# 650V Super-Junction Power MOSFET

## DESCRIPTION

**650V super-junction Power MOSFET**

Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs，designed according to the SJ principle. The SJ MOSFET is a price-performance optimized product enabling to target cost sensitive applications in Consumer and Lighting markets，designed by Wuxi Unigroup Microelectronics Company.

## FEATURES

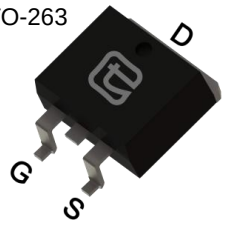
- Very low FOM $R_{DS(on)} \times Q_g$
- 100% avalanche tested
- RoHS compliant

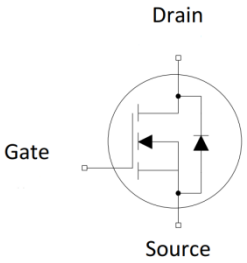
## APPLICATIONS

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

TO-220


TO-263




RoHS

## Device Marking and Package Information

| Device | Package | Marking |
|---|---|---|
| TPB65R070D | TO-263 | 65R070D |
| TPP65R070D | TO-220 | 65R070D |

## Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.07 | Ω |
| $I_D$ | 45 | A |
| $Q_{g,typ}$ | 80 | nC |
| $I_{DM}$ | 135 | A |

| **Absolute Maximum Ratings** $T_C$ = 25ºC, unless otherwise noted | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Value** | **Unit** |
| Drain-Source Voltage ($V_{GS}$ = 0V) | | $V_{DSS}$ | 650 | V |
| Continuous Drain Current | $T_C$ = 25ºC | $I_D$ | 45 | A |
| | $T_C$ = 100ºC | | 27 | |
| Pulsed Drain Current (note1) | | $I_{DM}$ | 135 | A |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Single Pulse Avalanche Energy (note2) | | $E_{AS}$ | 180 | mJ |
| Avalanche Current | | $I_{AS}$ | 6 | A |
| Power Dissipation | | $P_D$ | 312 | W |
| Continuous Body Diode Current | | $I_S$ | 45 | A |
| Pulsed Diode Forward Current (note1) | | $I_{SM}$ | 135 | |
| MOSFET dv/dt ruggedness, $V_{DS}$ = 0...650V | | dv/dt | 50 | V/ns |
| Reverse diode dv/dt, $V_{DS}$ = 0…650V, $I_{SD} \le I_D$ | | dv/dt | 5 | A/us |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | -55~+150 | ºC |

| **Thermal Resistance** | | | |
|---|---|---|---|
| **Parameter** | **Symbol** | **Value** | **Unit** |
| Thermal Resistance, Junction-to-Case | $R_{thJC}$ | 0.4 | ºC/W |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 62 | |

| **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 | -- | 4.5 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10V, $I_D$ = 22A | -- | 0.055 | 0.07 | Ω |
| Forward Transconductance (Note3) | $g_{fs}$ | $V_{DS}$ = 10V, $I_D$ = 22A | -- | 10 | -- | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0V, $V_{DS}$ = 100V, f = 1.0MHz | -- | 4134 | -- | pF |
| Output Capacitance | $C_{oss}$ | | -- | 160 | -- | |
| Reverse Transfer Capacitance | $C_{rss}$ | | -- | 4 | -- | |
| Total Gate Charge | $Q_g$ | $V_{DD}$ = 400V, $I_D$ = 22A, $V_{GS}$ = 10V | -- | 80 | -- | nC |
| Gate-Source Charge | $Q_{gs}$ | | -- | 24 | -- | |
| Gate-Drain Charge | $Q_{gd}$ | | -- | 24 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$ = 400V, $I_D$ = 22A, $R_G$ = 25Ω | -- | 51 | -- | ns |
| Turn-on Rise Time | $t_r$ | | -- | 71 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 154 | -- | |
| Turn-off Fall Time | $t_f$ | | -- | 67 | -- | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25ºC, $I_{SD}$ = 22A, $V_{GS}$ = 0V | -- | 0.9 | 1.2 | V |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 400V, $I_S$=22A, $di_F/dt$ = 100A/μs | -- | 354 | -- | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | -- | 4.2 | -- | μC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | -- | 24 | -- | A |

**Notes**

1. Repetitive Rating: Pulse Width limited by maximum junction temperature
2. $V_{DD}$ = 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**

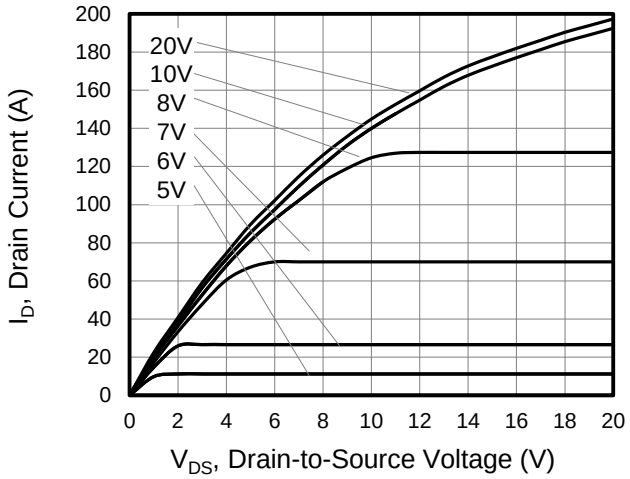



**Figure 2. Transfer Characteristics**

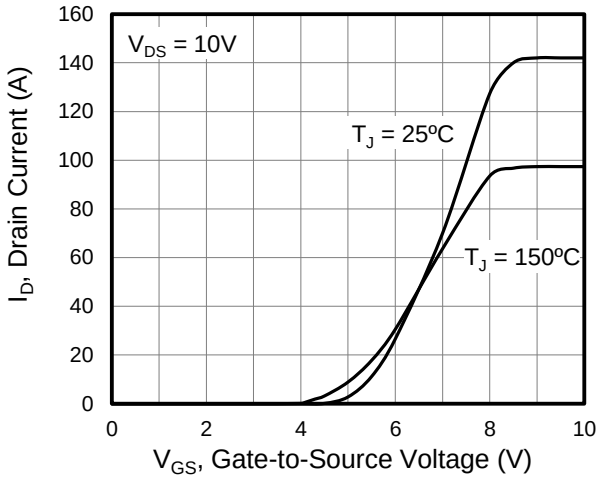



**Figure 3 . Body Diode Forward Voltage**

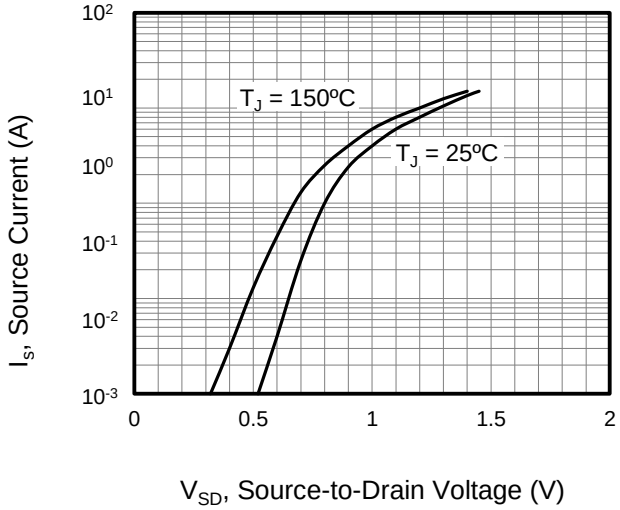



**Figure 4. Capacitance**

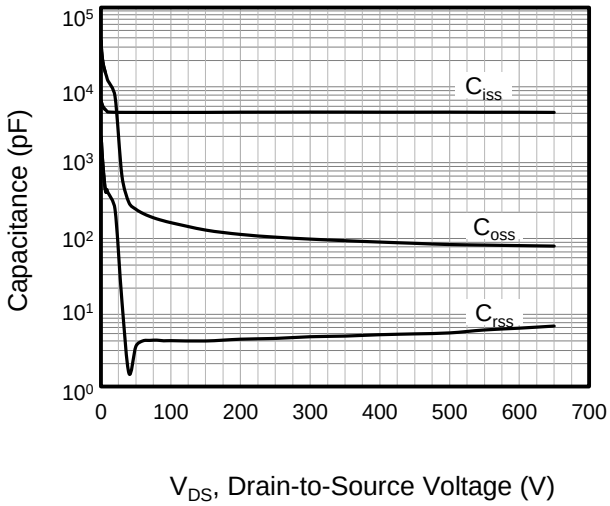



**Figure 5. Gate Charge**

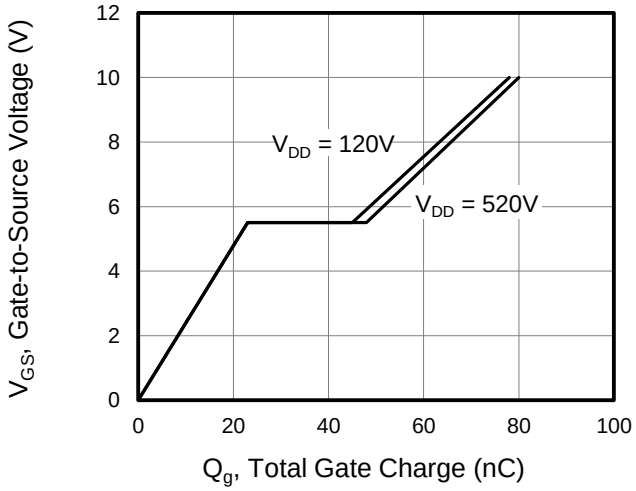



**Figure 6. On-Resistance vs. Junction Temperature**

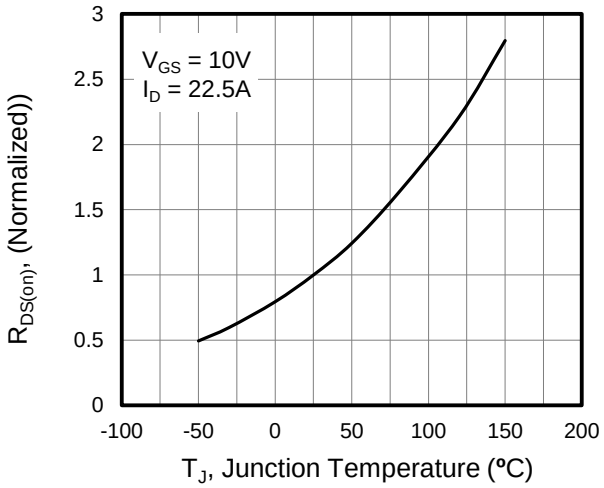


**Figure 7. Breakdown voltage vs. Junction Temperature**

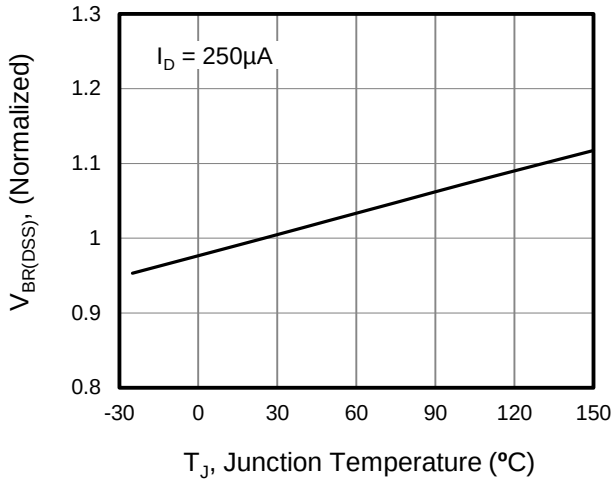



**Figure 8. Threshold Voltage vs. Junction Temperature**

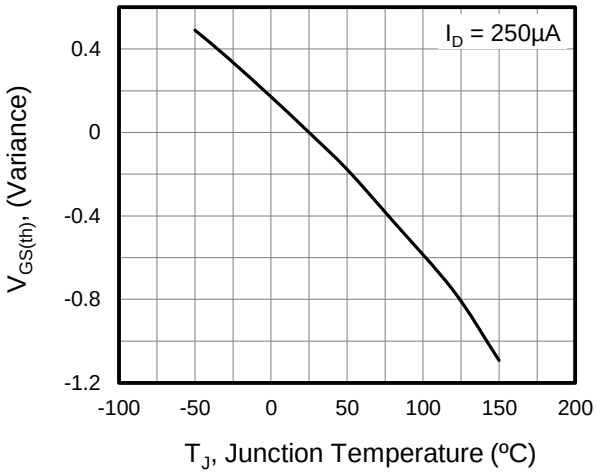



**Figure9 . Transient Thermal Impedance for TO-220**

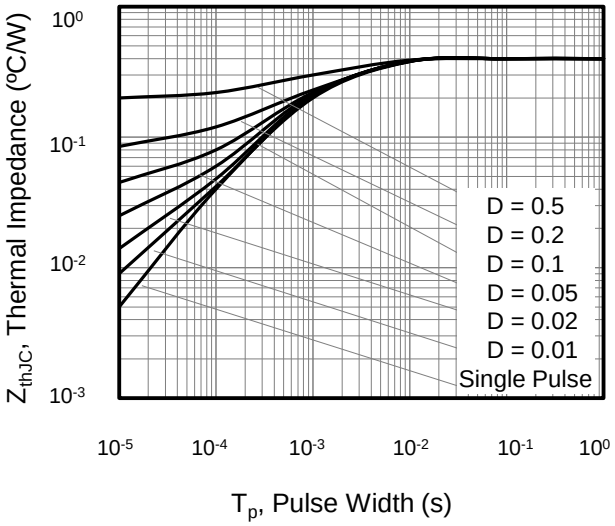



**Figure 10. Safe operation area for TO-220**

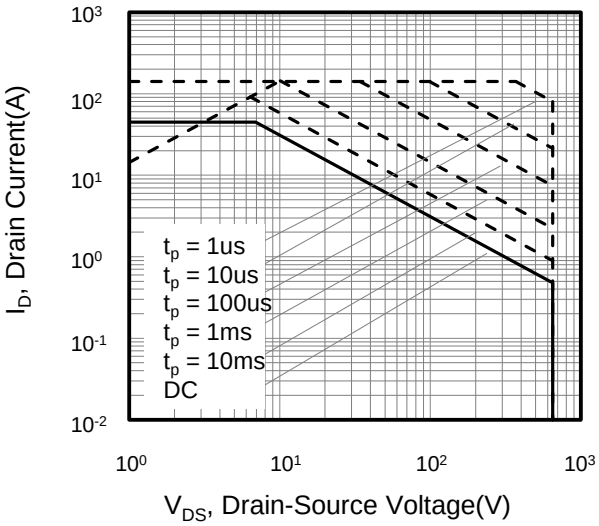


**Figure A：Gate Charge Test Circuit and Waveform**

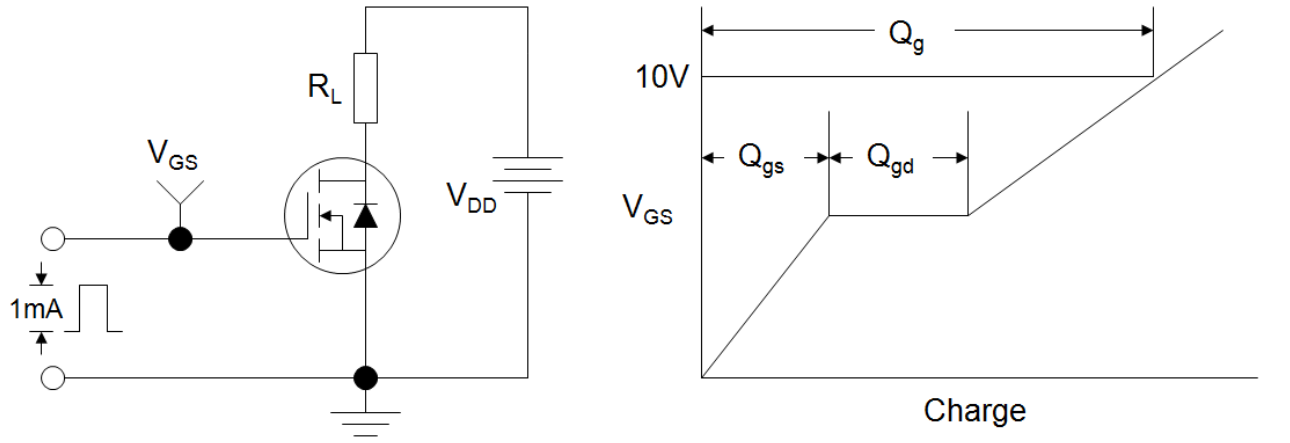



**Figure B：Resistive Switching Test Circuit and Waveform**

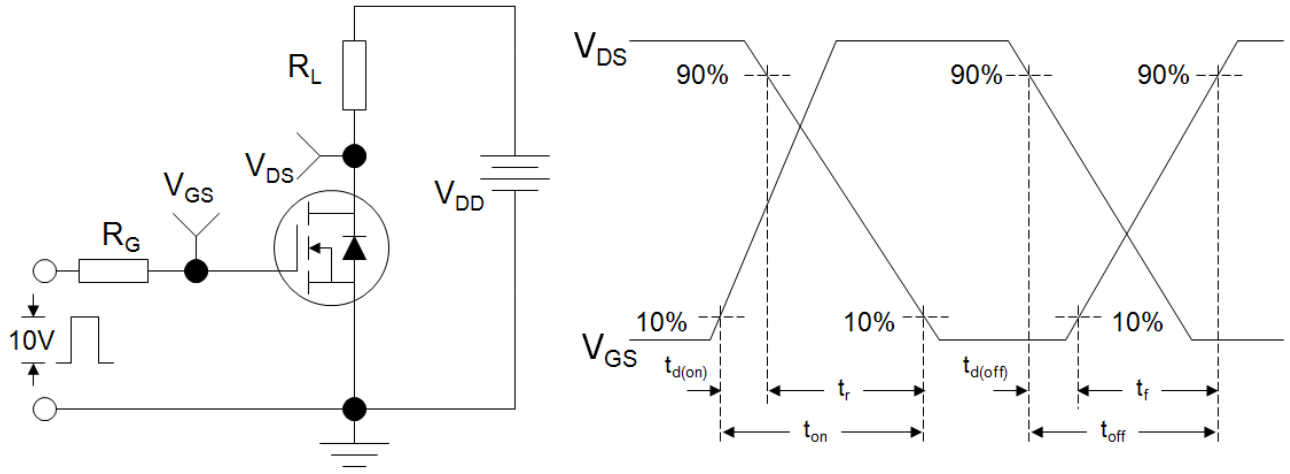
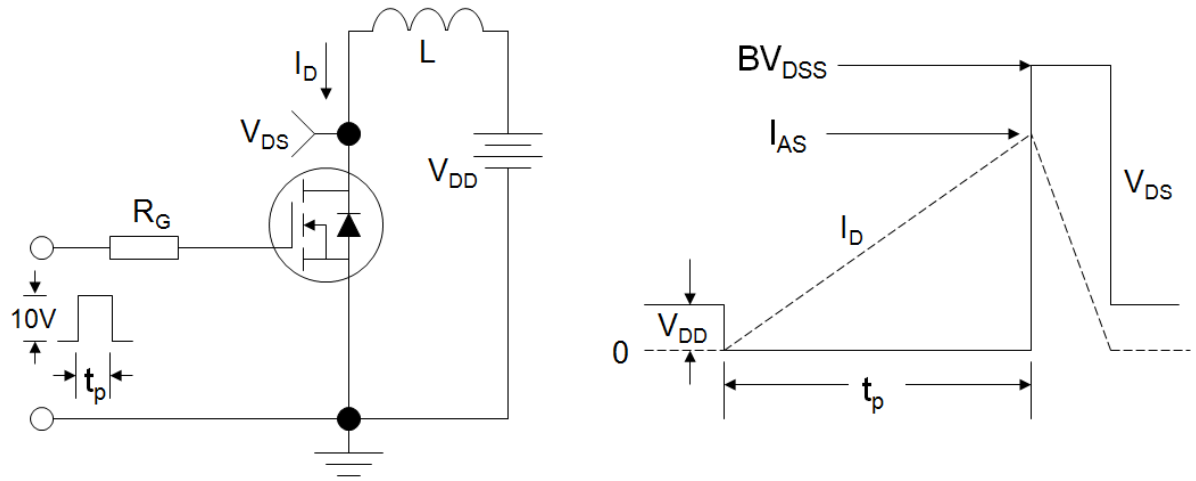
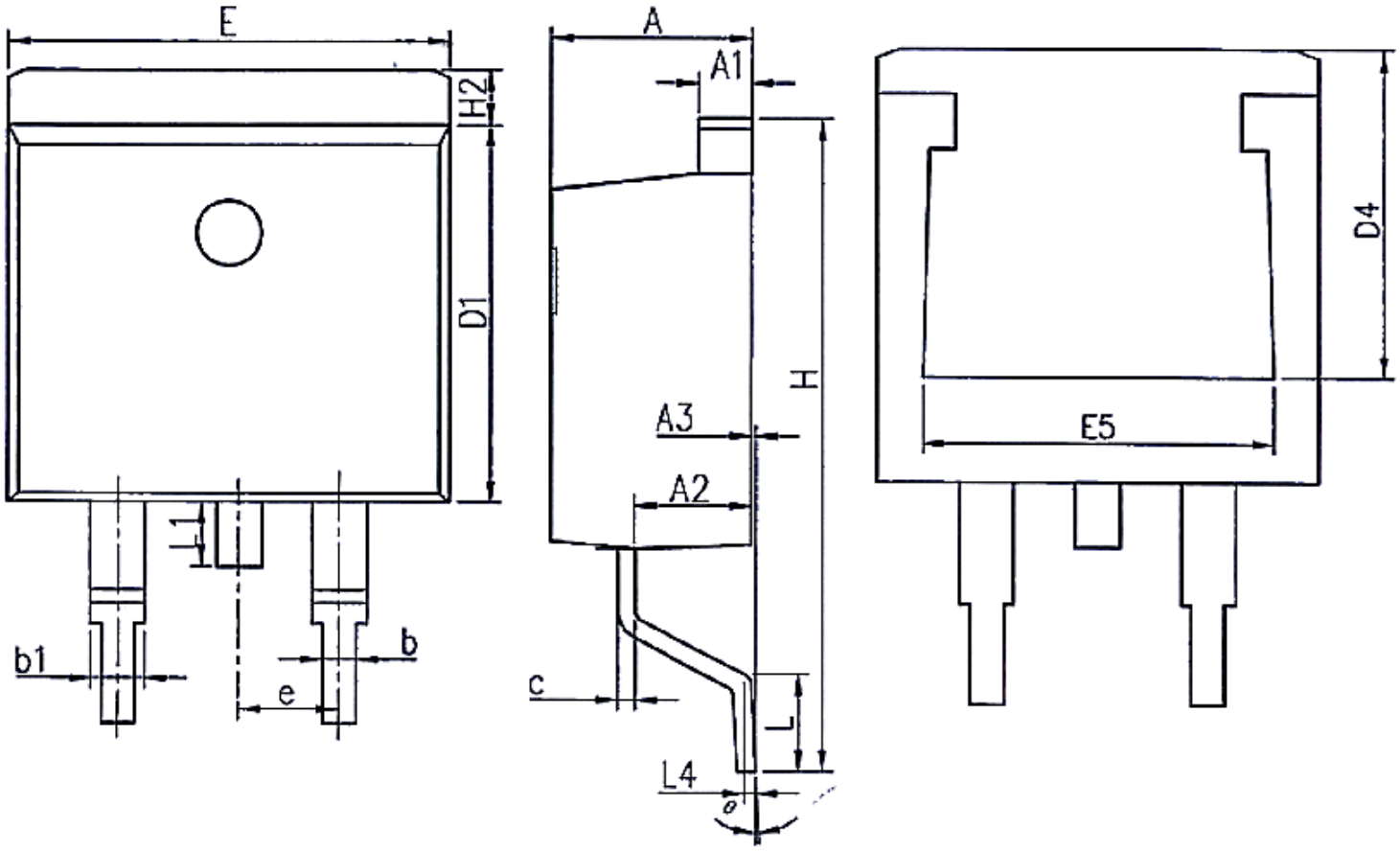



**Figure C：Unclamped Inductive Switching Test Circuit and Waveform**



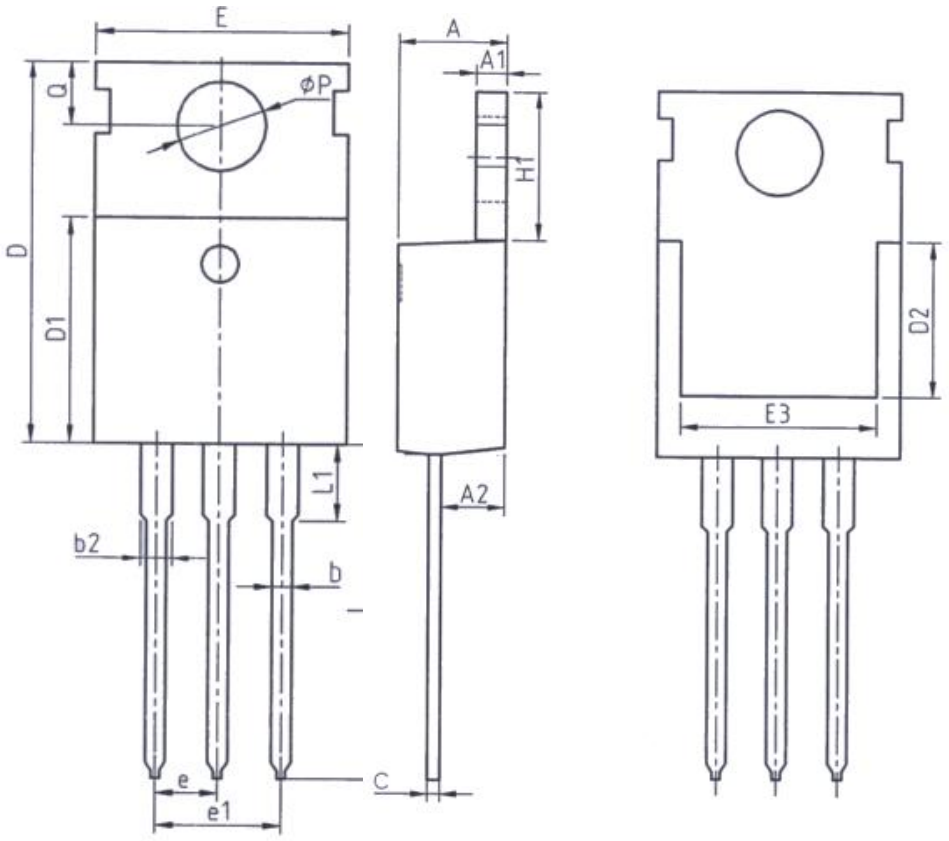
# TO-263




| Unit:mm | | | |
|---|---|---|---|
| Symbol | Min. | Nom | Max. |
| A | 4.37 | 4.57 | 4.77 |
| A1 | 1.22 | 1.27 | 1.42 |
| A2 | 2.49 | 2.69 | 2.89 |
| A3 | 0.00 | 0.13 | 0.25 |
| b | 0.70 | 0.81 | 0.96 |
| b1 | 1.17 | 1.27 | 1.47 |
| c | 0.30 | 0.38 | 0.53 |
| D1 | 8.50 | 8.70 | 8.90 |
| D4 | 6.60 | - | - |

| Unit:mm | | | |
|---|---|---|---|
| Symbol | Min. | Nom | Max. |
| E | 9.86 | 10.16 | 10.36 |
| E5 | 7.06 | - | - |
| e | 2.54BSC | | |
| H | 14.70 | 15.10 | 15.50 |
| H2 | 1.07 | 1.27 | 1.47 |
| L | 2.00 | 2.30 | 2.60 |
| L1 | 1.40 | 1.55 | 1.70 |
| L4 | 0.25BSC | | |
| θ | 0° | 5° | 9° |

# TO-220




| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| A | 4.37 | 4.77 |
| A1 | 1.25 | 1.45 |
| A2 | 2.20 | 2.60 |
| b | 0.70 | 0.95 |
| b2 | 1.17 | 1.47 |
| c | 0.40 | 0.65 |
| D | 15.10 | 16.10 |
| D1 | 8.80 | 9.40 |
| D2 | 5.50 | – |

| Unit: mm | | |
|---|---|---|
| Symbol | Min. | Max. |
| E | 9.70 | 10.30 |
| E3 | 7.00 | – |
| e | 2.54BSC | |
| e1 | 5.08BSC | |
| H1 | 6.25 | 6.85 |
| L | 12.75 | 13.80 |
| L1 | – | 3.40 |
| P | 3.40 | 3.80 |
| Q | 2.60 | 3.00 |

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