

# WEBENCH® Power Architect

## Project Report

Project : 4457758/14 : Duro\_Main\_PowerManagement\_2.0

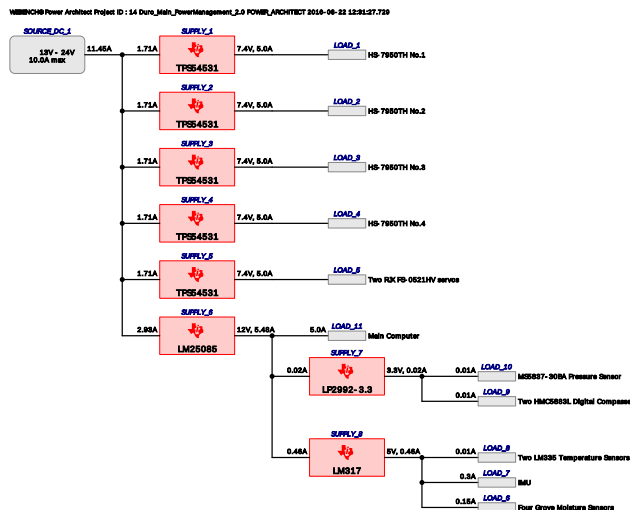
Created : 2016-08-22 12:31:27.729

Optimize project optFactor=3

### Project Summary

|                                   |            |
|-----------------------------------|------------|
| 1. Total System Efficiency        | 89.805 %   |
| 2. Total System BOM Count         | 95.0       |
| 3. Total System Footprint         | 2.709 kmm2 |
| 4. Total System BOM Cost          | \$19.52    |
| 5. Total System Power Dissipation | 28.082 W   |

--> Launch WEBENCH Power Architect.



## My Comments

No comments

## Sequencer Flag Table

| Supply   | Sequencer Flag | Load    | Load Name                      |
|----------|----------------|---------|--------------------------------|
| SUPPLY_1 | 0              | LOAD_1  | HS-7950TH No.1                 |
| SUPPLY_2 | 0              | LOAD_2  | HS-7950TH No.2                 |
| SUPPLY_3 | 0              | LOAD_3  | HS-7950TH No.3                 |
| SUPPLY_4 | 0              | LOAD_4  | HS-7950TH No.4                 |
| SUPPLY_5 | 0              | LOAD_5  | Two RJK FS-0521HV servos       |
| SUPPLY_6 | 0              | LOAD_11 | Main Computer                  |
| SUPPLY_7 | 0              | LOAD_10 | MS5837-30BA Pressure Sensor    |
| SUPPLY_7 | 0              | LOAD_9  | Two HMC5883L Digital Compasses |
| SUPPLY_8 | 0              | LOAD_8  | Two LM335 Temperature Sensors  |
| SUPPLY_8 | 0              | LOAD_7  | IMU                            |
| SUPPLY_8 | 0              | LOAD_6  | Four Grove Moisture Sensors    |

## Power Supplies

| #  | Name     | NSID       | Description                                                        | Vout  | Iout   | Efficiency | Foot-print | Cost   | Design | Page |
|----|----------|------------|--------------------------------------------------------------------|-------|--------|------------|------------|--------|--------|------|
| 1. | SUPPLY_1 | TPS54531   | Switcher : Step Down Converter with Eco-Mode                       | 7.4 V | 5.0 A  | 90.4%      | 317        | \$2.90 | 52     | 5    |
| 2. | SUPPLY_2 | TPS54531   | Switcher : Step Down Converter with Eco-Mode                       | 7.4 V | 5.0 A  | 90.4%      | 317        | \$2.90 | 53     | 11   |
| 3. | SUPPLY_3 | TPS54531   | Switcher : Step Down Converter with Eco-Mode                       | 7.4 V | 5.0 A  | 90.4%      | 317        | \$2.90 | 54     | 17   |
| 4. | SUPPLY_4 | TPS54531   | Switcher : Step Down Converter with Eco-Mode                       | 7.4 V | 5.0 A  | 90.4%      | 317        | \$2.90 | 55     | 23   |
| 5. | SUPPLY_5 | TPS54531   | Switcher : Step Down Converter with Eco-Mode                       | 7.4 V | 5.0 A  | 90.4%      | 317        | \$2.90 | 56     | 29   |
| 6. | SUPPLY_6 | LM25085    | Switcher : PFET COT BUCK controller with low output voltage ripple | 12 V  | 5.48 A | 93.6%      | 558        | \$3.88 | 59     | 43   |
| 7. | SUPPLY_7 | LP2992-3.3 | LDO : Micropower 250 mA Low-Noise Ultra Low-Dropout Regulator      | 3.3 V | 0.02 A | 25%        | 30         | \$0.42 | 57     | 35   |
| 8. | SUPPLY_8 | LM317      | LDO : 3-Terminal Adjustable Regulator                              | 5 V   | 0.46 A | 37.4%      | 536        | \$0.72 | 58     | 39   |

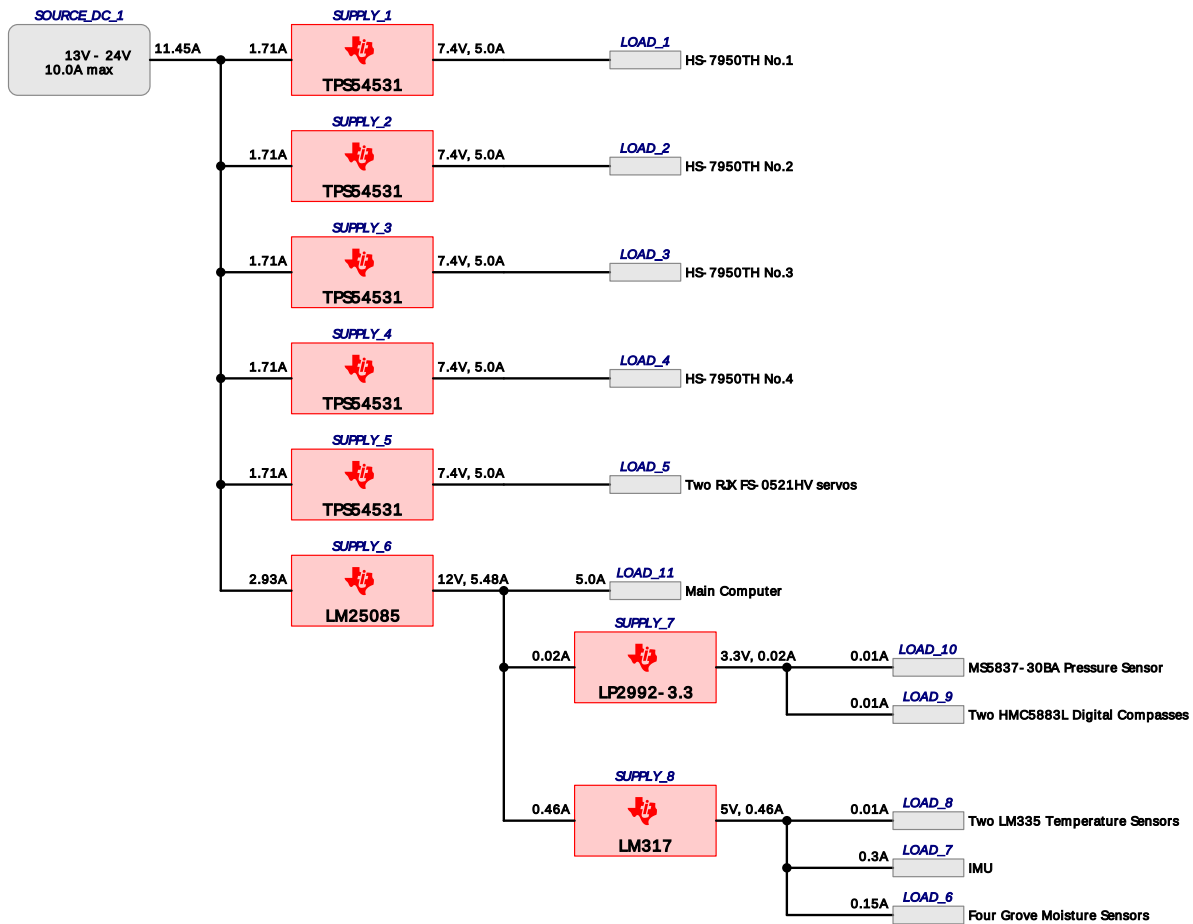
## Power Loads

| #  | Name           | VLoad | ILoad | Description                                |
|----|----------------|-------|-------|--------------------------------------------|
| 1. | HS-7950TH No.1 | 7.4 V | 5 A   | VoutRipple=10%, Requires a separate supply |
| 2. | HS-7950TH No.2 | 7.4 V | 5 A   | VoutRipple=10%, Requires a separate supply |
| 3. | HS-7950TH No.3 | 7.4 V | 5 A   | VoutRipple=10%, Requires a separate supply |
| 4. | HS-7950TH No.4 | 7.4 V | 5 A   | VoutRipple=10%, Requires a separate supply |

| #   | Name                           | VLoad | ILoad  | Description                                                  |
|-----|--------------------------------|-------|--------|--------------------------------------------------------------|
| 5.  | Two RFX FS-0521HV servos       | 7.4 V | 5 A    | VoutRipple=10%, Requires a separate supply<br>VoutRipple=10% |
| 6.  | Main Computer                  | 12 V  | 5 A    |                                                              |
| 7.  | MS5837-30BA Pressure Sensor    | 3.3 V | 0.01 A |                                                              |
| 8.  | Two HMC5883L Digital Compasses | 3.3 V | 0.01 A |                                                              |
| 9.  | Two LM335 Temperature Sensors  | 5 V   | 0.01 A |                                                              |
| 10. | IMU                            | 5 V   | 0.3 A  |                                                              |
| 11. | Four Grove Moisture Sensors    | 5 V   | 0.15 A |                                                              |

## Project Diagram

WEBENCH® Power Architect Project ID : 14 Duro\_Main\_PowerManagement\_2.0 POWER\_ARCHITECT 2016-08-22 12:31:27.729



## Electrical Procurement BOM

| Manufacturer              | Part Number         | Description   | Quantity  | Budgetary Price | Footprint<br>(mm <sup>2</sup> ) |
|---------------------------|---------------------|---------------|-----------|-----------------|---------------------------------|
| AVX                       | 0805YC474KAT2A      | 0805          | 1         | \$0.02          | 7                               |
| Vishay-Semiconductor      | 50WQ04FNPBF         | DPAK          | 5         | \$0.40          | 509                             |
| Aavid                     | 563002B00000G       | 563002        | 1         | \$0.46          | 403                             |
| Diodes Inc.               | B540C-13-F          | SMC           | 1         | \$0.17          | 83                              |
| Kemet                     | C0805C220K3GACTU    | 0805          | 5         | \$0.01          | 34                              |
| Samsung Electro-Mechanics | CL21C102JBCNFNC     | 0805          | 1         | \$0.01          | 7                               |
| Samsung Electro-Mechanics | CL21C122JBFNNWE     | 0805          | 5         | \$0.01          | 34                              |
| Vishay-Dale               | CRCW040210K0FKED    | 0402          | 1         | \$0.01          | 3                               |
| Vishay-Dale               | CRCW040210K2FKED    | 0402          | 5         | \$0.01          | 15                              |
| Vishay-Dale               | CRCW04021K24FKED    | 0402          | 5         | \$0.01          | 15                              |
| Vishay-Dale               | CRCW0402237KFKED    | 0402          | 1         | \$0.01          | 3                               |
| Vishay-Dale               | CRCW0402237RFKED    | 0402          | 1         | \$0.01          | 3                               |
| Vishay-Dale               | CRCW04022K37FKED    | 0402          | 1         | \$0.01          | 3                               |
| Vishay-Dale               | CRCW0402332KFKED    | 0402          | 1         | \$0.01          | 3                               |
| Vishay-Dale               | CRCW040254K9FKED    | 0402          | 5         | \$0.01          | 15                              |
| Vishay-Dale               | CRCW0402698RFKED    | 0402          | 1         | \$0.01          | 3                               |
| Stackpole Electronics Inc | CSR1206FK10L0       | 1206          | 1         | \$0.11          | 11                              |
| MuRata                    | GRM033R61A822KA01D  | 0201          | 5         | \$0.01          | 10                              |
| MuRata                    | GRM155R61A104KA01D  | 0402          | 5         | \$0.01          | 15                              |
| MuRata                    | GRM155R61C103KA01D  | 0402          | 1         | \$0.01          | 3                               |
| MuRata                    | GRM188R60J475KE19D  | 0603          | 1         | \$0.01          | 5                               |
| MuRata                    | GRM188R61C105KA93D  | 0603          | 1         | \$0.01          | 5                               |
| MuRata                    | GRM2195C1H912JA01D  | 0805          | 1         | \$0.06          | 7                               |
| MuRata                    | GRM32ER61C476ME15L  | 1210_280      | 10        | \$0.24          | 74                              |
| MuRata                    | GRM32ER71H475KA88L  | 1210          | 10        | \$0.19          | 74                              |
| MuRata                    | GRM32ER7YA106KA12L  | 1210_280      | 3         | \$0.22          | 15                              |
| Texas Instruments         | LM25085MY/NOPB      | MUY08A        | 1         | \$0.70          | 24                              |
| Texas Instruments         | LM317KCS            | TO-220-3      | 1         | \$0.24          | 127                             |
| Texas Instruments         | LP2992AIM5-3.3/NOPB | DBV0005A      | 1         | \$0.38          | 15                              |
| Yageo America             | RT0805BRD071K17L    | 0805          | 1         | \$0.05          | 7                               |
| Bourns                    | SRP1270-100M        | SRP1270       | 1         | \$0.60          | 246                             |
| Vishay-Siliconix          | Si7149DP            | PowerPAK_SO-8 | 1         | \$0.74          | 55                              |
| Kemet                     | T495D336K025ATE090  | 7343-31       | 1         | \$0.73          | 59                              |
| Texas Instruments         | TPS54531DDAR        | DDA0008E      | 5         | \$0.75          | 287                             |
| Coilcraft                 | XAL6060-682MEB      | XAL6060       | 5         | \$0.82          | 358                             |
| <b>Total</b>              |                     |               | <b>95</b> | <b>\$19.52</b>  | <b>2533.2398</b>                |

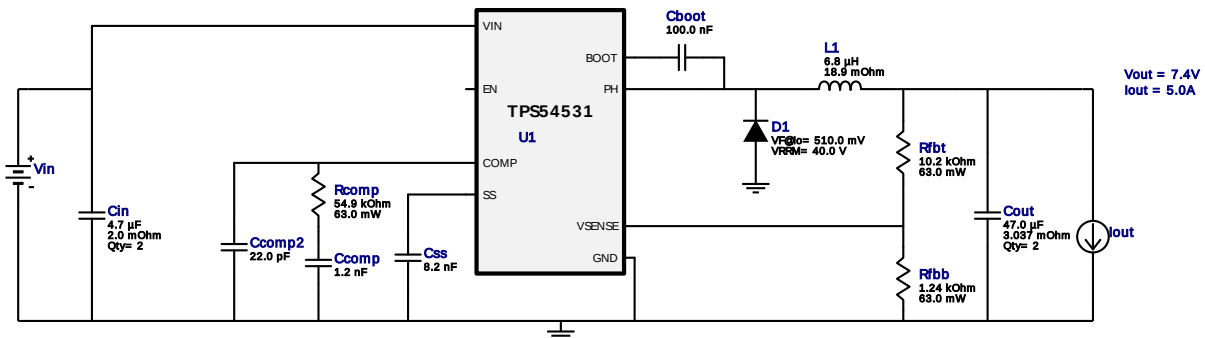


Vout = 7.4V  
Iout = 5.0A

Device = TPS54531DDAR  
Topology = Buck  
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BOM Cost = \$2.90  
BOM Count = 14  
Total Pd = 3.93W

## WEBENCH® Design Report

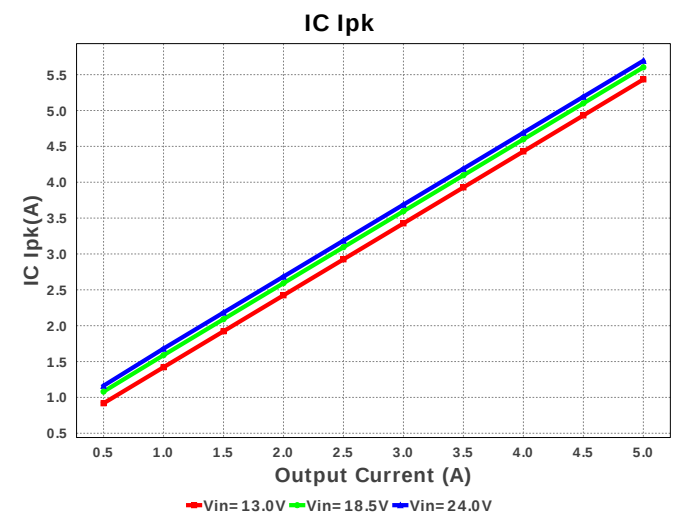
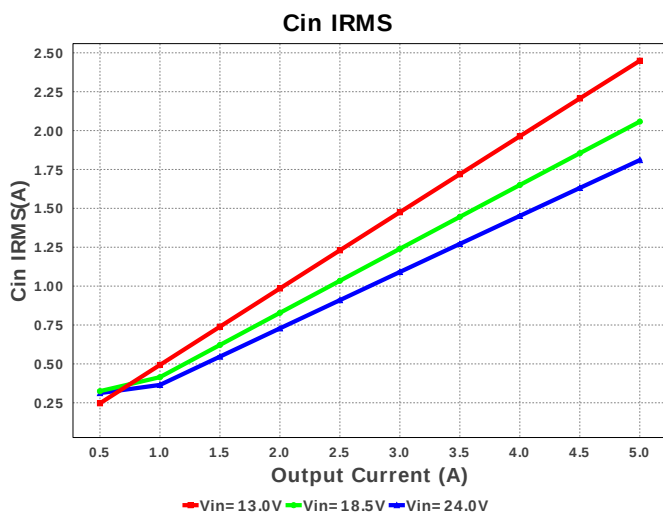
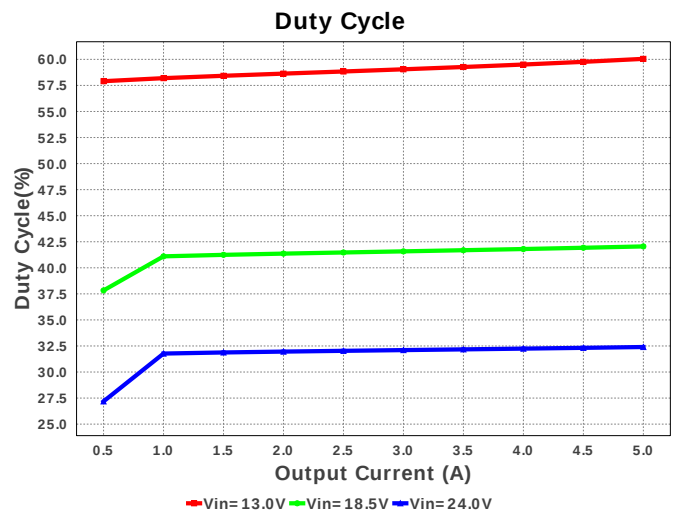
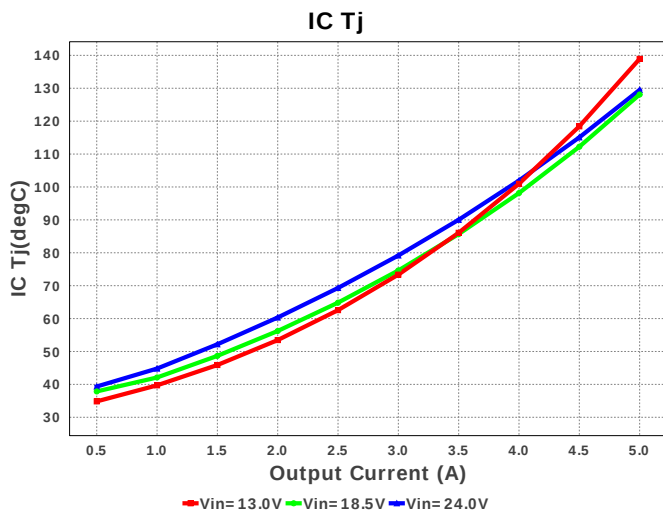
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TPS54531DDAR 13.0V-24.0V to 7.40V @ 5.0A

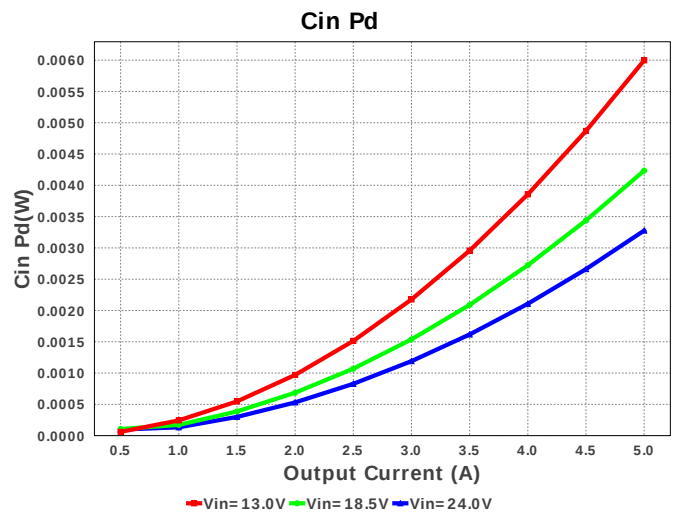
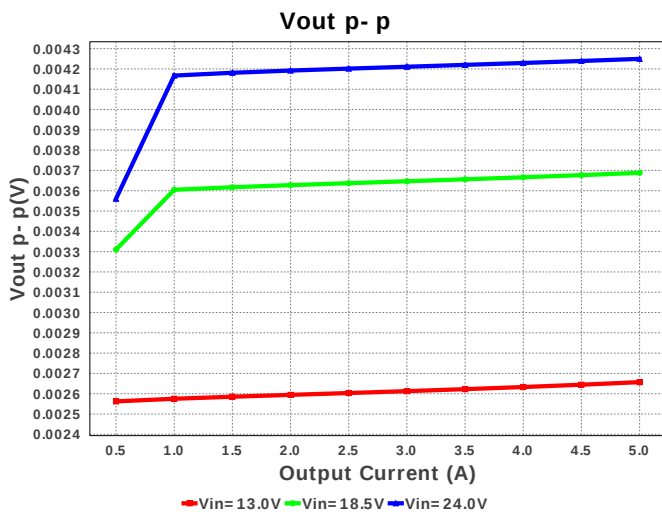
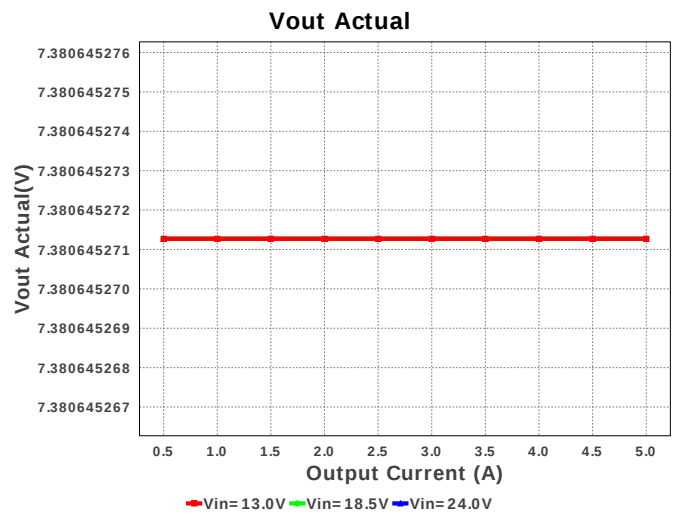
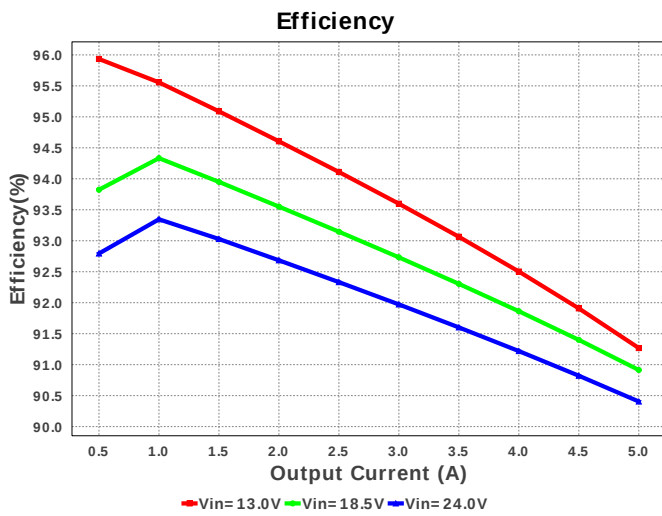
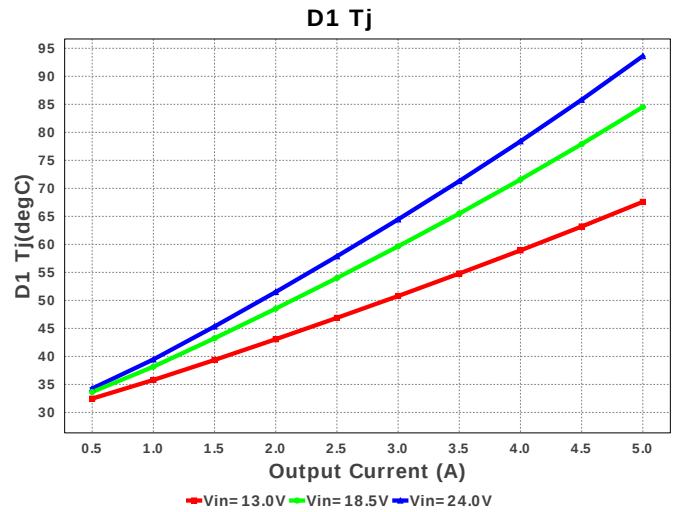
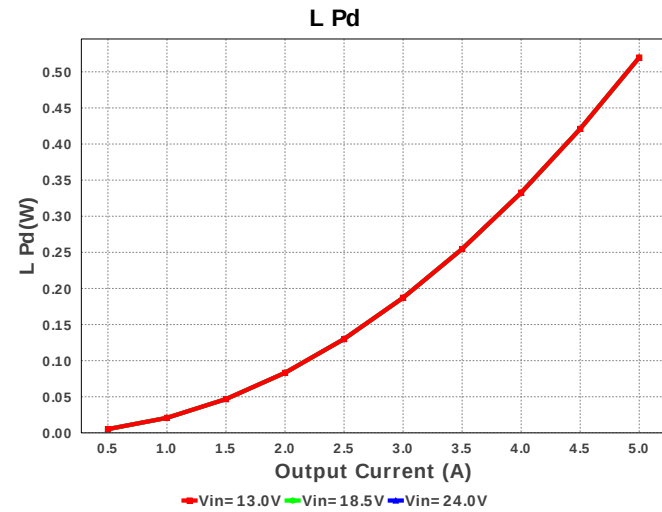


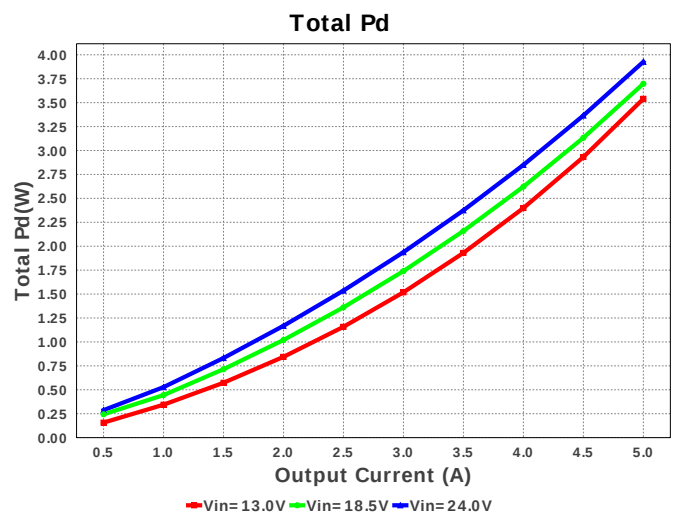
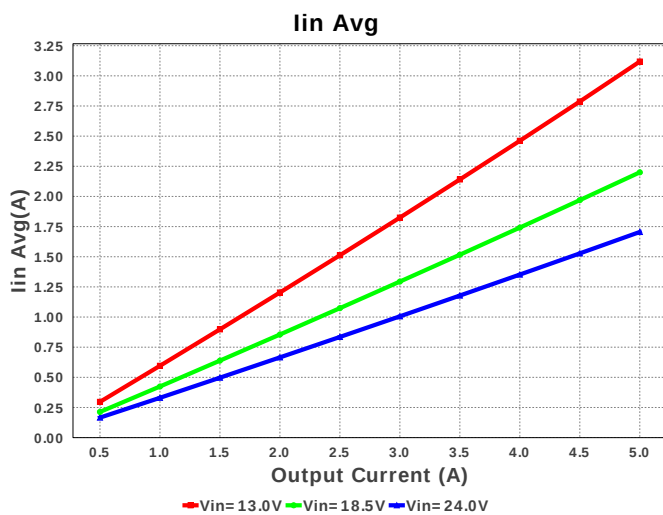
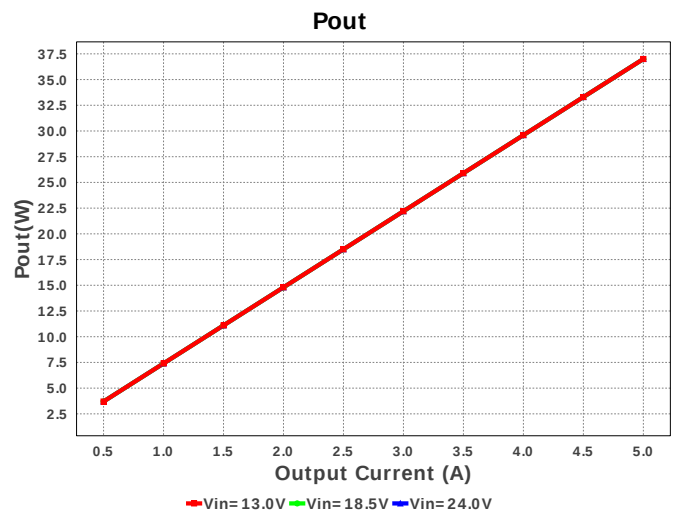
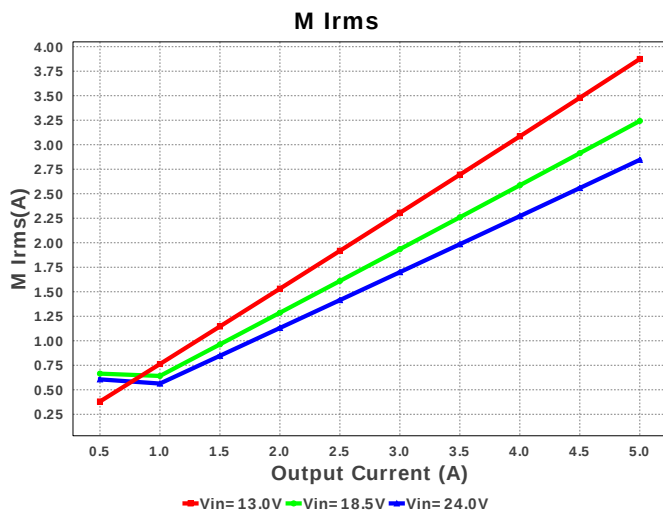
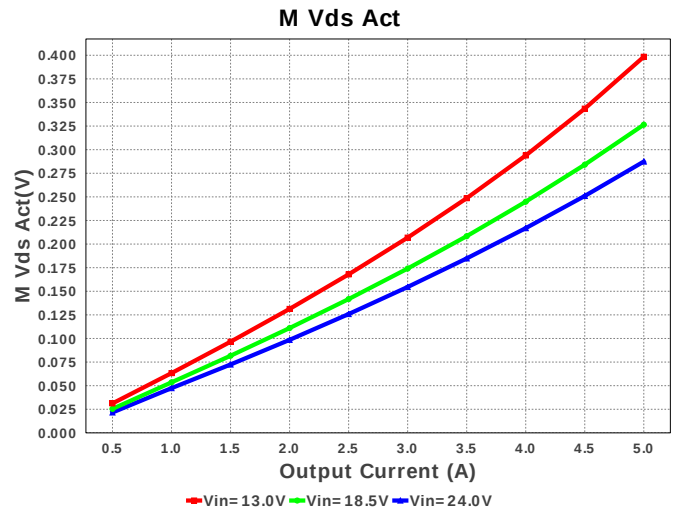
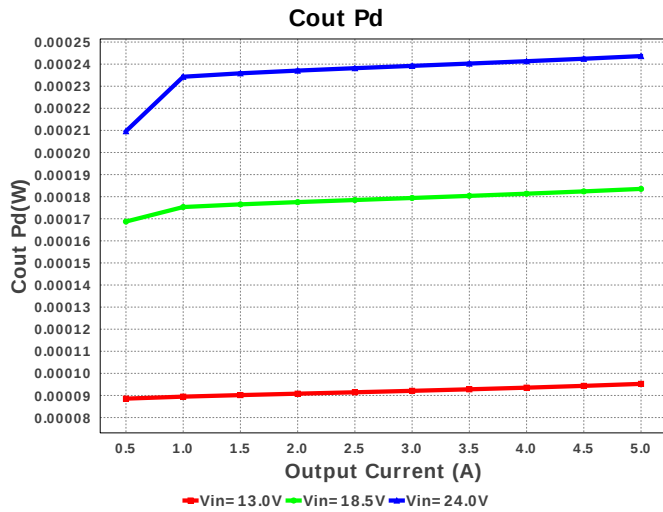
## Electrical BOM

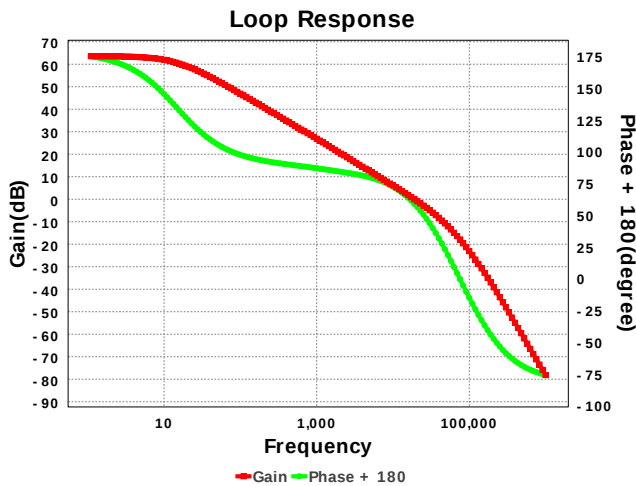
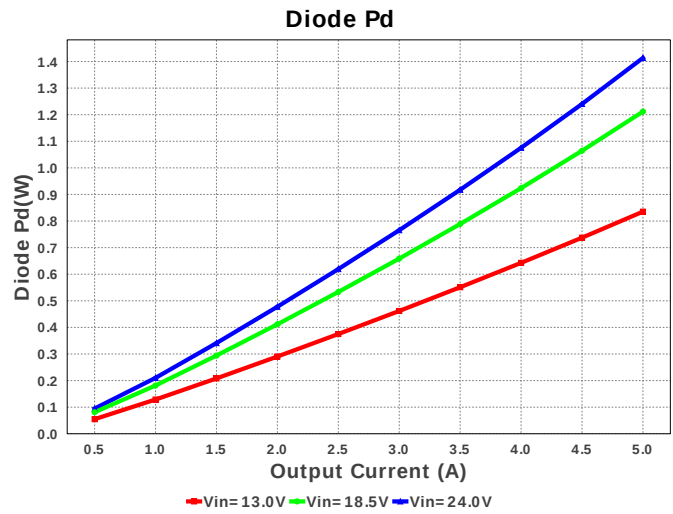
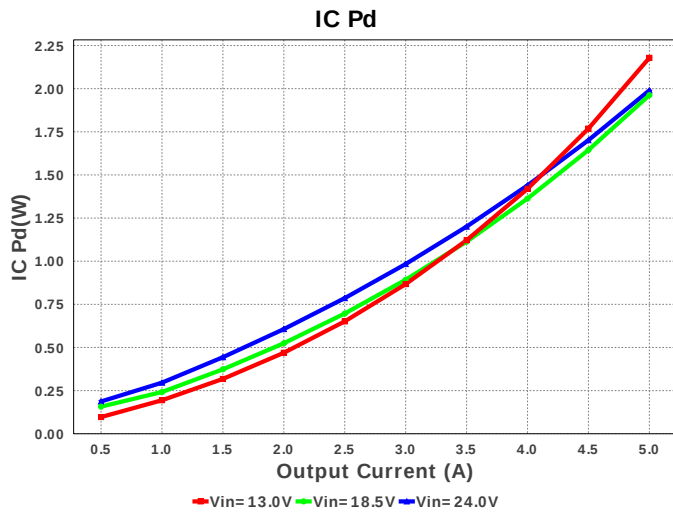
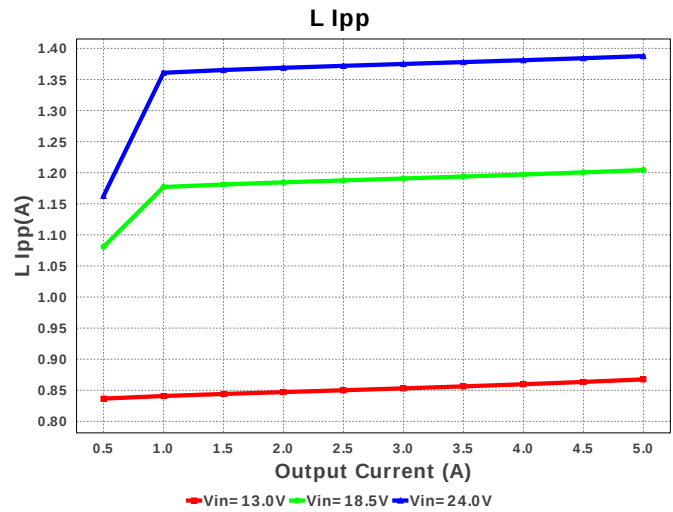
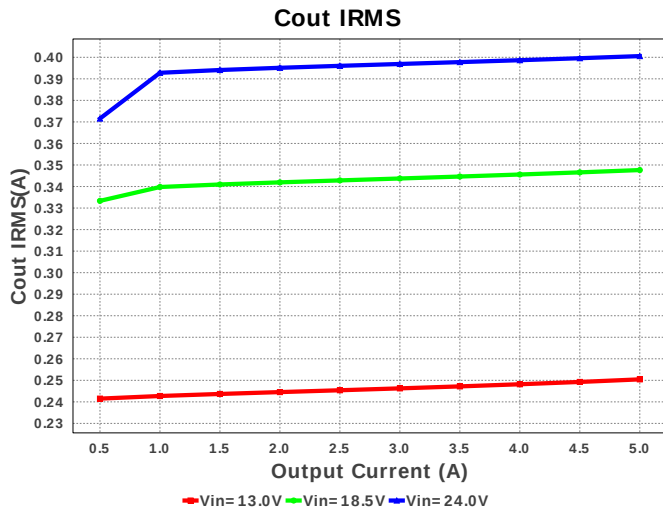
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                        | Qty | Price  | Footprint                   |
|-----|--------|---------------------------|--------------------------------------|-------------------------------------------------------------------|-----|--------|-----------------------------|
| 1.  | Cboot  | MuRata                    | GRM155R61A104KA01D<br>Series= X5R    | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |
| 2.  | Ccomp  | Samsung Electro-Mechanics | CL21C122JBFNNWE<br>Series= C0G/NP0   | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | 0805 7 mm <sup>2</sup>      |
| 3.  | Ccomp2 | Kemet                     | C0805C220K3GACTU<br>Series= C0G/NP0  | Cap= 22.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | 0805 7 mm <sup>2</sup>      |
| 4.  | Cin    | MuRata                    | GRM32ER71H475KA88L<br>Series= X7R    | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.35 A       | 2   | \$0.19 | 1210 15 mm <sup>2</sup>     |
| 5.  | 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 | 2   | \$0.24 | 1210_280 15 mm <sup>2</sup> |
| 6.  | Css    | MuRata                    | GRM033R61A822KA01D<br>Series= X5R    | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | 0201 2 mm <sup>2</sup>      |
| 7.  | D1     | Vishay-Semiconductor      | 50WQ04FNPBF                          | VF@Io= 510.0 mV<br>VRRM= 40.0 V                                   | 1   | \$0.40 | DPAK 102 mm <sup>2</sup>    |
| 8.  | L1     | Coilcraft                 | XAL6060-682MEB                       | L= 6.8 µH<br>DCR= 18.9 mOhm                                       | 1   | \$0.82 | XAL6060 72 mm <sup>2</sup>  |
| 9.  | Rcomp  | Vishay-Dale               | CRCW040254K9FKED<br>Series= CRCW..e3 | Res= 54.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |
| 10. | Rfbb   | Vishay-Dale               | CRCW04021K24FKED<br>Series= CRCW..e3 | Res= 1.24 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |

| #   | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                           |
|-----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------|
| 11. | Rfbt | Vishay-Dale       | CRCW040210K2FKED<br>Series= CRCW..e3 | Res= 10.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm²      |
| 12. | U1   | Texas Instruments | TPS54531DDAR                         | Switcher                                            | 1   | \$0.75 |  DDA0008E 57 mm² |









## Operating Values

| #   | Name      | Value                 | Category | Description                             |
|-----|-----------|-----------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS  | 1.81 A                | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS | 400.561 mA            | Current  | Output capacitor RMS ripple current     |
| 3.  | IC Ipk    | 5.694 A               | Current  | Peak switch current in IC               |
| 4.  | Iin Avg   | 1.705 A               | Current  | Average input current                   |
| 5.  | L Ipp     | 1.388 A               | Current  | Peak-to-peak inductor ripple current    |
| 6.  | M1 Irms   | 2.846 A               | Current  | Q Iavg                                  |
| 7.  | BOM Count | 14                    | General  | Total Design BOM count                  |
| 8.  | FootPrint | 317.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |
| 9.  | Frequency | 570.0 kHz             | General  | Switching frequency                     |
| 10. | M Vds Act | 287.403 mV            | General  | Voltage drop across the MosFET          |
| 11. | Mode      | CCM                   | General  | Conduction Mode                         |

| #   | Name           | Value        | Category | Description                                                                                |
|-----|----------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Pout           | 37.0 W       | General  | Total output power                                                                         |
| 13. | Total BOM      | \$2.9        | General  | Total BOM Cost                                                                             |
| 14. | D1 Tj          | 93.607 degC  | Op_Point | D1 junction temperature                                                                    |
| 15. | Low Freq Gain  | 63.565 dB    | Op_Point | Gain at 10Hz                                                                               |
| 16. | Vout Actual    | 7.381 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 17. | Vout OP        | 7.4 V        | Op_Point | Operational Output Voltage                                                                 |
| 18. | Cross Freq     | 19.106 kHz   | Op_point | Bode plot crossover frequency                                                              |
| 19. | Duty Cycle     | 32.399 %     | Op_point | Duty cycle                                                                                 |
| 20. | Efficiency     | 90.405 %     | Op_point | Steady state efficiency                                                                    |
| 21. | Gain Marg      | -17.974 dB   | Op_point | Bode Plot Gain Margin                                                                      |
| 22. | IC Tj          | 129.512 degC | Op_point | IC junction temperature                                                                    |
| 23. | ICThetaJA      | 50.0 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 24. | IOUT_OP        | 5.0 A        | Op_point | Iout operating point                                                                       |
| 25. | Phase Marg     | 59.46 deg    | Op_point | Bode Plot Phase Margin                                                                     |
| 26. | VIN_OP         | 24.0 V       | Op_point | Vin operating point                                                                        |
| 27. | Vout p-p       | 4.25 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 28. | Cin Pd         | 3.277 mW     | Power    | Input capacitor power dissipation                                                          |
| 29. | Cout Pd        | 243.642 µW   | Power    | Output capacitor power dissipation                                                         |
| 30. | Diode Pd       | 1.413 W      | Power    | Diode power dissipation                                                                    |
| 31. | IC Pd          | 1.99 W       | Power    | IC power dissipation                                                                       |
| 32. | L Pd           | 519.75 mW    | Power    | Inductor power dissipation                                                                 |
| 33. | Total Pd       | 3.927 W      | Power    | Total Power Dissipation                                                                    |
| 34. | Vout Tolerance | 5.364 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value    | Description            |
|----|---------|----------|------------------------|
| 1. | Iout    | 5.0      | Maximum Output Current |
| 2. | VinMax  | 24.0     | Maximum input voltage  |
| 3. | VinMin  | 13.0     | Minimum input voltage  |
| 4. | Vout    | 7.4      | Output Voltage         |
| 5. | base_pn | TPS54531 | Base Product Number    |
| 6. | source  | DC       | Input Source Type      |
| 7. | Ta      | 30.0     | Ambient temperature    |

## Design Assistance

1. **TPS54531** Product Folder : <http://www.ti.com/product/TPS54531> : contains the data sheet and other resources.

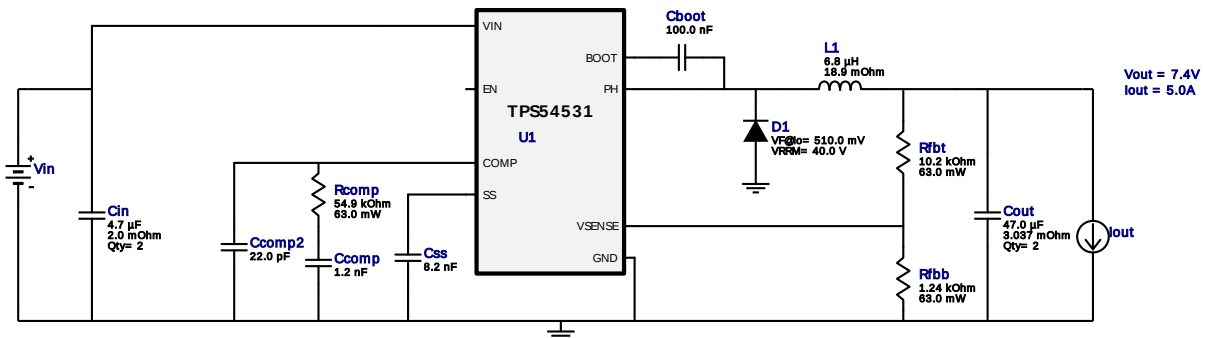


Vout = 7.4V  
Iout = 5.0A

Device = TPS54531DDAR  
Topology = Buck  
Created = 8/22/16 12:31:22 PM  
BOM Cost = \$2.90  
BOM Count = 14  
Total Pd = 3.93W

# WEBENCH<sup>®</sup> Design Report

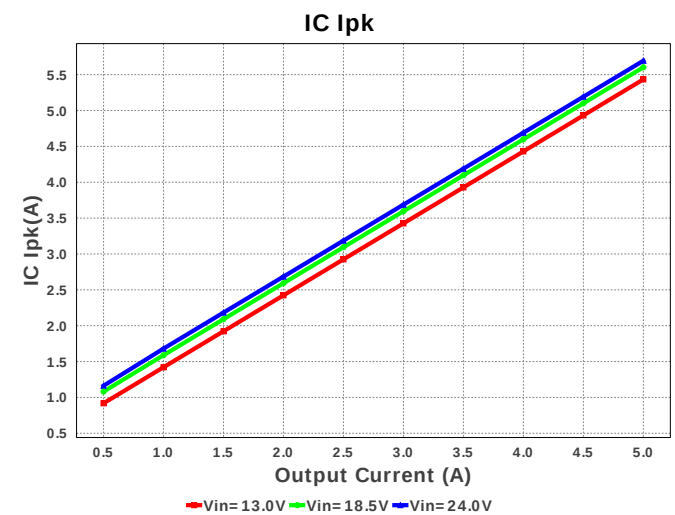
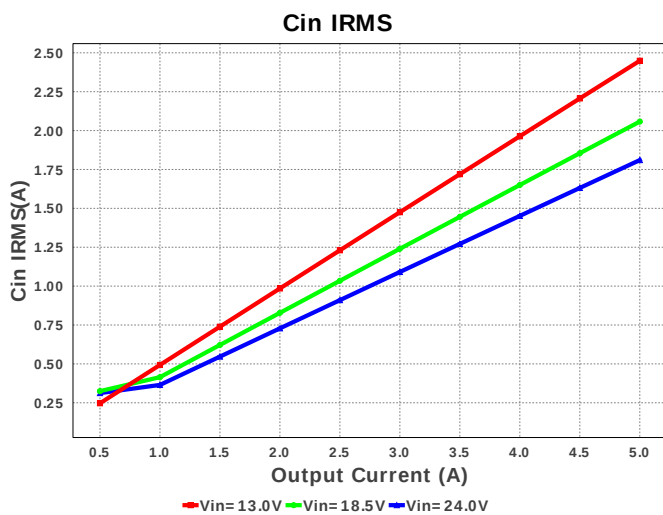
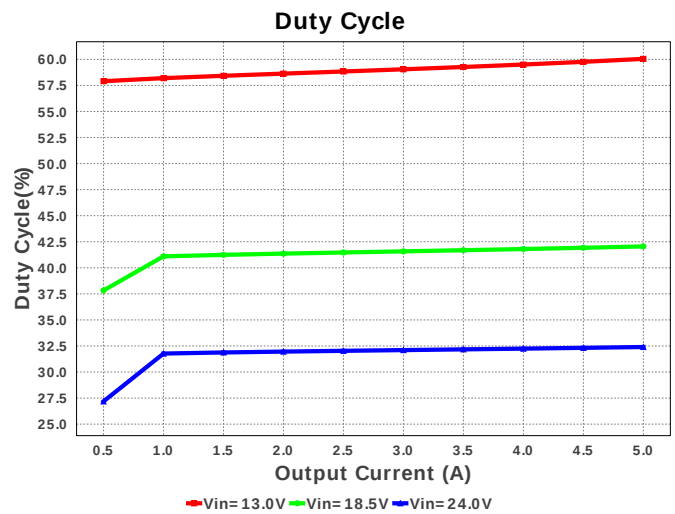
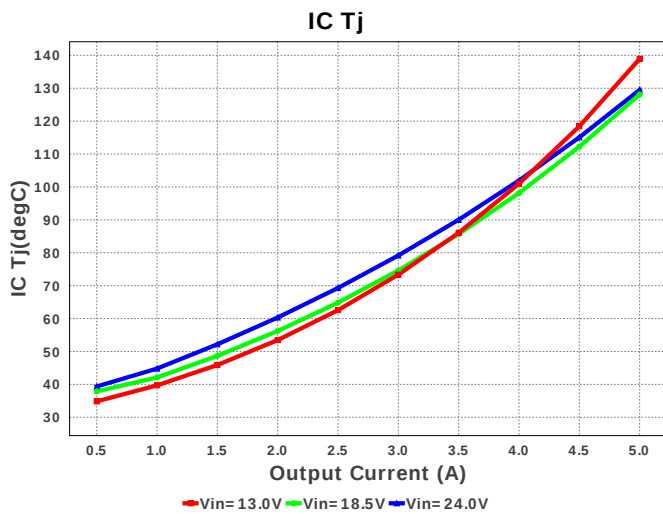
Design : 4457758/53 TPS54531DDAR  
TPS54531DDAR 13.0V-24.0V to 7.40V @ 5.0A

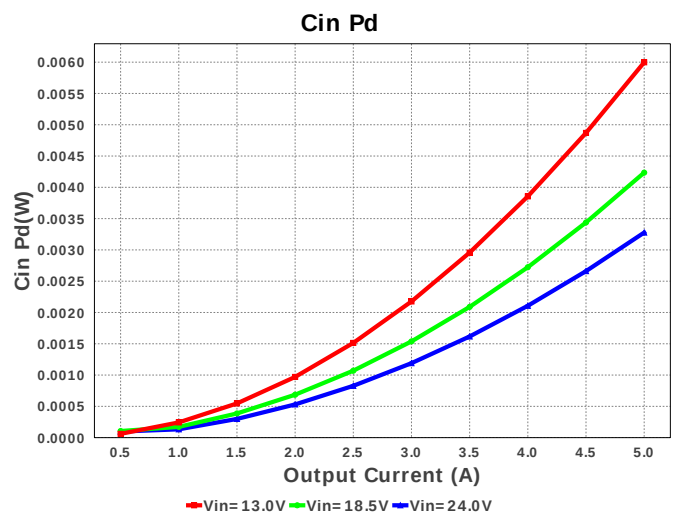
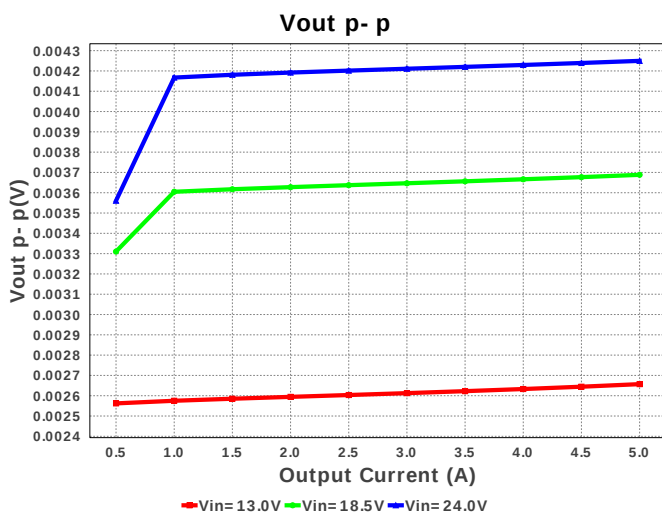
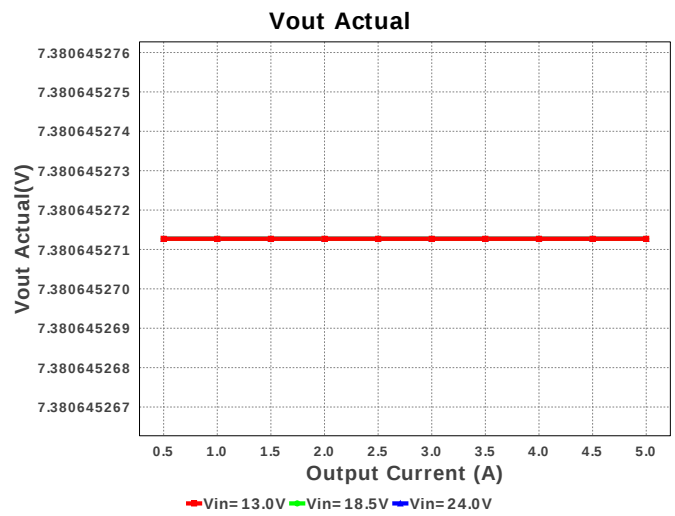
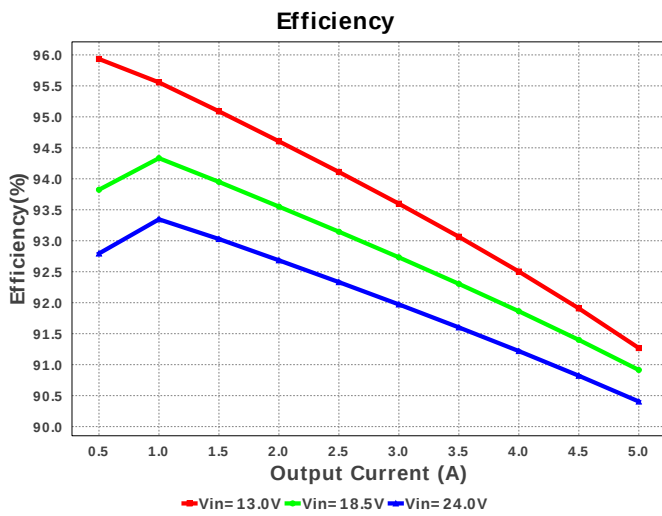
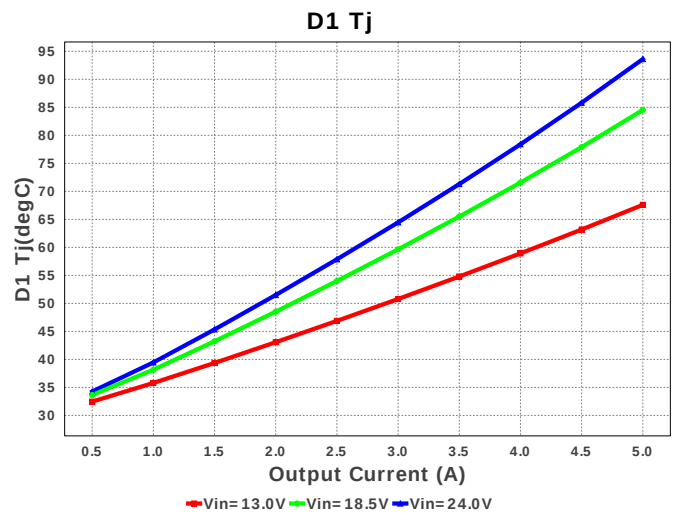
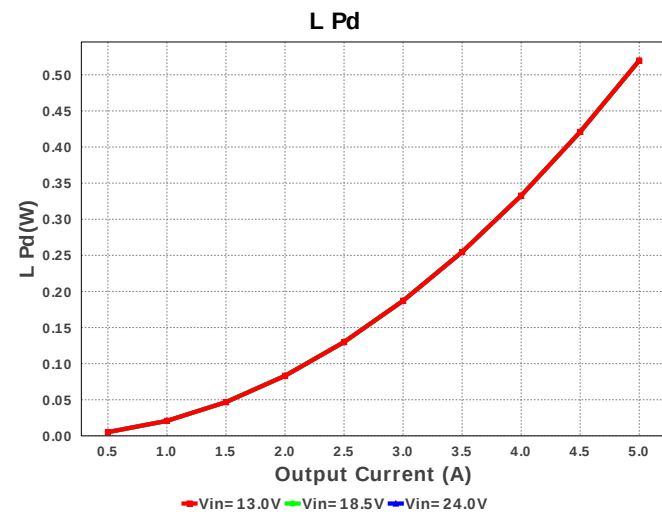


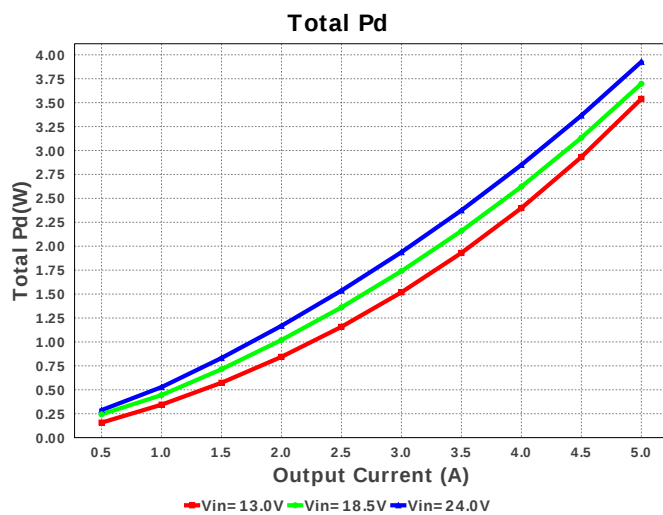
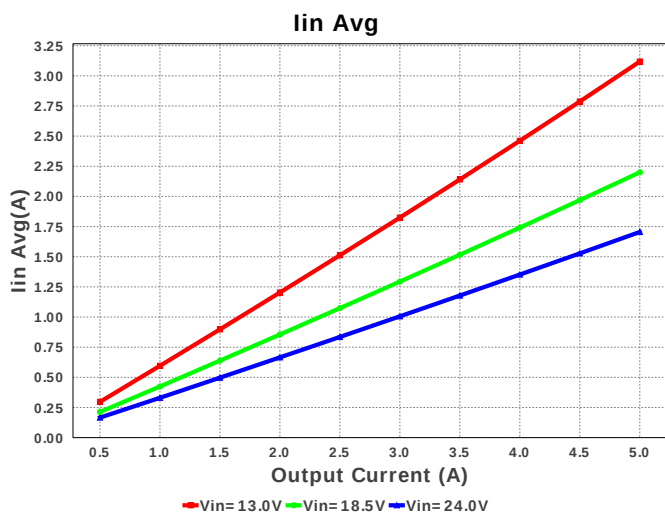
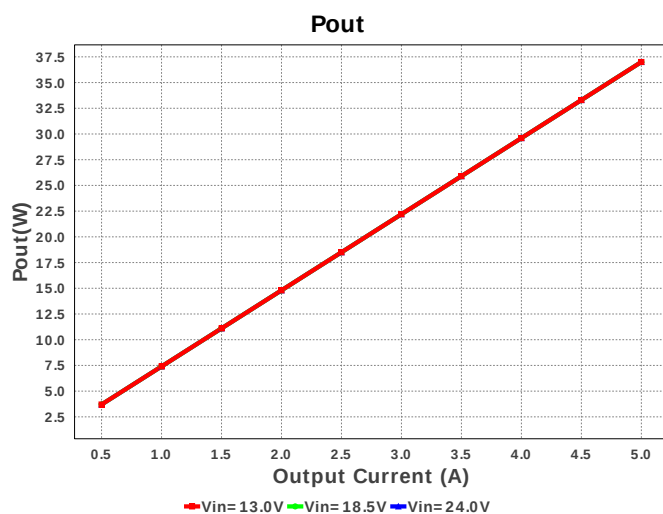
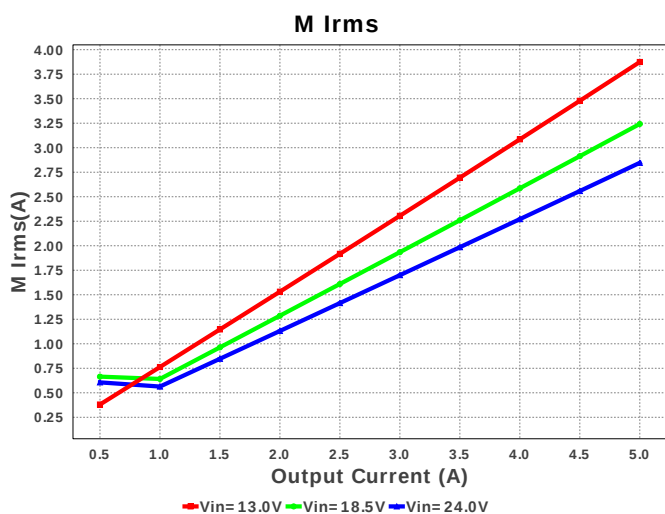
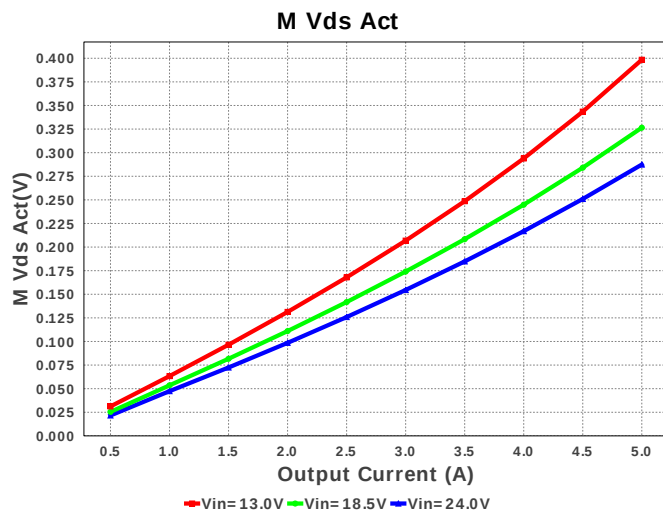
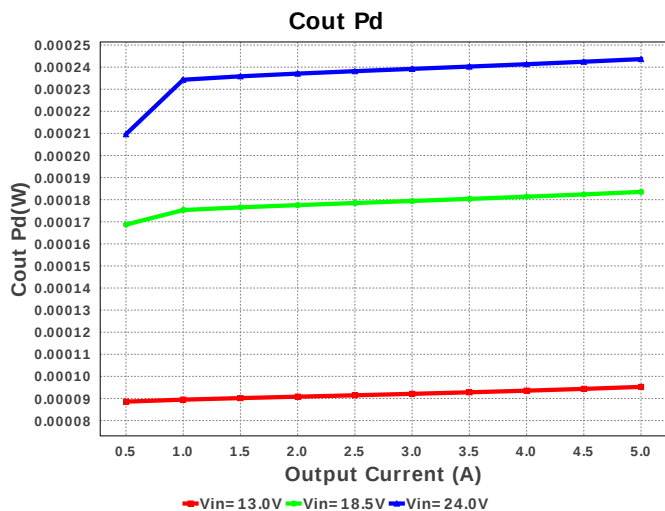
## Electrical BOM

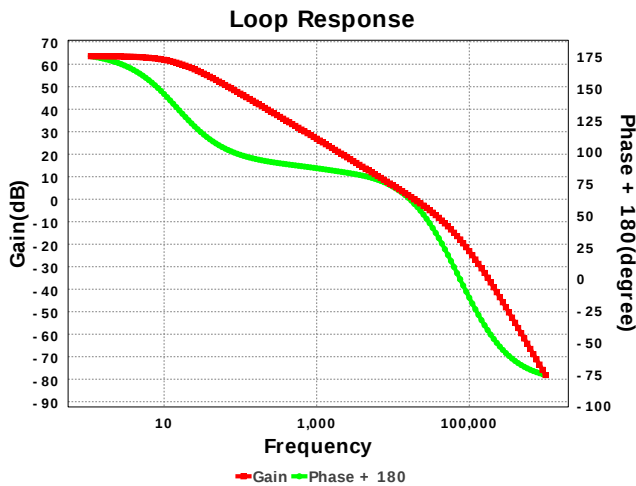
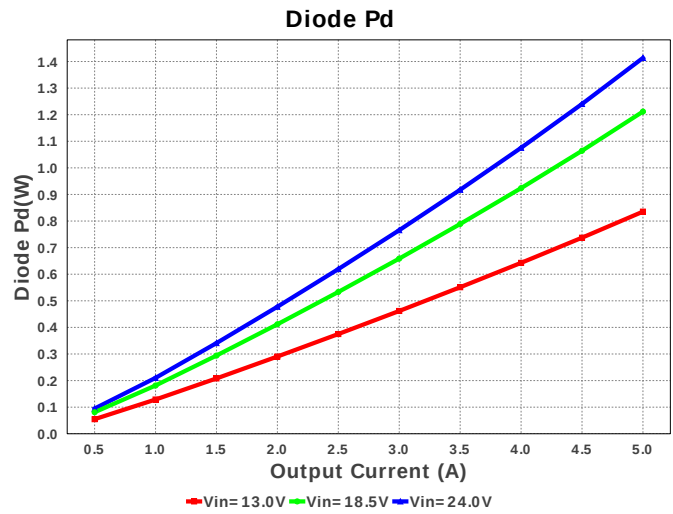
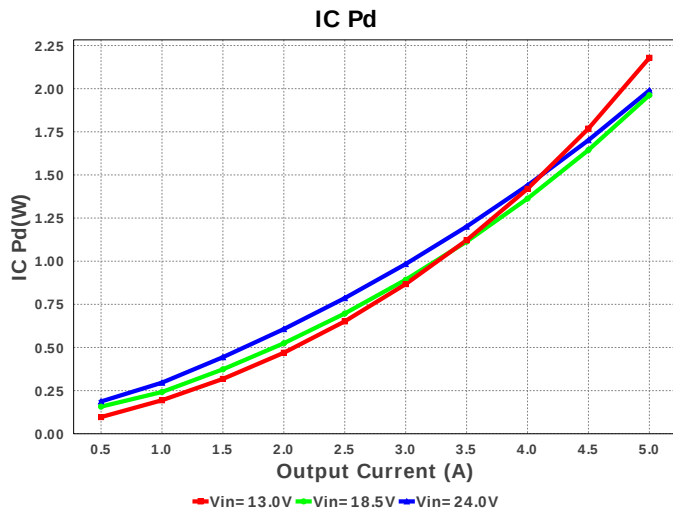
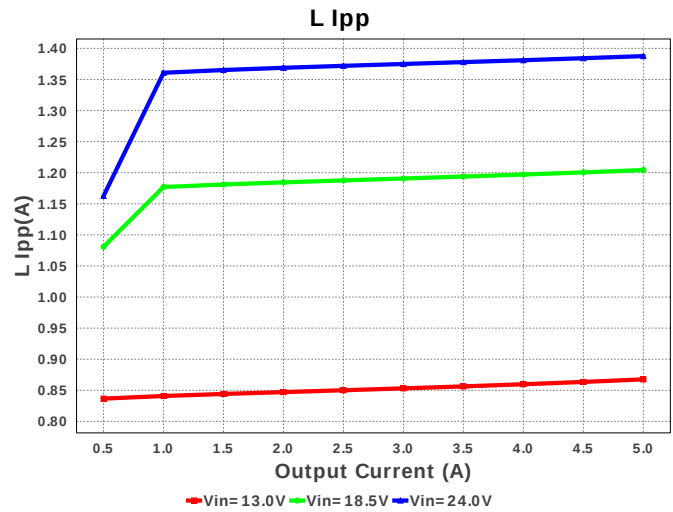
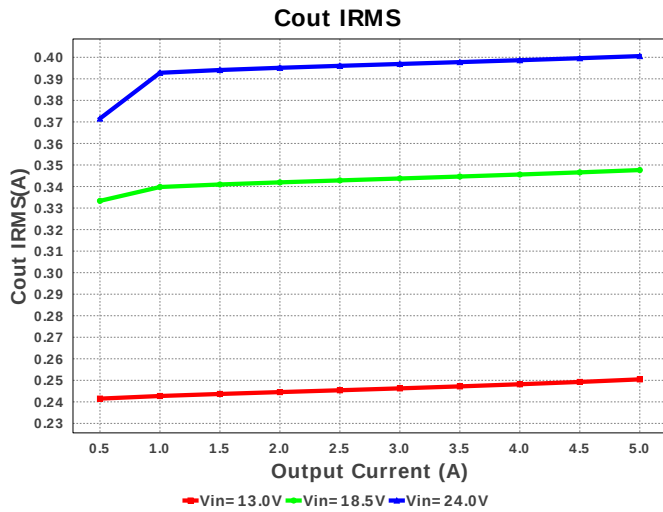
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                        | Qty | Price  | Footprint                                                                                                            |
|-----|--------|---------------------------|--------------------------------------|-------------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------|
| 1.  | Cboot  | MuRata                    | GRM155R61A104KA01D<br>Series= X5R    | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>       |
| 2.  | Ccomp  | Samsung Electro-Mechanics | CL21C122JBFNWWE<br>Series= C0G/NP0   | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>      |
| 3.  | Ccomp2 | Kemet                     | C0805C220K3GACTU<br>Series= C0G/NP0  | Cap= 22.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>      |
| 4.  | Cin    | MuRata                    | GRM32ER71H475KA88L<br>Series= X7R    | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.35 A       | 2   | \$0.19 | <br>1210 15 mm <sup>2</sup>     |
| 5.  | 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 | 2   | \$0.24 | <br>1210_280 15 mm <sup>2</sup> |
| 6.  | Css    | MuRata                    | GRM033R61A822KA01D<br>Series= X5R    | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | <br>0201 2 mm <sup>2</sup>      |
| 7.  | D1     | Vishay-Semiconductor      | 50WQ04FNPBF                          | VF@Io= 510.0 mV<br>VRRM= 40.0 V                                   | 1   | \$0.40 | <br>DPAK 102 mm <sup>2</sup>    |
| 8.  | L1     | Coilcraft                 | XAL6060-682MEB                       | L= 6.8 uH<br>DCR= 18.9 mOhm                                       | 1   | \$0.82 | <br>XAL6060 72 mm <sup>2</sup>  |
| 9.  | Rcomp  | Vishay-Dale               | CRCW040254K9FKED<br>Series= CRCW..e3 | Res= 54.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>      |
| 10. | Rfbb   | Vishay-Dale               | CRCW04021K24FKED<br>Series= CRCW..e3 | Res= 1.24 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>      |

| #   | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                           |
|-----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------|
| 11. | Rfbt | Vishay-Dale       | CRCW040210K2FKED<br>Series= CRCW..e3 | Res= 10.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm²      |
| 12. | U1   | Texas Instruments | TPS54531DDAR                         | Switcher                                            | 1   | \$0.75 |  DDA0008E 57 mm² |









## Operating Values

| #   | Name      | Value                 | Category | Description                             |
|-----|-----------|-----------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS  | 1.81 A                | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS | 400.561 mA            | Current  | Output capacitor RMS ripple current     |
| 3.  | IC Ipk    | 5.694 A               | Current  | Peak switch current in IC               |
| 4.  | Iin Avg   | 1.705 A               | Current  | Average input current                   |
| 5.  | L Ipp     | 1.388 A               | Current  | Peak-to-peak inductor ripple current    |
| 6.  | M1 Irms   | 2.846 A               | Current  | Q lavg                                  |
| 7.  | BOM Count | 14                    | General  | Total Design BOM count                  |
| 8.  | FootPrint | 317.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |
| 9.  | Frequency | 570.0 kHz             | General  | Switching frequency                     |
| 10. | M Vds Act | 287.403 mV            | General  | Voltage drop across the MosFET          |
| 11. | Mode      | CCM                   | General  | Conduction Mode                         |

| #   | Name           | Value        | Category | Description                                                                                |
|-----|----------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Pout           | 37.0 W       | General  | Total output power                                                                         |
| 13. | Total BOM      | \$2.9        | General  | Total BOM Cost                                                                             |
| 14. | D1 Tj          | 93.607 degC  | Op_Point | D1 junction temperature                                                                    |
| 15. | Low Freq Gain  | 63.565 dB    | Op_Point | Gain at 10Hz                                                                               |
| 16. | Vout Actual    | 7.381 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 17. | Vout OP        | 7.4 V        | Op_Point | Operational Output Voltage                                                                 |
| 18. | Cross Freq     | 19.106 kHz   | Op_point | Bode plot crossover frequency                                                              |
| 19. | Duty Cycle     | 32.399 %     | Op_point | Duty cycle                                                                                 |
| 20. | Efficiency     | 90.405 %     | Op_point | Steady state efficiency                                                                    |
| 21. | Gain Marg      | -17.974 dB   | Op_point | Bode Plot Gain Margin                                                                      |
| 22. | IC Tj          | 129.512 degC | Op_point | IC junction temperature                                                                    |
| 23. | ICThetaJA      | 50.0 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 24. | IOUT_OP        | 5.0 A        | Op_point | Iout operating point                                                                       |
| 25. | Phase Marg     | 59.46 deg    | Op_point | Bode Plot Phase Margin                                                                     |
| 26. | VIN_OP         | 24.0 V       | Op_point | Vin operating point                                                                        |
| 27. | Vout p-p       | 4.25 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 28. | Cin Pd         | 3.277 mW     | Power    | Input capacitor power dissipation                                                          |
| 29. | Cout Pd        | 243.642 µW   | Power    | Output capacitor power dissipation                                                         |
| 30. | Diode Pd       | 1.413 W      | Power    | Diode power dissipation                                                                    |
| 31. | IC Pd          | 1.99 W       | Power    | IC power dissipation                                                                       |
| 32. | L Pd           | 519.75 mW    | Power    | Inductor power dissipation                                                                 |
| 33. | Total Pd       | 3.927 W      | Power    | Total Power Dissipation                                                                    |
| 34. | Vout Tolerance | 5.364 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value    | Description            |
|----|---------|----------|------------------------|
| 1. | Iout    | 5.0      | Maximum Output Current |
| 2. | VinMax  | 24.0     | Maximum input voltage  |
| 3. | VinMin  | 13.0     | Minimum input voltage  |
| 4. | Vout    | 7.4      | Output Voltage         |
| 5. | base_pn | TPS54531 | Base Product Number    |
| 6. | source  | DC       | Input Source Type      |
| 7. | Ta      | 30.0     | Ambient temperature    |

## Design Assistance

1. **TPS54531** Product Folder : <http://www.ti.com/product/TPS54531> : contains the data sheet and other resources.

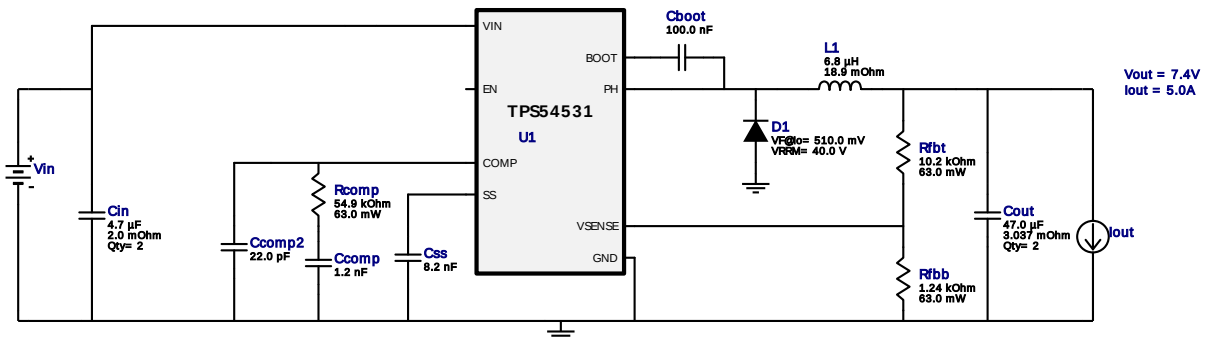


Vout = 7.4V  
Iout = 5.0A

Device = TPS54531DDAR  
Topology = Buck  
Created = 8/22/16 12:31:22 PM  
BOM Cost = \$2.90  
BOM Count = 14  
Total Pd = 3.93W

## WEBENCH® Design Report

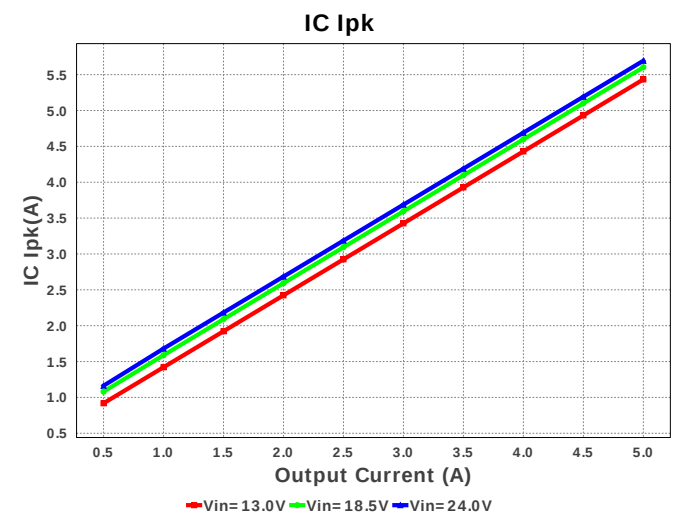
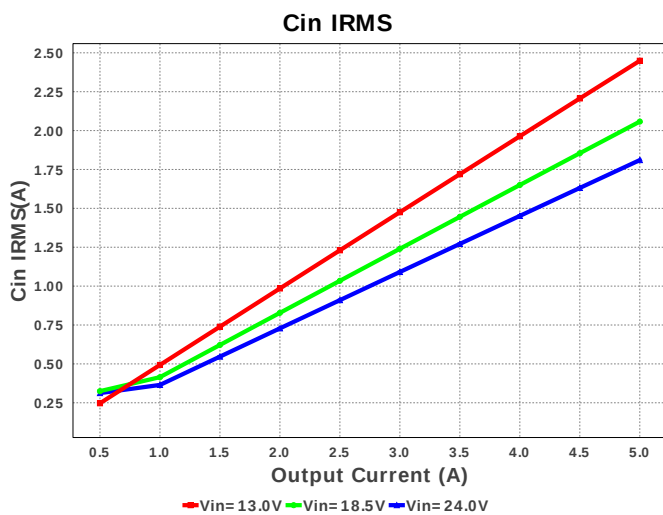
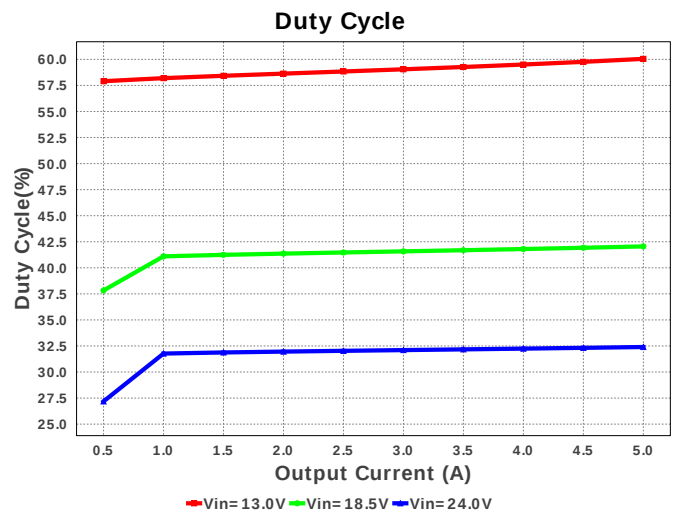
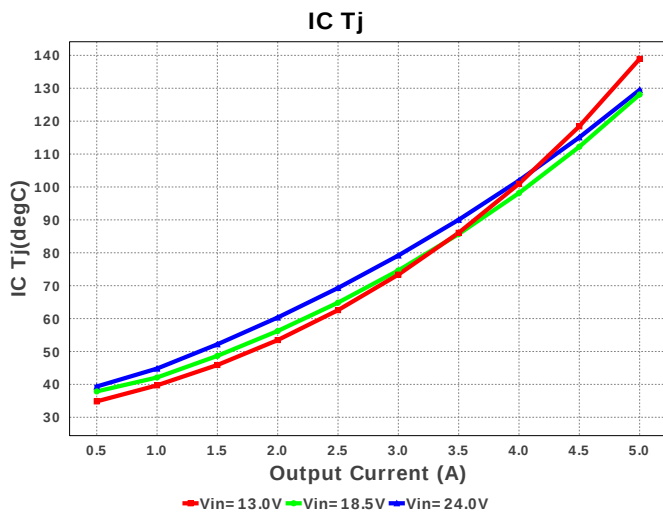
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TPS54531DDAR 13.0V-24.0V to 7.40V @ 5.0A

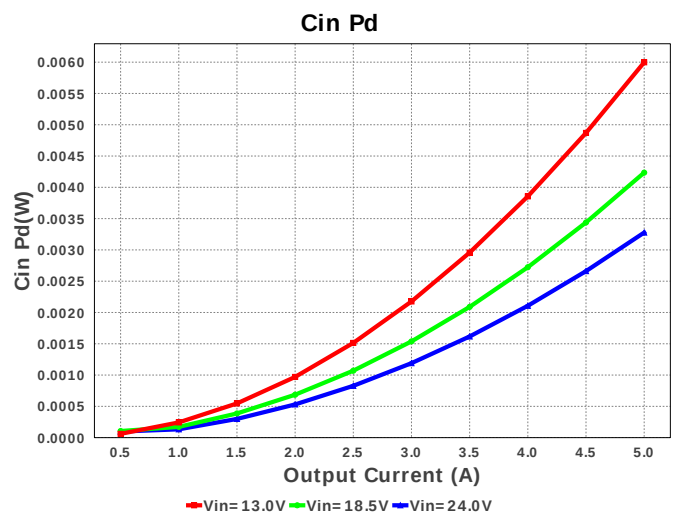
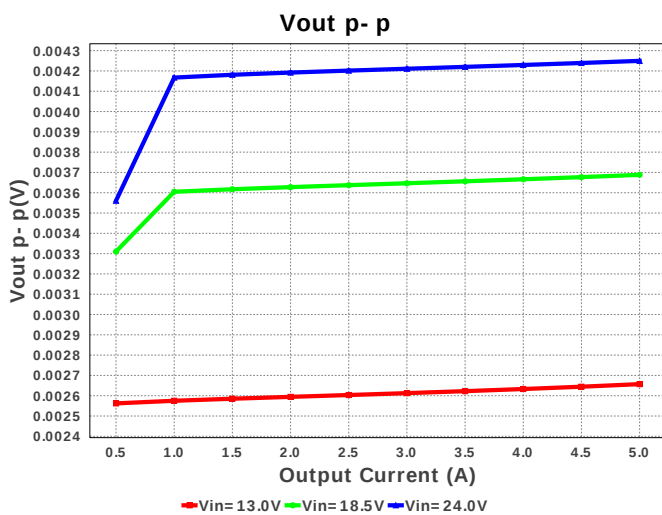
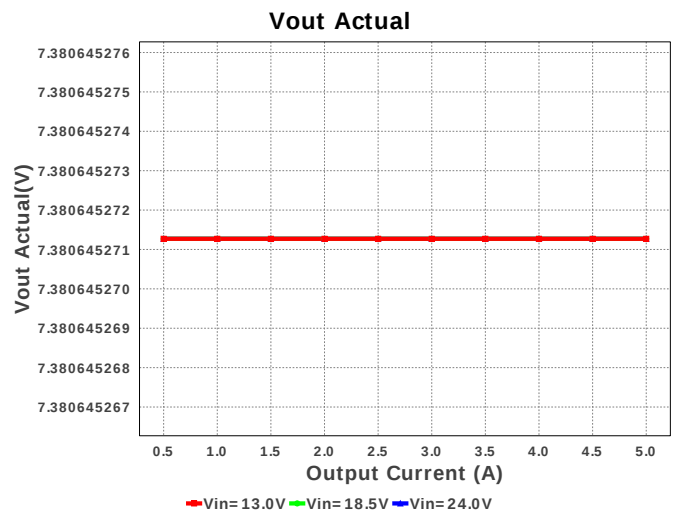
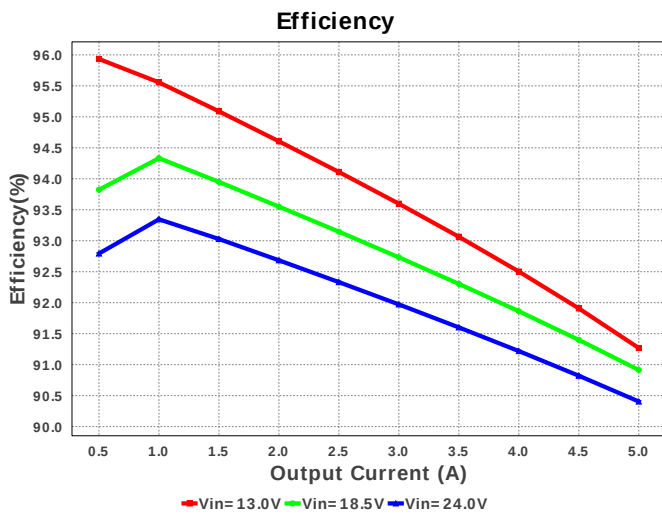
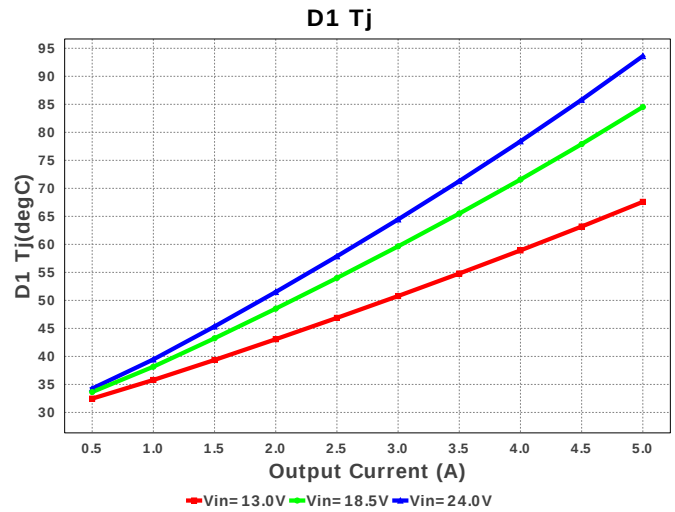
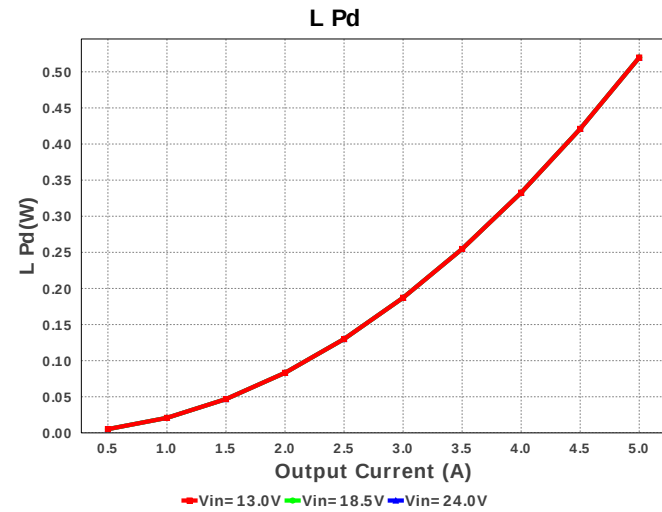


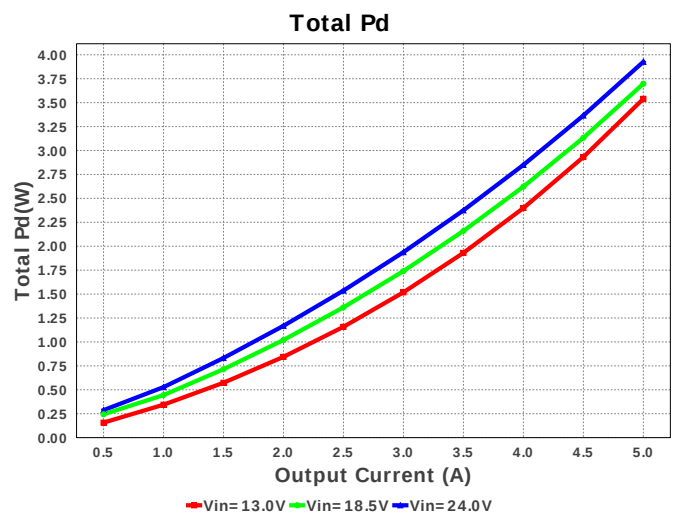
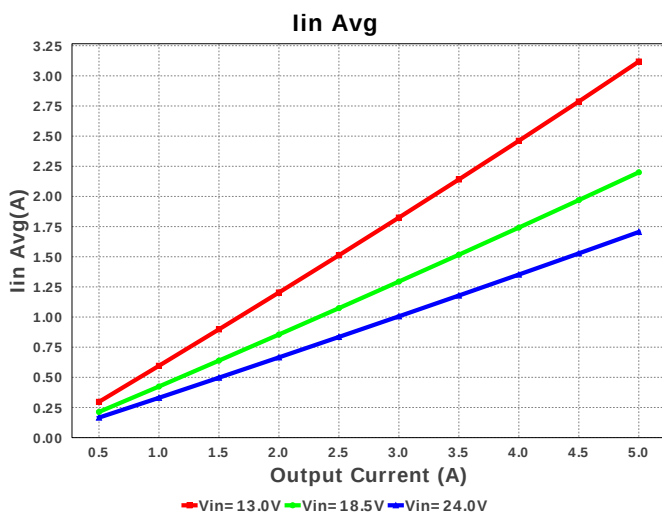
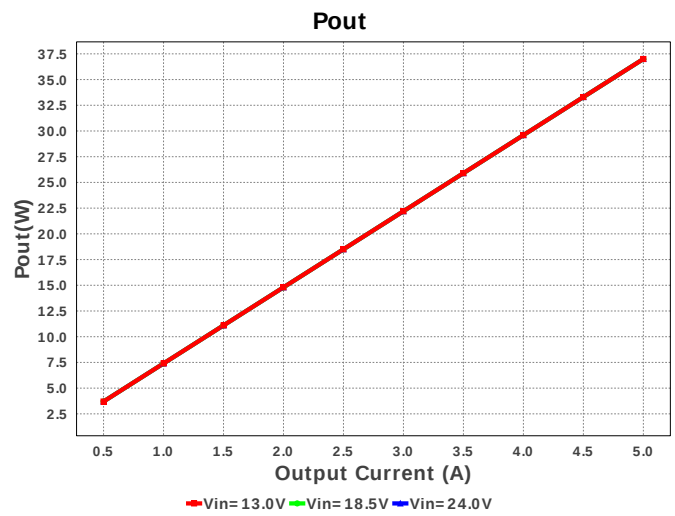
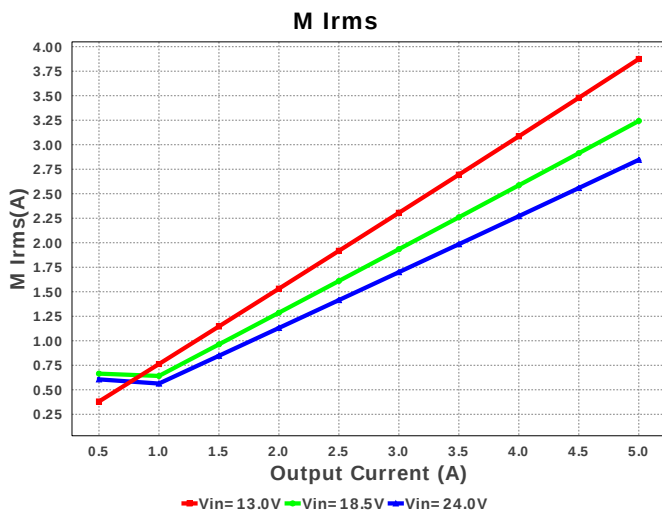
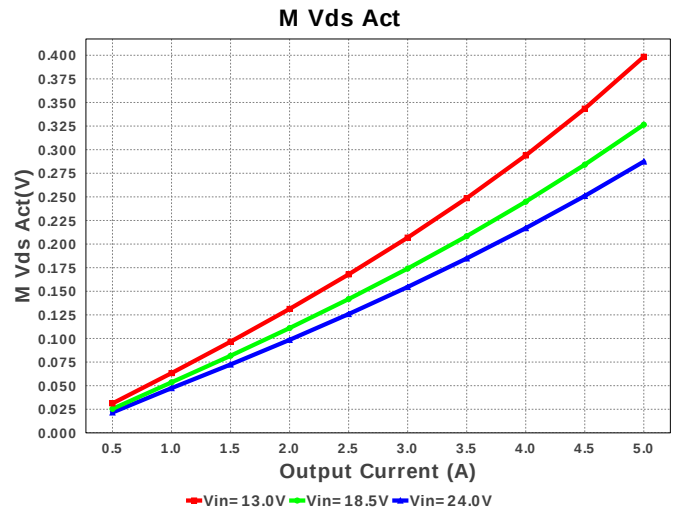
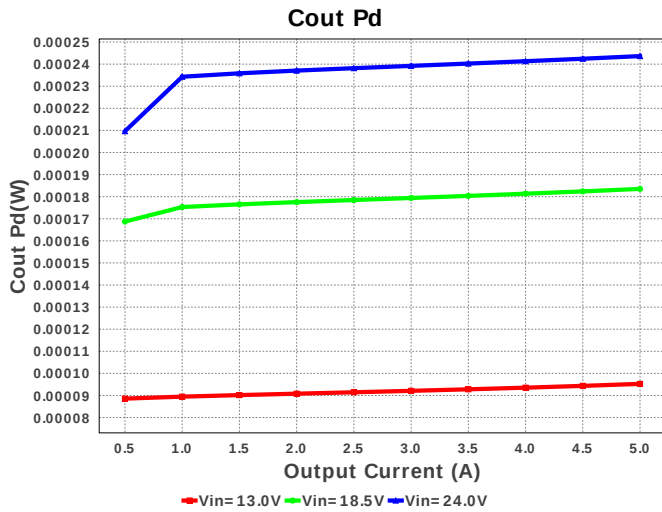
## Electrical BOM

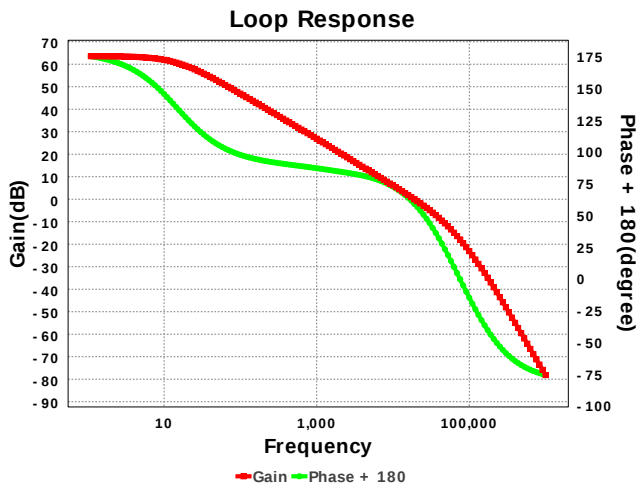
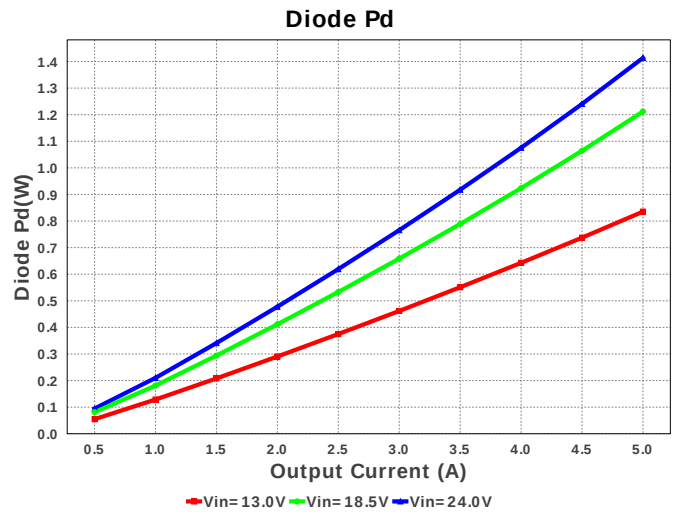
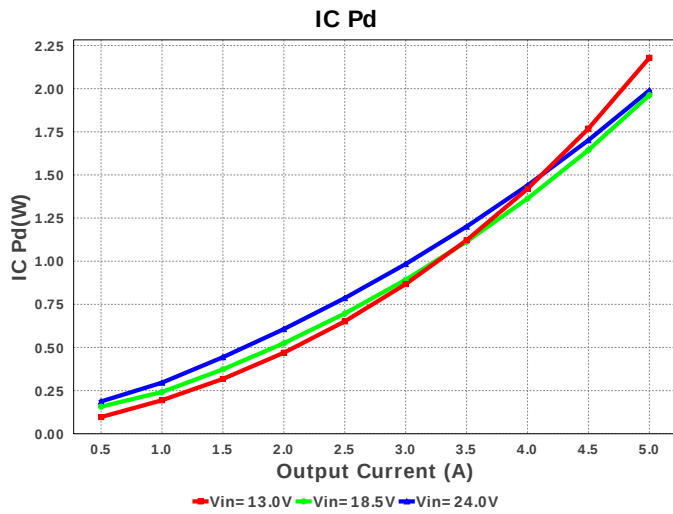
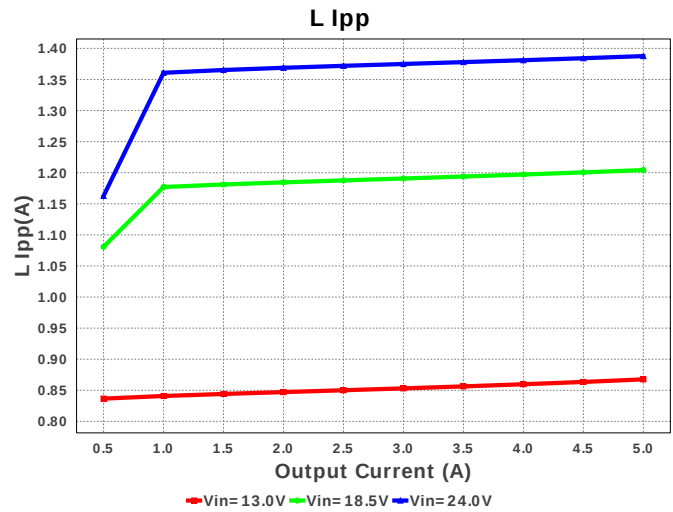
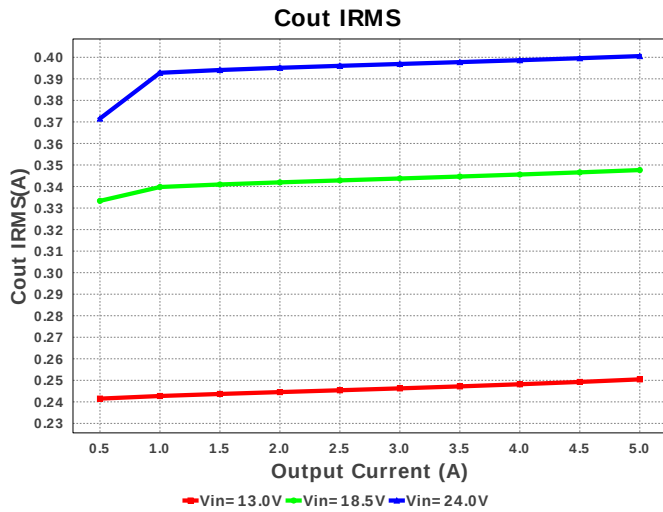
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                        | Qty | Price  | Footprint                                                                                                         |
|-----|--------|---------------------------|--------------------------------------|-------------------------------------------------------------------|-----|--------|-------------------------------------------------------------------------------------------------------------------|
| 1.  | Cboot  | MuRata                    | GRM155R61A104KA01D<br>Series= X5R    | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| 2.  | Ccomp  | Samsung Electro-Mechanics | CL21C122JBFNNWE<br>Series= C0G/NP0   | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 |  0805 7 mm <sup>2</sup>      |
| 3.  | Ccomp2 | Kemet                     | C0805C220K3GACTU<br>Series= C0G/NP0  | Cap= 22.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 |  0805 7 mm <sup>2</sup>      |
| 4.  | Cin    | MuRata                    | GRM32ER71H475KA88L<br>Series= X7R    | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.35 A       | 2   | \$0.19 |  1210 15 mm <sup>2</sup>     |
| 5.  | 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 | 2   | \$0.24 |  1210_280 15 mm <sup>2</sup> |
| 6.  | Css    | MuRata                    | GRM033R61A822KA01D<br>Series= X5R    | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 |  0201 2 mm <sup>2</sup>      |
| 7.  | D1     | Vishay-Semiconductor      | 50WQ04FNPBF                          | VF@Io= 510.0 mV<br>VRRM= 40.0 V                                   | 1   | \$0.40 |  DPAK 102 mm <sup>2</sup>    |
| 8.  | L1     | Coilcraft                 | XAL6060-682MEB                       | L= 6.8 µH<br>DCR= 18.9 mOhm                                       | 1   | \$0.82 |  XAL6060 72 mm <sup>2</sup>  |
| 9.  | Rcomp  | Vishay-Dale               | CRCW040254K9FKED<br>Series= CRCW..e3 | Res= 54.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 |  0402 3 mm <sup>2</sup>      |
| 10. | Rfbb   | Vishay-Dale               | CRCW04021K24FKED<br>Series= CRCW..e3 | Res= 1.24 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 |  0402 3 mm <sup>2</sup>      |

| #   | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                           |
|-----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------|
| 11. | Rfbt | Vishay-Dale       | CRCW040210K2FKED<br>Series= CRCW..e3 | Res= 10.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm²      |
| 12. | U1   | Texas Instruments | TPS54531DDAR                         | Switcher                                            | 1   | \$0.75 |  DDA0008E 57 mm² |









## Operating Values

| #   | Name      | Value                 | Category | Description                             |
|-----|-----------|-----------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS  | 1.81 A                | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS | 400.561 mA            | Current  | Output capacitor RMS ripple current     |
| 3.  | IC Ipk    | 5.694 A               | Current  | Peak switch current in IC               |
| 4.  | Iin Avg   | 1.705 A               | Current  | Average input current                   |
| 5.  | L Ipp     | 1.388 A               | Current  | Peak-to-peak inductor ripple current    |
| 6.  | M1 Irms   | 2.846 A               | Current  | Q Iavg                                  |
| 7.  | BOM Count | 14                    | General  | Total Design BOM count                  |
| 8.  | FootPrint | 317.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |
| 9.  | Frequency | 570.0 kHz             | General  | Switching frequency                     |
| 10. | M Vds Act | 287.403 mV            | General  | Voltage drop across the MosFET          |
| 11. | Mode      | CCM                   | General  | Conduction Mode                         |

| #   | Name           | Value        | Category | Description                                                                                |
|-----|----------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Pout           | 37.0 W       | General  | Total output power                                                                         |
| 13. | Total BOM      | \$2.9        | General  | Total BOM Cost                                                                             |
| 14. | D1 Tj          | 93.607 degC  | Op_Point | D1 junction temperature                                                                    |
| 15. | Low Freq Gain  | 63.565 dB    | Op_Point | Gain at 10Hz                                                                               |
| 16. | Vout Actual    | 7.381 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 17. | Vout OP        | 7.4 V        | Op_Point | Operational Output Voltage                                                                 |
| 18. | Cross Freq     | 19.106 kHz   | Op_point | Bode plot crossover frequency                                                              |
| 19. | Duty Cycle     | 32.399 %     | Op_point | Duty cycle                                                                                 |
| 20. | Efficiency     | 90.405 %     | Op_point | Steady state efficiency                                                                    |
| 21. | Gain Marg      | -17.974 dB   | Op_point | Bode Plot Gain Margin                                                                      |
| 22. | IC Tj          | 129.512 degC | Op_point | IC junction temperature                                                                    |
| 23. | ICThetaJA      | 50.0 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 24. | IOUT_OP        | 5.0 A        | Op_point | Iout operating point                                                                       |
| 25. | Phase Marg     | 59.46 deg    | Op_point | Bode Plot Phase Margin                                                                     |
| 26. | VIN_OP         | 24.0 V       | Op_point | Vin operating point                                                                        |
| 27. | Vout p-p       | 4.25 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 28. | Cin Pd         | 3.277 mW     | Power    | Input capacitor power dissipation                                                          |
| 29. | Cout Pd        | 243.642 μW   | Power    | Output capacitor power dissipation                                                         |
| 30. | Diode Pd       | 1.413 W      | Power    | Diode power dissipation                                                                    |
| 31. | IC Pd          | 1.99 W       | Power    | IC power dissipation                                                                       |
| 32. | L Pd           | 519.75 mW    | Power    | Inductor power dissipation                                                                 |
| 33. | Total Pd       | 3.927 W      | Power    | Total Power Dissipation                                                                    |
| 34. | Vout Tolerance | 5.364 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value    | Description            |
|----|---------|----------|------------------------|
| 1. | Iout    | 5.0      | Maximum Output Current |
| 2. | VinMax  | 24.0     | Maximum input voltage  |
| 3. | VinMin  | 13.0     | Minimum input voltage  |
| 4. | Vout    | 7.4      | Output Voltage         |
| 5. | base_pn | TPS54531 | Base Product Number    |
| 6. | source  | DC       | Input Source Type      |
| 7. | Ta      | 30.0     | Ambient temperature    |

## Design Assistance

1. **TPS54531** Product Folder : <http://www.ti.com/product/TPS54531> : contains the data sheet and other resources.

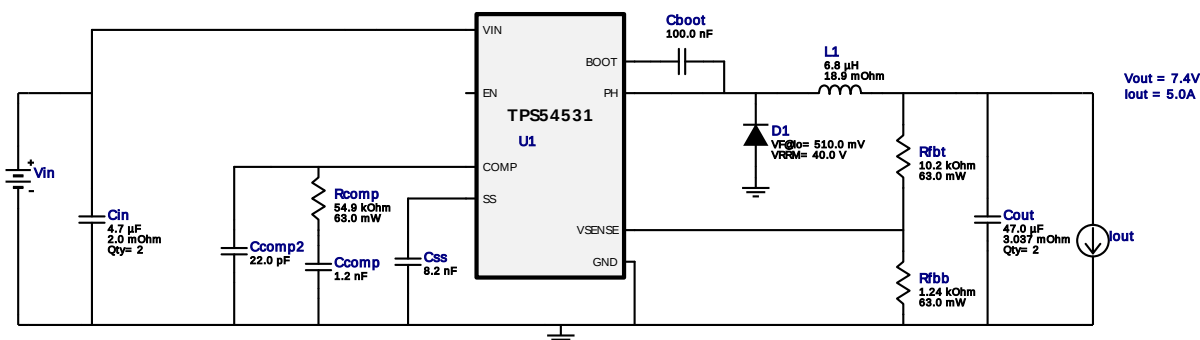


Vout = 7.4V  
Iout = 5.0A

Device = TPS54531DDAR  
Topology = Buck  
Created = 8/22/16 12:31:23 PM  
BOM Cost = \$2.90  
BOM Count = 14  
Total Pd = 3.93W

## WEBENCH® Design Report

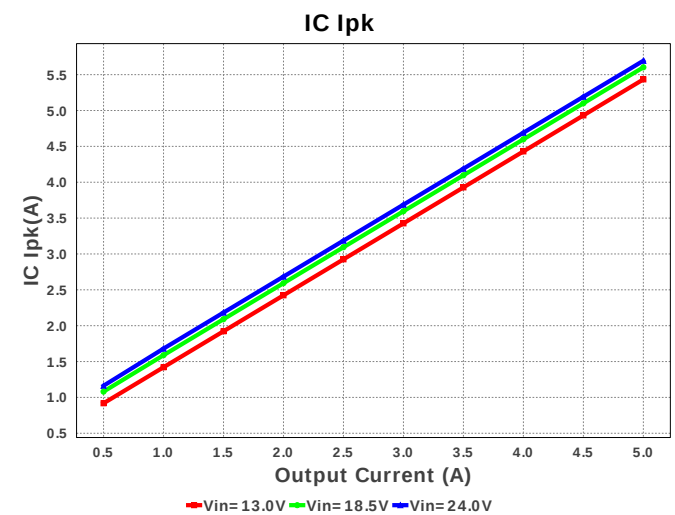
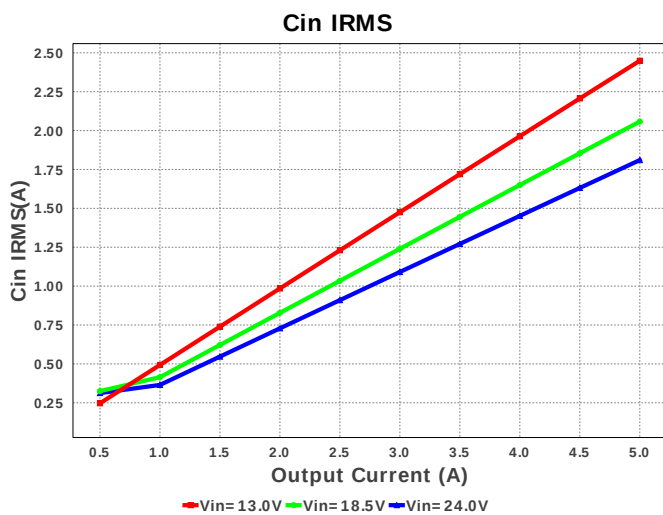
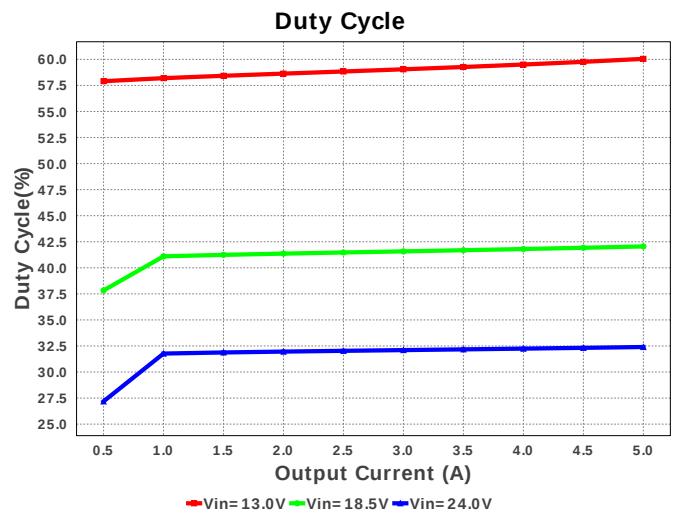
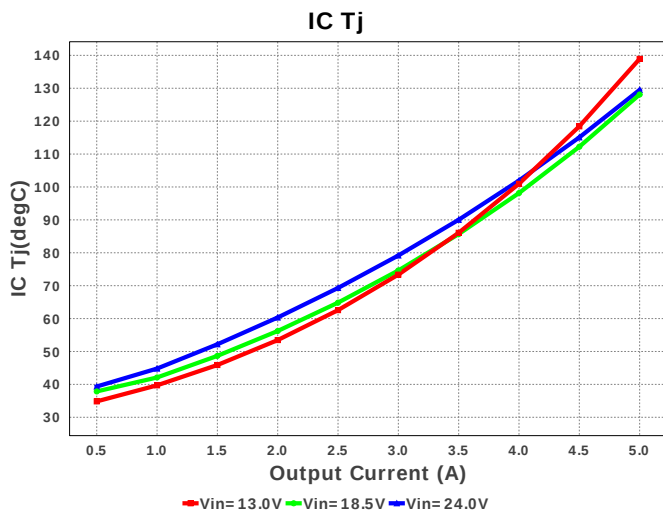
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TPS54531DDAR 13.0V-24.0V to 7.40V @ 5.0A

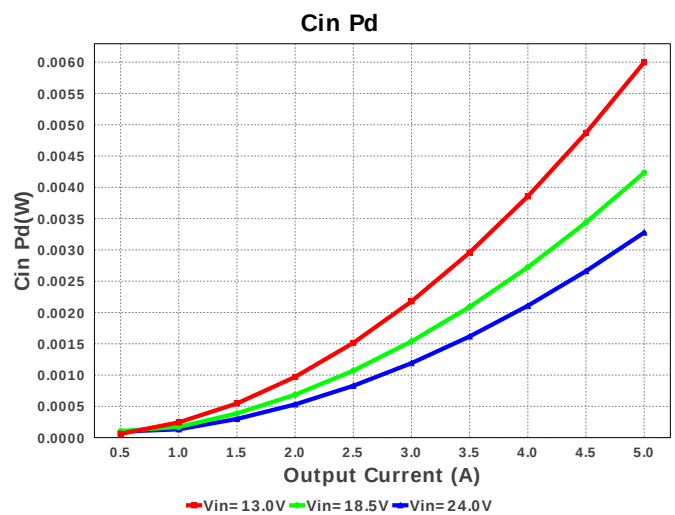
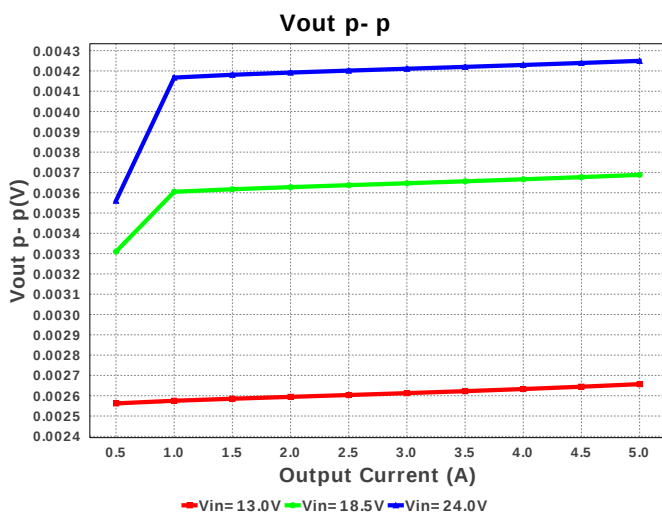
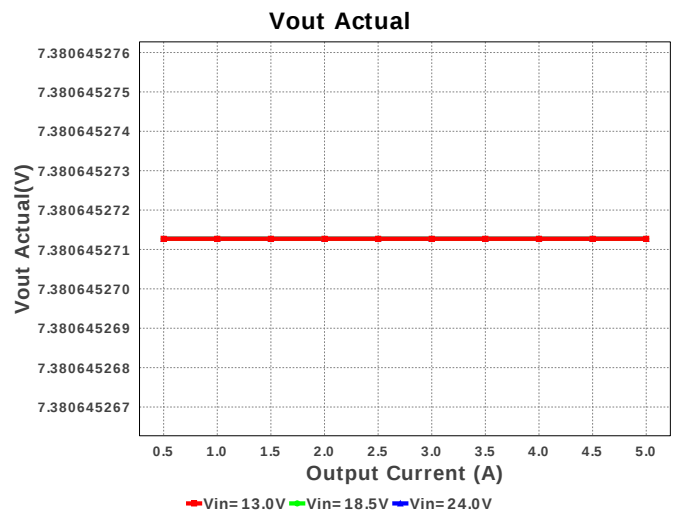
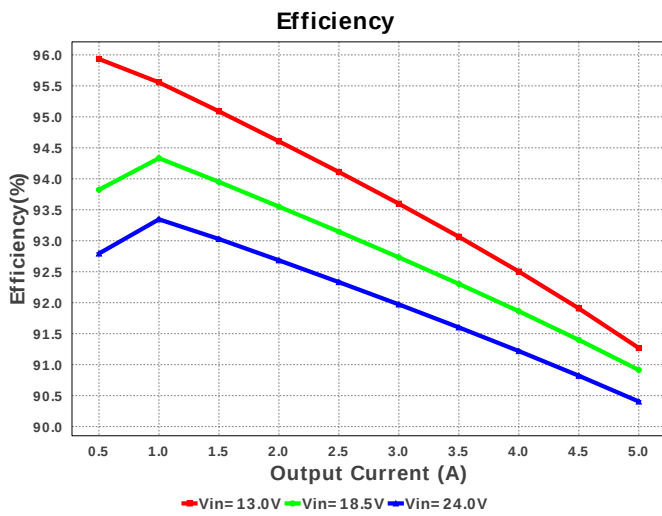
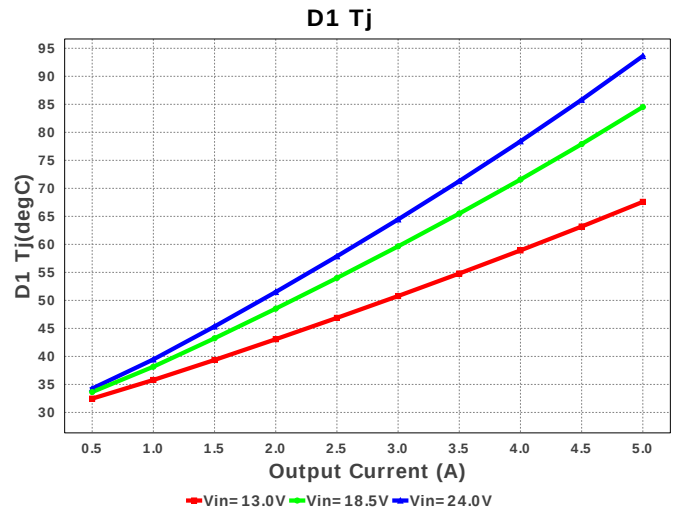
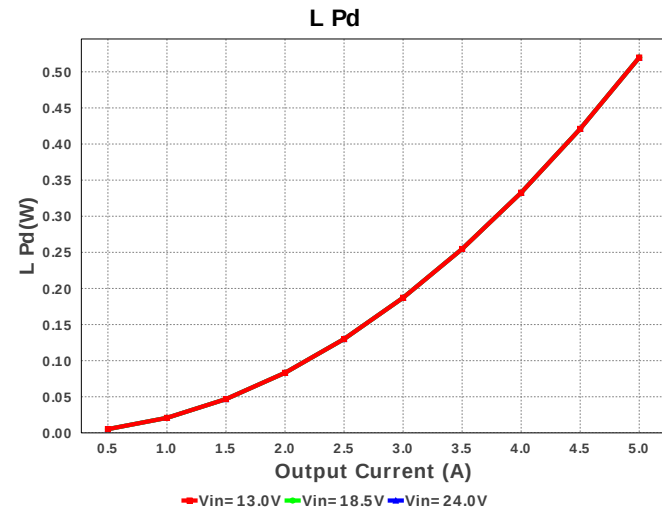


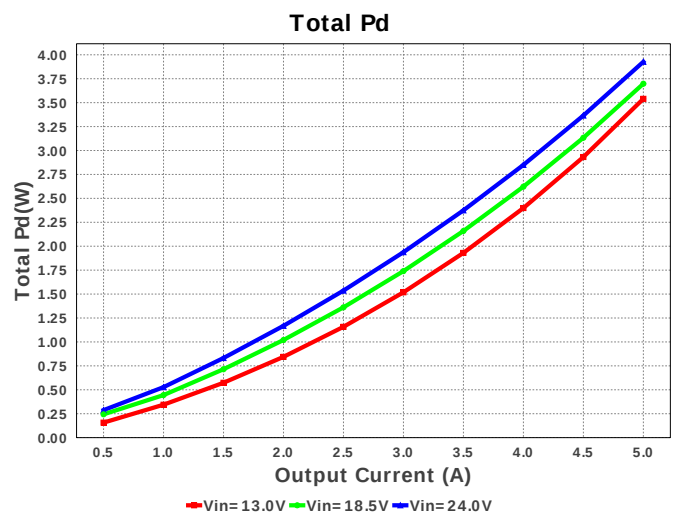
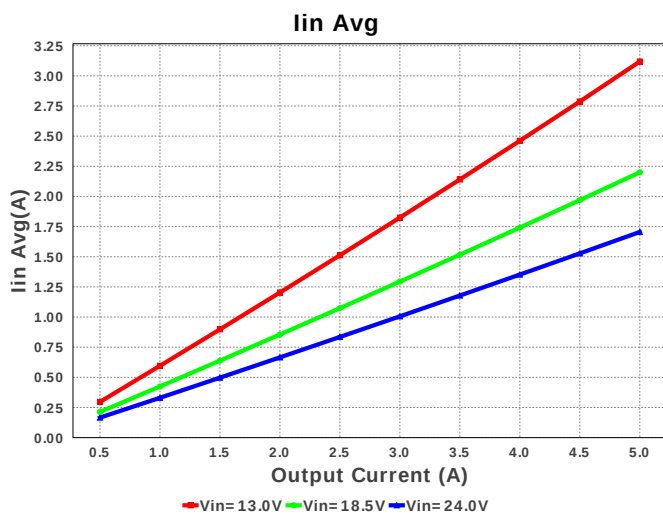
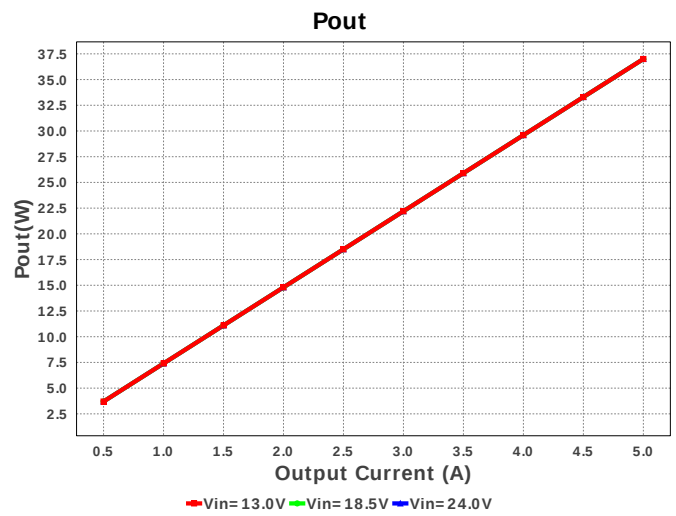
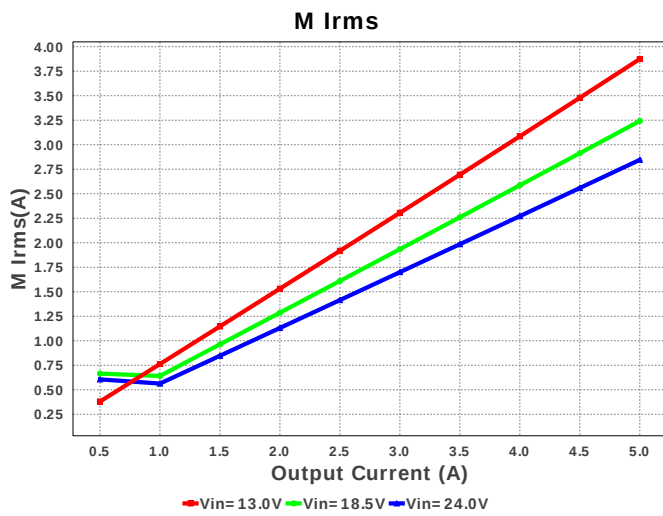
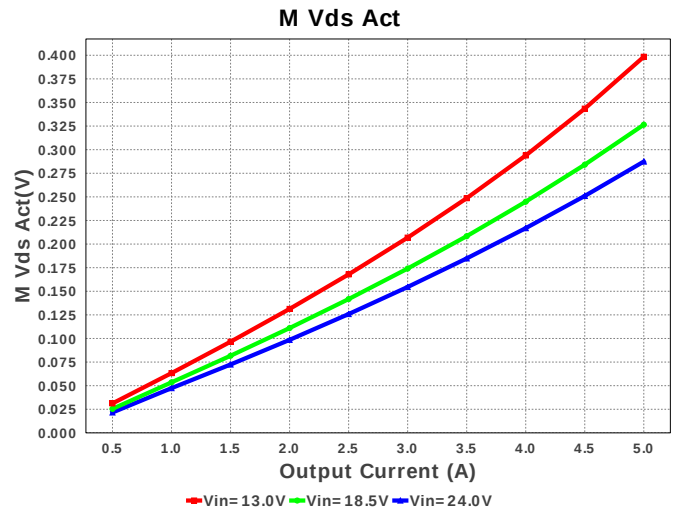
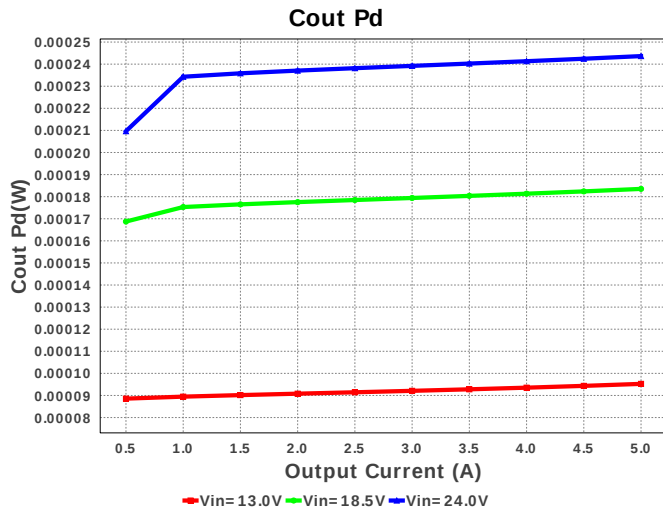
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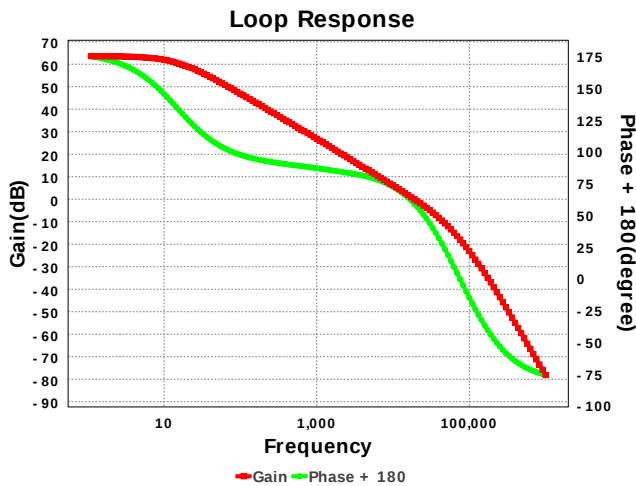
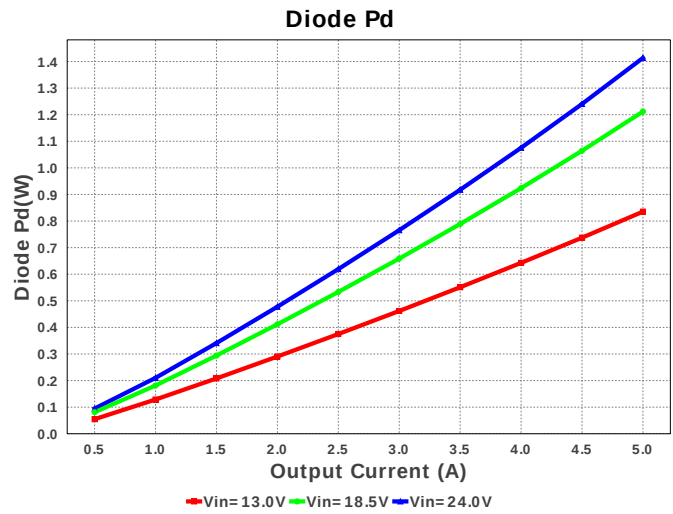
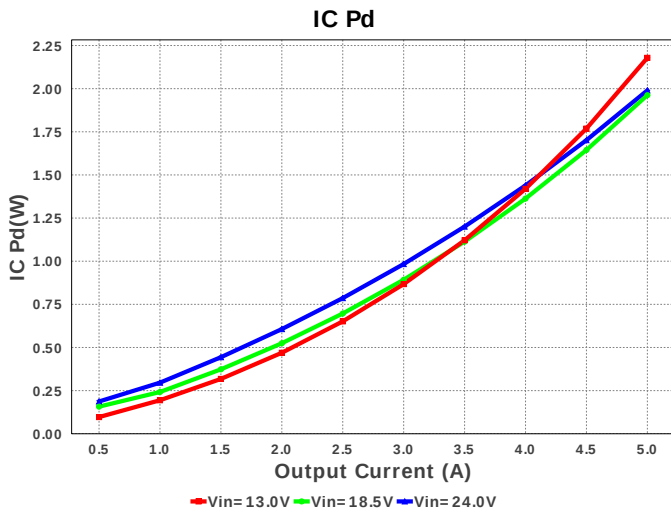
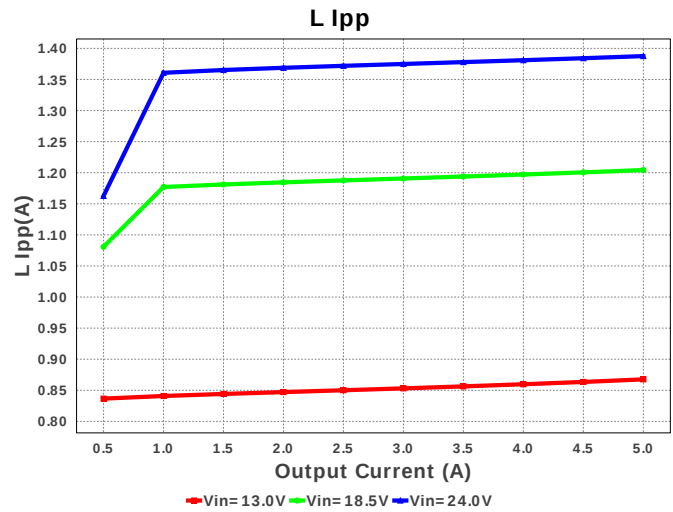
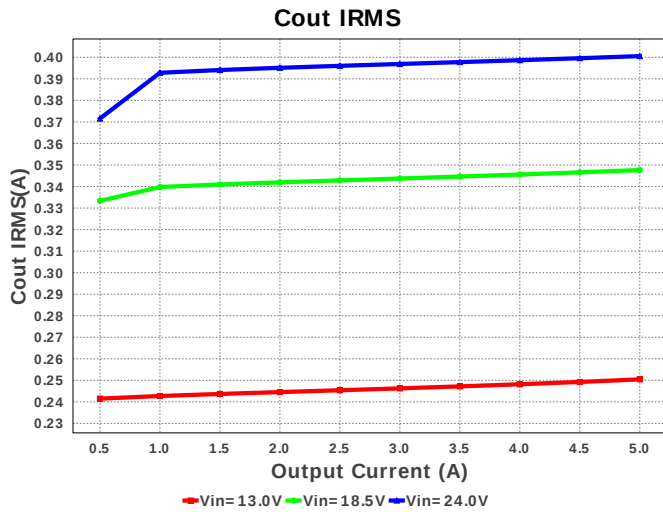
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                        | Qty | Price  | Footprint                   |
|-----|--------|---------------------------|--------------------------------------|-------------------------------------------------------------------|-----|--------|-----------------------------|
| 1.  | Cboot  | MuRata                    | GRM155R61A104KA01D<br>Series= X5R    | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |
| 2.  | Ccomp  | Samsung Electro-Mechanics | CL21C122JBFNNWE<br>Series= C0G/NP0   | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | 0805 7 mm <sup>2</sup>      |
| 3.  | Ccomp2 | Kemet                     | C0805C220K3GACTU<br>Series= C0G/NP0  | Cap= 22.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | 0805 7 mm <sup>2</sup>      |
| 4.  | Cin    | MuRata                    | GRM32ER71H475KA88L<br>Series= X7R    | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.35 A       | 2   | \$0.19 | 1210 15 mm <sup>2</sup>     |
| 5.  | 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 | 2   | \$0.24 | 1210_280 15 mm <sup>2</sup> |
| 6.  | Css    | MuRata                    | GRM033R61A822KA01D<br>Series= X5R    | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | 0201 2 mm <sup>2</sup>      |
| 7.  | D1     | Vishay-Semiconductor      | 50WQ04FNPBF                          | VF@Io= 510.0 mV<br>VRRM= 40.0 V                                   | 1   | \$0.40 | DPAK 102 mm <sup>2</sup>    |
| 8.  | L1     | Coilcraft                 | XAL6060-682MEB                       | L= 6.8 µH<br>DCR= 18.9 mOhm                                       | 1   | \$0.82 | XAL6060 72 mm <sup>2</sup>  |
| 9.  | Rcomp  | Vishay-Dale               | CRCW040254K9FKED<br>Series= CRCW..e3 | Res= 54.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |
| 10. | Rfbb   | Vishay-Dale               | CRCW04021K24FKED<br>Series= CRCW..e3 | Res= 1.24 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | 0402 3 mm <sup>2</sup>      |

| #   | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                           |
|-----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------|
| 11. | Rfbt | Vishay-Dale       | CRCW040210K2FKED<br>Series= CRCW..e3 | Res= 10.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm²      |
| 12. | U1   | Texas Instruments | TPS54531DDAR                         | Switcher                                            | 1   | \$0.75 |  DDA0008E 57 mm² |









## Operating Values

| #   | Name      | Value                 | Category | Description                             |
|-----|-----------|-----------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS  | 1.81 A                | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS | 400.561 mA            | Current  | Output capacitor RMS ripple current     |
| 3.  | IC Ipk    | 5.694 A               | Current  | Peak switch current in IC               |
| 4.  | Iin Avg   | 1.705 A               | Current  | Average input current                   |
| 5.  | L Ipp     | 1.388 A               | Current  | Peak-to-peak inductor ripple current    |
| 6.  | M1 Irms   | 2.846 A               | Current  | Q Iavg                                  |
| 7.  | BOM Count | 14                    | General  | Total Design BOM count                  |
| 8.  | FootPrint | 317.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |
| 9.  | Frequency | 570.0 kHz             | General  | Switching frequency                     |
| 10. | M Vds Act | 287.403 mV            | General  | Voltage drop across the MosFET          |
| 11. | Mode      | CCM                   | General  | Conduction Mode                         |

| #   | Name           | Value        | Category | Description                                                                                |
|-----|----------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Pout           | 37.0 W       | General  | Total output power                                                                         |
| 13. | Total BOM      | \$2.9        | General  | Total BOM Cost                                                                             |
| 14. | D1 Tj          | 93.607 degC  | Op_Point | D1 junction temperature                                                                    |
| 15. | Low Freq Gain  | 63.565 dB    | Op_Point | Gain at 10Hz                                                                               |
| 16. | Vout Actual    | 7.381 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 17. | Vout OP        | 7.4 V        | Op_Point | Operational Output Voltage                                                                 |
| 18. | Cross Freq     | 19.106 kHz   | Op_point | Bode plot crossover frequency                                                              |
| 19. | Duty Cycle     | 32.399 %     | Op_point | Duty cycle                                                                                 |
| 20. | Efficiency     | 90.405 %     | Op_point | Steady state efficiency                                                                    |
| 21. | Gain Marg      | -17.974 dB   | Op_point | Bode Plot Gain Margin                                                                      |
| 22. | IC Tj          | 129.512 degC | Op_point | IC junction temperature                                                                    |
| 23. | ICThetaJA      | 50.0 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 24. | IOUT_OP        | 5.0 A        | Op_point | Iout operating point                                                                       |
| 25. | Phase Marg     | 59.46 deg    | Op_point | Bode Plot Phase Margin                                                                     |
| 26. | VIN_OP         | 24.0 V       | Op_point | Vin operating point                                                                        |
| 27. | Vout p-p       | 4.25 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 28. | Cin Pd         | 3.277 mW     | Power    | Input capacitor power dissipation                                                          |
| 29. | Cout Pd        | 243.642 μW   | Power    | Output capacitor power dissipation                                                         |
| 30. | Diode Pd       | 1.413 W      | Power    | Diode power dissipation                                                                    |
| 31. | IC Pd          | 1.99 W       | Power    | IC power dissipation                                                                       |
| 32. | L Pd           | 519.75 mW    | Power    | Inductor power dissipation                                                                 |
| 33. | Total Pd       | 3.927 W      | Power    | Total Power Dissipation                                                                    |
| 34. | Vout Tolerance | 5.364 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value    | Description            |
|----|---------|----------|------------------------|
| 1. | Iout    | 5.0      | Maximum Output Current |
| 2. | VinMax  | 24.0     | Maximum input voltage  |
| 3. | VinMin  | 13.0     | Minimum input voltage  |
| 4. | Vout    | 7.4      | Output Voltage         |
| 5. | base_pn | TPS54531 | Base Product Number    |
| 6. | source  | DC       | Input Source Type      |
| 7. | Ta      | 30.0     | Ambient temperature    |

## Design Assistance

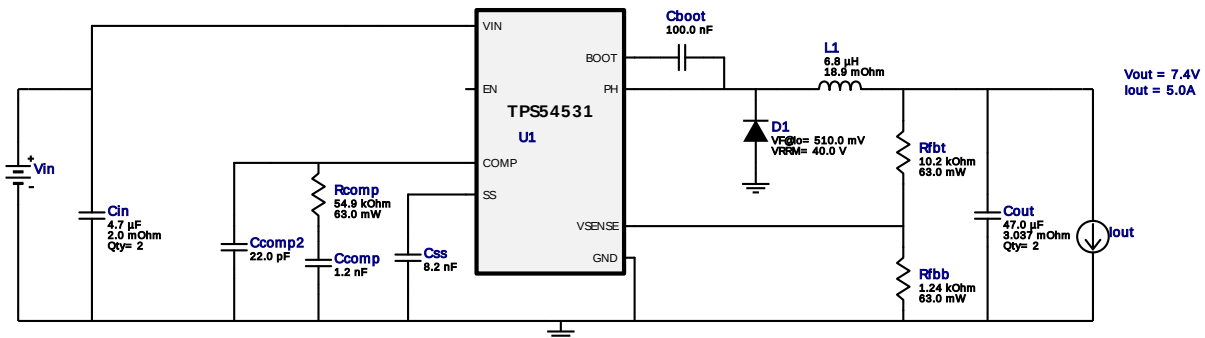
1. **TPS54531** Product Folder : <http://www.ti.com/product/TPS54531> : contains the data sheet and other resources.

Vout = 7.4V  
Iout = 5.0A

Device = TPS54531DDAR  
Topology = Buck  
Created = 8/22/16 12:31:23 PM  
BOM Cost = \$2.90  
BOM Count = 14  
Total Pd = 3.93W

# WEBENCH<sup>®</sup> Design Report

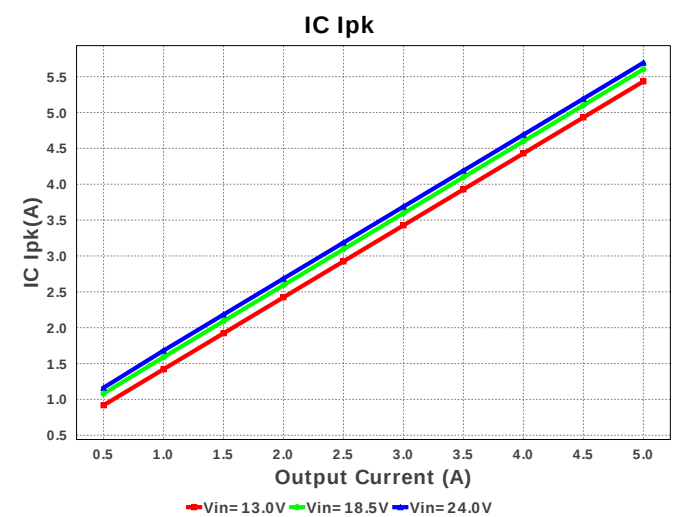
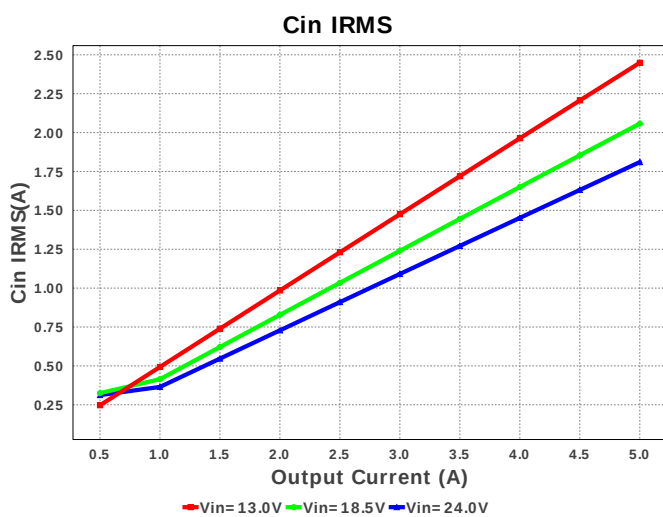
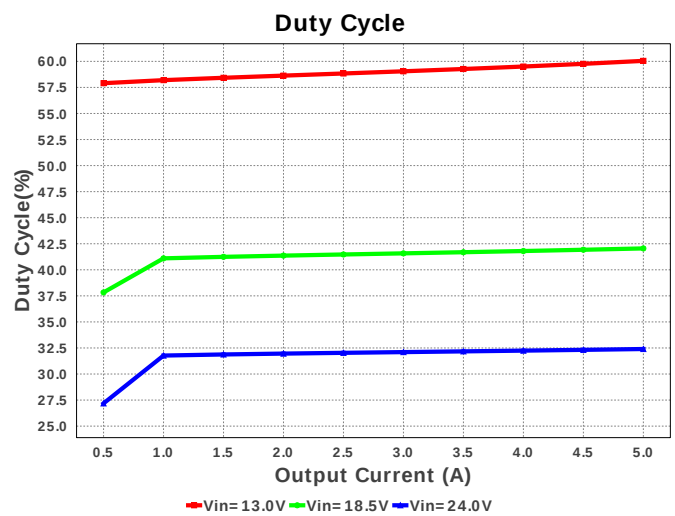
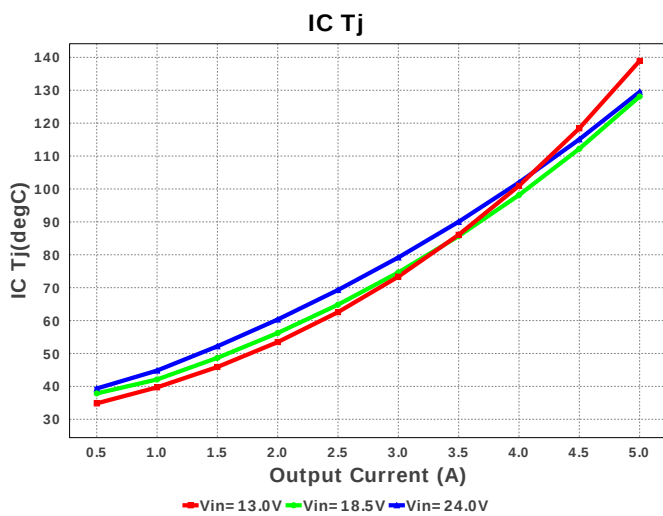
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TPS54531DDAR 13.0V-24.0V to 7.40V @ 5.0A

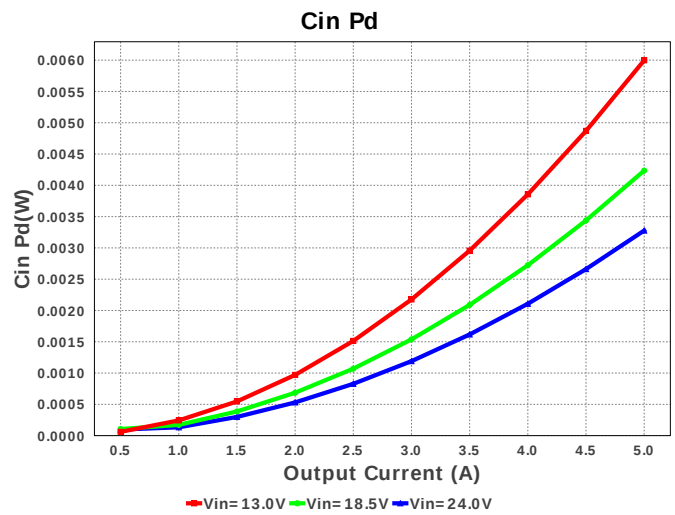
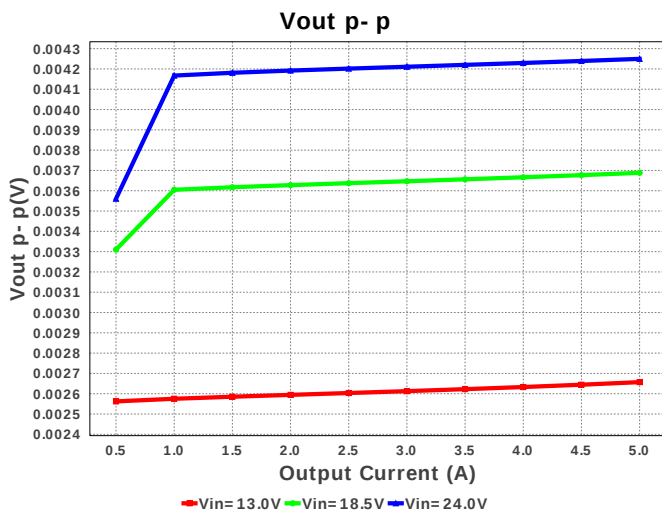
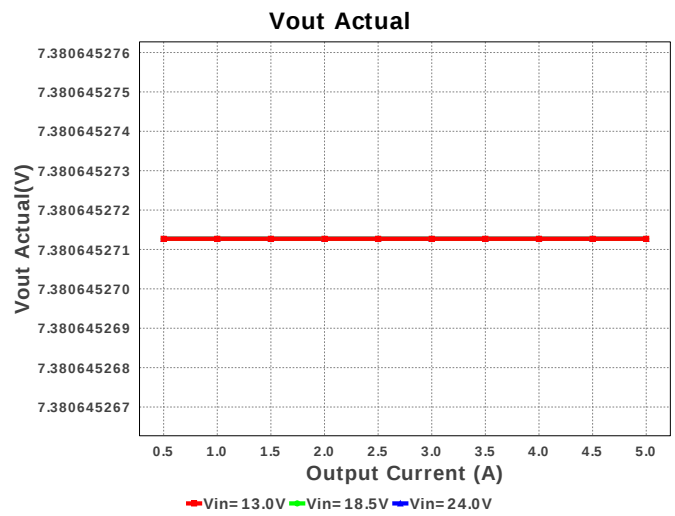
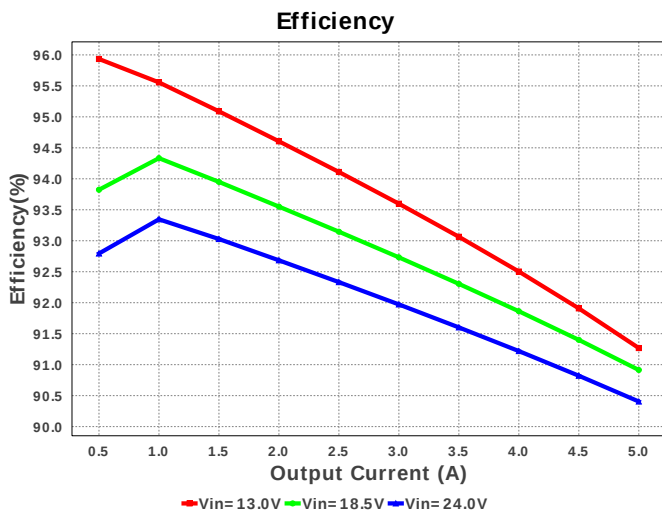
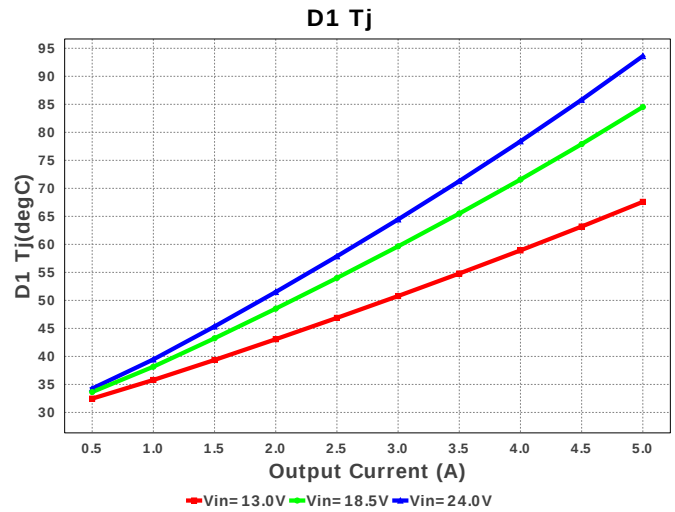
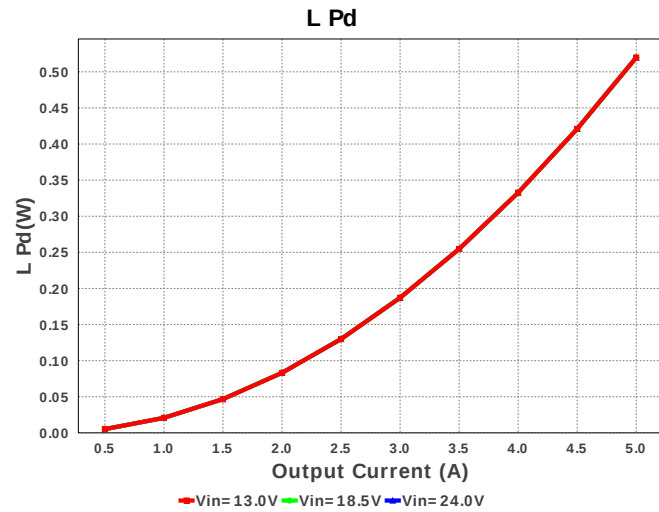


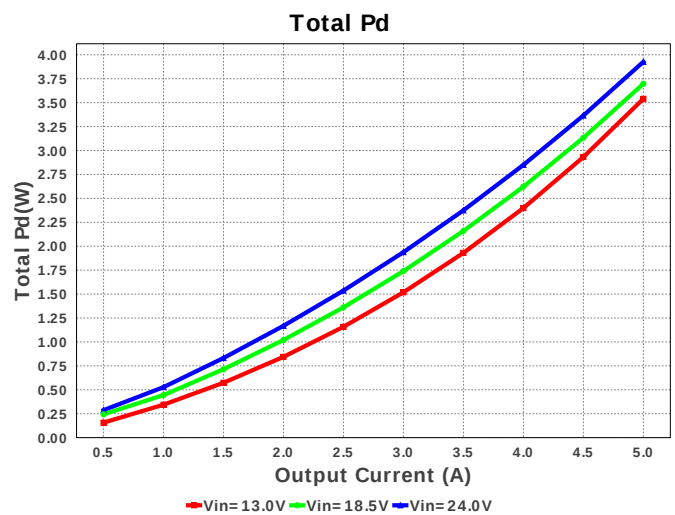
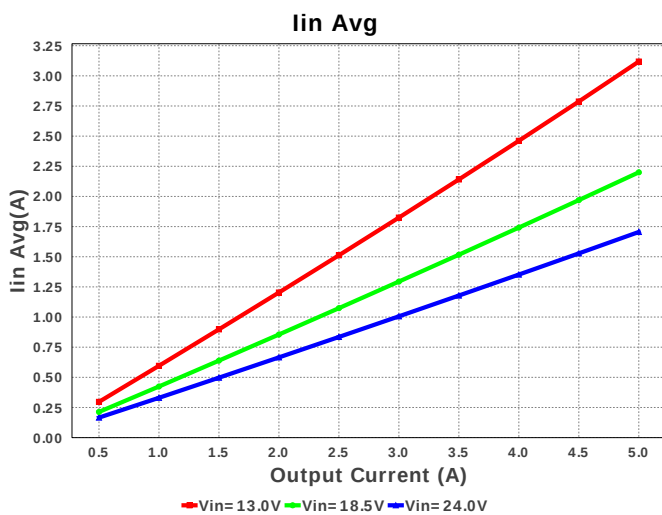
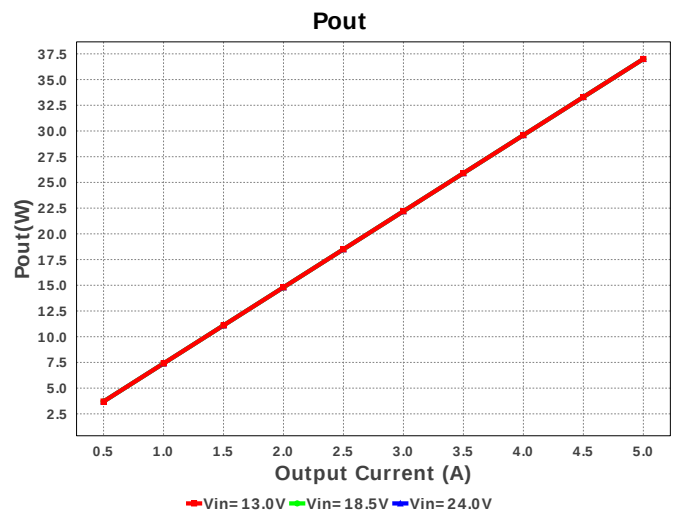
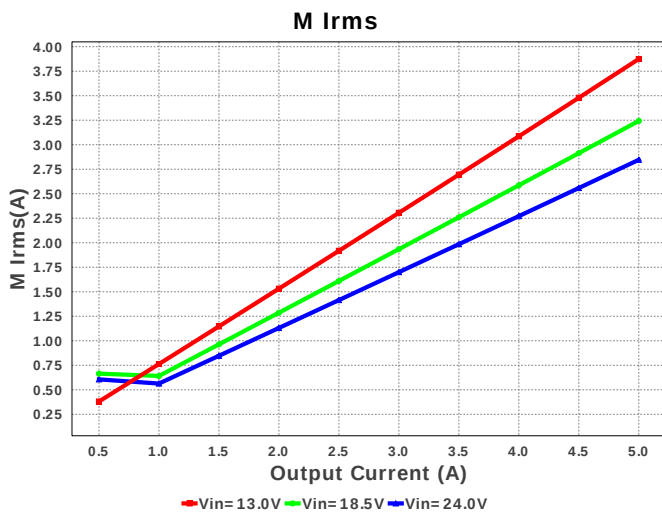
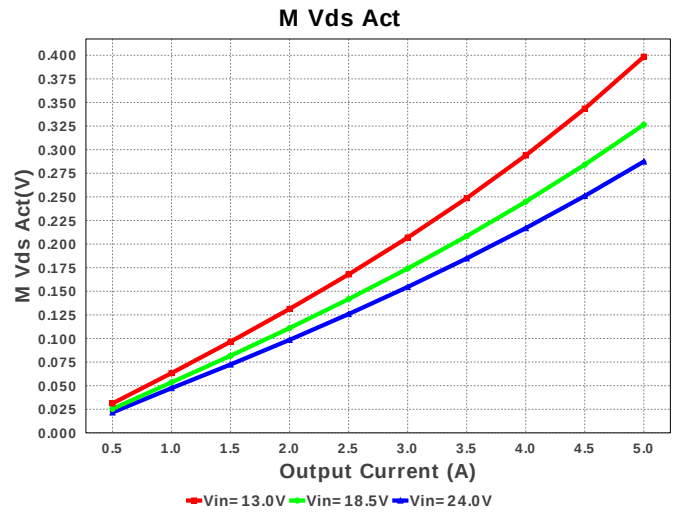
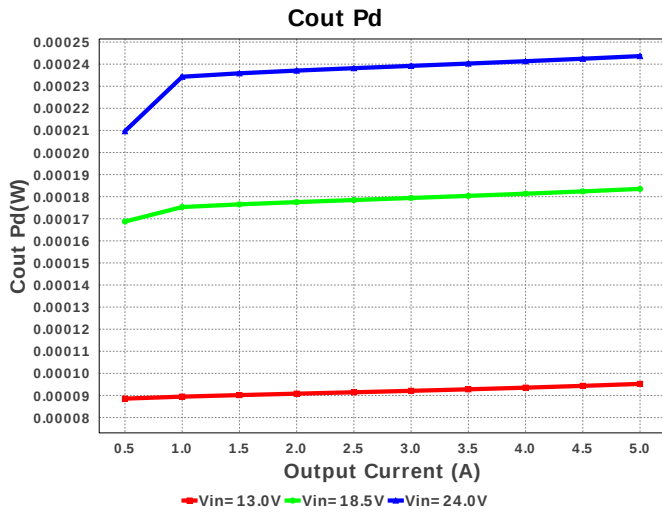
## Electrical BOM

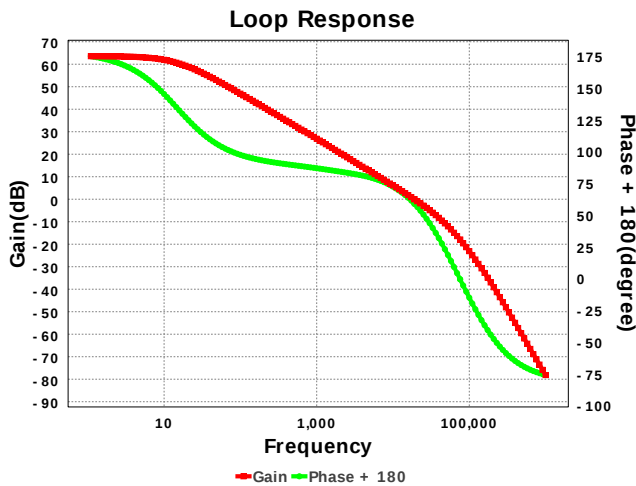
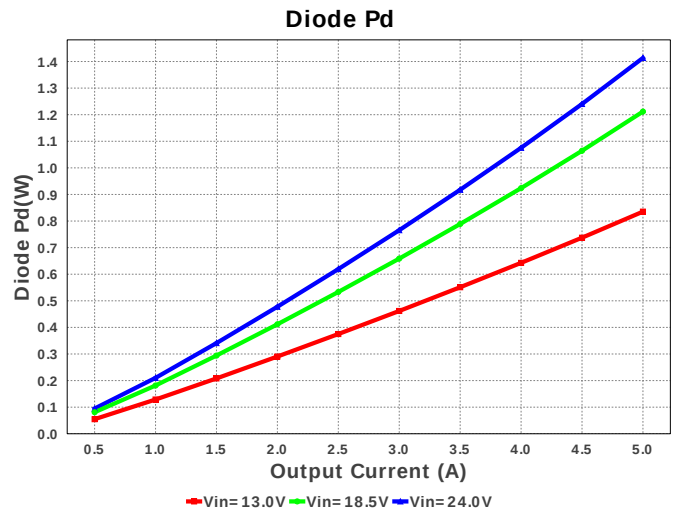
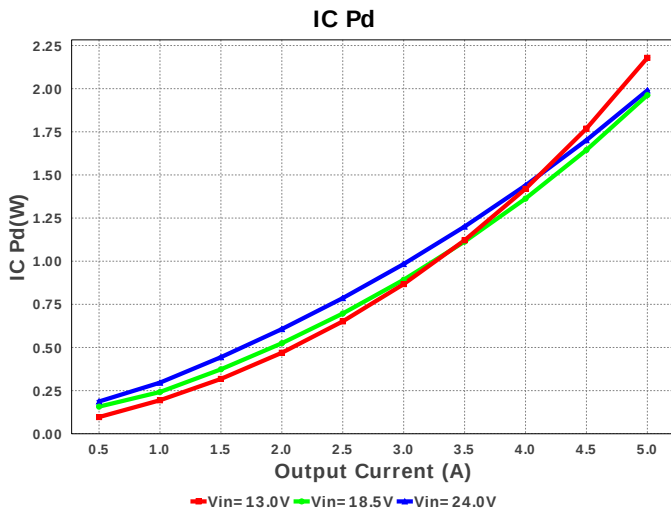
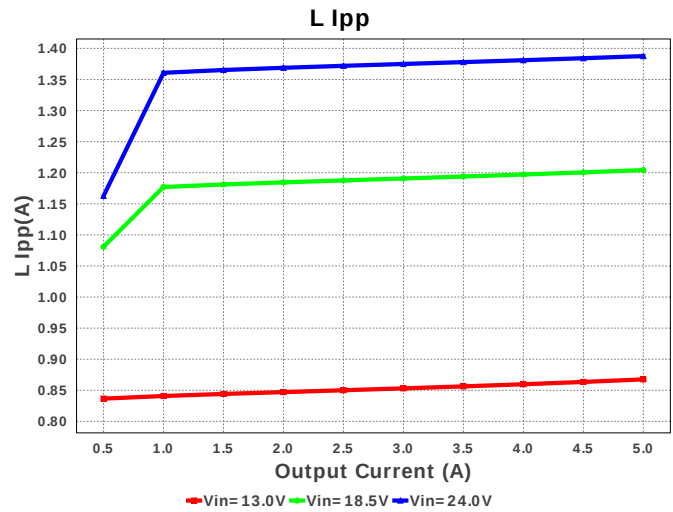
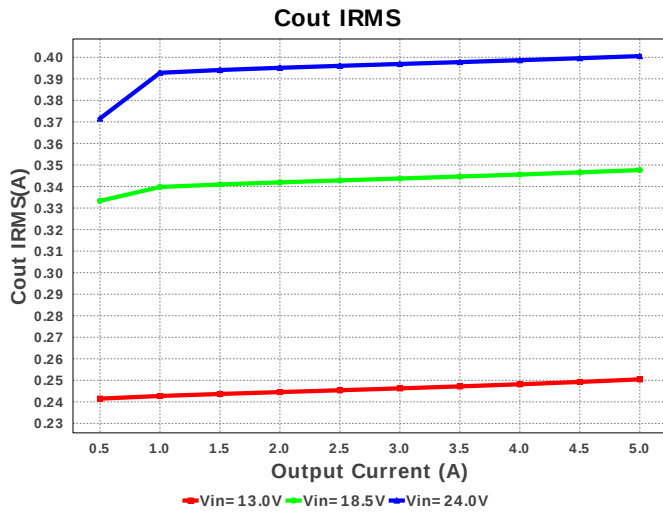
| #   | Name   | Manufacturer              | Part Number                          | Properties                                                        | Qty | Price  | Footprint                                                                                                            |
|-----|--------|---------------------------|--------------------------------------|-------------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------|
| 1.  | Cboot  | MuRata                    | GRM155R61A104KA01D<br>Series= X5R    | Cap= 100.0 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                       | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>       |
| 2.  | Ccomp  | Samsung Electro-Mechanics | CL21C122JBFNWWE<br>Series= C0G/NP0   | Cap= 1.2 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>      |
| 3.  | Ccomp2 | Kemet                     | C0805C220K3GACTU<br>Series= C0G/NP0  | Cap= 22.0 pF<br>VDC= 25.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>      |
| 4.  | Cin    | MuRata                    | GRM32ER71H475KA88L<br>Series= X7R    | Cap= 4.7 uF<br>ESR= 2.0 mOhm<br>VDC= 50.0 V<br>IRMS= 5.35 A       | 2   | \$0.19 | <br>1210 15 mm <sup>2</sup>     |
| 5.  | 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 | 2   | \$0.24 | <br>1210_280 15 mm <sup>2</sup> |
| 6.  | Css    | MuRata                    | GRM033R61A822KA01D<br>Series= X5R    | Cap= 8.2 nF<br>VDC= 10.0 V<br>IRMS= 0.0 A                         | 1   | \$0.01 | <br>0201 2 mm <sup>2</sup>      |
| 7.  | D1     | Vishay-Semiconductor      | 50WQ04FNPBF                          | VF@Io= 510.0 mV<br>VRRM= 40.0 V                                   | 1   | \$0.40 | <br>DPAK 102 mm <sup>2</sup>    |
| 8.  | L1     | Coilcraft                 | XAL6060-682MEB                       | L= 6.8 uH<br>DCR= 18.9 mOhm                                       | 1   | \$0.82 | <br>XAL6060 72 mm <sup>2</sup>  |
| 9.  | Rcomp  | Vishay-Dale               | CRCW040254K9FKED<br>Series= CRCW..e3 | Res= 54.9 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>      |
| 10. | Rfbb   | Vishay-Dale               | CRCW04021K24FKED<br>Series= CRCW..e3 | Res= 1.24 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%               | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>      |

| #   | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                           |
|-----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------|
| 11. | Rf1t | Vishay-Dale       | CRCW040210K2FKED<br>Series= CRCW..e3 | Res= 10.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm²      |
| 12. | U1   | Texas Instruments | TPS54531DDAR                         | Switcher                                            | 1   | \$0.75 |  DDA0008E 57 mm² |









## Operating Values

| #   | Name      | Value                 | Category | Description                             |
|-----|-----------|-----------------------|----------|-----------------------------------------|
| 1.  | Cin IRMS  | 1.81 A                | Current  | Input capacitor RMS ripple current      |
| 2.  | Cout IRMS | 400.561 mA            | Current  | Output capacitor RMS ripple current     |
| 3.  | IC Ipk    | 5.694 A               | Current  | Peak switch current in IC               |
| 4.  | Iin Avg   | 1.705 A               | Current  | Average input current                   |
| 5.  | L Ipp     | 1.388 A               | Current  | Peak-to-peak inductor ripple current    |
| 6.  | M1 Irms   | 2.846 A               | Current  | Q Iavg                                  |
| 7.  | BOM Count | 14                    | General  | Total Design BOM count                  |
| 8.  | FootPrint | 317.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components |
| 9.  | Frequency | 570.0 kHz             | General  | Switching frequency                     |
| 10. | M Vds Act | 287.403 mV            | General  | Voltage drop across the MosFET          |
| 11. | Mode      | CCM                   | General  | Conduction Mode                         |

| #   | Name           | Value        | Category | Description                                                                                |
|-----|----------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Pout           | 37.0 W       | General  | Total output power                                                                         |
| 13. | Total BOM      | \$2.9        | General  | Total BOM Cost                                                                             |
| 14. | D1 Tj          | 93.607 degC  | Op_Point | D1 junction temperature                                                                    |
| 15. | Low Freq Gain  | 63.565 dB    | Op_Point | Gain at 10Hz                                                                               |
| 16. | Vout Actual    | 7.381 V      | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 17. | Vout OP        | 7.4 V        | Op_Point | Operational Output Voltage                                                                 |
| 18. | Cross Freq     | 19.106 kHz   | Op_point | Bode plot crossover frequency                                                              |
| 19. | Duty Cycle     | 32.399 %     | Op_point | Duty cycle                                                                                 |
| 20. | Efficiency     | 90.405 %     | Op_point | Steady state efficiency                                                                    |
| 21. | Gain Marg      | -17.974 dB   | Op_point | Bode Plot Gain Margin                                                                      |
| 22. | IC Tj          | 129.512 degC | Op_point | IC junction temperature                                                                    |
| 23. | ICThetaJA      | 50.0 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 24. | IOUT_OP        | 5.0 A        | Op_point | Iout operating point                                                                       |
| 25. | Phase Marg     | 59.46 deg    | Op_point | Bode Plot Phase Margin                                                                     |
| 26. | VIN_OP         | 24.0 V       | Op_point | Vin operating point                                                                        |
| 27. | Vout p-p       | 4.25 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 28. | Cin Pd         | 3.277 mW     | Power    | Input capacitor power dissipation                                                          |
| 29. | Cout Pd        | 243.642 μW   | Power    | Output capacitor power dissipation                                                         |
| 30. | Diode Pd       | 1.413 W      | Power    | Diode power dissipation                                                                    |
| 31. | IC Pd          | 1.99 W       | Power    | IC power dissipation                                                                       |
| 32. | L Pd           | 519.75 mW    | Power    | Inductor power dissipation                                                                 |
| 33. | Total Pd       | 3.927 W      | Power    | Total Power Dissipation                                                                    |
| 34. | Vout Tolerance | 5.364 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value    | Description            |
|----|---------|----------|------------------------|
| 1. | Iout    | 5.0      | Maximum Output Current |
| 2. | VinMax  | 24.0     | Maximum input voltage  |
| 3. | VinMin  | 13.0     | Minimum input voltage  |
| 4. | Vout    | 7.4      | Output Voltage         |
| 5. | base_pn | TPS54531 | Base Product Number    |
| 6. | source  | DC       | Input Source Type      |
| 7. | Ta      | 30.0     | Ambient temperature    |

## Design Assistance

1. **TPS54531** Product Folder : <http://www.ti.com/product/TPS54531> : contains the data sheet and other resources.

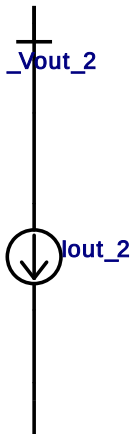
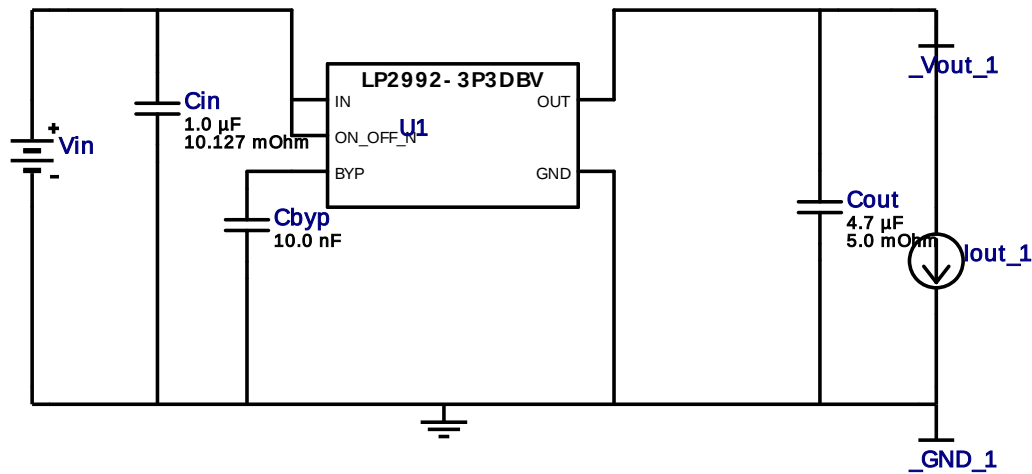


Vout = 3.3V  
Iout = 0.02A

Device = LP2992AIM5-3.3/NOPB  
Topology = LDO  
Created = 8/22/16 12:31:24 PM  
BOM Cost = \$0.42  
BOM Count = 5  
Total Pd = 0.2W

## WEBENCH® Design Report

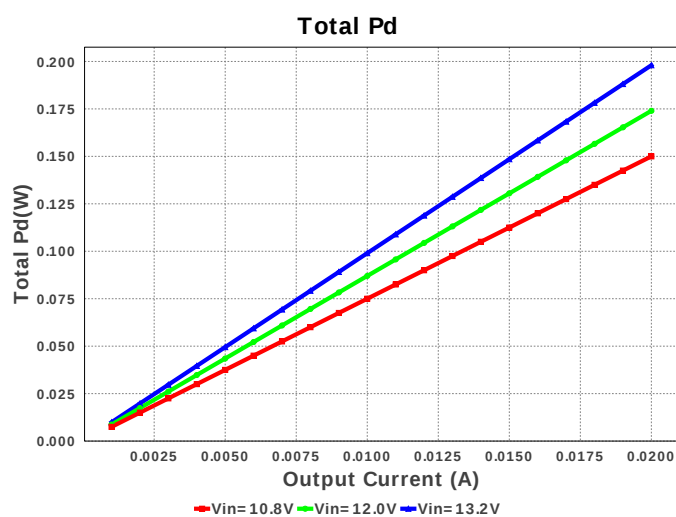
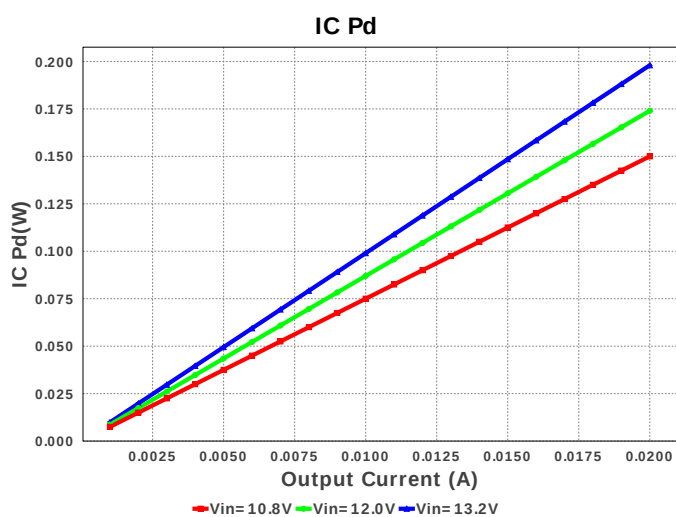
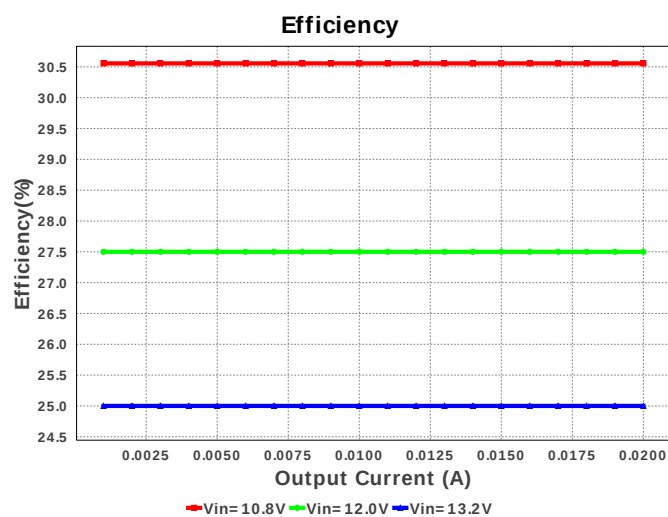
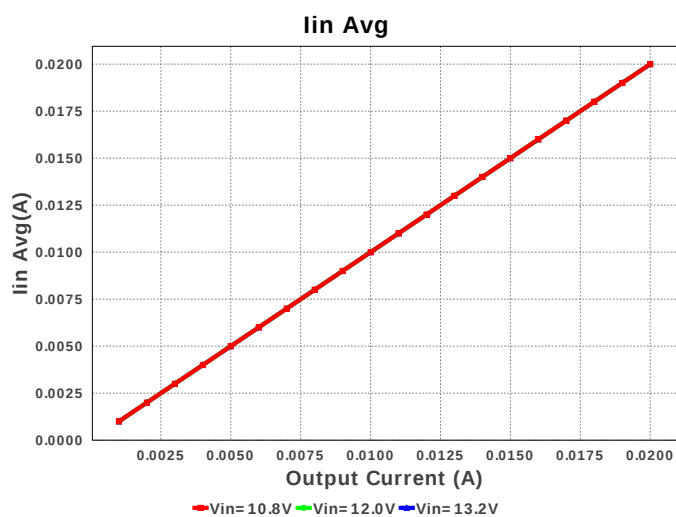
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LP2992AIM5-3.3/NOPB 10.8V-13.2V to 3.30V @ 0.02A

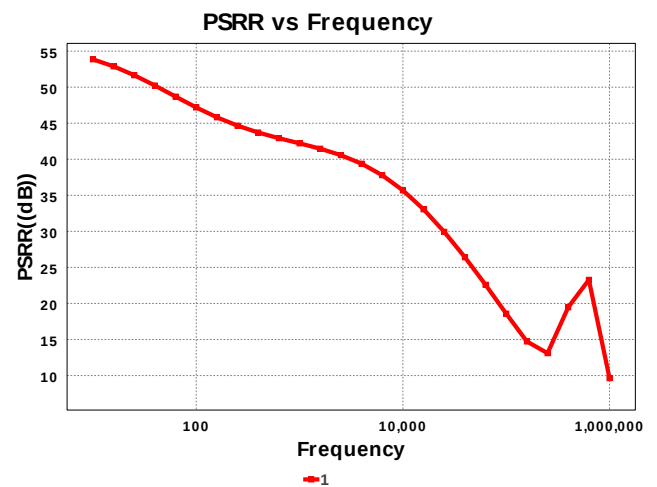
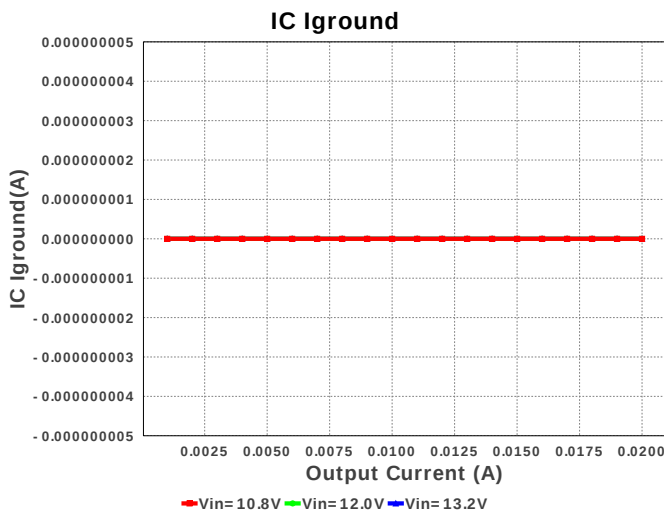
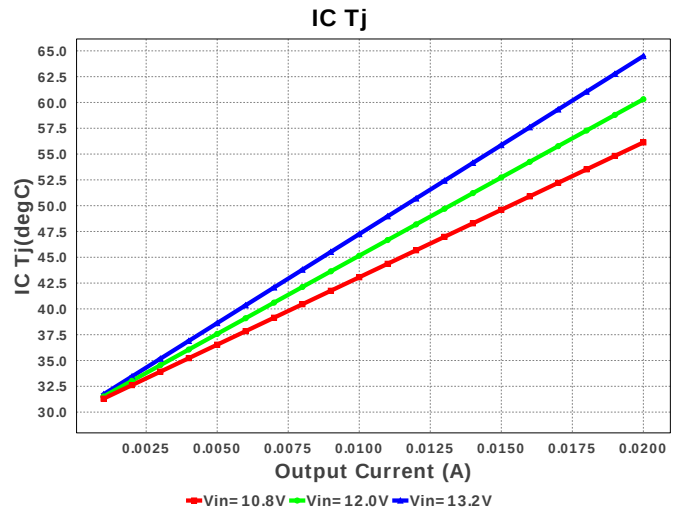
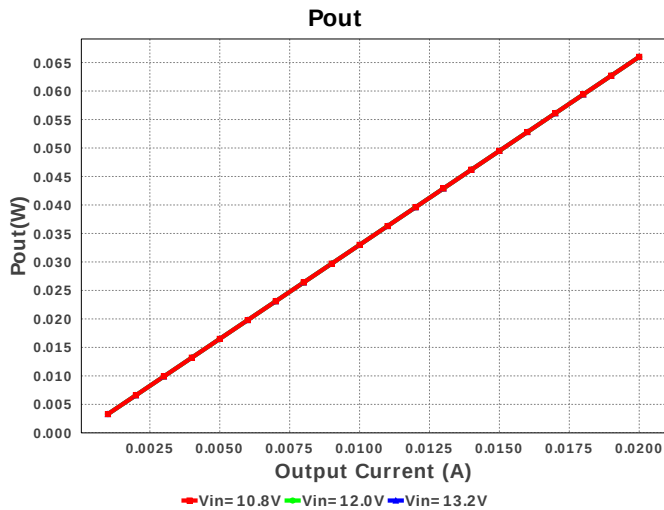


### Electrical BOM

| #  | Name | Manufacturer | Part Number                       | Properties                                                        | Qty | Price  | Footprint              |
|----|------|--------------|-----------------------------------|-------------------------------------------------------------------|-----|--------|------------------------|
| 1. | Cbyp | MuRata       | GRM155R61C103KA01D<br>Series= X5R | Cap= 10.0 nF<br>VDC= 16.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | 0402 3 mm <sup>2</sup> |
| 2. | Cin  | MuRata       | GRM188R61C105KA93D<br>Series= X5R | Cap= 1.0 uF<br>ESR= 10.127 mOhm<br>VDC= 16.0 V<br>IRMS= 994.63 mA | 1   | \$0.01 | 0603 5 mm <sup>2</sup> |

| #  | Name   | Manufacturer      | Part Number                          | Properties                                                | Qty | Price  | Footprint                                                                                                       |
|----|--------|-------------------|--------------------------------------|-----------------------------------------------------------|-----|--------|-----------------------------------------------------------------------------------------------------------------|
| 3. | Cout   | MuRata            | GRM188R60J475KE19D<br>Series= X5R    | Cap= 4.7 uF<br>ESR= 5.0 mOhm<br>VDC= 6.3 V<br>IRMS= 2.0 A | 1   | \$0.01 |  0603 5 mm <sup>2</sup>      |
| 4. | Rerror | Vishay-Dale       | CRCW0402332KFKED<br>Series= CRCW..e3 | Res= 332.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%      | 1   | \$0.01 |  0402 3 mm <sup>2</sup>      |
| 5. | U1     | Texas Instruments | LP2992AIM5-3.3/NOPB                  | Switcher                                                  | 1   | \$0.38 |  DBV0005A 15 mm <sup>2</sup> |





## Operating Values

| #   | Name                   | Value                | Category | Description                                                                                |
|-----|------------------------|----------------------|----------|--------------------------------------------------------------------------------------------|
| 1.  | IC Iground             | 0.0 A                | Current  | IC ground current                                                                          |
| 2.  | Iin Avg                | 20.0 mA              | Current  | Average input current                                                                      |
| 3.  | BOM Count              | 5                    | General  | Total Design BOM count                                                                     |
| 4.  | FootPrint              | 30.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components                                                    |
| 5.  | IC Tolerance           | 82.5 mV              | General  | IC Feedback Tolerance                                                                      |
| 6.  | Output Noise RMS       | 30.0 $\mu$ V         | General  | Noise RMS                                                                                  |
| 7.  | Pout                   | 66.0 mW              | General  | Total output power                                                                         |
| 8.  | Total BOM              | \$0.42               | General  | Total BOM Cost                                                                             |
| 9.  | Vin p-p                | 172.832 mV           | Op_Point | Input Source ripple voltage                                                                |
| 10. | Vout OP                | 0.0 V                | Op_Point | Operational Output Voltage                                                                 |
| 11. | Efficiency             | 25.0 %               | Op_point | Steady state efficiency                                                                    |
| 12. | IC Tj                  | 64.492 degC          | Op_point | IC junction temperature                                                                    |
| 13. | ICThetaJA              | 174.2 degC/W         | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 14. | IOUT_OP                | 20.0 mA              | Op_point | Iout operating point                                                                       |
| 15. | Input Ripple Frequency | 305.746 kHz          | Op_point | Input Source Ripple Frequency for PSRR Calculation                                         |
| 16. | PSRR est.              | -14.663 dB           | Op_point | Power Supply Rejection Ratio estimated                                                     |
| 17. | VIN_OP                 | 13.2 V               | Op_point | Vin operating point                                                                        |
| 18. | Vout p-p               | 31.949 mV            | Op_point | Peak-to-peak output ripple voltage                                                         |
| 19. | IC Pd                  | 198.0 mW             | Power    | IC power dissipation                                                                       |
| 20. | Total Pd               | 198.0 mW             | Power    | Total Power Dissipation                                                                    |
| 21. | Vout Tolerance         | 2.5 %                |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value      | Description            |
|----|---------|------------|------------------------|
| 1. | Iout    | 20.0 m     | Maximum Output Current |
| 2. | VinMax  | 13.2       | Maximum input voltage  |
| 3. | VinMin  | 10.8       | Minimum input voltage  |
| 4. | Vout    | 3.3        | Output Voltage         |
| 5. | base_pn | LP2992-3.3 | Base Product Number    |

| #  | Name   | Value | Description         |
|----|--------|-------|---------------------|
| 6. | source | DC    | Input Source Type   |
| 7. | Ta     | 30.0  | Ambient temperature |

## Design Assistance

- 1.
2. **LP2992-3.3** Product Folder : <http://www.ti.com/product/LP2992> : contains the data sheet and other resources.

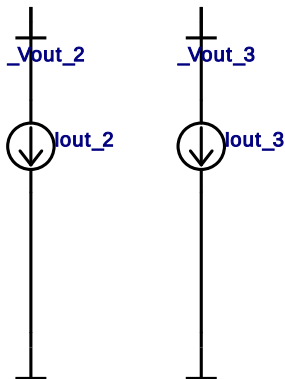
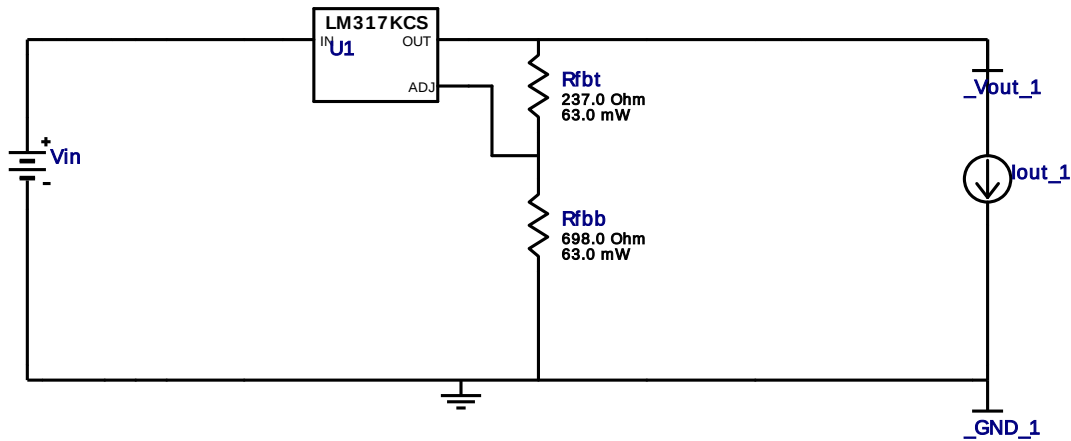


Vout = 5.0V  
Iout = 0.46A

Device = LM317KCS  
Topology = LINEAR  
Created = 8/22/16 12:31:24 PM  
BOM Cost = \$0.72  
BOM Count = 4  
Total Pd = 3.77W

## WEBENCH® Design Report

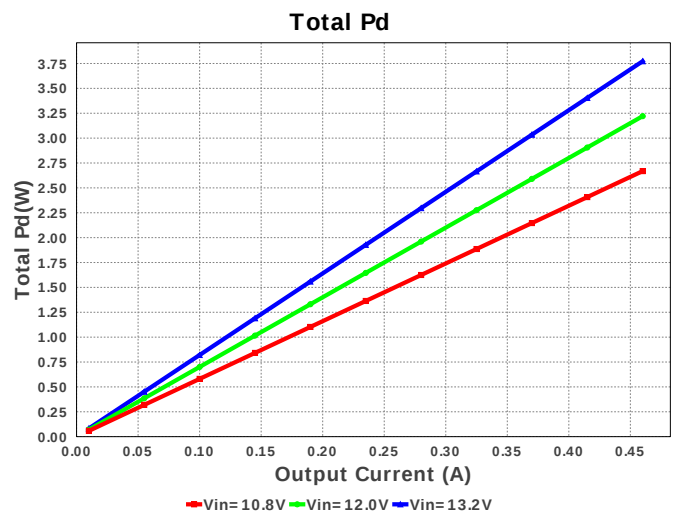
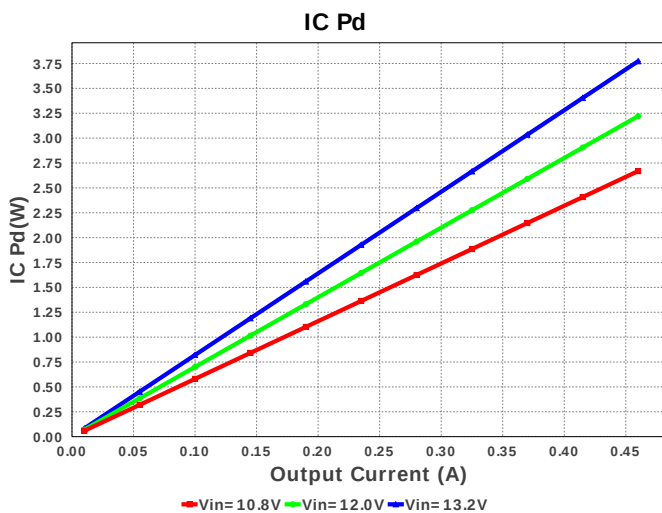
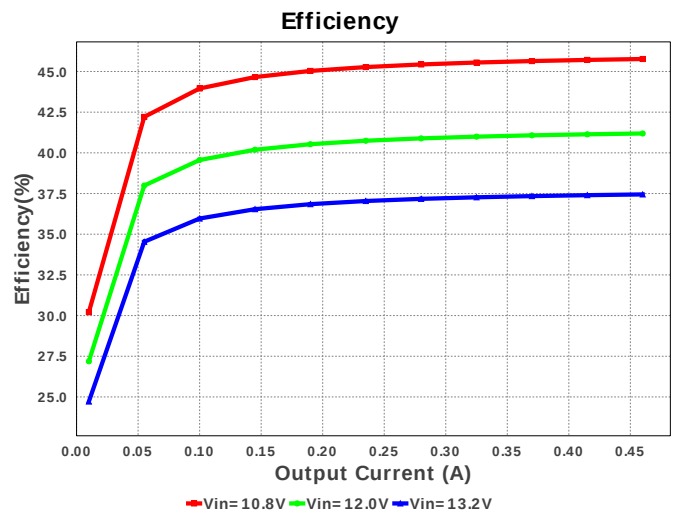
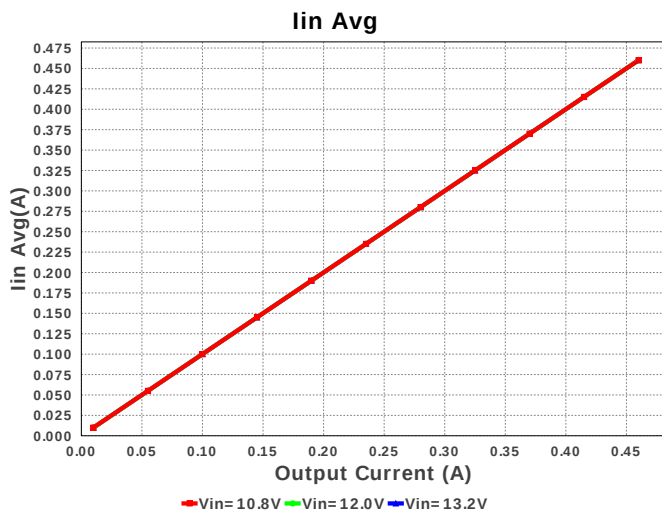
Design : 4457758/58 LM317KCS  
LM317KCS 10.8V-13.2V to 5.00V @ 0.46A

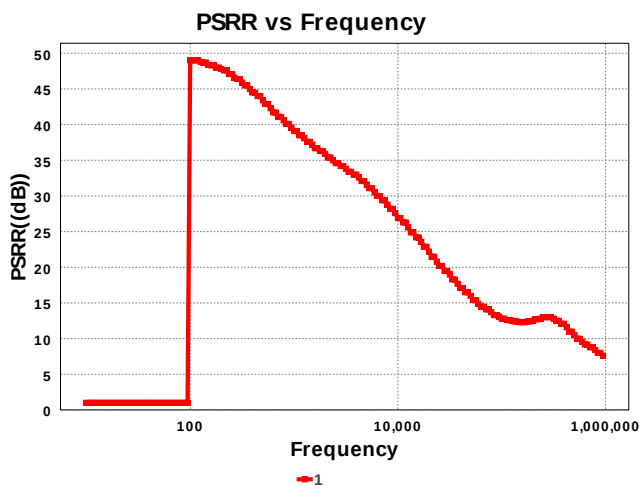
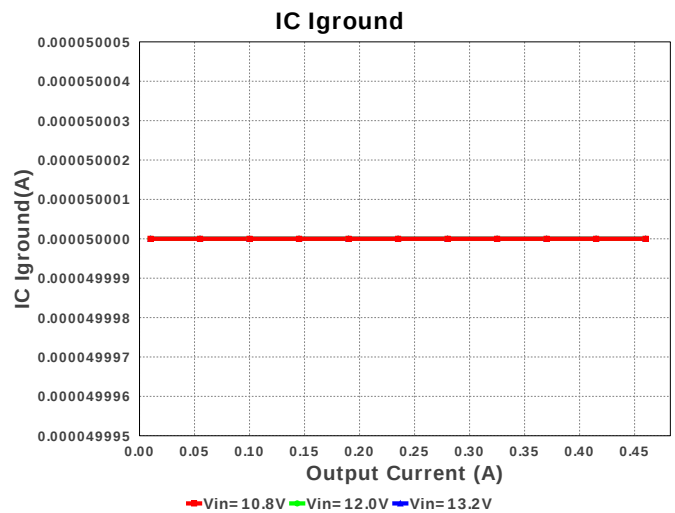
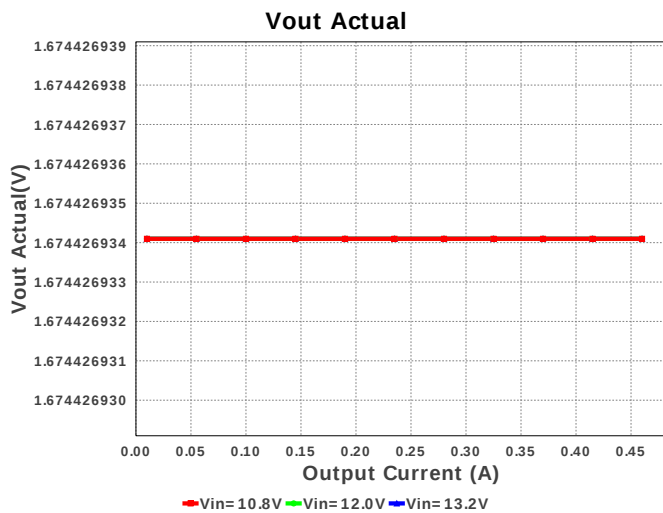
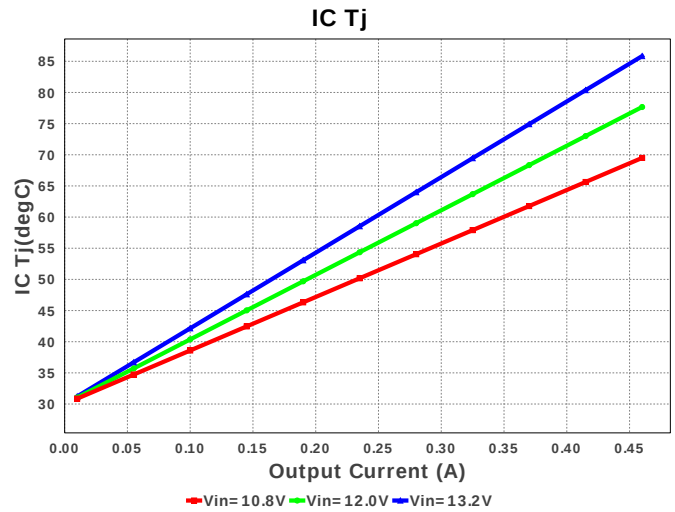
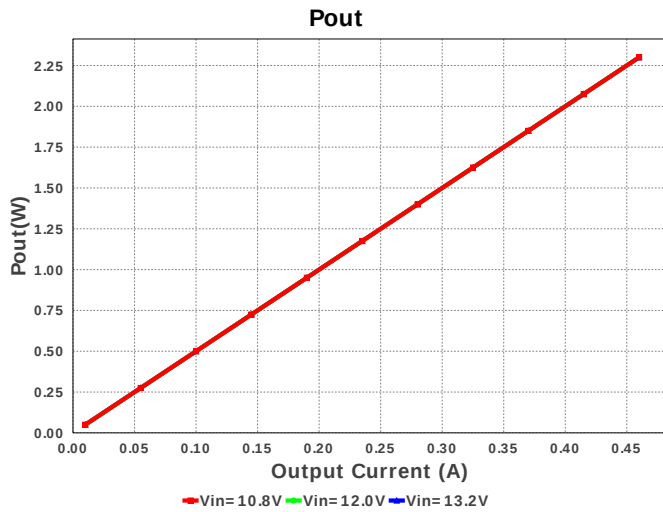


### Electrical BOM

| #  | Name     | Manufacturer | Part Number   | Properties | Qty | Price  | Footprint                                                                                                              |
|----|----------|--------------|---------------|------------|-----|--------|------------------------------------------------------------------------------------------------------------------------|
| 1. | HeatSink | Aavid        | 563002B00000G | Heatsink   | 1   | \$0.46 |  <p>563002 403 mm<sup>2</sup></p> |

| #  | Name | Manufacturer      | Part Number                          | Properties                                          | Qty | Price  | Footprint                                                                                                        |
|----|------|-------------------|--------------------------------------|-----------------------------------------------------|-----|--------|------------------------------------------------------------------------------------------------------------------|
| 2. | Rfbb | Vishay-Dale       | CRCW0402698RFKED<br>Series= CRCW..e3 | Res= 698.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| 3. | Rfbt | Vishay-Dale       | CRCW0402237RFKED<br>Series= CRCW..e3 | Res= 237.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 |  0402 3 mm <sup>2</sup>       |
| 4. | U1   | Texas Instruments | LM317KCS                             | Switcher                                            | 1   | \$0.24 |  TO-220-3 127 mm <sup>2</sup> |





## Operating Values

| #   | Name             | Value                 | Category | Description                                                        |
|-----|------------------|-----------------------|----------|--------------------------------------------------------------------|
| 1.  | IC Iground       | 50.0 μA               | Current  | IC ground current                                                  |
| 2.  | Iin Avg          | 460.05 mA             | Current  | Average input current                                              |
| 3.  | BOM Count        | 4                     | General  | Total Design BOM count                                             |
| 4.  | FootPrint        | 536.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components                            |
| 5.  | IC Tolerance     | 50.0 mV               | General  | IC Feedback Tolerance                                              |
| 6.  | Output Noise RMS | 150.0 μV              | General  | Noise RMS                                                          |
| 7.  | Pout             | 2.3 W                 | General  | Total output power                                                 |
| 8.  | Total BOM        | \$0.72                | General  | Total BOM Cost                                                     |
| 9.  | Vin p-p          | 172.832 mV            | Op_Point | Input Source ripple voltage                                        |
| 10. | Vout Actual      | 1.674 V               | Op_Point | Vout Actual calculated based on selected voltage divider resistors |
| 11. | Vout OP          | 5.0 V                 | Op_Point | Operational Output Voltage                                         |

| #   | Name                   | Value        | Category | Description                                                                                |
|-----|------------------------|--------------|----------|--------------------------------------------------------------------------------------------|
| 12. | Efficiency             | 37.445 %     | Op_point | Steady state efficiency                                                                    |
| 13. | IC Tj                  | 108.471 degC | Op_point | IC junction temperature                                                                    |
| 14. | ICThetaJA              | 20.8 degC/W  | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 15. | IOUT_OP                | 460.0 mA     | Op_point | Iout operating point                                                                       |
| 16. | Input Ripple Frequency | 305.746 kHz  | Op_point | Input Source Ripple Frequency for PSRR Calculation                                         |
| 17. | PSRR est.              | -12.799 dB   | Op_point | Power Supply Rejection Ratio estimated                                                     |
| 18. | VIN_OP                 | 13.2 V       | Op_point | Vin operating point                                                                        |
| 19. | Vout p-p               | 39.6 mV      | Op_point | Peak-to-peak output ripple voltage                                                         |
| 20. | IC Pd                  | 3.773 W      | Power    | IC power dissipation                                                                       |
| 21. | Total Pd               | 3.773 W      | Power    | Total Power Dissipation                                                                    |
| 22. | Vout Tolerance         | 4.533 %      |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value   | Description            |
|----|---------|---------|------------------------|
| 1. | Iout    | 460.0 m | Maximum Output Current |
| 2. | VinMax  | 13.2    | Maximum input voltage  |
| 3. | VinMin  | 10.8    | Minimum input voltage  |
| 4. | Vout    | 5.0     | Output Voltage         |
| 5. | base_pn | LM317   | Base Product Number    |
| 6. | source  | DC      | Input Source Type      |
| 7. | Ta      | 30.0    | Ambient temperature    |

## Design Assistance

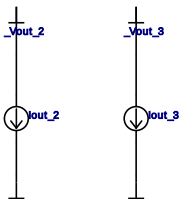
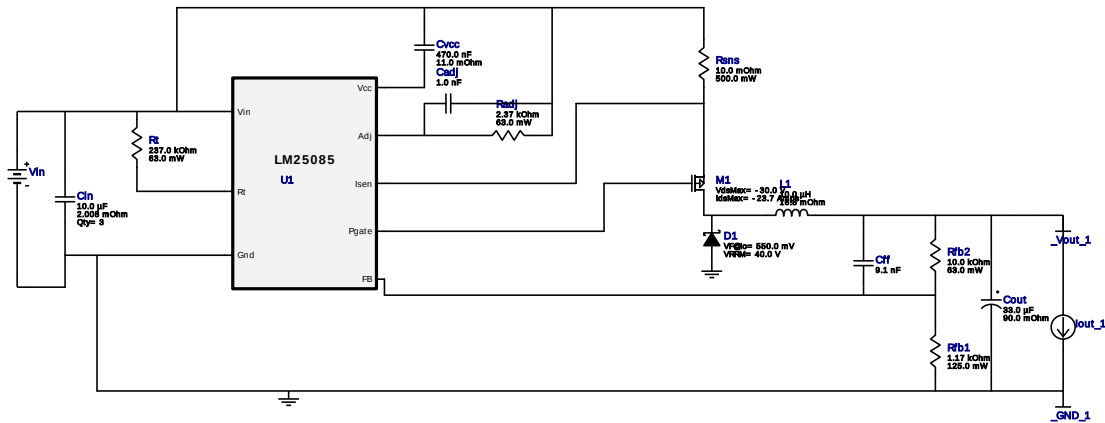
- 
- LM317** Product Folder : <http://www.ti.com/product/lm317> : contains the data sheet and other resources.

Vout = 12.0V  
Iout = 5.48A

Device = LM25085MY/NOPB  
Topology = Buck  
Created = 8/22/16 12:31:24 PM  
BOM Cost = \$3.88  
BOM Count = 16  
Total Pd = 4.48W

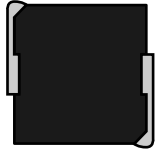
# WEBENCH<sup>®</sup> Design Report

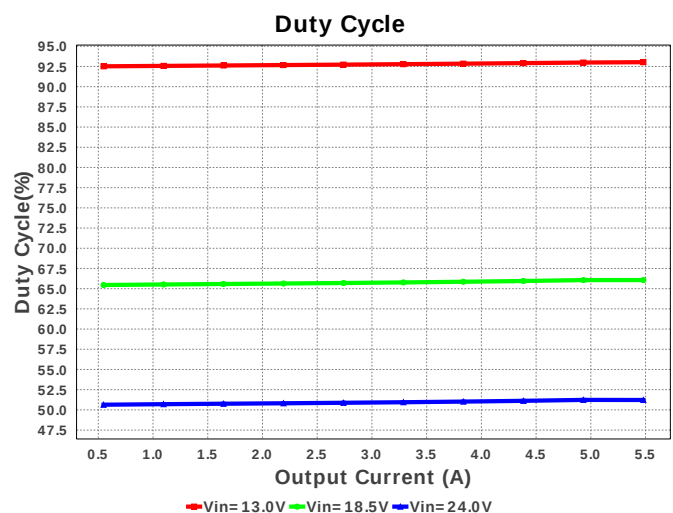
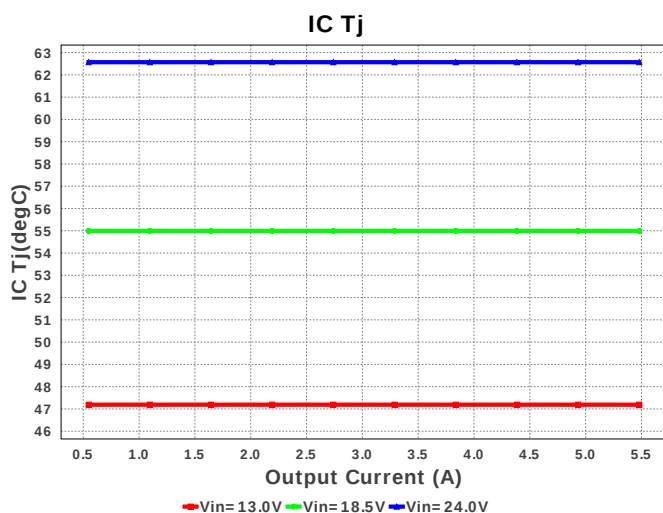
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LM25085MY/NOPB 13.0V-24.0V to 12.00V @ 5.48005A

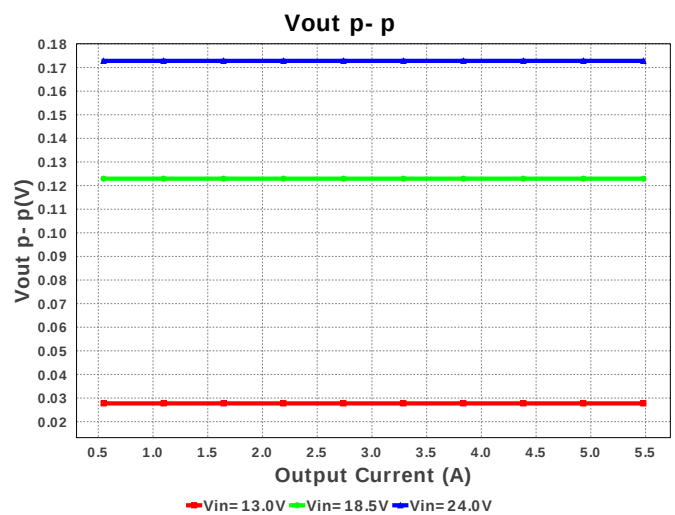
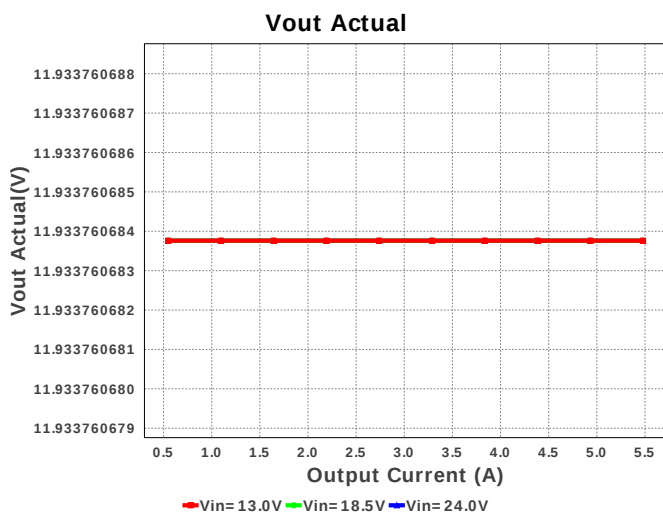
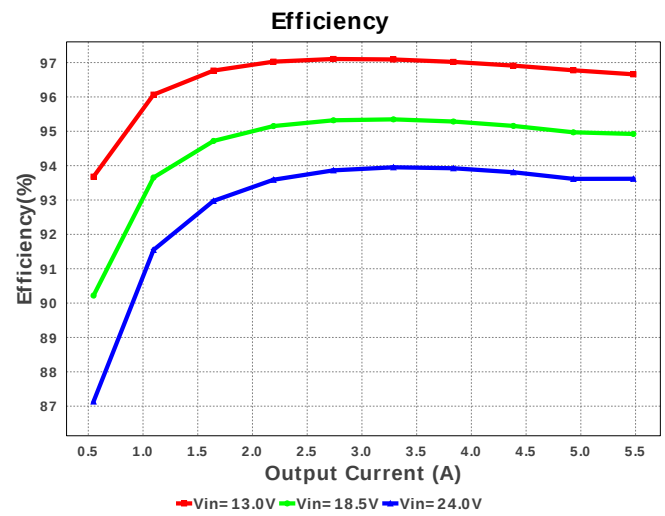
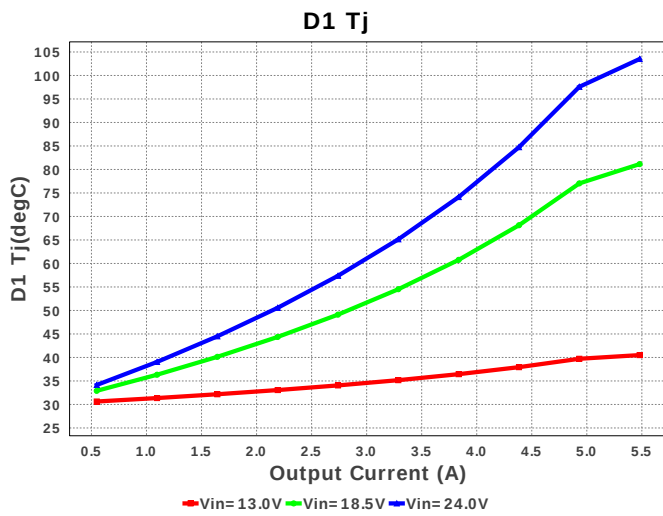
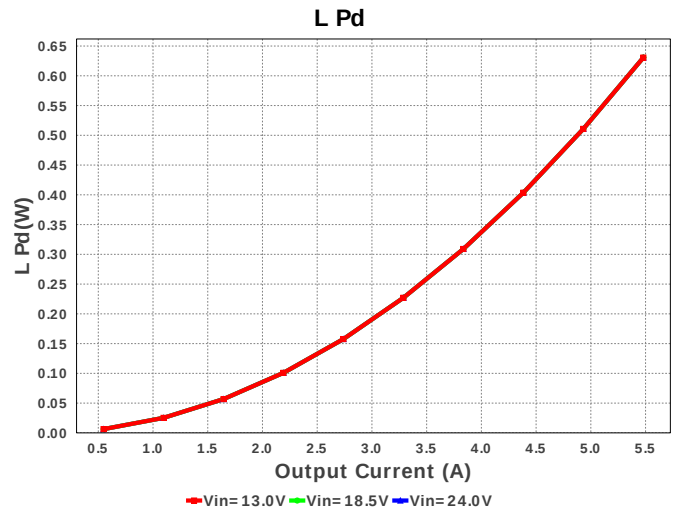
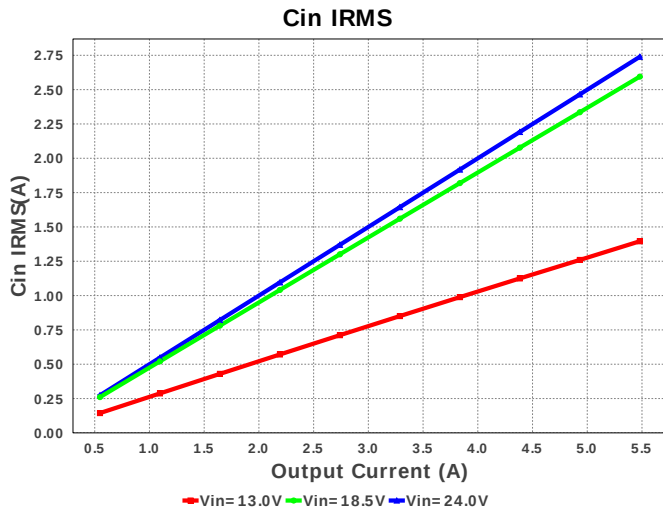


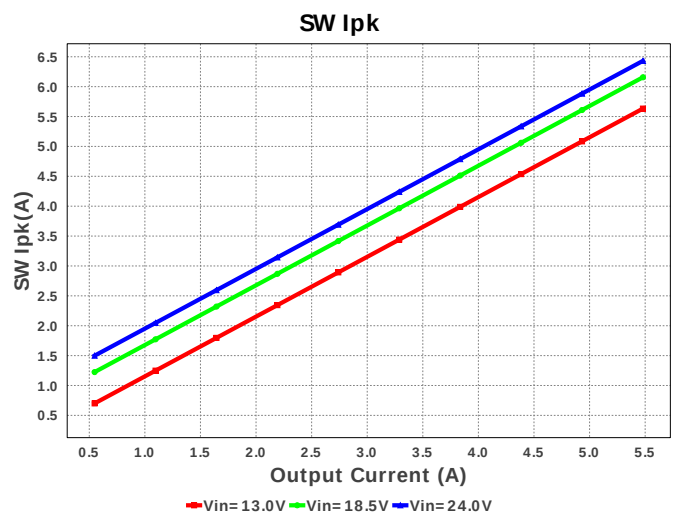
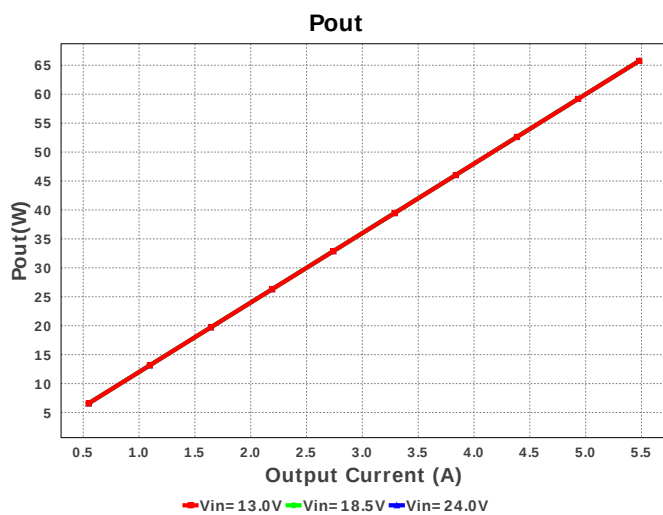
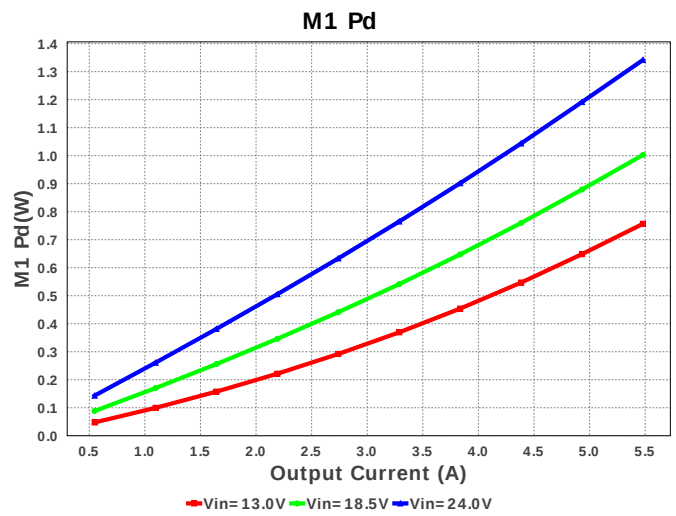
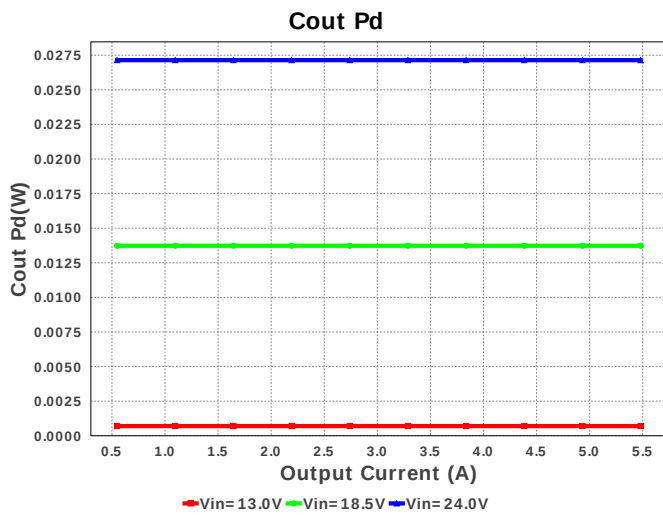
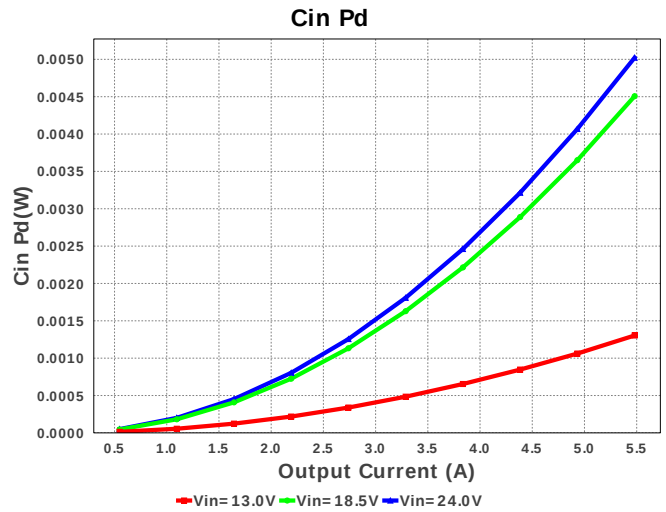
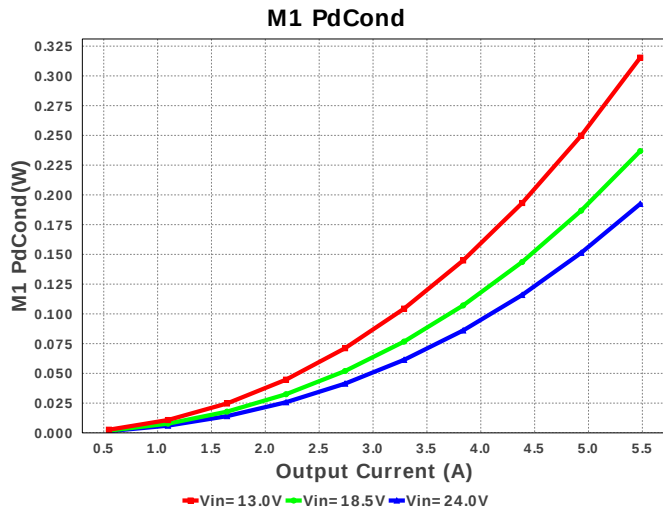
## Electrical BOM

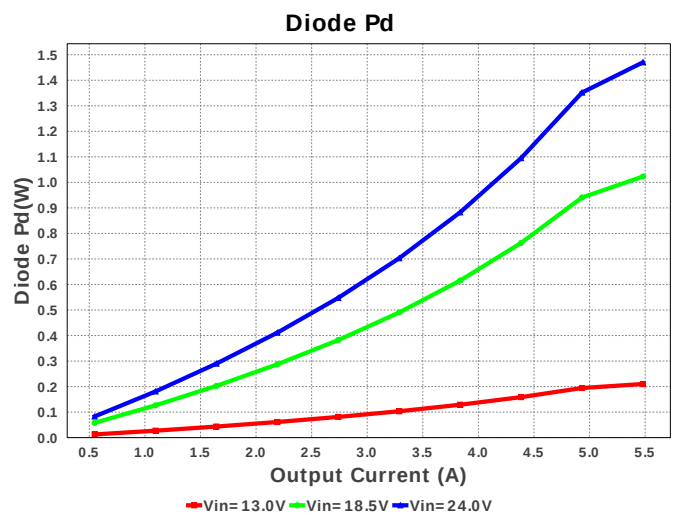
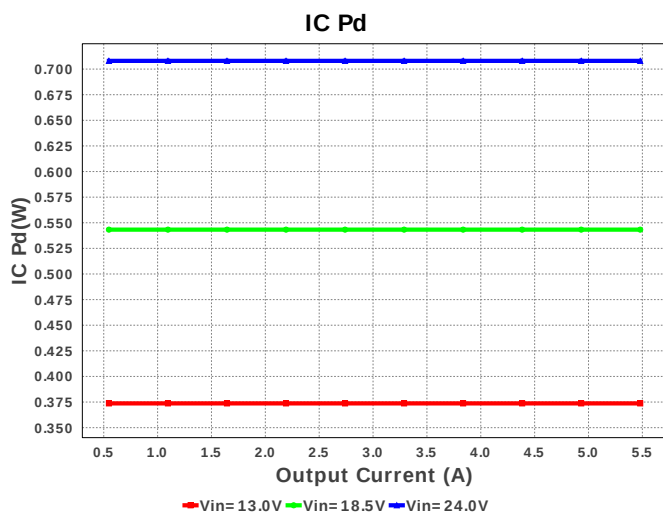
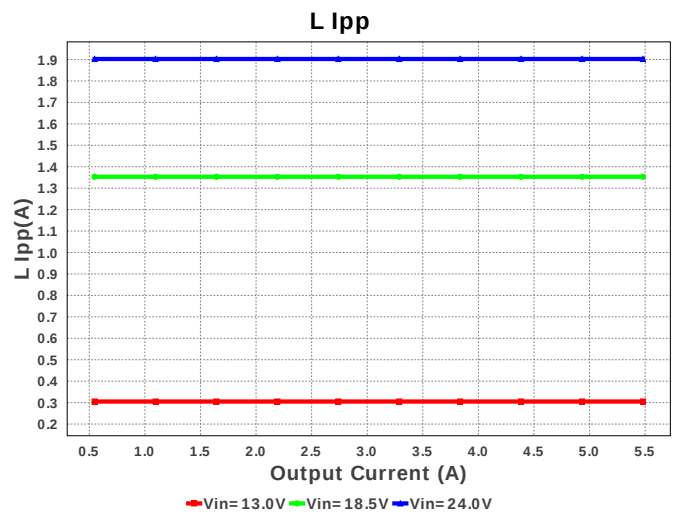
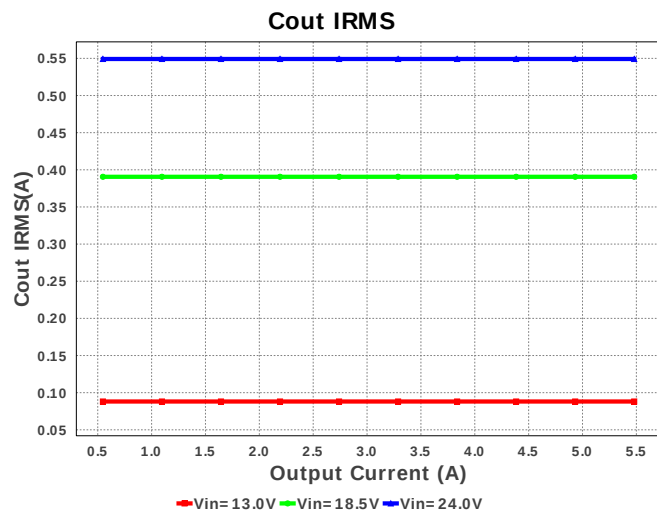
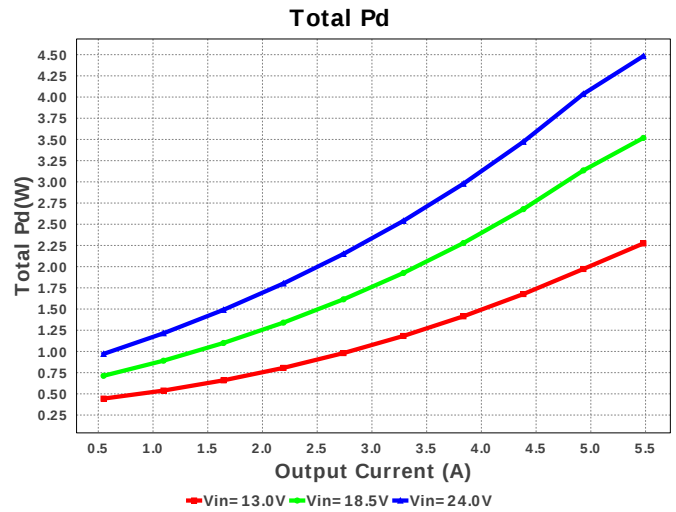
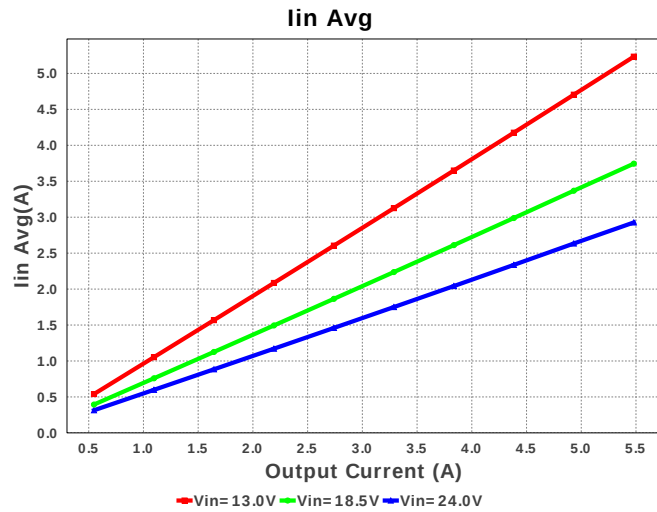
| #  | Name | Manufacturer              | Part Number                           | Properties                                                       | Qty | Price  | Footprint                                                                                                            |
|----|------|---------------------------|---------------------------------------|------------------------------------------------------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------|
| 1. | Cadj | Samsung Electro-Mechanics | CL21C102JBCNFNC<br>Series= C0G/NP0    | Cap= 1.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | <br>0805 7 mm <sup>2</sup>      |
| 2. | Cff  | MuRata                    | GRM2195C1H912JA01D<br>Series= C0G/NP0 | Cap= 9.1 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                        | 1   | \$0.06 | <br>0805 7 mm <sup>2</sup>      |
| 3. | Cin  | MuRata                    | GRM32ER7YA106KA12L<br>Series= X7R     | Cap= 10.0 uF<br>ESR= 2.008 mOhm<br>VDC= 35.0 V<br>IRMS= 4.6772 A | 3   | \$0.22 | <br>1210_280 15 mm <sup>2</sup> |
| 4. | Cout | Kemet                     | T495D336K025ATE090<br>Series= T495    | Cap= 33.0 uF<br>ESR= 90.0 mOhm<br>VDC= 25.0 V<br>IRMS= 1.162 A   | 1   | \$0.73 | <br>7343-31 59 mm <sup>2</sup>  |
| 5. | Cvcc | AVX                       | 0805YC474KAT2A<br>Series= X7R         | Cap= 470.0 nF<br>ESR= 11.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A    | 1   | \$0.02 | <br>0805 7 mm <sup>2</sup>      |
| 6. | D1   | Diodes Inc.               | B540C-13-F                            | VF@Io= 550.0 mV<br>VRRM= 40.0 V                                  | 1   | \$0.17 | <br>SMC 83 mm <sup>2</sup>      |

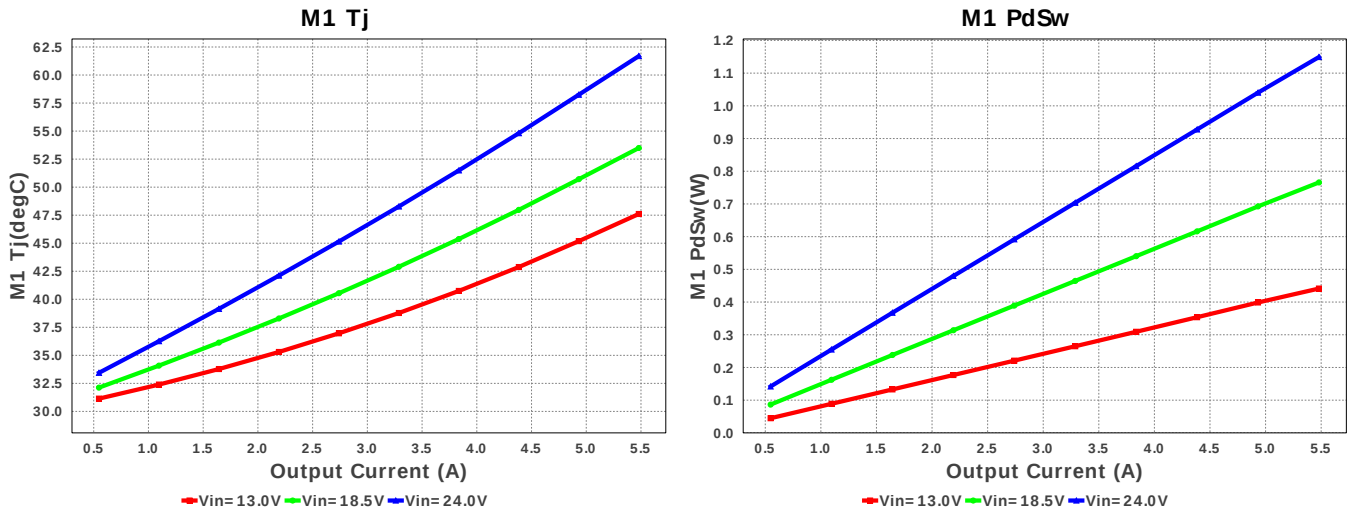
| #   | Name | Manufacturer              | Part Number                          | Properties                                           | Qty | Price  | Footprint                                                                                                               |
|-----|------|---------------------------|--------------------------------------|------------------------------------------------------|-----|--------|-------------------------------------------------------------------------------------------------------------------------|
| 7.  | L1   | Bourns                    | SRP1270-100M                         | L= 10.0 $\mu$ H<br>DCR= 16.8 mOhm                    | 1   | \$0.60 | <br>SRP1270 246 mm <sup>2</sup>      |
| 8.  | M1   | Vishay-Siliconix          | Si7149DP                             | VdsMax= -30.0 V<br>IdsMax= -23.7 Amps                | 1   | \$0.74 | <br>PowerPAK_SO-8 55 mm <sup>2</sup> |
| 9.  | Radj | Vishay-Dale               | CRCW04022K37FKED<br>Series= CRCW..e3 | Res= 2.37 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%  | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>           |
| 10. | Rfb1 | Yageo America             | RT0805BRD071K17L<br>Series= RT0805   | Res= 1.17 kOhm<br>Power= 125.0 mW<br>Tolerance= 0.1% | 1   | \$0.05 | <br>0805 7 mm <sup>2</sup>           |
| 11. | Rfb2 | 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 mm <sup>2</sup>           |
| 12. | Rsns | Stackpole Electronics Inc | CSR1206FK10L0<br>Series= ?           | Res= 10.0 mOhm<br>Power= 500.0 mW<br>Tolerance= 1.0% | 1   | \$0.11 | <br>1206 11 mm <sup>2</sup>          |
| 13. | Rt   | Vishay-Dale               | CRCW0402237KFKED<br>Series= CRCW..e3 | Res= 237.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0% | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>           |
| 14. | U1   | Texas Instruments         | LM25085MY/NOPB                       | Switcher                                             | 1   | \$0.70 | <br>MUY08A 24 mm <sup>2</sup>        |











## Operating Values

| #   | Name           | Value                 | Category | Description                                                                                |
|-----|----------------|-----------------------|----------|--------------------------------------------------------------------------------------------|
| 1.  | Cin IRMS       | 2.739 A               | Current  | Input capacitor RMS ripple current                                                         |
| 2.  | Cout IRMS      | 549.179 mA            | Current  | Output capacitor RMS ripple current                                                        |
| 3.  | Iin Avg        | 2.927 A               | Current  | Average input current                                                                      |
| 4.  | L Ipp          | 1.902 A               | Current  | Peak-to-peak inductor ripple current                                                       |
| 5.  | SW Ipk         | 6.431 A               | Current  | Peak switch current                                                                        |
| 6.  | BOM Count      | 16                    | General  | Total Design BOM count                                                                     |
| 7.  | FootPrint      | 558.0 mm <sup>2</sup> | General  | Total Foot Print Area of BOM components                                                    |
| 8.  | Frequency      | 305.746 kHz           | General  | Switching frequency                                                                        |
| 9.  | IC Tolerance   | 25.0 mV               | General  | IC Feedback Tolerance                                                                      |
| 10. | Mode           | CCM                   | General  | Conduction Mode                                                                            |
| 11. | Pout           | 65.761 W              | General  | Total output power                                                                         |
| 12. | Total BOM      | \$3.88                | General  | Total BOM Cost                                                                             |
| 13. | D1 Tj          | 103.513 degC          | Op_Point | D1 junction temperature                                                                    |
| 14. | Vout Actual    | 11.934 V              | Op_Point | Vout Actual calculated based on selected voltage divider resistors                         |
| 15. | Vout OP        | 12.0 V                | Op_Point | Operational Output Voltage                                                                 |
| 16. | Duty Cycle     | 51.219 %              | Op_point | Duty cycle                                                                                 |
| 17. | Efficiency     | 93.626 %              | Op_point | Steady state efficiency                                                                    |
| 18. | IC Tj          | 62.569 degC           | Op_point | IC junction temperature                                                                    |
| 19. | ICThetaJA      | 46.0 degC/W           | Op_point | IC junction-to-ambient thermal resistance                                                  |
| 20. | IOUT_OP        | 5.48 A                | Op_point | Iout operating point                                                                       |
| 21. | M1 Tj          | 61.688 degC           | Op_point | M1 MOSFET junction temperature                                                             |
| 22. | VIN_OP         | 24.0 V                | Op_point | Vin operating point                                                                        |
| 23. | Vout p-p       | 172.832 mV            | Op_point | Peak-to-peak output ripple voltage                                                         |
| 24. | Cin Pd         | 5.022 mW              | Power    | Input capacitor power dissipation                                                          |
| 25. | Cout Pd        | 27.144 mW             | Power    | Output capacitor power dissipation                                                         |
| 26. | Diode Pd       | 1.47 W                | Power    | Diode power dissipation                                                                    |
| 27. | IC Pd          | 708.023 mW            | Power    | IC power dissipation                                                                       |
| 28. | L Pd           | 630.65 mW             | Power    | Inductor power dissipation                                                                 |
| 29. | M1 Pd          | 1.336 W               | Power    | M1 MOSFET total power dissipation                                                          |
| 30. | M1 PdCond      | 186.641 mW            | Power    | M1 MOSFET conduction losses                                                                |
| 31. | M1 PdSw        | 1.149 W               | Power    | M1 MOSFET switching losses                                                                 |
| 32. | Total Pd       | 4.477 W               | Power    | Total Power Dissipation                                                                    |
| 33. | Vout Tolerance | 3.006 %               |          | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |

## Design Inputs

| #  | Name    | Value   | Description            |
|----|---------|---------|------------------------|
| 1. | Iout    | 5.48    | Maximum Output Current |
| 2. | VinMax  | 24.0    | Maximum input voltage  |
| 3. | VinMin  | 13.0    | Minimum input voltage  |
| 4. | Vout    | 12.0    | Output Voltage         |
| 5. | base_pn | LM25085 | Base Product Number    |
| 6. | source  | DC      | Input Source Type      |
| 7. | Ta      | 30.0    | Ambient temperature    |

## Design Assistance

1. For a Constant On Time device to be stable, we need to provide a ripple at the feedback comparator. There are various methods to implement the ripple. Depending on the circuit complexity vs. the allowable ripple, we have three options to choose from. The simplest option, 'Low Complexity', would require only a high ESR cap at the output. This means that the BOM count will be small, but the output voltage ripple

will be quite large. The 'optimal solution' would require a feed-forward cap in parallel with the upper feedback resistor to AC couple the ripple to the feedback node. This increases the BOM count slightly, but now we have more control over the output voltage ripple. If the output voltage requirement is very tight, then the best option is to go for the 'Low Output Ripple' solution. In this option we can go with very low ESR output caps and have very good control over the output voltage ripple

2. **LM25085** Product Folder : <http://www.ti.com/product/LM25085> : contains the data sheet and other resources.

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