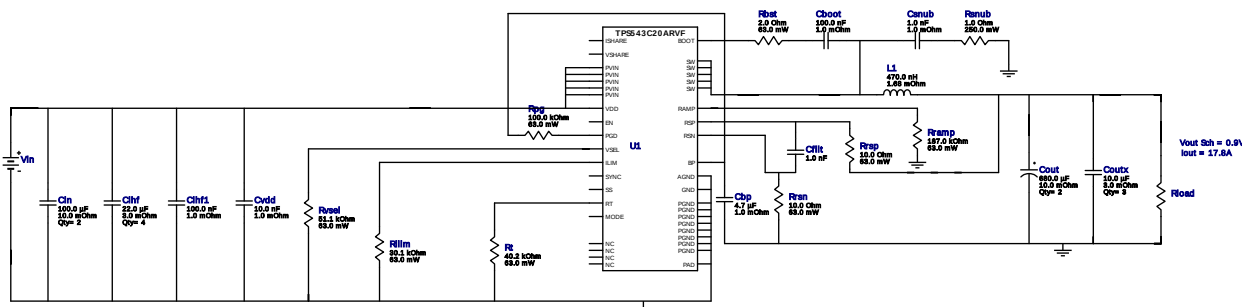




Design : 46 TPS543C20ARVFR  
TPS543C20ARVFR 12V-12V to .90V @ 17.8A

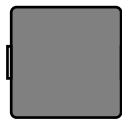
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VinMax = 12.0V  
Vout = 0.9V  
Vout Sch = 0.9V  
Iout = 17.8A

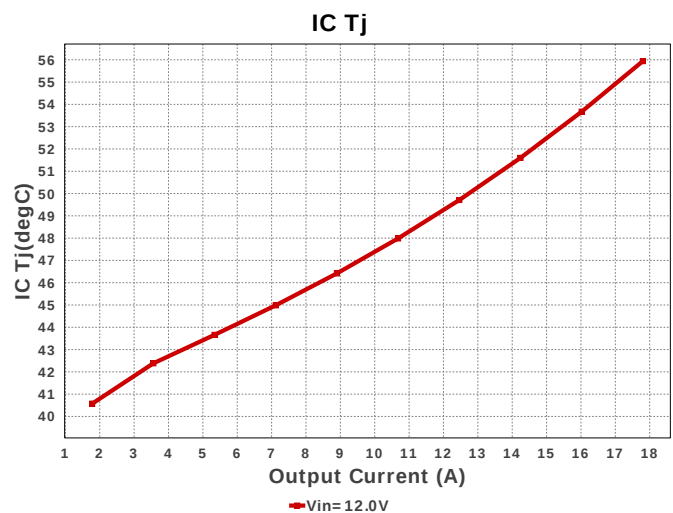
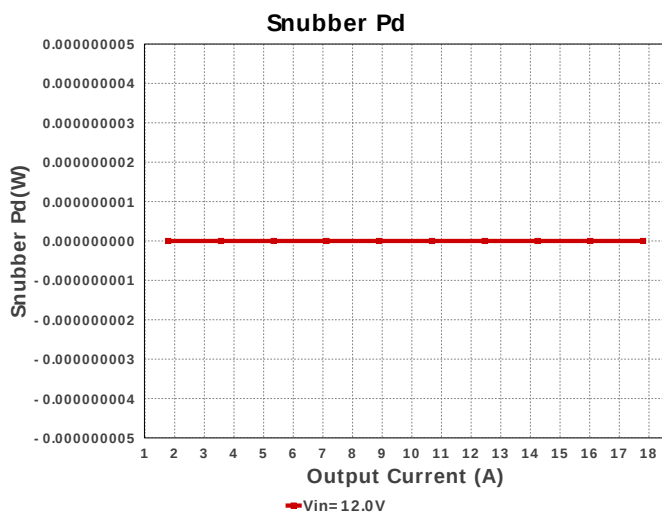
Device = TPS543C20ARVFR  
Topology = Buck  
Created = 2020-10-12 02:55:10.858  
BOM Cost = NA  
BOM Count = 31  
Total Pd = 2.38W

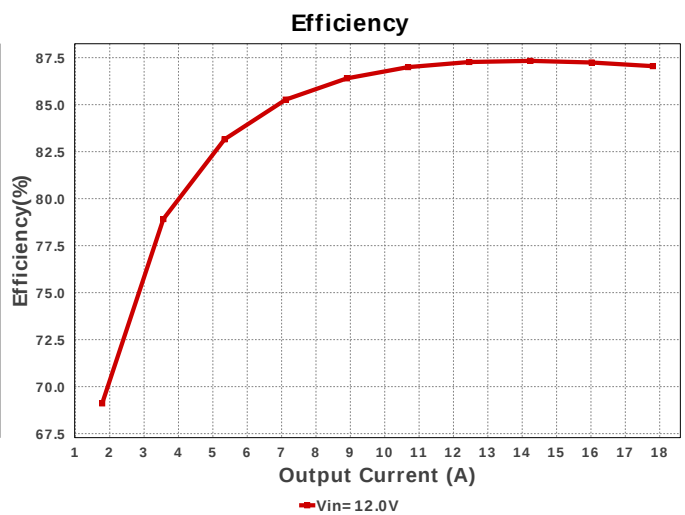
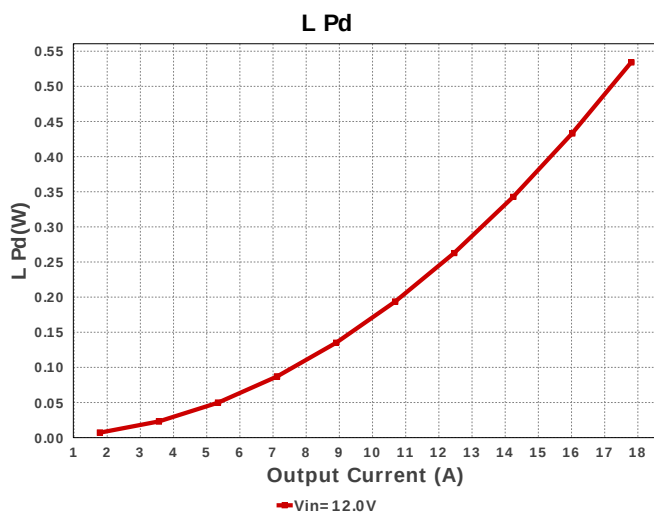
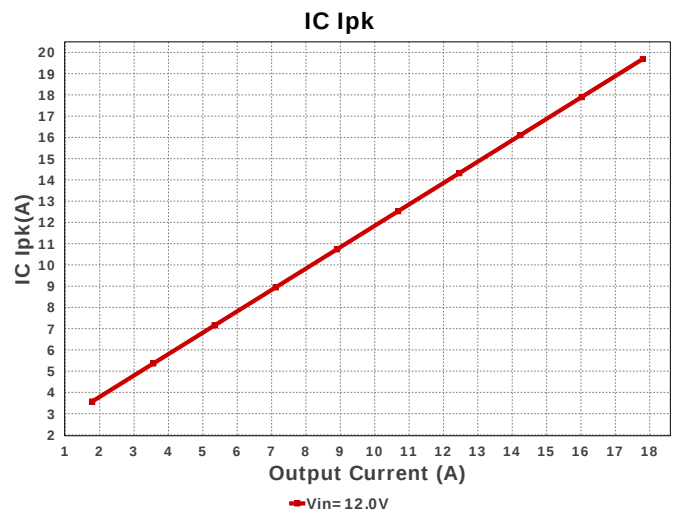
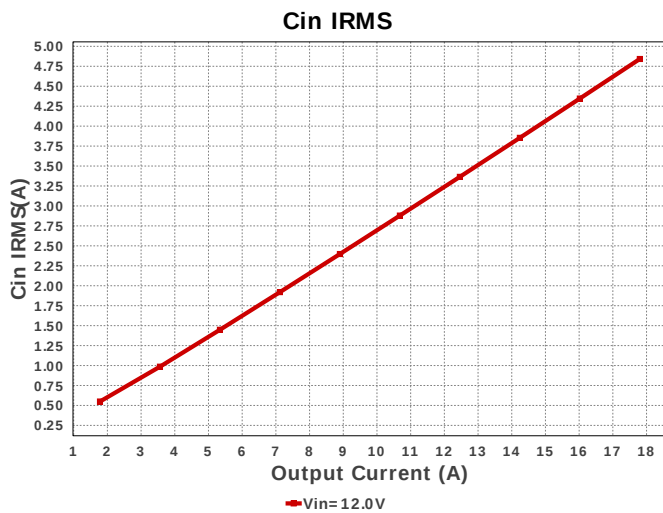
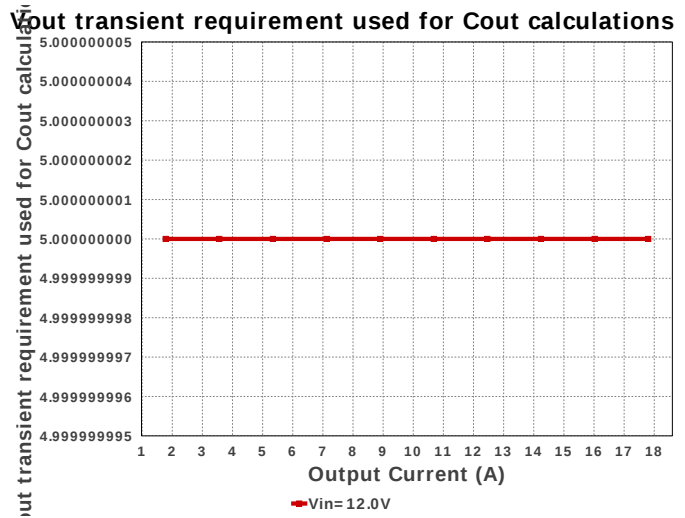
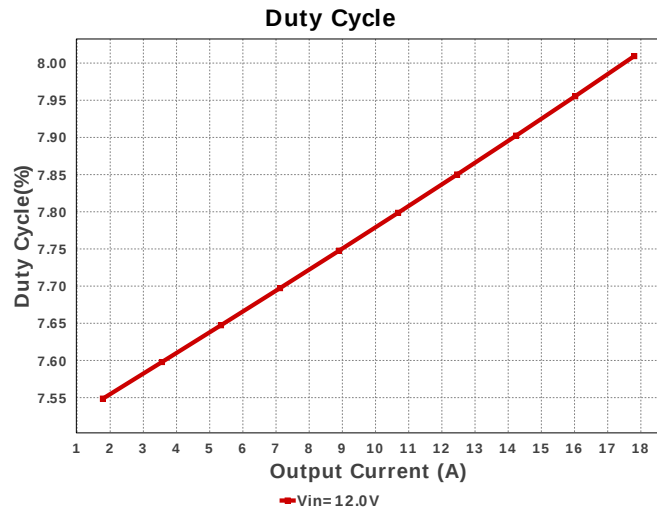


## Electrical BOM

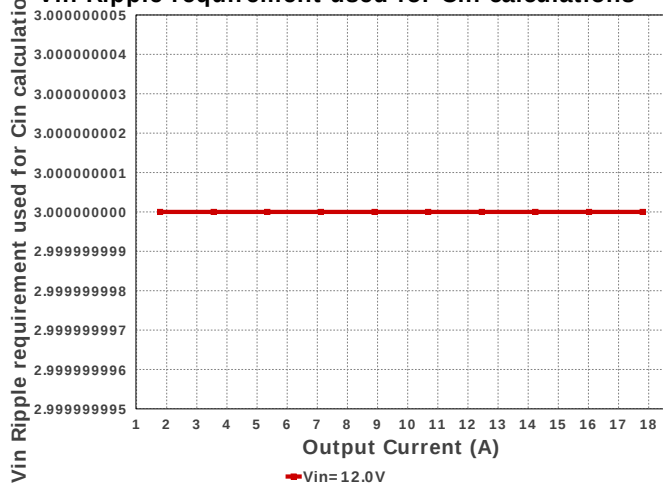
| Name  | Manufacturer | Part Number                           | Properties                                                       | Qty | Price  | Footprint                                                                                                                |
|-------|--------------|---------------------------------------|------------------------------------------------------------------|-----|--------|--------------------------------------------------------------------------------------------------------------------------|
| Cboot | Kemet        | C0603C104K3RACTU<br>Series= X7R       | Cap= 100.0 nF<br>ESR= 1.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A     | 1   | \$0.02 | <br>0603 5 mm <sup>2</sup>            |
| Cbp   | Taiyo Yuden  | EMK212BJ475KG-T<br>Series= X5R        | Cap= 4.7 uF<br>ESR= 1.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A       | 1   | \$0.05 | <br>0805 7 mm <sup>2</sup>           |
| Cfilt | MuRata       | GRM1555C1H102JA01J<br>Series= C0G/NP0 | Cap= 1.0 nF<br>VDC= 50.0 V<br>IRMS= 0.0 A                        | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>          |
| Cihf  | CUSTOM       | CUSTOM<br>Series= X7R                 | Cap= 22.0 uF<br>ESR= 3.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A      | 4   | NA     | <br>0402 0 mm <sup>2</sup>          |
| Cihf1 | MuRata       | GRM155R71C104KA88D<br>Series= X7R     | Cap= 100.0 nF<br>ESR= 1.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A     | 1   | \$0.01 | <br>0402 3 mm <sup>2</sup>          |
| Cin   | CUSTOM       | CUSTOM<br>Series= X7R                 | Cap= 100.0 uF<br>ESR= 10.0 mOhm<br>VDC= 25.0 V<br>IRMS= 2.8649 A | 2   | NA     | <br>1206_190 0 mm <sup>2</sup>      |
| Cinx  | MuRata       | GRM155R71C104KA88D<br>Series= X7R     | Cap= 100.0 nF<br>ESR= 1.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A     | 2   | \$0.01 | <br>0402 3 mm <sup>2</sup>          |
| Cout  | CUSTOM       | CUSTOM<br>Series= SVPE                | Cap= 680.0 uF<br>ESR= 10.0 mOhm<br>VDC= 2.5 V<br>IRMS= 3.86 A    | 2   | NA     | <br>CAPSMT_62_E61 0 mm <sup>2</sup> |
| Coutx | CUSTOM       | CUSTOM<br>Series= X5R                 | Cap= 10.0 uF<br>ESR= 3.0 mOhm<br>VDC= 6.3 V<br>IRMS= 4.4118 A    | 3   | NA     | <br>1206_190 0 mm <sup>2</sup>      |
| CsnuB | Kemet        | C0603C102K5RACTU<br>Series= X7R       | Cap= 1.0 nF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A       | 1   | \$0.01 | <br>0603 5 mm <sup>2</sup>          |

| Name  | Manufacturer      | Part Number                          | Properties                                                  | Qty | Price  | Footprint                                                                                               |
|-------|-------------------|--------------------------------------|-------------------------------------------------------------|-----|--------|---------------------------------------------------------------------------------------------------------|
| Cvdd  | CUSTOM            | CUSTOM<br>Series= X7R                | Cap= 10.0 nF<br>ESR= 1.0 mOhm<br>VDC= 25.0 V<br>IRMS= 0.0 A | 1   | NA     |  0402 0 mm²          |
| L1    | Vishay-Dale       | IHLP4040DZERR47M11                   | L= 470.0 nH<br>1.68 mOhm                                    | 1   | \$0.68 |  IHLP-4040DZ 166 mm² |
| Rbst  | Vishay-Dale       | CRCW04022R00FKED<br>Series= CRCW..e3 | Res= 2.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%           | 1   | \$0.01 |  0402 3 mm²          |
| Rilim | CUSTOM            | CUSTOM<br>Series= CRCW..e3           | Res= 30.1 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%         | 1   | NA     |  0402 0 mm²          |
| Rmode | Vishay-Dale       | CRCW0402121KFKED<br>Series= CRCW..e3 | Res= 121.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%        | 1   | \$0.01 |  0402 3 mm²          |
| Rpg   | Vishay-Dale       | CRCW0402100KFKED<br>Series= CRCW..e3 | Res= 100.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%        | 1   | \$0.01 |  0402 3 mm²          |
| Rramp | Vishay-Dale       | CRCW0402187KFKED<br>Series= CRCW..e3 | Res= 187.0 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%        | 1   | \$0.01 |  0402 3 mm²          |
| Rrsn  | Vishay-Dale       | CRCW040210R0FKED<br>Series= CRCW..e3 | Res= 10.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%          | 1   | \$0.01 |  0402 3 mm²          |
| Rrsp  | Vishay-Dale       | CRCW040210R0FKED<br>Series= CRCW..e3 | Res= 10.0 Ohm<br>Power= 63.0 mW<br>Tolerance= 1.0%          | 1   | \$0.01 |  0402 3 mm²         |
| Rsnub | Vishay-Dale       | CRCW12061R00FKEA<br>Series= CRCW..e3 | Res= 1.0 Ohm<br>Power= 250.0 mW<br>Tolerance= 1.0%          | 1   | \$0.01 |  1206 11 mm²       |
| Rt    | Vishay-Dale       | CRCW040240K2FKED<br>Series= CRCW..e3 | Res= 40.2 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%         | 1   | \$0.01 |  0402 3 mm²        |
| Rvsel | Vishay-Dale       | CRCW040251K1FKED<br>Series= CRCW..e3 | Res= 51.1 kOhm<br>Power= 63.0 mW<br>Tolerance= 1.0%         | 1   | \$0.01 |  0402 3 mm²        |
| U1    | Texas Instruments | TPS543C20ARVFR                       | Switcher                                                    | 1   | \$3.76 |  RVF0040A 63 mm²   |

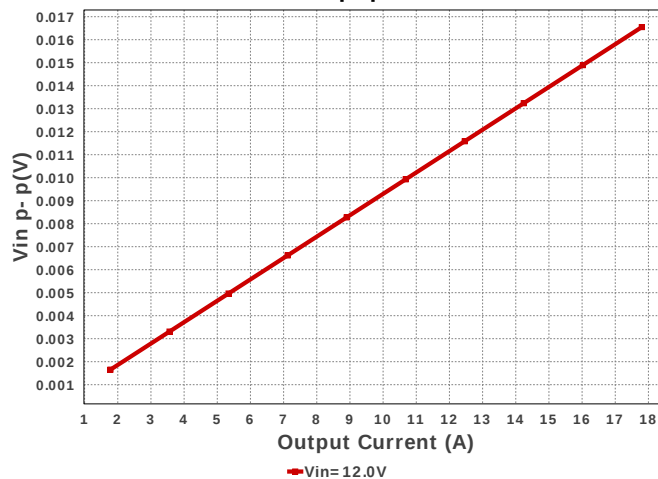




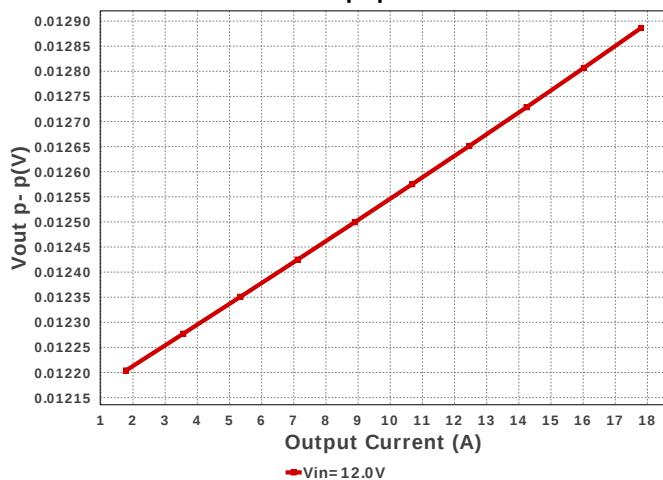
Vin Ripple requirement used for Cin calculations



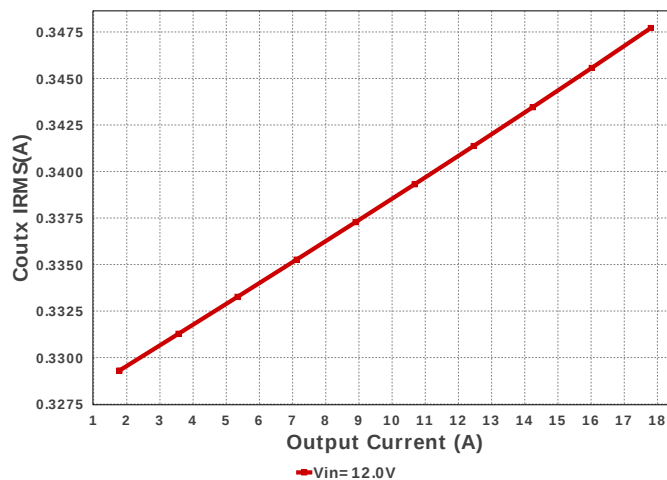
Vin p- p



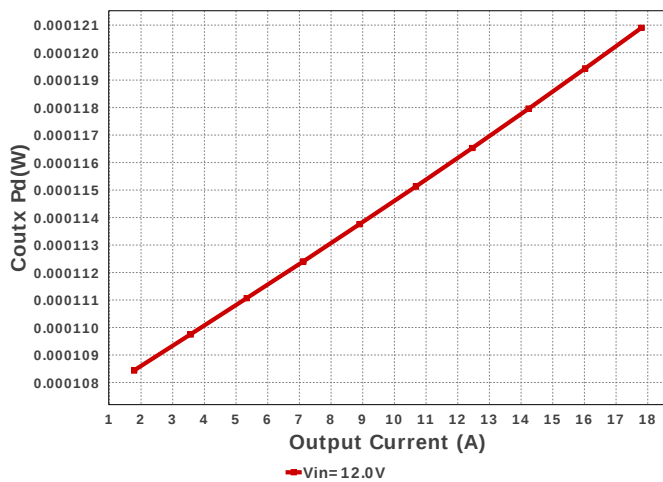
Vout p- p



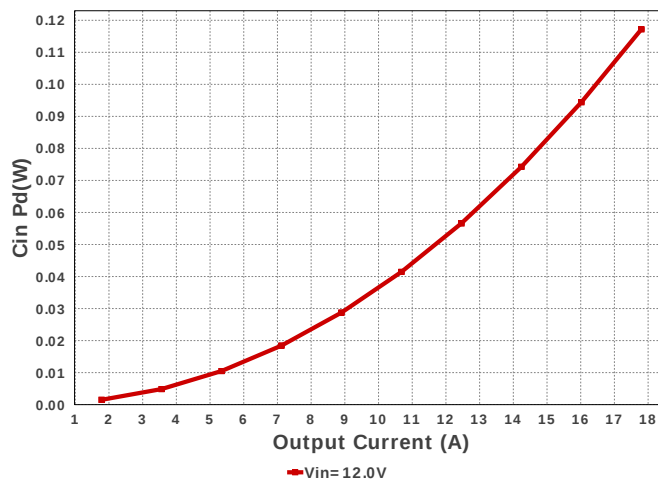
Coutx IRMS



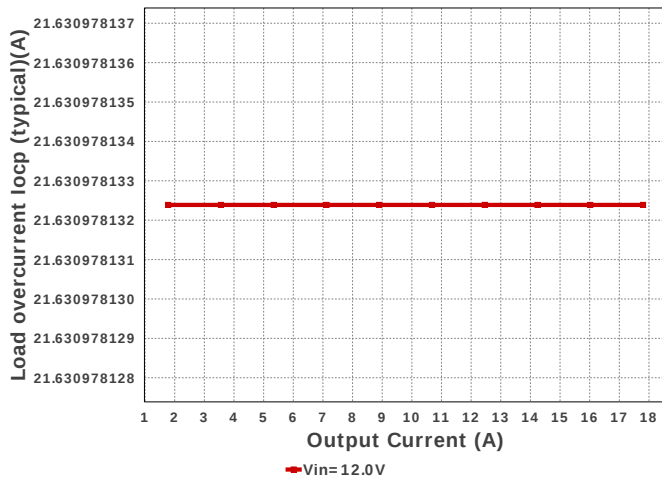
Coutx Pd



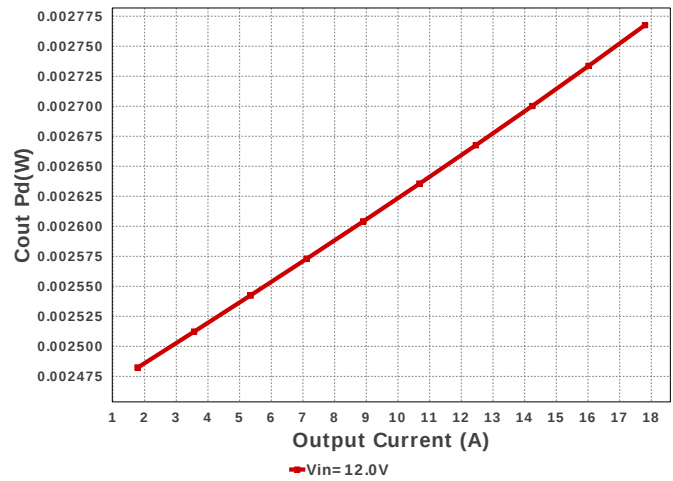
Cin Pd



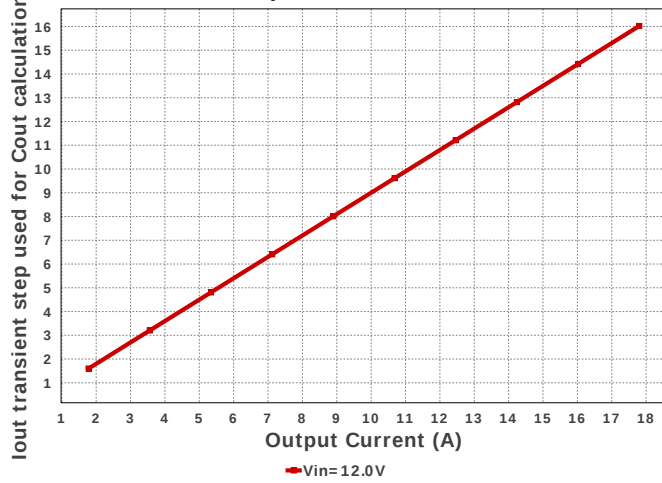
Load overcurrent loop (typical)



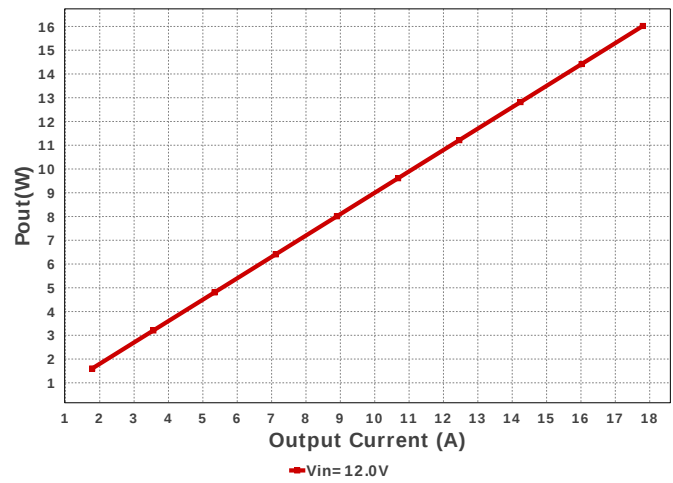
Cout Pd



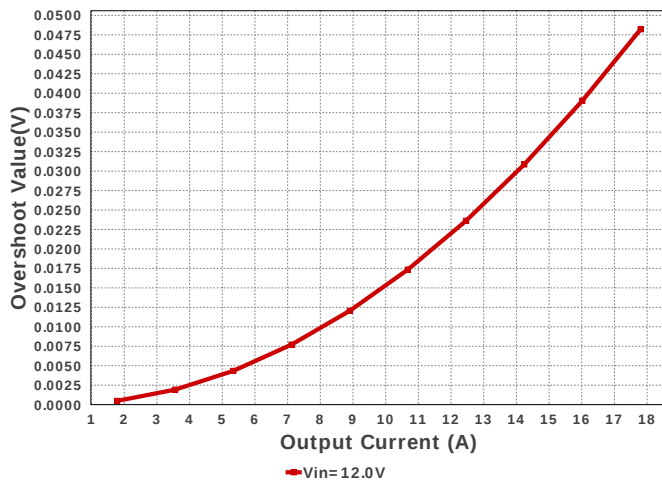
Iout transient step used for Cout calculations



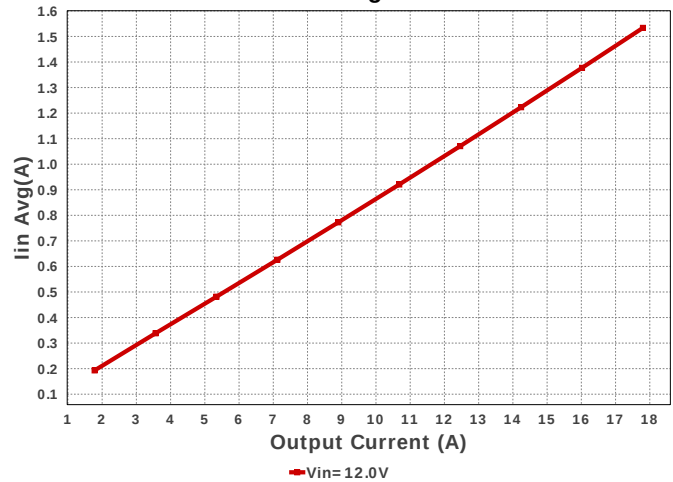
Pout



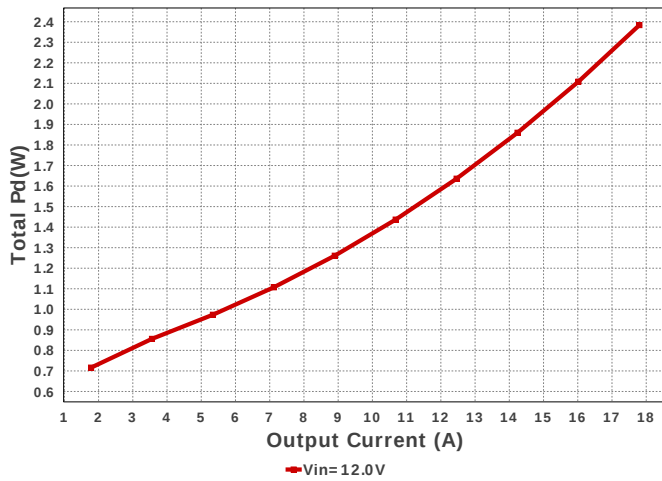
Overshoot Value



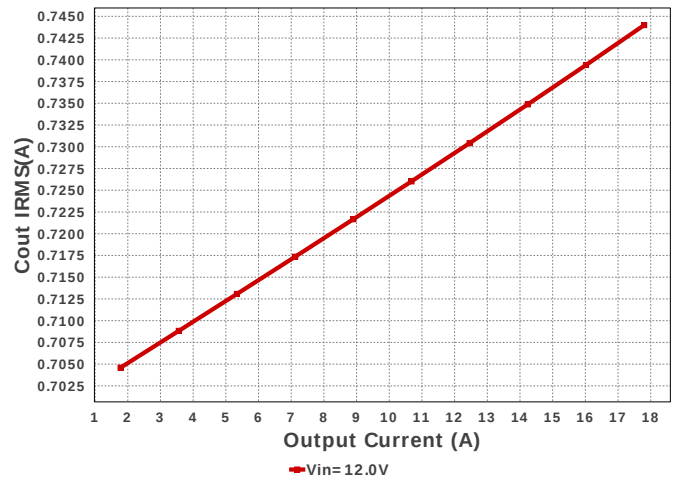
Iin Avg



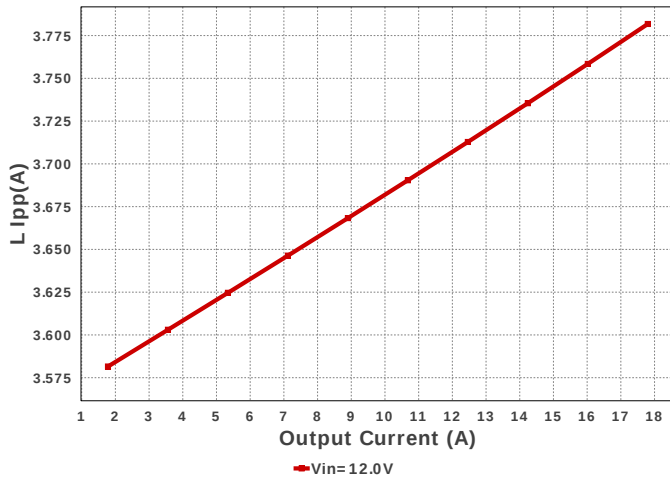
Total Pd



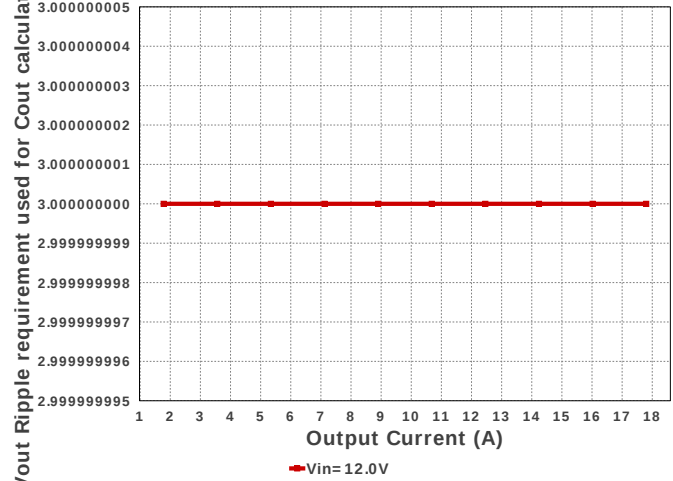
Cout IRMS



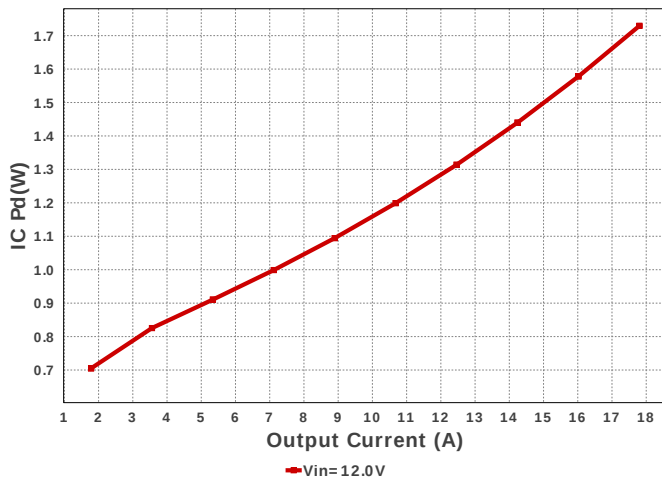
L Ipp



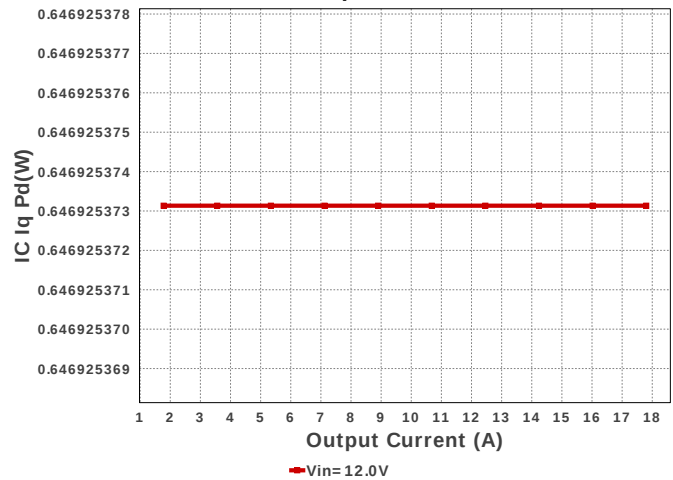
Vout Ripple requirement used for Cout calculations

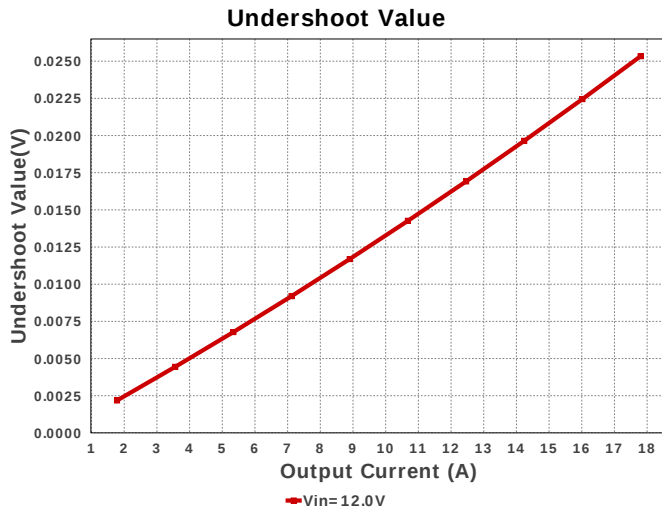


IC Pd



IC Iq Pd





## Operating Values

| #   | Name                                             | Value                 | Category              | Description                                                                                |
|-----|--------------------------------------------------|-----------------------|-----------------------|--------------------------------------------------------------------------------------------|
| 1.  | BOM Count                                        | 31                    |                       | Total Design BOM count                                                                     |
| 2.  | Total BOM                                        | NA                    |                       | Total BOM Cost                                                                             |
| 3.  | Cin IRMS                                         | 4.841 A               | Capacitor             | Input capacitor RMS ripple current                                                         |
| 4.  | Cin Pd                                           | 117.2 mW              | Capacitor             | Input capacitor power dissipation                                                          |
| 5.  | Cout IRMS                                        | 743.991 mA            | Capacitor             | Output capacitor RMS ripple current                                                        |
| 6.  | Cout Pd                                          | 2.768 mW              | Capacitor             | Output capacitor power dissipation                                                         |
| 7.  | Coutx IRMS                                       | 347.713 mA            | Capacitor             | Output capacitor_x RMS ripple current                                                      |
| 8.  | Coutx Pd                                         | 120.9 $\mu$ W         | Capacitor             | Output capacitor_x power loss                                                              |
| 9.  | IC Ipk                                           | 19.691 A              | IC                    | Peak switch current in IC                                                                  |
| 10. | IC Iq Pd                                         | 646.925 mW            | IC                    | IC Iq Pd                                                                                   |
| 11. | IC Pd                                            | 1.729 W               | IC                    | IC power dissipation                                                                       |
| 12. | IC Tj                                            | 55.939 degC           | IC                    | IC junction temperature                                                                    |
| 13. | ICThetaJA Effective                              | 15.0 degC/W           | IC                    | Effective IC Junction-to-Ambient Thermal Resistance                                        |
| 14. | Iin Avg                                          | 1.534 A               | IC                    | Average input current                                                                      |
| 15. | L Ipp                                            | 3.782 A               | Inductor              | Peak-to-peak inductor ripple current                                                       |
| 16. | L Pd                                             | 534.29 mW             | Inductor              | Inductor power dissipation                                                                 |
| 17. | Cin Pd                                           | 117.2 mW              | Power                 | Input capacitor power dissipation                                                          |
| 18. | Cout Pd                                          | 2.768 mW              | Power                 | Output capacitor power dissipation                                                         |
| 19. | Coutx Pd                                         | 120.9 $\mu$ W         | Power                 | Output capacitor_x power loss                                                              |
| 20. | IC Pd                                            | 1.729 W               | Power                 | IC power dissipation                                                                       |
| 21. | L Pd                                             | 534.29 mW             | Power                 | Inductor power dissipation                                                                 |
| 22. | Snubber Pd                                       | 0.0 W                 | Power                 | Snubber Power Dissipation                                                                  |
| 23. | Total Pd                                         | 2.384 W               | Power                 | Total Power Dissipation                                                                    |
| 24. | Duty Cycle                                       | 8.009 %               | System                | Duty cycle                                                                                 |
| 25. | Efficiency                                       | 87.048 %              | Information<br>System | Steady state efficiency                                                                    |
| 26. | FootPrint                                        | 471.0 mm <sup>2</sup> | Information<br>System | Total Foot Print Area of BOM components                                                    |
| 27. | Frequency                                        | 497.512 kHz           | Information<br>System | Switching frequency                                                                        |
| 28. | Iout                                             | 17.8 A                | Information<br>System | Iout operating point                                                                       |
| 29. | Iout transient step used for Cout calculations   | 16.02 A               | Information<br>System | Custom Transient current step requirement that was used for Cout selection (A).            |
| 30. | Load overcurrent Iocp (typical)                  | 21.631 A              | Information<br>System | Over current protection threshold                                                          |
| 31. | Mode                                             | CCM                   | Information<br>System | Conduction Mode                                                                            |
| 32. | Overshoot Value                                  | 48.21 mV              | Information<br>System | Theoretical Vout Overshoot Value                                                           |
| 33. | Pout                                             | 16.02 W               | Information<br>System | Total output power                                                                         |
| 34. | Undershoot Value                                 | 25.337 mV             | Information<br>System | Theoretical Vout Undershoot Value                                                          |
| 35. | Vin                                              | 12.0 V                | Information<br>System | Vin operating point                                                                        |
| 36. | Vin Ripple requirement used for Cin calculations | 3.0 %                 | Information<br>System | Custom maximum input ripple requirement that was used for Cin selection(% of Minimum Vin). |
| 37. | Vin p-p                                          | 16.547 mV             | Information<br>System | Peak-to-peak input voltage                                                                 |

| #   | Name                                                  | Value     | Category           | Description                                                                                |
|-----|-------------------------------------------------------|-----------|--------------------|--------------------------------------------------------------------------------------------|
| 38. | Vout                                                  | 900.0 mV  | System Information | Operational Output Voltage                                                                 |
| 39. | Vout Ripple requirement used for Cout calculations    | 3.0 %     | System Information | Custom maximum output ripple requirement that was used for Cout selection(% of Vout).      |
| 40. | Vout Tolerance                                        | 500.0 m%  | System Information | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |
| 41. | Vout p-p                                              | 12.886 mV | System Information | Peak-to-peak output ripple voltage                                                         |
| 42. | Vout transient requirement used for Cout calculations | 5.0 %     | System Information | Custom Transient voltage change requirement that was used for Cout selection (% of Vout).  |

## Design Inputs

|    | Name     | Value      | Description                 |
|----|----------|------------|-----------------------------|
|    | Iout     | 17.8       | Maximum Output Current      |
|    | VinMax   | 12.0       | Maximum input voltage       |
|    | VinMin   | 12.0       | Minimum input voltage       |
|    | Vout     | 900.0 m    | Output Voltage              |
|    | base_pn  | TPS543C20A | Base Product Number         |
|    | source   | DC         | Input Source Type           |
|    | Ta       | 30.0       | Ambient temperature         |
|    | UserFsw  | 498.0 k    | Customer Selected Frequency |
| 1. | Vout Sch | 900.0 m    | Output voltage selected     |

## WEBENCH® Assembly

### Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of  $C_{in}$  and  $C_{out}$ , and the inductance and DC resistance of  $L1$  before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

### Soldering Component to Board

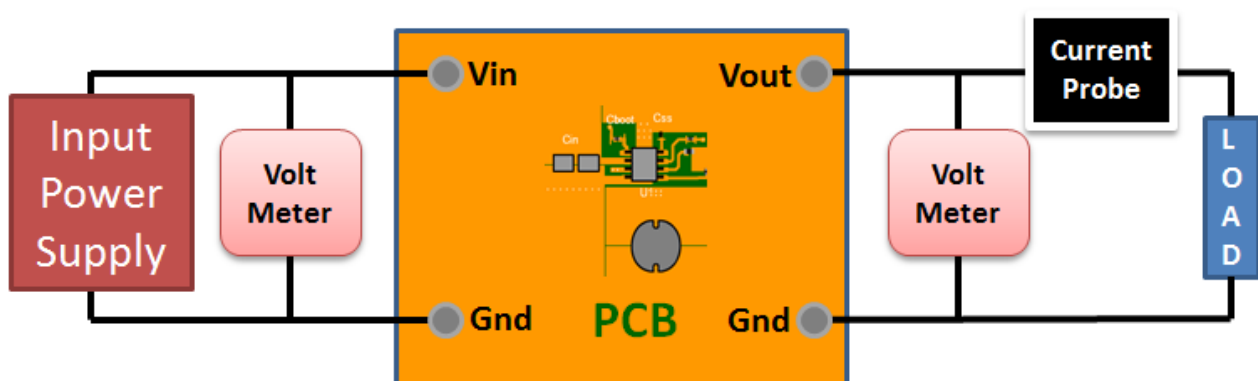
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

### Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 12.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to  $V_{in}$  and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from  $V_{out}$  and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

### Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between  $V_{in}$  and GND, a load is connected between  $V_{out}$  and GND and a current meter is connected in series between  $V_{out}$  and the load. The load must be able to handle at least rated output power + 50% ( 7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



### Design Assistance

1. Master key : 848D11E0DD4CA7AE[v1]
2. **TPS543C20A** Product Folder : <http://www.ti.com/product/TPS543C20A> : contains the data sheet and other resources.

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