

# TPCC8093

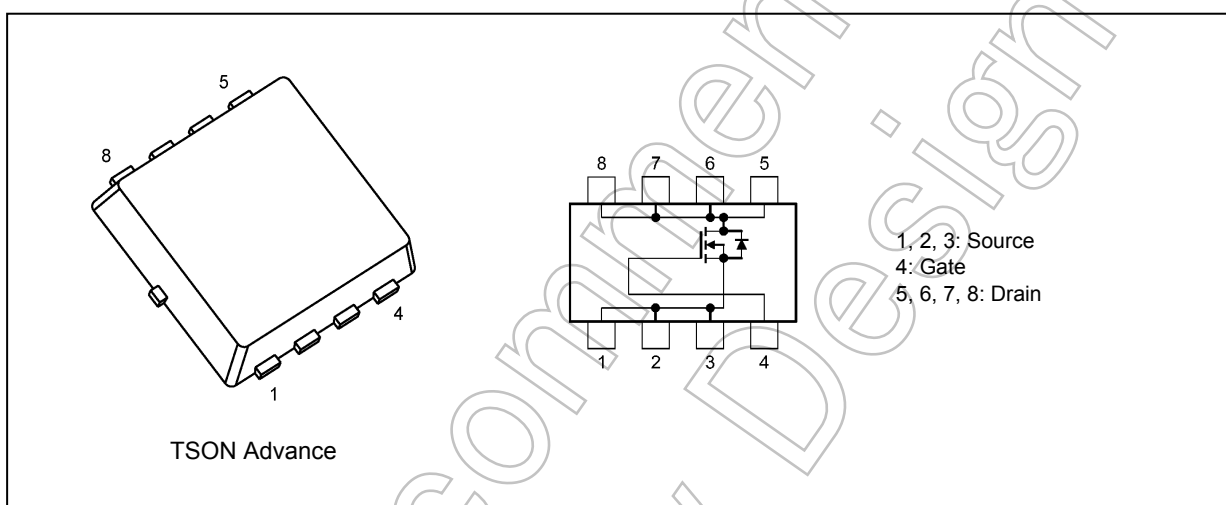
## 1. Applications

- Lithium-Ion Secondary Batteries

## 2. Features

- (1) Small footprint due to a small and thin package
- (2) Low drain-source on-resistance:  $R_{DS(ON)} = 4.5 \text{ m}\Omega$  (typ.) ( $V_{GS} = 4.5 \text{ V}$ )
- (3) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 20 \text{ V}$ )
- (4) Enhancement mode:  $V_{th} = 0.5 \text{ to } 1.2 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.5 \text{ mA}$ )

## 3. Packaging and Internal Circuit



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

| Characteristics               | Symbol    | Rating     | Unit             |
|-------------------------------|-----------|------------|------------------|
| Drain-source voltage          | $V_{DS}$  | 20         | V                |
| Gate-source voltage           | $V_{GS}$  | $\pm 12$   |                  |
| Drain current (DC)            | $I_D$     | 21         | A                |
| Drain current (pulsed)        | $I_{DP}$  | 63         |                  |
| Power dissipation             | $P_D$     | 30         | W                |
| Power dissipation             | $P_D$     | 1.9        | W                |
| Power dissipation             | $P_D$     | 0.7        | W                |
| Single-pulse avalanche energy | $E_{AS}$  | 81         | mJ               |
| Avalanche current             | $I_{AR}$  | 21         | 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

2011-08

## 5. Thermal Characteristics

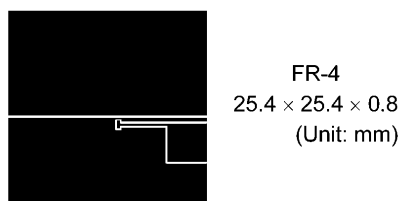
| Characteristics                                                      | Symbol         | Max  | Unit               |
|----------------------------------------------------------------------|----------------|------|--------------------|
| Channel-to-case thermal resistance ( $T_c = 25^\circ\text{C}$ )      | $R_{th(ch-c)}$ | 4.16 | $^\circ\text{C/W}$ |
| Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 2) | $R_{th(ch-a)}$ | 65.7 | $^\circ\text{C/W}$ |
| Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 3) | $R_{th(ch-a)}$ | 178  | $^\circ\text{C/W}$ |

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

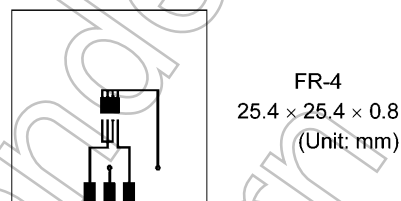
Note 2: Device mounted on a glass-epoxy board (a), Figure 5.1

Note 3: Device mounted on a glass-epoxy board (b), Figure 5.2

Note 4:  $V_{DD} = 16\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 0.141\text{ mH}$ ,  $R_G = 1\ \Omega$ ,  $I_{AR} = 21\text{ A}$



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

| Characteristics                | Symbol        | Test Condition                                  | Min | Typ. | Max       | Unit             |
|--------------------------------|---------------|-------------------------------------------------|-----|------|-----------|------------------|
| Gate leakage current           | $I_{GSS}$     | $V_{GS} = \pm 12\text{ V}, V_{DS} = 0\text{ V}$ | —   | —    | $\pm 0.1$ | $\mu\text{A}$    |
| Drain cut-off current          | $I_{DSS}$     | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$     | —   | —    | 10        |                  |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$       | 20  | —    | —         | V                |
|                                | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}, V_{GS} = -12\text{ V}$     | 8   | —    | —         |                  |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}, I_D = 0.5\text{ mA}$     | 0.5 | —    | 1.2       |                  |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 2.5\text{ V}, I_D = 10.5\text{ A}$    | —   | 6.8  | 9.5       | $\text{m}\Omega$ |
|                                |               | $V_{GS} = 4.5\text{ V}, I_D = 10.5\text{ A}$    | —   | 4.5  | 5.8       |                  |

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

| Characteristics                | Symbol    | Test Condition                                                | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|---------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | —   | 1860 | —   | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                               | —   | 140  | —   |             |
| Output capacitance             | $C_{oss}$ |                                                               | —   | 365  | —   |             |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1.                                             | —   | 4    | —   | ns          |
| Switching time (turn-on time)  | $t_{on}$  |                                                               | —   | 11   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                               | —   | 12   | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                               | —   | 44   | —   |             |

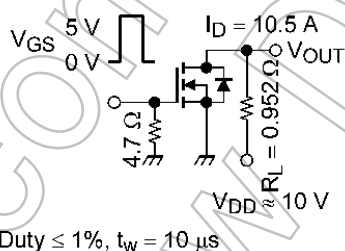


Fig. 6.2.1 Switching Time Test Circuit

### 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) | $Q_g$     | $V_{DD} \approx 16\text{ V}, V_{GS} = 5\text{ V}, I_D = 21\text{ A}$ | —   | 16   | —   | nC   |
| Gate-source charge 1                            | $Q_{gs1}$ |                                                                      | —   | 4    | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |                                                                      | —   | 3.1  | —   |      |

### 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 (pulsed) (Note 5) | $I_{DRP}$ | —                                           | —   | —    | 63   | A    |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 21\text{ A}, V_{GS} = 0\text{ V}$ | —   | —    | -1.2 | V    |

Note 5: Ensure that the channel temperature does not exceed  $150^\circ\text{C}$ .

## 7. Marking

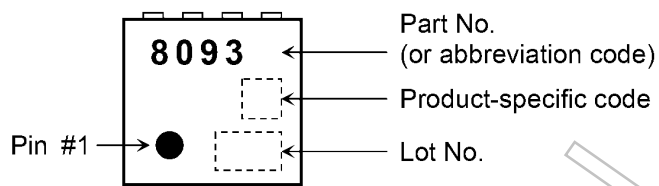
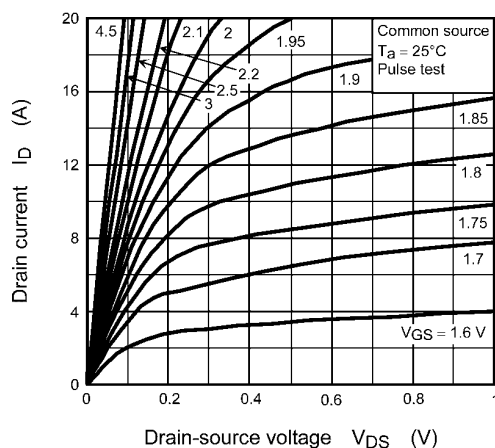


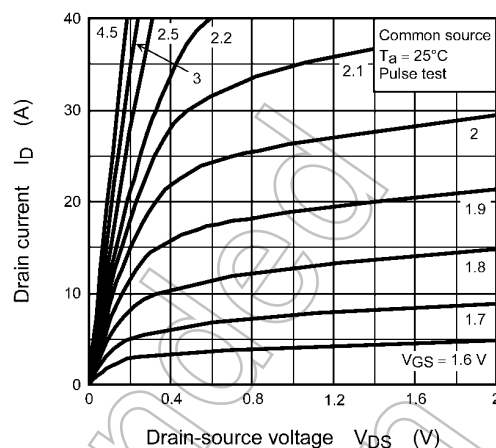
Fig. 7.1 Marking

Not Recommended  
for New Design

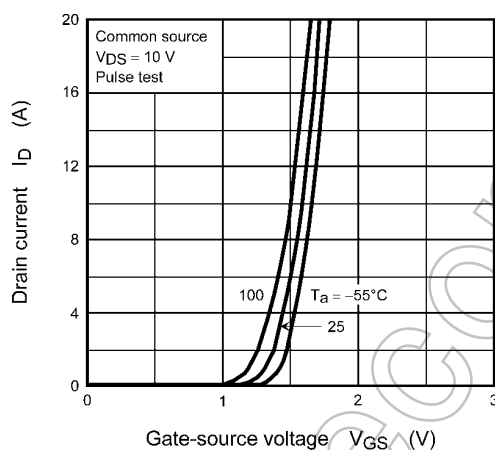
# 8. Characteristics Curves (Note)



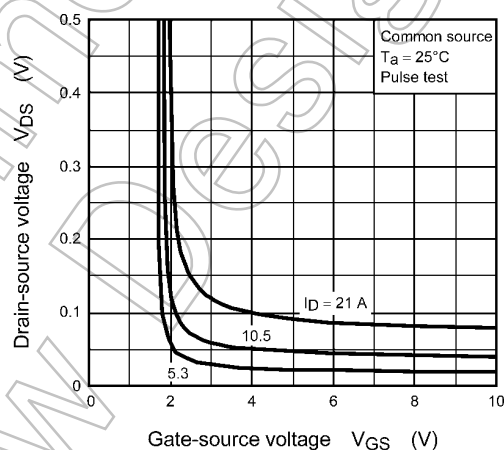
**Fig. 8.1  $I_D - V_{DS}$**



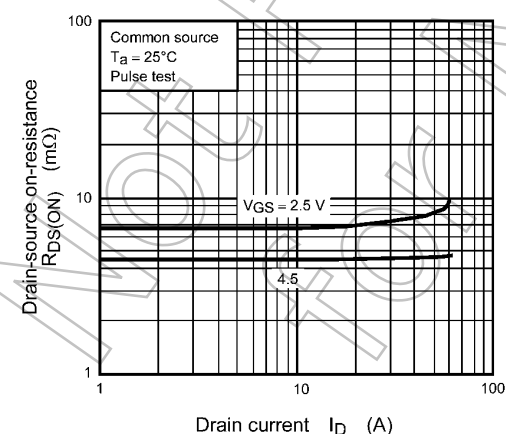
**Fig. 8.2  $I_D - V_{DS}$**



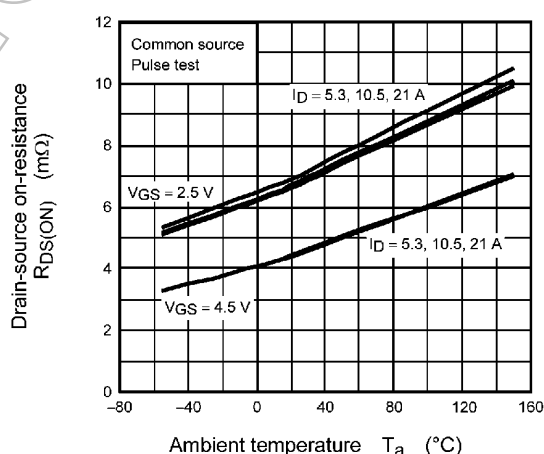
**Fig. 8.3  $I_D - V_{GS}$**



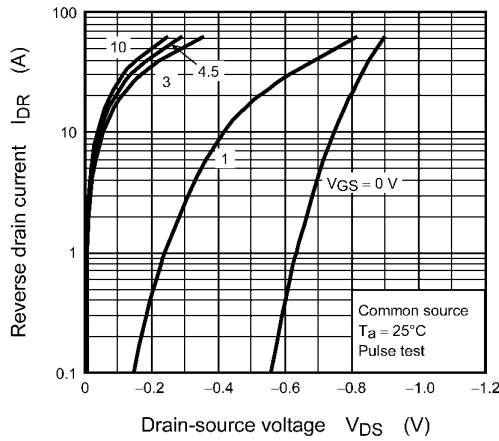
**Fig. 8.4  $V_{DS} - V_{GS}$**



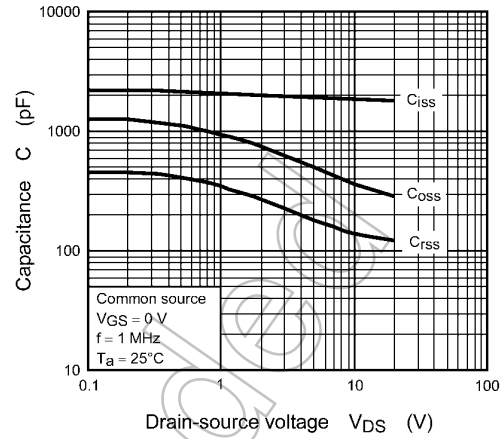
**Fig. 8.5  $R_{DS(ON)} - I_D$**



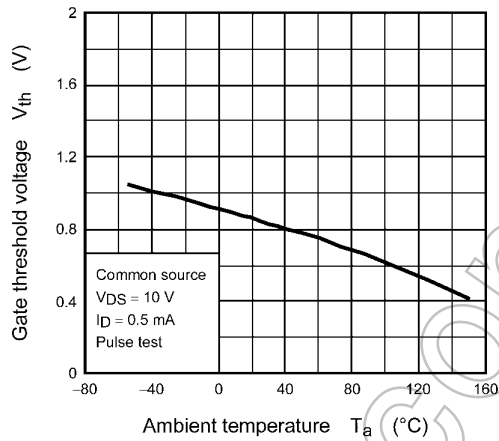
**Fig. 8.6  $R_{DS(ON)} - T_a$**



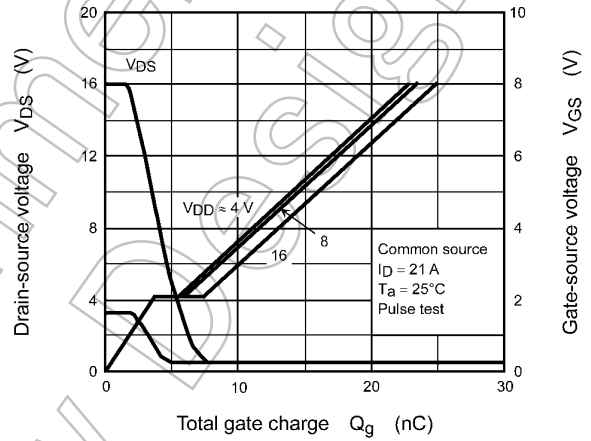
**Fig. 8.7  $I_{DR} - V_{DS}$**



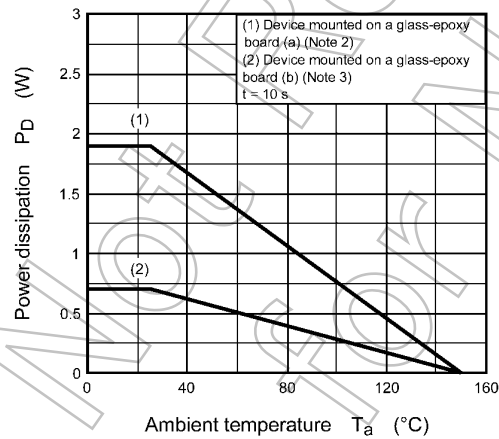
**Fig. 8.8 Capacitance -  $V_{DS}$**



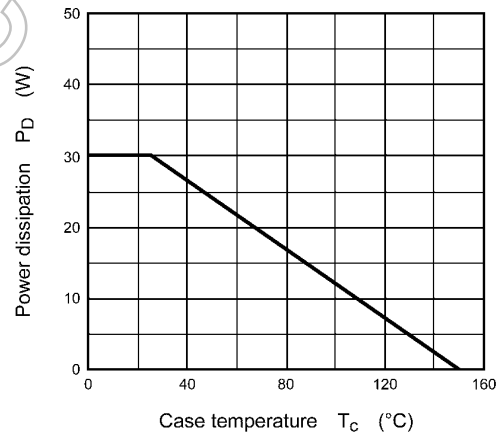
**Fig. 8.9  $V_{th} - T_a$**



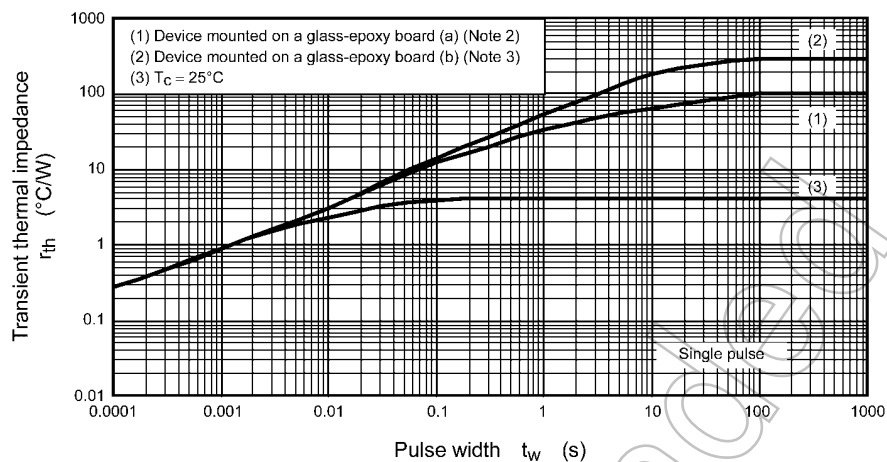
**Fig. 8.10 Dynamic Input/Output Characteristics**



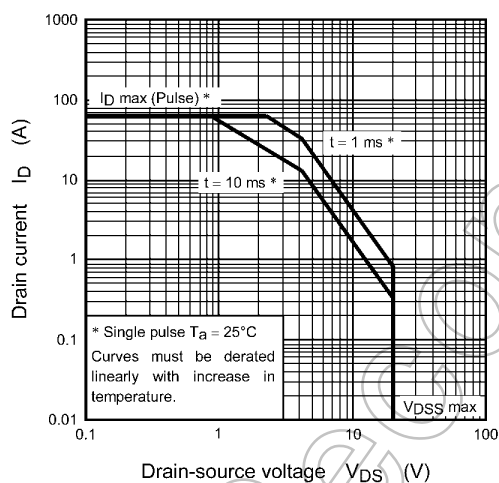
**Fig. 8.11  $P_D - T_a$   
(Guaranteed Maximum)**



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



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

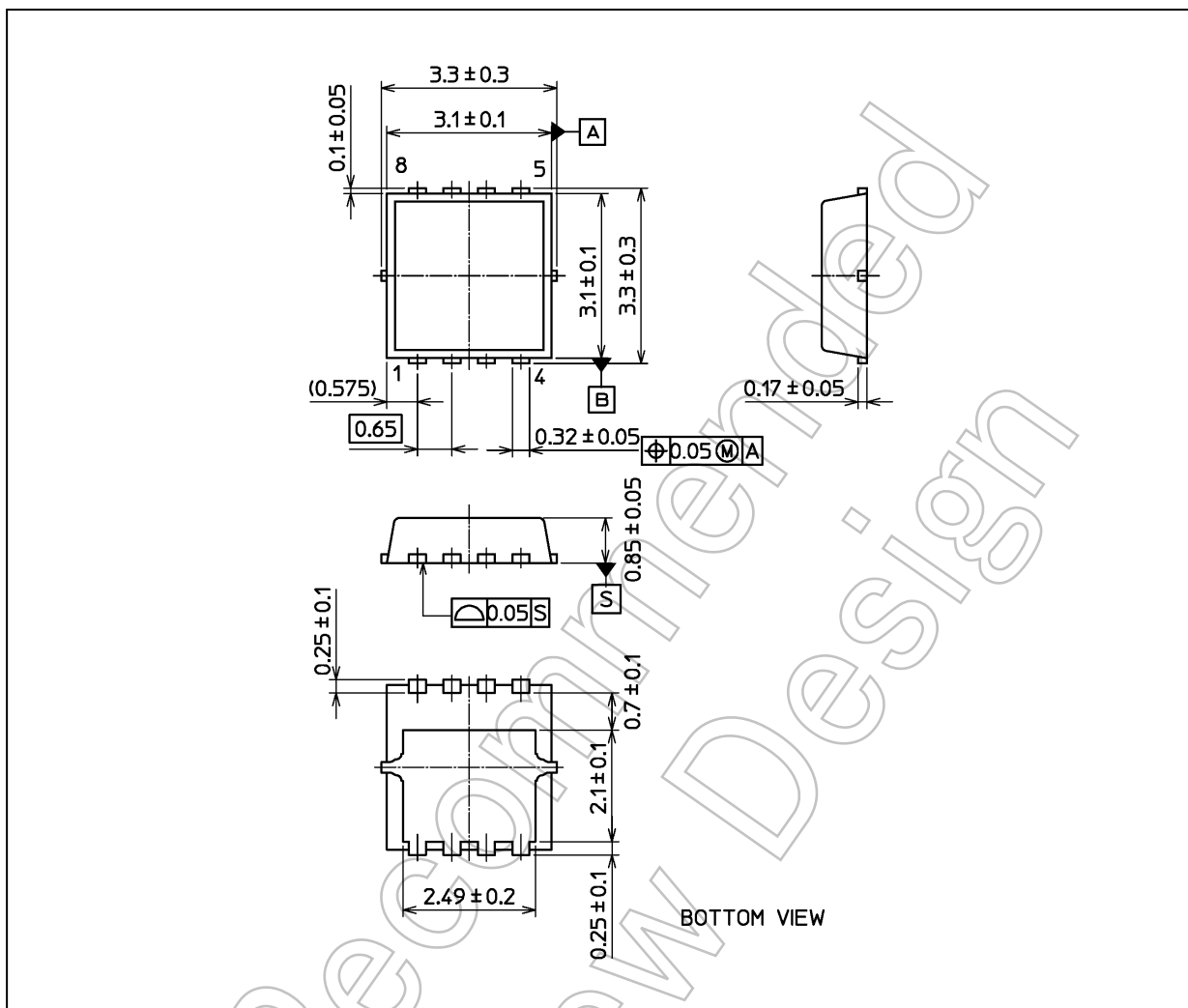


**Fig. 8.14 Safe Operating Area**  
 (Guaranteed Maximum)

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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