

# TK70J04K3Z

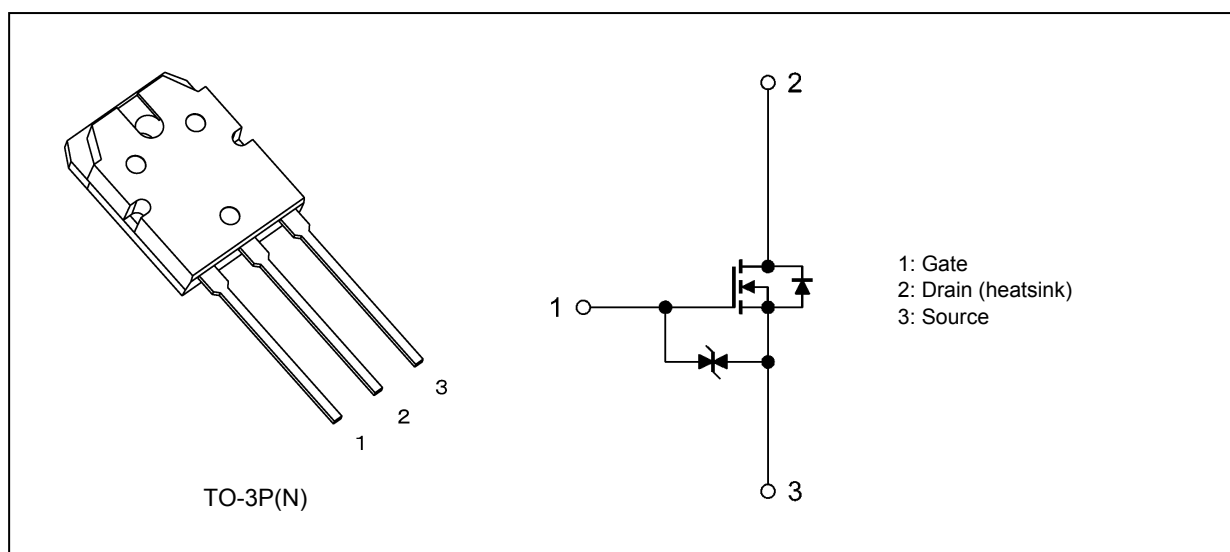
## 1. Applications

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

## 2. Features

- (1) Low drain-source on-resistance:  $R_{DS(ON)} = 3.2 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (2) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 40 \text{ V}$ )
- (3) Enhancement mode:  $V_{th} = 3.0 \text{ to } 4.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

## 3. Packaging and Internal Circuit



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

| Characteristics               | Symbol    | Rating     | Unit             |
|-------------------------------|-----------|------------|------------------|
| Drain-source voltage          | $V_{DSS}$ | 40         | V                |
| Gate-source voltage           | $V_{GSS}$ | $\pm 20$   |                  |
| Drain current (DC)            | $I_D$     | 70         | A                |
| Drain current (pulsed)        | $I_{DP}$  | 280        |                  |
| Power dissipation             | $P_D$     | 125        | W                |
| Single-pulse avalanche energy | $E_{AS}$  | 184        | mJ               |
| Avalanche current             | $I_{AR}$  | 70         | A                |
| Channel temperature           | $T_{ch}$  | 175        | $^\circ\text{C}$ |
| Storage temperature           | $T_{stg}$ | -55 to 175 |                  |

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    | $R_{th(ch-c)}$ | 1.2 | °C/W |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 50  |      |

Note 1: Ensure that the channel temperature does not exceed 175°C.

Note 2:  $V_{DD} = 25\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 39\ \mu\text{H}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 70\ \text{A}$

Note 3: The definitions of the absolute maximum channel and storage temperatures are based on AEC-Q101.

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

**6. Electrical Characteristics**

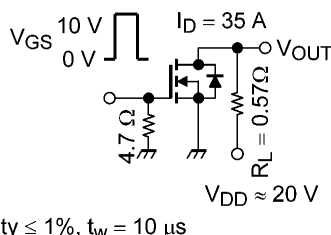
**6.1. Static Characteristics ( $T_a = 25^\circ\text{C}$  unless otherwise specified)**

| Characteristics                     | Symbol        | Test Condition                                  | Min | Typ. | Max      | Unit             |
|-------------------------------------|---------------|-------------------------------------------------|-----|------|----------|------------------|
| Gate leakage current                | $I_{GSS}$     | $V_{GS} = \pm 16\text{ V}, V_{DS} = 0\text{ V}$ | —   | —    | $\pm 10$ | $\mu\text{A}$    |
| Drain cut-off current               | $I_{DSS}$     | $V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$     | —   | —    | 10       |                  |
| Drain-source breakdown voltage      | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$       | 40  | —    | —        | V                |
| Drain-source breakdown voltage      | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$     | 20  | —    | —        |                  |
| Gate threshold voltage              | $V_{th}$      | $V_{DS} = 10\text{ V}, I_D = 1\text{ mA}$       | 3.0 | —    | 4.0      |                  |
| Drain-source on-resistance (Note 4) | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}, I_D = 35\text{ A}$       | —   | 3.2  | 4.1      | $\text{m}\Omega$ |

Note 4: Measured at lead standoff.

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

| Characteristics                | Symbol    | Test Condition                                                | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|---------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | —   | 4500 | —   | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                               | —   | 800  | —   |             |
| Output capacitance             | $C_{oss}$ |                                                               | —   | 1150 | —   |             |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1.                                             | —   | 20   | —   | ns          |
| Switching time (turn-on time)  | $t_{on}$  |                                                               | —   | 45   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                               | —   | 30   | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                               | —   | 95   | —   |             |



**Fig. 6.2.1 Switching Time Test Circuit**

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

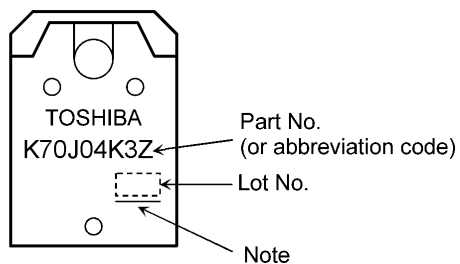
| Characteristics                                 | Symbol   | Test Condition                                                        | Min | Typ. | Max | Unit |
|-------------------------------------------------|----------|-----------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$    | $V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 70\text{ A}$ | —   | 100  | —   | nC   |
| Gate-source charge                              | $Q_{gs}$ |                                                                       | —   | 45   | —   |      |
| Gate-drain charge                               | $Q_{gd}$ |                                                                       | —   | 55   | —   |      |

**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 5)     | $I_{DR}$  | —                                                                                      | —   | —    | 70   | A    |
| Reverse drain current (pulsed) (Note 5) | $I_{DRP}$ | —                                                                                      | —   | —    | 280  |      |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 70\text{ A}, V_{GS} = 0\text{ V}$                                            | —   | —    | -1.2 | V    |
| Reverse recovery time                   | $t_{rr}$  | $I_{DR} = 70\text{ A}, V_{GS} = 0\text{ V}$<br>$-dI_{DR}/dt = 50\text{ A}/\mu\text{s}$ | —   | 48   | —    | ns   |
| Reverse recovery charge                 | $Q_{rr}$  |                                                                                        | —   | 26   | —    | nC   |

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

**7. Marking (Note)**



**Fig. 7.1 Marking**

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

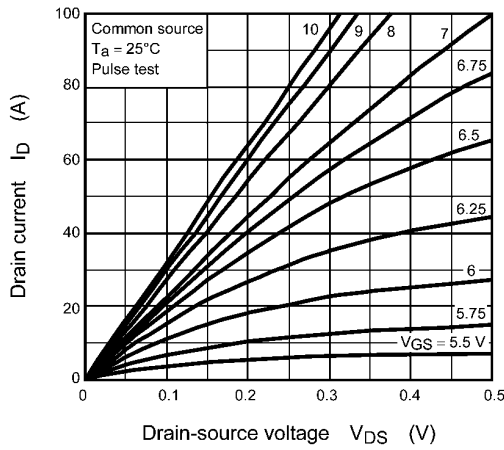
Not underlined: [[Pb]]/INCLUDES > MCV

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

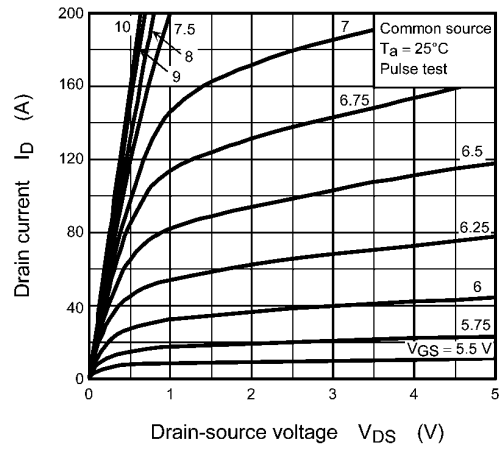
Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

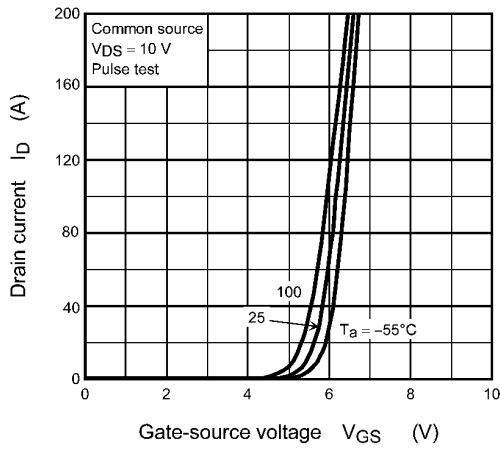
**8. Characteristics Curves (Note)**



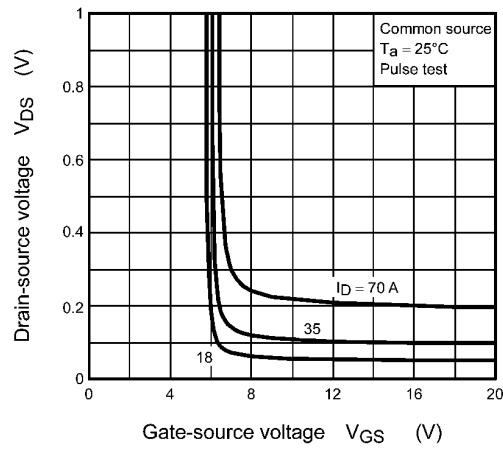
**Fig. 8.1  $I_D - V_{DS}$**



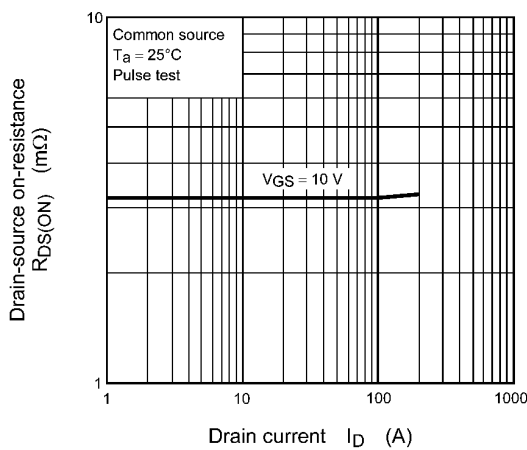
**Fig. 8.2  $I_D - V_{DS}$**



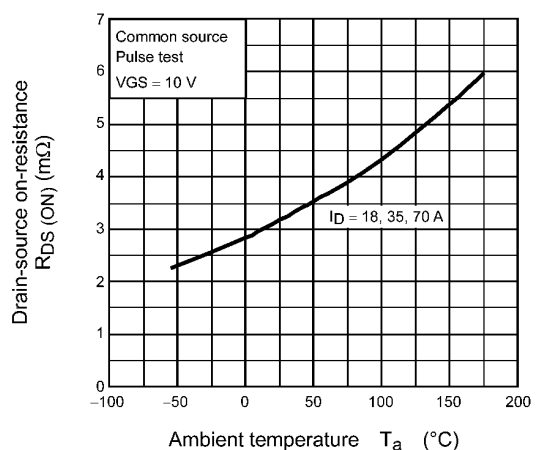
**Fig. 8.3  $I_D - V_{GS}$**



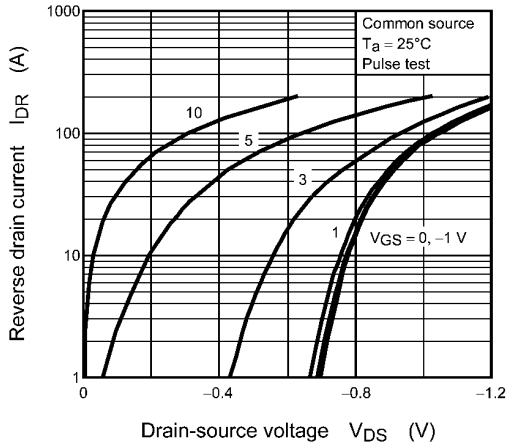
**Fig. 8.4  $V_{DS} - V_{GS}$**



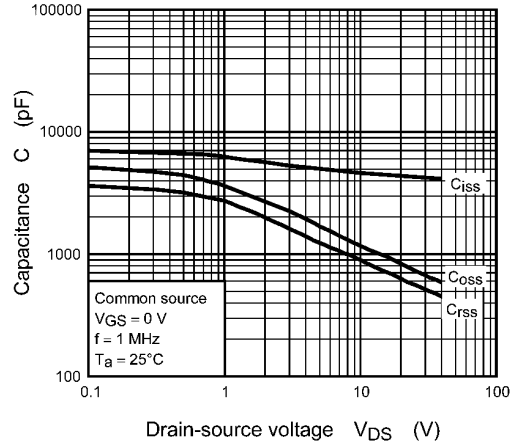
**Fig. 8.5  $R_{DS(ON)} - I_D$**



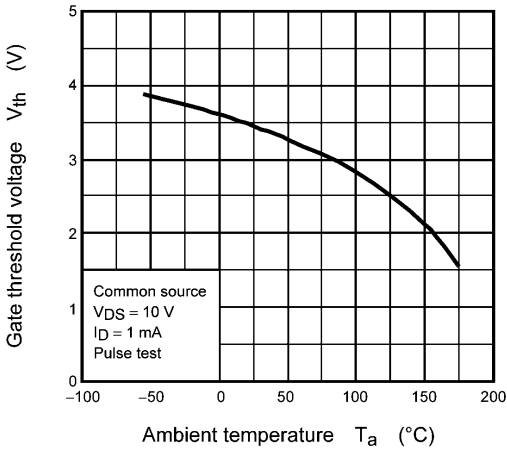
**Fig. 8.6  $R_{DS(ON)} - T_a$**



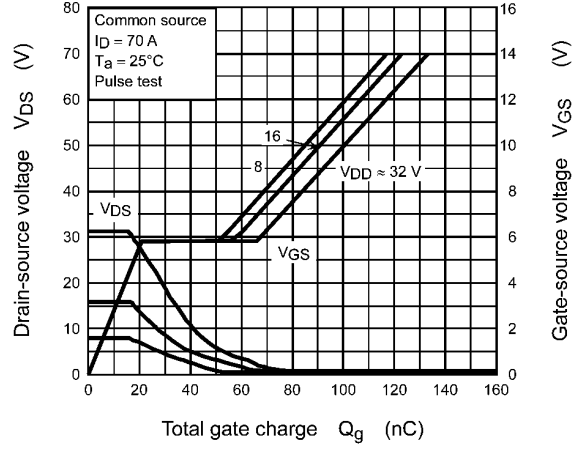
**Fig. 8.7  $I_{DR} - V_{DS}$**



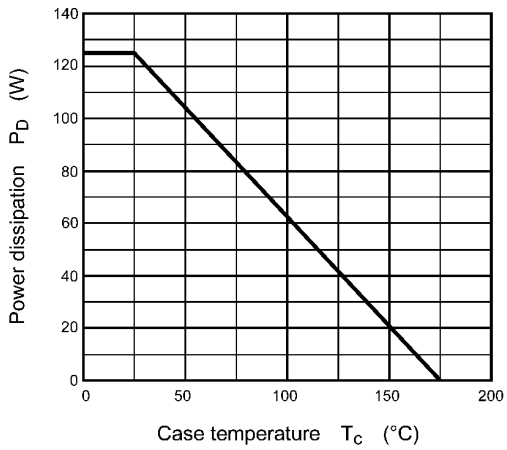
**Fig. 8.8 Capacitance -  $V_{DS}$**



**Fig. 8.9  $V_{th} - T_a$**



**Fig. 8.10 Dynamic Input/Output Characteristics**



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

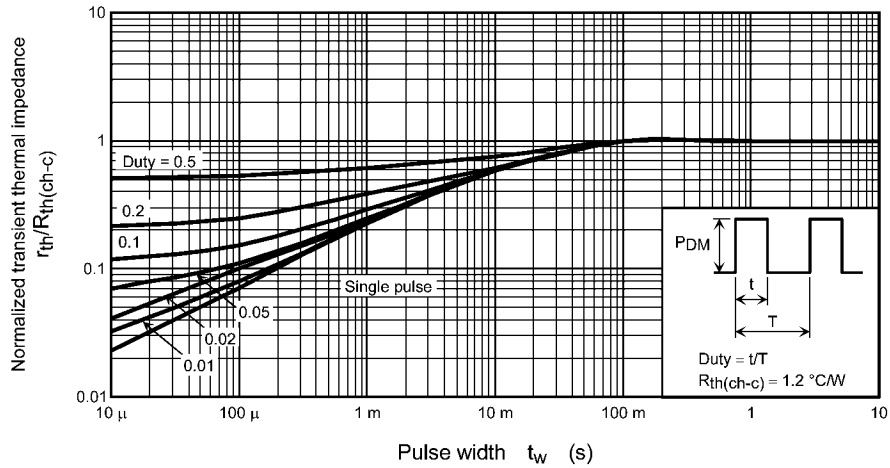


Fig. 8.12  $r_{th}/R_{th(ch-c)} - t_w$   
(Guaranteed Maximum)

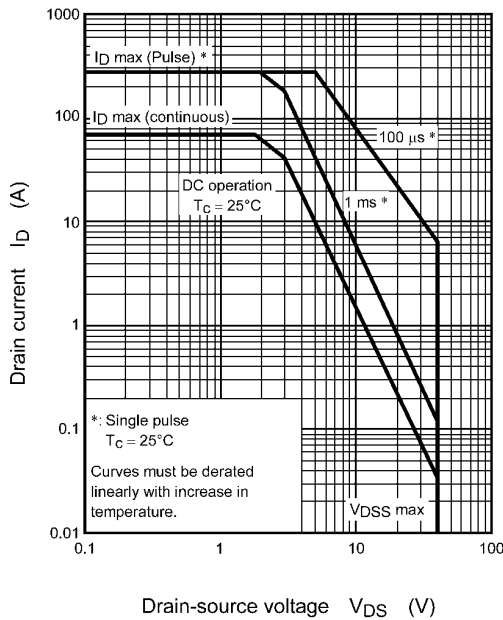


Fig. 8.13 Safe Operating Area  
(Guaranteed Maximum)

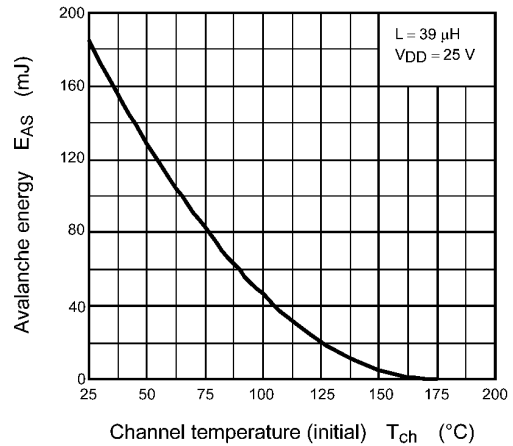


Fig. 8.14  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)

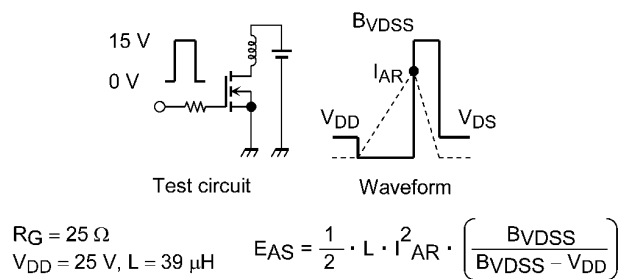
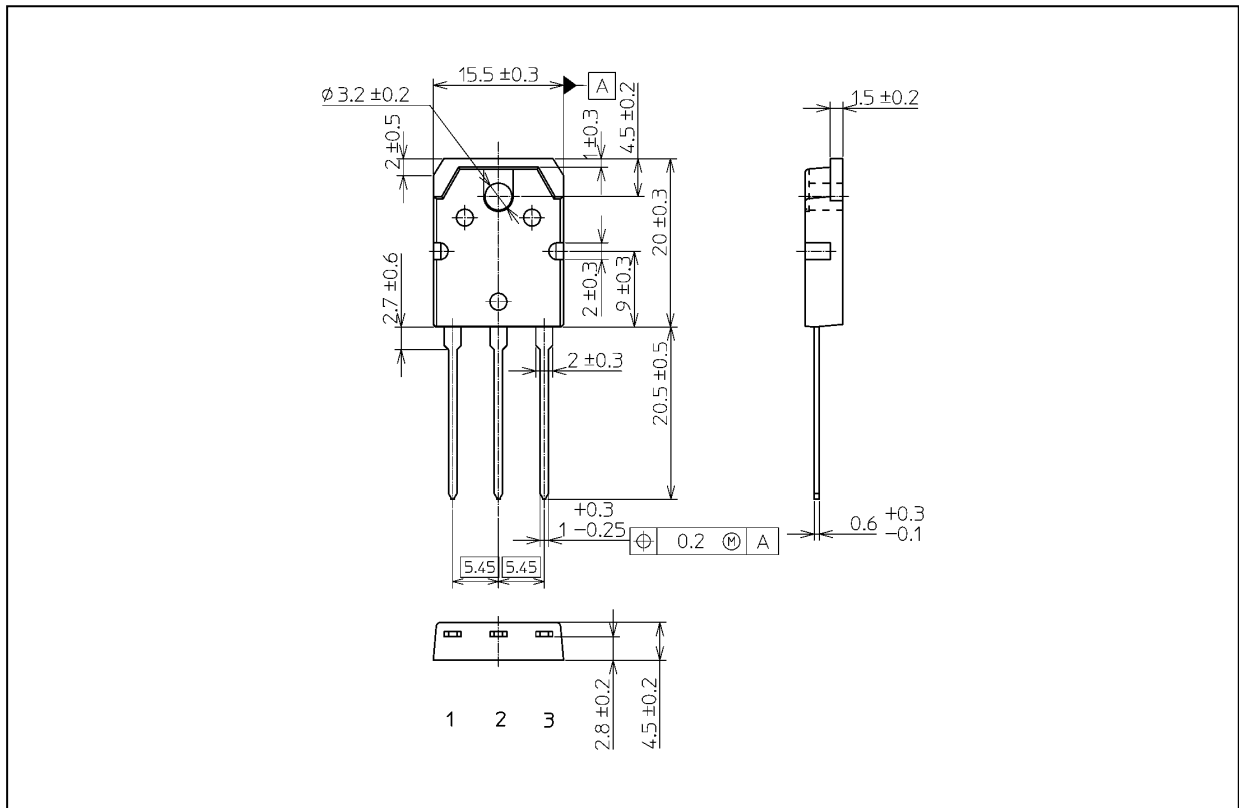


Fig. 8.15 Test Circuit/Waveform

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

**Package Dimensions**

Unit: mm



Weight: 4.6 g (typ.)

| Package Name(s)    |
|--------------------|
| JEITA: SC-65       |
| TOSHIBA: 2-16C1S   |
| Nickname: TO-3P(N) |



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