

MOSFETs Silicon N-channel MOS (U-MOS X-H)

# TK5R1A08QM

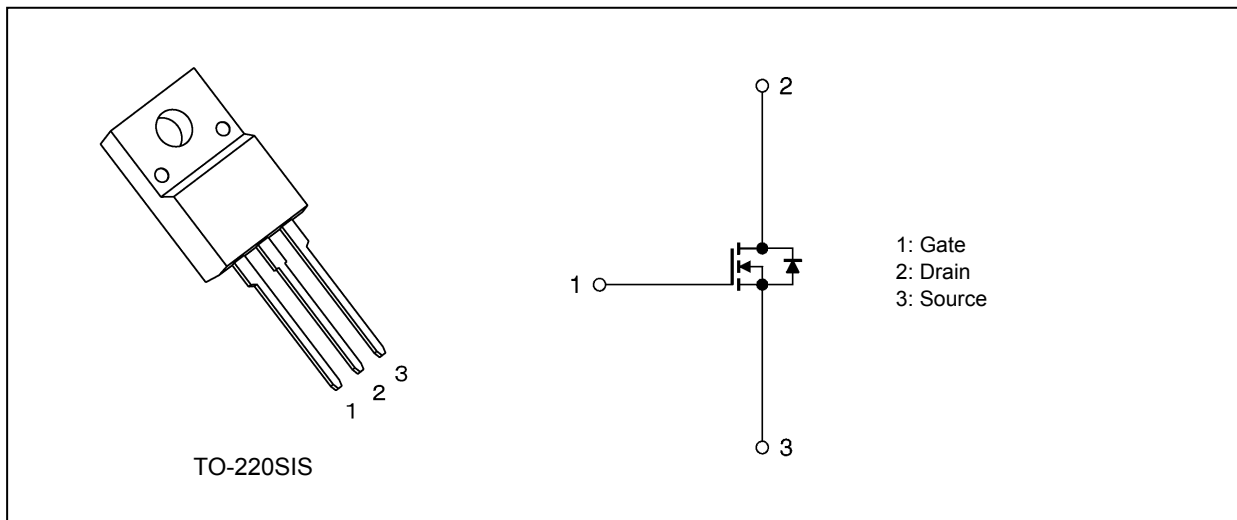
## 1. Applications

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

## 2. Features

- (1) High-speed switching
- (2) Small gate charge:  $Q_{SW} = 17 \text{ nC}$  (typ.)
- (3) Small output charge:  $Q_{OSS} = 66 \text{ nC}$  (typ.)
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 4.1 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (5) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 80 \text{ V}$ )
- (6) Enhancement mode:  $V_{th} = 2.5 \text{ to } 3.5 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.7 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2021-01

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

| Characteristics                                                    | Symbol         | Rating     | Unit               |
|--------------------------------------------------------------------|----------------|------------|--------------------|
| Drain-source voltage                                               | $V_{DSS}$      | 80         | V                  |
| Gate-source voltage                                                | $V_{GSS}$      | $\pm 20$   |                    |
| Drain current (DC) ( $T_c = 25\text{ }^{\circ}\text{C}$ ) (Note 1) | $I_D$          | 70         | A                  |
| Drain current (DC) (Silicon limit) (Note 1), (Note 2)              | $I_D$          | 71         |                    |
| Drain current (pulsed) ( $t = 100\text{ }\mu\text{s}$ ) (Note 1)   | $I_{DP}$       | 320        |                    |
| Power dissipation ( $T_c = 25\text{ }^{\circ}\text{C}$ )           | $P_D$          | 45         | W                  |
| Single-pulse avalanche energy (Note 3)                             | $E_{AS}$       | 36         | mJ                 |
| Single-pulse avalanche current (Note 3)                            | $I_{AS}$       | 70         | A                  |
| Channel temperature                                                | $T_{ch}$       | 175        | $^{\circ}\text{C}$ |
| Storage temperature                                                | $T_{stg}$      | -55 to 175 |                    |
| Isolation voltage (RMS) ( $t = 1.0\text{ s}$ )                     | $V_{ISO(RMS)}$ | 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 ( $T_c = 25\text{ }^{\circ}\text{C}$ )    | $R_{th(ch-c)}$ | 3.33 | $^{\circ}\text{C}/\text{W}$ |
| Channel-to-ambient thermal resistance ( $T_a = 25\text{ }^{\circ}\text{C}$ ) | $R_{th(ch-a)}$ | 62.5 |                             |

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

Note 2: Limited 70 A by package capability.

Note 3:  $V_{DD} = 64\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 5.8\text{ }\mu\text{H}$ ,  $I_{AS} = 70\text{ A}$

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

## 6. Electrical Characteristics

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

| Characteristics                         | Symbol        | Test Condition                                  | Min | Typ. | Max       | Unit             |
|-----------------------------------------|---------------|-------------------------------------------------|-----|------|-----------|------------------|
| Gate leakage current                    | $I_{GSS}$     | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$ | —   | —    | $\pm 0.1$ | $\mu\text{A}$    |
| Drain cut-off current                   | $I_{DSS}$     | $V_{DS} = 80\text{ V}, V_{GS} = 0\text{ V}$     | —   | —    | 10        |                  |
| Drain-source breakdown voltage          | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$       | 80  | —    | —         | V                |
| Drain-source breakdown voltage (Note 4) | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$     | 60  | —    | —         |                  |
| Gate threshold voltage                  | $V_{th}$      | $V_{DS} = 10\text{ V}, I_D = 0.7\text{ mA}$     | 2.5 | —    | 3.5       |                  |
| Drain-source on-resistance              | $R_{DS(ON)}$  | $V_{GS} = 6\text{ V}, I_D = 32\text{ A}$        | —   | 5.2  | 7.1       | $\text{m}\Omega$ |
|                                         |               | $V_{GS} = 10\text{ V}, I_D = 35\text{ A}$       | —   | 4.1  | 5.1       |                  |

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

| Characteristics                | Symbol    | Test Condition                                                | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|---------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | —   | 3980 | —   | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                               | —   | 55   | —   |             |
| Output capacitance             | $C_{oss}$ |                                                               | —   | 1000 | —   |             |
| Gate resistance                | $r_g$     | —                                                             | —   | 1.6  | 2.4 | $\Omega$    |
| Switching time (rise time)     | $t_r$     | See Fig. 6.2.1                                                | —   | 47   | —   | ns          |
| Switching time (turn-on time)  | $t_{on}$  |                                                               | —   | 65   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                               | —   | 51   | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                               | —   | 101  | —   |             |

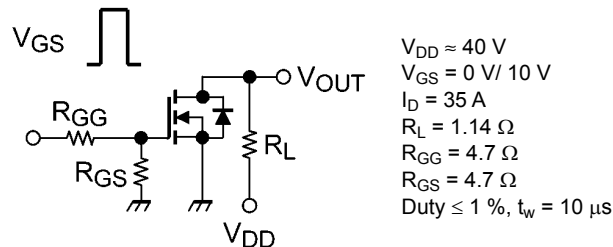


Fig. 6.2.1 Switching Time Test Circuit

### 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) | $Q_g$     | $V_{DD} \approx 40\text{ V}, V_{GS} = 10\text{ V}, I_D = 35\text{ A}$ | —   | 54   | —   | nC   |
|                                                 |           | $V_{DD} \approx 40\text{ V}, V_{GS} = 6\text{ V}, I_D = 32\text{ A}$  | —   | 32   | —   |      |
| Gate-source charge 1                            | $Q_{gs1}$ | $V_{DD} \approx 40\text{ V}, V_{GS} = 10\text{ V}, I_D = 35\text{ A}$ | —   | 14   | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |                                                                       | —   | 12   | —   |      |
| Gate switch charge                              | $Q_{SW}$  |                                                                       | —   | 17   | —   |      |
| Output charge                                   | $Q_{oss}$ | $V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$         | —   | 66   | —   |      |

6.4. Source-Drain Characteristics (T<sub>a</sub> = 25 °C unless otherwise specified)

| Characteristics                         | Symbol           | Test Condition                                                                       | Min | Typ. | Max  | Unit |
|-----------------------------------------|------------------|--------------------------------------------------------------------------------------|-----|------|------|------|
| Reverse drain current (pulsed) (Note 5) | I <sub>DRP</sub> | t = 100 μs                                                                           | —   | —    | 320  | A    |
| Diode forward voltage                   | V <sub>DSF</sub> | I <sub>DR</sub> = 35 A, V <sub>GS</sub> = 0 V                                        | —   | —    | -1.2 | V    |
| Reverse recovery time                   | t <sub>rr</sub>  | I <sub>DR</sub> = 17.5 A, V <sub>GS</sub> = 0 V,<br>-dI <sub>DR</sub> /dt = 100 A/μs | —   | 45   | —    | ns   |
| Reverse recovery charge                 | Q <sub>rr</sub>  |                                                                                      | —   | 48   | —    | nC   |

Note 5: Ensure that the channel temperature does not exceed 175 °C.

7. Marking (Note)

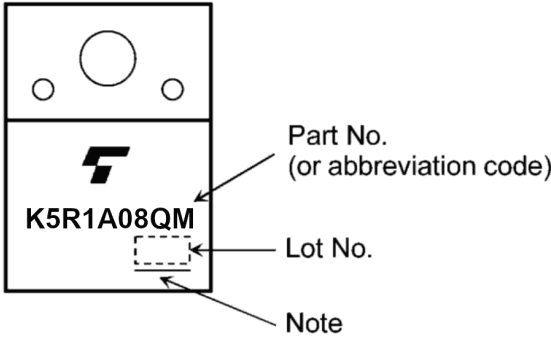


Fig. 7.1 Marking

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)

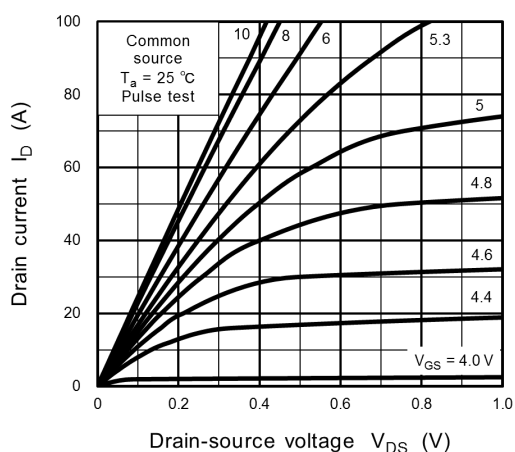


Fig. 8.1  $I_D - V_{DS}$

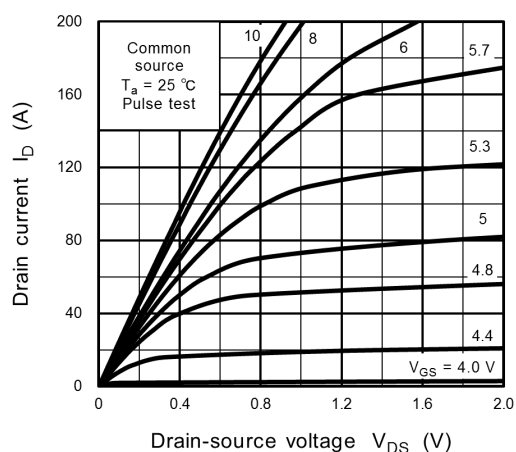


Fig. 8.2  $I_D - V_{DS}$

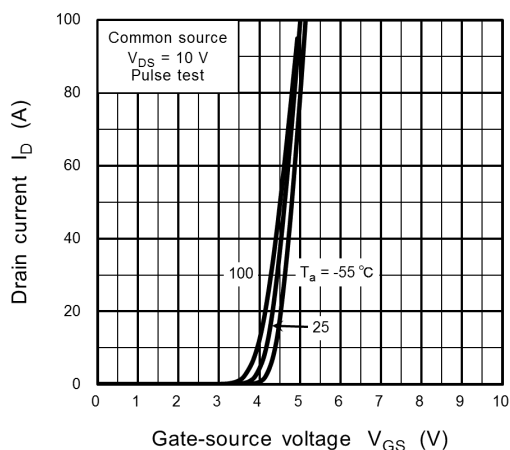


Fig. 8.3  $I_D - V_{GS}$

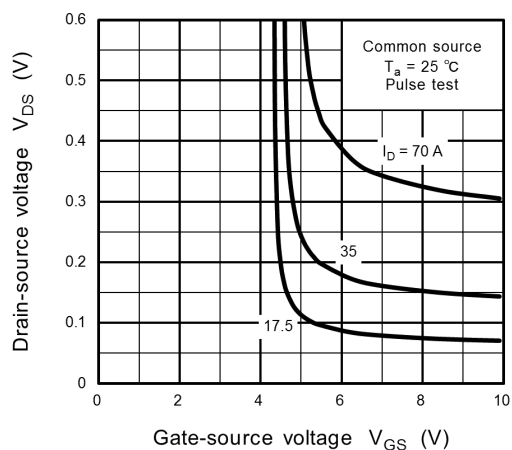


Fig. 8.4  $V_{DS} - V_{GS}$

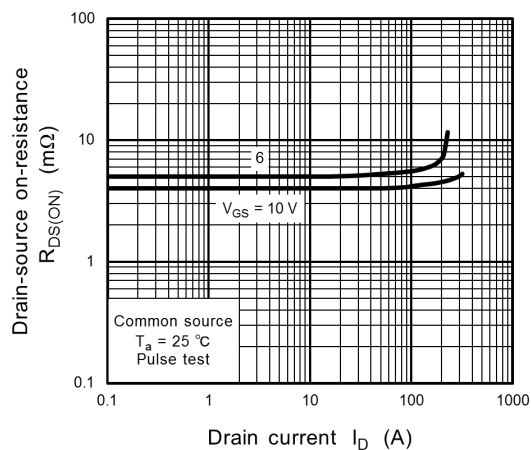


Fig. 8.5  $R_{DS(ON)} - I_D$

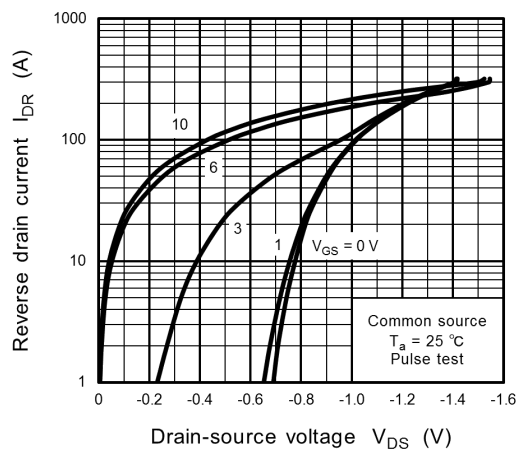


Fig. 8.6  $I_{DR} - V_{DS}$

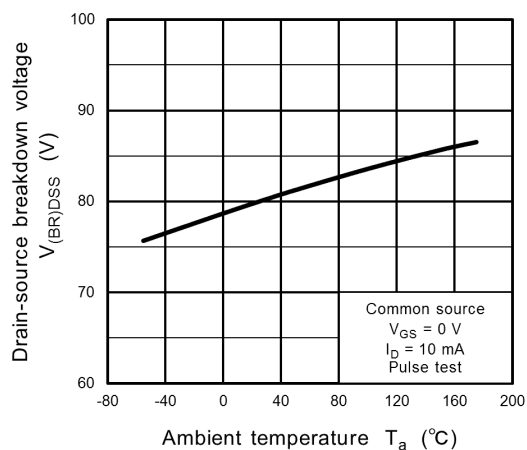


Fig. 8.7  $V_{(BR)DSS} - T_a$

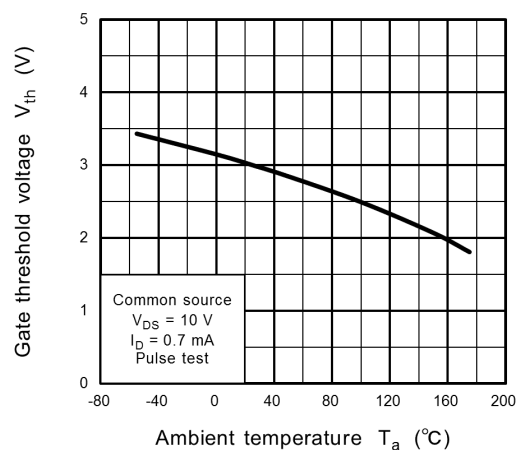


Fig. 8.8  $V_{th} - T_a$

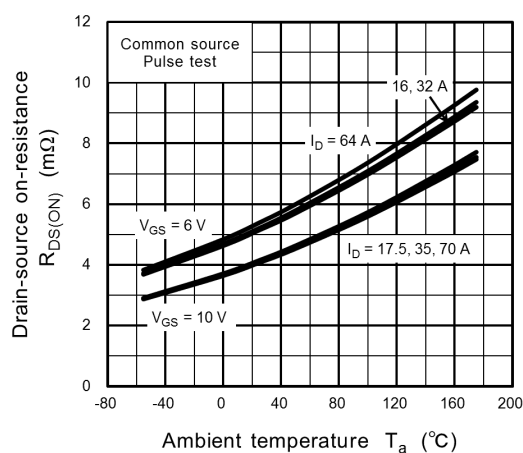


Fig. 8.9  $R_{DS(ON)} - T_a$

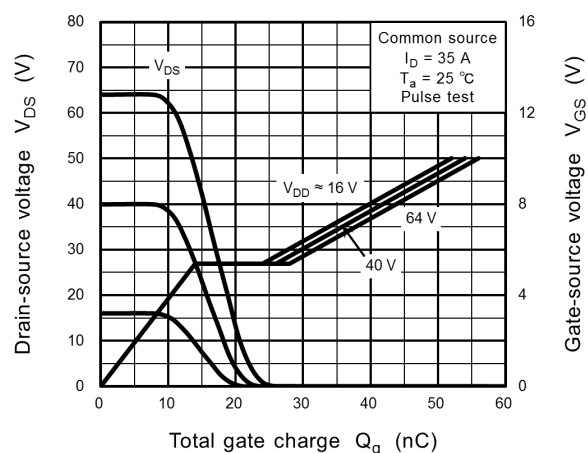


Fig. 8.10 Dynamic Input/Output Characteristics

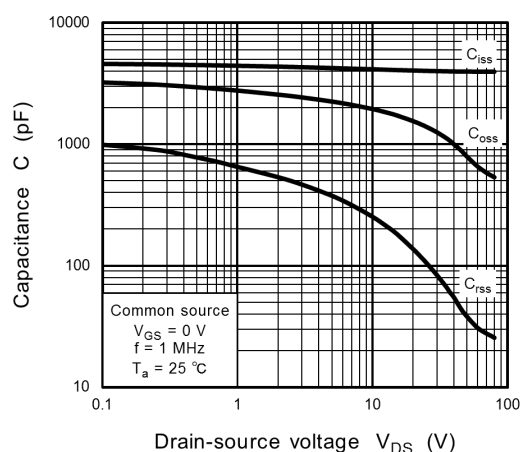


Fig. 8.11 Capacitance -  $V_{DS}$

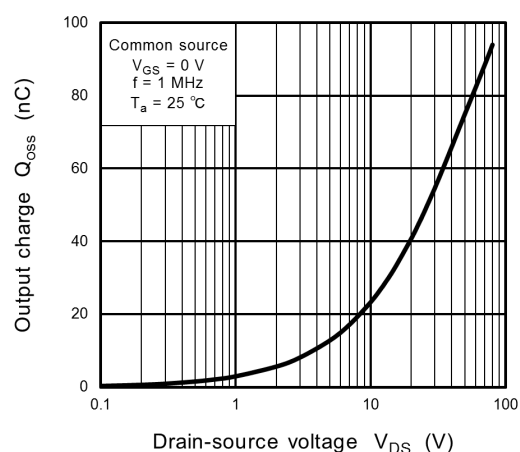


Fig. 8.12  $Q_{oss} - V_{DS}$

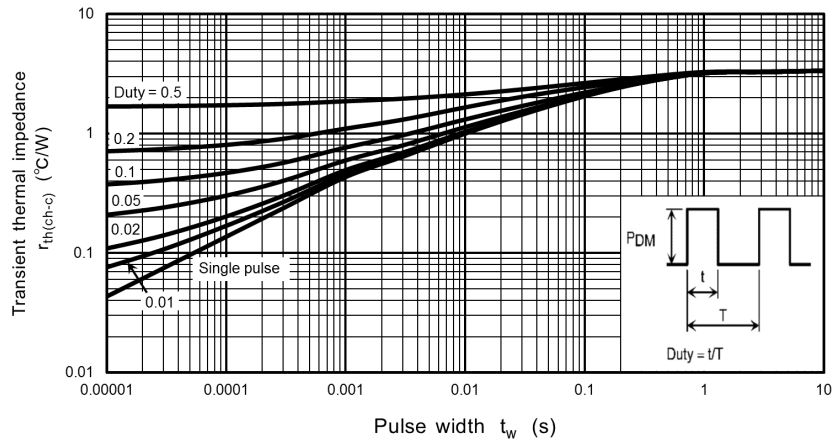


Fig. 8.13  $r_{th} - t_w$   
(Guaranteed Maximum)

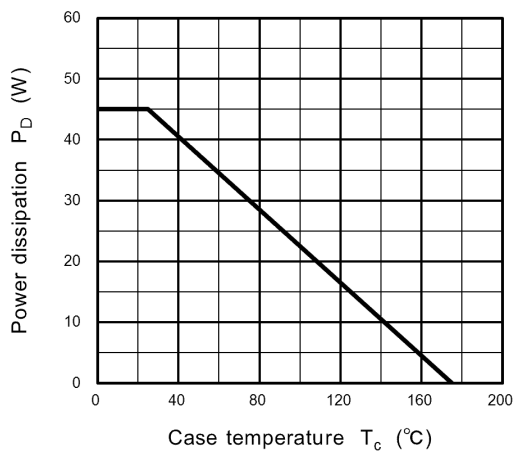


Fig. 8.14  $P_D - T_c$   
(Guaranteed Maximum)

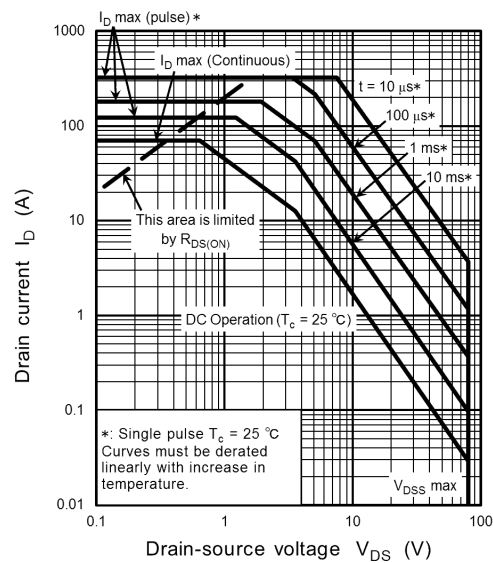
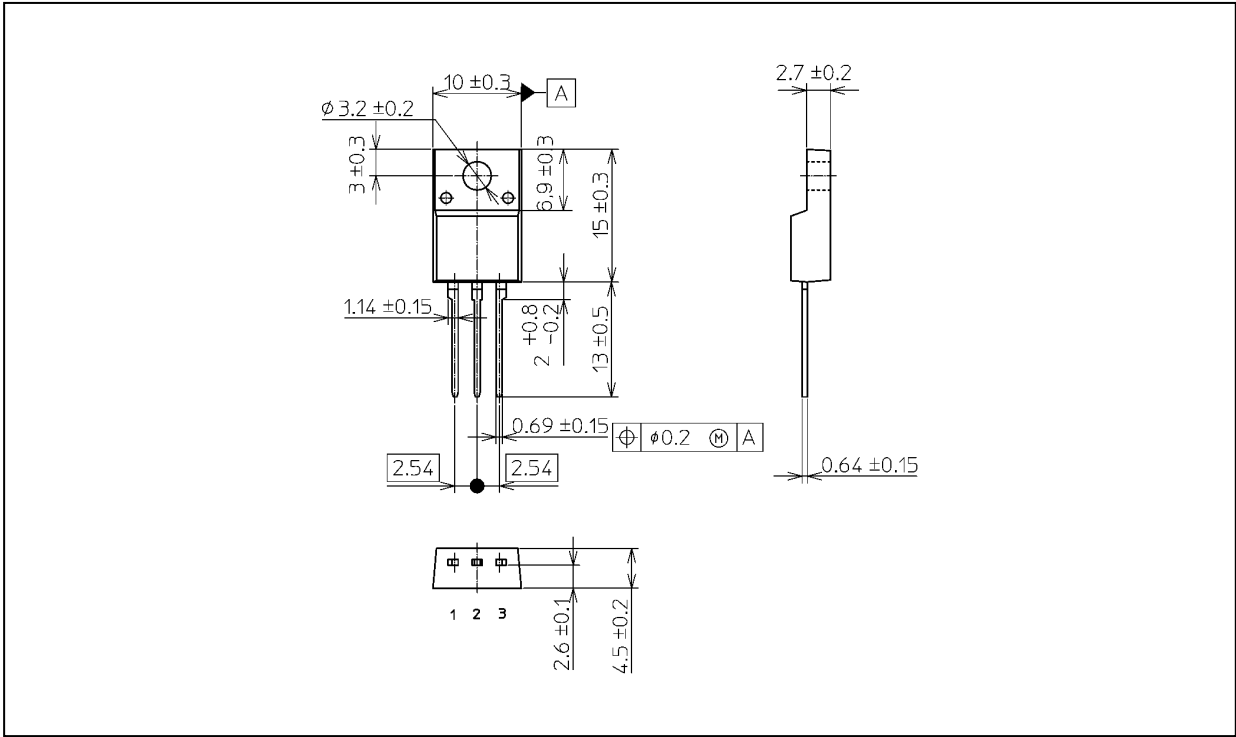


Fig. 8.15 Safe Operating Area  
(Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 1.56 g (typ.)

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

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