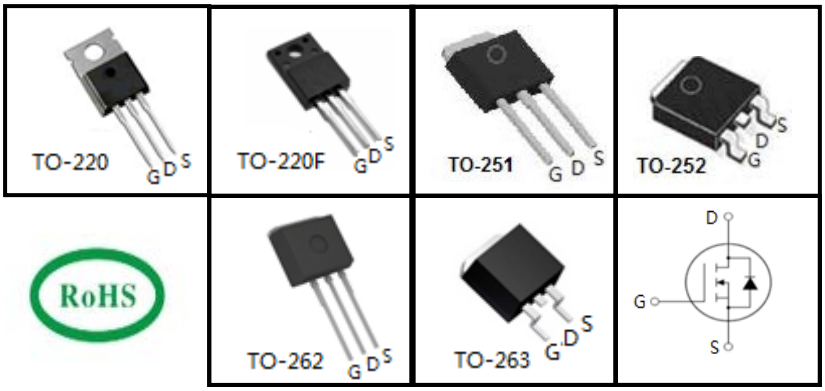
Wuxi Unigroup Microelectronics Company

# 650V Super-Junction Power MOSFET

## FEATURES

- Very low FOM $R_{DS(on)} \times Q_g$
- 100% avalanche tested
- RoHS compliant




RoHS

## APPLICATIONS

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

| Device Marking and Package Information | | | | | | |
|---|---|---|---|---|---|---|
| **Device** | TPP65R940C | TPA65R940C | TPU65R940C | TPD65R940C | TPC65R940C | TPB65R940C |
| **Package** | TO-220 | TO-220F | TO-251 | TO-252 | TO-262 | TO-263 |
| **Marking** | 65R940C | 65R940C | 65R940C | 65R940C | 65R940C | 65R940C |

**Absolute Maximum Ratings** $T_C$ = 25ºC, unless otherwise noted

| **Parameter** | **Symbol** | **Value** | | **Unit** |
|---|---|---|---|---|
| | | TO-251, TO-252 | TO-220F | |
| Drain-Source Voltage ($V_{GS}$ = 0V) | $V_{DSS}$ | 650 | | V |
| Continuous Drain Current | $I_D$ | 4 | | A |
| Pulsed Drain Current (note1) | $I_{DM}$ | 12 | | A |
| Gate-Source Voltage | $V_{GSS}$ | ±30 | | V |
| Single Pulse Avalanche Energy (note2) | $E_{AS}$ | 52.8 | | mJ |
| Avalanche Current (note1) | $I_{AR}$ | 0.8 | | A |
| Repetitive Avalanche Energy (note1) | $E_{AR}$ | 0.09 | | mJ |
| Power Dissipation ($T_C$ = 25ºC) | $P_D$ | 28 | 23 | W |
| Operating Junction and Storage Temperature Range | $T_J$, $T_{stg}$ | -55~+150 | | ºC |

**Thermal Resistance**

| **Parameter** | **Symbol** | **Value** | | **Unit** |
|---|---|---|---|---|
| | | TO-251, TO-252 | TO-220F | |
| Thermal Resistance, Junction-to-Case | $R_{thJC}$ | 4.4 | 5.5 | ºC/W |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 62 | 80 | |

**Specifications** $T_J$ = 25ºC, unless otherwise noted

| Parameter | Symbol | Test Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 650 | -- | -- | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 650V, $V_{GS}$ = 0V, $T_J$ = 25ºC | -- | -- | 1 | μA |
| | | $V_{DS}$ = 650V, $V_{GS}$ = 0V, $T_J$ = 150ºC | -- | -- | 100 | |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ±30V | -- | -- | ±100 | nA |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA | 2.5 | -- | 4.0 | V |
| Drain-Source On-Resistance (Note3) | $R_{DS(on)}$ | $V_{GS}$ = 10V, $I_D$ = 1A | -- | 0.88 | 1.0 | Ω |
| Forward Transconductance (Note3) | $g_{fs}$ | $V_{DS}$ = 10V, $I_D$ = 1A | -- | 3 | -- | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0V, $V_{DS}$ = 50V, f = 1.0MHz | -- | 350 | -- | pF |
| Output Capacitance | $C_{oss}$ | | -- | 20 | -- | |
| Reverse Transfer Capacitance | $C_{rss}$ | | -- | 2.6 | -- | |
| Total Gate Charge | $Q_g$ | $V_{DD}$ = 520V, $I_D$ = 4A, $V_{GS}$ = 10V | -- | 7 | -- | nC |
| Gate-Source Charge | $Q_{gs}$ | | -- | 1.5 | -- | |
| Gate-Drain Charge | $Q_{gd}$ | | -- | 2.5 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$ = 400V, $I_D$ = 4A, $R_G$ = 25Ω | -- | 36 | -- | ns |
| Turn-on Rise Time | $t_r$ | | -- | 27 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 79 | -- | |
| Turn-off Fall Time | $t_f$ | | -- | 29 | -- | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Body Diode Current | $I_S$ | $T_C$ = 25ºC | -- | -- | 3.9 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | | -- | -- | 12 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25ºC, $I_{SD}$ = 4A, $V_{GS}$ = 0V | -- | 0.9 | 1.2 | V |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 480V, $I_F$ = $I_S$, $di_F/dt$ = 100A/μs | -- | 220 | -- | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | -- | 0.9 | -- | μC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | -- | 8 | -- | A |

**Notes**

1. Repetitive Rating: Pulse Width limited by maximum junction temperature
2. $I_{AS}$ = 0.8A, $V_{DD}$ = 50V, $R_G$ = 25Ω, Starting $T_J$ = 25°C
3. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 1%

**Typical Characteristics** $T_J$ = 25ºC, unless otherwise noted

**Figure 1. Output Characteristics**

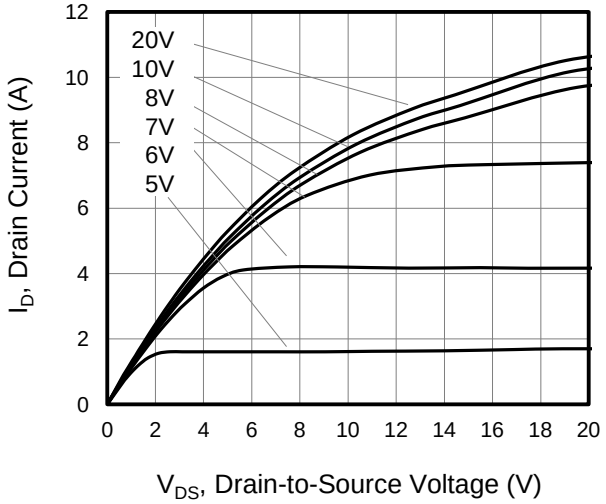



**Figure 2. Transfer Characteristics**

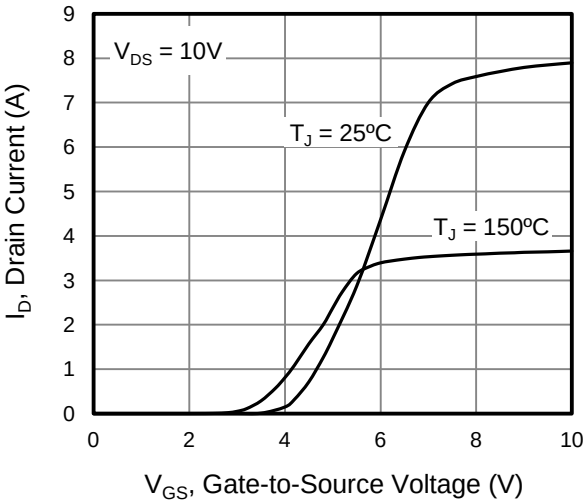



**Figure 3. On-Resistance vs. Drain Current**

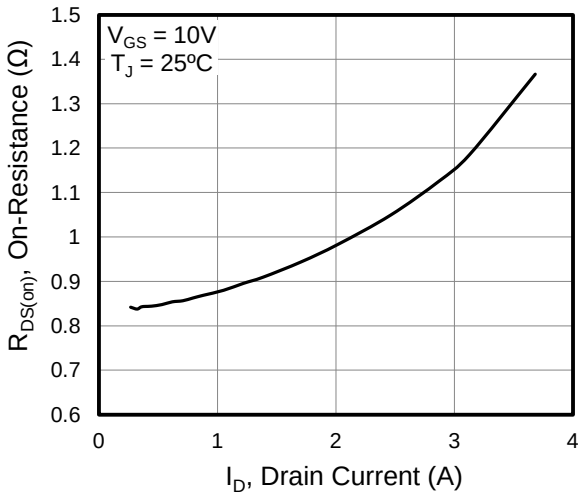



**Figure 4. Capacitance**

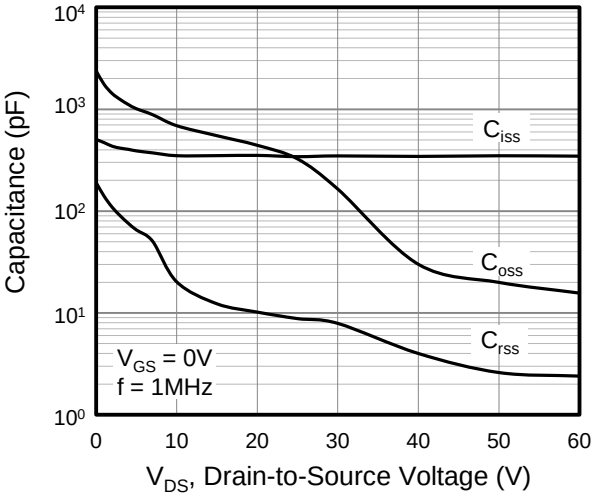



**Figure 5. Gate Charge**

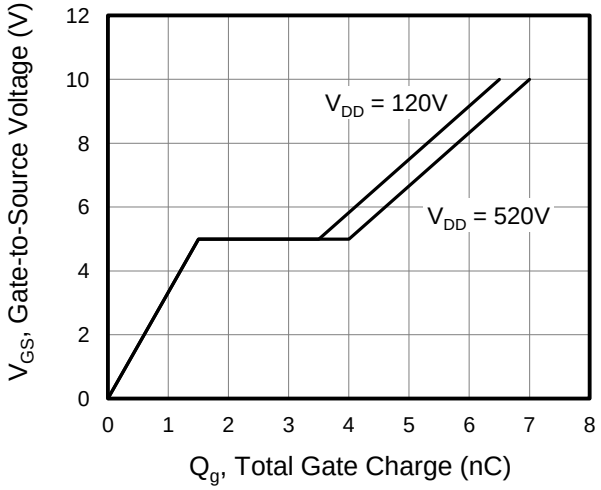
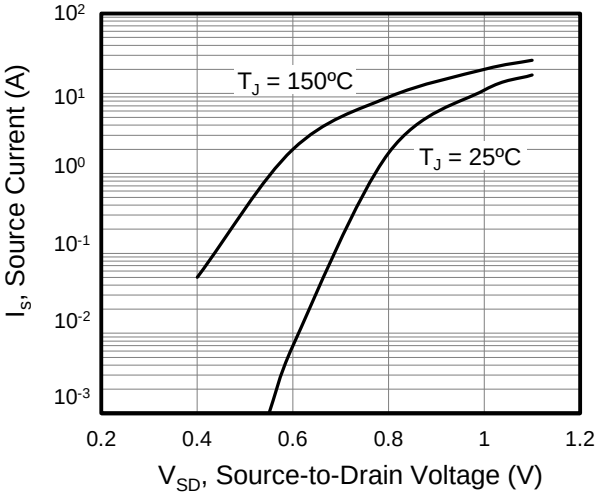



**Figure 6. Body Diode Forward Voltage**



**Typical Characteristics** $T_J$ = 25ºC, unless otherwise noted

**Figure 7. On-Resistance vs. Junction Temperature**

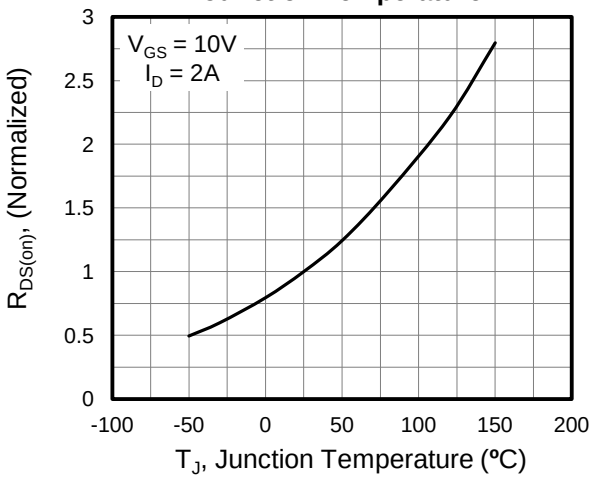



**Figure 8. Threshold Voltage vs. Junction Temperature**

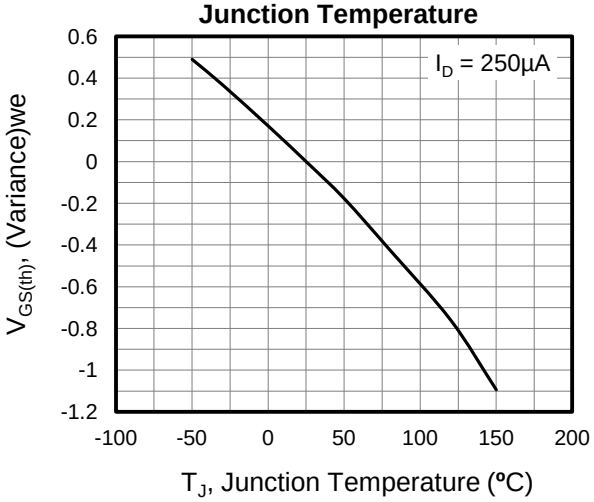



**Figure 9. Transient Thermal Impedance TO-251,TO-252**

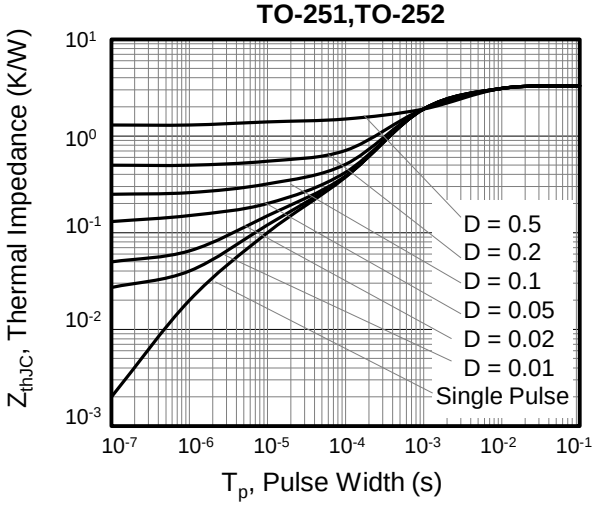



**Figure 10. Transient Thermal Impedance TO-220F**

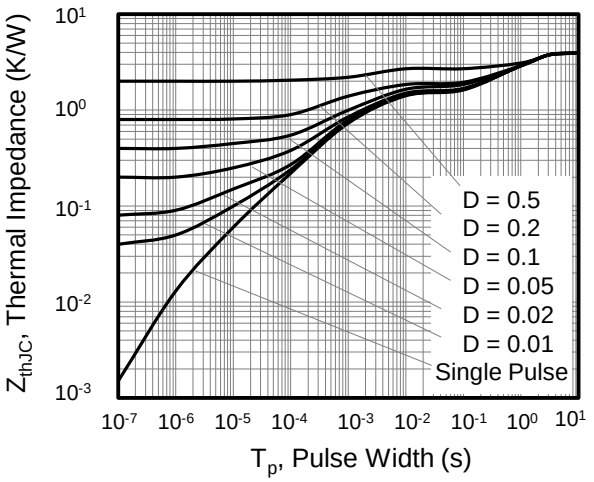


**Figure A：Gate Charge Test Circuit and Waveform**

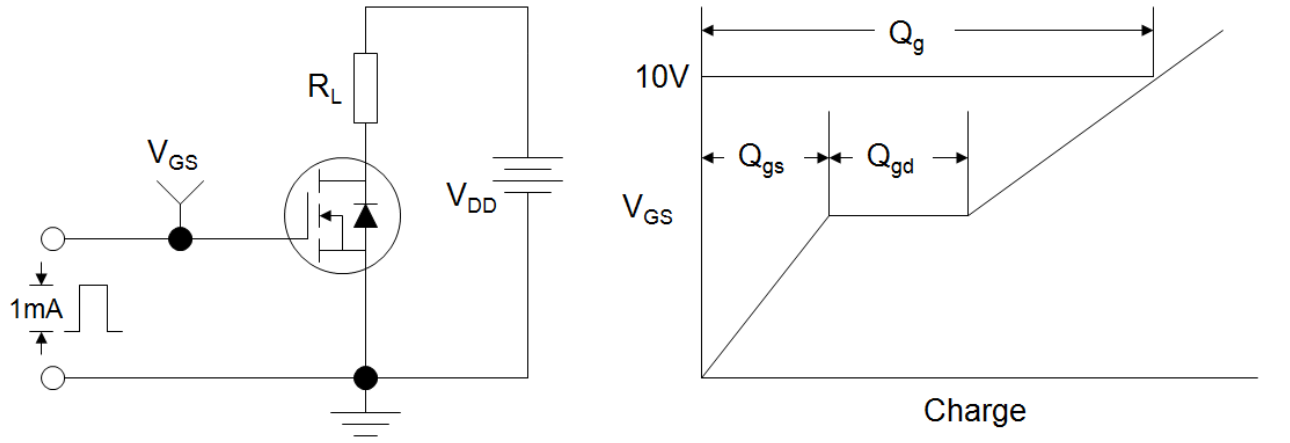



**Figure B：Resistive Switching Test Circuit and Waveform**

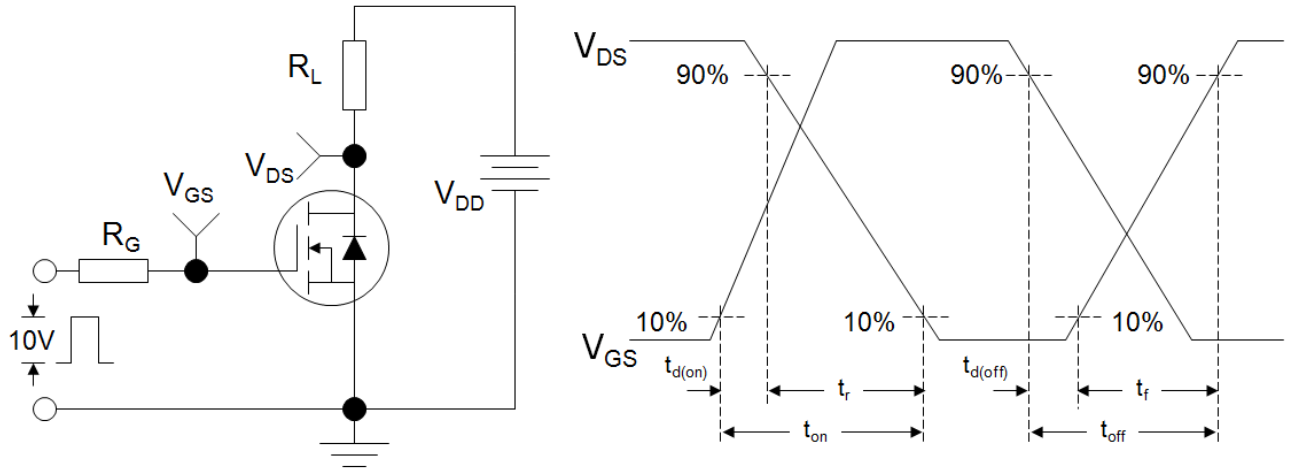
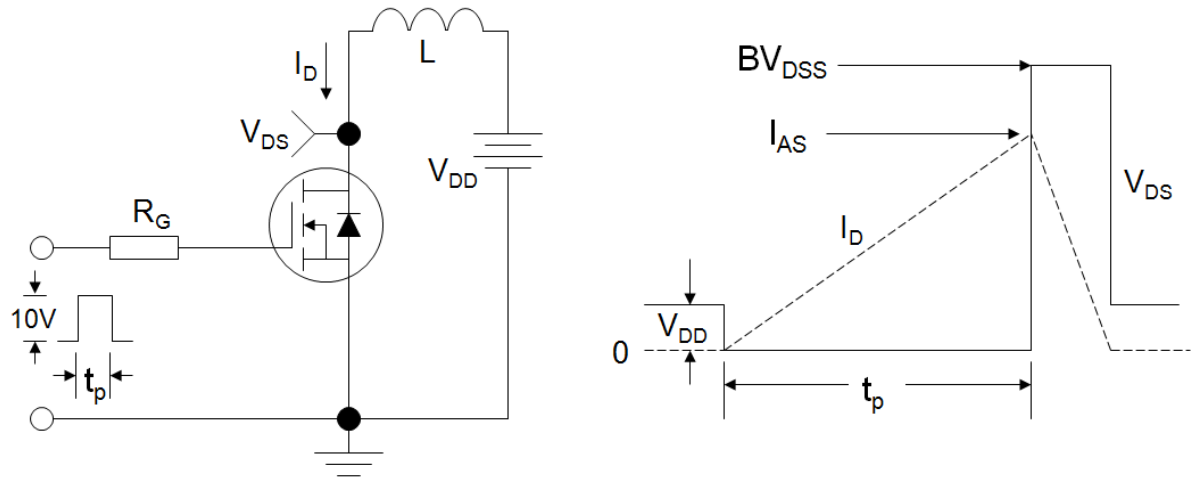
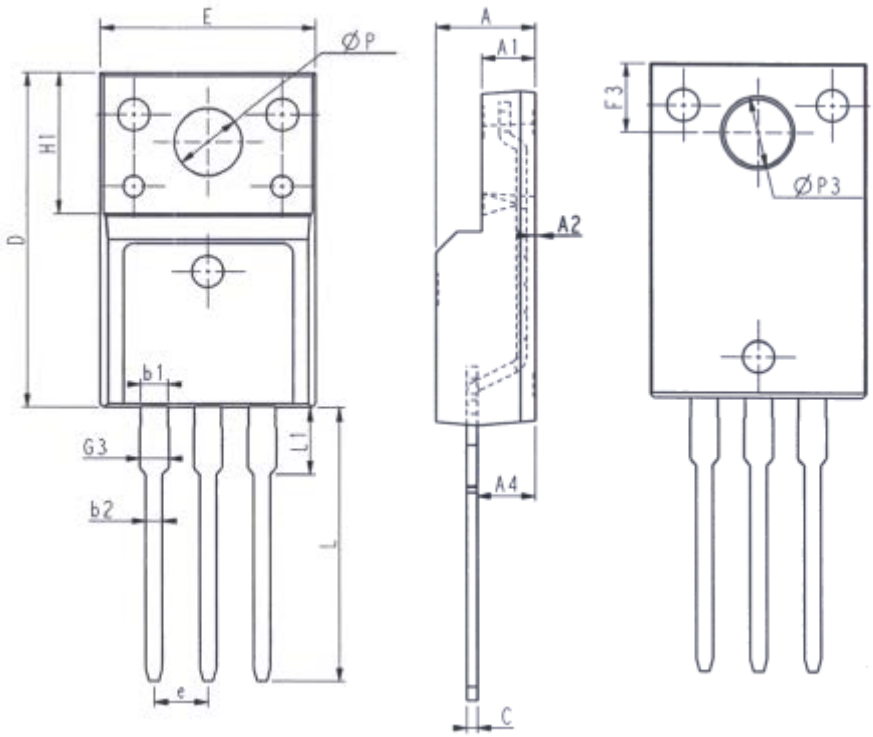



**Figure C：Unclamped Inductive Switching Test Circuit and Waveform**



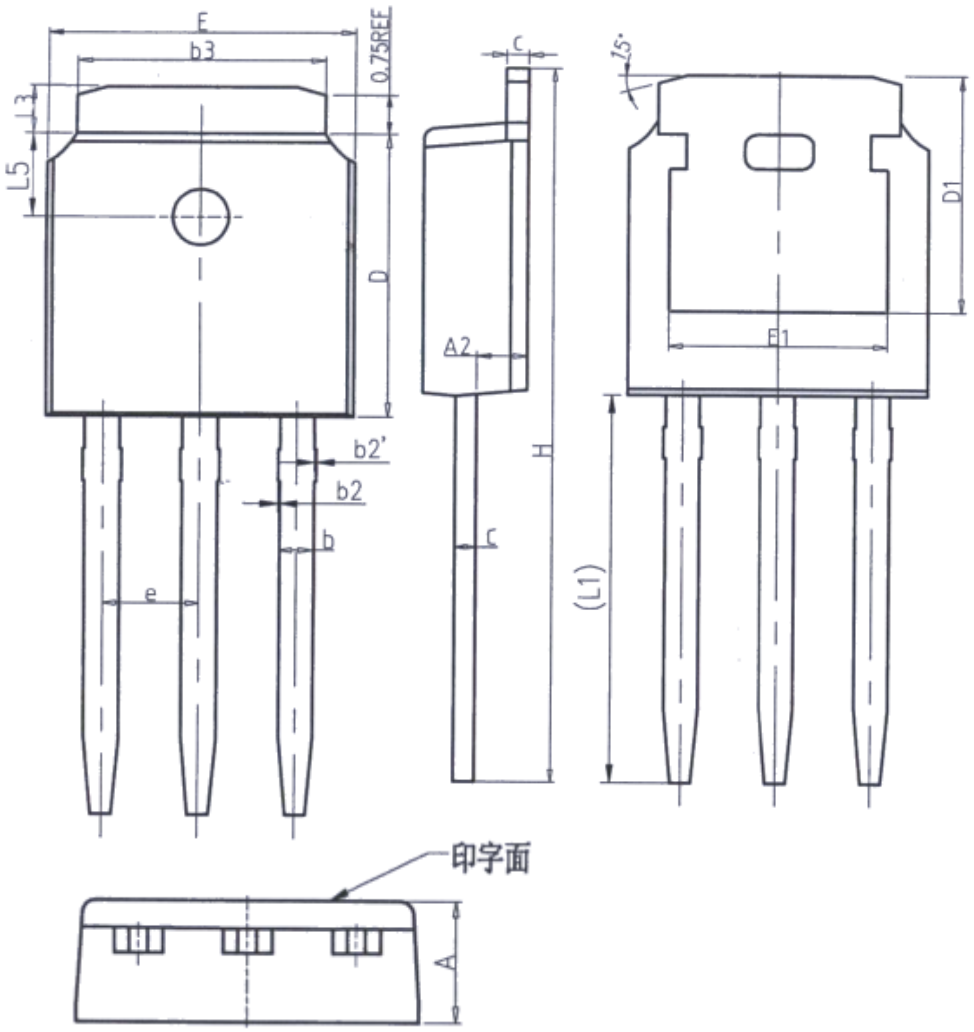
# TO-220F




| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| E | 9.96 | 10.36 |
| A | 4.50 | 4.90 |
| A1 | 2.34 | 2.74 |
| A2 | 0.30 | 0.60 |
| A4 | 2.56 | 2.96 |
| c | 0.40 | 0.65 |
| D | 15.57 | 16.17 |
| H1 | 6.70REF | |
| e | 2.54BSC | |

| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| L | 12.68 | 13.28 |
| L1 | 2.93 | 3.13 |
| P | 3.03 | 3.38 |
| P3 | 3.15 | 3.65 |
| F3 | 3.15 | 3.45 |
| G3 | 1.25 | 1.55 |
| b1 | 1.18 | 1.43 |
| b2 | 0.70 | 0.95 |

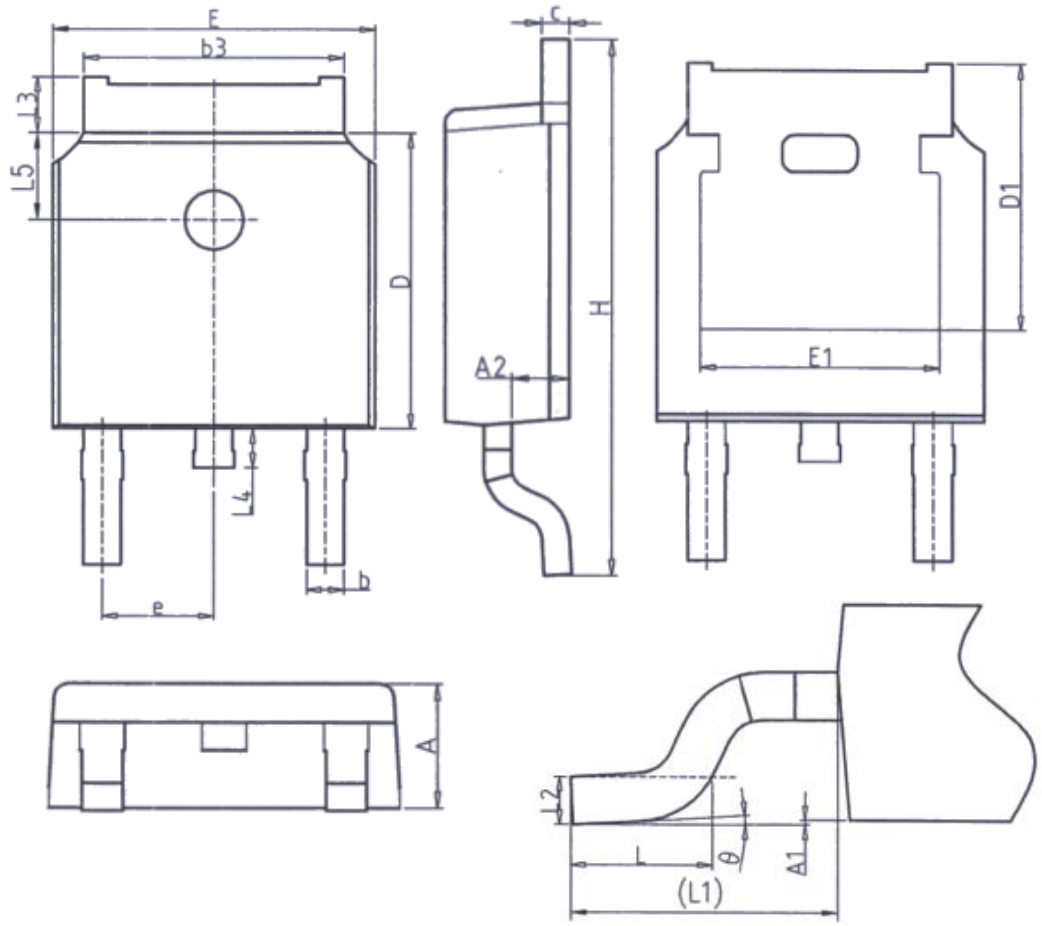
# TO-251




| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| A | 2.20 | 2.40 |
| A2 | 0.97 | 1.17 |
| b | 0.68 | 0.90 |
| b2 | 0.00 | 0.10 |
| b2′ | 0.00 | 0.10 |
| b3 | 5.20 | 5.50 |
| c | 0.43 | 0.63 |
| D | 5.98 | 6.22 |

| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| D1 | 5.30REF | |
| E | 6.40 | 6.80 |
| E1 | 4.63 | - |
| e | 2.286BSC | |
| H | 16.22 | 16.82 |
| L1 | 9.15 | 9.65 |
| L3 | 0.88 | 1.28 |
| L5 | 1.65 | 1.95 |

# TO-252




| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| A | 2.20 | 2.40 |
| A1 | 0.00 | 0.20 |
| A2 | 0.97 | 1.17 |
| b | 0.68 | 0.90 |
| b3 | 5.20 | 5.50 |
| c | 0.43 | 0.63 |
| D | 5.98 | 6.22 |
| D1 | 5.30REF | |
| E | 6.40 | 6.80 |
| E1 | 4.63 | – |

| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| e | 2.286BSC | |
| H | 9.40 | 10.50 |
| L | 1.38 | 1.75 |
| L1 | 2.90REF | |
| L2 | 0.51BSC | |
| L3 | 0.88 | 1.28 |
| L4 | – | 1.00 |
| L5 | 1.65 | 1.95 |
| θ | 0° | 8° |

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