



650V Super-Junction Power MOSFET

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)



| Device Marking and Package Information | | | | |
|--|------------|------------|------------|------------|
| Device | TPA65R170M | TPP65R170M | TPV65R170M | TPW65R170M |
| Package | TO-220F | TO-220 | TO-3PN | TO-247 |
| Marking | 65R170M | 65R170M | 65R170M | 65R170M |

| Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, unless otherwise noted | | | | | | |
|--|----------------|----------|--------|--------|---------|------------------|
| Parameter | Symbol | Value | | | | Unit |
| | | TO-220 | TO-3PN | TO-247 | TO-220F | |
| Drain-Source Voltage ($V_{GS} = 0\text{V}$) | V_{DSS} | 650 | | | | V |
| Continuous Drain Current | I_D | 20 | | | | A |
| Pulsed Drain Current (note1) | I_{DM} | 60 | | | | A |
| Gate-Source Voltage | V_{GSS} | ± 30 | | | | V |
| Single Pulse Avalanche Energy (note2) | E_{AS} | 484 | | | | mJ |
| Avalanche Current (note1) | I_{AR} | 3.5 | | | | A |
| Repetitive Avalanche Energy (note1) | E_{AR} | 0.7 | | | | mJ |
| Power Dissipation ($T_C = 25^\circ\text{C}$) | P_D | 151 | | 34 | | W |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | -55~+150 | | | | $^\circ\text{C}$ |

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



| Specifications $T_J = 25^\circ\text{C}$, unless otherwise noted | | | | | | |
|--|---------------|--|-------|------|-----------|----------|
| Parameter | Symbol | Test Conditions | Value | | | Unit |
| | | | Min. | Typ. | Max. | |
| Static | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = 250\mu A$ | 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 | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\mu A$ | 2.5 | -- | 4.5 | V |
| Drain-Source On-Resistance (Note3) | $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 10A$ | -- | 0.15 | 0.17 | Ω |
| Forward Transconductance (Note3) | g_{fs} | $V_{DS} = 10V, I_D = 10A$ | -- | 23 | -- | S |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0V,$ $V_{DS} = 50V,$ $f = 1.0\text{MHz}$ | -- | 1840 | -- | μF |
| Output Capacitance | C_{oss} | | -- | 197 | -- | |
| Reverse Transfer Capacitance | C_{rss} | | -- | 8 | -- | |
| Total Gate Charge | Q_g | $V_{DD} = 520V, I_D = 20A,$ $V_{GS} = 10V$ | -- | 54 | -- | nC |
| Gate-Source Charge | Q_{gs} | | -- | 12 | -- | |
| Gate-Drain Charge | Q_{gd} | | -- | 18 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD} = 400V, I_D = 20A,$ $R_G = 25\Omega$ | -- | 66 | -- | ns |
| Turn-on Rise Time | t_r | | -- | 27 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 167 | -- | |
| Turn-off Fall Time | t_f | | -- | 21 | -- | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous Body Diode Current | I_S | $T_C = 25^\circ\text{C}$ | -- | -- | 20 | A |
| Pulsed Diode Forward Current | I_{SM} | | -- | -- | 60 | |
| Body Diode Voltage | V_{SD} | $T_J = 25^\circ\text{C}, I_{SD} = 20A, V_{GS} = 0V$ | -- | 0.9 | 1.2 | V |
| Reverse Recovery Time | t_{rr} | $V_R = 480V, I_F = I_S,$ $di_F/dt = 100A/\mu s$ | -- | 336 | -- | ns |
| Reverse Recovery Charge | Q_{rr} | | -- | 3.4 | -- | μC |
| Peak Reverse Recovery Current | I_{rrm} | | -- | 20 | -- | 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 $\leq 300\mu s, \text{Duty Cycle } \leq 1\%$



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

Figure 1. Output Characteristics

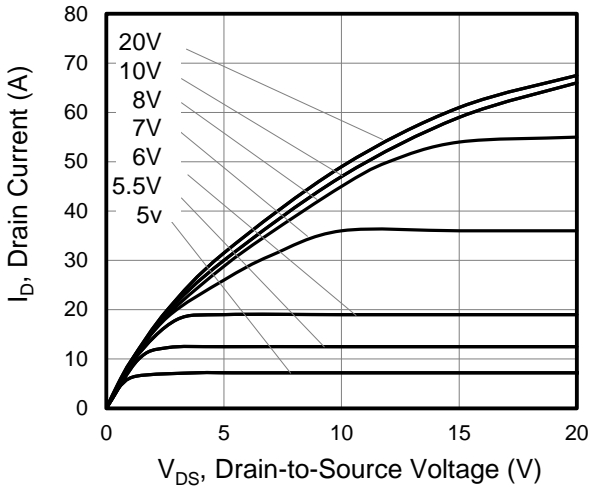


Figure 2. Transfer Characteristics

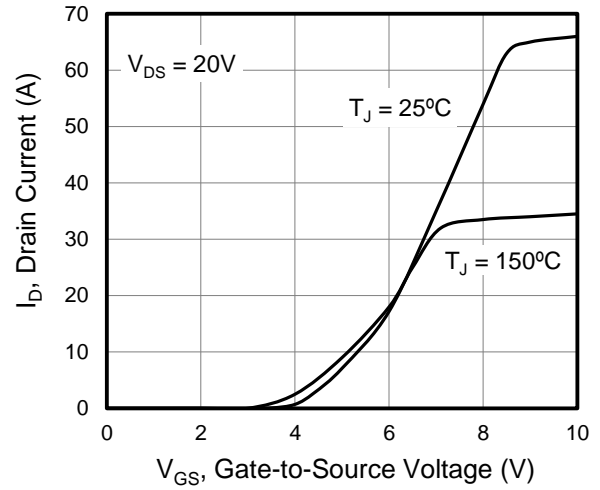


Figure 3. On-Resistance vs. Drain Current

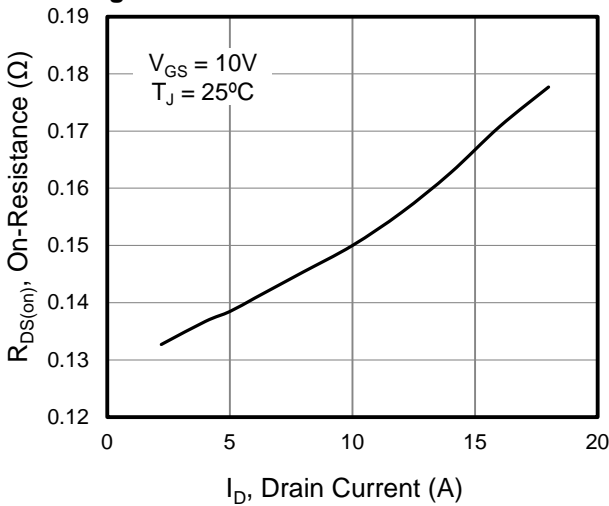


Figure 4. Capacitance

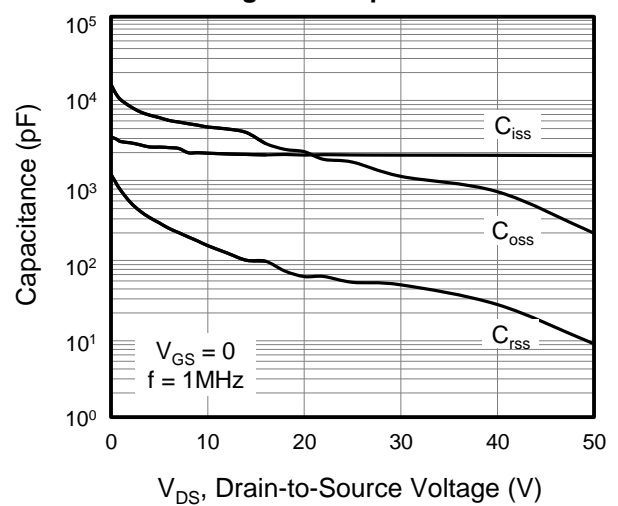


Figure 5. Gate Charge

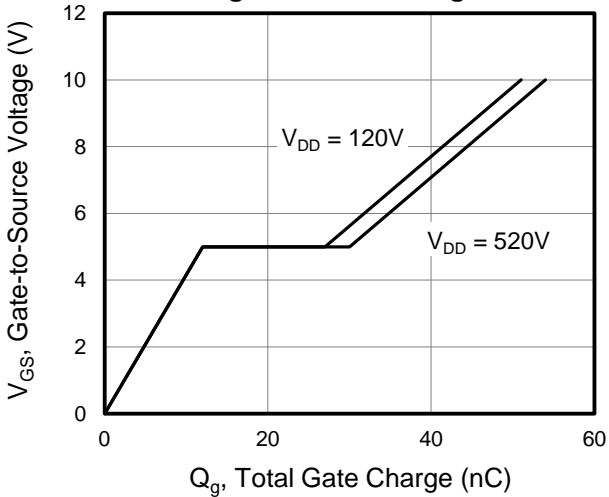
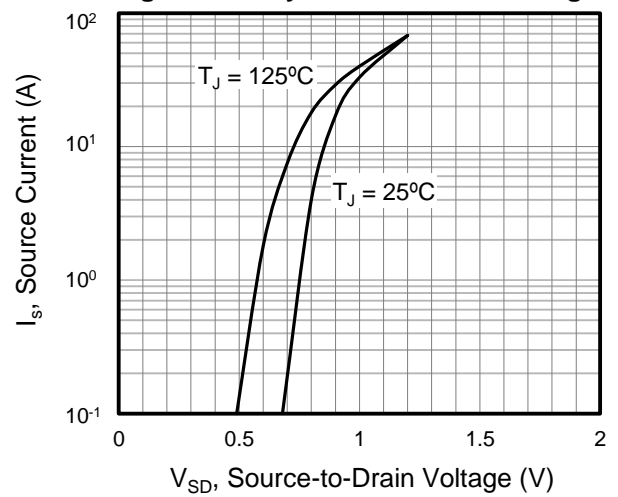


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Junction Temperature

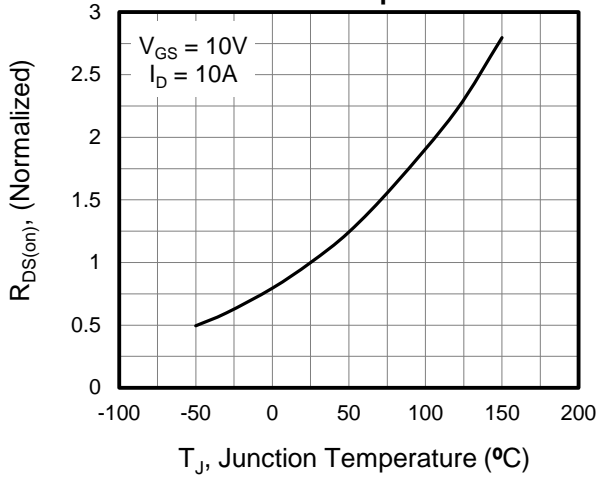


Figure 8. Threshold Voltage vs. Junction Temperature

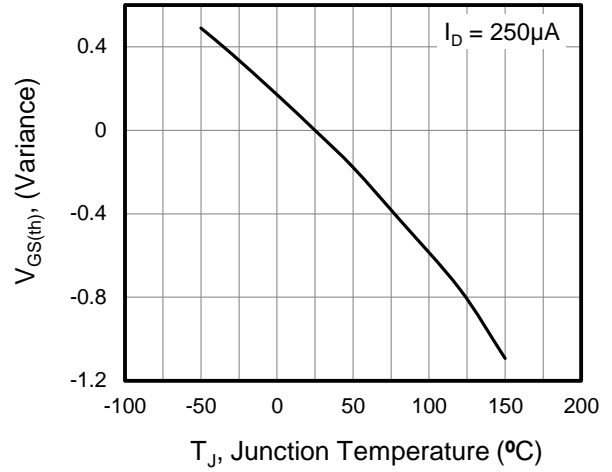


Figure 9. Transient Thermal Impedance TO-220/TO-3PN/TO-247

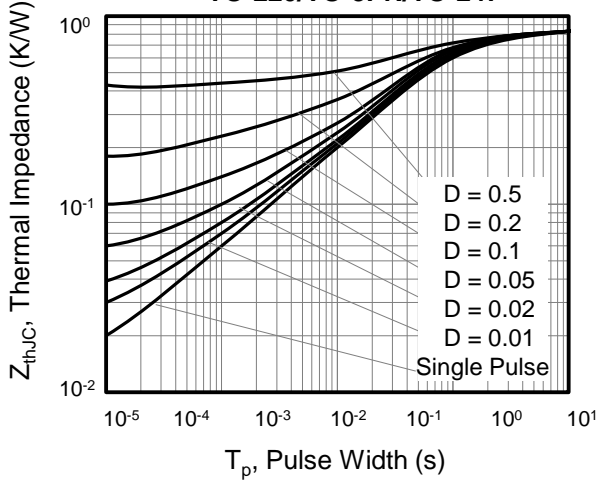


Figure 10. Transient Thermal Impedance TO-220F

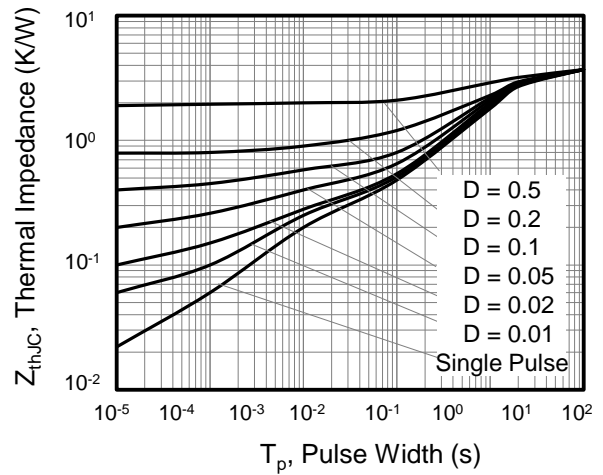




Figure A: Gate Charge Test Circuit and Waveform

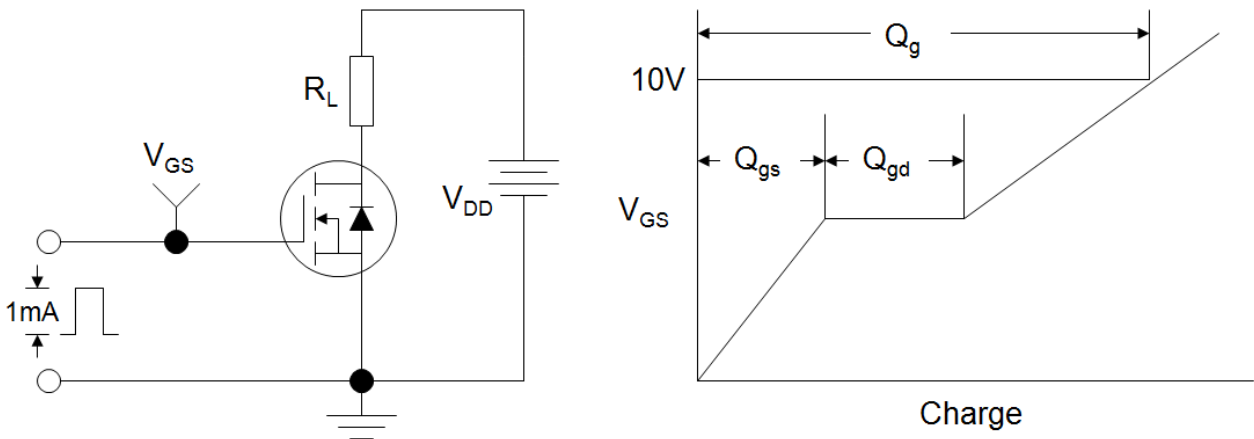


Figure B: Resistive Switching Test Circuit and Waveform

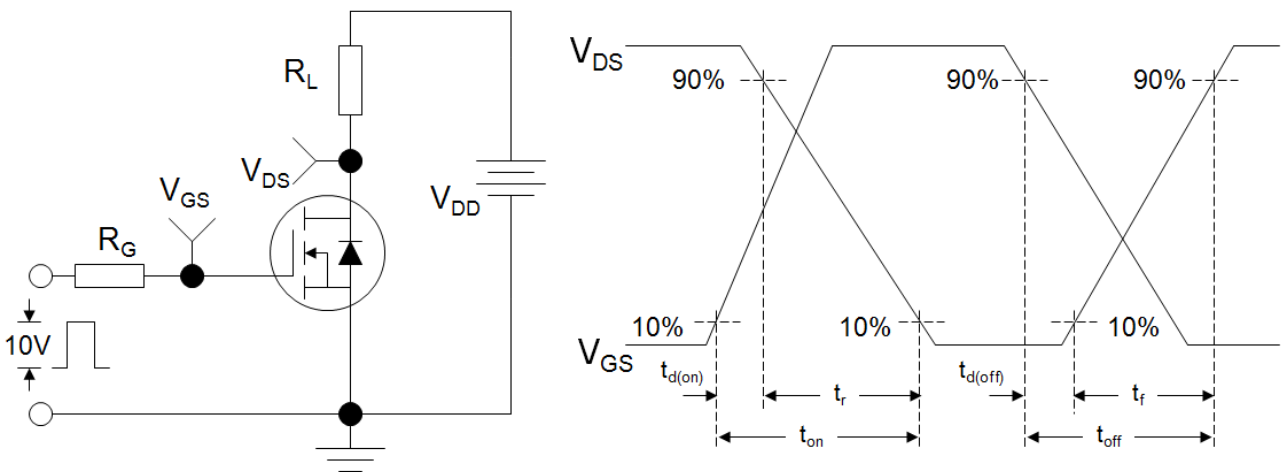
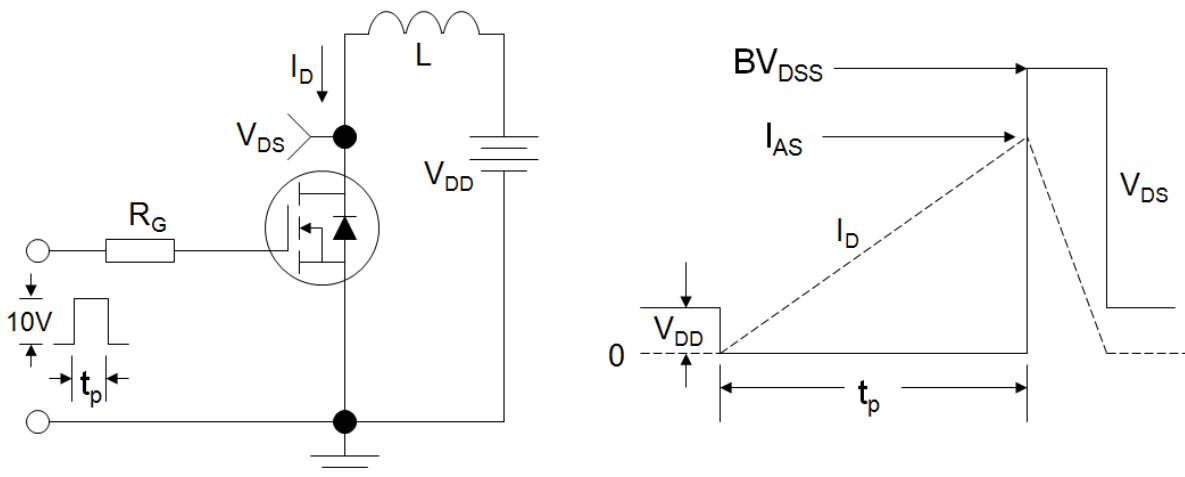
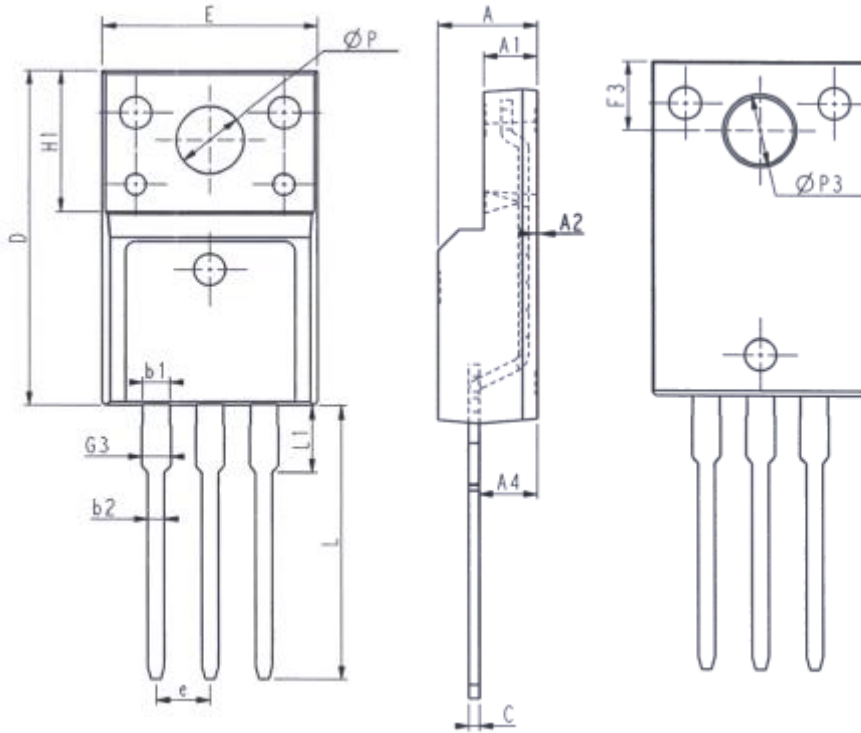


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





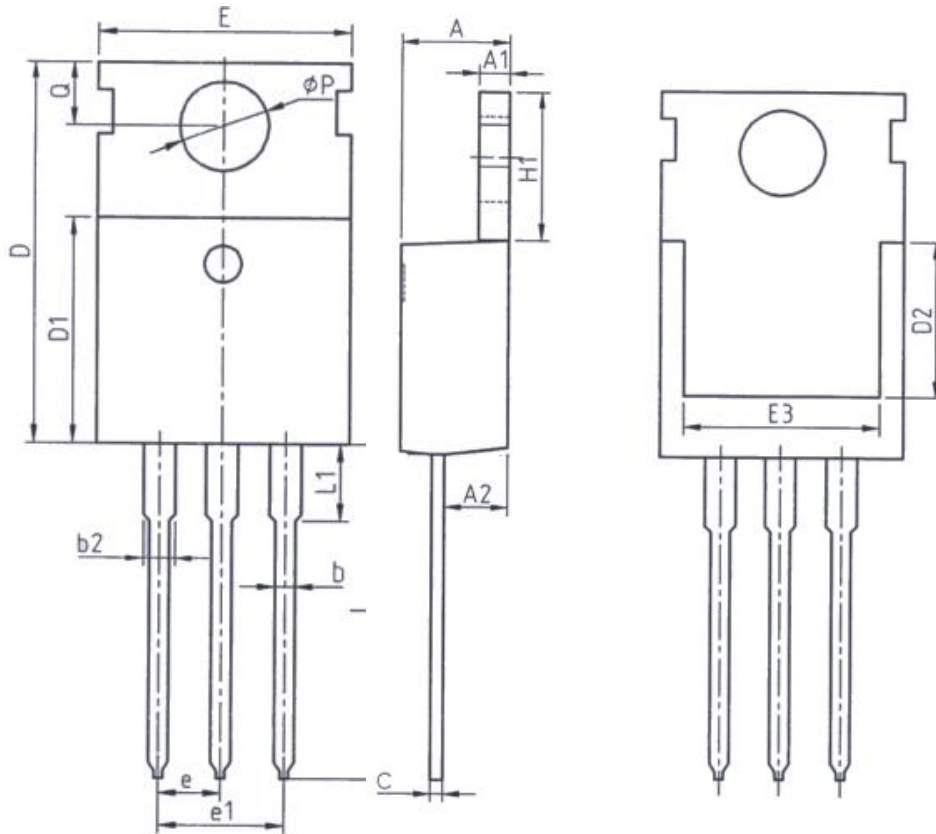
TO-220F



| Unit: mm | | | Unit: mm | | |
|----------|---------|-------|----------|-------|-------|
| Symbol | Min. | Max. | Symbol | Min. | Max. |
| E | 9.96 | 10.36 | L | 12.68 | 13.28 |
| A | 4.50 | 4.90 | L1 | 2.93 | 3.13 |
| A1 | 2.34 | 2.74 | P | 3.03 | 3.38 |
| A2 | 0.30 | 0.60 | P3 | 3.15 | 3.65 |
| A4 | 2.56 | 2.96 | F3 | 3.15 | 3.45 |
| c | 0.40 | 0.65 | G3 | 1.25 | 1.55 |
| D | 15.57 | 16.17 | b1 | 1.18 | 1.43 |
| H1 | 6.70REF | | b2 | 0.70 | 0.95 |
| e | 2.54BSC | | | | |



TO-220

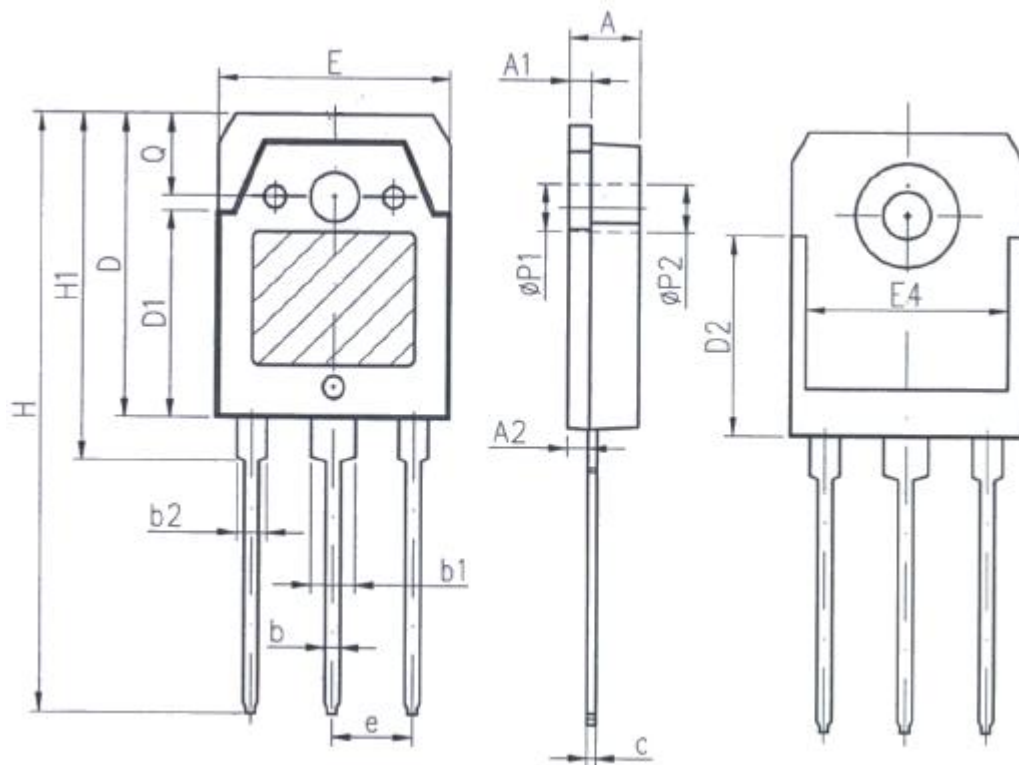


| Unit: mm | | |
|----------|-------|-------|
| Symbol | Min. | Max. |
| A | 4.37 | 4.77 |
| A1 | 1.25 | 1.45 |
| A2 | 2.20 | 2.60 |
| b | 0.70 | 0.95 |
| b2 | 1.17 | 1.47 |
| c | 0.40 | 0.65 |
| D | 15.10 | 16.10 |
| D1 | 8.80 | 9.40 |
| D2 | 5.50 | - |

| 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 |



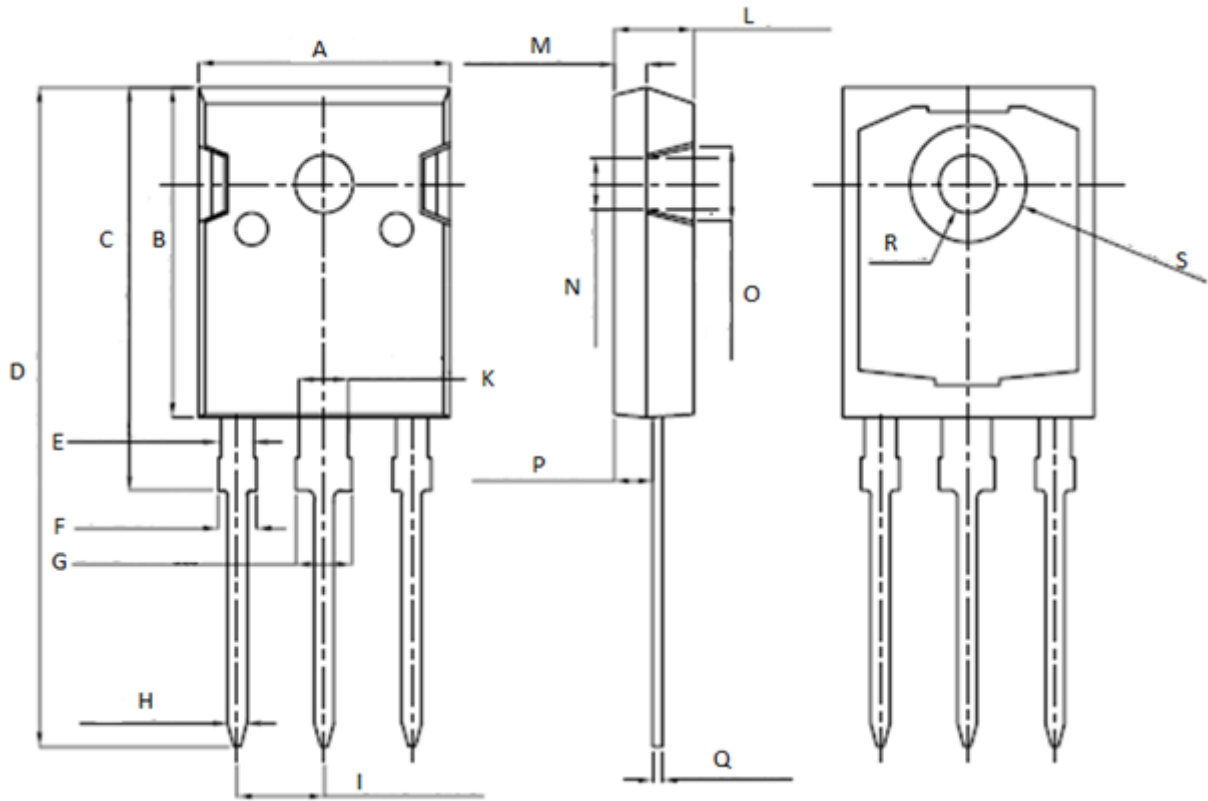
TO-3PN



| Unit:mm | | |
|---------|---------|-------|
| Symbol | Min. | Max. |
| A | 4.6 | 5 |
| A1 | 1.4 | 1.65 |
| A2 | 1.18 | 1.58 |
| b | 0.8 | 1.2 |
| b1 | 2.8 | 3.2 |
| b2 | 1.8 | 2.2 |
| c | 0.5 | 0.75 |
| D | 19.6 | 20.2 |
| D1 | 13.55 | 14.25 |
| D2 | 12.9REF | |
| E | 15.35 | 15.85 |
| E4 | 12.6 | - |
| e | 5.45TYP | |
| H | 40.1 | 40.9 |
| H1 | 23.15 | 23.65 |
| P1 | 3.2REF | |
| P2 | 3.5REF | |



TO-247



| 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 | ϕ 3.5 | ϕ 3.7 |
| S | ϕ 7.1 | ϕ 7.3 |



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