MOSFETs Silicon N-Channel MOS (DTMOSⅣ)

# TK7A60W5

## 1. Applications

- Switching Voltage Regulators
- Motor Drivers

## 2. Features

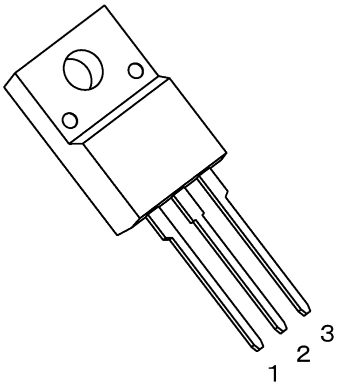
(1) Fast reverse recovery time: $t_{rr}$ = 75 ns (typ.)

(2) Low drain-source on-resistance: $R_{DS(ON)}$ = 0.54 Ω (typ.)
by used to Super Junction Structure : DTMOS

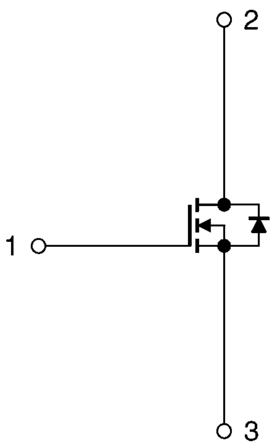
(3) Easy to control Gate switching

(4) Enhancement mode: $V_{th}$ = 3 to 4.5 V ($V_{DS}$ = 10 V, $I_D$ = 0.35 mA)

## 3. Packaging and Internal Circuit




TO-220SIS




1: Gate
2: Drain
3: Source

Start of commercial production
2013-10

## 4. Absolute Maximum Ratings (Note) ($T_a$ = 25°C unless otherwise specified)

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-source voltage | | $V_{DSS}$ | 600 | V |
| Gate-source voltage | | $V_{GSS}$ | ±30 | |
| Drain current (DC) | (Note 1) | $I_D$ | 7.0 | A |
| Drain current (pulsed) | (Note 1) | $I_{DP}$ | 28 | |
| Power dissipation | ($T_c$ = 25°C) | $P_D$ | 30 | W |
| Single-pulse avalanche energy | (Note 2) | $E_{AS}$ | 92 | mJ |
| Avalanche current | | $I_{AR}$ | 1.8 | A |
| Reverse drain current (DC) | (Note 1) | $I_{DR}$ | 7.0 | |
| Reverse drain current (pulsed) | (Note 1) | $I_{DRP}$ | 28 | |
| Channel temperature | | $T_{ch}$ | 150 | °C |
| Storage temperature | | $T_{stg}$ | -55 to 150 | |
| Isolation voltage (RMS) | (t = 1.0 s) | $V_{ISO(RMS)}$ | 2000 | V |
| 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 | $R_{th(ch-c)}$ | 4.17 | °C/W |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 62.5 | |

Note 1: Ensure that the channel temperature does not exceed 150°C.
Note 2: $V_{DD}$ = 90 V, $T_{ch}$ = 25°C (initial), L = 49.9 mH, $R_G$ = 25 Ω, $I_{AR}$ = 1.8 A

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

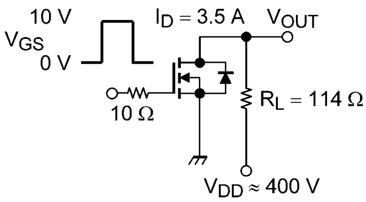
# 6. Electrical Characteristics

## 6.1. Static Characteristics ($T_a$ = 25°C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Gate leakage current | $I_{GSS}$ | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | — | — | ±1 | μA |
| Drain cut-off current | $I_{DSS}$ | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | — | — | 100 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 600 | — | — | V |
| Gate threshold voltage | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 0.35 mA | 3 | — | 4.5 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS}$ = 10 V, $I_D$ = 3.5 A | — | 0.54 | 0.65 | Ω |

## 6.2. Dynamic Characteristics ($T_a$ = 25°C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 300 V, $V_{GS}$ = 0 V, f = 1 MHz | — | 490 | — | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 1.7 | — | |
| Output capacitance | $C_{oss}$ | | — | 13 | — | |
| Effective output capacitance | $C_{o(er)}$ | $V_{DS}$ = 0 to 400 V, $V_{GS}$ = 0 V | — | 24 | — | |
| Gate resistance | $r_g$ | $V_{DS}$ = OPEN, f = 1 MHz | — | 7.0 | — | Ω |
| Switching time (rise time) | $t_r$ | See Figure 6.2.1 | — | 40 | — | ns |
| Switching time (turn-on time) | $t_{on}$ | | — | 60 | — | |
| Switching time (fall time) | $t_f$ | | — | 5 | — | |
| Switching time (turn-off time) | $t_{off}$ | | — | 70 | — | |
| MOSFET dv/dt ruggedness | dv/dt | $V_{DD}$ = 0 to 400 V, $I_D$ = 3.5 A | 25 | — | — | V/ns |




Duty ≤ 1%, $t_w$ = 10 μs

**Fig. 6.2.1 Switching Time Test Circuit**

## 6.3. Gate Charge Characteristics ($T_a$ = 25°C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge (gate-source plus gate-drain) | $Q_g$ | $V_{DD}$ ≈ 400 V, $V_{GS}$ = 10 V, $I_D$ = 7.0 A | — | 16 | — | nC |
| Gate-source charge 1 | $Q_{gs1}$ | | — | 4.6 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 10.5 | — | |

## 6.4. Source-Drain Characteristics ($T_a$ = 25°C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Diode forward voltage | $V_{DSF}$ | $I_{DR}$ = 7.0 A, $V_{GS}$ = 0 V | — | — | -1.7 | V |
| Reverse recovery time | $t_{rr}$ | $I_{DR}$ = 3.5 A, $V_{GS}$ = 0 V -$dI_{DR}/dt$ = 100 A/μs | — | 75 | 120 | ns |
| Reverse recovery charge | $Q_{rr}$ | | — | 0.3 | — | μC |
| Peak reverse recovery current | $I_{rr}$ | | — | 9 | — | A |
| Diode dv/dt ruggedness | dv/dt | $I_{DR}$ = 3.5 A, $V_{GS}$ = 0 V, $V_{DD}$ = 400 V | 50 | — | — | V/ns |

## 7. Marking (Note)

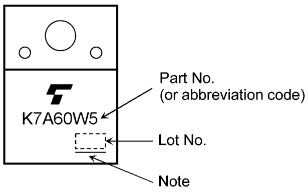



**Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.
Not underlined: [[Pb]]/INCLUDES > MCV
Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]
Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## 8. Characteristics Curves (Note)

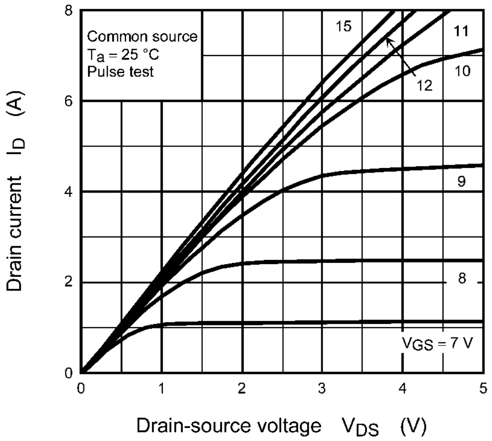



Fig. 8.1 $I_D$ - $V_{DS}$

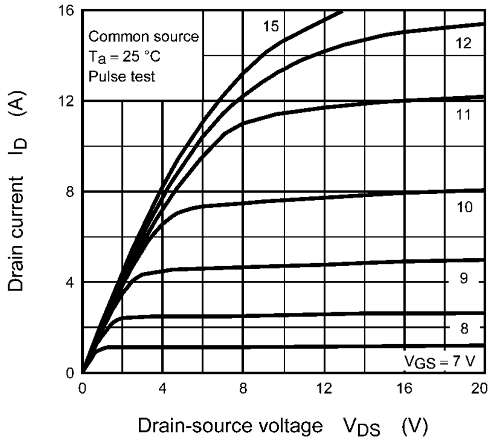



Fig. 8.2 $I_D$ - $V_{DS}$

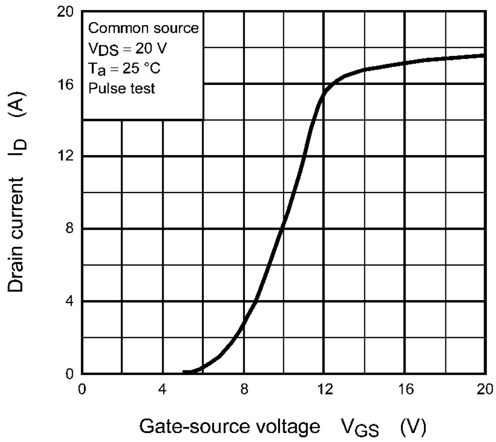



Fig. 8.3 $I_D$ - $V_{GS}$

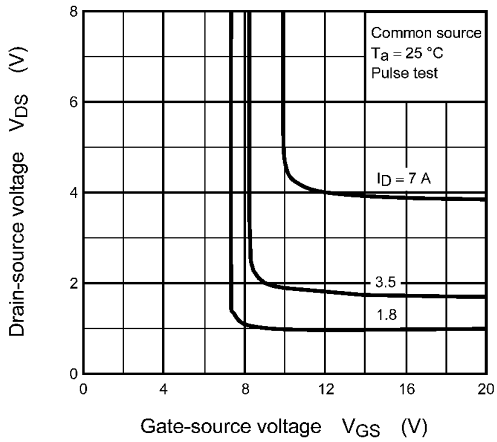



Fig. 8.4 $V_{DS}$ - $V_{GS}$

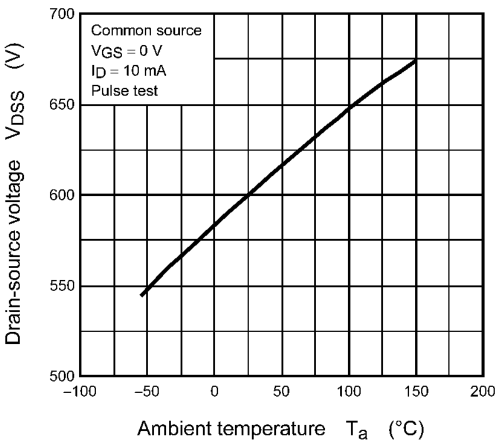



Fig. 8.5 $V_{DSS}$ - $T_a$

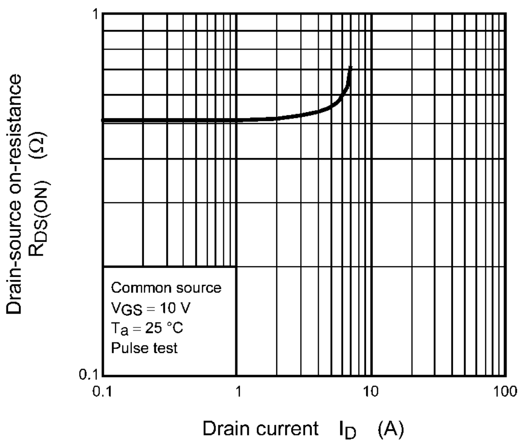



Fig. 8.6 $R_{DS(ON)}$ - $I_D$

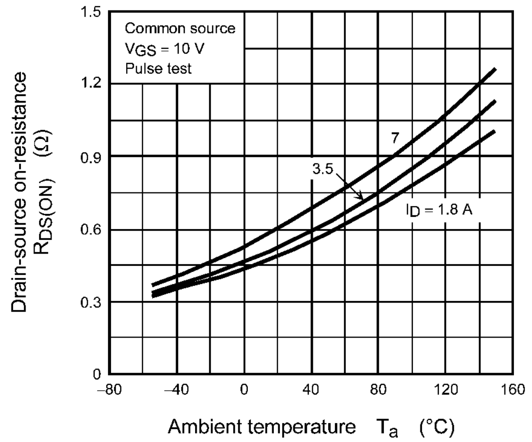



Fig. 8.7 $R_{DS(ON)}$ - $T_a$

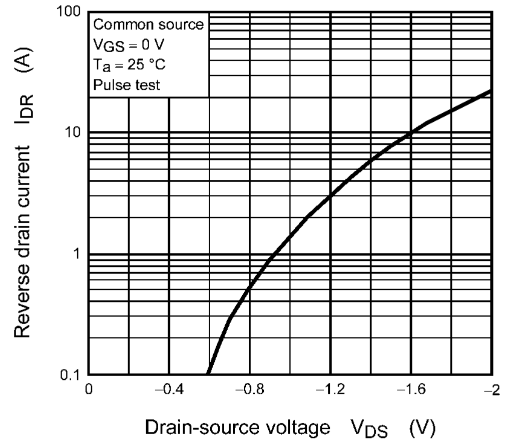



Fig. 8.8 $I_{DR}$ - $V_{DS}$

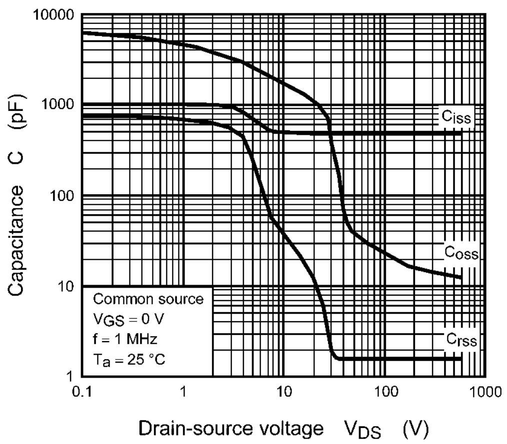



Fig. 8.9 C - $V_{DS}$

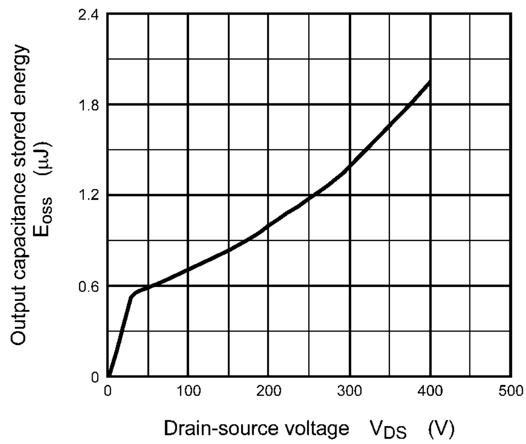



Fig. 8.10 $E_{OSS}$ - $V_{DS}$

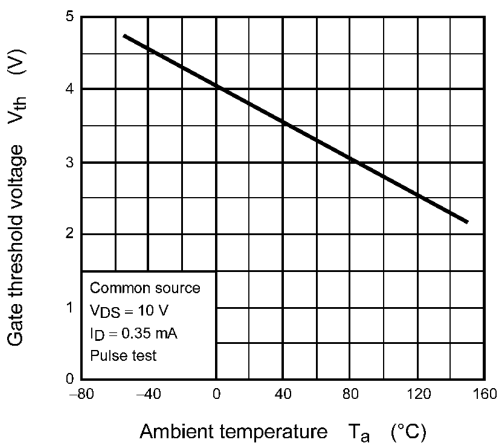



Fig. 8.11 $V_{th}$ - $T_a$

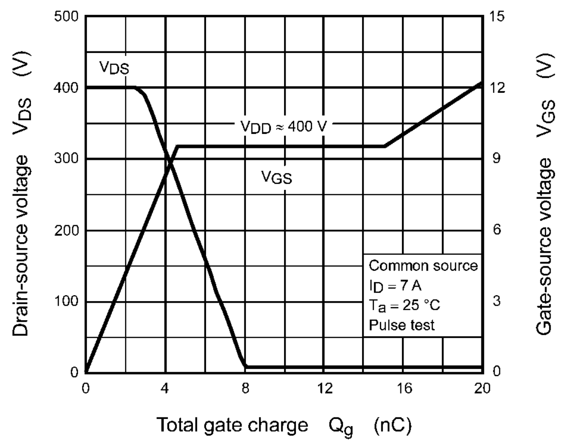



Fig. 8.12 Dynamic Input/Output Characteristics

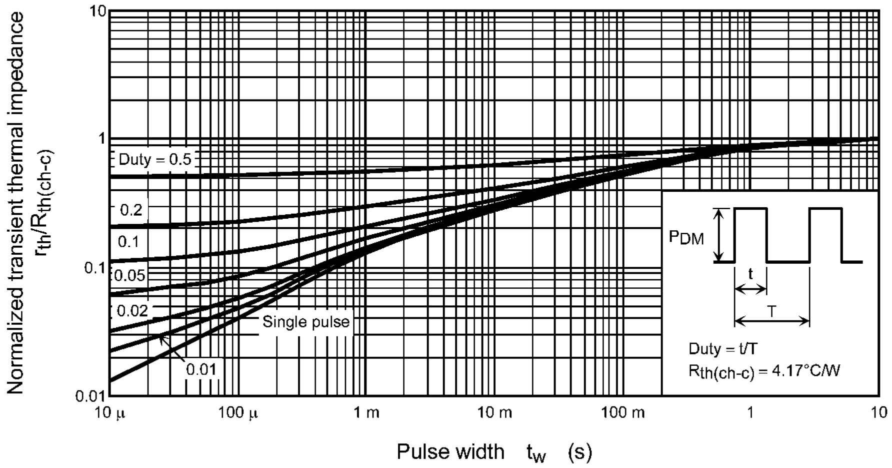



**Fig. 8.13 $r_{th}$ - $t_w$**
**(Guaranteed Maximum)**

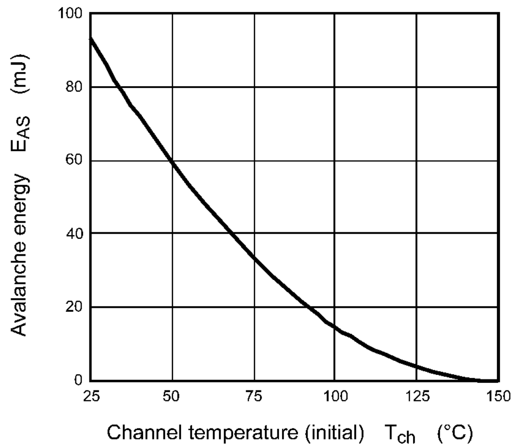



**Fig. 8.14 $E_{AS}$ - $T_{ch}$**
**(Guaranteed Maximum)**

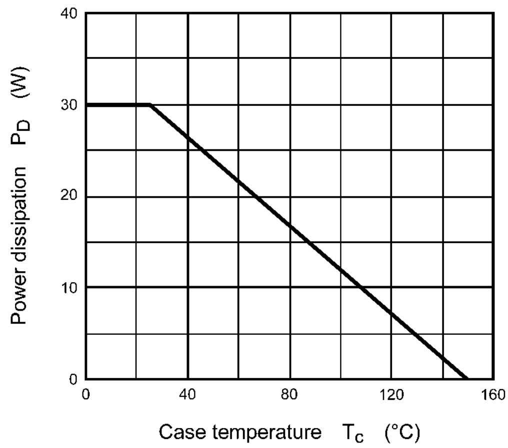
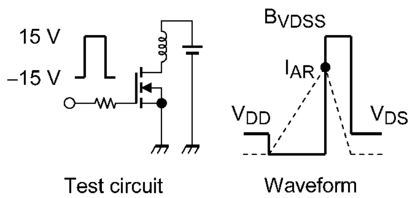



**Fig. 8.15 $P_D$ - $T_c$**
**(Guaranteed Maximum)**




$R_G$ = 25 Ω, $V_{DD}$ = 90 V $E_{AS} = \frac{1}{2} \cdot L \cdot I_{AR}^2 \cdot \left( \frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$

**Fig. 8.16 Test Circuit/Waveform**

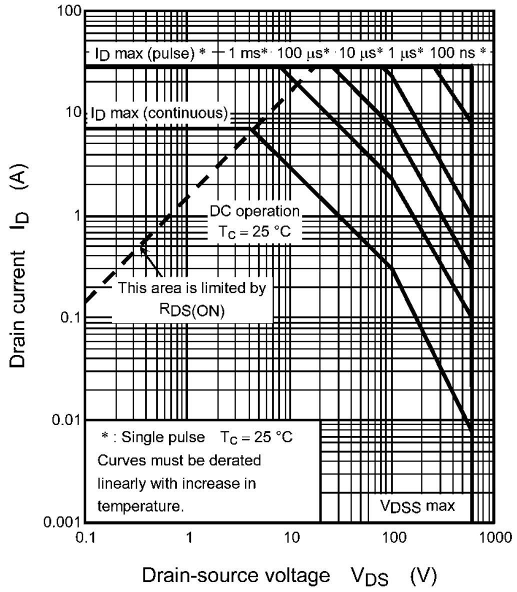
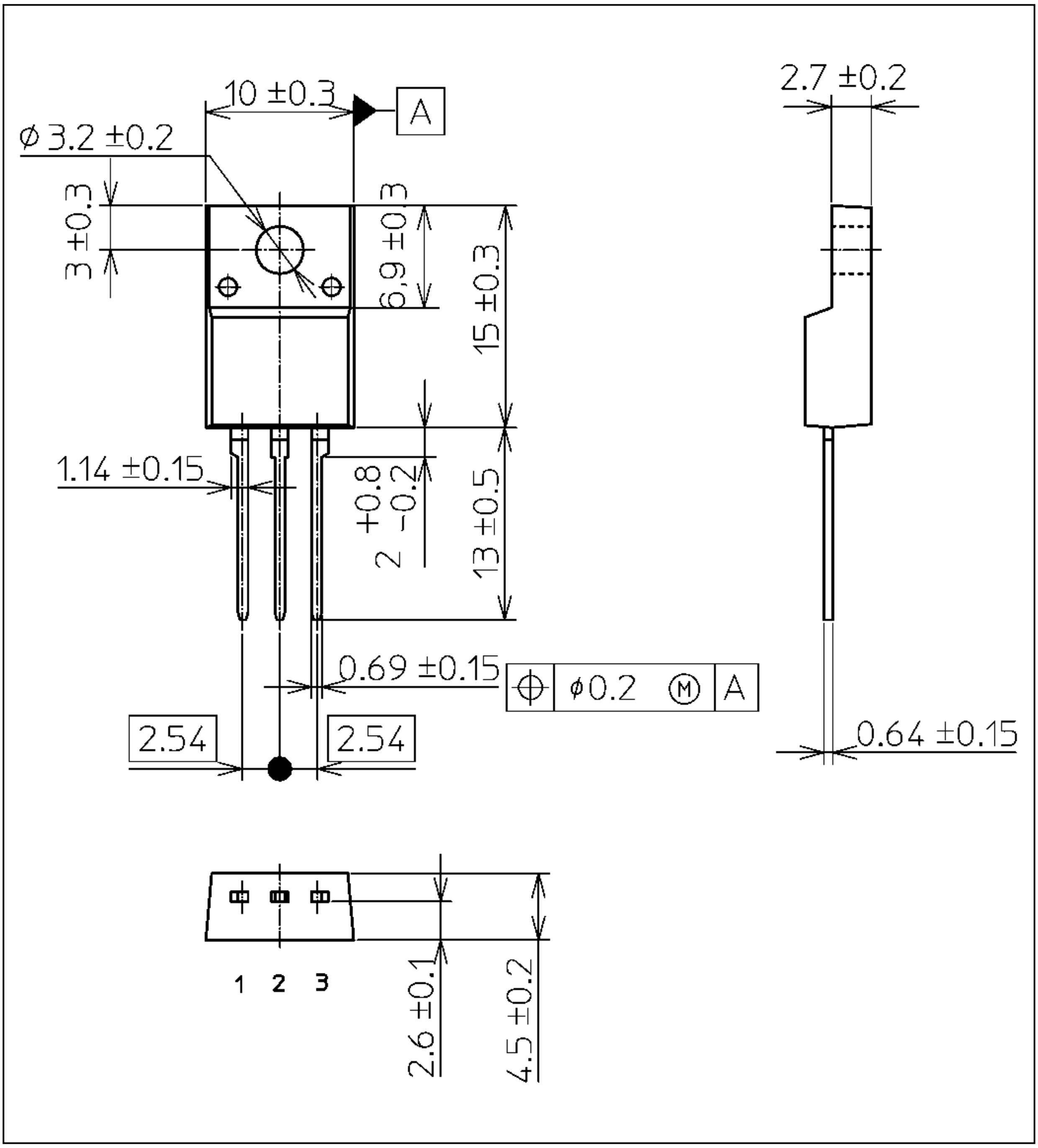



**Fig. 8.17 Safe Operating Area (Guaranteed Maximum)**

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

## Package Dimensions

Unit: mm




Weight: 1.7 g (typ.)

| Package Name(s) |
|---|
| JEITA: SC-67 |
| TOSHIBA: 2-10U1S |
| Nickname: TO-220SIS |

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