

TK4R3E06PL

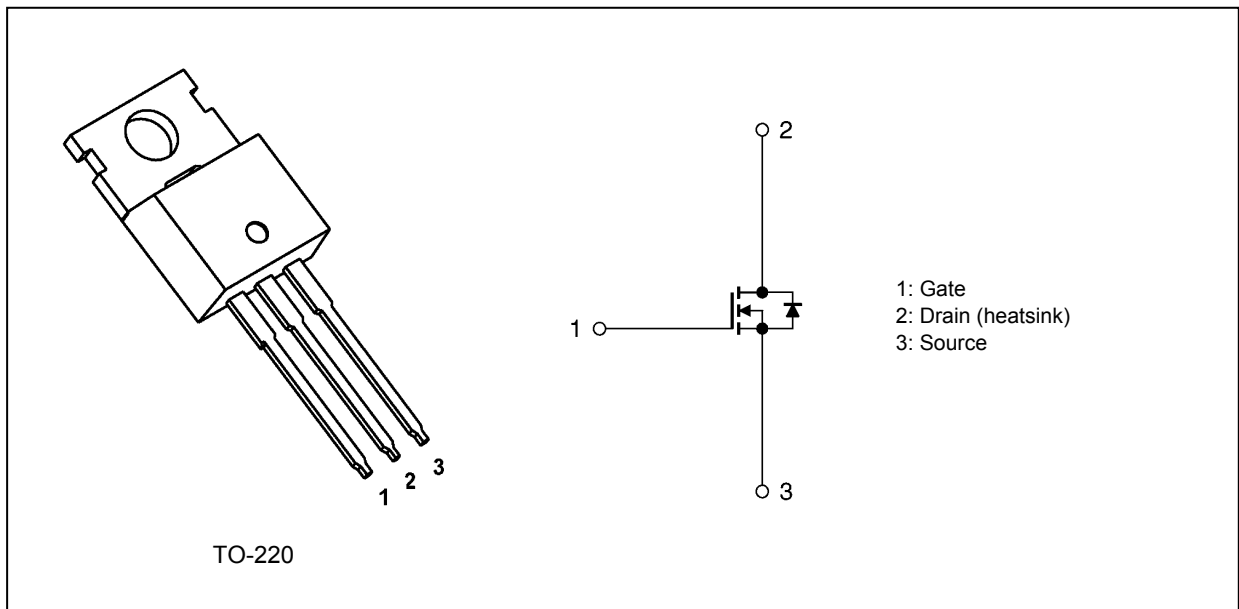
1. Applications

- High-Efficiency DC-DC Converters
- Switching Voltage Regulators
- Motor Drivers

2. Features

- (1) High-speed switching
- (2) Small gate charge: $Q_{SW} = 15.1 \text{ nC (typ.)}$
- (3) Small output charge: $Q_{OSS} = 39 \text{ nC (typ.)}$
- (4) Low drain-source on-resistance: $R_{DS(ON)} = 3.3 \text{ m}\Omega \text{ (typ.) (} V_{GS} = 10 \text{ V)}$
- (5) Low leakage current: $I_{DSS} = 10 \text{ }\mu\text{A (max) (} V_{DS} = 60 \text{ V)}$
- (6) Enhancement mode: $V_{th} = 1.5 \text{ to } 2.5 \text{ V (} V_{DS} = 10 \text{ V, } I_D = 0.5 \text{ mA)}$

3. Packaging and Internal Circuit



Start of commercial production

2016-10

4. Absolute Maximum Ratings (Note) ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Rating | Unit |
|--|-----------|------------|------------------|
| Drain-source voltage | V_{DSS} | 60 | V |
| Gate-source voltage | V_{GSS} | ± 20 | |
| Drain current (DC) ($T_c = 25\text{ }^\circ\text{C}$) (Note 1) | I_D | 80 | A |
| Drain current (DC) (Silicon limit) (Note 1), (Note 2) | I_D | 106 | |
| Drain current (pulsed) ($t = 100\text{ }\mu\text{s}$) (Note 1) | I_{DP} | 350 | |
| Power dissipation ($T_c = 25\text{ }^\circ\text{C}$) | P_D | 87 | W |
| Single-pulse avalanche energy (Note 3) | E_{AS} | 29 | mJ |
| Single-pulse avalanche current (Note 3) | I_{AS} | 80 | A |
| Channel temperature | T_{ch} | 175 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55 to 175 | $^\circ\text{C}$ |
| Mounting torque | TOR | 0.6 | N · m |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

5. Thermal Characteristics

| Characteristics | Symbol | Max | Unit |
|--|----------------|------|---------------------------|
| Channel-to-case thermal resistance ($T_c = 25\text{ }^\circ\text{C}$) | $R_{th(ch-c)}$ | 1.72 | $^\circ\text{C}/\text{W}$ |
| Channel-to-ambient thermal resistance ($T_a = 25\text{ }^\circ\text{C}$) | $R_{th(ch-a)}$ | 83.3 | |

Note 1: Ensure that the channel temperature does not exceed 175 $^\circ\text{C}$.

Note 2: Limited by silicon chip capability.

Note 3: $V_{DD} = 48\text{ V}$, $T_{ch} = 25\text{ }^\circ\text{C}$ (initial), $L = 3.5\text{ }\mu\text{H}$, $I_{AS} = 80\text{ A}$

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

6. Electrical Characteristics

6.1. Static Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---------------|---|-----|------|-----------|------------------|
| Gate leakage current | I_{GSS} | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$ | — | — | ± 0.1 | μA |
| Drain cut-off current | I_{DSS} | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$ | — | — | 10 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$ | 60 | — | — | V |
| Drain-source breakdown voltage (Note 4) | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$ | 45 | — | — | |
| Gate threshold voltage | V_{th} | $V_{DS} = 10\text{ V}, I_D = 0.5\text{ mA}$ | 1.5 | — | 2.5 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS} = 4.5\text{ V}, I_D = 15\text{ A}$ | — | 5.2 | 7.2 | $\text{m}\Omega$ |
| | | $V_{GS} = 10\text{ V}, I_D = 34\text{ A}$ | — | 3.3 | 4.3 | |

Note 4: If a reverse bias is applied between gate and source, this device enters $V_{(BR)DSX}$ mode. Note that the drain-source breakdown voltage is lowered in this mode.

6.2. Dynamic Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|-----------|---|-----|------|-----|-------------|
| Input capacitance | C_{iss} | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | — | 3280 | — | pF |
| Reverse transfer capacitance | C_{rss} | | — | 60 | — | |
| Output capacitance | C_{oss} | | — | 600 | — | |
| Gate resistance | r_g | — | — | 1.7 | — | Ω |
| Switching time (rise time) | t_r | See Fig. 6.2.1 | — | 10 | — | ns |
| Switching time (turn-on time) | t_{on} | | — | 24 | — | |
| Switching time (fall time) | t_f | | — | 18 | — | |
| Switching time (turn-off time) | t_{off} | | — | 55 | — | |

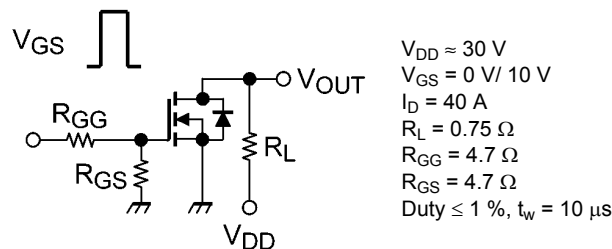


Fig. 6.2.1 Switching Time Test Circuit

6.3. Gate Charge Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|-----------|--|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | Q_g | $V_{DD} \approx 30\text{ V}, V_{GS} = 10\text{ V}, I_D = 40\text{ A}$ | — | 48.2 | — | nC |
| | | $V_{DD} \approx 30\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 40\text{ A}$ | — | 23.9 | — | |
| Gate-source charge 1 | Q_{gs1} | $V_{DD} \approx 30\text{ V}, V_{GS} = 10\text{ V}, I_D = 40\text{ A}$ | — | 13.1 | — | |
| Gate-drain charge | Q_{gd} | | — | 8.6 | — | |
| Gate switch charge | Q_{SW} | | — | 15.1 | — | |
| Output charge | Q_{oss} | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | — | 39 | — | |

6.4. Source-Drain Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|-----|------|------|------|
| Reverse drain current (pulsed) (Note 5) | I_{DRP} ($t = 100\ \mu\text{s}$) | — | — | — | 350 | A |
| Diode forward voltage | V_{DSF} | $I_{DR} = 80\ \text{A}, V_{GS} = 0\ \text{V}$ | — | — | -1.5 | V |
| Reverse recovery time | t_{rr} | $I_{DR} = 20\ \text{A}, V_{GS} = 0\ \text{V},$ $-di_{DR}/dt = 100\ \text{A}/\mu\text{s}$ | — | 47 | — | ns |
| Reverse recovery charge | Q_{rr} | | — | 57 | — | nC |

Note 5: Ensure that the channel temperature does not exceed $175\text{ }^\circ\text{C}$.

7. Marking

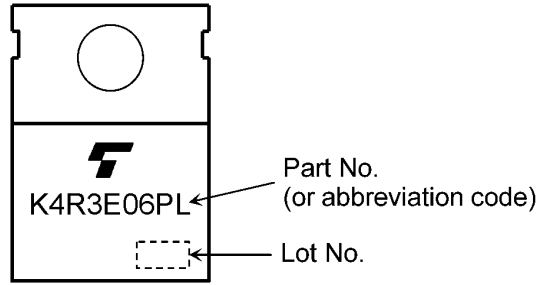


Fig. 7.1 Marking

8. Characteristics Curves (Note)

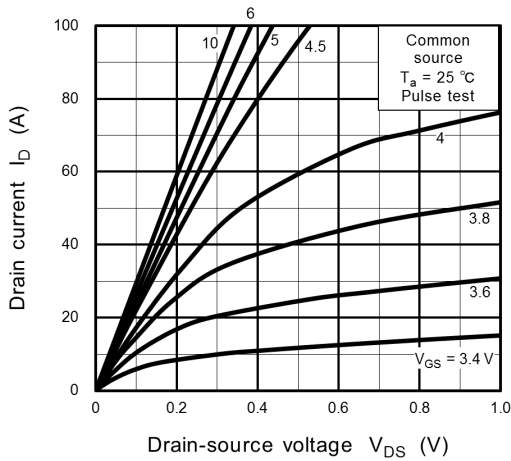


Fig. 8.1 $I_D - V_{DS}$

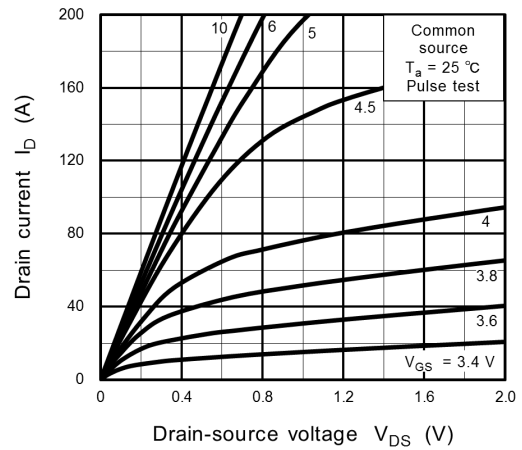


Fig. 8.2 $I_D - V_{DS}$

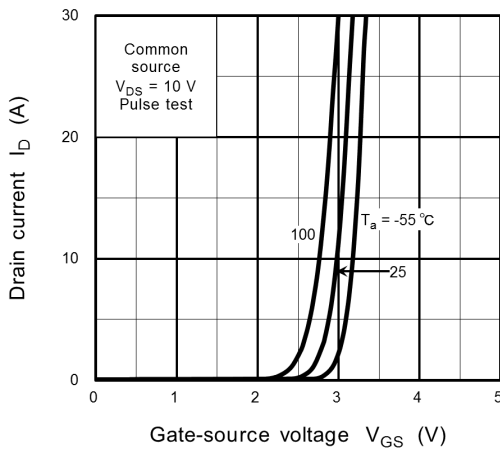


Fig. 8.3 $I_D - V_{GS}$

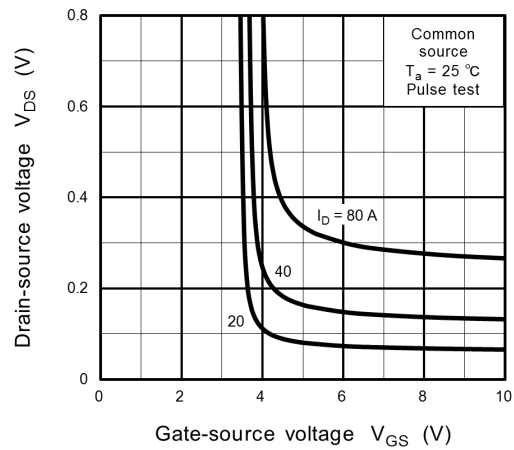


Fig. 8.4 $V_{DS} - V_{GS}$

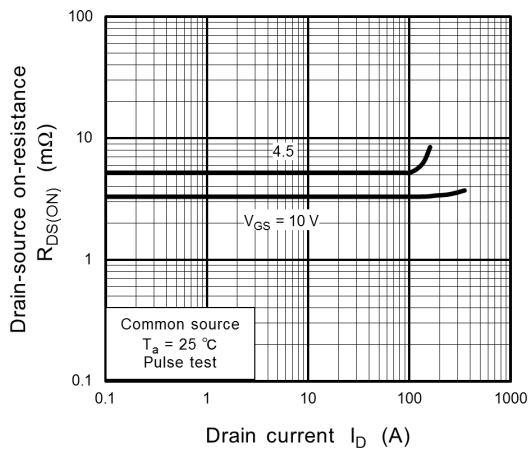


Fig. 8.5 $R_{DS(ON)} - I_D$

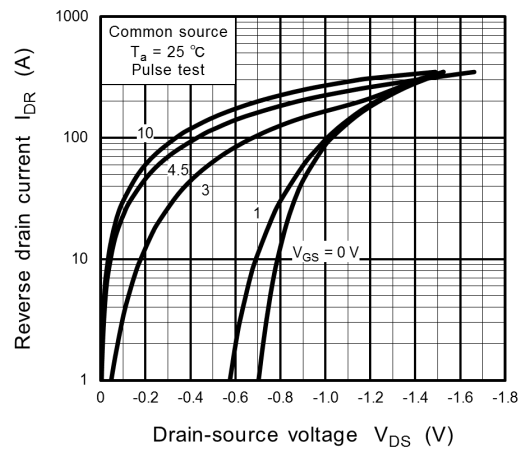


Fig. 8.6 $I_{DR} - V_{DS}$

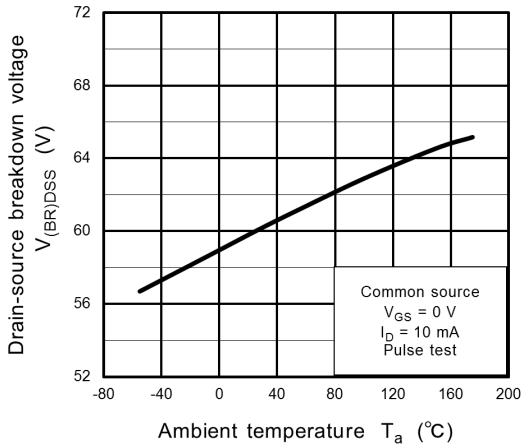


Fig. 8.7 $V_{(BR)DSS} - T_a$

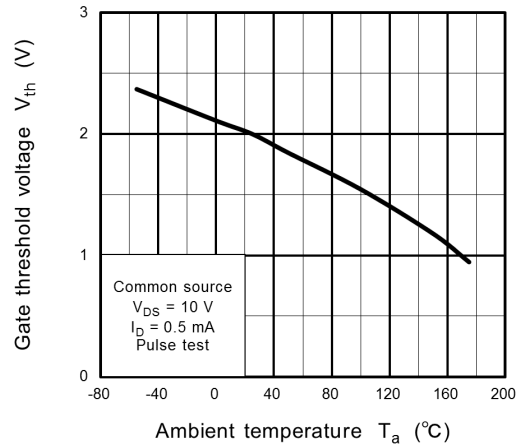


Fig. 8.8 $V_{th} - T_a$

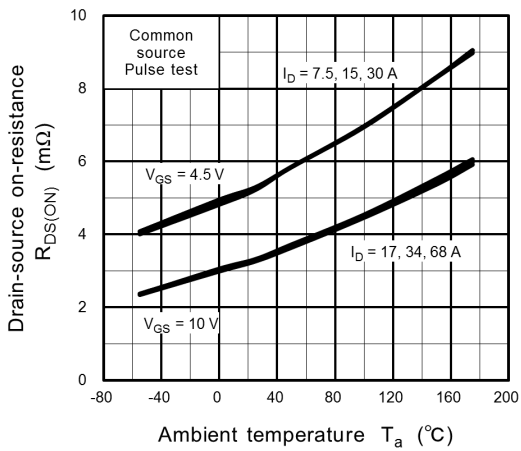


Fig. 8.9 $R_{DS(ON)} - T_a$

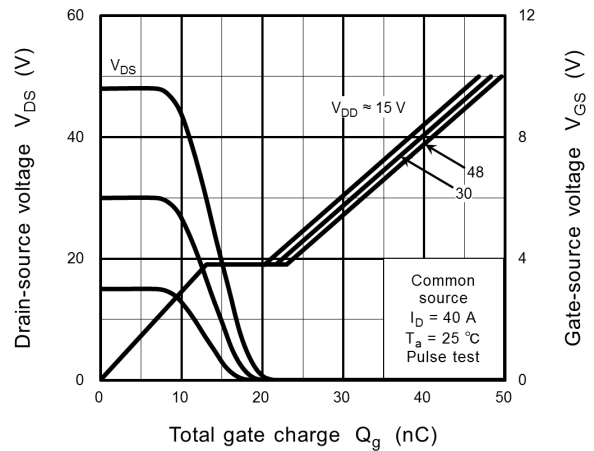


Fig. 8.10 Dynamic Input/Output Characteristics

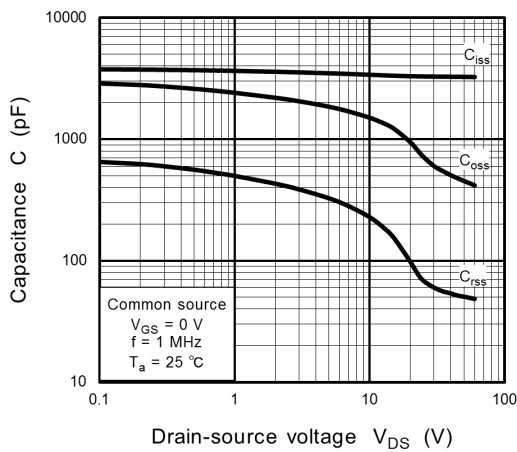


Fig. 8.11 Capacitance - V_{DS}

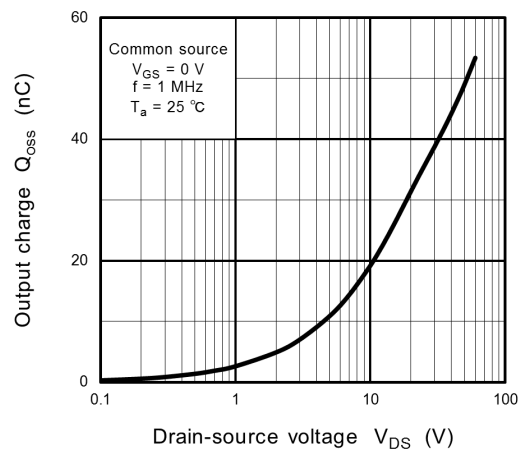


Fig. 8.12 $Q_{oss} - V_{DS}$

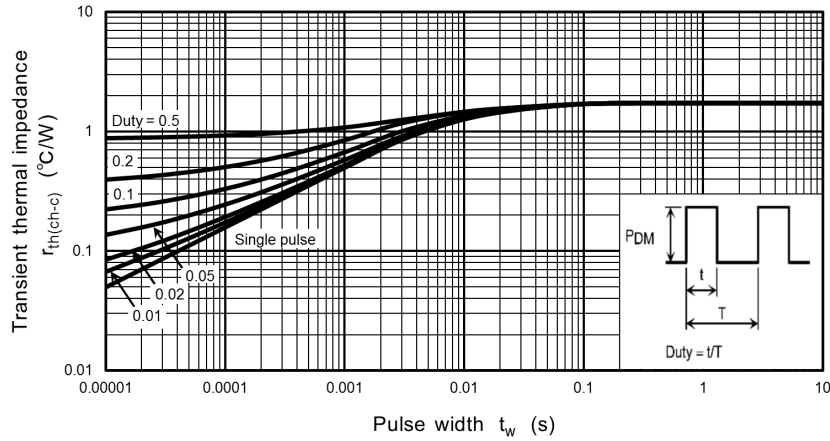


Fig. 8.13 $r_{th} - t_w$
(Guaranteed Maximum)

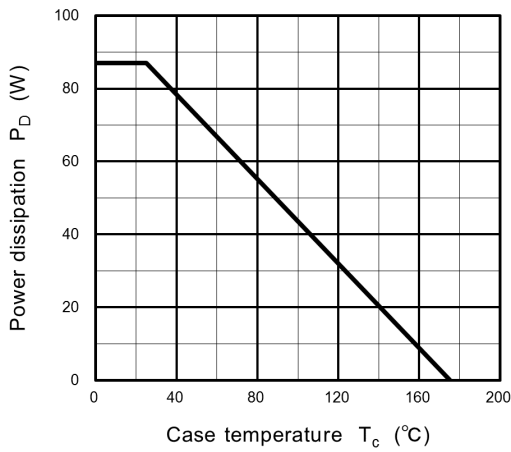


Fig. 8.14 $P_D - T_c$
(Guaranteed Maximum)

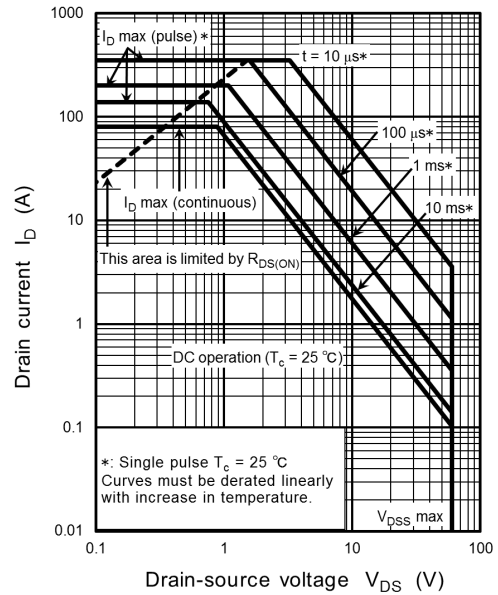
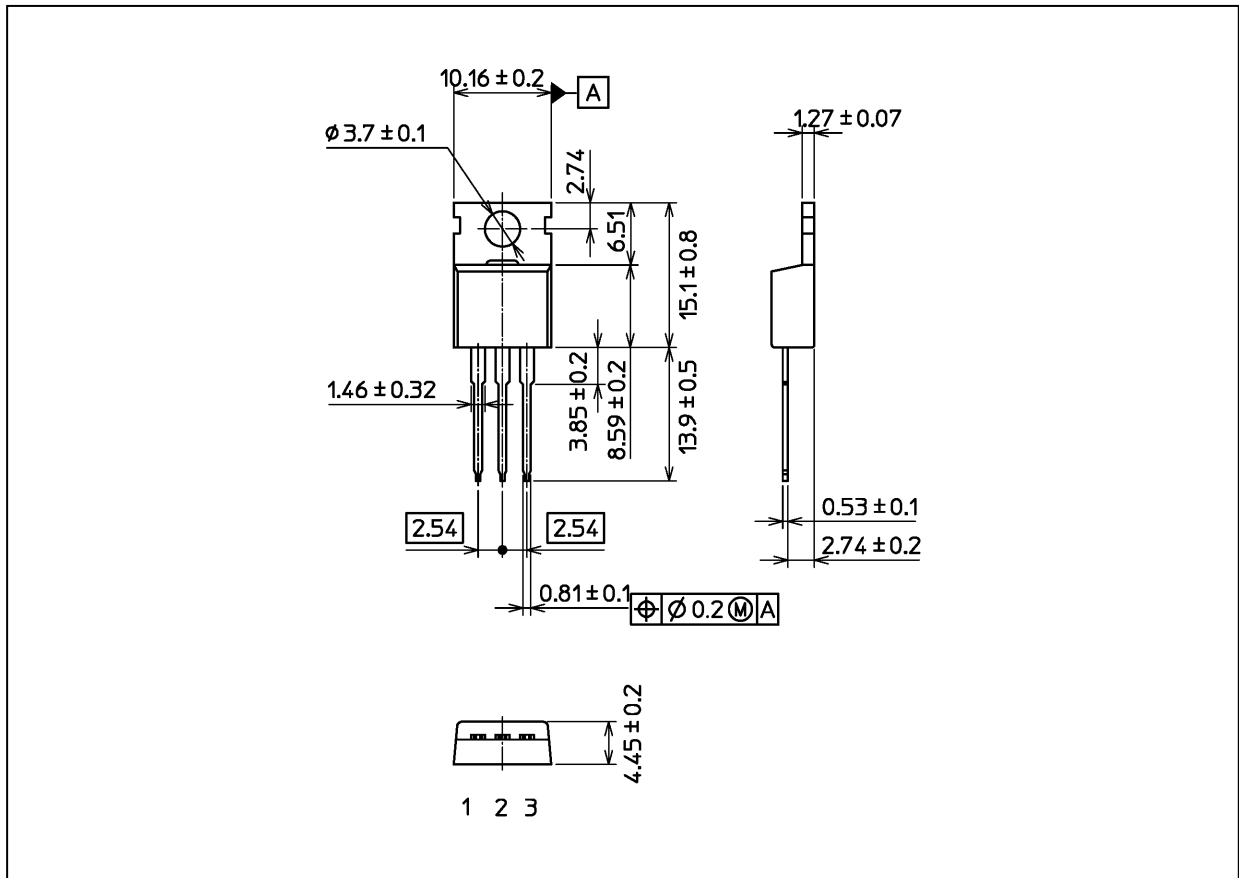


Fig. 8.15 Safe Operating Area
(Guaranteed Maximum)

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Dimensions

Unit: mm



Weight: 1.93 g (typ.)

| Package Name(s) |
|------------------|
| TOSHIBA: 2-10X1A |
| Nickname: TO-220 |

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