



650V Super-junction Power MOSFET

DESCRIPTION

650V Super-junction Power MOSFET

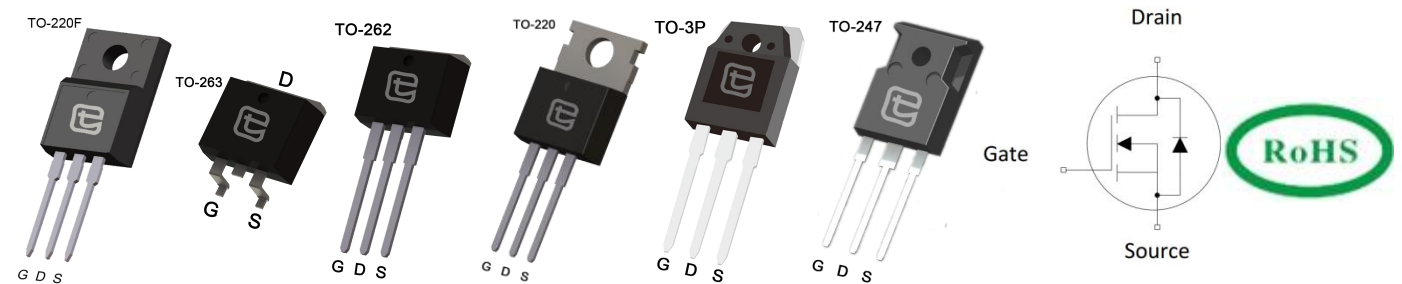
Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs, designed according to the SJ principle. The Multi-EPI SJ MOSFET provide an extremely low switching, communication and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler, designed by Wuxi Unigroup Microelectronics Company.

FEATURES

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

APPLICATIONS

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



Device Marking and Package Information

| Device | Package | Marking |
|------------|---------|---------|
| TPA65R170M | TO-220F | 65R170M |
| TPB65R170M | TO-263 | 65R170M |
| TPC65R170M | TO-262 | 65R170M |
| TPP65R170M | TO-220 | 65R170M |
| TPV65R170M | TO-3PN | 65R170M |
| TPW65R170M | TO-247 | 65R170M |

Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|----------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.17 | Ω |
| I_D | 20 | A |
| $Q_{g,typ}$ | 38.8 | nC |
| I_{DM} | 60 | A |



| Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, unless otherwise noted | | | | |
|--|----------------|---------------------------|--|------------------|
| Parameter | Symbol | Value | | Unit |
| | | TO-220F | TO-263/TO-262/TO-220/ TO-3PN/TO-247 | |
| Drain-Source Voltage ($V_{GS} = 0\text{V}$) | V_{DSS} | 650 | | V |
| Continuous Drain Current | I_D | $T_C = 25^\circ\text{C}$ | 20 | A |
| | | $T_C = 100^\circ\text{C}$ | 12 | |
| Pulsed Drain Current (note1) | I_{DM} | 60 | | A |
| Gate-Source Voltage | V_{GSS} | ± 30 | | V |
| Single Pulse Avalanche Energy (note2) | E_{AS} | 484 | | mJ |
| Repetitive Avalanche Energy (note2) | E_{AR} | 0.7 | | mJ |
| Avalanche Current | I_{AR} | 3.5 | | A |
| MOSFET dv/dt ruggedness, $V_{DS} = 0 \dots 480\text{V}$ | dv/dt | 50 | | V/ns |
| Power Dissipation | P_D | 34 | 151 | W |
| Continuous Body Diode Current | I_S | 17 | | A |
| Pulsed Diode Forward Current (note1) | I_{SM} | 60 | | |
| Reverse diode dv/dt (note3) | dv/dt | 15 | | V/ns |
| Maximum diode commutation speed (note3) | di_f/dt | 500 | | A/us |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | -55~+150 | | $^\circ\text{C}$ |

| Thermal Resistance | | | | |
|---|------------|---------|--|--------------------|
| Parameter | Symbol | Value | | Unit |
| | | TO-220F | TO-263/TO-262/TO-220/ TO-3PN/TO-247 | |
| Thermal Resistance, Junction-to-Case | R_{thJC} | 3.7 | 0.83 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient | R_{thJA} | 80 | 62 | |



| Specifications $T_J = 25^\circ\text{C}$, unless otherwise noted | | | | | | |
|--|---------------|---|-------|------|-----------|---------------|
| Parameter | Symbol | Test Conditions | Value | | | Unit |
| | | | Min. | Typ. | Max. | |
| Static | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = 250\mu\text{A}$ | 650 | -- | -- | V |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$ | -- | -- | 1 | μA |
| | | $V_{DS} = 650V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ | -- | -- | 100 | |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 30V$ | -- | -- | ± 100 | nA |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\mu\text{A}$ | 2.5 | -- | 4.5 | V |
| Drain-Source On-Resistance | $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 10A$ | -- | 0.15 | 0.17 | Ω |
| Gate resistance | R_G | $f = 1.0\text{MHz}$ open drain | -- | 12 | -- | Ω |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$ | -- | 1676 | -- | μF |
| Output Capacitance | C_{oss} | | -- | 59 | -- | |
| Reverse Transfer Capacitance | C_{rss} | | -- | 2.5 | -- | |
| Total Gate Charge | Q_g | $V_{DD} = 520V, I_D = 20A,$ $V_{GS} = 10V$ | -- | 38.5 | -- | nC |
| Gate-Source Charge | Q_{gs} | | -- | 8 | -- | |
| Gate-Drain Charge | Q_{gd} | | -- | 15 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD} = 400V, I_D = 20A,$ $R_G = 25\Omega$ | -- | 15 | -- | ns |
| Turn-on Rise Time | t_r | | -- | 59 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 121 | -- | |
| Turn-off Fall Time | t_f | | -- | 44 | -- | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Body Diode Voltage | V_{SD} | $T_J = 25^\circ\text{C}, I_{SD} = 10A, V_{GS} = 0V$ | -- | 0.9 | 1.2 | V |
| Reverse Recovery Time | t_{rr} | $V_R = 400V, I_F = I_S,$ $di_F/dt = 100A/\mu\text{s}$ | -- | 423 | -- | ns |
| Reverse Recovery Charge | Q_{rr} | | -- | 5.3 | -- | μC |
| Peak Reverse Recovery Current | I_{rrm} | | -- | 25 | -- | A |

Notes

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS} = 3.5A, V_{DD} = 50V, R_G = 25\Omega$, Starting $T_J = 25^\circ\text{C}$
3. Identical low side and high side switch with identical R_G



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

Figure 1. Output Characteristics

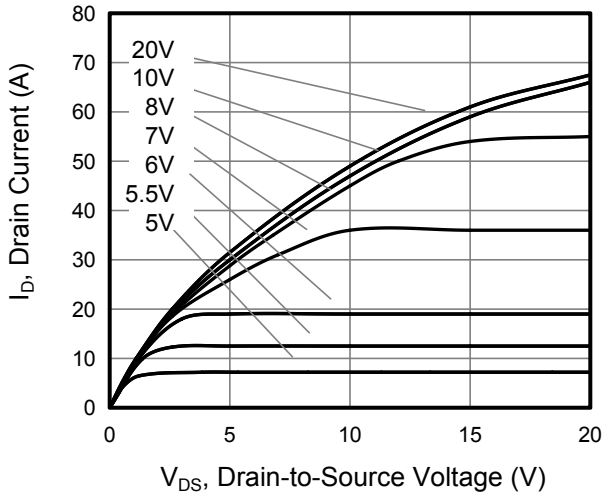


Figure 2. Transfer Characteristics

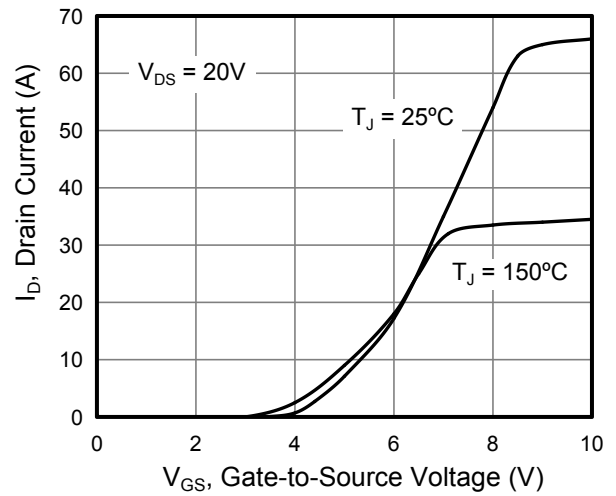


Figure 3. On-Resistance vs. Drain Current

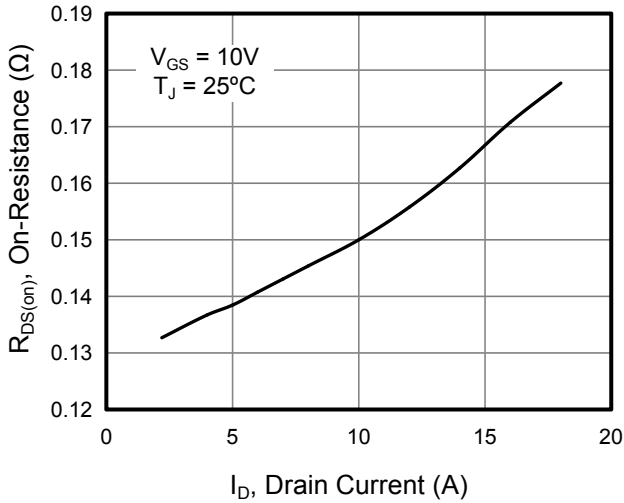


Figure 4. Capacitance

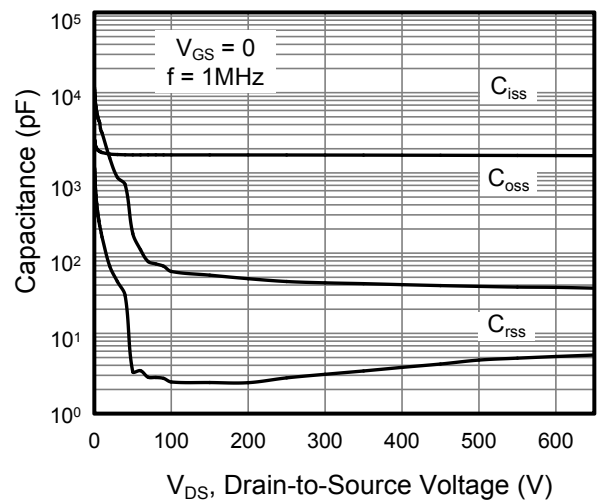


Figure 5. Gate Charge

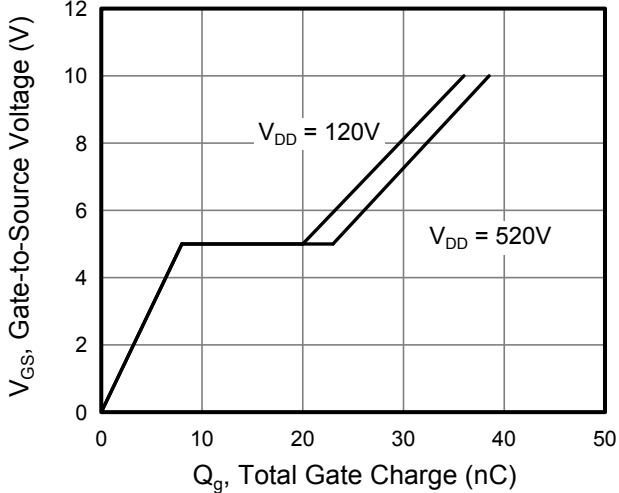
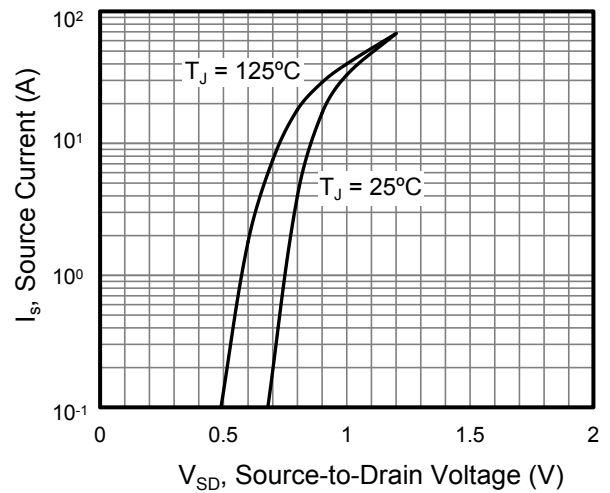


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

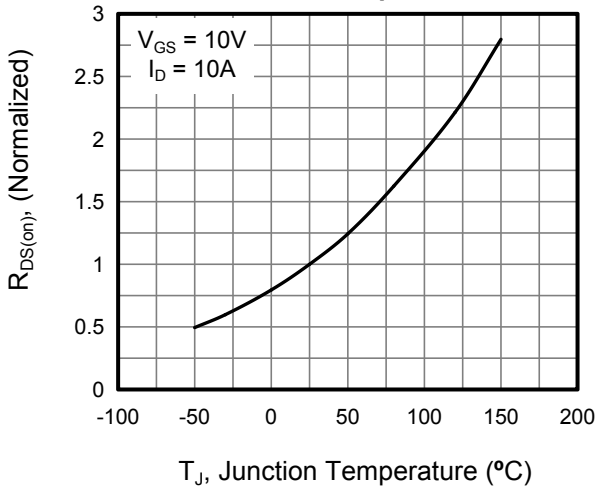


Figure 8. Breakdown voltage vs. Junction Temperature

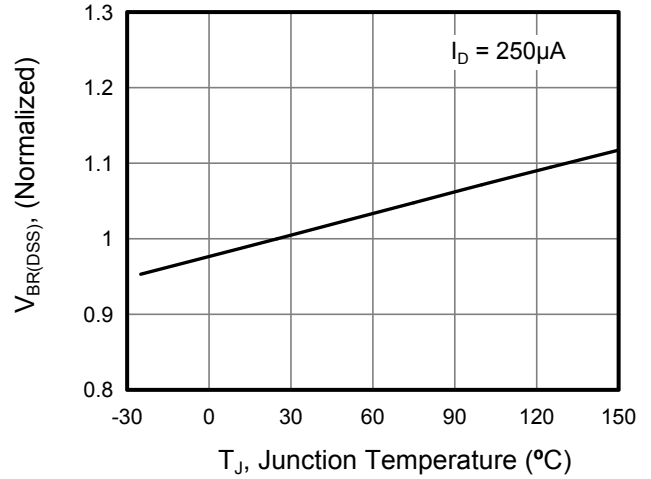


Figure 9. Transient Thermal Impedance TO-220F

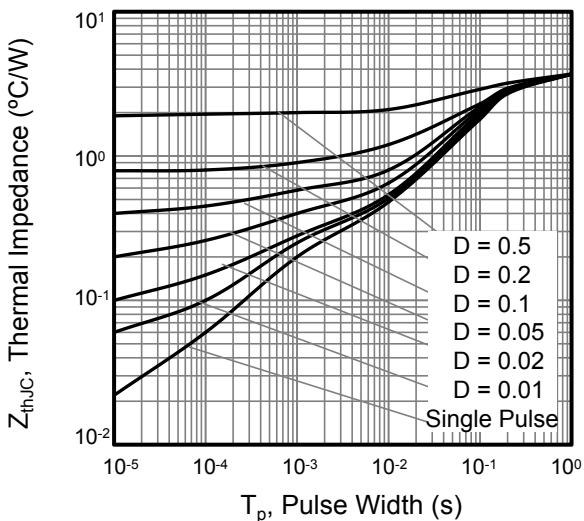


Figure 10. Safe operation area for TO-220F

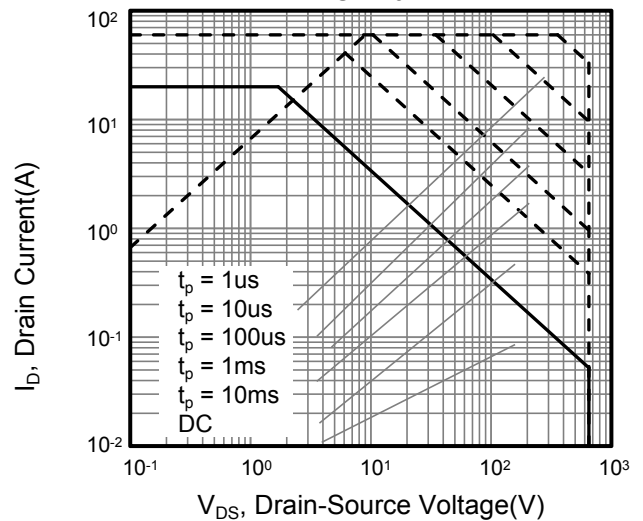


Figure 11. Transient Thermal Impedance TO-263/TO-262/TO-220/TO-3PN/TO-247

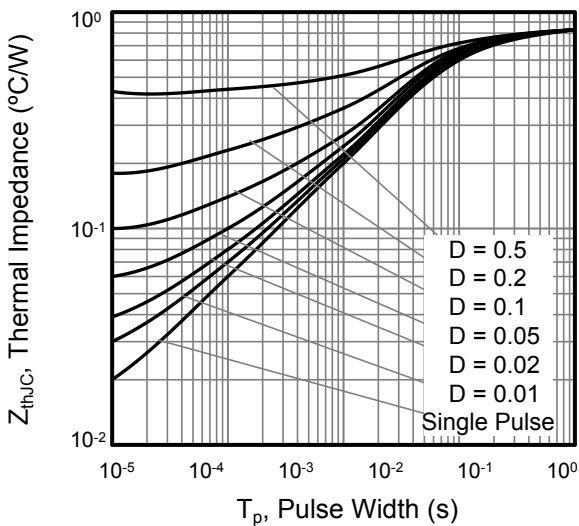


Figure 12. Safe operation area for TO-263/TO-262/TO-220/TO-3PN/TO-247

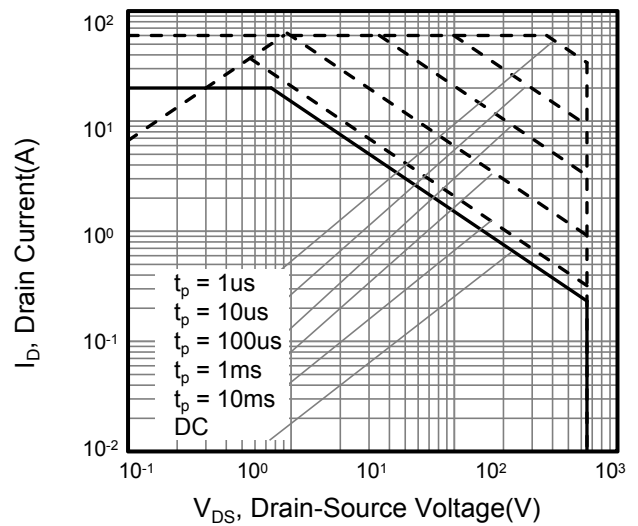




Figure A: Gate Charge Test Circuit and Waveform

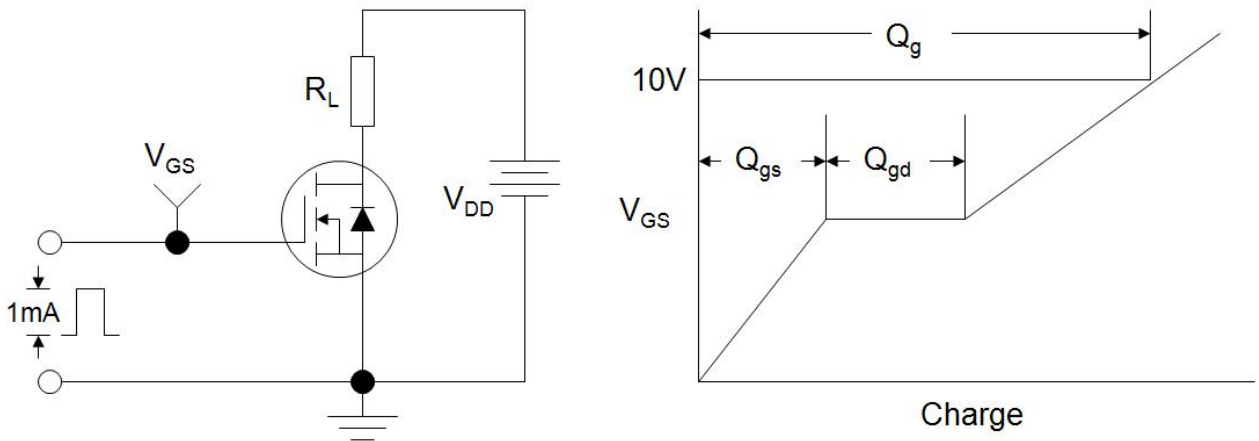


Figure B: Resistive Switching Test Circuit and Waveform

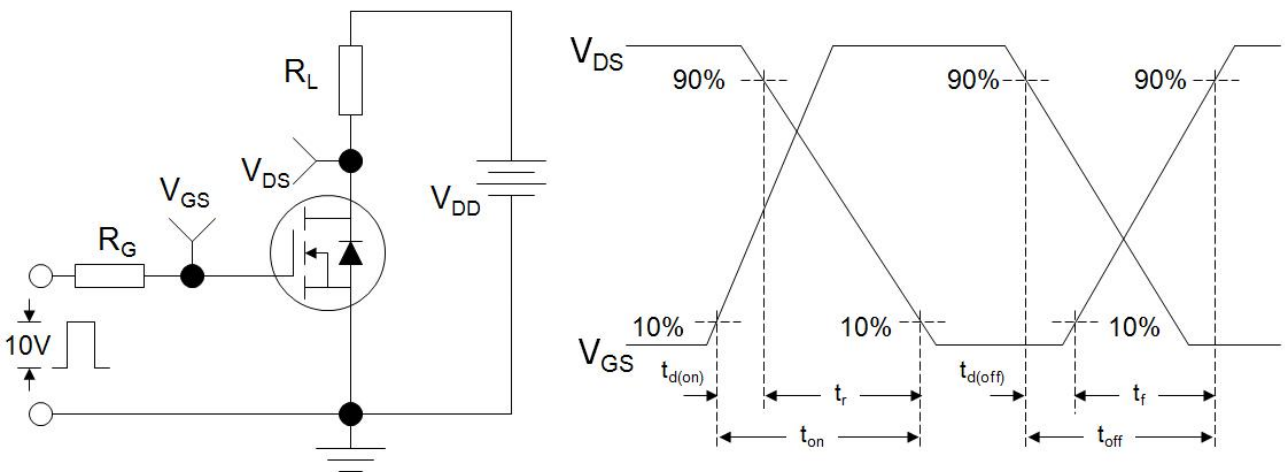
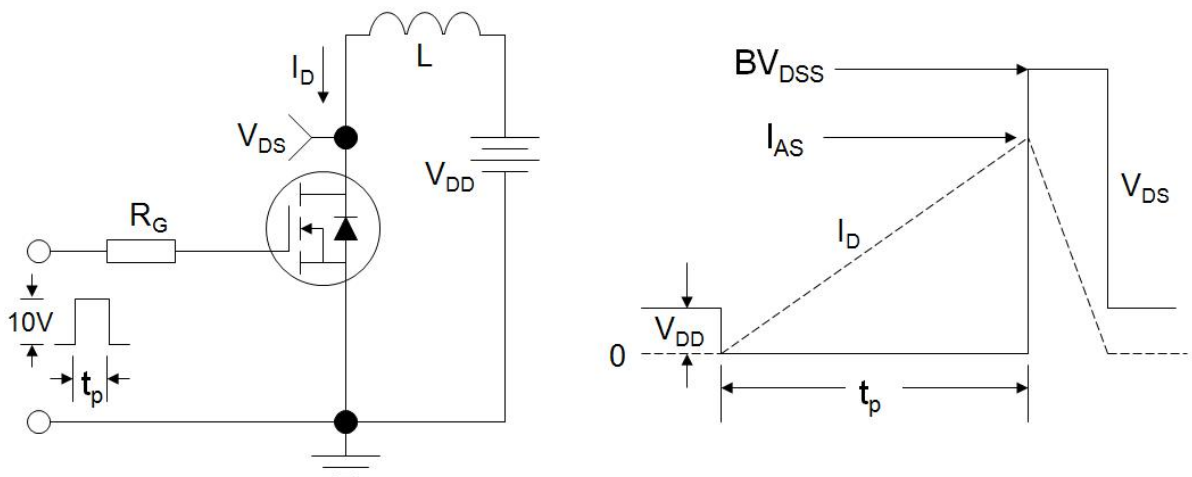
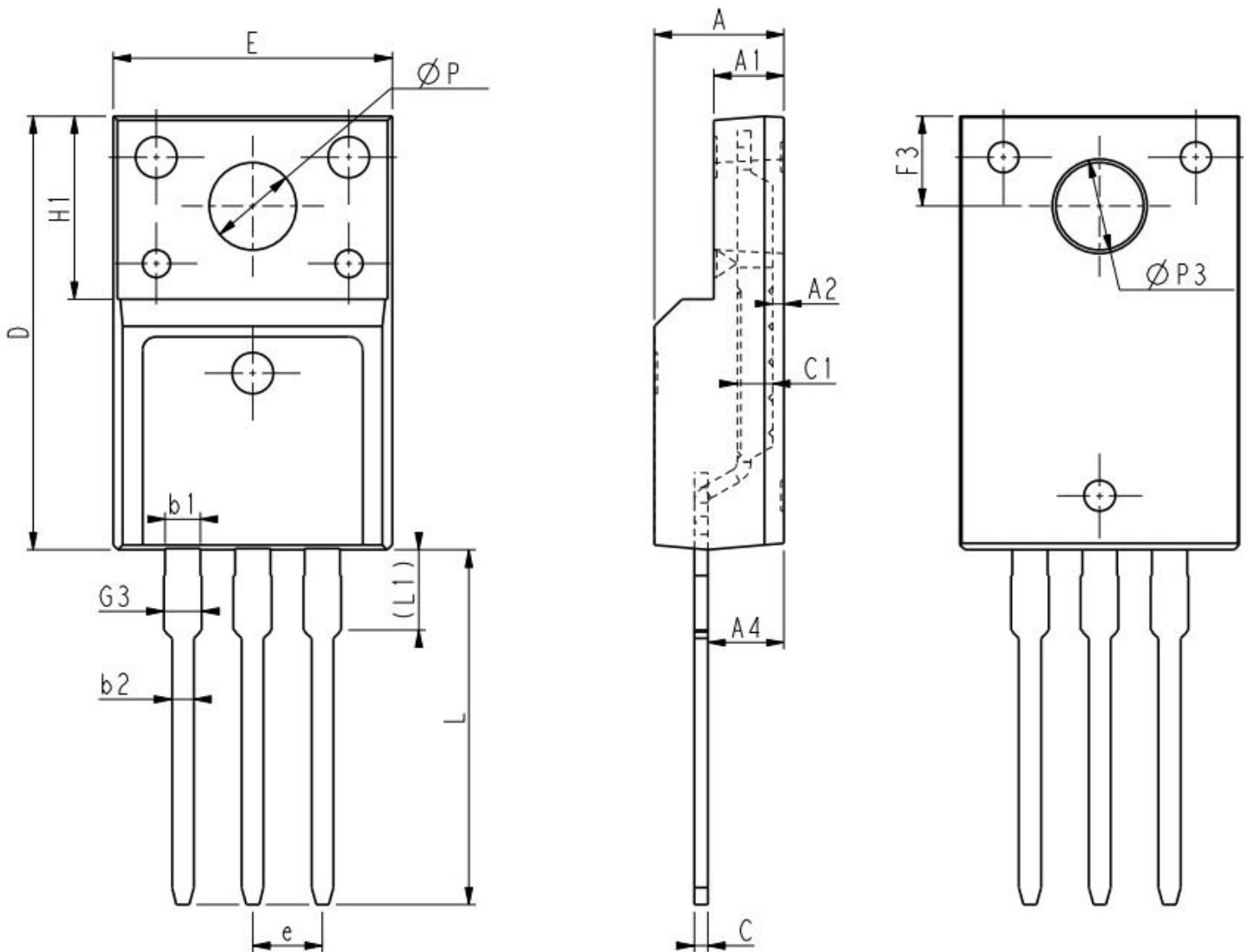


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-220F

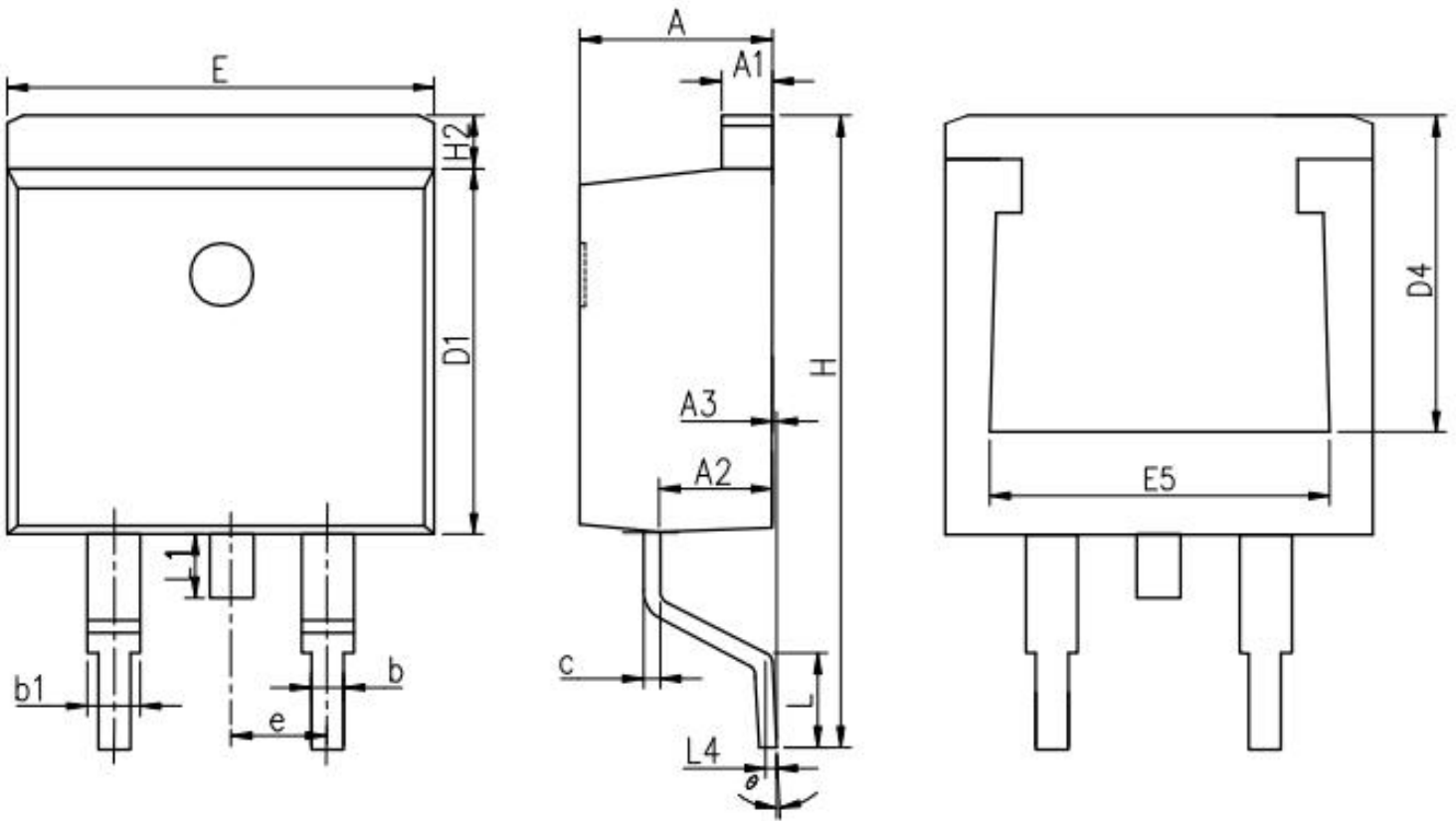


| Unit:mm | | | |
|---------|---------|-------|-------|
| Symbol | Min. | Nom | Max. |
| E | 9.96 | 10.16 | 10.36 |
| A | 4.50 | 4.70 | 4.90 |
| A1 | 2.34 | 2.54 | 2.74 |
| A2 | 0.30 | 0.45 | 0.60 |
| A4 | 2.56 | 2.76 | 2.96 |
| c | 0.40 | 0.50 | 0.65 |
| c1 | 1.20 | 1.30 | 1.35 |
| D | 15.57 | 15.87 | 16.17 |
| H1 | 6.70REF | | |

| Unit:mm | | | |
|-----------|---------|-------|-------|
| Symbol | Min. | Nom | Max. |
| e | 2.54BSC | | |
| L | 12.68 | 12.98 | 13.28 |
| L1 | 2.93 | 3.03 | 3.13 |
| ΦP | 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 |



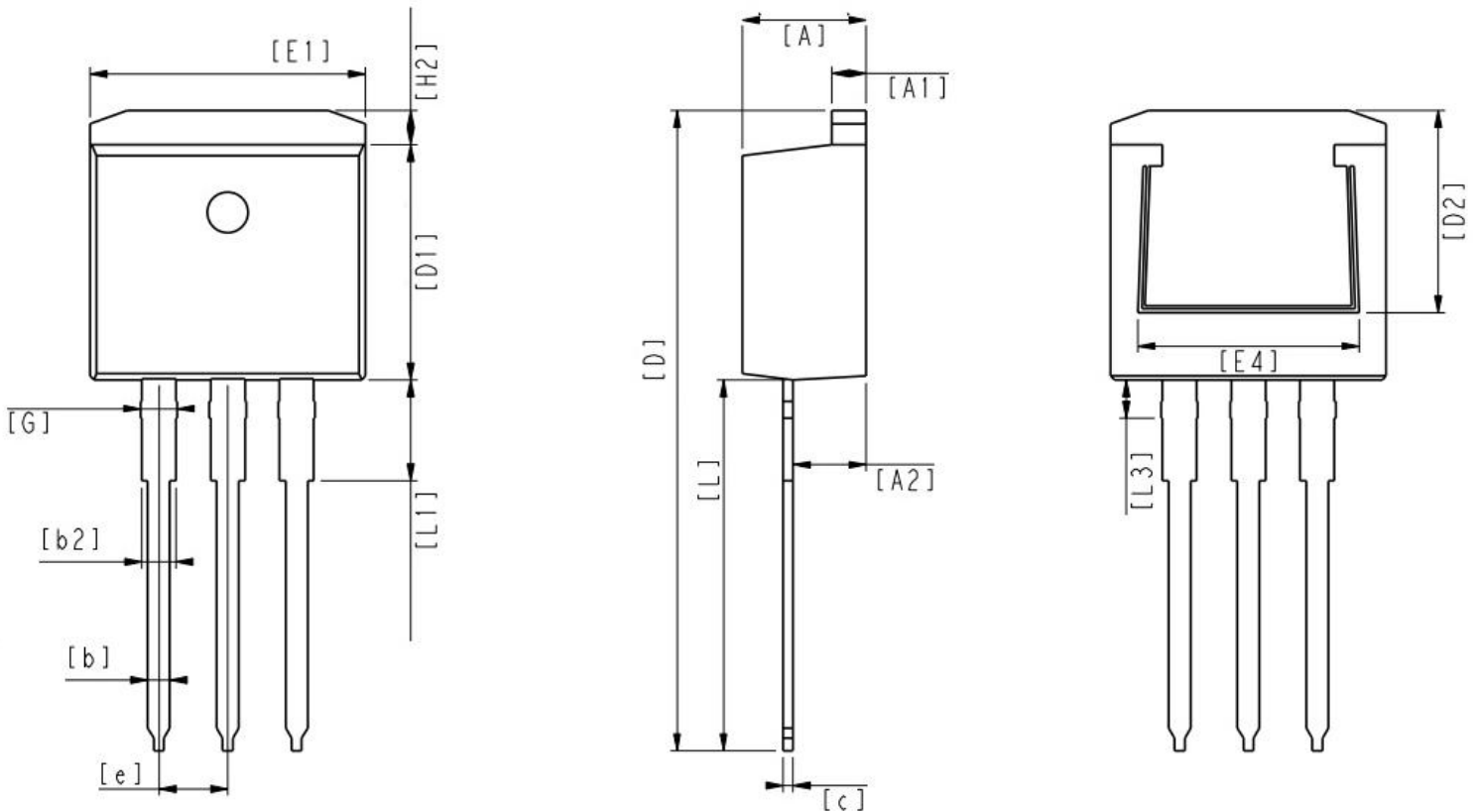
TO-263



| Unit:mm | | | | Unit:mm | | | |
|---------|------|------|------|---------|---------|-------|-------|
| Symbol | Min. | Nom | Max. | Symbol | Min. | Nom | Max. |
| A | 4.37 | 4.57 | 4.77 | E | 9.86 | 10.16 | 10.36 |
| A1 | 1.22 | 1.27 | 1.42 | E5 | 7.06 | - | - |
| A2 | 2.49 | 2.69 | 2.89 | e | 2.54BSC | | |
| A3 | 0.00 | 0.13 | 0.25 | H | 14.70 | 15.10 | 15.50 |
| b | 0.70 | 0.81 | 0.96 | H2 | 1.07 | 1.27 | 1.47 |
| b1 | 1.17 | 1.27 | 1.47 | L | 2.00 | 2.30 | 2.60 |
| c | 0.30 | 0.38 | 0.53 | L1 | 1.40 | 1.55 | 1.70 |
| D1 | 8.50 | 8.70 | 8.90 | L4 | 0.25BSC | | |
| D4 | 6.60 | - | - | θ | 0° | 5° | 9° |



TO-262

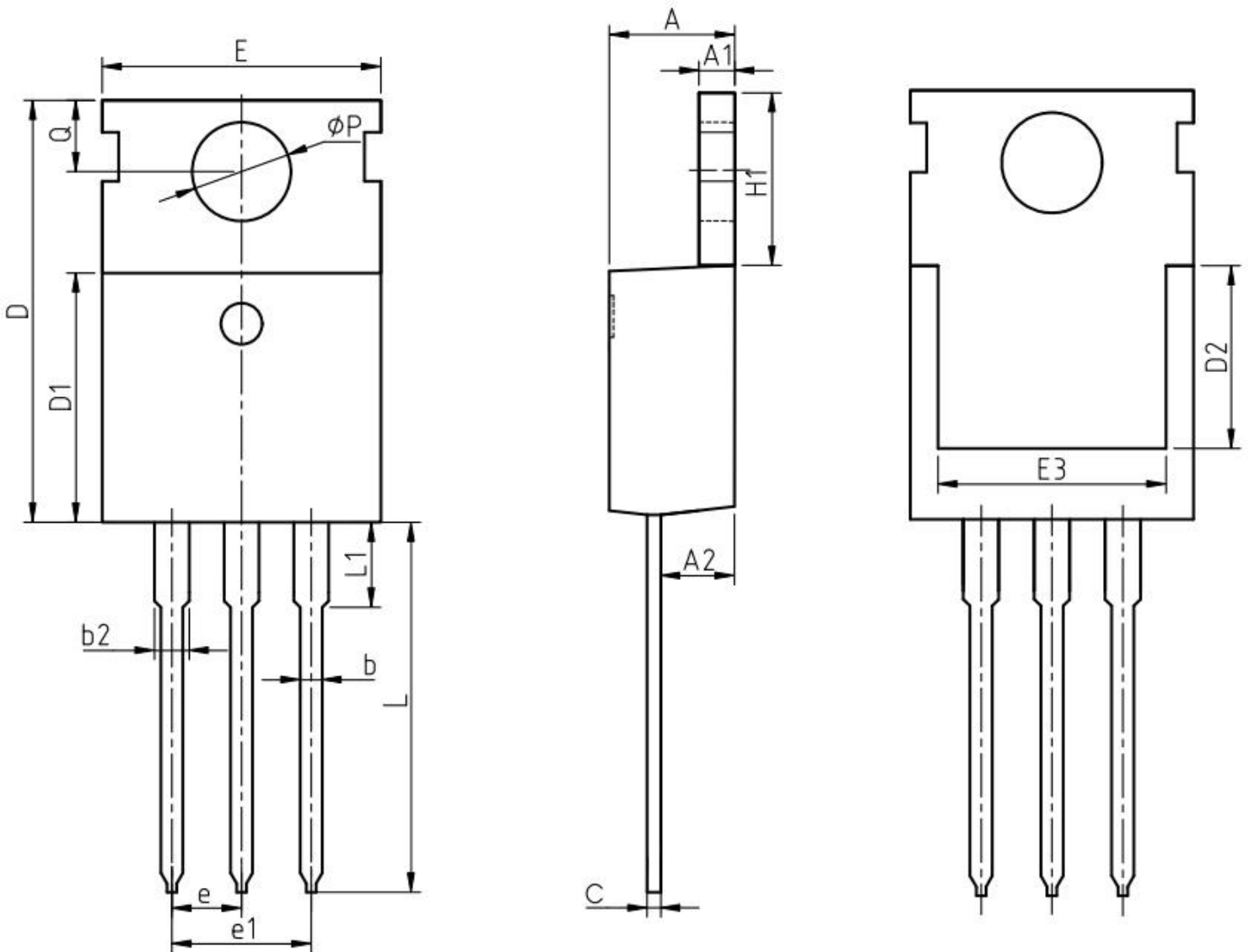


| Unit:mm | | | |
|---------|-------|-------|-------|
| Symbol | Min. | Nom | Max. |
| A | 4.37 | 4.57 | 4.77 |
| A1 | 1.22 | 1.27 | 1.42 |
| A2 | 2.49 | 2.69 | 2.89 |
| b | 0.71 | 0.81 | 0.96 |
| b2 | 1.17 | 1.27 | 1.42 |
| c | 0.28 | 0.38 | 0.53 |
| D | 23.20 | 23.70 | 24.02 |
| D1 | 8.50 | 8.70 | 8.90 |
| D2 | 6.00 | - | - |

| Unit:mm | | | |
|---------|----------|-------|-------|
| Symbol | Min. | Nom | Max. |
| E1 | 9.86 | 10.16 | 10.36 |
| E4 | 7.06 | - | - |
| e | 2.54 BSC | | |
| G | 1.25 | 1.35 | 1.50 |
| H2 | - | - | 1.50 |
| L | 13.33 | 13.73 | 14.13 |
| L1 | 3.50 | 3.75 | 4.00 |
| L3 | 1.28 | 1.43 | 1.58 |



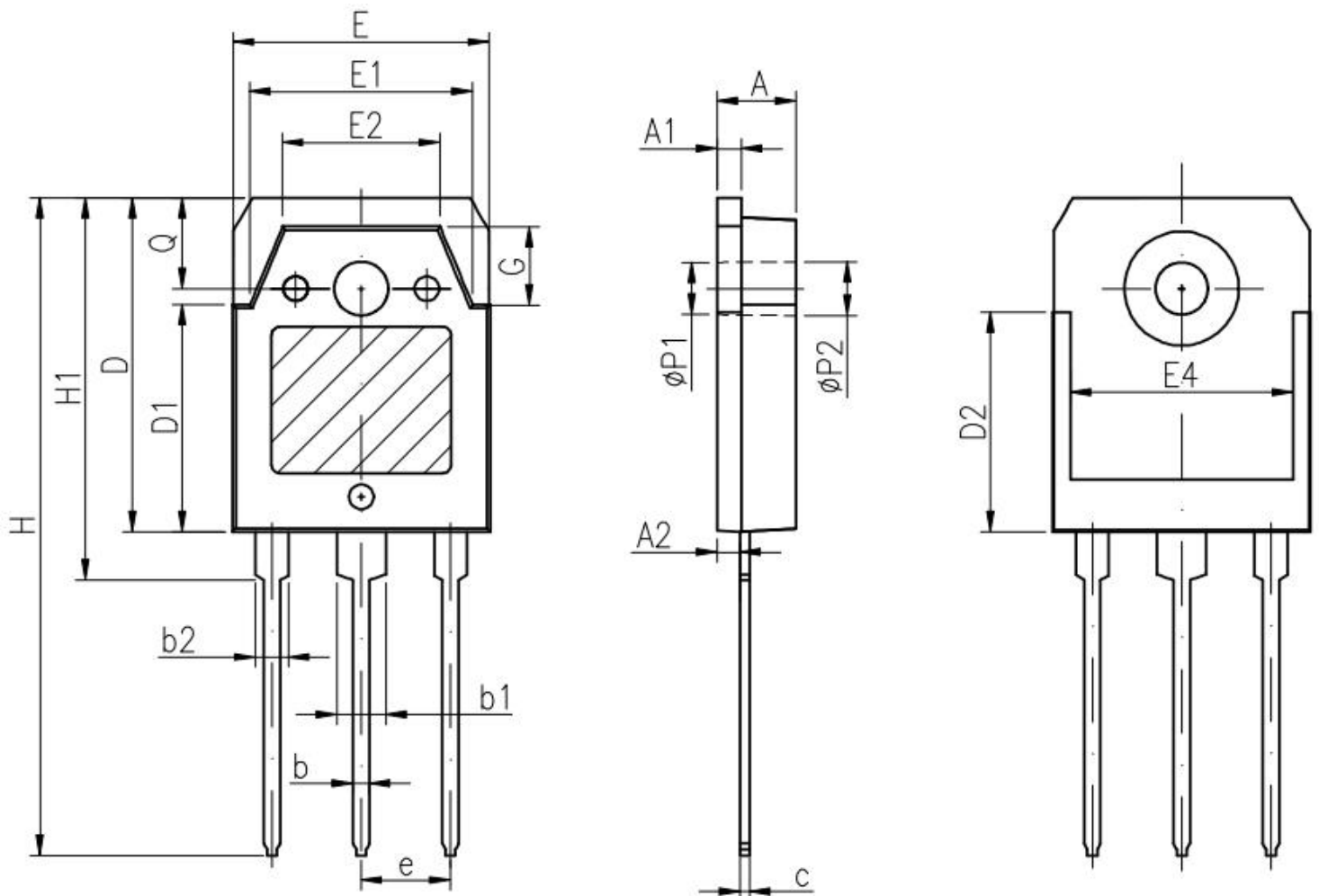
TO-220



| Unit:mm | | | | Unit:mm | | | |
|---------|-------|-------|-------|---------|----------|-------|-------|
| Symbol | Min. | Nom | Max. | Symbol | Min. | Nom | Max. |
| A | 4.37 | 4.57 | 4.77 | E | 9.70 | 10.00 | 10.30 |
| A1 | 1.25 | 1.30 | 1.40 | E3 | 7.00 | - | - |
| A2 | 2.20 | 2.40 | 2.60 | e | 2.54 BSC | | |
| b | 0.70 | 0.80 | 0.95 | e1 | 5.08 BSC | | |
| b2 | 1.17 | 1.27 | 1.47 | H1 | 6.25 | 6.50 | 6.85 |
| c | 0.45 | 0.50 | 0.60 | L | 12.75 | 13.50 | 13.80 |
| D | 15.10 | 15.60 | 16.10 | L1 | - | 3.10 | 3.40 |
| D1 | 8.80 | 9.10 | 9.40 | ΦP | 3.40 | 3.60 | 3.80 |
| D2 | 5.50 | - | - | Q | 2.60 | 2.80 | 3.00 |



TO-3PN

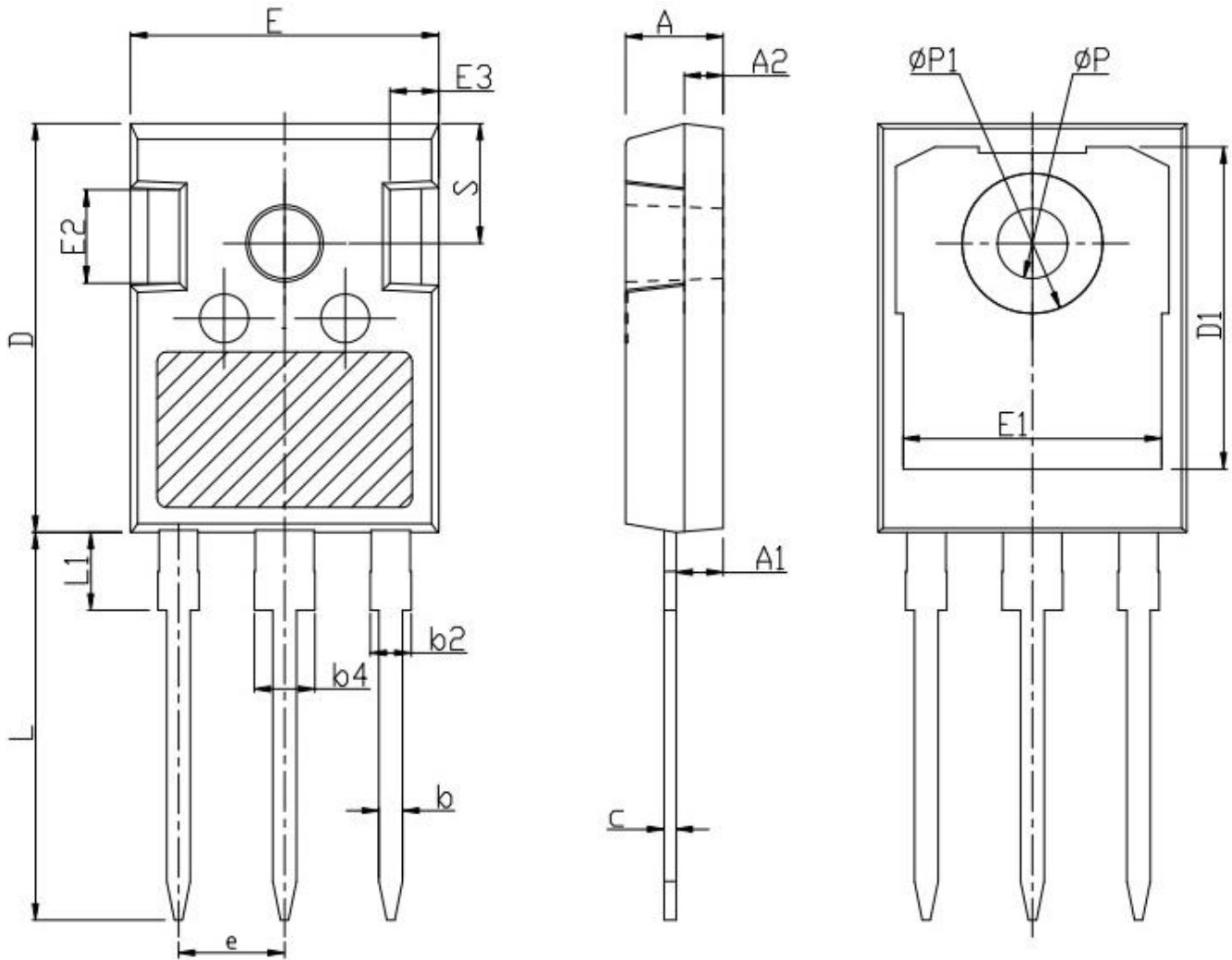


| Unit:mm | | | |
|---------|-----------|-------|-------|
| Symbol | Min. | Nom | Max. |
| A | 4.60 | 4.80 | 5.00 |
| A1 | 1.40 | 1.50 | 1.65 |
| A2 | 1.18 | 1.38 | 1.58 |
| b | 0.80 | 1.00 | 1.20 |
| b1 | 2.80 | 3.00 | 3.20 |
| b2 | 1.80 | 2.00 | 2.20 |
| c | 0.50 | 0.60 | 0.75 |
| D | 19.60 | 19.90 | 20.20 |
| D1 | 13.55 | 13.90 | 14.25 |
| D2 | 12.90 REF | | |

| Unit:mm | | | |
|---------|----------|-------|-------|
| Symbol | Min. | Nom | Max. |
| E | 15.35 | 15.60 | 15.85 |
| E1 | 13.40 | 13.60 | 13.80 |
| E2 | 9.40 | 9.60 | 9.80 |
| E4 | 12.60 | - | - |
| e | 5.45 TYP | | |
| G | 4.55 | 4.80 | 5.05 |
| H | 40.10 | 40.50 | 40.90 |
| H1 | 23.15 | 23.40 | 23.65 |
| ΦP1 | 3.20 REF | | |
| ΦP2 | 3.50REF | | |
| Q | 5.00 REF | | |



TO-247



| Unit:mm | | | |
|---------|-------|-------|-------|
| Symbol | Min. | Nom | Max. |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.21 | 2.41 | 2.61 |
| A2 | 1.85 | 2.00 | 2.15 |
| b | 1.11 | 1.21 | 1.36 |
| b2 | 1.91 | 2.01 | 2.21 |
| b4 | 2.91 | 3.01 | 3.21 |
| c | 0.51 | 0.61 | 0.75 |
| D | 20.70 | 21.00 | 21.30 |
| D1 | 16.25 | 16.55 | 16.85 |

| Unit:mm | | | |
|-----------|---------|-------|-------|
| Symbol | Min. | Nom. | Max. |
| E | 15.50 | 15.80 | 16.10 |
| E1 | 13.00 | 13.30 | 13.60 |
| E2 | 4.80 | 5.00 | 5.20 |
| E3 | 2.30 | 2.50 | 2.70 |
| e | 5.44BSC | | |
| L | 19.62 | 19.92 | 20.22 |
| L1 | - | - | 4.30 |
| ΦP | 3.40 | 3.60 | 3.80 |
| $\Phi P1$ | - | - | 7.30 |
| S | 6.15BSC | | |



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