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

# TPN4R303NL

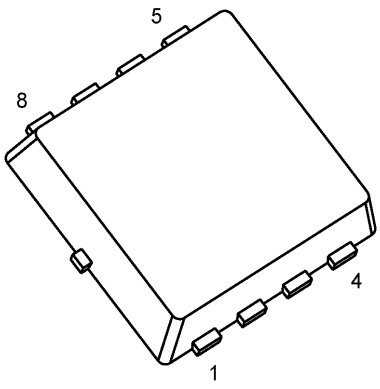
## 1. Applications

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

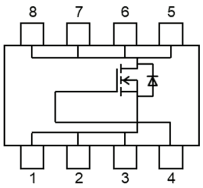
## 2. Features

(1) High-speed switching
(2) Small gate charge: $Q_{SW}$ = 3.9 nC (typ.)
(3) Low drain-source on-resistance: $R_{DS(ON)}$ = 5.1 mΩ (typ.) ($V_{GS}$ = 4.5 V)
(4) Low leakage current: $I_{DSS}$ = 10 μA (max) ($V_{DS}$ = 30 V)
(5) Enhancement mode: $V_{th}$ = 1.3 to 2.3 V ($V_{DS}$ = 10 V, $I_D$ = 0.2 mA)

## 3. Packaging and Internal Circuit




TSON Advance




1, 2, 3: Source
4: Gate
5, 6, 7, 8: Drain

Start of commercial production
2013-08

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## 4. Absolute Maximum Ratings (Note) ($T_a$ = 25 °C unless otherwise specified)

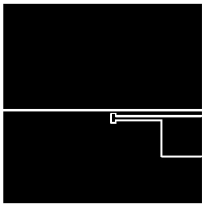
| Characteristics | | | Symbol | Rating | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DSS}$ | 30 | V |
| Gate-source voltage | | | $V_{GSS}$ | ±20 | |
| Drain current (DC) | (Silicon limit) | (Note 1), (Note 2) | $I_D$ | 63 | A |
| Drain current (DC) | ($T_c$ = 25 °C) | (Note 1) | $I_D$ | 40 | |
| Drain current (pulsed) | (t = 1 ms) | (Note 1) | $I_{DP}$ | 154 | |
| Power dissipation | ($T_c$ = 25 °C) | | $P_D$ | 34 | W |
| Power dissipation | (t = 10 s) | (Note 3) | $P_D$ | 1.9 | |
| Power dissipation | (t = 10 s) | (Note 4) | $P_D$ | 0.7 | |
| Single-pulse avalanche energy | | (Note 5) | $E_{AS}$ | 37 | mJ |
| Avalanche current | | | $I_{AR}$ | 40 | A |
| Channel temperature | | | $T_{ch}$ | 150 | °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).

## 5. Thermal Characteristics

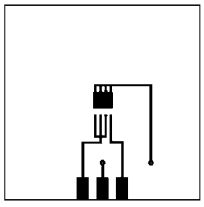
| Characteristics | | | Symbol | Max | Unit |
|---|---|---|---|---|---|
| Channel-to-case thermal resistance | ($T_c$ = 25 °C) | | $R_{th(ch-c)}$ | 3.67 | °C/W |
| Channel-to-ambient thermal resistance | (t = 10 s) | (Note 3) | $R_{th(ch-a)}$ | 65.7 | |
| Channel-to-ambient thermal resistance | (t = 10 s) | (Note 4) | $R_{th(ch-a)}$ | 178 | |

Note 1: Ensure that the channel temperature does not exceed 150 °C.
Note 2: Limited by silicon chip capability. Package limit is 45 A.
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 V, $T_{ch}$ = 25 °C (initial), L = 18 μH, $I_{AR}$ = 40 A



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

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



FR-4
25.4 × 25.4 × 0.8
(Unit: mm)

**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.

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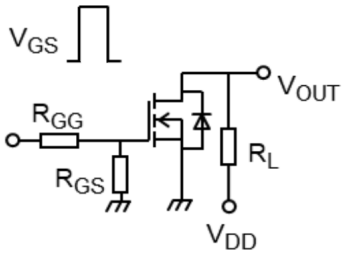
# 6. Electrical Characteristics

## 6.1. Static Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Gate leakage current | $I_{GSS}$ | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | — | — | ±0.1 | μA |
| Drain cut-off current | $I_{DSS}$ | $V_{DS}$ = 30 V, $V_{GS}$ = 0 V | — | — | 10 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 30 | — | — | V |
| | $V_{(BR)DSX}$ | $I_D$ = 10 mA, $V_{GS}$ = -20 V | 15 | — | — | |
| Gate threshold voltage | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 0.2 mA | 1.3 | — | 2.3 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS}$ = 4.5 V, $I_D$ = 9.5 A | — | 5.1 | 6.3 | mΩ |
| | | $V_{GS}$ = 10 V, $I_D$ = 20 A | — | 3.6 | 4.3 | |

## 6.2. Dynamic Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 15 V, $V_{GS}$ = 0 V, f = 1 MHz | — | 1110 | 1400 | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 39 | 88 | |
| Output capacitance | $C_{oss}$ | | — | 640 | — | |
| Gate resistance | $r_g$ | — | — | 1.2 | 1.8 | Ω |
| Switching time (rise time) | $t_r$ | See Fig. 6.2.1 | — | 4.5 | — | ns |
| Switching time (turn-on time) | $t_{on}$ | | — | 10.5 | — | |
| Switching time (fall time) | $t_f$ | | — | 3.5 | — | |
| Switching time (turn-off time) | $t_{off}$ | | — | 19 | — | |




$V_{DD}$ ≈ 15 V
$V_{GS}$ = 0 V/ 10 V
$I_D$ = 20 A
$R_L$ = 0.75 Ω
$R_{GG}$ = 4.7 Ω
$R_{GS}$ = 4.7 Ω
Duty ≤ 1 %, $t_w$ = 10 μs

**Fig. 6.2.1 Switching Time Test Circuit**

## 6.3. Gate Charge Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge (gate-source plus gate-drain) | $Q_g$ | $V_{DD}$ ≈ 15 V, $V_{GS}$ = 10 V, $I_D$ = 40 A | — | 14.8 | — | nC |
| | | $V_{DD}$ ≈ 15 V, $V_{GS}$ = 4.5 V, $I_D$ = 40 A | — | 6.8 | — | |
| Gate-source charge 1 | $Q_{gs1}$ | $V_{DD}$ ≈ 15 V, $V_{GS}$ = 10 V, $I_D$ = 40 A | — | 3.7 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 1.9 | — | |
| Gate switch charge | $Q_{SW}$ | | — | 3.9 | — | |

## 6.4. Source-Drain Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Reverse drain current (pulsed) (Note 6) | $I_{DRP}$ | — | — | — | 154 | A |
| Diode forward voltage | $V_{DSF}$ | $I_{DR}$ = 40 A, $V_{GS}$ = 0 V | — | — | -1.2 | V |

Note 6: Ensure that the channel temperature does not exceed 150 °C.

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## 7. Marking

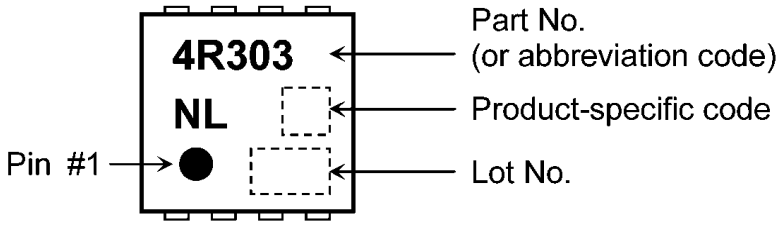


Fig. 7.1 Marking

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## 8. Characteristics Curves (Note)

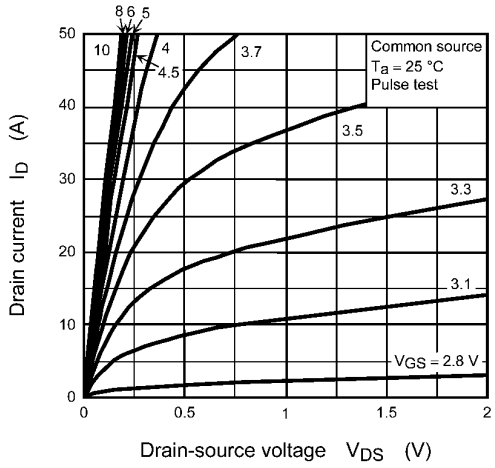


Fig. 8.1 $I_D$ - $V_{DS}$

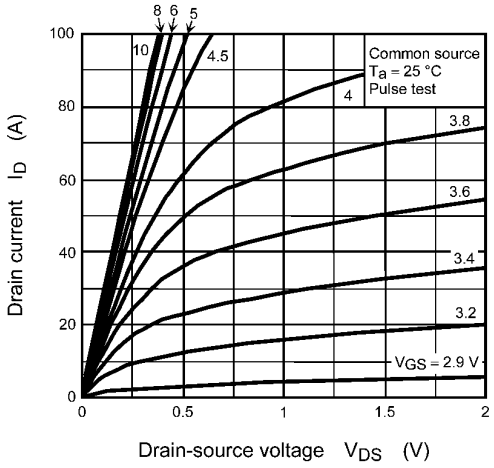


Fig. 8.2 $I_D$ - $V_{DS}$

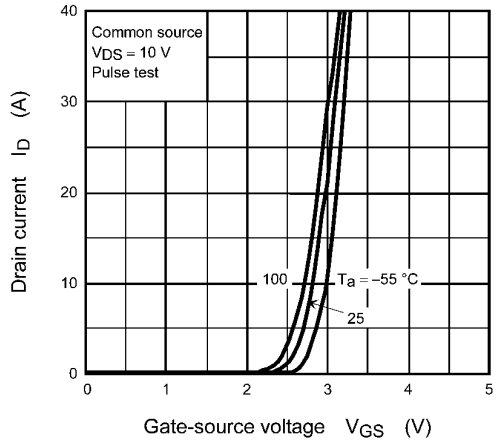


Fig. 8.3 $I_D$ - $V_{GS}$

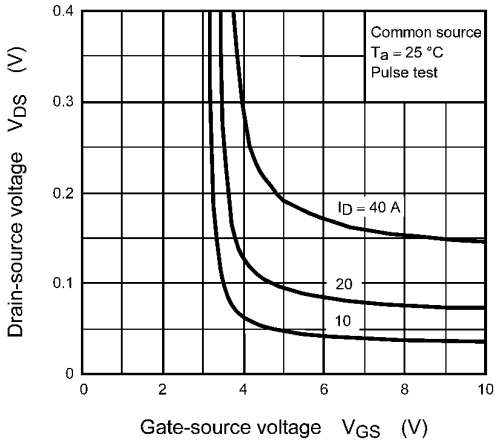


Fig. 8.4 $V_{DS}$ - $V_{GS}$

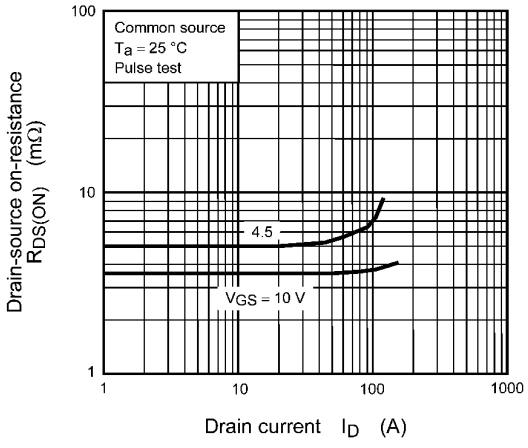


Fig. 8.5 $R_{DS(ON)}$ - $I_D$

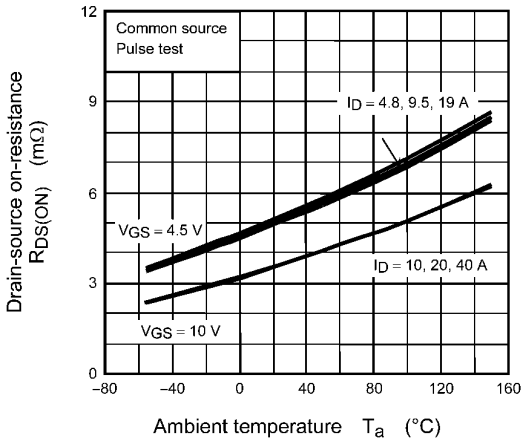


Fig. 8.6 $R_{DS(ON)}$ - $T_a$

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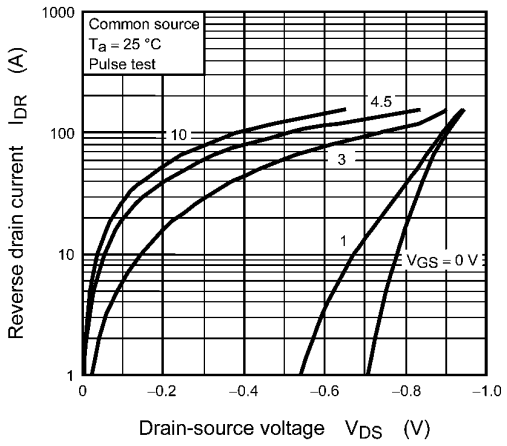



Fig. 8.7 $I_{DR}$ - $V_{DS}$

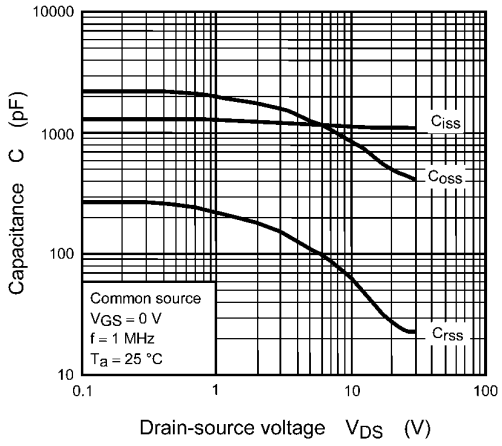



Fig. 8.8 Capacitance - $V_{DS}$

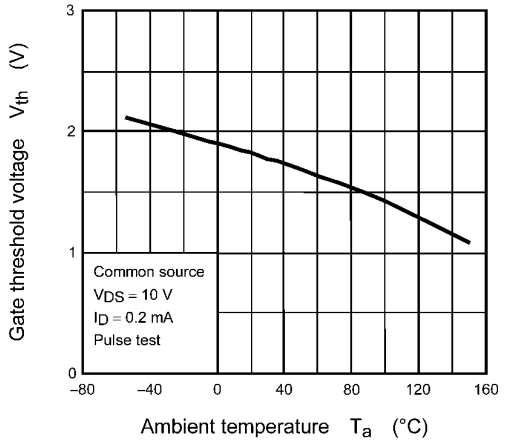



Fig. 8.9 $V_{th}$ - $T_a$

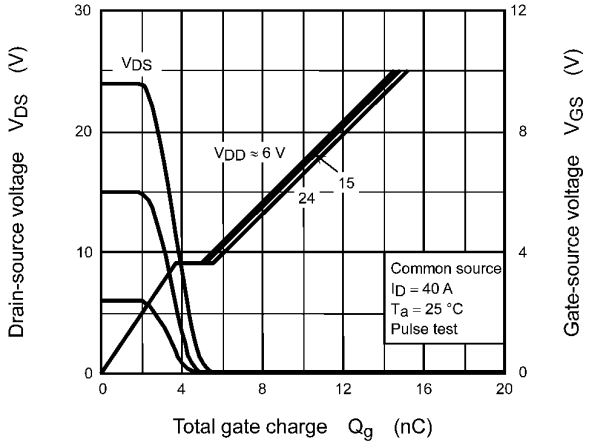



Fig. 8.10 Dynamic Input/Output Characteristics

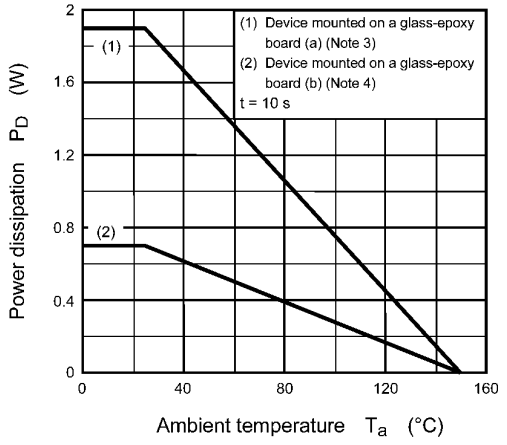



Fig. 8.11 $P_D$ - $T_a$
(Guaranteed Maximum)

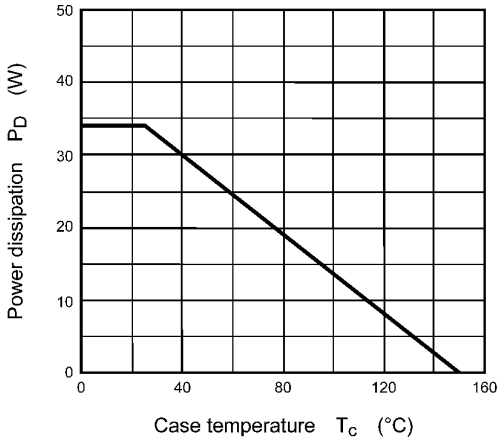



Fig. 8.12 $P_D$ - $T_c$
(Guaranteed Maximum)

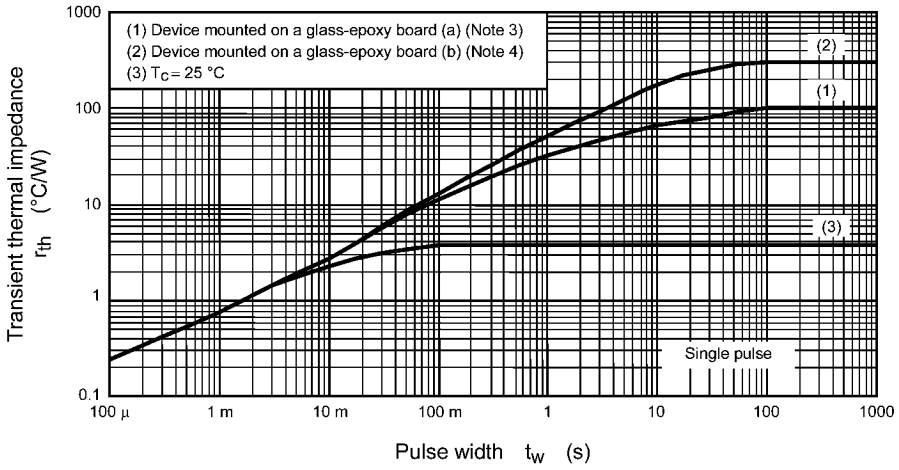



**Fig. 8.13 $r_{th}$ - $t_w$**
**(Guaranteed Maximum)**

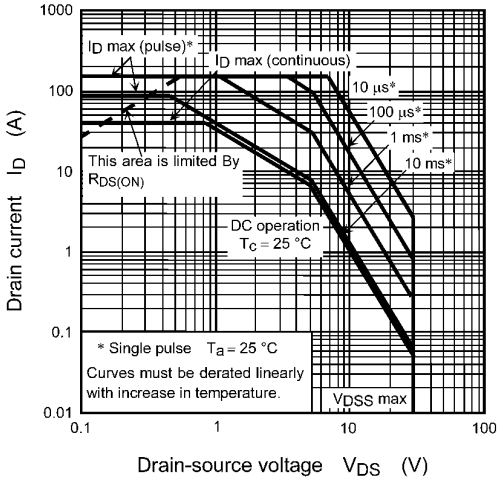
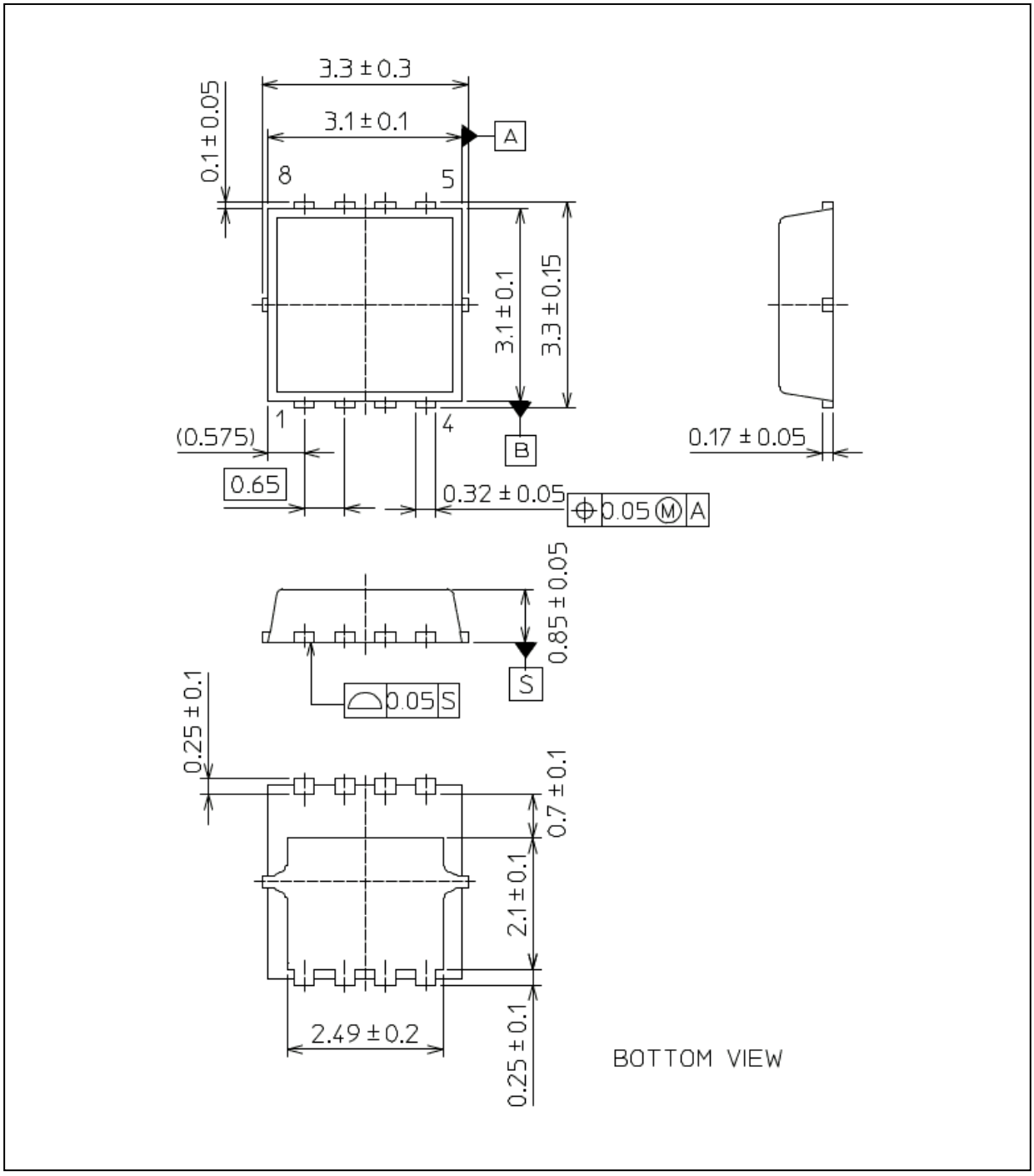



**Fig. 8.14 Safe Operating Area**
**(Guaranteed Maximum)**

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

## Package Dimensions

Unit: mm




Weight: 0.026 g (typ.)

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

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