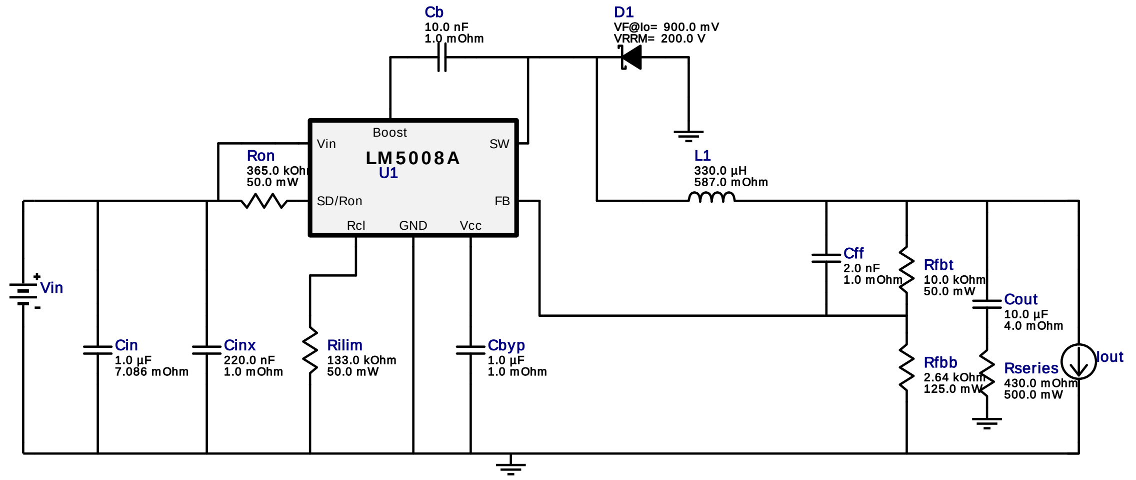
TEXAS INSTRUMENTS

# WEBENCH® Design Report

VinMin = 36.0V
VinMax = 90.0V
Vout = 12.0V
Iout = 0.35A

Device = LM5008AMM/NOPB
Topology = Buck
Created = 2025-07-15 22:45:13.595
BOM Cost = $2.63
BOM Count = 6
Total Pd = 0.85W

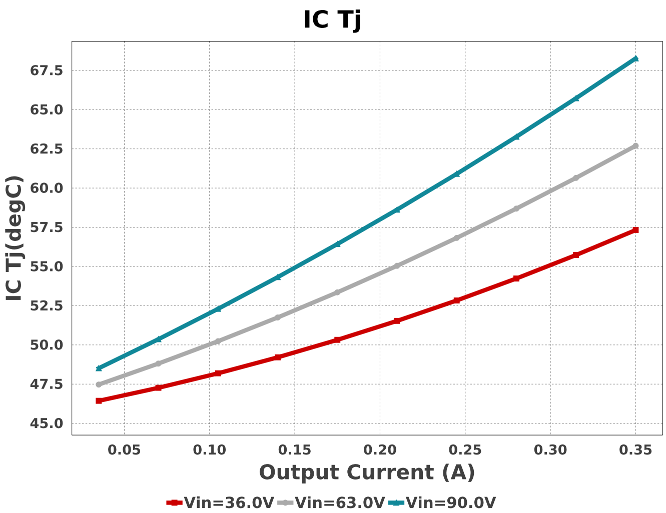
Design : 4 LM5008AMM/NOPB
LM5008AMM/NOPB 36V-90V to 12.00V @ 0.35A

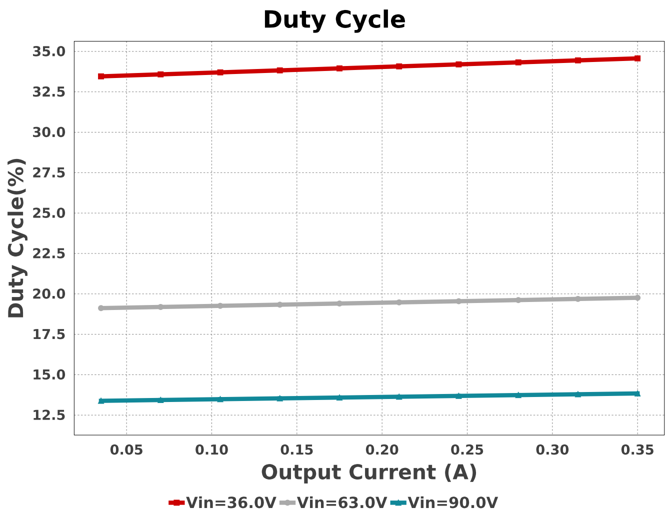


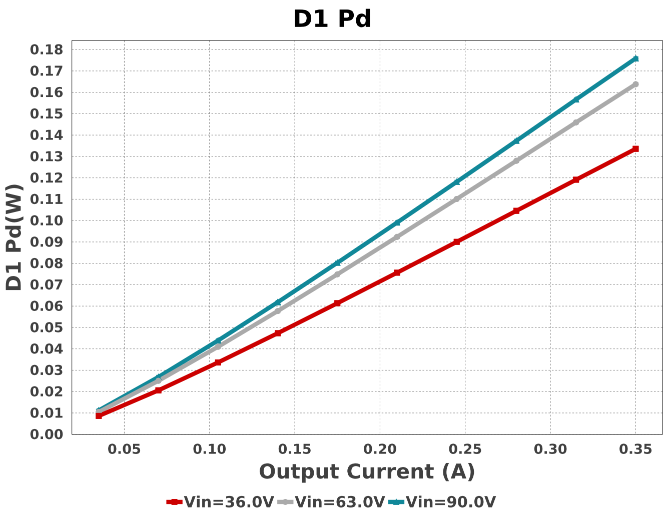

## Electrical BOM

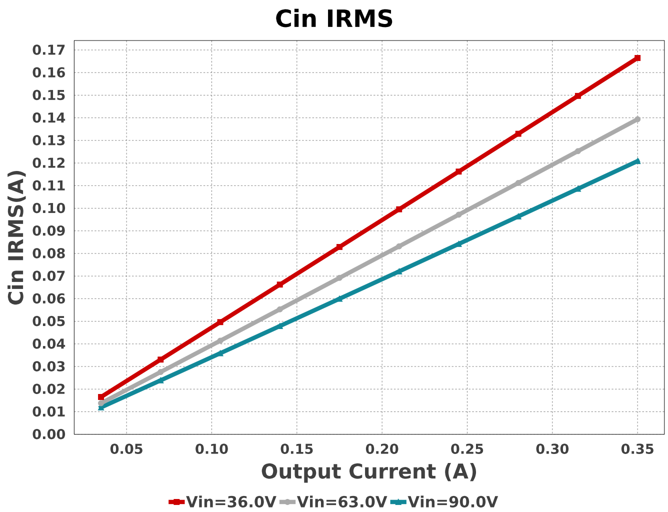
| Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|
| Cb | MuRata | GRM155R71H103KA88D<br>Series= X7R | Cap= 10.0 nF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0402 3 $mm^2$ |
| Cbyp | Taiyo Yuden | EMK107B7105KA-T<br>Series= X7R | Cap= 1.0 uF<br>ESR= 1.0 mOhm<br>VDC= 16.0 V<br>IRMS= 0.0 A | 1 | $0.01 | 0603 5 $mm^2$ |
| Cff | MuRata | GRM1885C1H202JA01D<br>Series= C0G/NP0 | Cap= 2.0 nF<br>ESR= 1.0 mOhm<br>VDC= 50.0 V<br>IRMS= 0.0 A | 1 | $0.02 | 0603 5 $mm^2$ |
| Cin | MuRata | GRM55DR72E105KW01L<br>Series= X7R | Cap= 1.0 uF<br>ESR= 7.086 mOhm<br>VDC= 250.0 V<br>IRMS= 2.0605 A | 1 | $0.35 | 2220_200 54 $mm^2$ |
| Cinx | MuRata | GRM21AR72A224KAC5L<br>Series= X7R | Cap= 220.0 nF<br>ESR= 1.0 mOhm<br>VDC= 100.0 V<br>IRMS= 0.0 A | 1 | $0.08 | 0805 7 $mm^2$ |
| Cout | MuRata | GRM21BR61E106MA73L<br>Series= X5R | Cap= 10.0 uF<br>ESR= 4.0 mOhm<br>VDC= 25.0 V<br>IRMS= 2.8 A | 1 | $0.04 | 0805 7 $mm^2$ |
| D1 | SMC Diode Solutions | SK220ATR | VF@Io= 900.0 mV<br>VRRM= 200.0 V | 1 | $0.06 | SMA 37 $mm^2$ |
| L1 | Wurth Elektronik | 7447720331 | L= 330.0 µH<br>587.0 mOhm | 1 | $0.55 | WE-TI_8095 96 $mm^2$ |
| Rfbb | Yageo | RT0805BRD072K64L<br>Series= ? | Res= 2.64 kOhm<br>Power= 125.0 mW<br>Tolerance= 0.1% | 1 | $0.05 | 0805 7 $mm^2$ |
| Rfbt | Yageo | RC0201FR-0710KL<br>Series= ? | Res= 10.0 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0201 2 $mm^2$ |

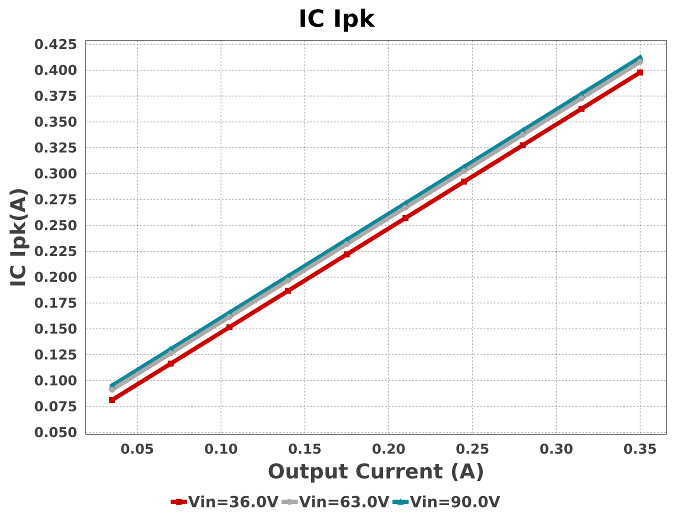
| Name | Manufacturer | Part Number | Properties | Qty | Price | Footprint |
|---|---|---|---|---|---|---|
| Rilim | Yageo | RC0201FR-07133KL<br>Series= ? | Res= 133.0 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0201 2 mm² |
| Ron | Yageo | RC0201FR-07365KL<br>Series= ? | Res= 365.0 kOhm<br>Power= 50.0 mW<br>Tolerance= 1.0% | 1 | $0.01 | 0201 2 mm² |
| Rseries | Rohm | MCR25JZHFLR430<br>Series= MCR25 | Res= 430.0 mOhm<br>Power= 500.0 mW<br>Tolerance= 1.0% | 1 | $0.03 | 1210 15 mm² |
| U1 | Texas Instruments | LM5008AMM/NOPB | Switcher | 1 | $1.39 | MUA08A 24 mm² |

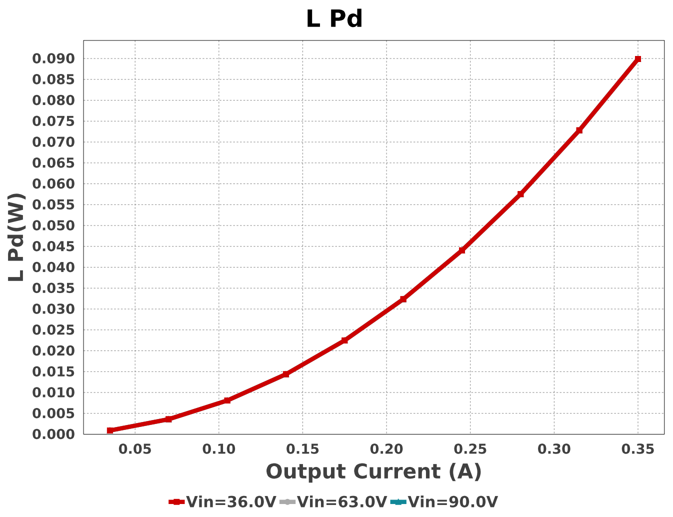


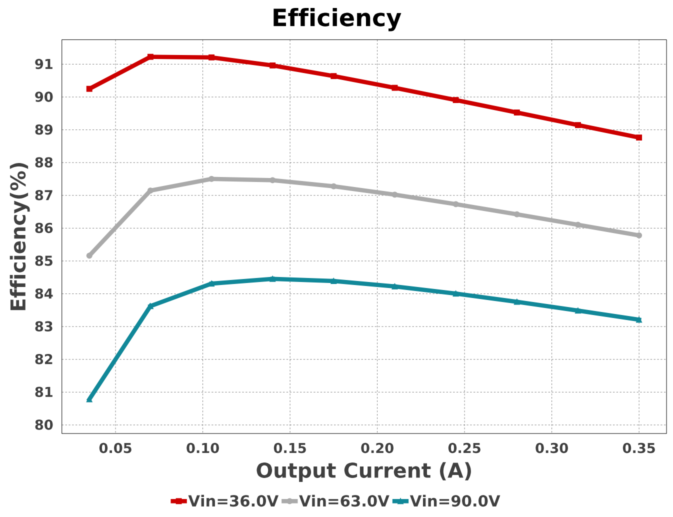



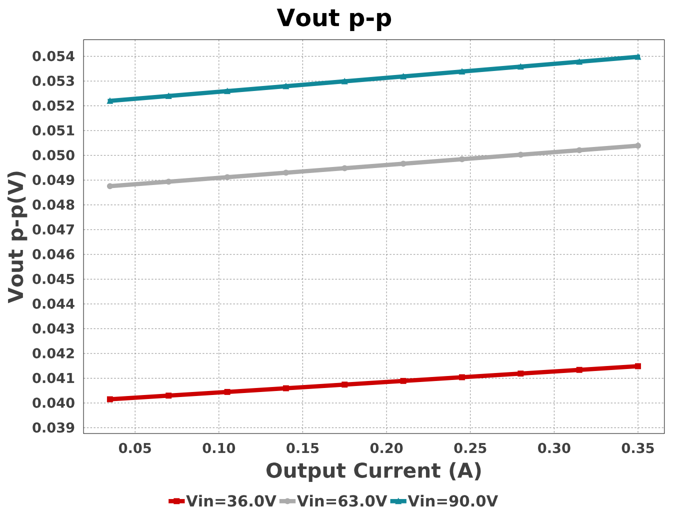



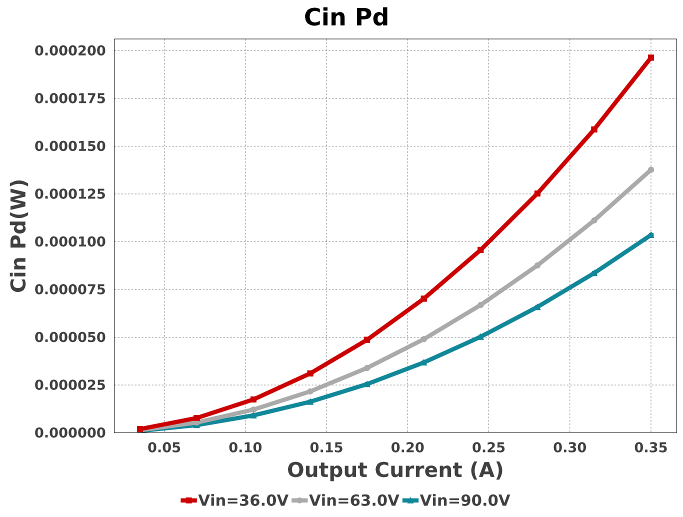



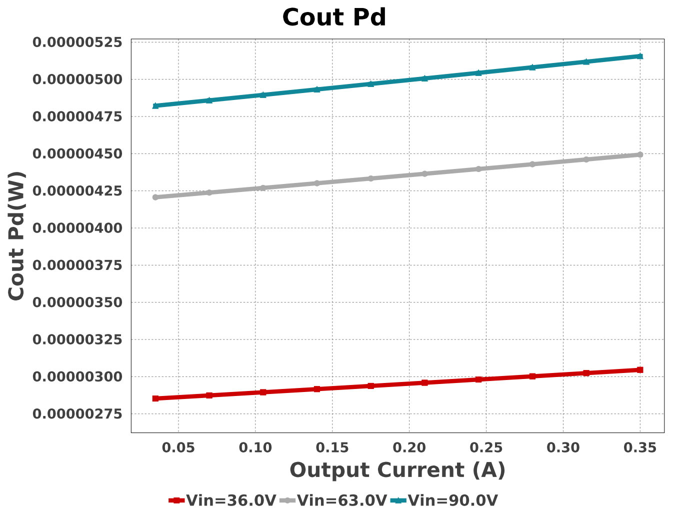

IC Ipk
IC Ipk(A)
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

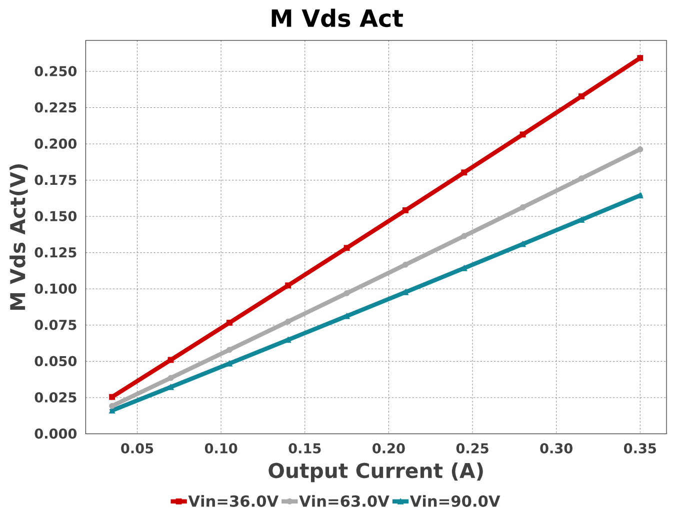

L Pd
L Pd(W)
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

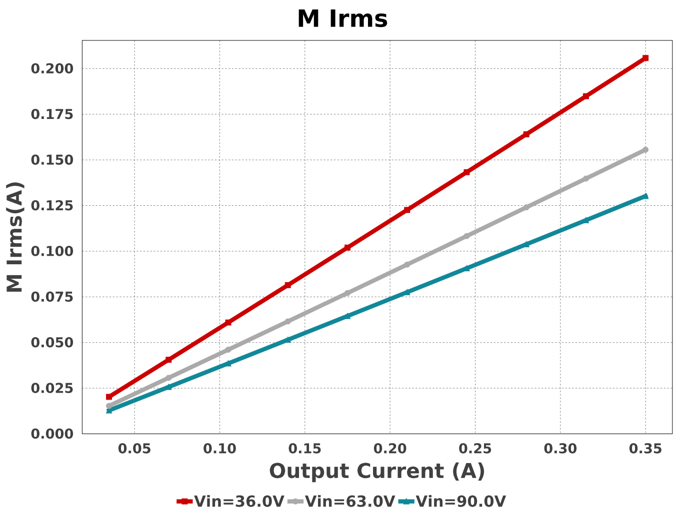

Efficiency
Efficiency(%)
91
90
89
88
87
86
85
84
83
82
81
80
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

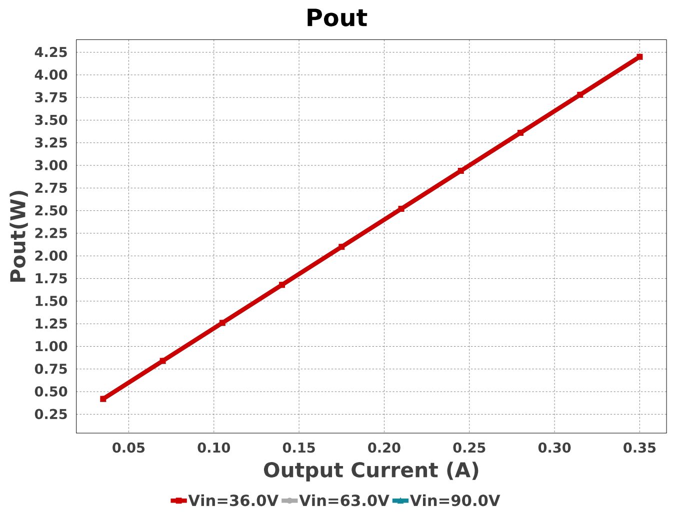

Vout p-p
Vout p-p(V)
0.054
0.053
0.052
0.051
0.050
0.049
0.048
0.047
0.046
0.045
0.044
0.043
0.042
0.041
0.040
0.039
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

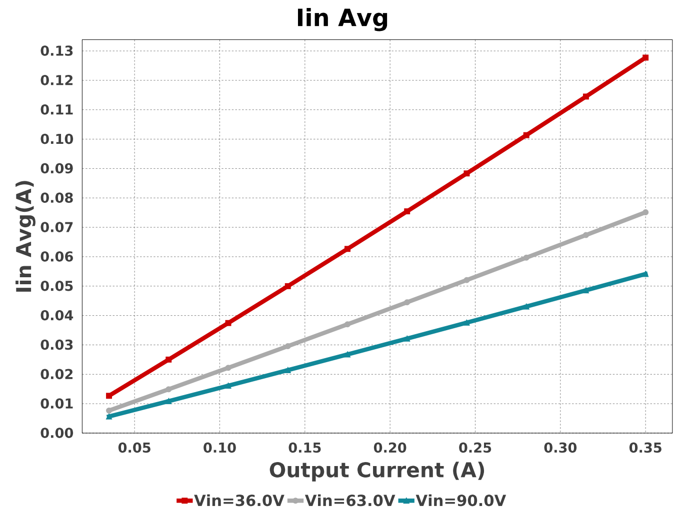

Cin Pd
Cin Pd(W)
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

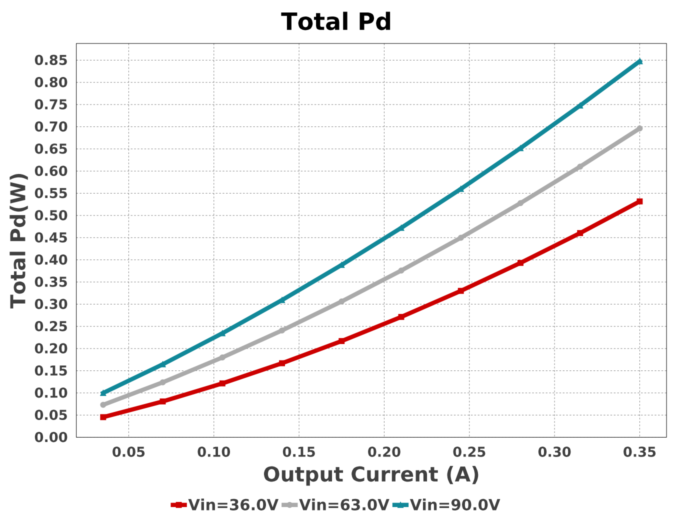

Cout Pd
Cout Pd(W)
0.00000525
0.00000500
0.00000475
0.00000450
0.00000425
0.00000400
0.00000375
0.00000350
0.00000325
0.00000300
0.00000275
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

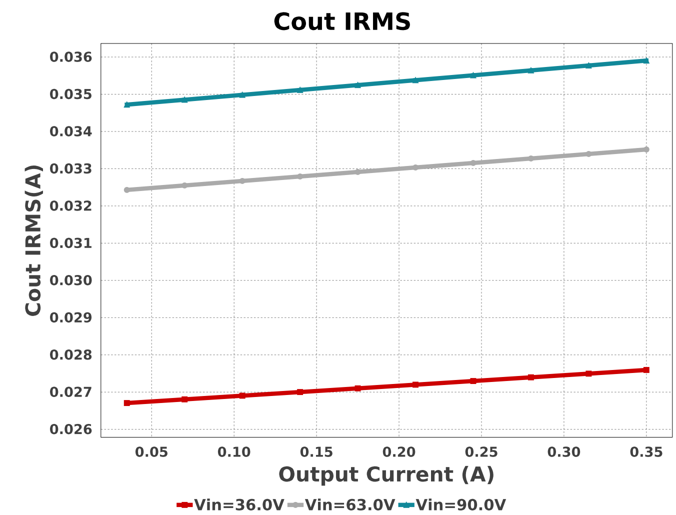

M Vds Act
M Vds Act(V)
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

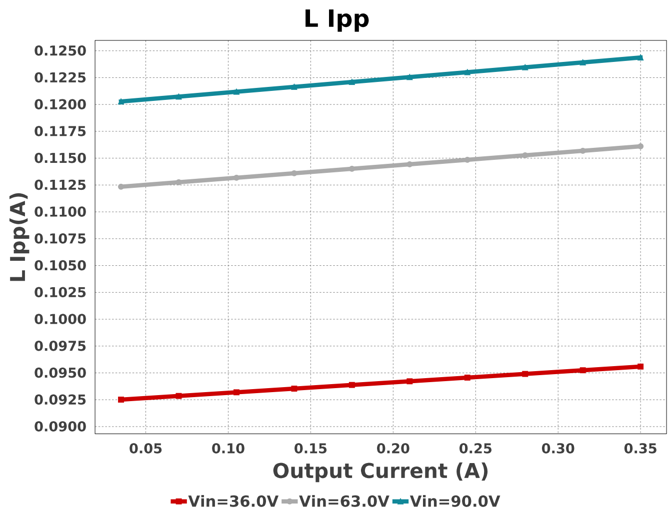

M Irms
M Irms(A)
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V

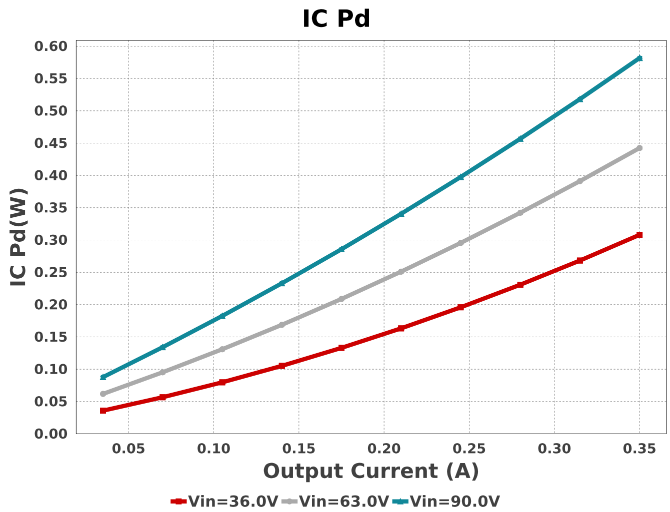

Pout
Pout(W)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V


Iin Avg
Iin Avg(A)
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V


Total Pd
Total Pd(W)
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V


Cout IRMS
Cout IRMS(A)
0.036
0.035
0.034
0.033
0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Output Current (A)
Vin=36.0V
Vin=63.0V
Vin=90.0V




## Operating Values

| # | Name | Value | Category | Description |
|---|---|---|---|---|
| 1. | Cin IRMS | 120.861 mA | Capacitor | Input capacitor RMS ripple current |
| 2. | Cin Pd | 103.51 µW | Capacitor | Input capacitor power dissipation |
| 3. | Cout IRMS | 35.904 mA | Capacitor | Output capacitor RMS ripple current |
| 4. | Cout Pd | 5.156 µW | Capacitor | Output capacitor power dissipation |
| 5. | D1 Pd | 175.87 mW | Diode | Output Diode Power Dissipation |
| 6. | IC Ipk | 412.187 mA | IC | Peak switch current in IC |
| 7. | IC Pd | 581.69 mW | IC | IC power dissipation |
| 8. | IC Tj | 68.268 degC | IC | IC junction temperature |
| 9. | IC Tolerance | 50.0 mV | IC | IC Feedback Tolerance |
| 10. | ICThetaJA | 40.0 degC/W | IC | IC junction-to-ambient thermal resistance |
| 11. | Iin Avg | 54.13 mA | IC | Average input current |
| 12. | L Ipp | 124.374 mA | Inductor | Peak-to-peak inductor ripple current |
| 13. | L Pd | 89.884 mW | Inductor | Inductor power dissipation |
| 14. | M1 Irms | 130.206 mA | Mosfet | Q Iavg |
| 15. | M Vds Act | 164.448 mV | Mosfet | Voltage drop across the MosFET |
| 16. | Cin Pd | 103.51 µW | Power | Input capacitor power dissipation |
| 17. | Cout Pd | 5.156 µW | Power | Output capacitor power dissipation |
| 18. | D1 Pd | 175.87 mW | Power | Output Diode Power Dissipation |
| 19. | IC Pd | 581.69 mW | Power | IC power dissipation |
| 20. | L Pd | 89.884 mW | Power | Inductor power dissipation |
| 21. | Total Pd | 847.552 mW | Power | Total Power Dissipation |
| 22. | BOM Count | 6 | System Information | Total Design BOM count |
| 23. | Duty Cycle | 13.84 % | System Information | Duty cycle |
| 24. | Efficiency | 83.209 % | System Information | Steady state efficiency |
| 25. | FootPrint | 264.0 $mm^2$ | System Information | Total Foot Print Area of BOM components |
| 26. | Frequency | 263.014 kHz | System Information | Switching frequency |
| 27. | Iout | 350.0 mA | System Information | Iout operating point |
| 28. | Mode | CCM | System Information | Conduction Mode |
| 29. | Pout | 4.2 W | System Information | Total output power |
| 30. | Total BOM | $2.625 | System Information | Total BOM Cost |
| 31. | Vin | 90.0 V | System Information | Vin operating point |
| 32. | Vout | 12.0 V | System Information | Operational Output Voltage |
| 33. | Vout Actual | 11.97 V | System Information | Vout Actual calculated based on selected voltage divider resistors |
| 34. | Vout Tolerance | 2.889 % | System Information | Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable |
| 35. | Vout p-p | 53.978 mV | System Information | Peak-to-peak output ripple voltage |

## Design Inputs

| Name | Value | Description |
|---|---|---|
| Iout | 350.0 m | Maximum Output Current |
| VinMax | 90.0 | Maximum input voltage |
| VinMin | 36.0 | Minimum input voltage |
| Vout | 12.0 | Output Voltage |
| base_pn | LM5008A | Base Product Number |
| source | DC | Input Source Type |
| Ta | 45.0 | Ambient temperature |
| UserFsw | 300.0 k | Customer Selected Frequency |

# 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 Cin and Cout, 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

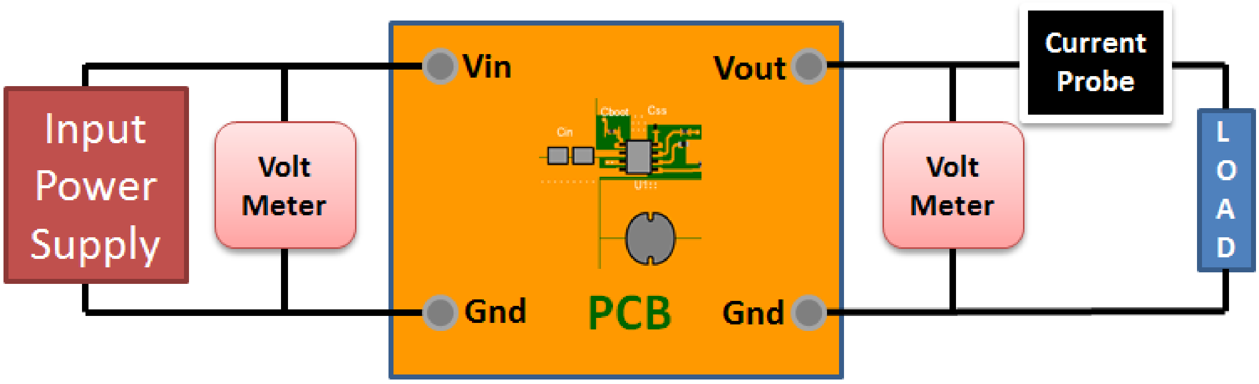
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town 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 36.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout 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 Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout 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. 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. Master key : 899DA37B8B0572B838E91FF5840BDDB6[v1]

3. **LM5008A** Product Folder : http://www.ti.com/product/LM5008A : contains the data sheet and other resources.