

MOSFETs Silicon N-channel MOS (U-MOS<sup>Ⅷ</sup>)

# TPN2R203NC

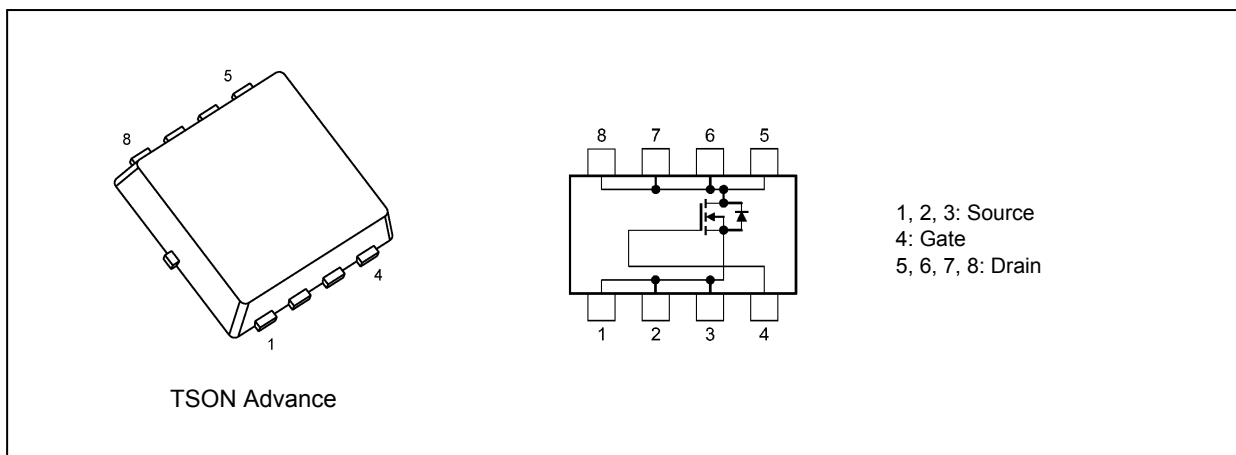
## 1. Applications

- Power Management Switches

## 2. Features

- (1) Low drain-source on-resistance:  $R_{DS(ON)} = 1.8 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (2) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 30 \text{ V}$ )
- (3) Enhancement mode:  $V_{th} = 1.3 \text{ to } 2.3 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.5 \text{ mA}$ )

## 3. Packaging and Internal Circuit



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

| Characteristics               | Symbol    | Rating     | Unit             |
|-------------------------------|-----------|------------|------------------|
| Drain-source voltage          | $V_{DSS}$ | 30         | V                |
| Gate-source voltage           | $V_{GSS}$ | $\pm 20$   | V                |
| Drain current (DC)            | $I_D$     | 100        | A                |
| Drain current (DC)            | $I_D$     | 45         | A                |
| Drain current (pulsed)        | $I_{DP}$  | 200        | A                |
| Power dissipation             | $P_D$     | 42         | W                |
| Power dissipation             | $P_D$     | 1.9        | W                |
| Power dissipation             | $P_D$     | 0.7        | W                |
| Single-pulse avalanche energy | $E_{AS}$  | 126        | mJ               |
| Avalanche current             | $I_{AR}$  | 45         | A                |
| Channel temperature           | $T_{ch}$  | 150        | $^\circ\text{C}$ |
| Storage temperature           | $T_{stg}$ | -55 to 150 | $^\circ\text{C}$ |

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

2013-05

## 5. Thermal Characteristics

| Characteristics  | Symbol         | Max  | Unit               |
|--|----------------|------|--------------------|
| Channel-to-case thermal resistance<br>( $T_c = 25\text{ }^\circ\text{C}$ ) | $R_{th(ch-c)}$ | 2.97 | $^\circ\text{C/W}$ |
| Channel-to-ambient thermal resistance<br>( $t = 10\text{ s}$ ) (Note 3)    | $R_{th(ch-a)}$ | 65.7 | $^\circ\text{C/W}$ |
| Channel-to-ambient thermal resistance<br>( $t = 10\text{ s}$ ) (Note 4)    | $R_{th(ch-a)}$ | 178  | $^\circ\text{C/W}$ |

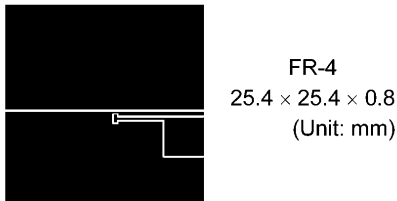
Note 1: Ensure that the channel temperature does not exceed  $150\text{ }^\circ\text{C}$ .

Note 2: Limited by silicon chip capability.

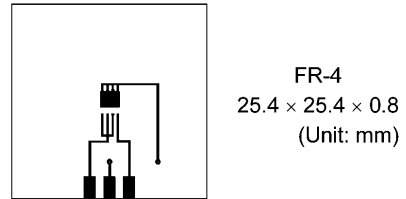
Note 3: Device mounted on a glass-epoxy board (a), Figure 5.1

Note 4: Device mounted on a glass-epoxy board (b), Figure 5.2

Note 5:  $V_{DD} = 24\text{ V}$ ,  $T_{ch} = 25\text{ }^\circ\text{C}$  (initial),  $L = 0.048\text{ mH}$ ,  $I_{AR} = 45\text{ A}$



**Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)**



**Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)**

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

### 6. Electrical Characteristics

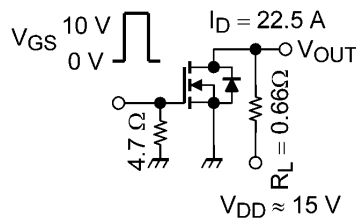
#### 6.1. Static Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics                         | Symbol        | Test Condition                                  | Min | Typ. | Max       | Unit             |
|---|---------------|---|-----|------|-----------|------------------|
| Gate leakage current                    | $I_{GSS}$     | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$ | —   | —    | $\pm 0.1$ | $\mu\text{A}$    |
| Drain cut-off current                   | $I_{DSS}$     | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}$     | —   | —    | 10        | $\mu\text{A}$    |
| Drain-source breakdown voltage          | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$       | 30  | —    | —         | V                |
| Drain-source breakdown voltage (Note 6) | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$     | 15  | —    | —         | V                |
| Gate threshold voltage                  | $V_{th}$      | $V_{DS} = 10\text{ V}, I_D = 0.5\text{ mA}$     | 1.3 | —    | 2.3       | V                |
| Drain-source on-resistance              | $R_{DS(ON)}$  | $V_{GS} = 4.5\text{ V}, I_D = 22.5\text{ A}$    | —   | 2.8  | 3.6       | $\text{m}\Omega$ |
| Drain-source on-resistance              | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}, I_D = 22.5\text{ A}$     | —   | 1.8  | 2.2       | $\text{m}\Omega$ |

Note 6: 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              | $C_{iss}$ | $V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | —   | 2230 | —   | pF   |
| Reverse transfer capacitance   | $C_{rss}$ |   | —   | 160  | —   | pF   |
| Output capacitance             | $C_{oss}$ |   | —   | 650  | —   | pF   |
| Switching time (rise time)     | $t_r$     | See Fig. 6.2.1  | —   | 9    | —   | ns   |
| Switching time (turn-on time)  | $t_{on}$  |   | —   | 14   | —   | ns   |
| Switching time (fall time)     | $t_f$     |   | —   | 24   | —   | ns   |
| Switching time (turn-off time) | $t_{off}$ |   | —   | 68   | —   | ns   |



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

Fig. 6.2.1 Switching Time Test Circuit

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

| Characteristics                                 | Symbol    | Test Condition  | Min | Typ. | Max | Unit |
|---|-----------|---|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$     | $V_{DD} \approx 15\text{ V}, V_{GS} = 10\text{ V}, I_D = 45\text{ A}$ | —   | 34   | —   | nC   |
| Gate-source charge 1                            | $Q_{gs1}$ |   | —   | 8    | —   | nC   |
| Gate-drain charge                               | $Q_{gd}$  |   | —   | 6    | —   | nC   |

#### 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) (1 ms) (Note 7) | $I_{DRP}$ | —   | —   | —    | 200  | A    |
| Diode forward voltage                          | $V_{DSF}$ | $I_{DR} = 45\text{ A}, V_{GS} = 0\text{ V}$ | —   | —    | -1.2 | V    |

Note 7: Ensure that the channel temperature does not exceed  $150\text{ }^\circ\text{C}$ .

## 7. Marking

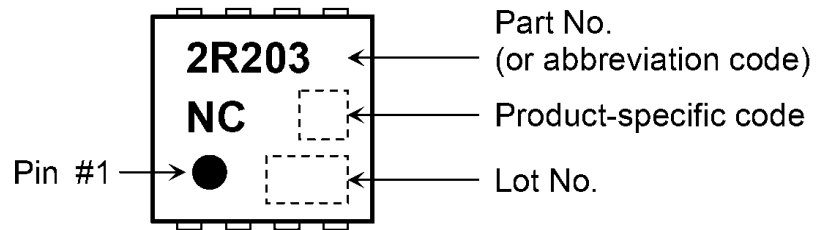
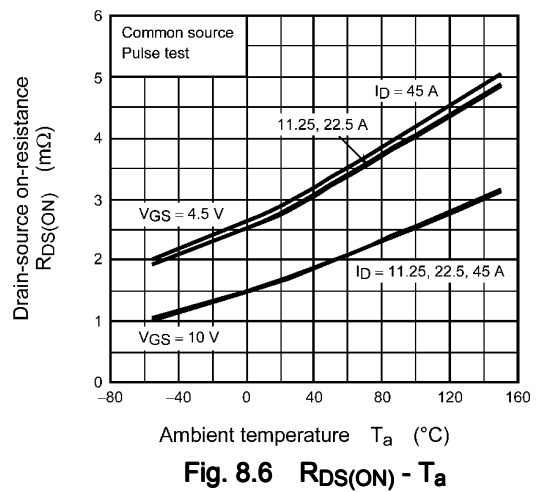
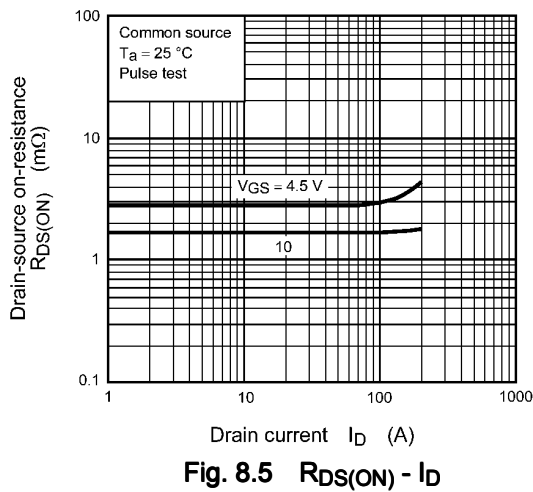
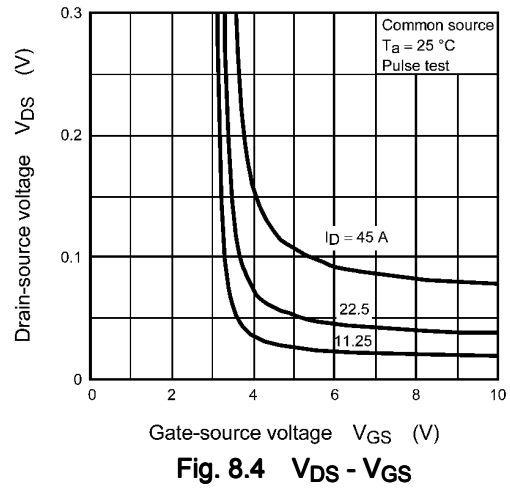
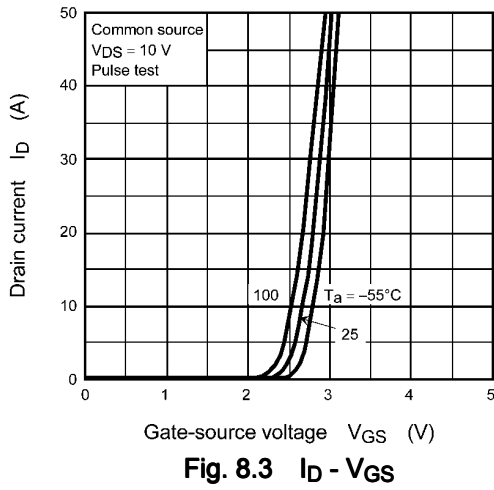
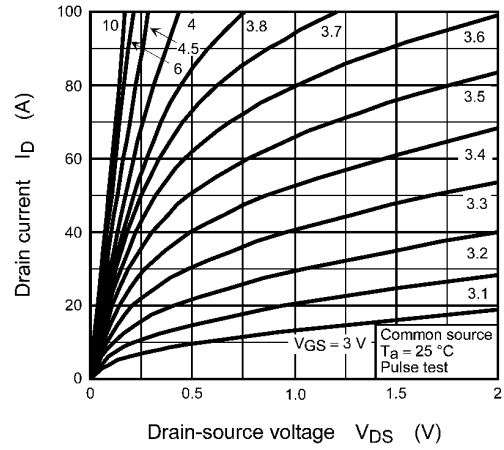
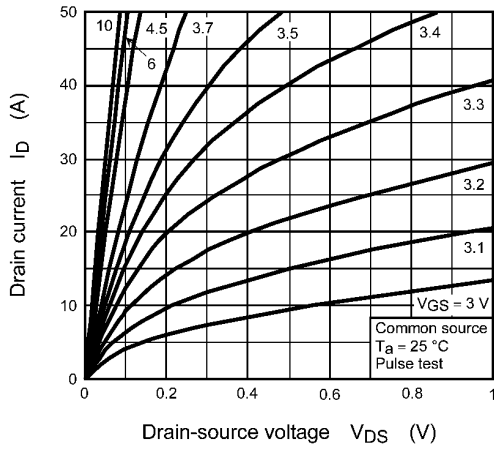
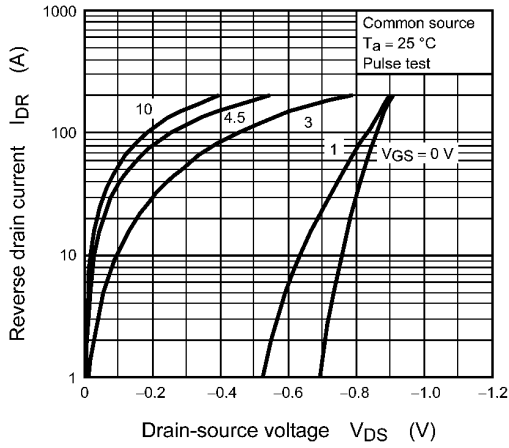


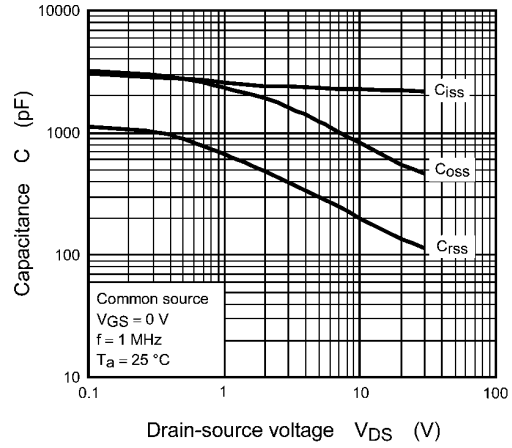
Fig. 7.1 Marking

## 8. Characteristics Curves (Note)

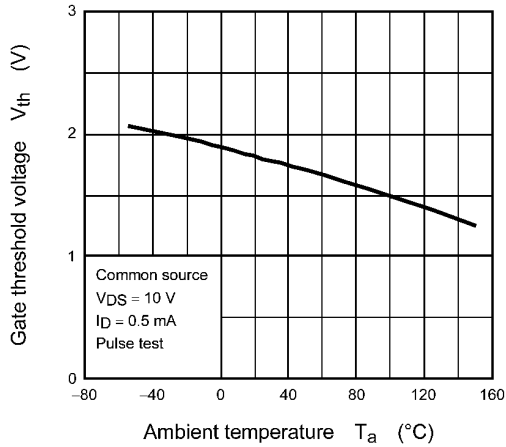




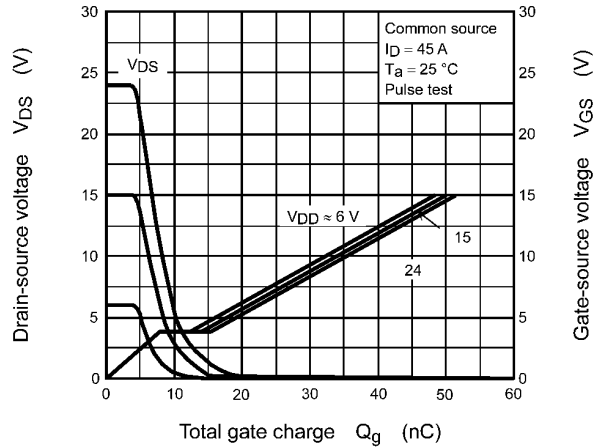
**Fig. 8.7  $I_{DR} - V_{DS}$**



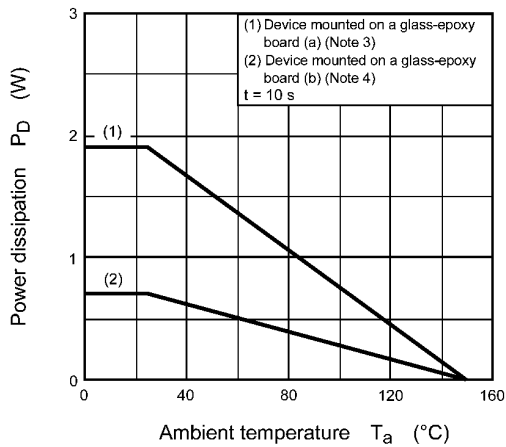
**Fig. 8.8 Capacitance -  $V_{DS}$**



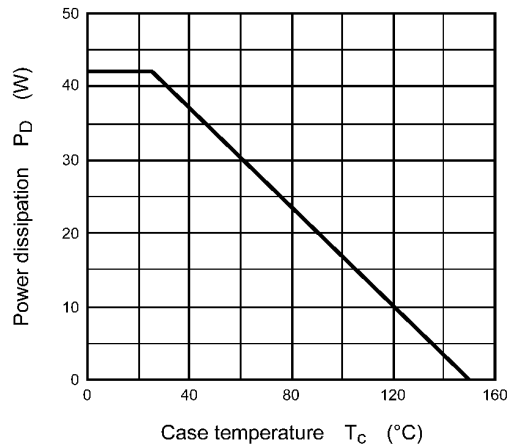
**Fig. 8.9  $V_{th} - T_a$**



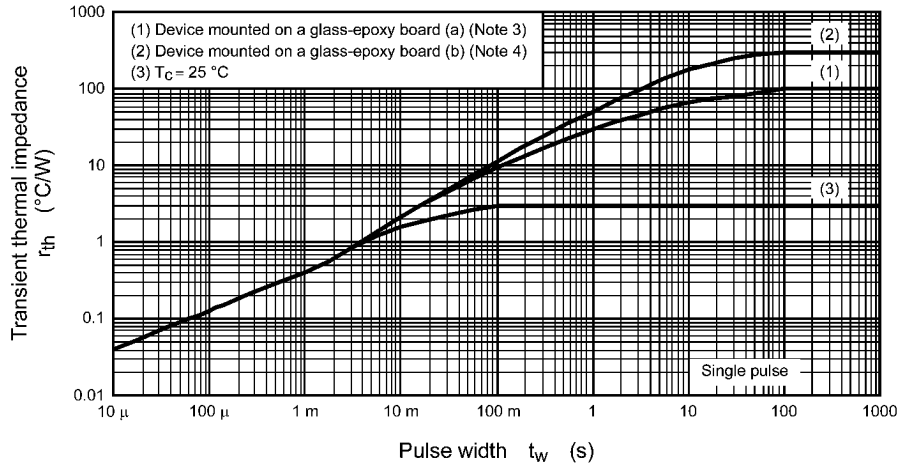
**Fig. 8.10 Dynamic Input/Output Characteristics**



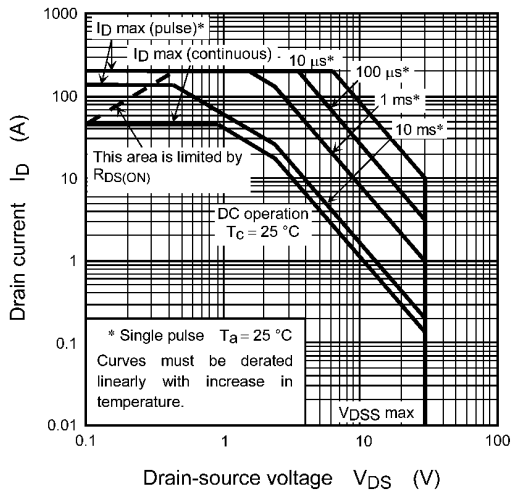
**Fig. 8.11  $P_D - T_a$   
(Guaranteed Maximum)**



**Fig. 8.12  $P_D - T_c$   
(Guaranteed Maximum)**



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

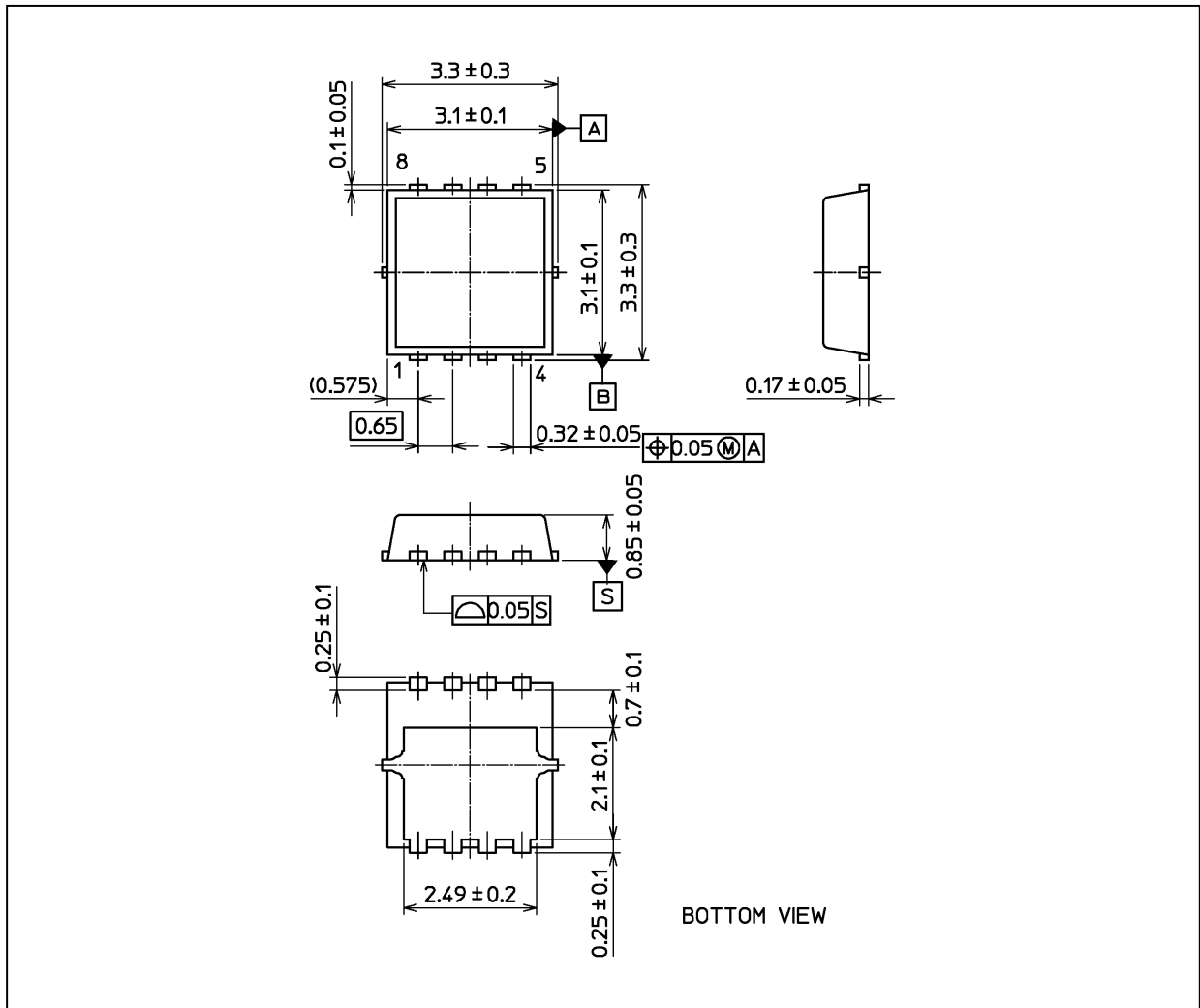


**Fig. 8.14 Safe Operating Area**  
(Guaranteed Maximum)

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

## Package Dimensions

Unit: mm



Weight: 0.029 g (typ.)

| Package Name(s)        |
|------------------------|
| TOSHIBA: 2-3X1S        |
| Nickname: TSON Advance |



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