

# TK2A65D

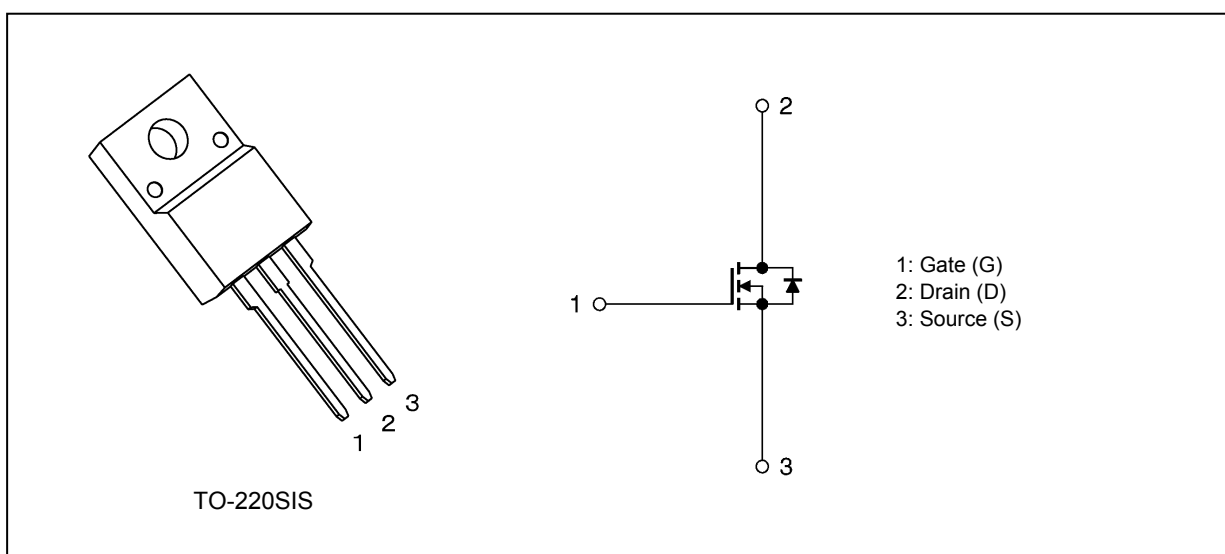
## 1. Applications

- Switching Voltage Regulators

## 2. Features

- Low drain-source on-resistance:  $R_{DS(ON)} = 2.8 \Omega$  (typ.)
- High forward transfer admittance:  $|Y_{fs}| = 1.5 S$  (typ.)
- Low leakage current:  $I_{DSS} = 10 \mu A$  (max) ( $V_{DS} = 650 V$ )
- Enhancement mode:  $V_{th} = 2.4$  to  $4.4 V$  ( $V_{DS} = 10 V$ ,  $I_D = 1 mA$ )

## 3. Packaging and Internal Circuit



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

| Characteristics                          | Symbol    | Rating     | Unit       |
|------------------------------------------|-----------|------------|------------|
| Drain-source voltage                     | $V_{DSS}$ | 650        | V          |
| Gate-source voltage                      | $V_{GSS}$ | $\pm 30$   |            |
| Drain current (DC) (Note 1)              | $I_D$     | 2          | A          |
| Drain current (pulsed) (Note 1)          | $I_{DP}$  | 8          |            |
| Power dissipation ( $T_c = 25^\circ C$ ) | $P_D$     | 30         | W          |
| Single-pulse avalanche energy (Note 2)   | $E_{AS}$  | 195        | mJ         |
| Avalanche current                        | $I_{AR}$  | 2          | A          |
| Repetitive avalanche energy (Note 3)     | $E_{AR}$  | 3.0        | mJ         |
| Channel temperature                      | $T_{ch}$  | 150        | $^\circ C$ |
| Storage temperature                      | $T_{stg}$ | -55 to 150 |            |

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.).

Start of commercial production

2009-09

## 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:  $V_{DD} = 90\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 86\text{ mH}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 2\text{ A}$

Note 3: Repetitive rating; pulse width limited by maximum channel temperature

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

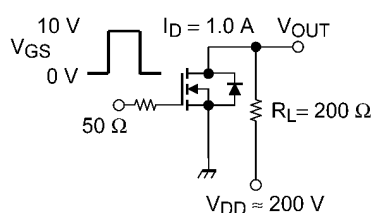
## 6. Electrical Characteristics

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

| Characteristics                | Symbol        | Test Condition                                     | Min | Typ. | Max     | Unit          |
|--------------------------------|---------------|----------------------------------------------------|-----|------|---------|---------------|
| Gate leakage current           | $I_{GSS}$     | $V_{GS} = \pm 30\text{ V}$ , $V_{DS} = 0\text{ V}$ | —   | —    | $\pm 1$ | $\mu\text{A}$ |
| Drain cut-off current          | $I_{DSS}$     | $V_{DS} = 650\text{ V}$ , $V_{GS} = 0\text{ V}$    | —   | —    | 10      |               |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$       | 650 | —    | —       | V             |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 1\text{ mA}$       | 2.4 | —    | 4.4     |               |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}$ , $I_D = 1.0\text{ A}$      | —   | 2.8  | 3.26    | $\Omega$      |
| Forward transfer admittance    | $ Y_{fs} $    | $V_{DS} = 10\text{ V}$ , $I_D = 1.0\text{ A}$      | 0.4 | 1.5  | —       | S             |

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

| Characteristics                | Symbol    | Test Condition                                                      | Min | Typ. | Max | Unit |
|--------------------------------|-----------|---------------------------------------------------------------------|-----|------|-----|------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 25\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | —   | 380  | —   | pF   |
| Reverse transfer capacitance   | $C_{rss}$ |                                                                     | —   | 2.5  | —   |      |
| Output capacitance             | $C_{oss}$ |                                                                     | —   | 45   | —   |      |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1.                                                   | —   | 15   | —   | ns   |
| Switching time (turn-on time)  | $t_{on}$  |                                                                     | —   | 35   | —   |      |
| Switching time (fall time)     | $t_f$     |                                                                     | —   | 7    | —   |      |
| Switching time (turn-off time) | $t_{off}$ |                                                                     | —   | 55   | —   |      |



Duty  $\leq 1\%$ ,  $t_w = 10\text{ }\mu\text{s}$

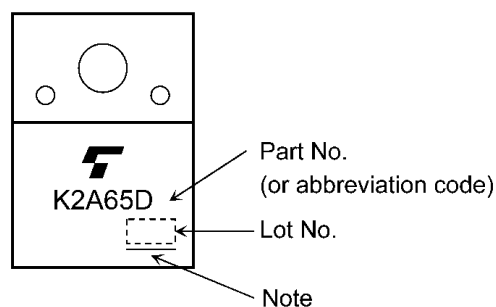
Fig. 6.2.1 Switching Time Test Circuit

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

| Characteristics                                 | Symbol   | Test Condition                                                              | Min | Typ. | Max | Unit |
|-------------------------------------------------|----------|-----------------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$    | $V_{DD} \approx 400\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 2\text{ A}$ | —   | 9    | —   | nC   |
| Gate-source charge                              | $Q_{gs}$ |                                                                             | —   | 5    | —   |      |
| Gate-drain charge                               | $Q_{gd}$ |                                                                             | —   | 4    | —   |      |

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

| Characteristics                         | Symbol    | Test Condition                                                                            | Min | Typ. | Max  | Unit          |
|-----------------------------------------|-----------|-------------------------------------------------------------------------------------------|-----|------|------|---------------|
| Reverse drain current (DC) (Note 1)     | $I_{DR}$  | —                                                                                         | —   | —    | 2    | A             |
| Reverse drain current (pulsed) (Note 1) | $I_{DRP}$ | —                                                                                         | —   | —    | 8    |               |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR1} = 2\text{ A}$ , $V_{GS} = 0\text{ V}$                                            | —   | —    | -1.7 | V             |
| Reverse recovery time                   | $t_{rr}$  | $I_{DR} = 2\text{ A}$ , $V_{GS} = 0\text{ V}$<br>$-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$ | —   | 700  | —    | ns            |
| Reverse recovery charge                 | $Q_{rr}$  |                                                                                           | —   | 3.5  | —    | $\mu\text{C}$ |

**7. Marking (Note)****Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

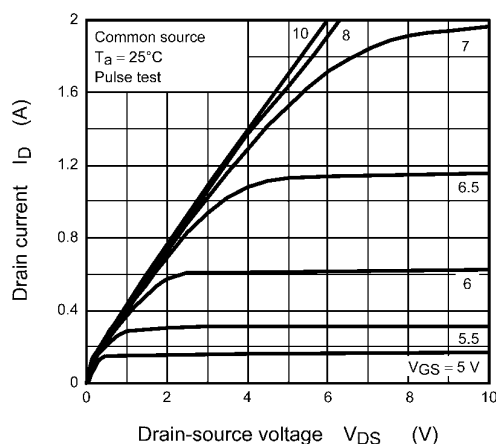
Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

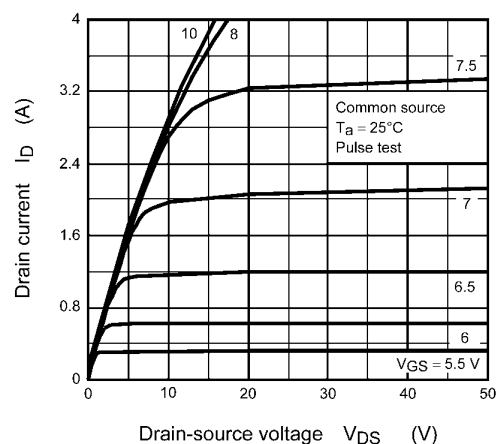
Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

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.

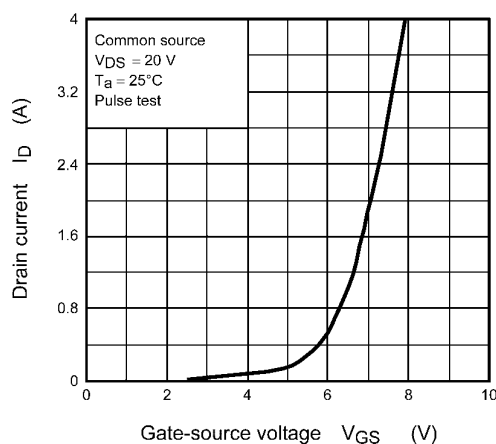
# 8. Characteristics Curves (Note)



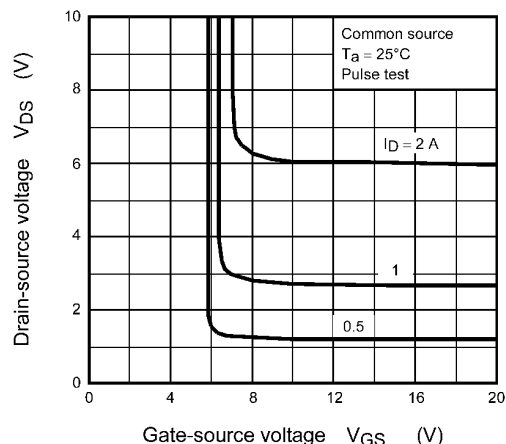
**Fig. 8.1  $I_D - V_{DS}$**



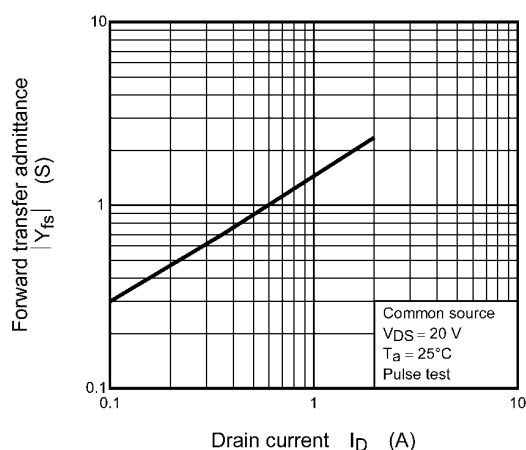
**Fig. 8.2  $I_D - V_{DS}$**



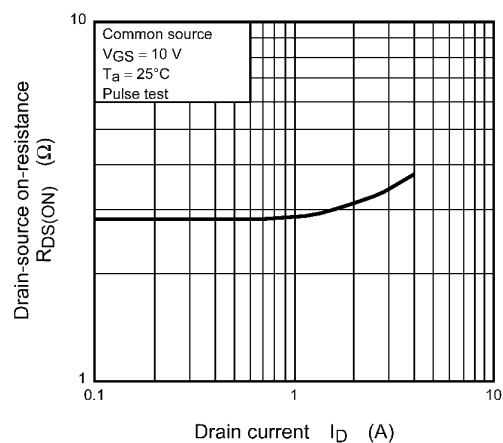
**Fig. 8.3  $I_D - V_{GS}$**



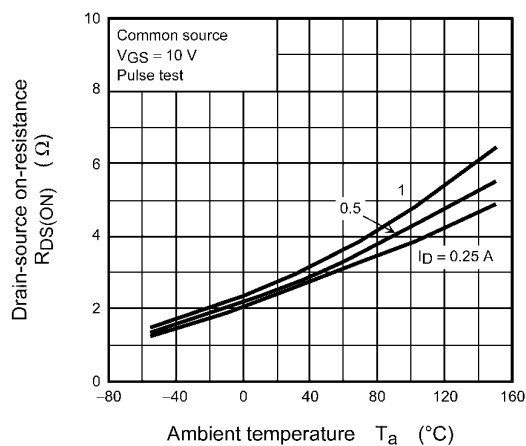
**Fig. 8.4  $V_{DS} - V_{GS}$**



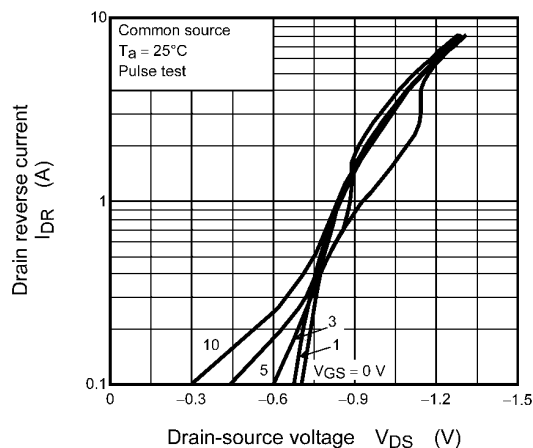
**Fig. 8.5  $|Y_{fs}| - I_D$**



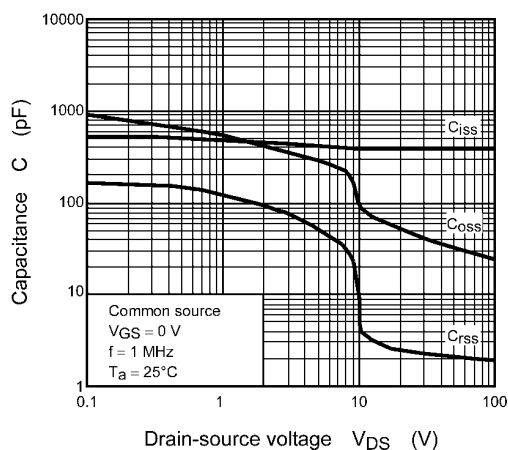
**Fig. 8.6  $R_{DS(ON)} - I_D$**



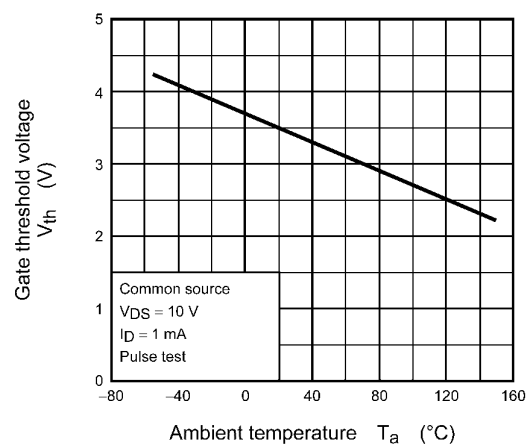
**Fig. 8.7  $R_{DS(ON)} - T_a$**



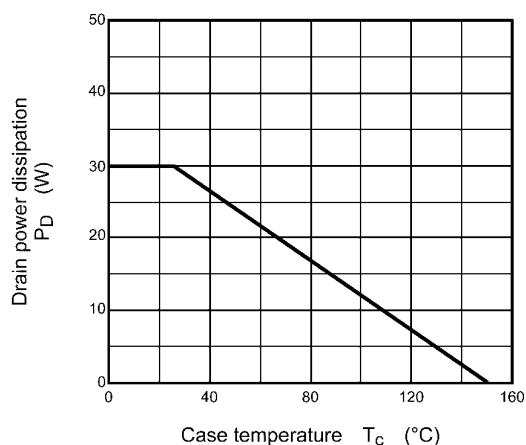
**Fig. 8.8  $I_{DR} - V_{DS}$**



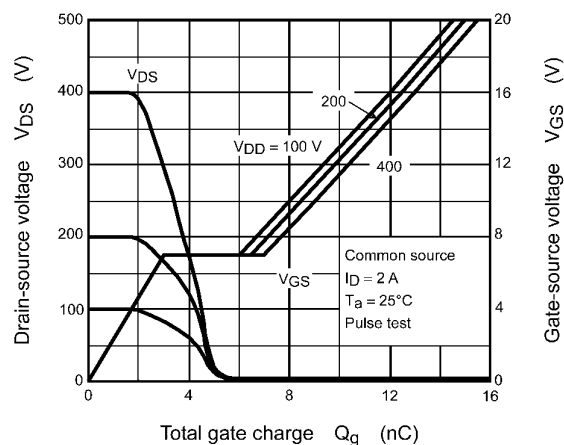
**Fig. 8.9  $C - V_{DS}$**



**Fig. 8.10  $V_{th} - T_a$**



**Fig. 8.11  $P_D - T_c$   
(Guaranteed Maximum)**



**Fig. 8.12 Dynamic Input/Output Characteristics**

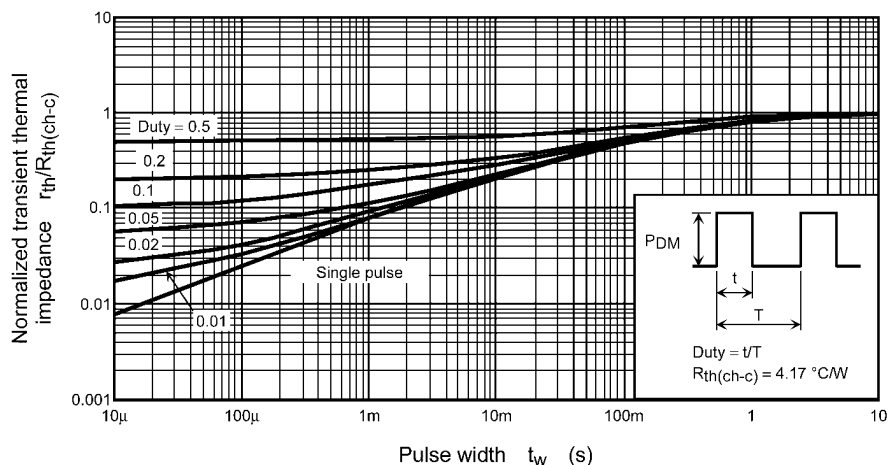


Fig. 8.13  $r_{th}/R_{th(ch-c)} - t_w$   
(Guaranteed Maximum)

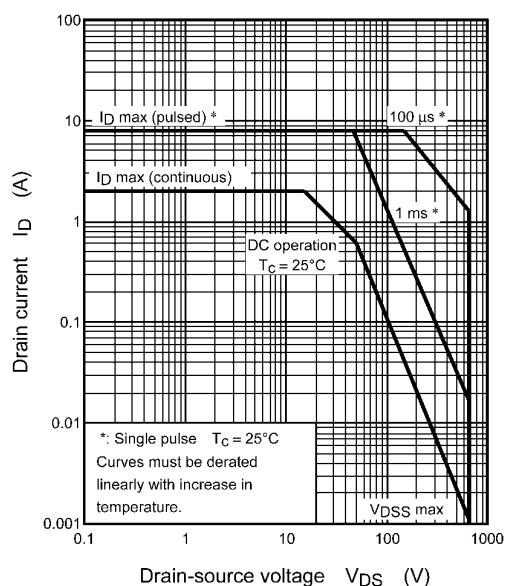


Fig. 8.14 Safe Operating Area  
(Guaranteed Maximum)

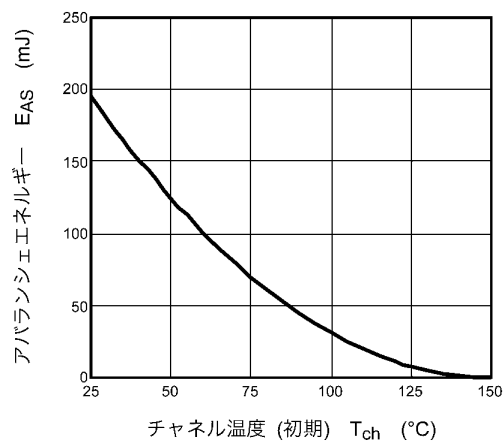


Fig. 8.15  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)

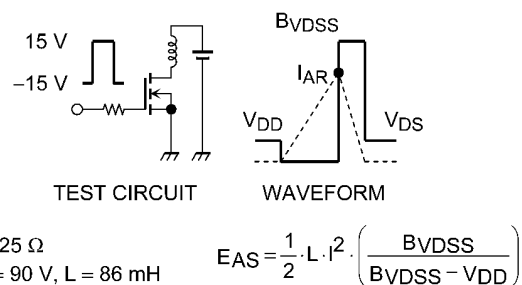
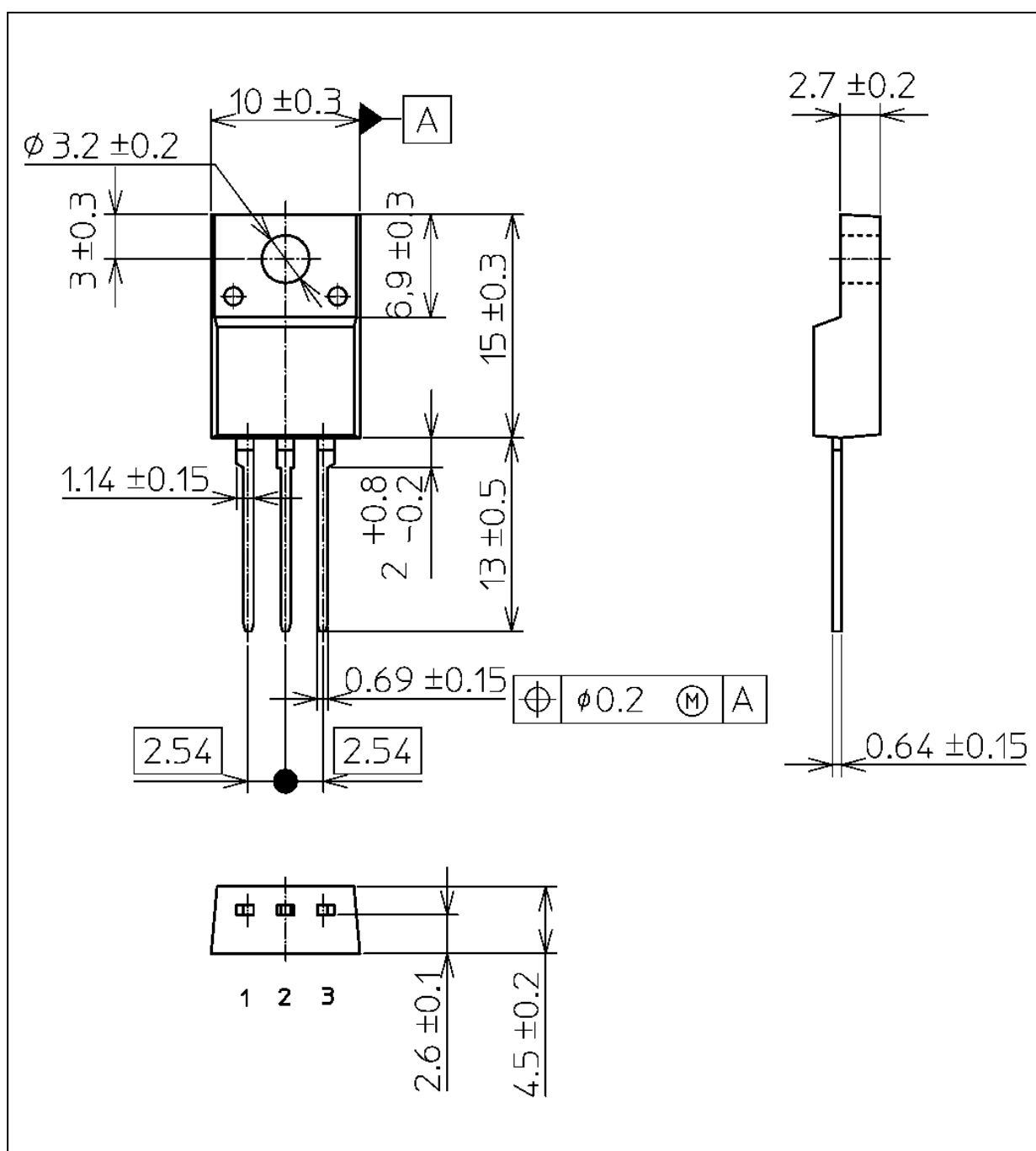


Fig. 8.16 Test Circuit/Waveform

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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