

# TPN2010FNH

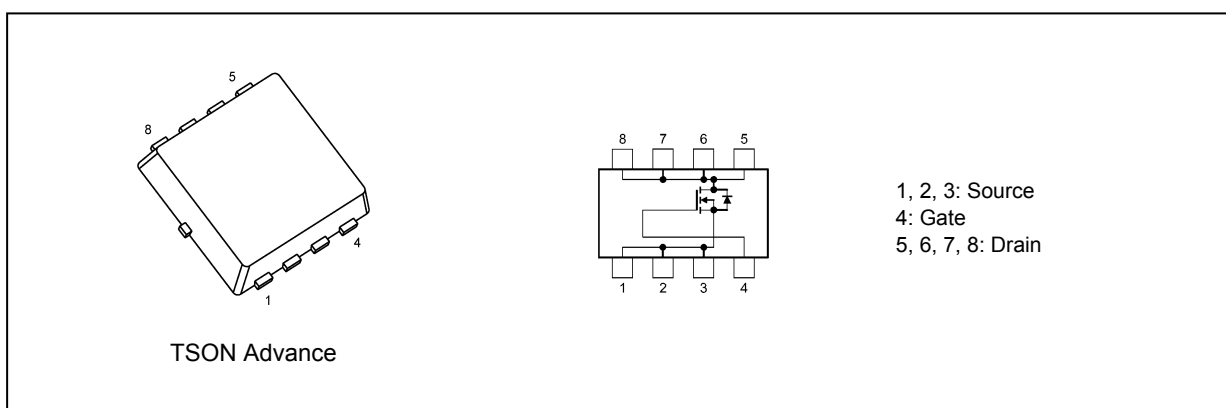
## 1. Applications

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

## 2. Features

- (1) High-speed switching
- (2) Small gate charge:  $Q_{SW} = 2.6 \text{ nC (typ.)}$
- (3) Low drain-source on-resistance:  $R_{DS(ON)} = 168 \text{ m}\Omega \text{ (typ.)}$  ( $V_{GS} = 10 \text{ V}$ )
- (4) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A (max)}$  ( $V_{DS} = 250 \text{ V}$ )
- (5) Enhancement mode:  $V_{th} = 2.0 \text{ to } 4.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.2 \text{ mA}$ )

## 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                                    | $V_{DSS}$ | 250        | V                |
| Gate-source voltage                                     | $V_{GSS}$ | $\pm 20$   |                  |
| Drain current (DC) (Silicon limit) (Note 1), (Note 2)   | $I_D$     | 9.9        | A                |
| Drain current (DC) (Continuous) (Note 1)                | $I_D$     | 5.6        |                  |
| Drain current (pulsed) ( $t = 1 \text{ ms}$ ) (Note 1)  | $I_{DP}$  | 19         |                  |
| Power dissipation ( $T_c = 25 \text{ }^\circ\text{C}$ ) | $P_D$     | 39         | W                |
| Power dissipation ( $t = 10 \text{ s}$ ) (Note 3)       | $P_D$     | 1.9        |                  |
| Power dissipation ( $t = 10 \text{ s}$ ) (Note 4)       | $P_D$     | 0.7        |                  |
| Single-pulse avalanche energy (Note 5)                  | $E_{AS}$  | 34         | mJ               |
| Avalanche current                                       | $I_{AR}$  | 5.6        | A                |
| Channel temperature                                     | $T_{ch}$  | 150        | $^\circ\text{C}$ |
| 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

2013-10

## 5. Thermal Characteristics

| Characteristics                                                              | Symbol         | Max  | Unit                 |
|------------------------------------------------------------------------------|----------------|------|----------------------|
| Channel-to-case thermal resistance<br>( $T_c = 25\text{ }^{\circ}\text{C}$ ) | $R_{th(ch-c)}$ | 3.20 | $^{\circ}\text{C/W}$ |
| Channel-to-ambient thermal resistance<br>( $t = 10\text{ s}$ ) (Note 3)      | $R_{th(ch-a)}$ | 65.7 |                      |
| Channel-to-ambient thermal resistance<br>( $t = 10\text{ s}$ ) (Note 4)      | $R_{th(ch-a)}$ | 178  |                      |

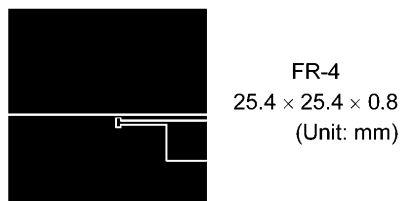
Note 1: Ensure that the channel temperature does not exceed  $150\text{ }^{\circ}\text{C}$ .

Note 2: Limited by silicon chip capability.

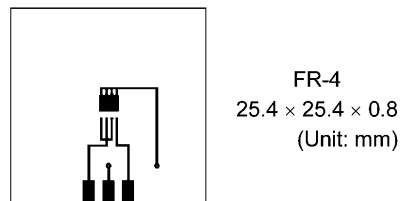
Note 3: Device mounted on a glass-epoxy board (a), Figure 5.1

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

Note 5:  $V_{DD} = 60\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 1.8\text{ mH}$ ,  $I_{AR} = 5.6\text{ A}$



**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          | $I_{DSS}$     | $V_{DS} = 250\text{ V}$ , $V_{GS} = 0\text{ V}$    | —   | —    | 10        |                  |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$       | 250 | —    | —         | V                |
|                                | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}$ , $V_{GS} = -20\text{ V}$     | 175 | —    | —         |                  |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 0.2\text{ mA}$     | 2.0 | —    | 4.0       |                  |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}$ , $I_D = 2.8\text{ A}$      | —   | 168  | 198       | $\text{m}\Omega$ |

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

| Characteristics                | Symbol    | Test Condition                                                       | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|----------------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 100\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | —   | 460  | 600 | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                                      | —   | 3.0  | 50  |             |
| Output capacitance             | $C_{oss}$ |                                                                      | —   | 45   | —   |             |
| Gate resistance                | $r_g$     | —                                                                    | —   | 4.0  | 6.0 | $\Omega$    |
| Switching time (rise time)     | $t_r$     | See Fig. 6.2.1                                                       | —   | 5.2  | —   | $\text{ns}$ |
| Switching time (turn-on time)  | $t_{on}$  |                                                                      | —   | 14   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                                      | —   | 4.5  | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                                      | —   | 19   | —   |             |

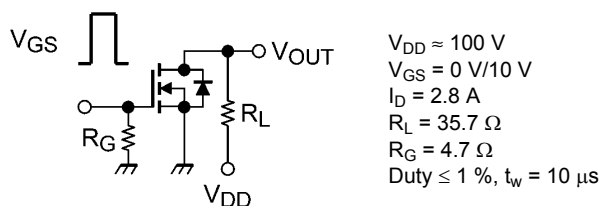


Fig. 6.2.1 Switching Time Test Circuit

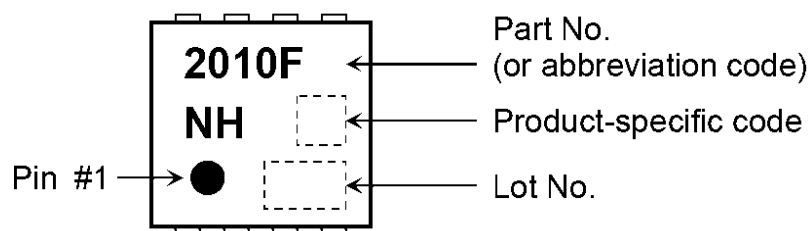
### 6.3. Gate Charge Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics                                 | Symbol    | Test Condition                                                                | Min | Typ. | Max | Unit        |
|-------------------------------------------------|-----------|-------------------------------------------------------------------------------|-----|------|-----|-------------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$     | $V_{DD} \approx 100\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 5.6\text{ A}$ | —   | 7.0  | —   | $\text{nC}$ |
| Gate-source charge 1                            | $Q_{gs1}$ |                                                                               | —   | 2.4  | —   | $\text{nC}$ |
| Gate-drain charge                               | $Q_{gd}$  |                                                                               | —   | 1.5  | —   |             |
| Gate switch charge                              | $Q_{sw}$  |                                                                               | —   | 2.6  | —   |             |

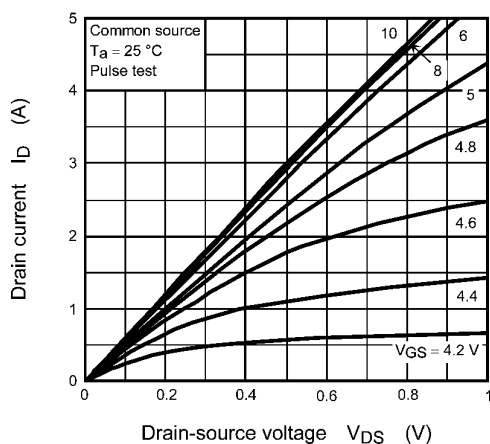
### 6.4. Source-Drain Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics                         | Symbol    | Test Condition                                  | Min | Typ. | Max  | Unit |
|-----------------------------------------|-----------|-------------------------------------------------|-----|------|------|------|
| Reverse drain current (pulsed) (Note 6) | $I_{DRP}$ | —                                               | —   | —    | 19   | A    |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 5.6\text{ A}$ , $V_{GS} = 0\text{ V}$ | —   | —    | -1.2 | V    |

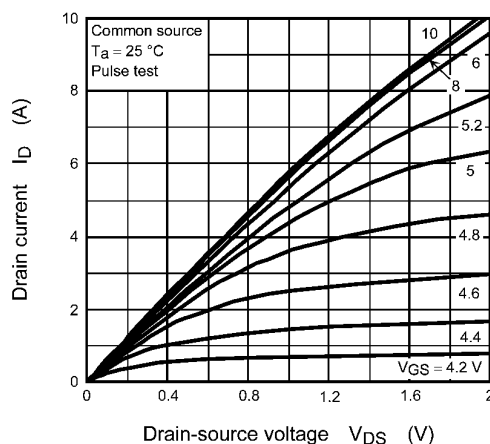
Note 6: Ensure that the channel temperature does not exceed  $150\text{ }^\circ\text{C}$ .

**7. Marking****Fig. 7.1 Marking**

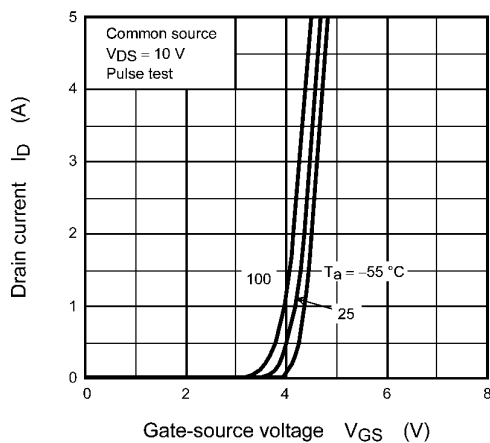
# 8. Characteristics Curves (Note)



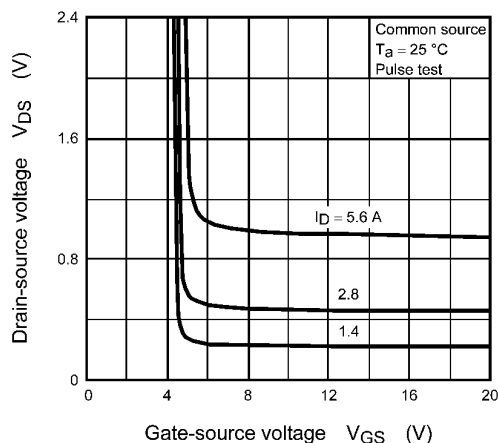
**Fig. 8.1  $I_D - V_{DS}$**



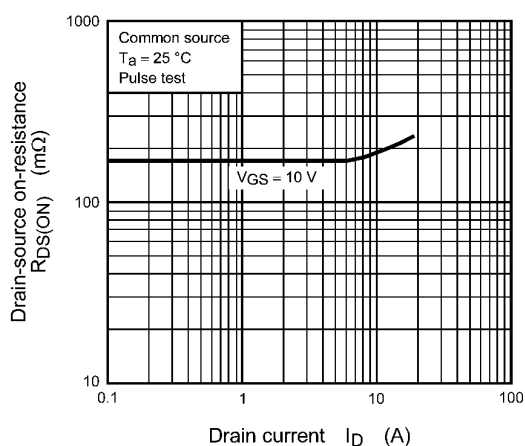
**Fig. 8.2  $I_D - V_{DS}$**



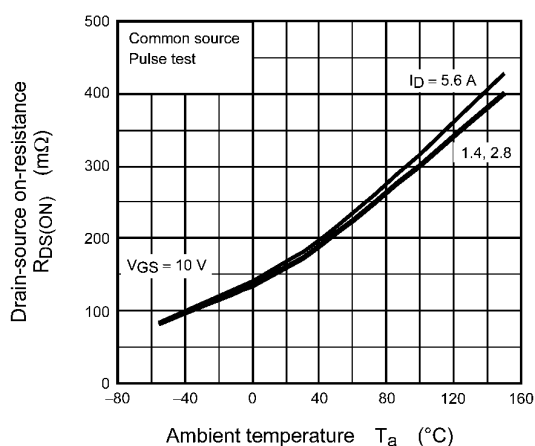
**Fig. 8.3  $I_D - V_{GS}$**



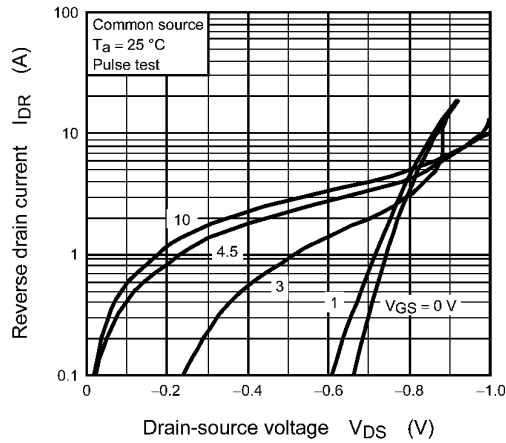
**Fig. 8.4  $V_{DS} - V_{GS}$**



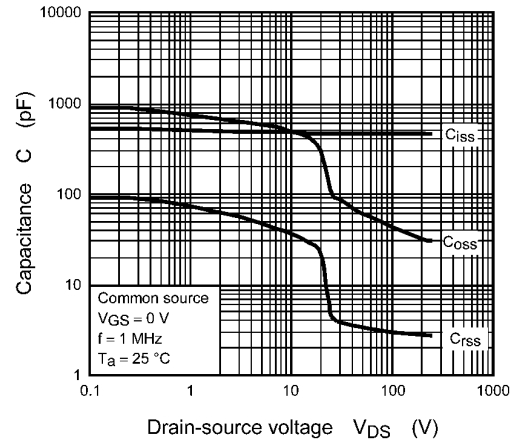
**Fig. 8.5  $R_{DS(ON)} - I_D$**



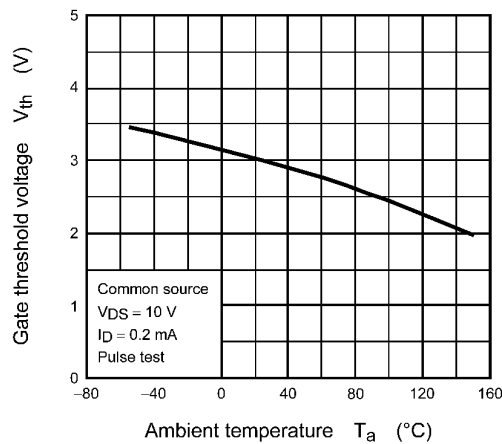
**Fig. 8.6  $R_{DS(ON)} - T_a$**



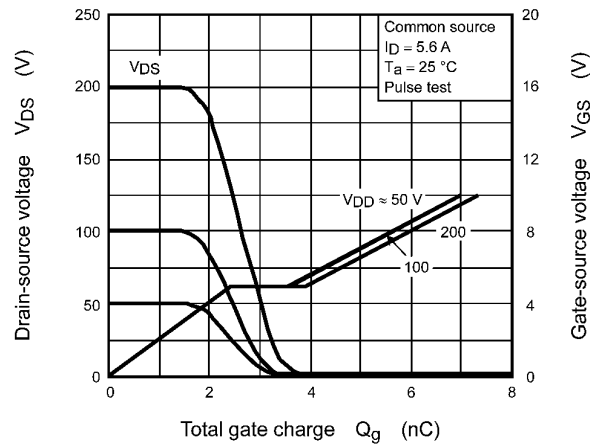
**Fig. 8.7  $I_{DR} - V_{DS}$**



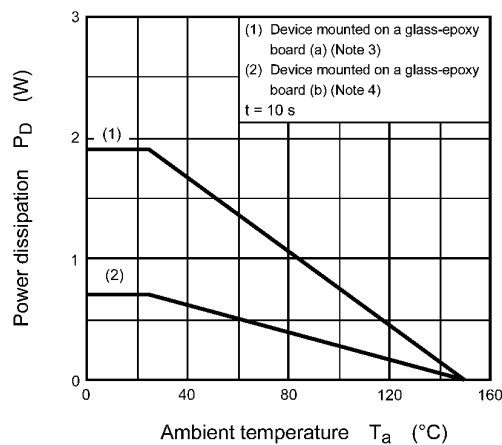
**Fig. 8.8 Capacitance -  $V_{DS}$**



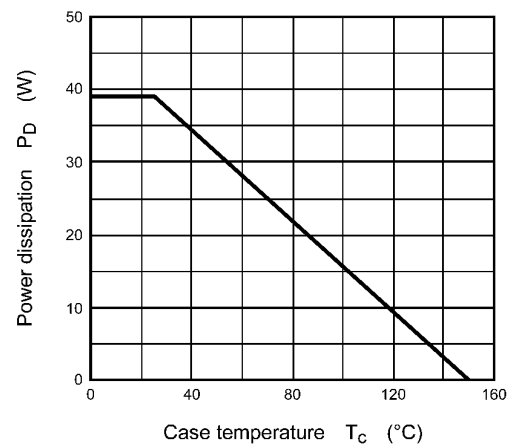
**Fig. 8.9  $V_{th} - T_a$**



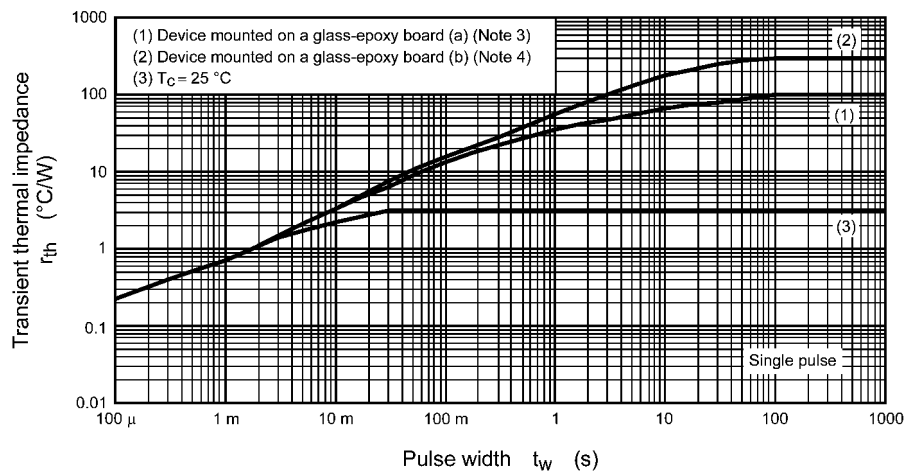
**Fig. 8.10 Dynamic Input/Output Characteristics**



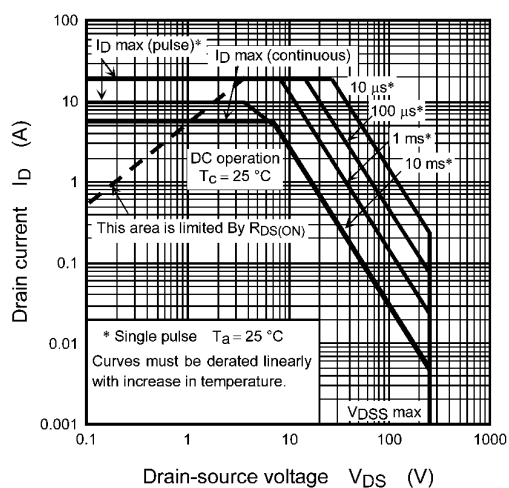
**Fig. 8.11  $P_D - T_a$   
(Guaranteed Maximum)**



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



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

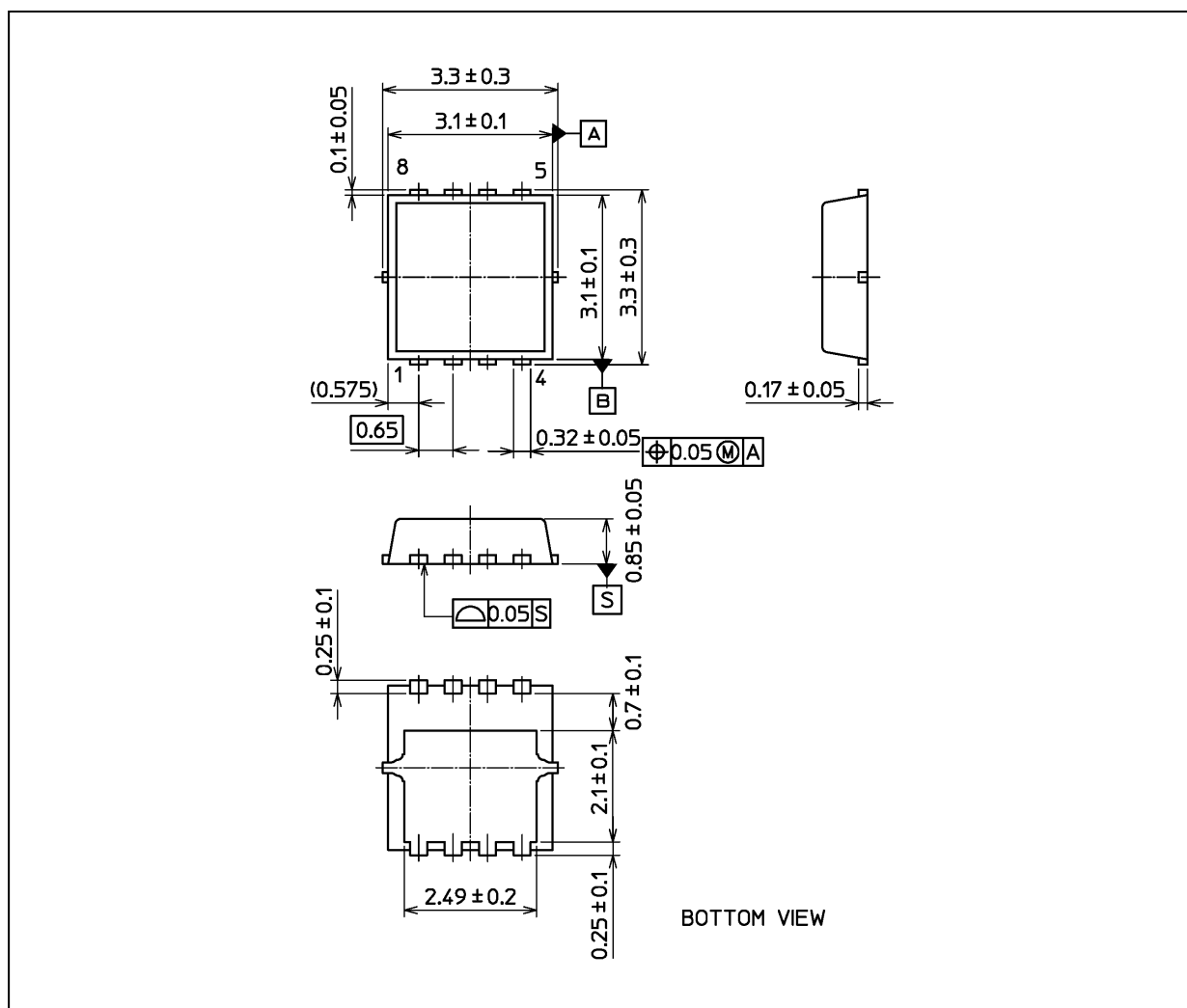


**Fig. 8.14 Safe Operating Area**  
**(Guaranteed Maximum)**

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

## Package Dimensions

Unit: mm



Weight: 0.02 g (typ.)

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

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