



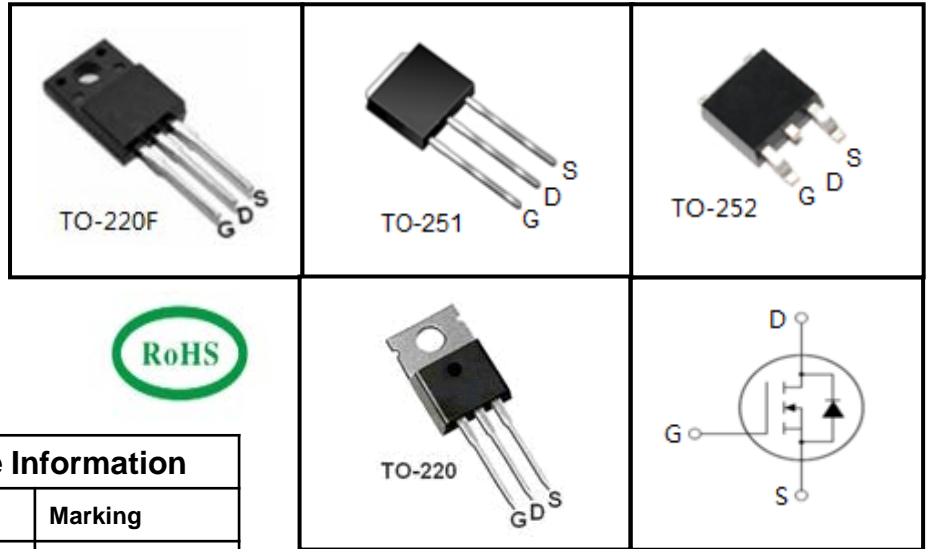
650V N-Channel MOSFET

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 |
| TMA4N65H | TO-220F | A4N65H |
| TMU4N65H | TO-251 | U4N65H |
| TMP4N65H | TO-220 | P4N65H |
| TMD4N65H | TO-252 | D4N65H |

| 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 ($V_{GS} = 0\text{V}$) | V_{DSS} | 650 | | | | V |
| Continuous Drain Current | I_D | 4 | | | | A |
| Pulsed Drain Current (note1) | I_{DM} | 16 | | | | A |
| Gate-Source Voltage | V_{GSS} | ± 30 | | | | V |
| Single Pulse Avalanche Energy (note2) | E_{AS} | 160 | | | | mJ |
| Avalanche Current (note1) | I_{AR} | 4 | | | | A |
| Repetitive Avalanche Energy (note1) | E_{AR} | 20 | | | | mJ |
| Power Dissipation ($T_C = 25^\circ\text{C}$) | P_D | 36 | 75 | | | 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-220 | TO-251 | TO-252 | |
| Thermal Resistance, Junction-to-Case | R_{thJC} | 3.47 | 1.67 | | | 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. | |
| 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 |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 30V$ | -- | -- | ± 100 | nA |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\mu A$ | 3.0 | -- | 4.0 | V |
| Drain-Source On-Resistance (Note3) | $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 2.0A$ | -- | 2 | 2.4 | Ω |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0V,$ $V_{DS} = 25V,$ $f = 1.0\text{MHz}$ | -- | 580 | -- | pF |
| Output Capacitance | C_{oss} | | -- | 69.5 | -- | |
| Reverse Transfer Capacitance | C_{rss} | | -- | 10.9 | -- | |
| Total Gate Charge | Q_g | $V_{DD} = 520V, I_D = 4.0A,$ $V_{GS} = 10V$ | -- | 15 | -- | nC |
| Gate-Source Charge | Q_{gs} | | -- | 2.5 | -- | |
| Gate-Drain Charge | Q_{gd} | | -- | 7.5 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD} = 400V, I_D = 4.0A,$ $R_G = 25\Omega$ | -- | 12 | -- | ns |
| Turn-on Rise Time | t_r | | -- | 22 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 50 | -- | |
| Turn-off Fall Time | t_f | | -- | 48 | -- | |
| Drain-Source Body Diode Characteristics | | | | | | |
| 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} | $T_J = 25^\circ\text{C}, I_{SD} = 4.0A, V_{GS} = 0V$ | -- | -- | 1.4 | V |
| Reverse Recovery Time | t_{rr} | $V_{GS} = 0V, I_S = 4.0A,$ $di_F/dt = 100A/\mu s$ | -- | 250 | -- | ns |
| Reverse Recovery Charge | Q_{rr} | | -- | 3.5 | -- | μC |

Notes

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS} = 4A, V_{DD} = 50V, R_G = 25\Omega, \text{Starting } T_J = 25^\circ\text{C}$
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 ($T_J = 25^\circ\text{C}$)

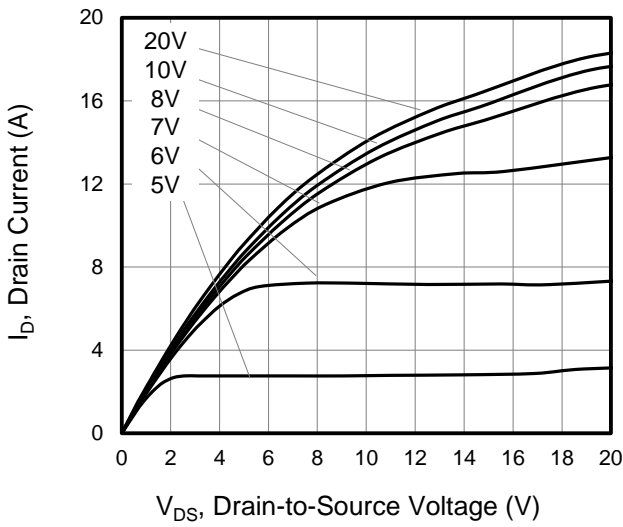


Figure 2. Body Diode Forward Voltage

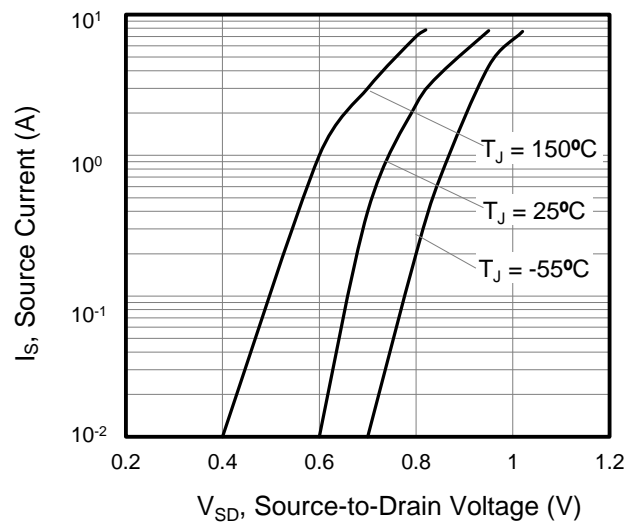


Figure 3. Drain Current vs. Temperature

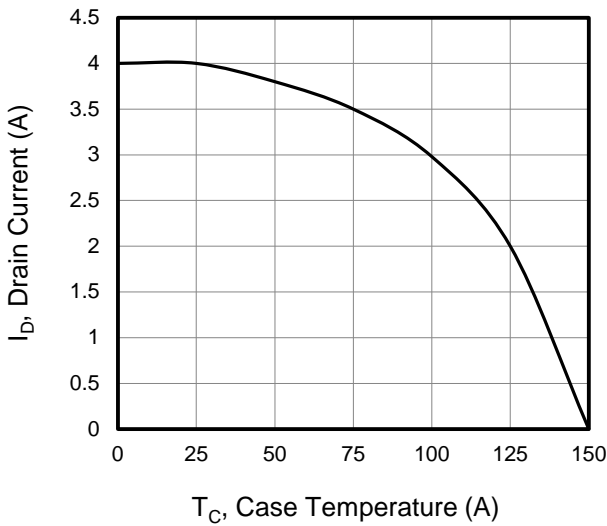


Figure 4. Power Dissipation vs. Temperature

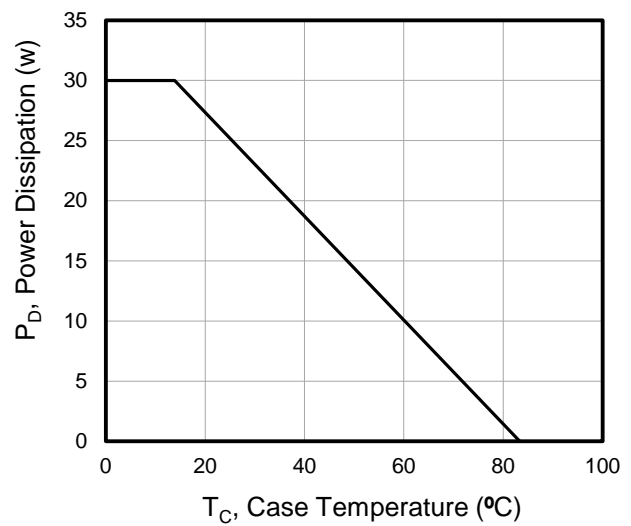


Figure 5. Transfer Characteristics

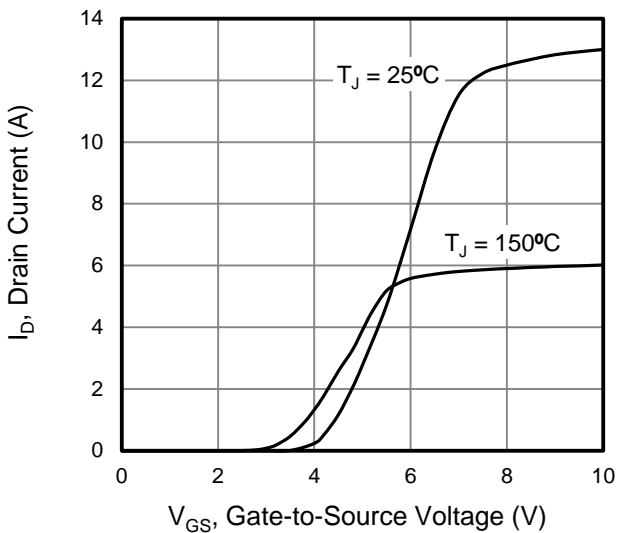
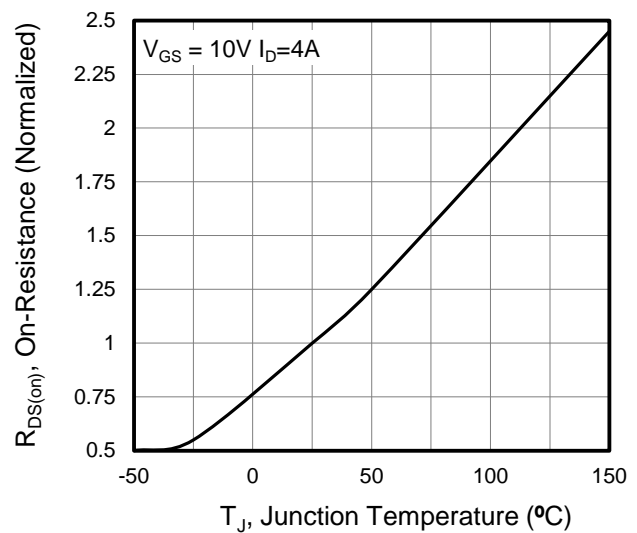


Figure 6. On-Resistance vs. Temperature





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

Figure 7. Capacitance

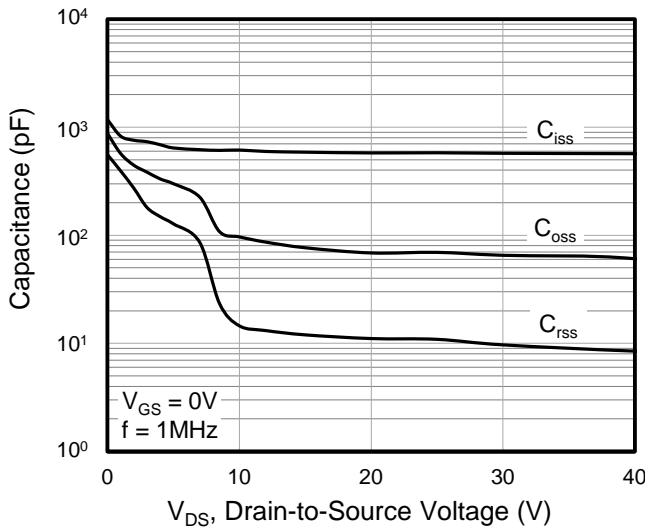


Figure 8. Gate Charge

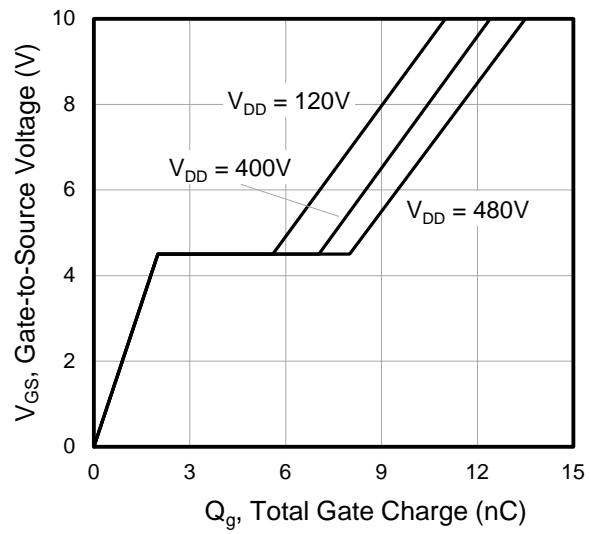


Figure 9. Transient Thermal Impedance TO-220F

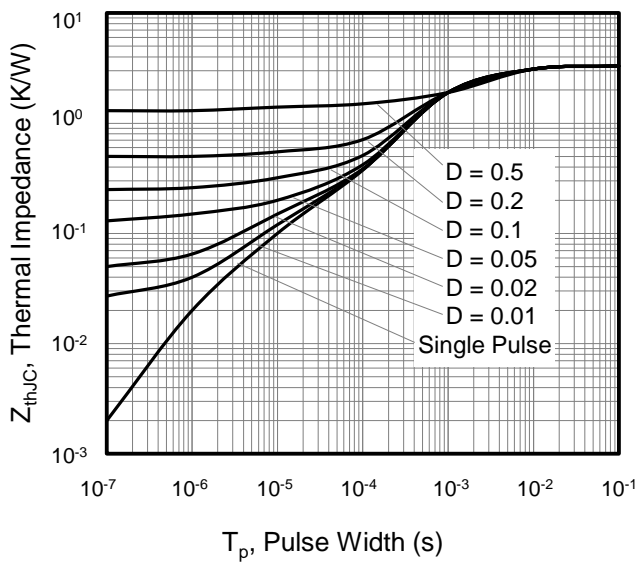


Figure 10. Transient Thermal Impedance TO-220, TO-251, TO-252

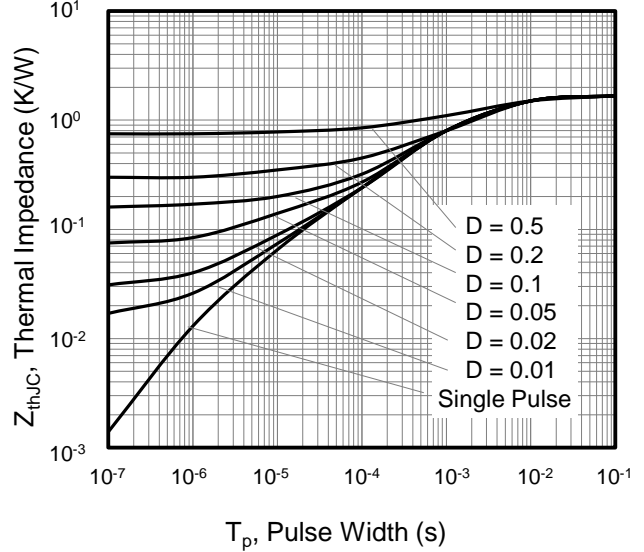




Figure A: Gate Charge Test Circuit and Waveform

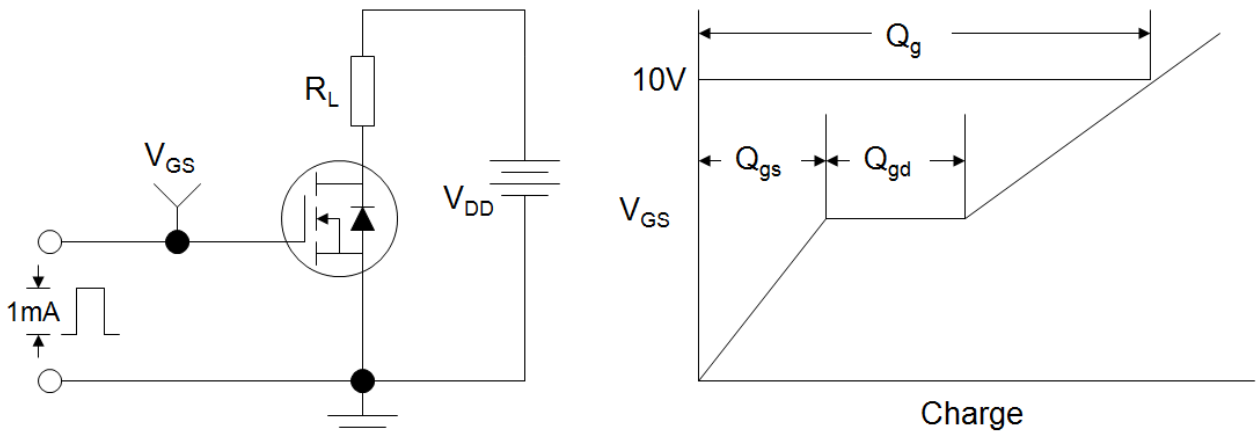


Figure B: Resistive Switching Test Circuit and Waveform

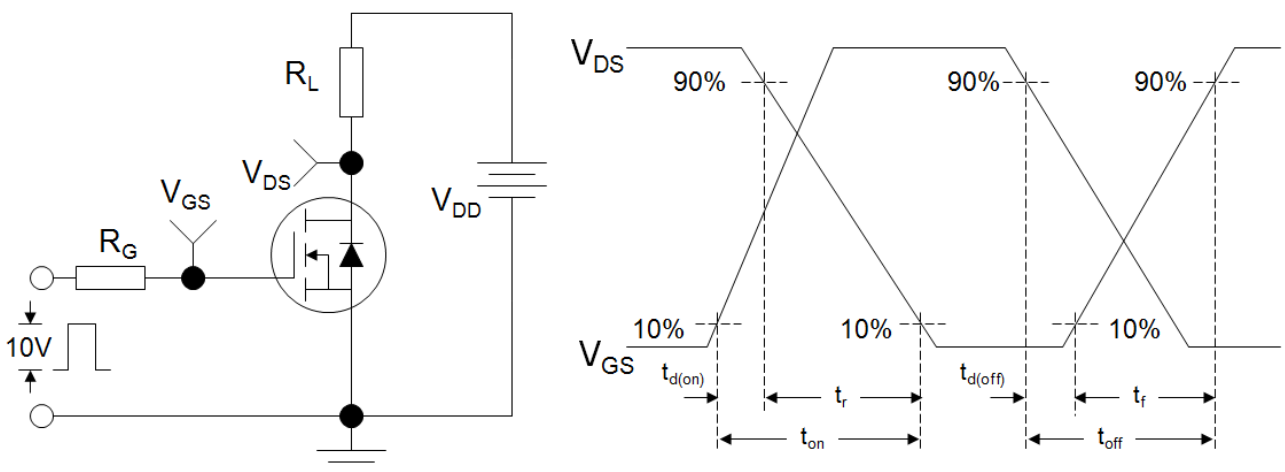
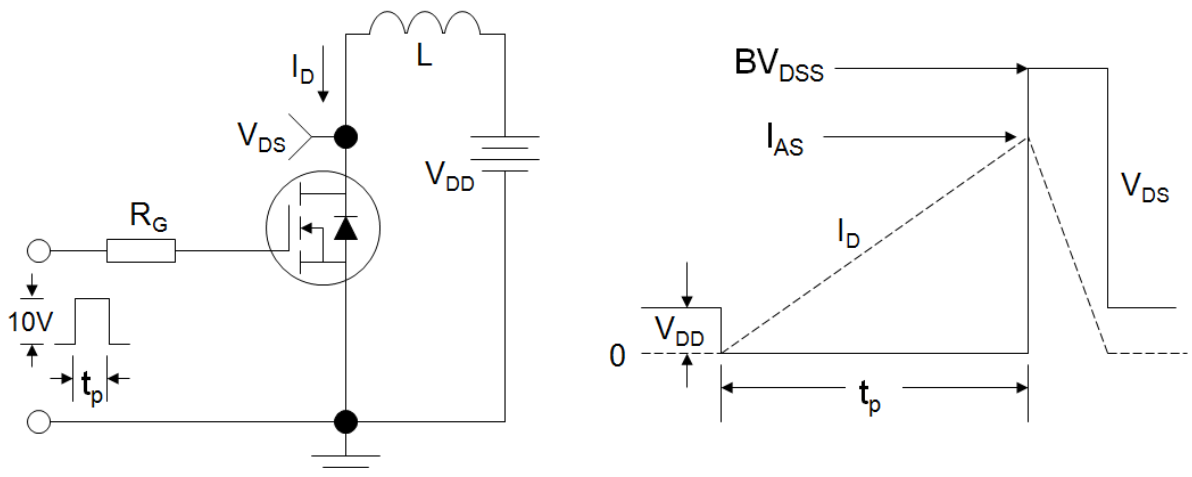
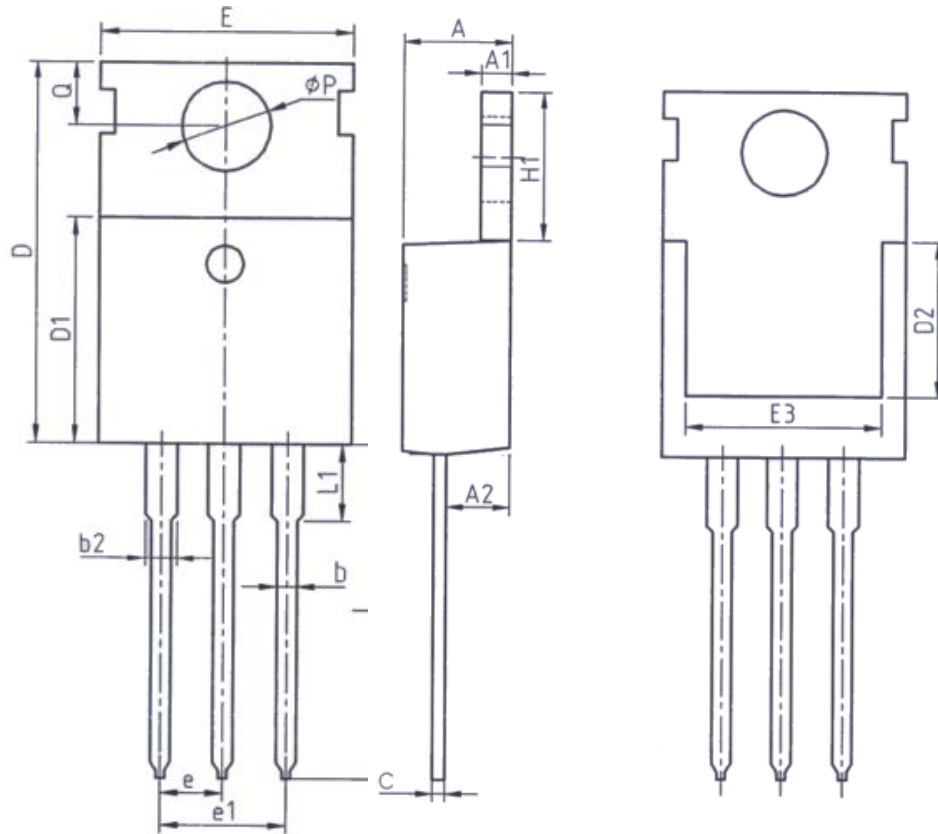


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-220

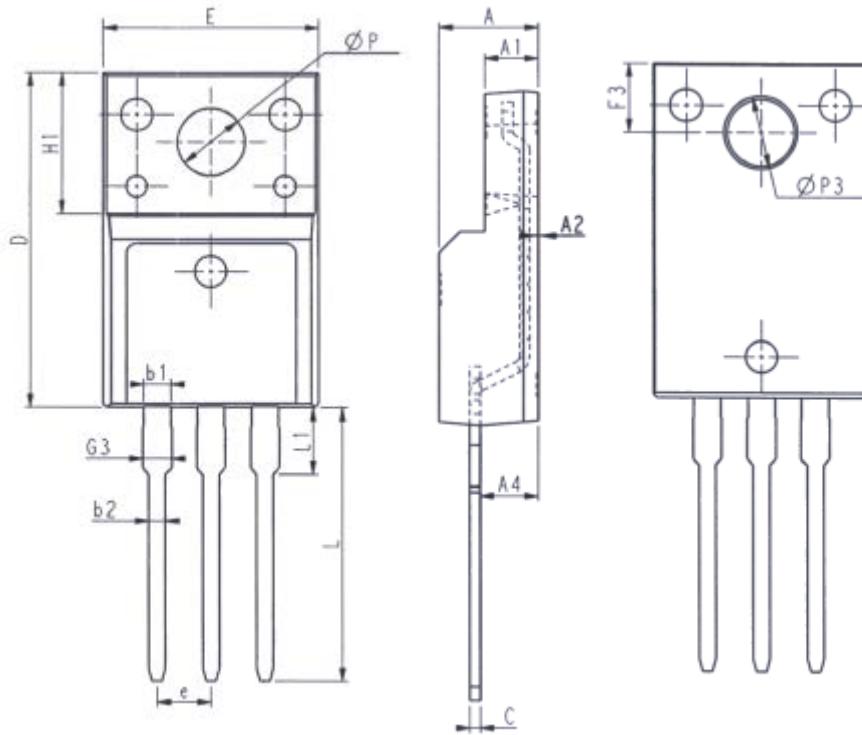


| Unit: mm | | |
|----------|-------|-------|
| Symbol | Min. | Max. |
| A | 4.37 | 4.77 |
| A1 | 1.25 | 1.45 |
| A2 | 2.20 | 2.60 |
| b | 0.70 | 0.95 |
| b2 | 1.17 | 1.47 |
| c | 0.40 | 0.65 |
| D | 15.10 | 16.10 |
| D1 | 8.80 | 9.40 |
| D2 | 5.50 | - |

| 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 |



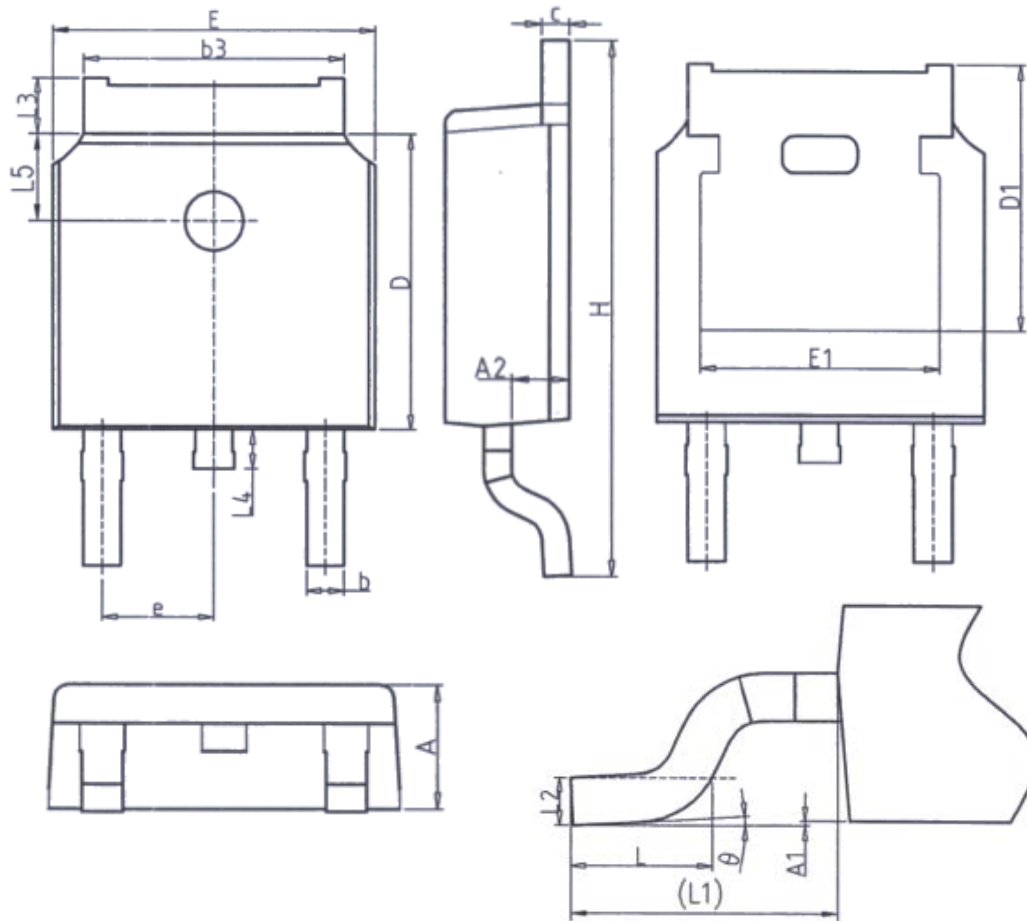
TO-220F



| 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-252

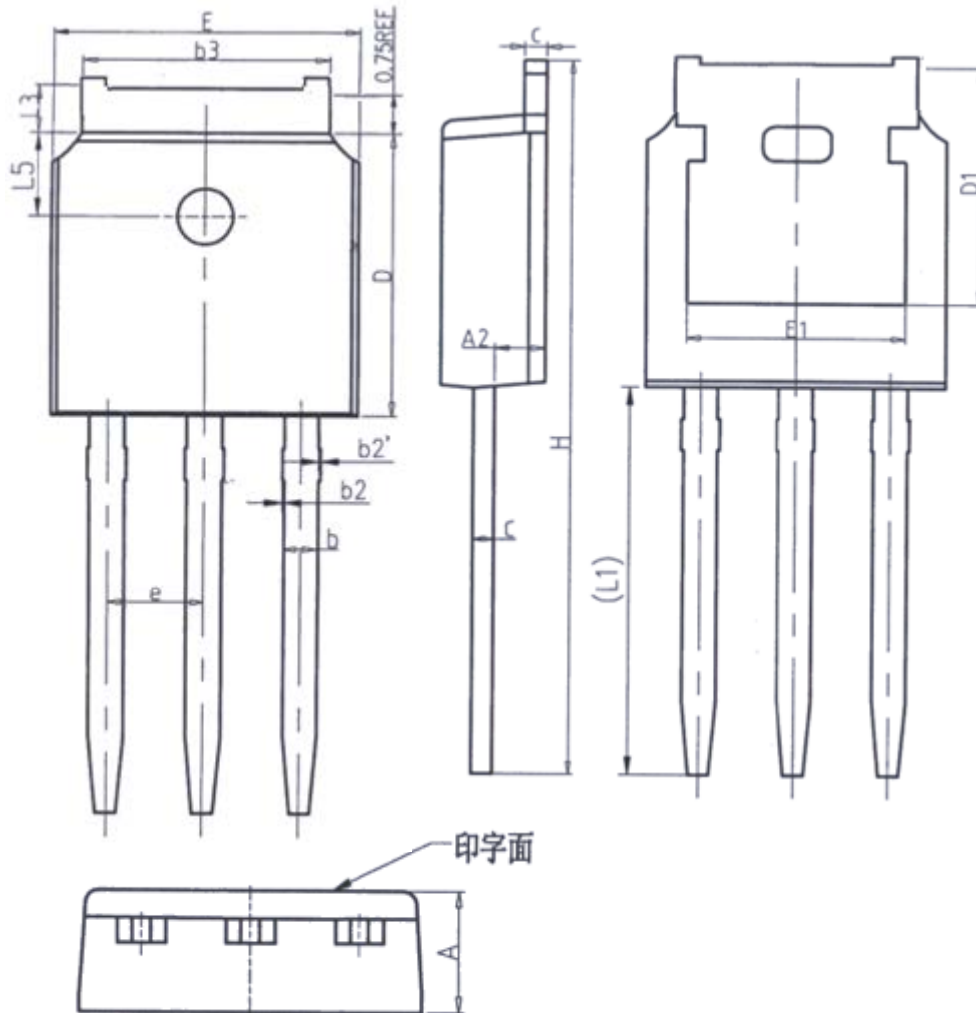


| Unit: mm | | |
|----------|---------|------|
| Symbol | Min. | Max. |
| A | 2.20 | 2.40 |
| A1 | 0.00 | 0.20 |
| A2 | 0.97 | 1.17 |
| b | 0.68 | 0.90 |
| b3 | 5.20 | 5.50 |
| c | 0.43 | 0.63 |
| D | 5.98 | 6.22 |
| D1 | 5.30REF | |
| E | 6.40 | 6.80 |
| E1 | 4.63 | - |

| 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 |
| theta | 0° | 8° |



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 |



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