

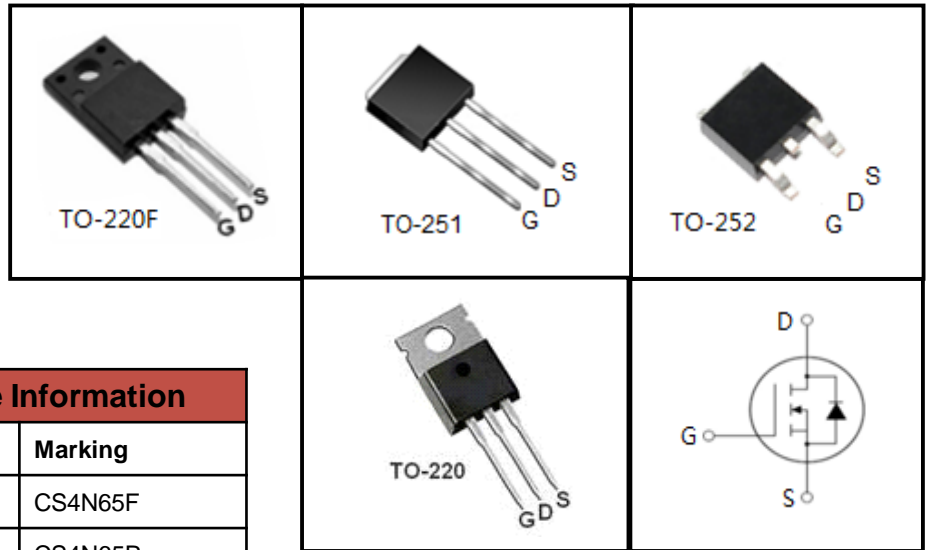
## 650V N-Channel MOSFET

### FEATURES

- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

### APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)



### Device Marking and Package Information

| Device  | Package | Marking |
|---------|---------|---------|
| CS4N65F | TO-220F | CS4N65F |
| CS4N65P | TO-220  | CS4N65P |
| CS4N65U | TO-251  | CS4N65U |
| CS4N65D | TO-252  | CS4N65D |

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

| Parameter  | Symbol         | Value    |        |        |        | Unit             |
|--|----------------|----------|--------|--------|--------|------------------|
|  |                | TO-220F  | TO-220 | TO-251 | TO-252 |                  |
| Drain-Source Voltage ( $V_{GS} = 0V$ )           | $V_{DSS}$      | 650      |        |        |        | V                |
| Continuous Drain Current                         | $I_D$          | 4        |        |        |        | A                |
| Pulsed Drain Current (note1)                     | $I_{DM}$       | 16       |        |        |        | A                |
| Gate-Source Voltage                              | $V_{GSS}$      | $\pm 20$ |        |        |        | V                |
| Single Pulse Avalanche Energy (note2)            | $E_{AS}$       | 76       |        |        |        | mJ               |
| Avalanche Current (note1)                        | $I_{AS}$       | 4        |        |        |        | A                |
| Repetitive Avalanche Energy (note1)              | $E_{AR}$       | 45       |        |        |        | mJ               |
| Power Dissipation ( $T_C = 25^\circ\text{C}$ )   | $P_D$          | 20       | 25     |        |        | W                |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | -55~+150 |        |        |        | $^\circ\text{C}$ |

### Thermal Resistance

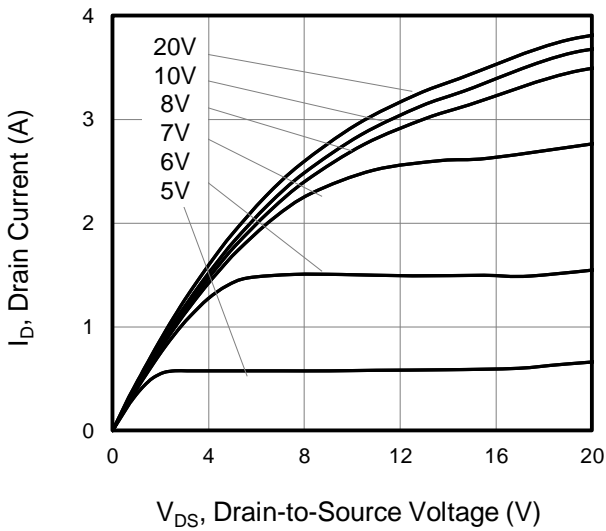
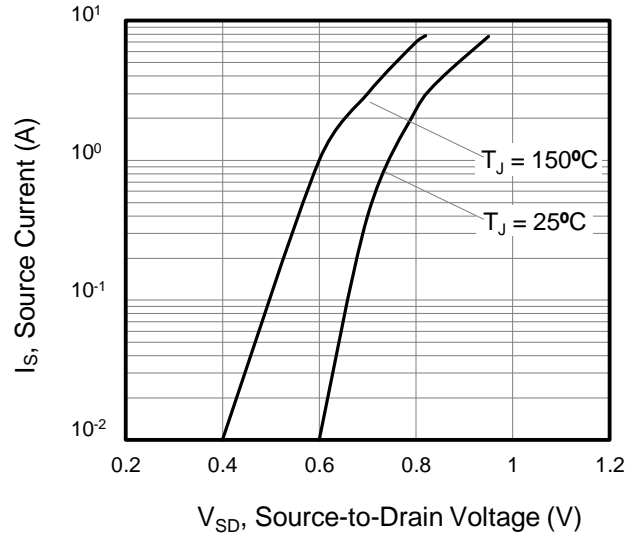
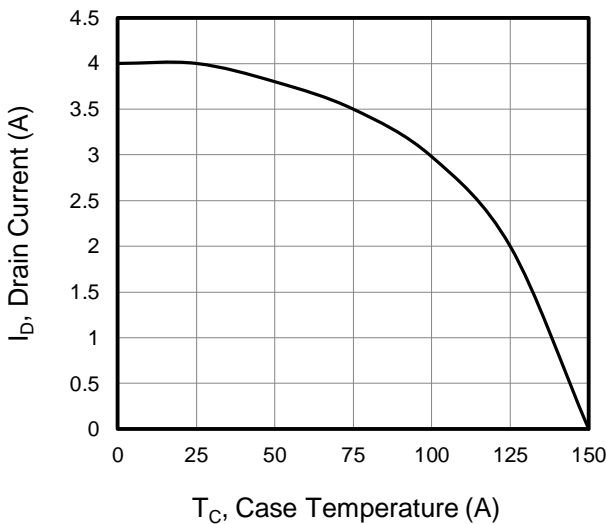
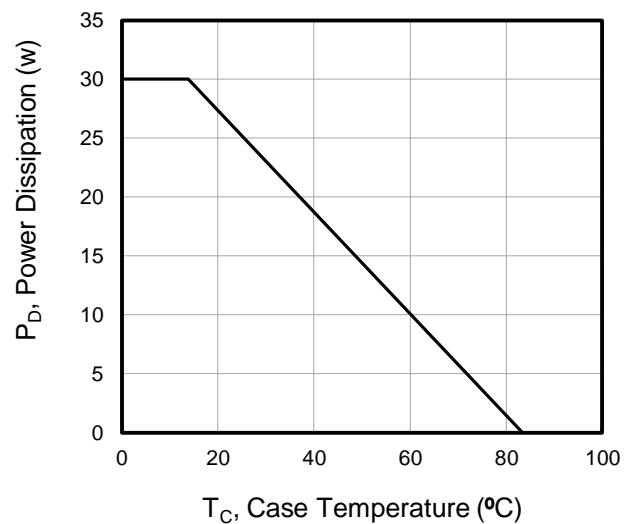
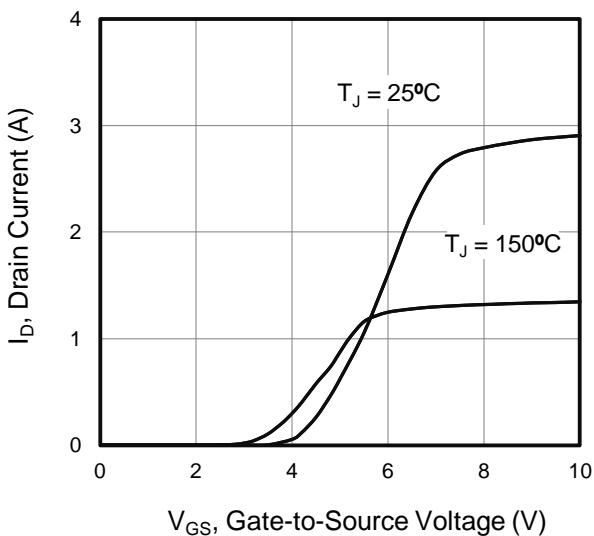
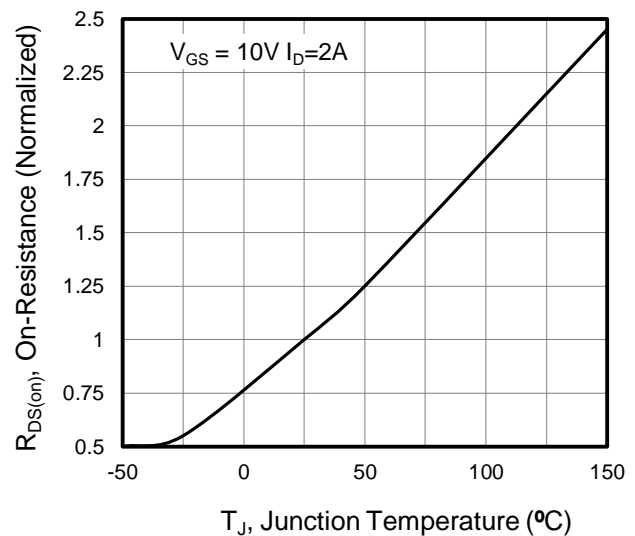
| Parameter                               | Symbol     | Value   |        |        |        | Unit |
|---|------------|---------|--------|--------|--------|------|
|   |            | TO-220F | TO-251 | TO-252 | TO-220 |      |
| Thermal Resistance, Junction-to-Case    | $R_{thJC}$ | 6.25    | 5      |        |        | K/W  |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 62.5    | 60     |        |        |      |

| Specifications $T_J = 25^\circ\text{C}$ , unless otherwise noted |               |  |       |      |           |          |
|--|---------------|--|-------|------|-----------|----------|
| Parameter  | Symbol        | Test Conditions                                      | Value |      |           | Unit     |
|  |               |  | Min.  | Typ. | Max.      |          |
| <b>Static</b>  |               |  |       |      |           |          |
| Drain-Source Breakdown Voltage                                   | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = 250\mu A$                        | 650   | --   | --        | V        |
| Zero Gate Voltage Drain Current                                  | $I_{DSS}$     | $V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$ | --    | --   | 1         | $\mu A$  |
| Gate-Source Leakage  | $I_{GSS}$     | $V_{GS} = \pm 20V$                                   | --    | --   | $\pm 100$ | nA       |
| Gate-Source Threshold Voltage                                    | $V_{GS(th)}$  | $V_{DS} = V_{GS}, I_D = 250\mu A$                    | 3.0   | --   | 4.0       | V        |
| Drain-Source On-Resistance (Note3)                               | $R_{DS(on)}$  | $V_{GS} = 10V, I_D = 2A$                             | --    | 2    | 2.4       | $\Omega$ |
| <b>Dynamic</b>   |               |  |       |      |           |          |
| Input Capacitance  | $C_{iss}$     | $V_{GS} = 0V, V_{DS} = 25V, f = 1.0\text{MHz}$       | --    | 545  | --        | pF       |
| Output Capacitance   | $C_{oss}$     |  | --    | 53   | --        |          |
| Reverse Transfer Capacitance                                     | $C_{rss}$     |  | --    | 4.5  | --        |          |
| Total Gate Charge  | $Q_g$         | $V_{DD} = 520V, I_D = 4A, V_{GS} = 10V$              | --    | 15   | --        | nC       |
| Gate-Source Charge   | $Q_{gs}$      |  | --    | 3    | --        |          |
| Gate-Drain Charge  | $Q_{gd}$      |  | --    | 7    | --        |          |
| Turn-on Delay Time   | $t_{d(on)}$   | $V_{DD} = 250V, I_D = 4A, R_G = 25\Omega$            | --    | 36   | --        | ns       |
| Turn-on Rise Time  | $t_r$         |  | --    | 13   | --        |          |
| Turn-off Delay Time  | $t_{d(off)}$  |  | --    | 80   | --        |          |
| Turn-off Fall Time   | $t_f$         |  | --    | 24   | --        |          |
| <b>Drain-Source Body Diode Characteristics</b>                   |               |  |       |      |           |          |
| Continuous Body Diode Current                                    | $I_S$         | $T_C = 25^\circ\text{C}$                             | --    | --   | 4         | A        |
| Pulsed Diode Forward Current                                     | $I_{SM}$      |  | --    | --   | 16        |          |
| Body Diode Voltage   | $V_{SD}$      | $T_J = 25^\circ\text{C}, I_{SD} = 2.0A, V_{GS} = 0V$ | --    | --   | 1.4       | V        |
| Reverse Recovery Time  | $t_{rr}$      | $V_{GS} = 0V, I_S = 4A, di_F/dt = 100A/\mu s$        | --    | 550  | --        | ns       |
| Reverse Recovery Charge  | $Q_{rr}$      |  | --    | 1.38 | --        | $\mu C$  |

### Notes

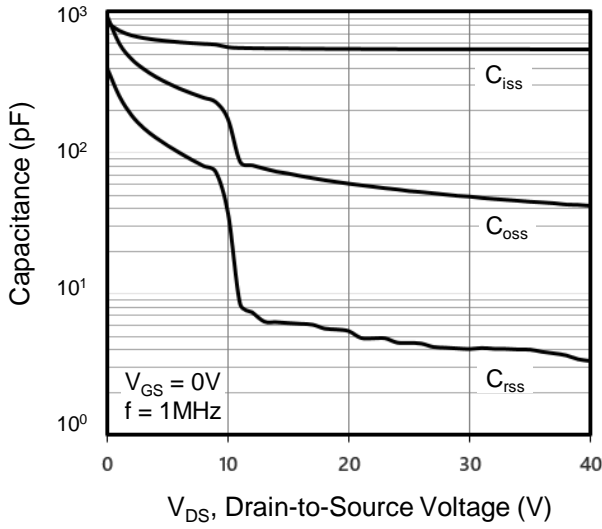
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $L = 10.0\text{mH}, V_{DD} = 50V, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty Cycle  $\leq 1\%$

**Typical Characteristics**  $T_J = 25^\circ\text{C}$ , unless otherwise noted

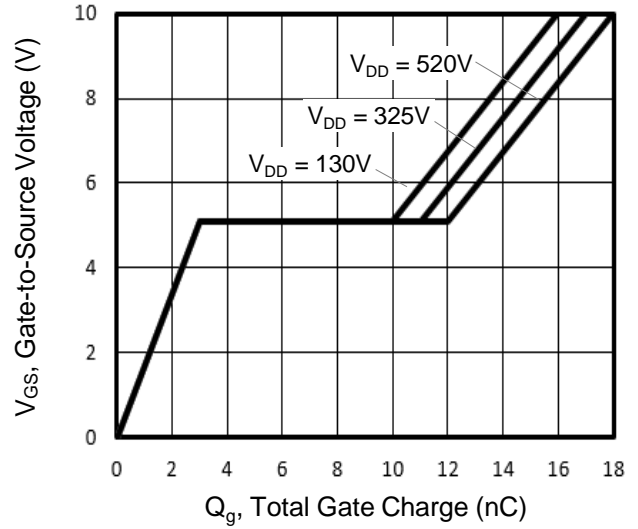
**Figure 1. Output Characteristics ( $T_J = 25^\circ\text{C}$ )**

**Figure 2. Body Diode Forward Voltage**

**Figure 3. Drain Current vs. Temperature**

**Figure 4. Power Dissipation vs. Temperature**

**Figure 5. Transfer Characteristics**

**Figure 6. On-Resistance vs. Temperature**


Typical Characteristics  $T_J = 25^\circ\text{C}$ , unless otherwise noted

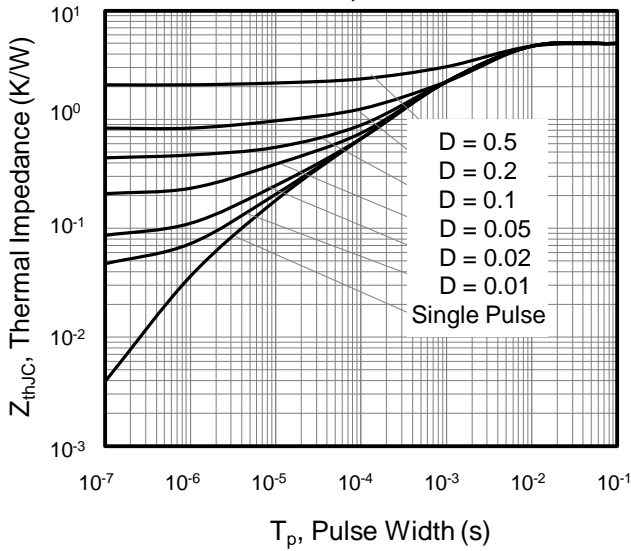
**Figure 7. Capacitance**



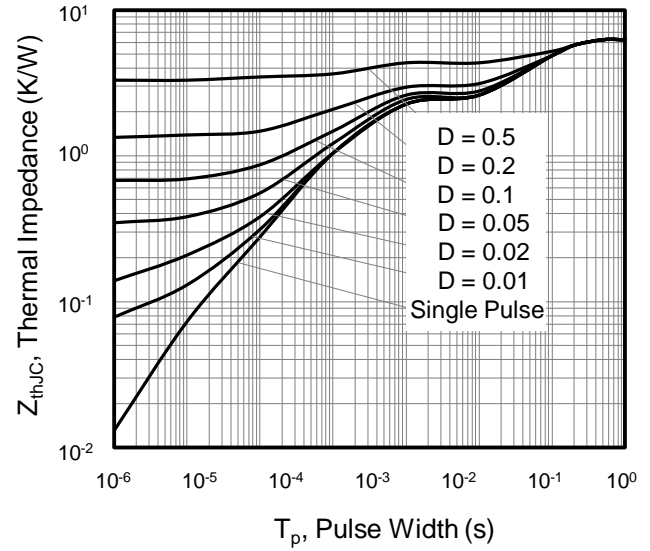
**Figure 8. Gate Charge**



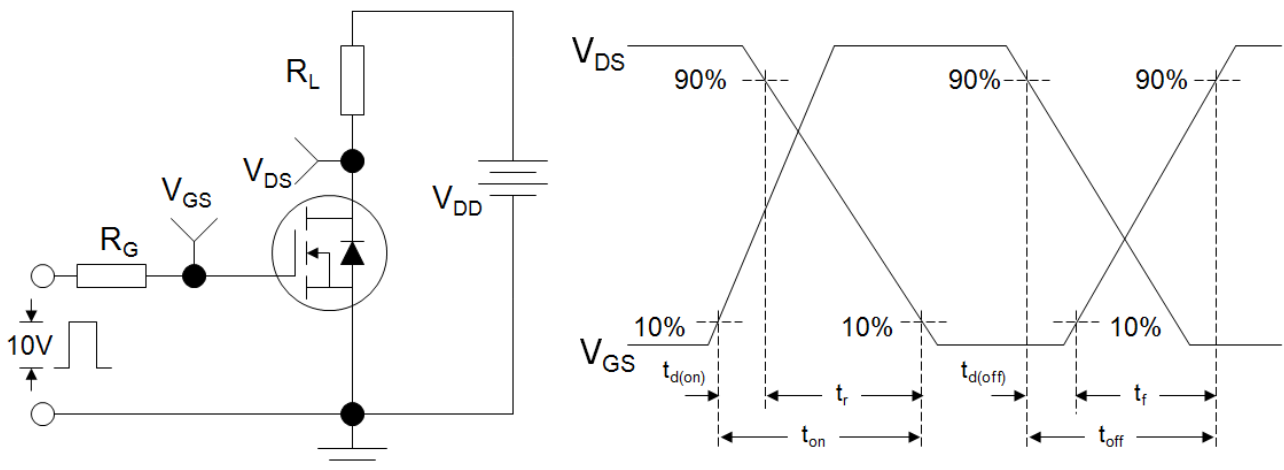
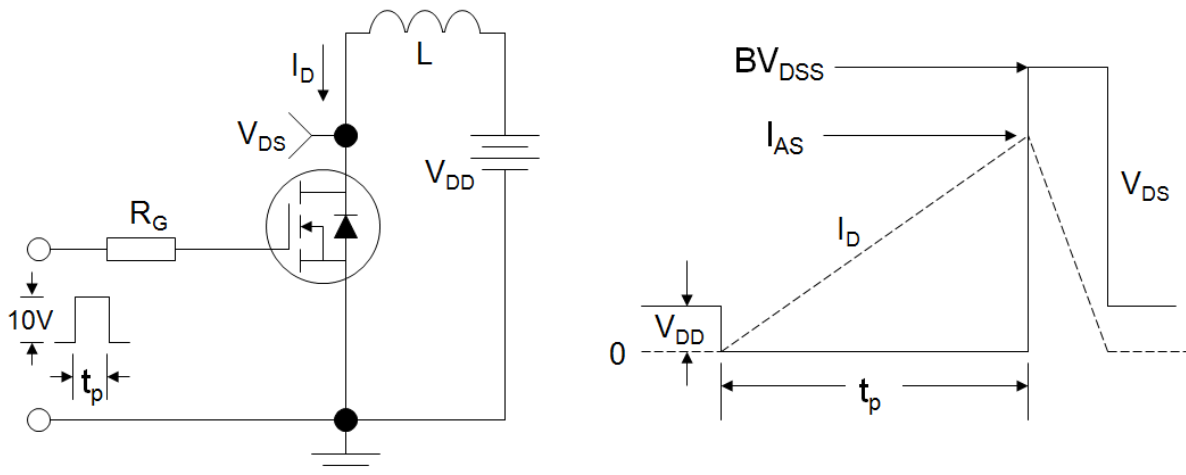
**Figure 9. Transient Thermal Impedance TO-251, TO-252**

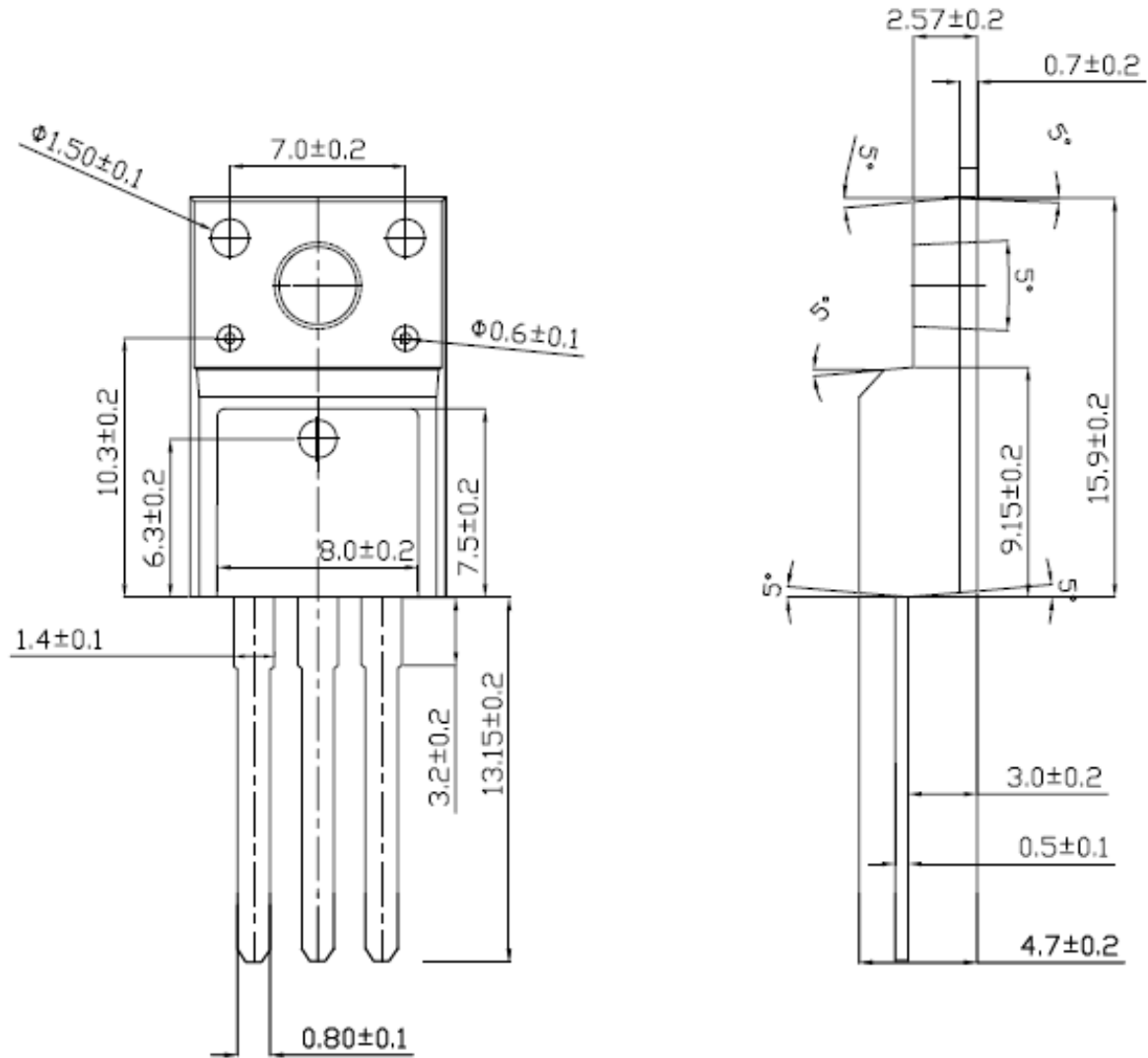


**Figure 10. Transient Thermal Impedance TO-220F**

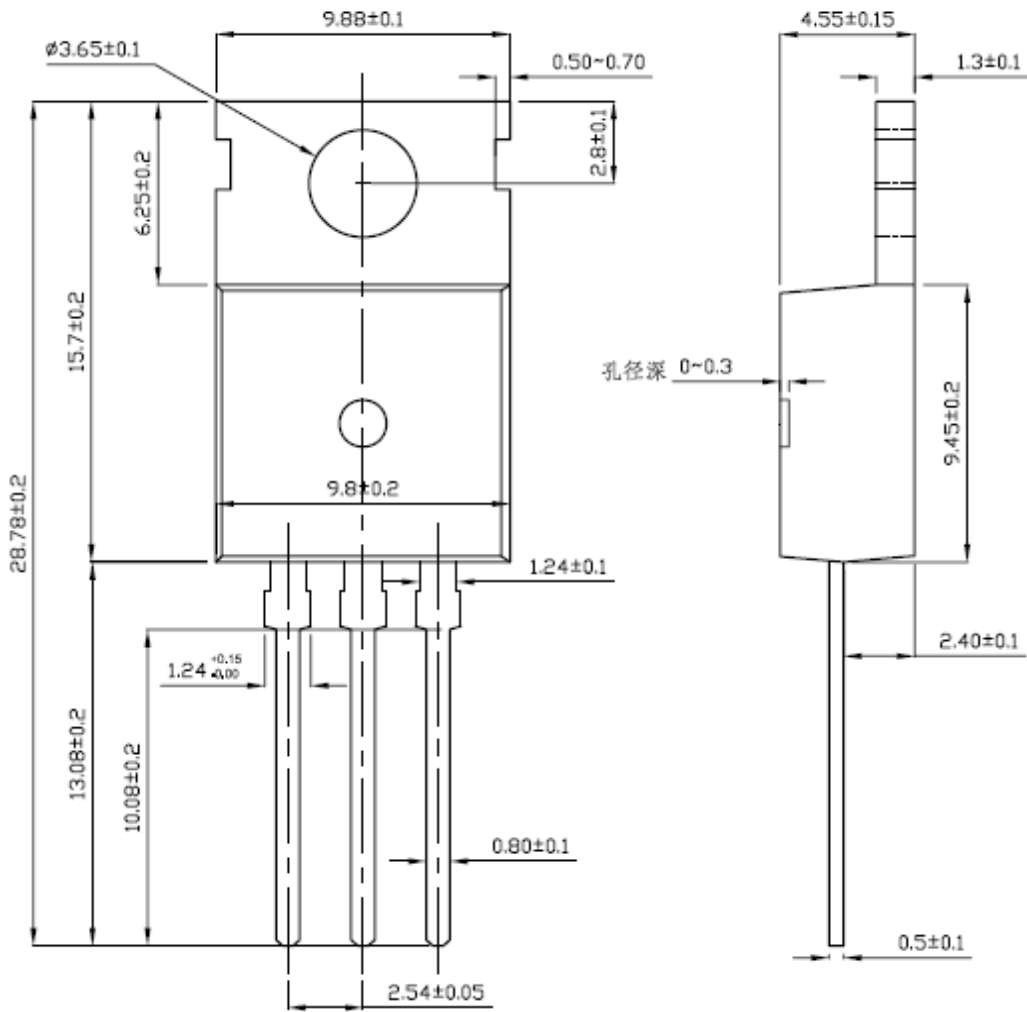


**Figure A: Gate Charge Test Circuit and Waveform**

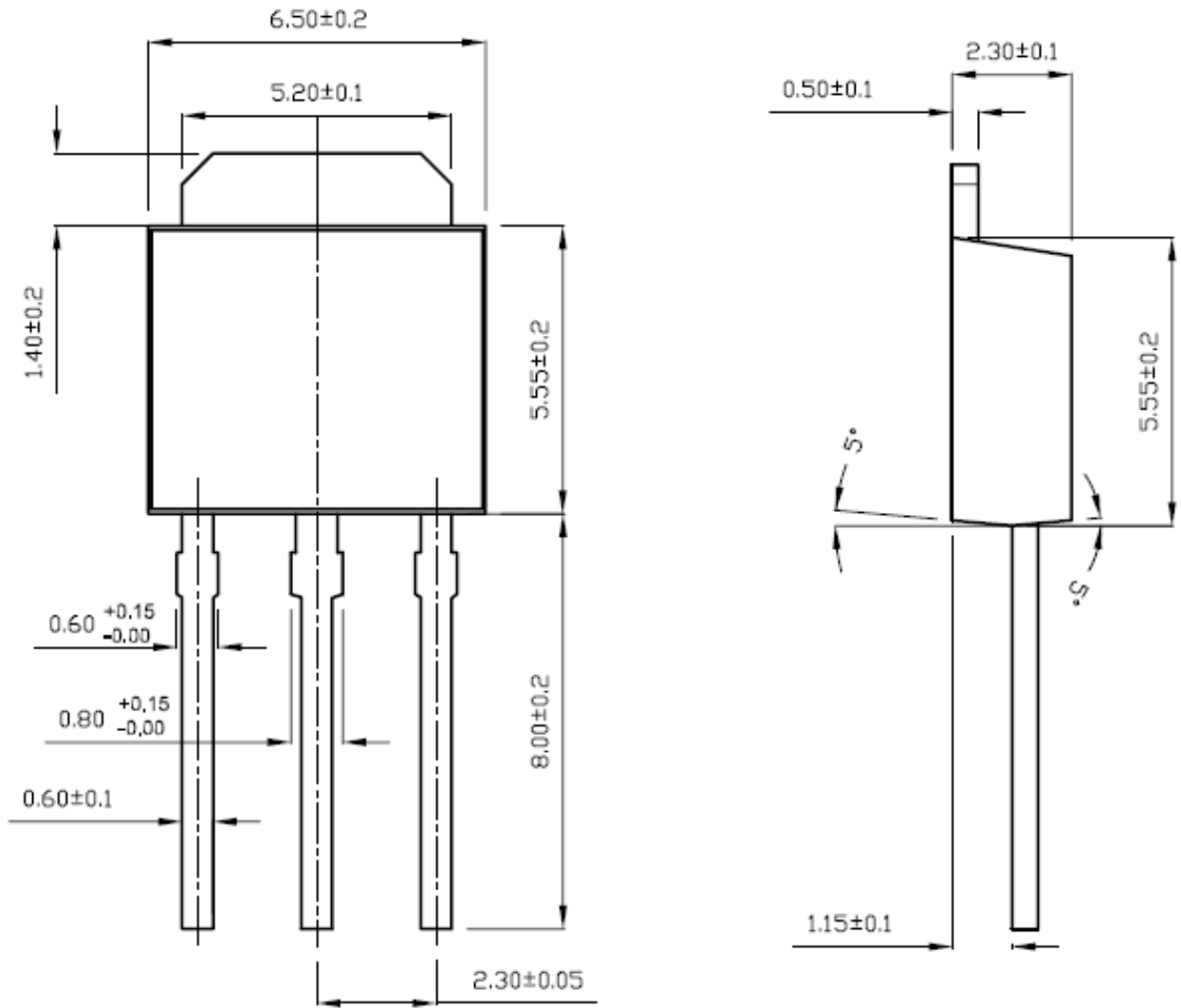
**Figure B: Resistive Switching Test Circuit and Waveform**

**Figure C: Unclamped Inductive Switching Test Circuit and Waveform**


**TO-220F**


**TO-220**

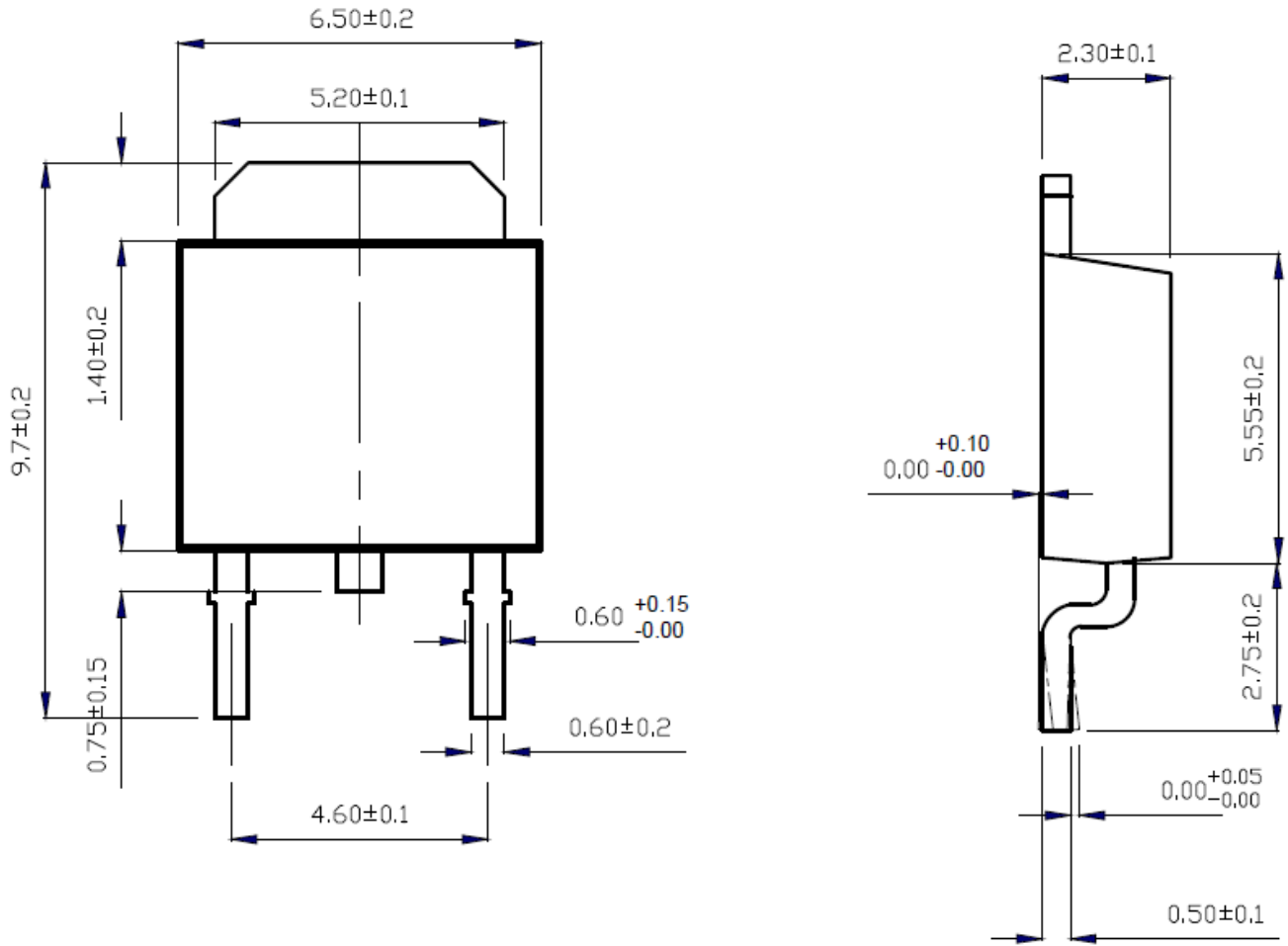


**TO-251**





**TO-252**



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