

## Description

The GC20N65 uses advanced super junction technology and design to provide excellent  $R_{DS(ON)}$  and low gate charge. This device is suitable for industry AC-DC SMPS requirement of PFC, AC/DC power conversion, and other industrial power applications.

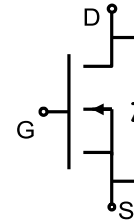
## General Features

- Optimized body diode reverse recovery performance
- Low on-resistance and low conduction losses
- Small Package
- Ultra Low Gate Charge cause lower driving requirement
- 100% Avalanche Tested
- RoHS Compliant

## Application

- Power Factor Correction (PFC)
- Switched Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- LLC Half-bridge

| $V_{DS}$ | $R_{DS(ON)}$<br>@ 10V (Typ) | $I_D$ |
|----------|-----------------------------|-------|
| 650V     | 150mΩ                       | 20 A  |



Schematic Diagram



Marking and Pin Assignment

## Ordering Information

| Part Number | Marking | Case    | Packaging  |
|-------------|---------|---------|------------|
| GC20N65Q    | GC20N65 | TO-247  | 50pcs/Tube |
| GC20N65T    | GC20N65 | TO-220  | 50pcs/Tube |
| GC20N65F    | GC20N65 | TO-220F | 50pcs/Tube |

## Absolute Maximum Ratings ( $T_C=25^\circ\text{C}$ unless otherwise noted)

| Parameter   | Symbol              | Value            |         | Unit |
|---|---------------------|------------------|---------|------|
|   |                     | TO-247<br>TO-220 | TO-220F |      |
| Drain-Source Voltage  | $V_{DS}$            | 650              |         | V    |
| Gate-Source Voltage   | $V_{GS}$            | ±30              |         | V    |
| Drain Current-Continuous ( $T_C=25^\circ\text{C}$ )                     | $I_D$               | 20               |         | A    |
| Drain Current-Continuous ( $T_C=100^\circ\text{C}$ )                    | $I_D$               | 12               |         | A    |
| Drain Current-Pulsed (Note 1)   | $I_{DM}$            | 60               |         | A    |
| Single Pulse Avalanche Energy (Note 2)                                  | $E_{AS}$            | 484              |         | mJ   |
| Repetitive Avalanche Energy (Note 1)                                    | $E_{AR}$            | 0.7              |         | mJ   |
| Avalanche Current (Note 1)  | $I_{AR}$            | 3.5              |         | A    |
| Maximum Power Dissipation ( $T_C=25^\circ\text{C}$ )                    | $P_D$               | 151              | 34      | W    |
| MOSFET dv/dt ruggedness, $V_{DS} = 0 \dots 480\text{V}$                 | dv/dt               | 50               |         | V/ns |
| Reverse diode dv/dt, $V_{DS} = 0 \dots 480\text{V}$ , $I_{SD} \leq I_D$ | di <sub>F</sub> /dt | 15               |         | V/μs |
| Operating Junction and Storage Temperature Range                        | $T_J, T_{STG}$      | -55 To 150       |         | °C   |

## Thermal Characteristic

| Parameter                                       | Symbol     | Value            |         | Unit |
|---|------------|------------------|---------|------|
|   |            | TO-247<br>TO-220 | TO-220F |      |
| Thermal Resistance,Junction-to-Case             | $R_{thJC}$ | 0.83             | 3.7     | °C/W |
| Thermal Resistance,Junction-to-Ambient (Note 2) | $R_{thJA}$ | 62               | 80      | °C/W |

## Electrical Characteristics ( $T_A=25^{\circ}\text{C}$ unless otherwise noted)

| Parameter   | Symbol       | Condition  | Min | Typ  | Max       | Unit       |
|---|--------------|--|-----|------|-----------|------------|
| <b>On/ Off Characteristics</b>                                |              |  |     |      |           |            |
| Drain-Source Breakdown Voltage                                | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                                | 650 | -    | -         | V          |
| Zero Gate Voltage Drain Current ( $T_C=25^{\circ}\text{C}$ )  | $I_{DSS}$    | $V_{DS}=650V, V_{GS}=0V$                                 | -   | -    | 1         | $\mu A$    |
| Zero Gate Voltage Drain Current ( $T_C=125^{\circ}\text{C}$ ) | $I_{DSS}$    | $V_{DS}=650V, V_{GS}=0V$                                 | -   | -    | 100       | $\mu A$    |
| Gate-Body Leakage Current                                     | $I_{GSS}$    | $V_{GS}=\pm 30V, V_{DS}=0V$                              | -   | -    | $\pm 100$ | nA         |
| <b>On Characteristics (Note 3)</b>                            |              |  |     |      |           |            |
| Gate Threshold Voltage  | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                            | 2.5 | -    | 4.5       | V          |
| Drain-Source On-State Resistance                              | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=10A$                                    | -   | 150  | 170       | m $\Omega$ |
| Gate resistance   | $R_G$        | $f = 1.0\text{MHz}$ open drain                           | -   | 12   | -         | $\Omega$   |
| <b>Dynamic Characteristics (Note4)</b>                        |              |  |     |      |           |            |
| Input Capacitance   | $C_{iss}$    | $V_{DS}=100V, V_{GS}=0$<br>$V, F=1.0\text{MHz}$          | -   | 1724 | -         | PF         |
| Output Capacitance  | $C_{oss}$    |  | -   | 61   | -         | PF         |
| Reverse Transfer Capacitance                                  | $C_{rss}$    |  | -   | 6    | -         | PF         |
| <b>Switching Characteristics (Note 4)</b>                     |              |  |     |      |           |            |
| Turn-on Delay Time  | $t_{d(on)}$  | $V_{DD}=400V, I_D=20A$<br>$V_{GS}=10V, R_{GEN}=25\Omega$ | -   | 15   | -         | ns         |
| Turn-on Rise Time   | $t_r$        |  | -   | 59   | -         | ns         |
| Turn-Off Delay Time   | $t_{d(off)}$ |  | -   | 121  | -         | ns         |
| Turn-Off Fall Time  | $t_f$        |  | -   | 44   | -         | ns         |
| Total Gate Charge   | $Q_g$        | $V_{DD}=520V, I_D=20A, V_{GS}=10V$                       | -   | 39   | -         | nC         |
| Gate-Source Charge  | $Q_{gs}$     |  | -   | 8    | -         | nC         |
| Gate-Drain Charge   | $Q_{gd}$     |  | -   | 15   | -         | nC         |
| <b>Drain-Source Diode Characteristics</b>                     |              |  |     |      |           |            |
| Continuous Body Diode Current                                 | $I_S$        | $T_C=25^{\circ}\text{C}$                                 | -   | -    | 20        | A          |
| Pulsed Diode Forward Current                                  | $I_{SM}$     | $T_C=25^{\circ}\text{C}$                                 | -   | -    | 60        | A          |
| Diode Forward Voltage   | $V_{SD}$     | $T_J=25^{\circ}\text{C},$<br>$I_{SD}=20A, V_{GS}=0V$     | -   | -    | 1.2       | V          |
| Reverse Recovery Time   | $t_{rr}$     | $V_R=400V, I_F=I_S,$<br>$di_F/dt = 100A/\mu s$           | -   | 423  | -         | ns         |
| Reverse Recovery Charge                                       | $Q_{rr}$     |  | -   | 5.3  | -         | $\mu C$    |
| Peak Reverse Recovery Current                                 | $I_{rrm}$    |  | -   | 25   | -         | A          |

## Notes:

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2.  $I_{AS} = 3.5A, V_{DD} = 50V, R_G = 25\Omega, \text{Starting } T_J = 25^{\circ}\text{C}$
3. Pulse Test: Pulse Width  $\leq 300\mu s, \text{Duty Cycle } \leq 1\%$ .
4. Guaranteed by design, not subject to production

Typical Electrical And Thermal Characteristics

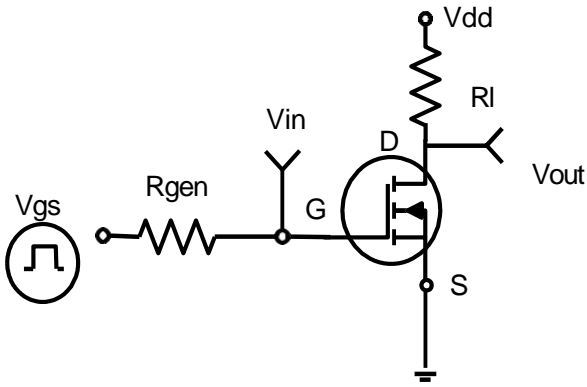


Figure 1. Switching Test Circuit

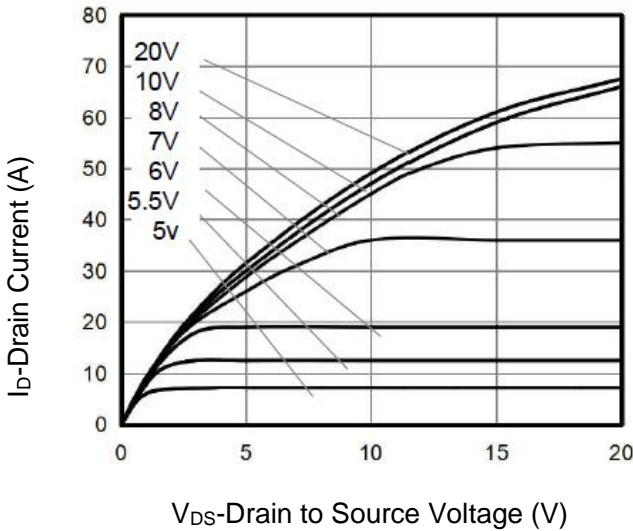


Figure 3. Output Characteristics

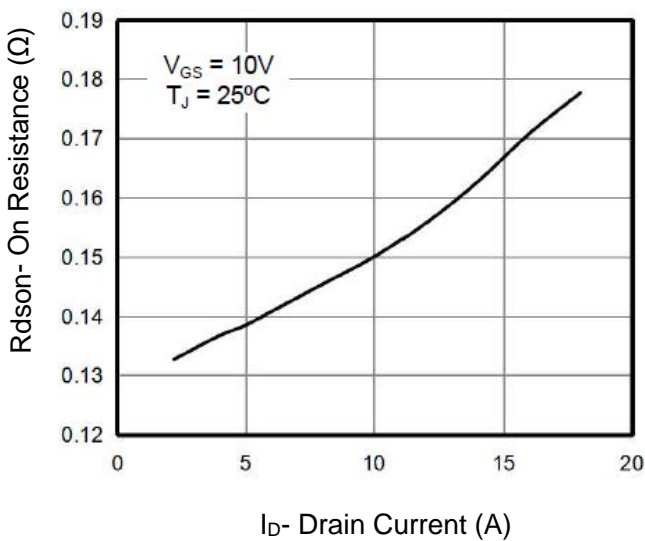


Figure 5. On Resistance vs. Drain Current

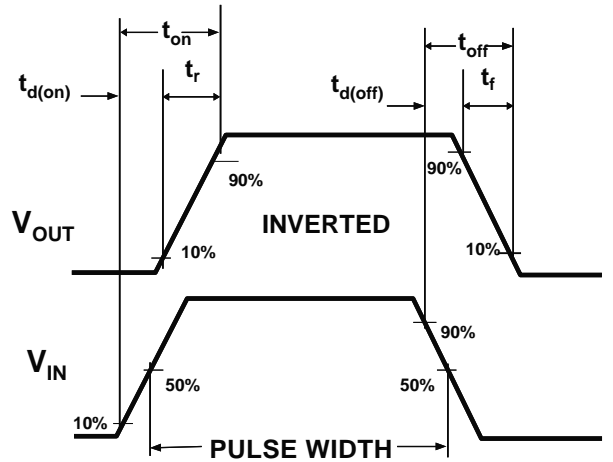


Figure 2. Switching Waveforms

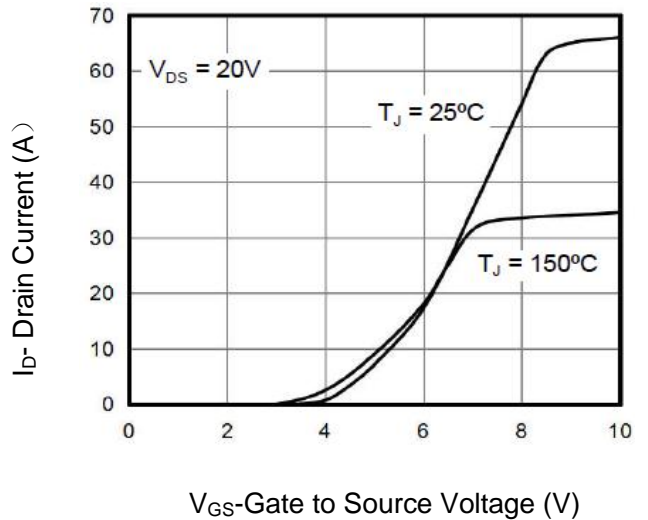


Figure 4. Transfer Characteristics

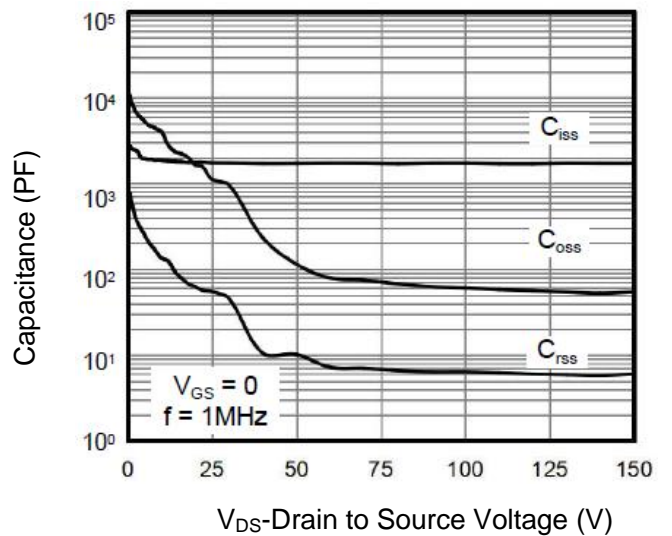


Figure 6. Capacitance

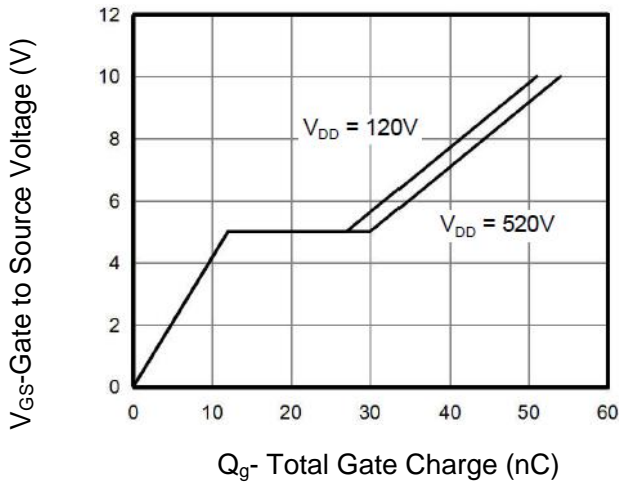


Figure 7. Gate Charge

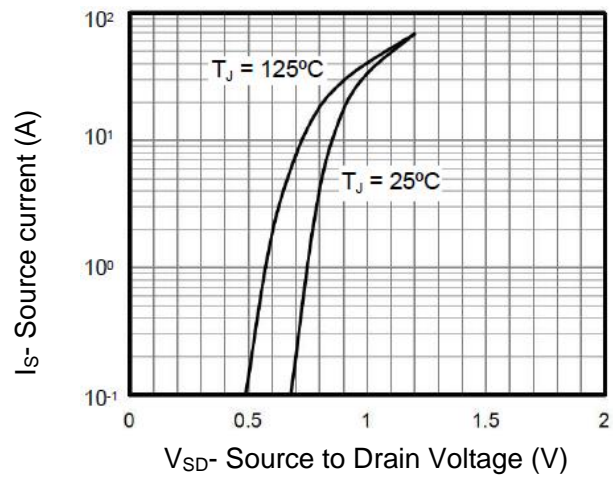


Figure 8. Body Diode Forward Voltage

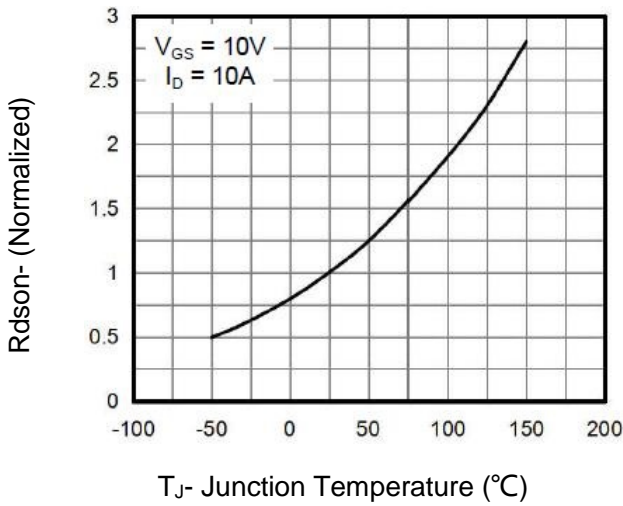


Figure 9. On- Resistance vs. Junction Temperature

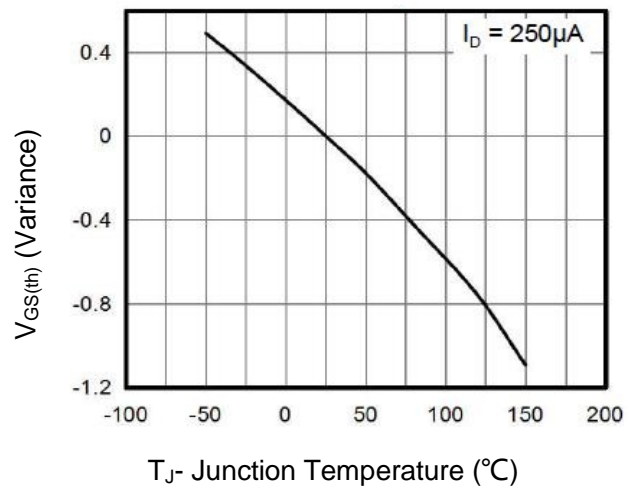


Figure 10. Threshold Voltage vs. Junction Temperature

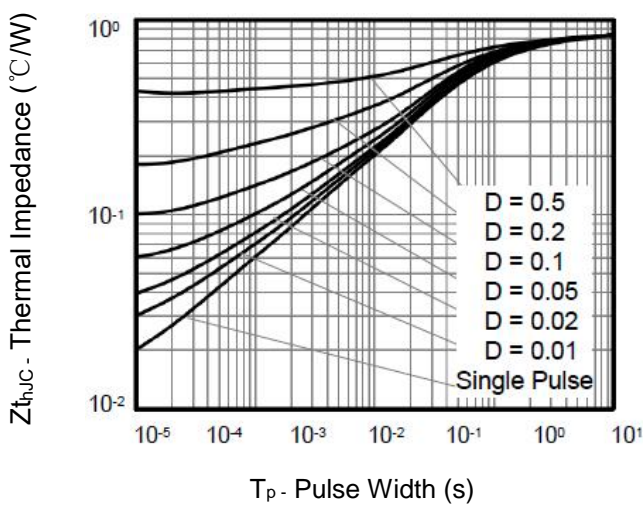


Figure 11. Transient Thermal Impedance (TO-247/TO-220)

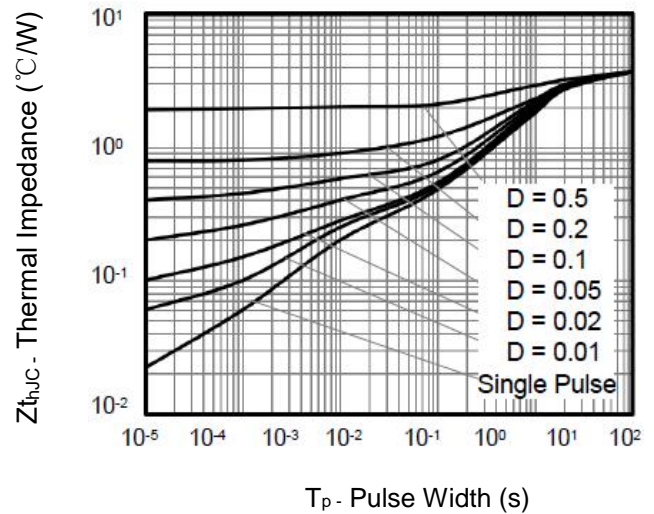
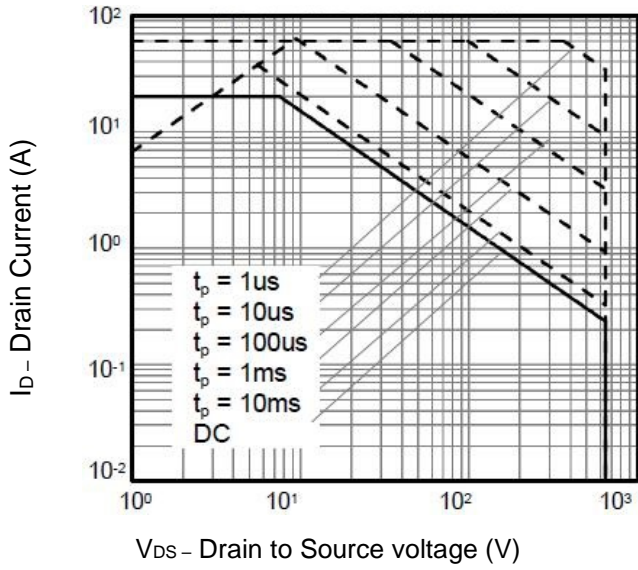
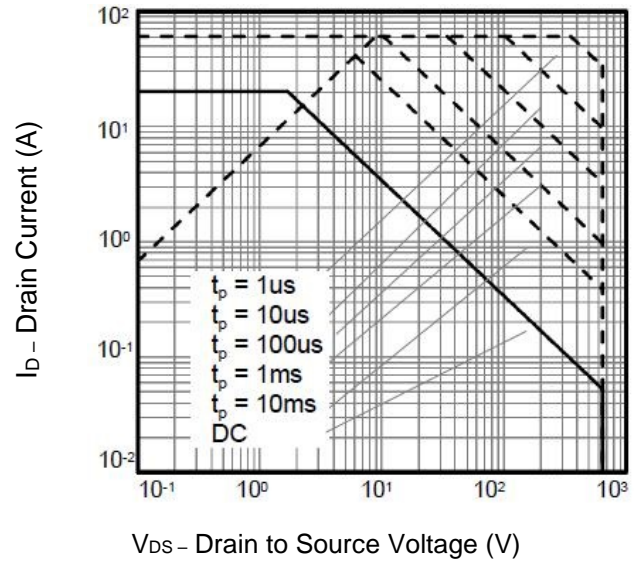


Figure 12. Transient Thermal Impedance (TO-220F)

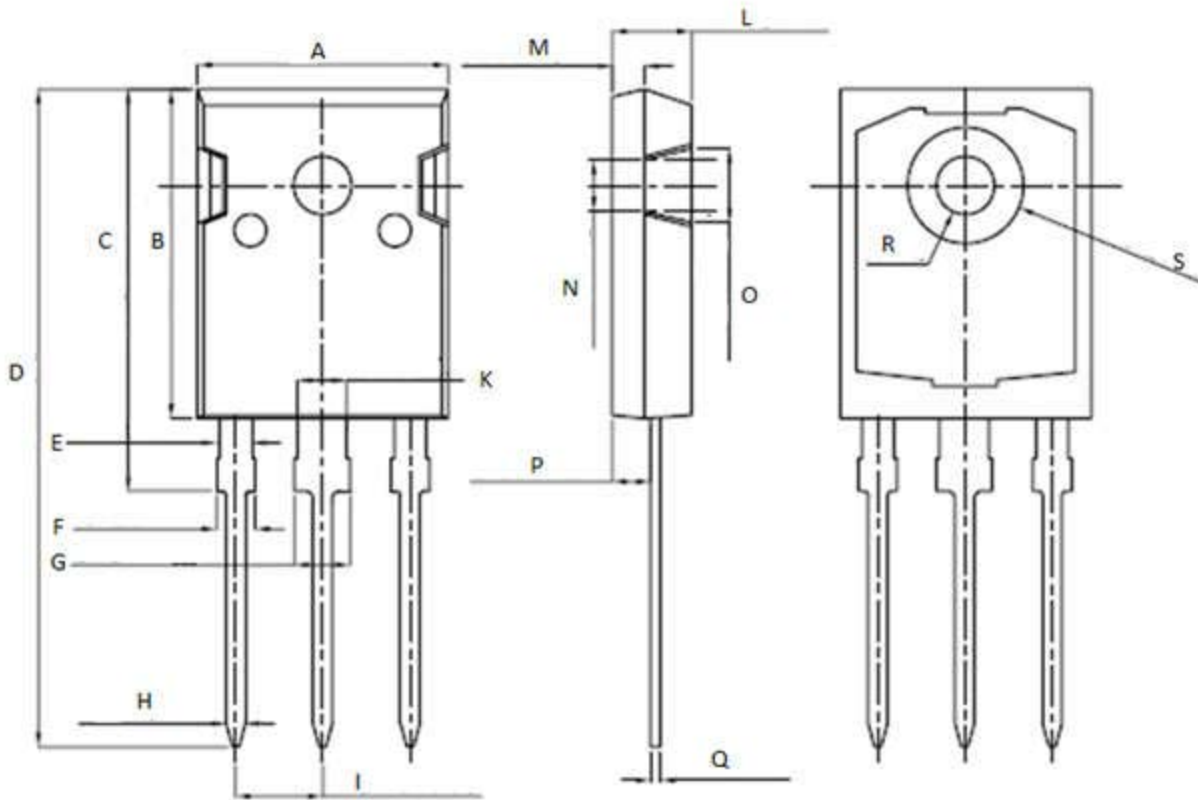


**Figure 13. Safe Operation Area for TO-247/TO-220**



**Figure 14. Safe Operation Area for TO-220F**

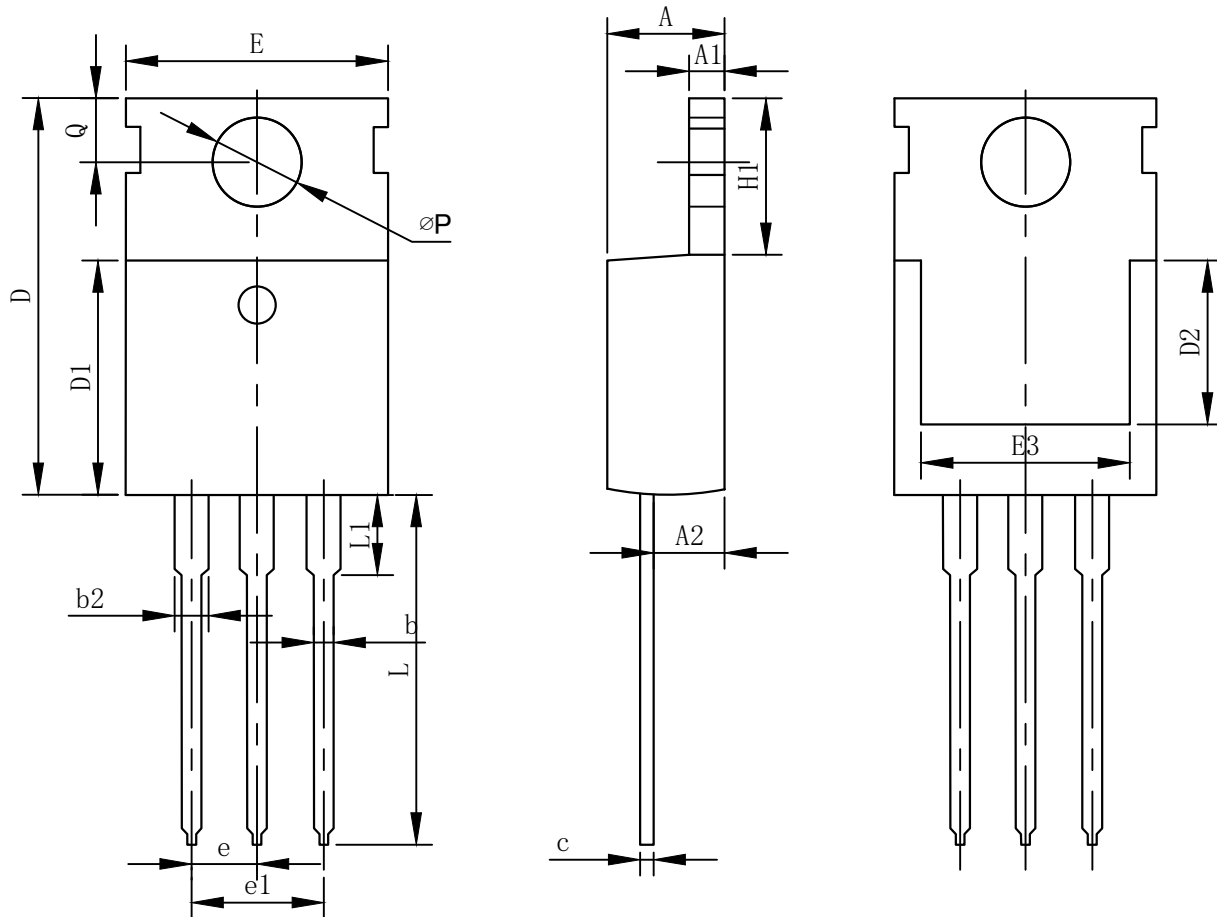
**TO-247 Package information**



| Unit: mm |       |       |
|----------|-------|-------|
| Symbol   | Min.  | Max.  |
| A        | 15.95 | 16.25 |
| B        | 20.85 | 21.25 |
| C        | 20.95 | 21.35 |
| D        | 40.5  | 40.9  |
| E        | 1.9   | 2.1   |
| F        | 2.1   | 2.25  |
| G        | 3.1   | 3.25  |
| H        | 1.1   | 1.3   |
| I        | 5.40  | 5.50  |

| Unit: mm |      |      |
|----------|------|------|
| Symbol   | Min. | Max. |
| K        | 2.90 | 3.10 |
| L        | 4.90 | 5.30 |
| M        | 1.90 | 2.10 |
| N        | 4.50 | 4.70 |
| O        | 5.40 | 5.60 |
| P        | 2.29 | 2.49 |
| Q        | 0.51 | 0.71 |
| R        | Φ3.5 | Φ3.7 |
| S        | Φ7.1 | Φ7.3 |

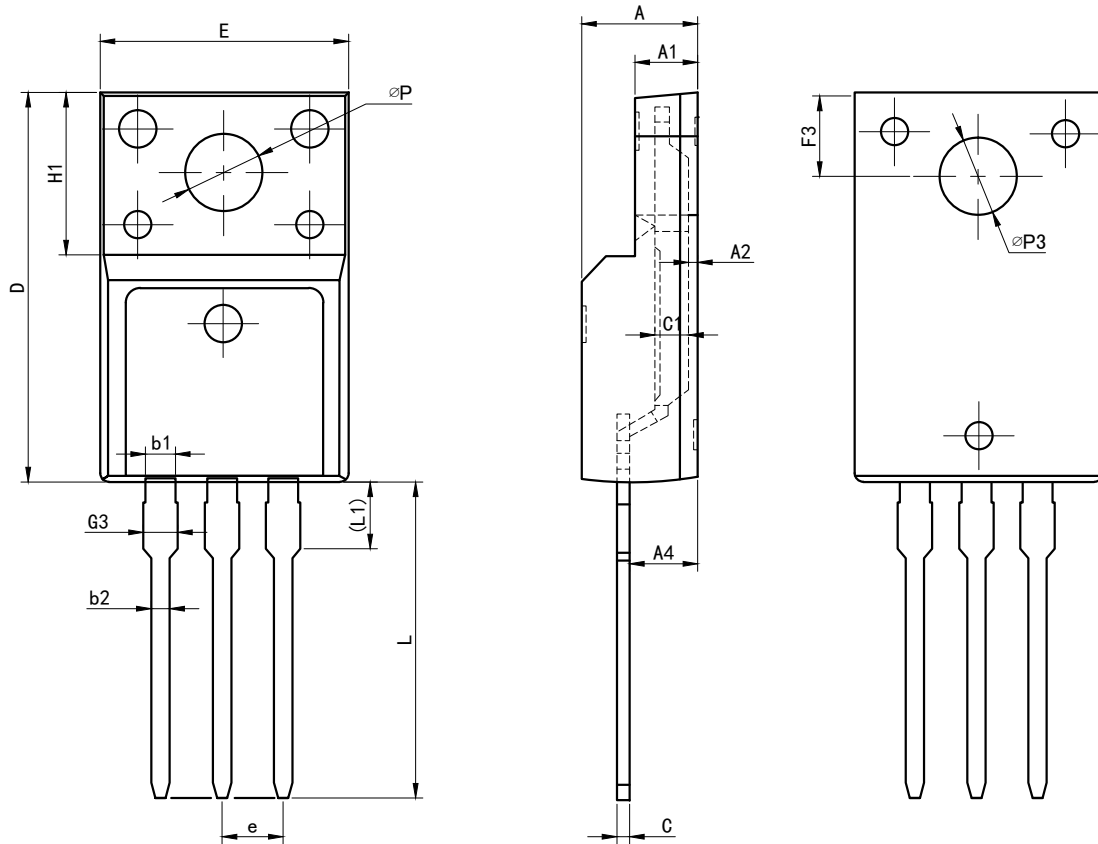
TO-220 Package information



COMMON DIMENSIONS

| SYMBOL | mm      |       |       |
|--------|---------|-------|-------|
|        | MIN     | NOM   | MAX   |
| A      | 4.37    | 4.57  | 4.70  |
| A1     | 1.25    | 1.30  | 1.40  |
| A2     | 2.20    | 2.40  | 2.60  |
| b      | 0.70    | 0.80  | 0.95  |
| b2     | 1.70    | 1.27  | 1.47  |
| c      | 0.45    | 0.50  | 0.60  |
| D      | 15.10   | 15.60 | 16.10 |
| D1     | 8.80    | 9.10  | 9.40  |
| D2     | 5.50    | -     | -     |
| E      | 9.70    | 10.00 | 10.30 |
| E3     | 7.00    | -     | -     |
| e      | 2.54BSC |       |       |
| e1     | 5.08BSC |       |       |
| H1     | 6.25    | 6.50  | 6.85  |
| L      | 12.75   | 13.50 | 13.80 |
| L1     | -       | 3.10  | 3.40  |
| øP     | 3.40    | 3.60  | 3.80  |
| Q      | 2.60    | 2.80  | 3.00  |

## TO-220F Package information



### COMMON DIMENSIONS

| SYMBOL    | mm      |       |       |
|-----------|---------|-------|-------|
|           | MIN     | NOM   | MAX   |
| E         | 9.96    | 10.16 | 10.36 |
| A         | 4.50    | 4.70  | 4.90  |
| A1        | 2.34    | 2.54  | 2.74  |
| A2        | 0.30    | 0.45  | 0.60  |
| A4        | 2.56    | 2.76  | 2.96  |
| c         | 0.40    | 0.50  | 0.65  |
| c1        | 1.20    | 1.30  | 1.35  |
| D         | 15.57   | 15.87 | 16.17 |
| H1        | 6.70REF |       |       |
| e         | 2.54BSC |       |       |
| L         | 12.68   | 12.98 | 13.28 |
| L1        | 2.93    | 3.03  | 3.13  |
| $\phi P$  | 3.03    | 3.18  | 3.38  |
| $\phi P3$ | 3.15    | 3.45  | 3.65  |
| F3        | 3.15    | 3.30  | 3.45  |
| G3        | 1.25    | 1.35  | 1.55  |
| b1        | 1.18    | 1.28  | 1.43  |
| b2        | 0.70    | 0.80  | 0.95  |