| 1. | Motors | 6 V | 2 A | VoutRipple=10% |
| 2. | 5v | 5 V | 1 A | |

Project Diagram

## Electrical Procurement BOM

| Manufacturer | Part Number | Description | Quantity | Budgetary Price | Footprint ($mm^2$) |
|---|---|---|---|---|---|
| AVX | 08053C104KAT2A | 0805 | 1 | $0.01 | 7 |
| Kemet | C0201C560J3GACTU | 0201 | 1 | $0.01 | 2 |
| Kemet | C0603C100K3GACTU | 0603 | 1 | $0.01 | 5 |
| TDK | C3216X5R1A686M160AC | 1206_190 | 1 | $0.47 | 11 |
| Vishay-Dale | CRCW0402100KFKED | 0402 | 1 | $0.01 | 3 |
| Vishay-Dale | CRCW0402118KFKED | 0402 | 1 | $0.01 | 3 |
| Vishay-Dale | CRCW0402147KFKED | 0402 | 1 | $0.01 | 3 |
| Vishay-Dale | CRCW040222K1FKED | 0402 | 1 | $0.01 | 3 |
| Vishay-Dale | CRCW0402261KFKED | 0402 | 1 | $0.01 | 3 |
| Vishay-Dale | CRCW0402316KFKED | 0402 | 1 | $0.01 | 3 |
| MuRata | GRM033R71C122KA01D | 0201 | 1 | $0.01 | 2 |
| MuRata | GRM155R60J103KA01D | 0402 | 1 | $0.01 | 3 |
| MuRata | GRM155R60J104KA01D | 0402 | 1 | $0.01 | 3 |
| MuRata | GRM155R71C822KA01D | 0402 | 1 | $0.01 | 3 |
| MuRata | GRM188R61A105KA61D | 0603 | 1 | $0.01 | 5 |
| MuRata | GRM21BR60J226ME39L | 0805 | 1 | $0.04 | 7 |
| MuRata | GRM31CR61A226KE19L | 1206_190 | 2 | $0.07 | 11 |
| MuRata | GRM32ER61C476ME15L | 1210_280 | 1 | $0.24 | 15 |
| Yageo America | RC0603FR-07470KL | 0603 | 1 | $0.01 | 5 |
| Bourns | SRN8040-1R5Y | SRN8040 | 1 | $0.22 | 100 |
| Texas Instruments | TPS61088RHLR | RHL0020A | 1 | $1.60 | 25 |
| Texas Instruments | TPS61230ARNSR | RNS0007A | 1 | $0.68 | 9 |
| TDK | VLP8040T-1R0N | VLP8040 | 1 | $0.22 | 113 |
| **Total** | | | 24 | $3.42 | 340.40999999999997 |

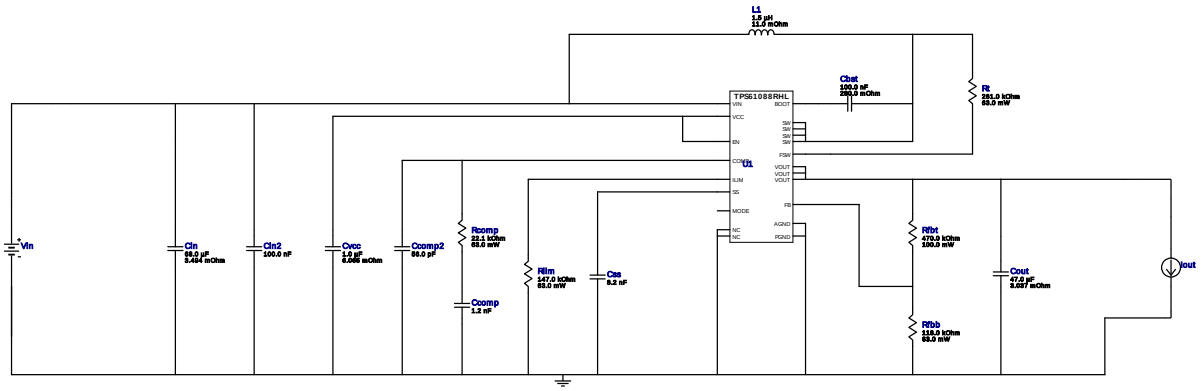
TEXAS INSTRUMENTS

# WEBENCH® Design Report

Vout = 6.0V
Iout = 2.0A

Device = TPS61088RHLR
Topology = Boost
Created = 3/11/17 5:00:19 PM
BOM Cost = $2.64
BOM Count = 15
Total Pd = 0.65W

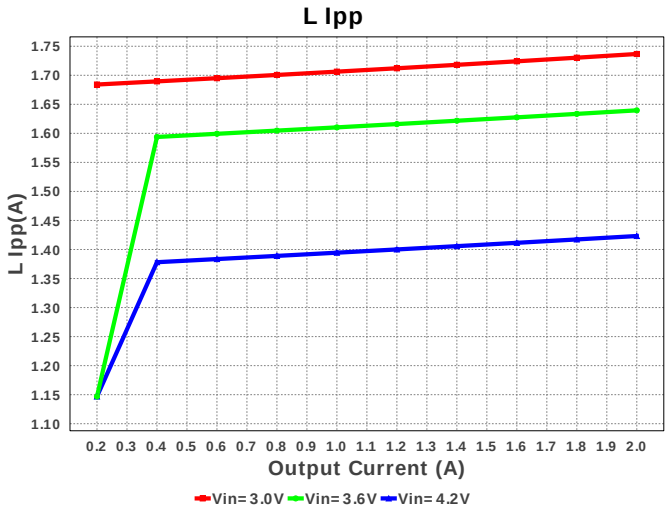
Design : 4653448/31 TPS61088RHLR
TPS61088RHLR 3.0V-4.2V to 6.00V @ 2.0A

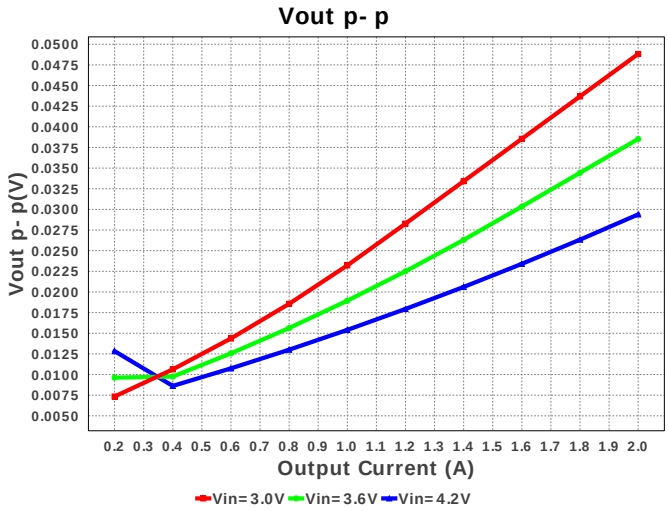


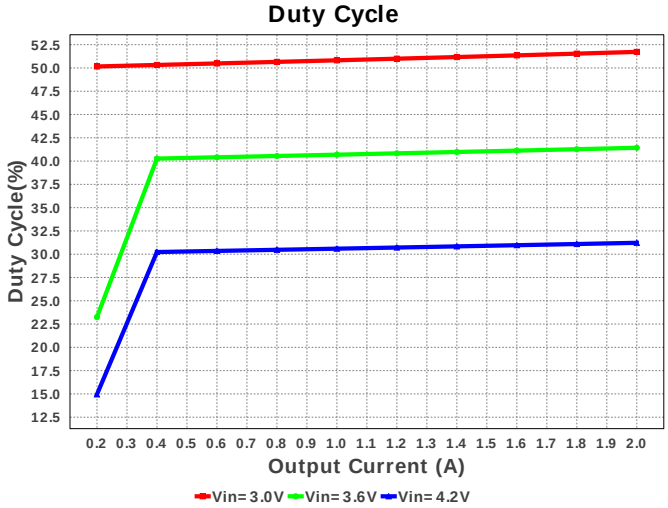

## Electrical BOM

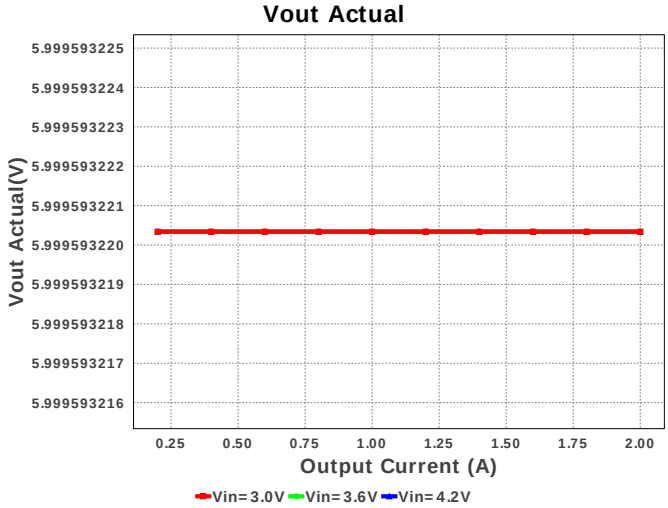
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cbst | AVX | 08053C104KAT2A<br>Series= X7R | Cap= 100.0 nF<br>ESR= 280.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0805 7 mm$^2$ |
| 2. | Ccomp | MuRata | GRM033R71C122KA01D<br>Series= X7R | Cap= 1.2 nF<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0201 2 mm$^2$ |
| 3. | Ccomp2 | Kemet | C0201C560J3GACTU<br>Series= C0G/NP0 | Cap= 56.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0201 2 mm$^2$ |
| 4. | Cin | TDK | C3216X5R1A686M160AC<br>Series= X5R | Cap= 68.0 uF<br>ESR= 3.494 mOhm<br>VDC= 10.0 V<br>IRMS= 3.8813 A | 1 | $0.47 | 1206_190 11 mm$^2$ |
| 5. | Cin2 | MuRata | GRM155R60J104KA01D<br>Series= X5R | Cap= 100.0 nF<br>VDC= 6.3 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 mm$^2$ |
| 6. | Cout | MuRata | GRM32ER61C476ME15L<br>Series= X5R | Cap= 47.0 uF<br>ESR= 3.037 mOhm<br>VDC= 16.0 V<br>IRMS= 4.59346 A | 1 | $0.24 | 1210_280 15 mm$^2$ |
| 7. | Css | MuRata | GRM155R71C822KA01D<br>Series= X7R | Cap= 8.2 nF<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 mm$^2$ |
| 8. | Cvcc | MuRata | GRM188R61A105KA61D<br>Series= X5R | Cap= 1.0 uF<br>ESR= 6.065 mOhm<br>VDC= 10.0 V<br>IRMS= 1.30675 A | 1 | $0.01 | 0603 5 mm$^2$ |
| 9. | L1 | Bourns | SRN8040-1R5Y | L= 1.5 µH<br>DCR= 11.0 mOhm | 1 | $0.22 | SRN8040 100 mm$^2$ |
| 10. | Rcomp | Vishay-Dale | CRCW040222K1FKED<br>Series= CRCW..e3 | Res= 22.1 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm$^2$ |

| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 11. | Rfbb | Vishay-Dale | CRCW0402118KFKED<br>Series= CRCW..e3 | Res= 118.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 12. | Rfbt | Yageo America | RC0603FR-07470KL<br>Series= ? | Res= 470.0 kOhm<br>Power= 100.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0603 5 mm² |
| 13. | Rlim | Vishay-Dale | CRCW0402147KFKED<br>Series= CRCW..e3 | Res= 147.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 14. | Rt | Vishay-Dale | CRCW0402261KFKED<br>Series= CRCW..e3 | Res= 261.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 15. | U1 | Texas Instruments | TPS61088RHLR | Switcher | 1 | $1.60 | RHL0020A 25 mm² |

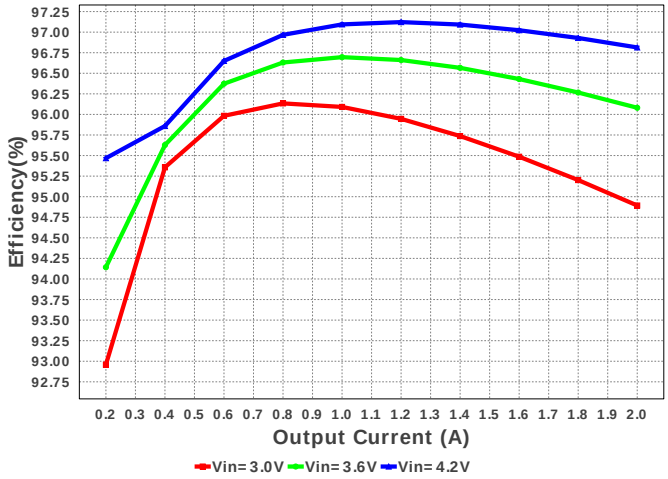


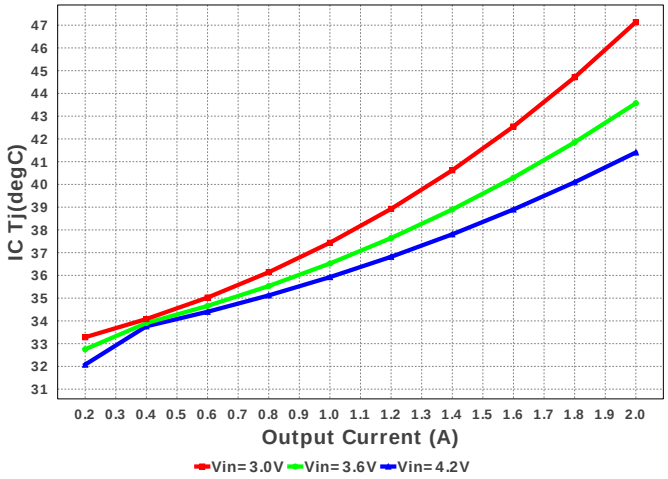



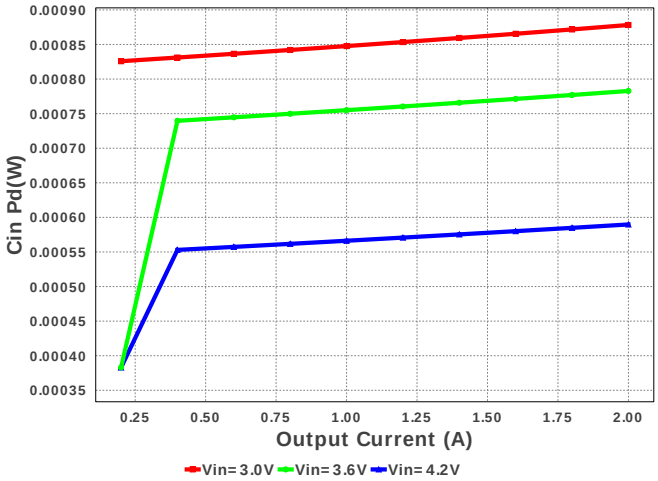
## Efficiency



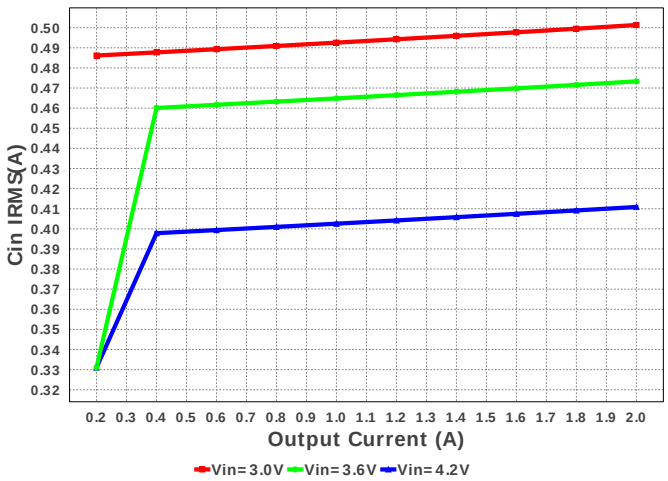

## IC Tj



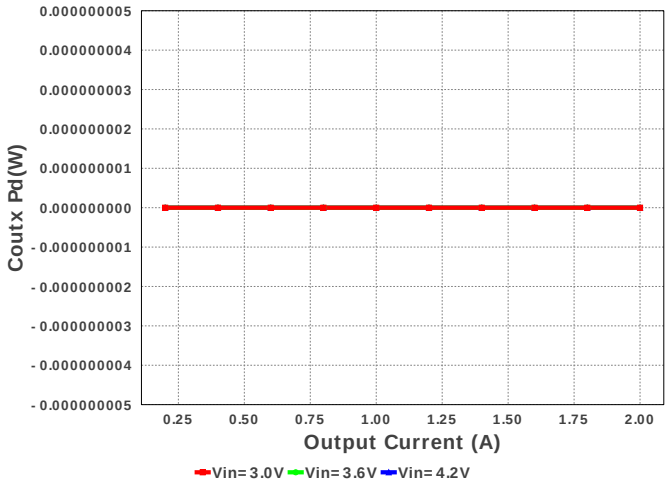

## Cin Pd



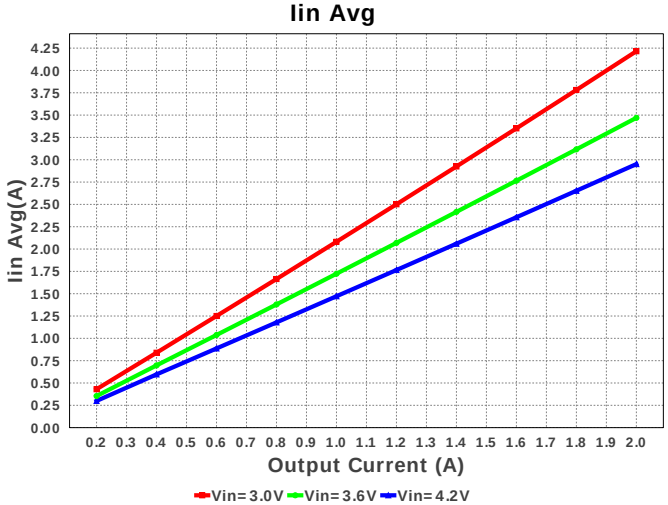

## Cin IRMS

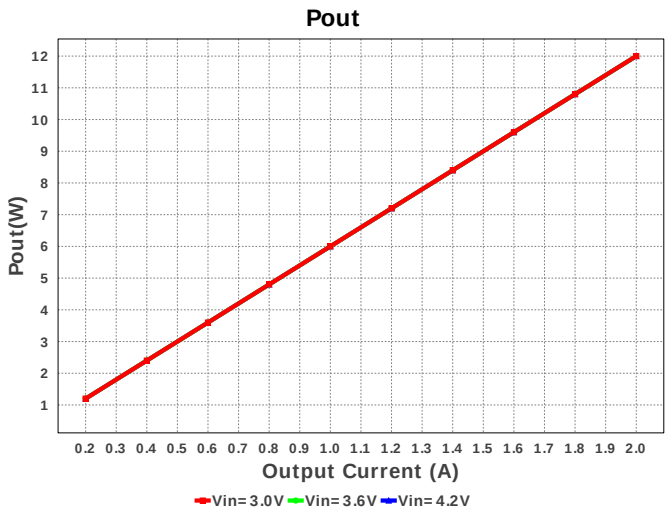


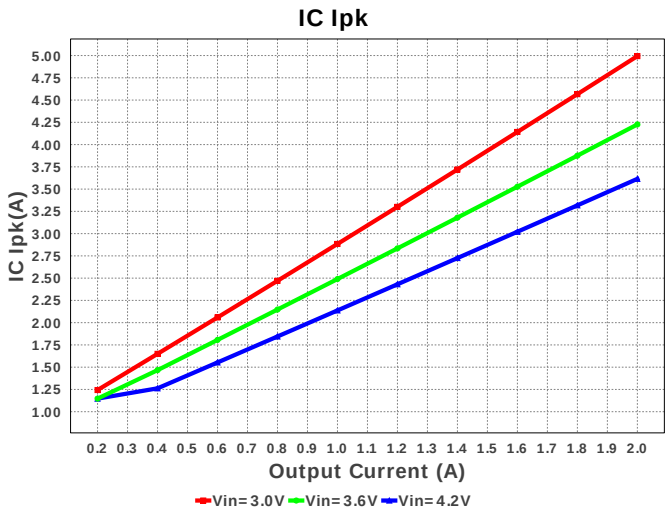

## Coutx Pd

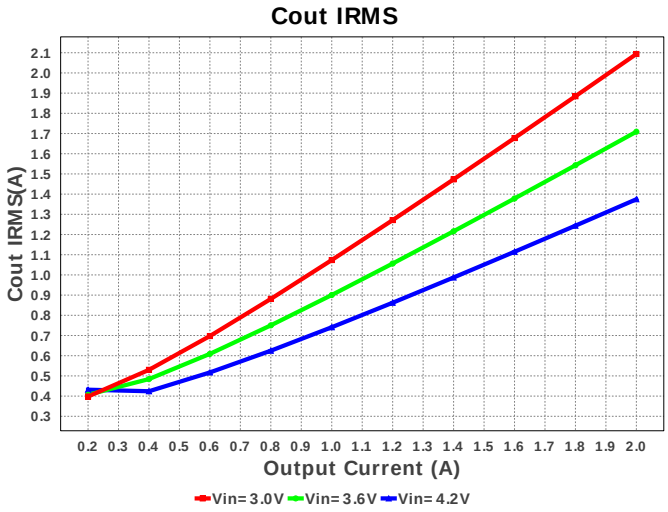


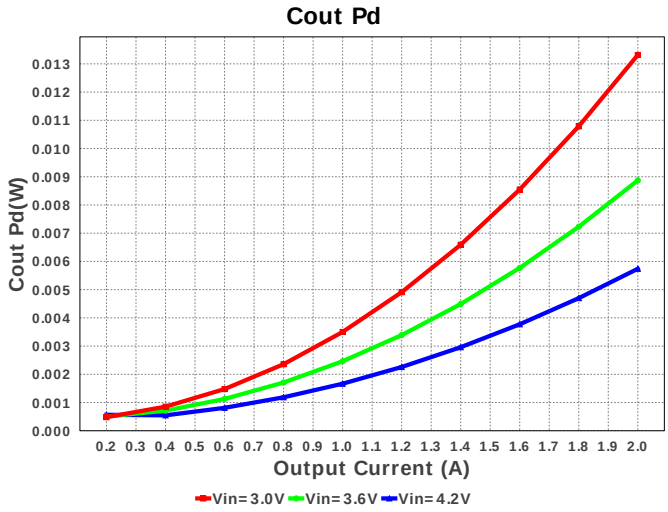

## Iin Avg

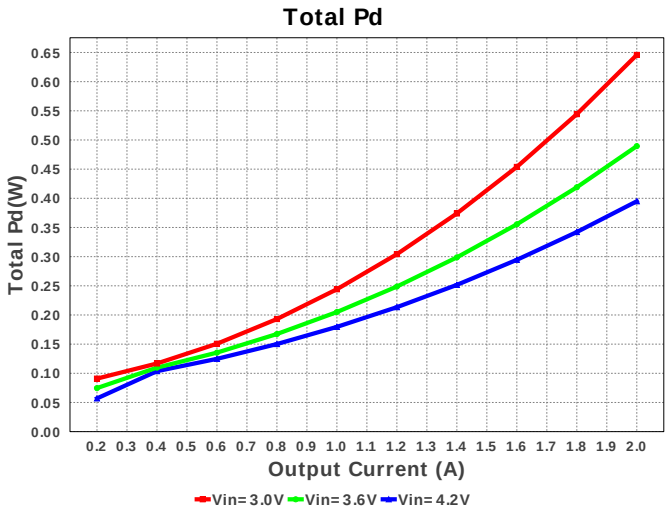


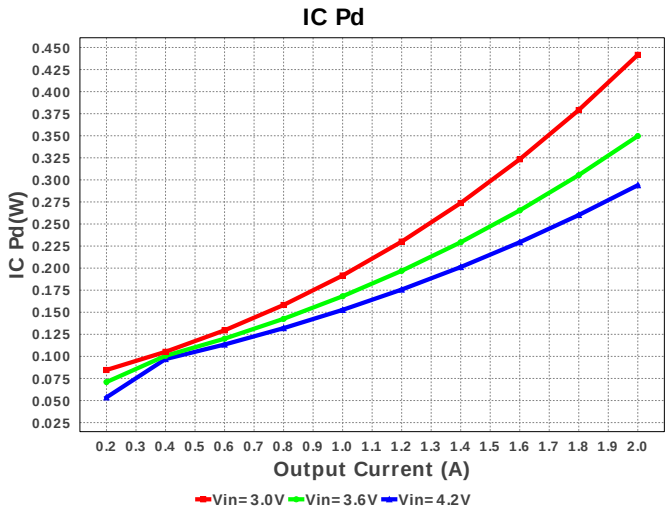


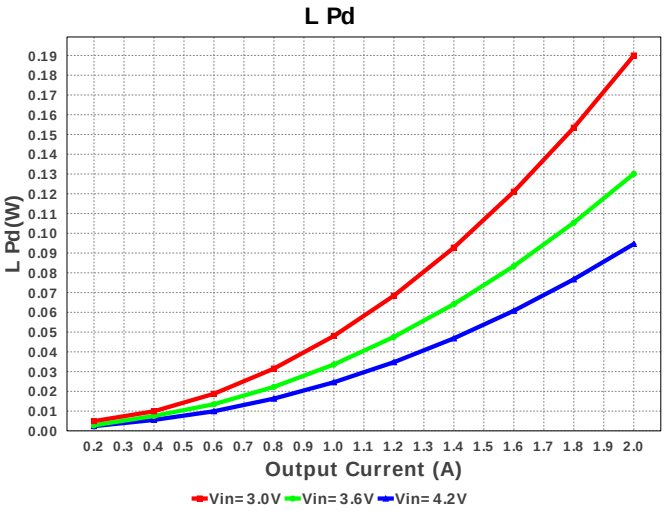



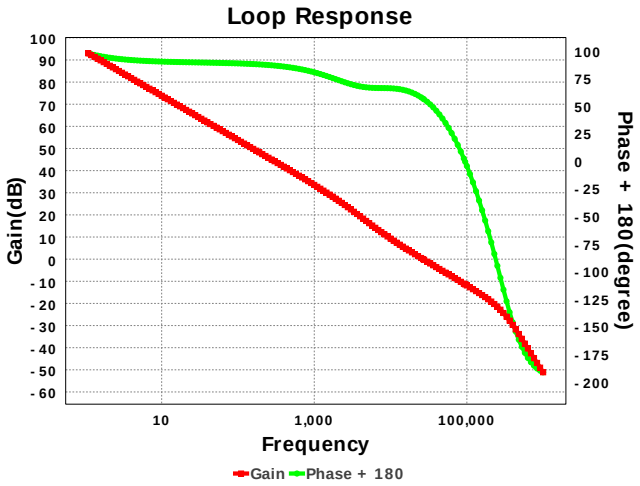



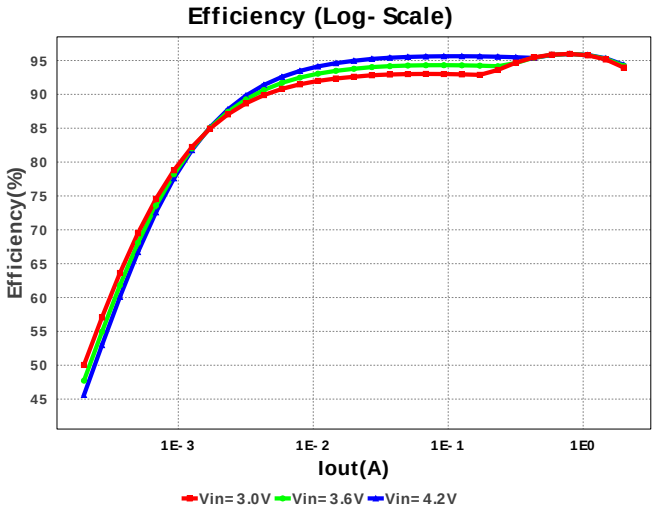






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 501.34 mA | Current | Input capacitor RMS ripple current |
| 2. | Cout IRMS | 2.094 A | Current | Output capacitor RMS ripple current |
| 3. | IC Ipk | 4.994 A | Current | Peak switch current in IC |
| 4. | Iin Avg | 4.215 A | Current | Average input current |
| 5. | L Ipp | 1.737 A | Current | Peak-to-peak inductor ripple current |
| 6. | BOM Count | 15 | General | Total Design BOM count |
| 7. | FootPrint | 189.0 $mm^2$ | General | Total Foot Print Area of BOM components |
| 8. | Frequency | 595.681 kHz | General | Switching frequency |
| 9. | Mode | BOOST CCM | General | PWM/PFM Mode |
| 10. | Pout | 12.0 W | General | Total output power |
| 11. | Total BOM | $2.64 | General | Total BOM Cost |
| 12. | Low Freq Gain | 92.477 dB | Op_Point | Gain at 10Hz |
| 13. | Vout Actual | 6.0 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 14. | Cross Freq | 26.508 kHz | Op_point | Bode plot crossover frequency |
| 15. | Duty Cycle | 51.726 % | Op_point | Duty cycle |
| 16. | Efficiency | 94.893 % | Op_point | Steady state efficiency |
| 17. | Gain Marg | -11.3 dB | Op_point | Bode Plot Gain Margin |
| 18. | IC Tj | 47.135 degC | Op_point | IC junction temperature |
| 19. | ICThetaJA | 38.8 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 20. | IOUT_OP | 2.0 A | Op_point | Iout operating point |
| 21. | Phase Marg | 57.343 deg | Op_point | Bode Plot Phase Margin |
| 22. | VIN_OP | 3.0 V | Op_point | Vin operating point |
| 23. | Vout p-p | 48.822 mV | Op_point | Peak-to-peak output ripple voltage |
| 24. | Cin Pd | 878.188 µW | Power | Input capacitor power dissipation |
| 25. | Cout Pd | 13.315 mW | Power | Output capacitor power dissipation |
| 26. | Coutx Pd | 0.0 W | Power | Output capacitor_x power loss |
| 27. | IC Pd | 441.637 mW | Power | IC power dissipation |
| 28. | L Pd | 189.976 mW | Power | Inductor power dissipation |
| 29. | Total Pd | 645.826 mW | Power | Total Power Dissipation |
| 30. | Vout Tolerance | 4.273 % | | 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 | 4.2 | Maximum input voltage |
| 3. | VinMin | 3.0 | Minimum input voltage |
| 4. | Vout | 6.0 | Output Voltage |
| 5. | base_pn | TPS61088 | Base Product Number |
| 6. | source | DC | Input Source Type |
| 7. | Ta | 30.0 | Ambient temperature |

## Design Assistance

1. **TPS61088** Product Folder : http://www.ti.com/product/TPS61088 : contains the data sheet and other resources.

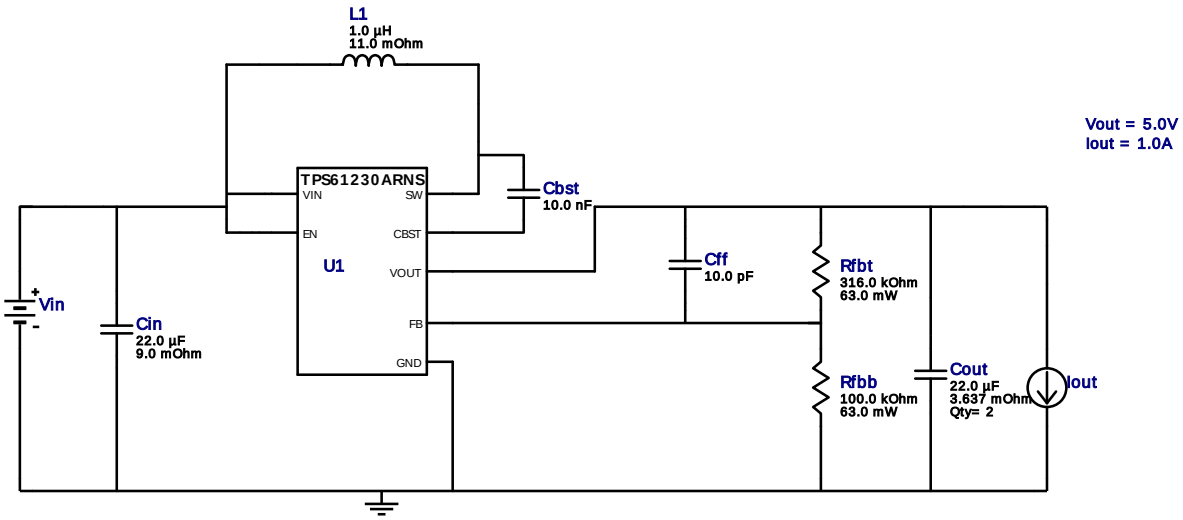
TEXAS INSTRUMENTS

# WEBENCH® Design Report

Vout = 5.0V
Iout = 1.0A

Device = TPS61230ARNSR
Topology = Boost
Created = 3/11/17 5:00:20 PM
BOM Cost = $1.12
BOM Count = 9
Total Pd = 0.32W

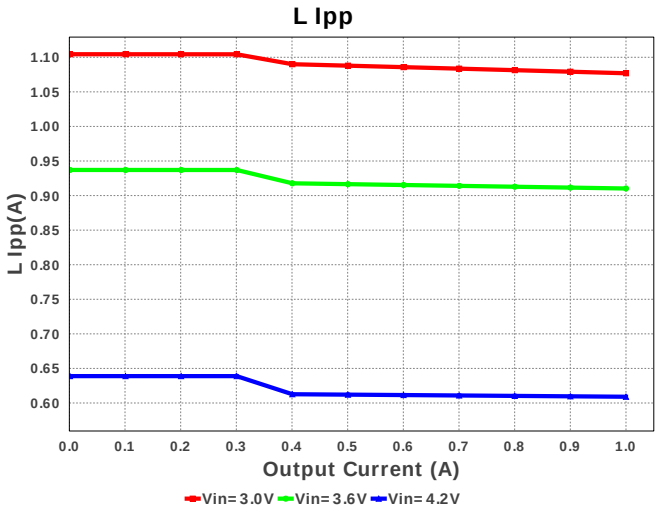
Design : 4653448/32 TPS61230ARNSR
TPS61230ARNSR 3.0V-4.2V to 5.00V @ 1.0A

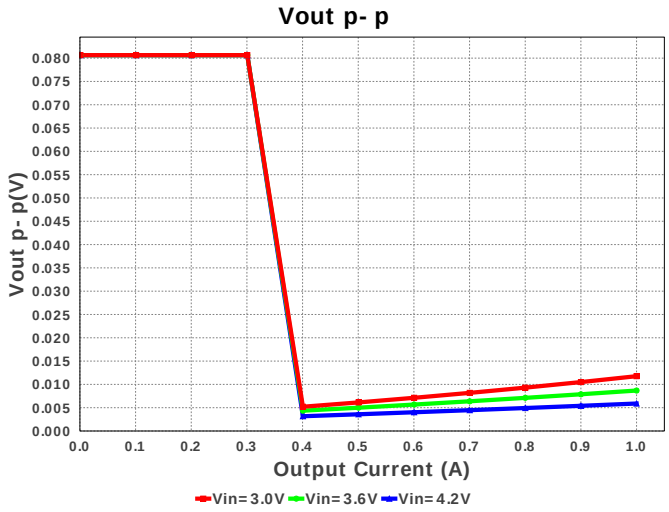


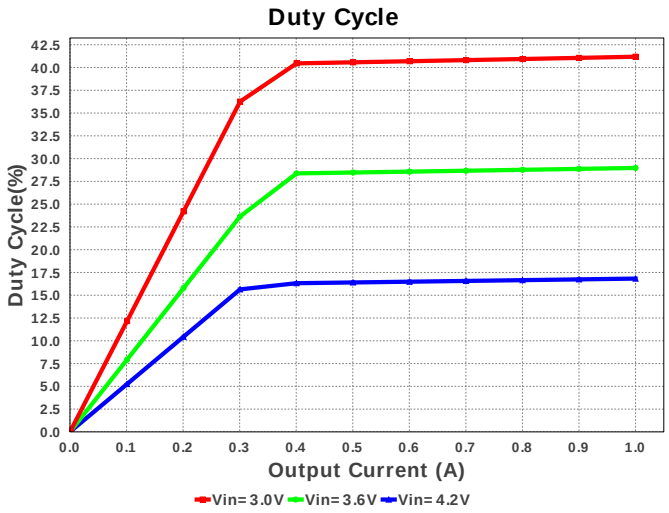

## Electrical BOM

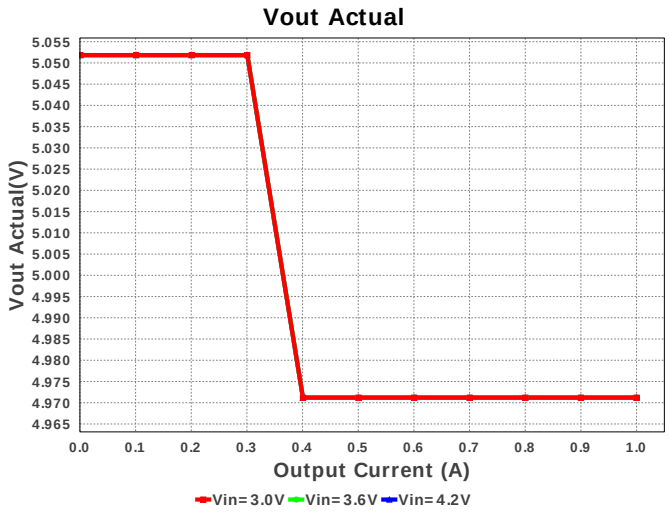
| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 1. | Cbst | MuRata | GRM155R60J103KA01D<br>Series= X5R | Cap= 10.0 nF<br>VDC= 6.3 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 mm² |
| 2. | Cff | Kemet | C0603C100K3GACTU<br>Series= C0G/NP0 | Cap= 10.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0603 5 mm² |
| 3. | Cin | MuRata | GRM21BR60J226ME39L<br>Series= X5R | Cap= 22.0 uF<br>ESR= 9.0 mOhm<br>VDC= 6.3 V<br>IRMS= 3.5 A | 1 | $0.04 | 0805 7 mm² |
| 4. | Cout | MuRata | GRM31CR61A226KE19L<br>Series= X5R | Cap= 22.0 uF<br>ESR= 3.637 mOhm<br>VDC= 10.0 V<br>IRMS= 3.56456 A | 2 | $0.07 | 1206_190 11 mm² |
| 5. | L1 | TDK | VLP8040T-1R0N | L= 1.0 µH<br>DCR= 11.0 mOhm | 1 | $0.22 | VLP8040 113 mm² |
| 6. | Rfbb | Vishay-Dale | CRCW0402100KFKED<br>Series= CRCW..e3 | Res= 100.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |
| 7. | Rfbt | Vishay-Dale | CRCW0402316KFKED<br>Series= CRCW..e3 | Res= 316.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0402 3 mm² |

| # | Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|---|
| 8. | U1 | Texas Instruments | TPS61230ARNSR | Switcher | 1 | $0.68 | RNS0007A 9 mm$^2$ |

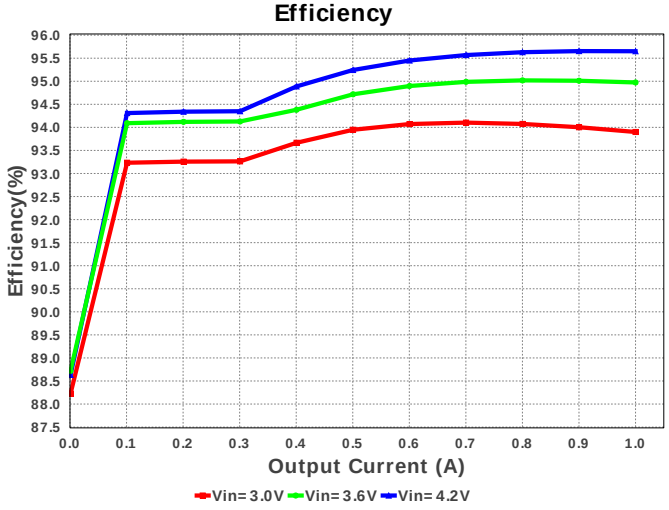


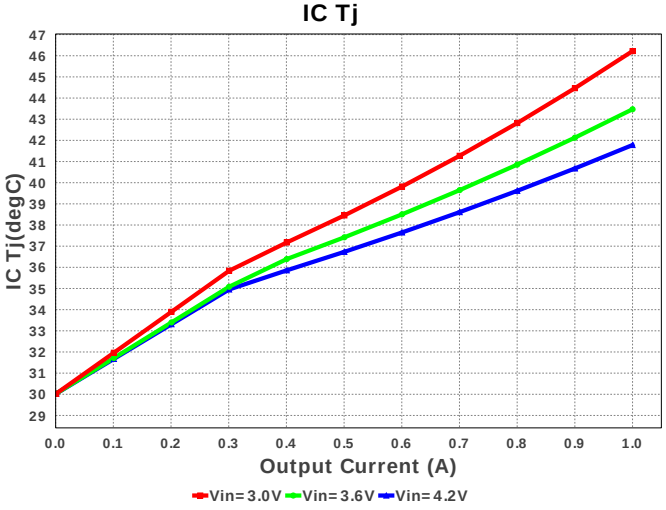



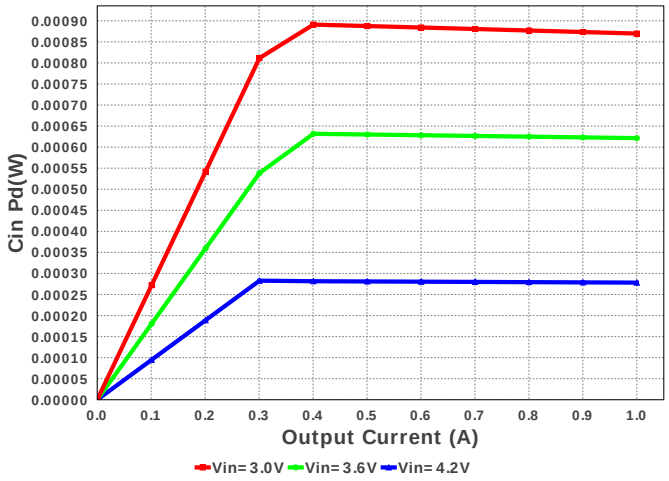
## Efficiency



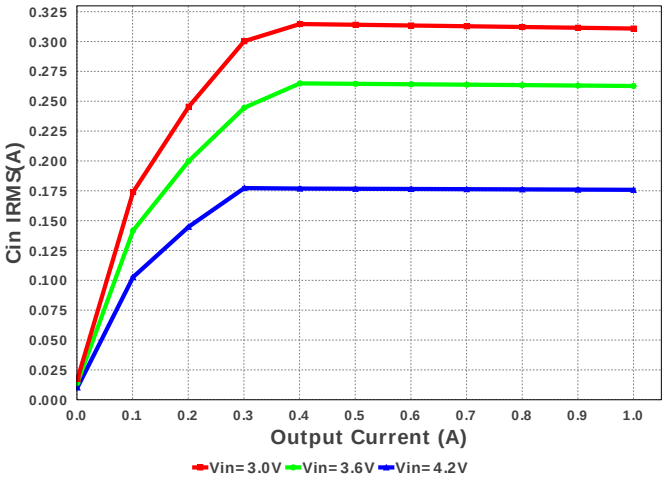

## IC Tj



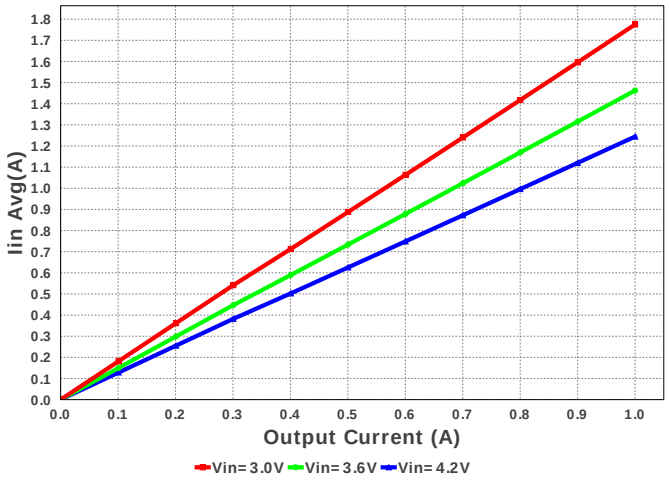

## Cin Pd



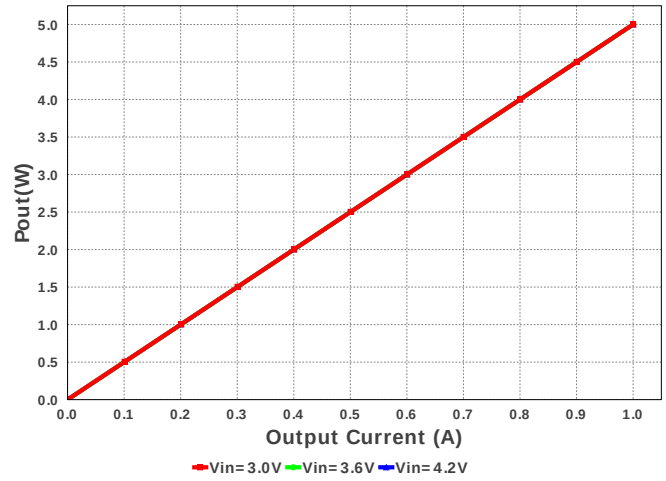

## Cin IRMS

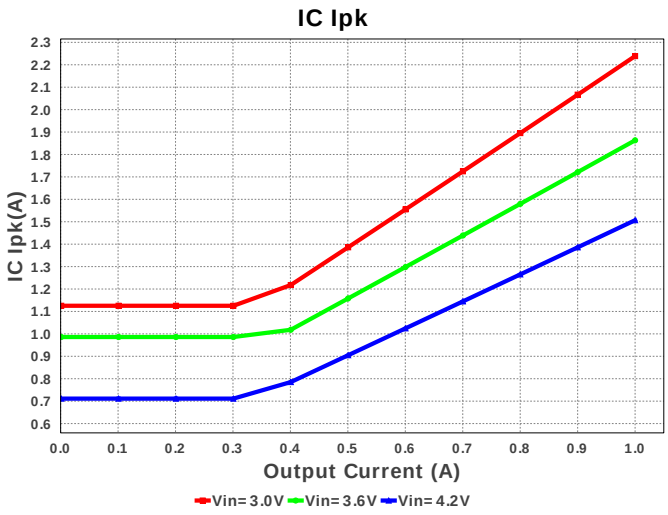


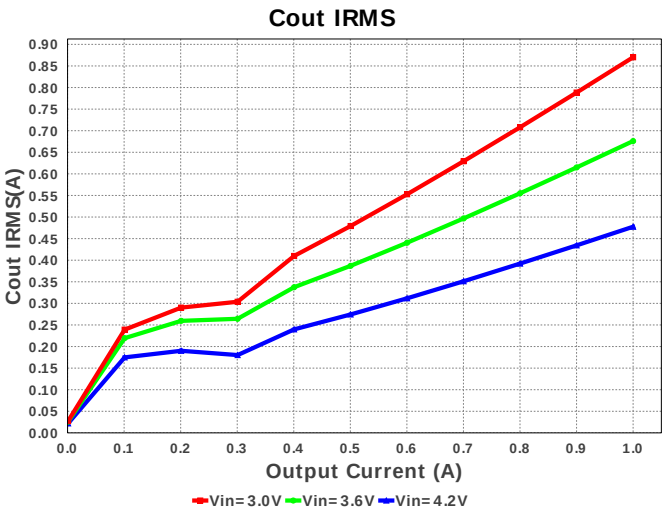

## Iin Avg

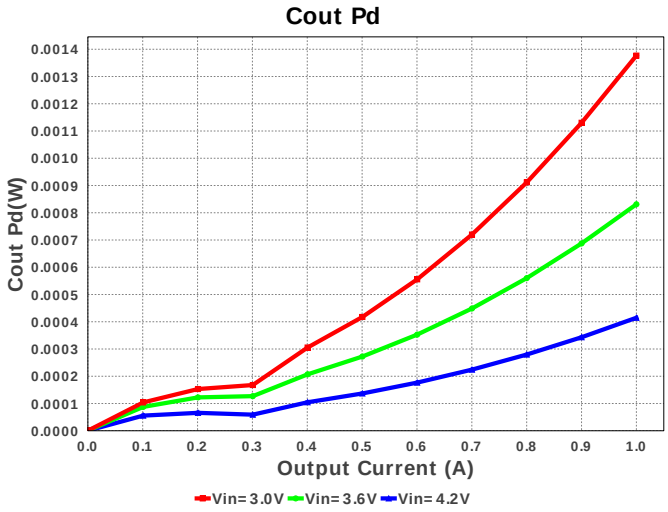


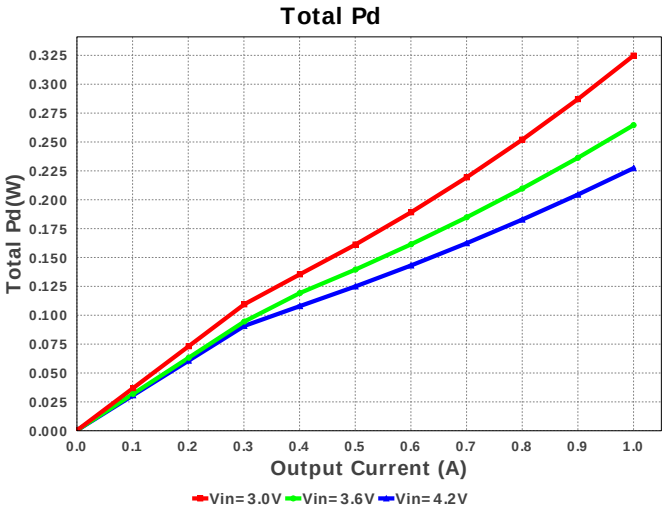

## Pout

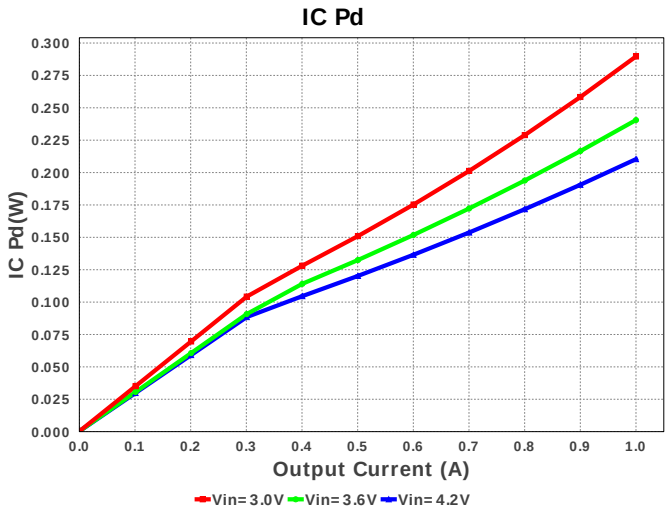


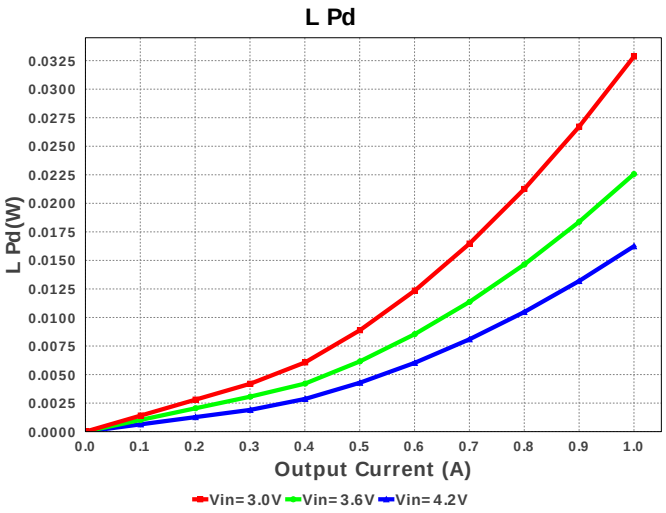


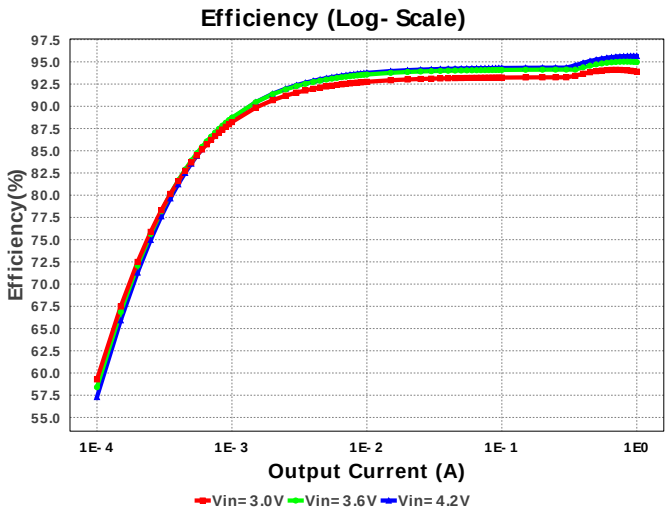






## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 310.869 mA | Current | Input capacitor RMS ripple current |
| 2. | Cout IRMS | 870.087 mA | Current | Output capacitor RMS ripple current |
| 3. | IC Ipk | 2.239 A | Current | Peak switch current in IC |
| 4. | Iin Avg | 1.775 A | Current | Average input current |
| 5. | L Ipp | 1.077 A | Current | Peak-to-peak inductor ripple current |
| 6. | BOM Count | 9 | General | Total Design BOM count |
| 7. | FootPrint | 165.0 $mm^2$ | General | Total Foot Print Area of BOM components |
| 8. | Frequency | 1.125 MHz | General | Switching frequency |
| 9. | Mode | BOOST PWM CCM | General | PWM/PFM Mode |
| 10. | Pout | 5.0 W | General | Total output power |
| 11. | Total BOM | $1.12 | General | Total BOM Cost |
| 12. | Vout Actual | 4.971 V | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 13. | Duty Cycle | 41.185 % | Op_point | Duty cycle |
| 14. | Efficiency | 93.9 % | Op_point | Steady state efficiency |
| 15. | IC Tj | 46.219 degC | Op_point | IC junction temperature |
| 16. | ICThetaJA | 56.0 degC/W | Op_point | IC junction-to-ambient thermal resistance |
| 17. | IOUT_OP | 1.0 A | Op_point | Iout operating point |
| 18. | VIN_OP | 3.0 V | Op_point | Vin operating point |
| 19. | Vout p-p | 11.759 mV | Op_point | Peak-to-peak output ripple voltage |
| 20. | Cin Pd | 869.756 µW | Power | Input capacitor power dissipation |
| 21. | Cout Pd | 1.377 mW | Power | Output capacitor power dissipation |
| 22. | IC Pd | 289.629 mW | Power | IC power dissipation |
| 23. | L Pd | 32.862 mW | Power | Inductor power dissipation |
| 24. | Total Pd | 324.807 mW | Power | Total Power Dissipation |
| 25. | Vout Tolerance | 1.255 % | | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| # | Name | Value | Description |
|---|---|---|---|
| 1. | Iout | 1.0 | Maximum Output Current |
| 2. | VinMax | 4.2 | Maximum input voltage |
| 3. | VinMin | 3.0 | Minimum input voltage |
| 4. | Vout | 5.0 | Output Voltage |
| 5. | base_pn | TPS61230A | Base Product Number |
| 6. | source | DC | Input Source Type |
| 7. | Ta | 30.0 | Ambient temperature |

## Design Assistance

1. **TPS61230A** Product Folder : http://www.ti.com/product/TPS61230A : contains the data sheet and other resources.