

# TPN4R712MD

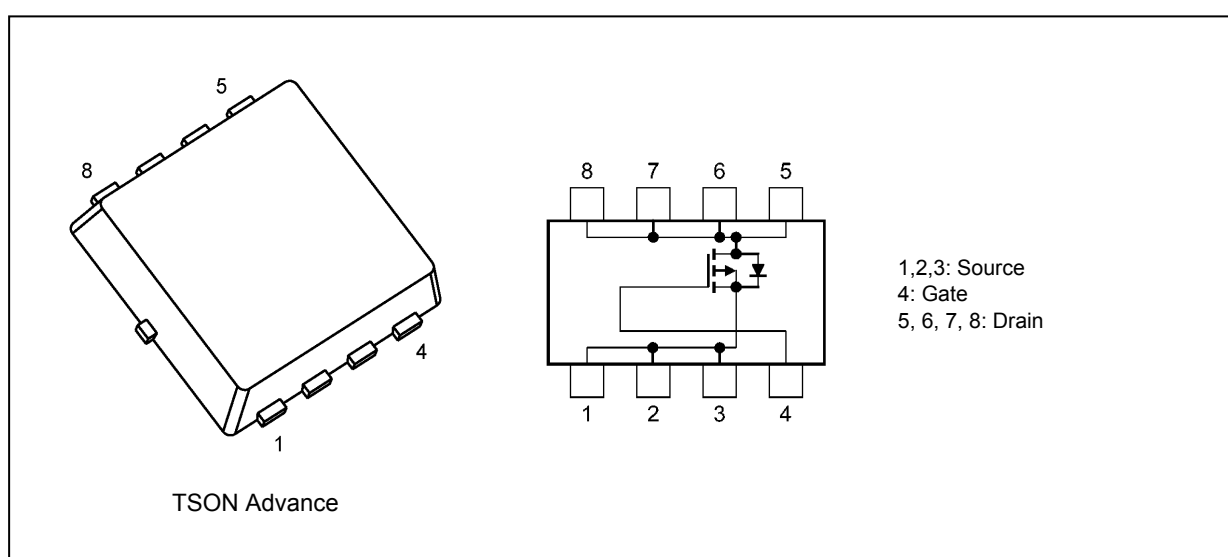
## 1. Applications

- Lithium-Ion Secondary Batteries
- Power Management Switches

## 2. Features

- (1) Low drain-source on-resistance:  $R_{DS(ON)} = 3.8 \text{ m}\Omega$  (typ.) ( $V_{GS} = -4.5 \text{ V}$ )
- (2) Low leakage current:  $I_{DSS} = -10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = -20 \text{ V}$ )
- (3) Enhancement mode:  $V_{th} = -0.5 \text{ to } -1.2 \text{ V}$  ( $V_{DS} = -10 \text{ V}$ ,  $I_D = -1.0 \text{ mA}$ )

## 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	$V_{DS}$	-20	V
Gate-source voltage	$V_{GS}$	$\pm 12$	
Drain current (DC) ( $T_c = 25\text{ }^{\circ}\text{C}$ ) (Note 1)	$I_D$	-36	A
Drain current (pulsed) ( $t = 1\text{ ms}$ ) (Note 1)	$I_{DP}$	-180	
Power dissipation ( $T_c = 25\text{ }^{\circ}\text{C}$ )	$P_D$	42	W
Power dissipation ( $t = 10\text{ s}$ ) (Note 2)		1.9	
Power dissipation ( $t = 10\text{ s}$ ) (Note 3)		0.7	
Single-pulse avalanche energy (Note 4)	$E_{AS}$	320	mJ
Single-pulse avalanche current	$I_{AS}$	-36	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.).

#### 5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance ( $T_c = 25\text{ }^{\circ}\text{C}$ )	$R_{th(ch-c)}$	2.97	$^{\circ}\text{C/W}$
Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 2)	$R_{th(ch-a)}$	65.7	
Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 3)	$R_{th(ch-a)}$	178	

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

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:  $V_{DD} = -16\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 190\text{ }\mu\text{H}$ ,  $I_{AS} = -36\text{ A}$

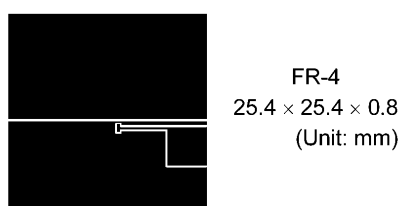


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

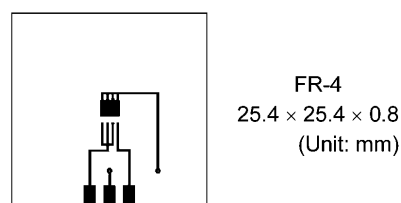


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

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	$I_{GSS}$	$V_{GS} = \pm 12\text{ V}$ , $V_{DS} = 0\text{ V}$	—	—	$\pm 0.1$	$\mu\text{A}$
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
Drain-source breakdown voltage (Note 5)	$V_{(BR)DSX}$	$I_D = -10\text{ mA}$ , $V_{GS} = 8.0\text{ V}$	-12	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = -10\text{ V}$ , $I_D = -1.0\text{ mA}$	-0.5	—	-1.2	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = -2.5\text{ V}$ , $I_D = -16\text{ A}$	—	6.0	8.1	$\text{m}\Omega$
		$V_{GS} = -4.5\text{ V}$ , $I_D = -18\text{ A}$	—	3.8	4.7	

Note 5: 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	$C_{iss}$	$V_{DS} = -10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	4300	—	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	640	—	
Output capacitance	$C_{oss}$		—	700	—	
Switching time (rise time)	$t_r$	See Fig. 6.2.1.	—	11	—	$\text{ns}$
Switching time (turn-on time)	$t_{on}$		—	18	—	
Switching time (fall time)	$t_f$		—	145	—	
Switching time (turn-off time)	$t_{off}$		—	443	—	

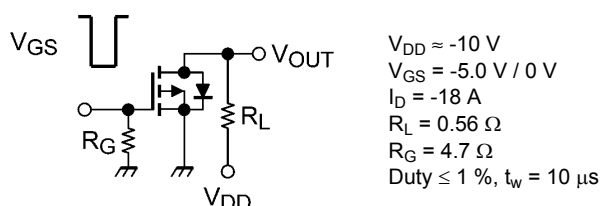


Fig. 6.2.1 Switching Time Test Circuit

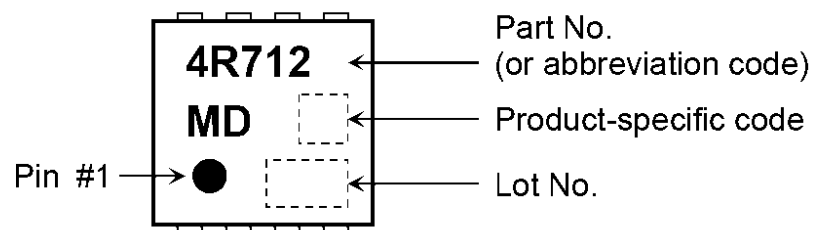
### 6.3. Gate Charge Characteristics ( $T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx -16\text{ V}$ , $V_{GS} = -5.0\text{ V}$ , $I_D = -36\text{ A}$	—	65	—	$\text{nC}$
Gate-source charge 1	$Q_{gs1}$		—	7.5	—	
Gate-drain charge	$Q_{gd}$		—	20	—	

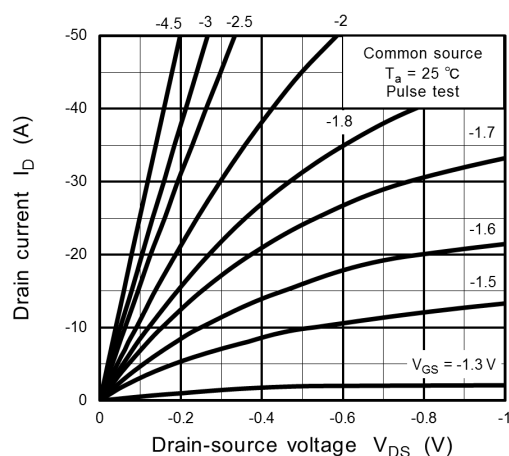
### 6.4. Source-Drain Characteristics ( $T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (Note6)	$I_{DRP}$	—	—	—	-180	A
Diode forward voltage	$V_{DSF}$	$I_{DR} = -36\text{ A}$ , $V_{GS} = 0\text{ V}$	—	—	1.2	V

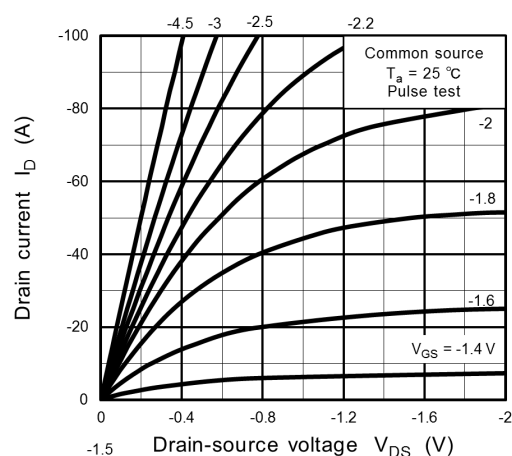
Note6: Ensure that the channel temperature does not exceed  $150\text{ }^{\circ}\text{C}$ .

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

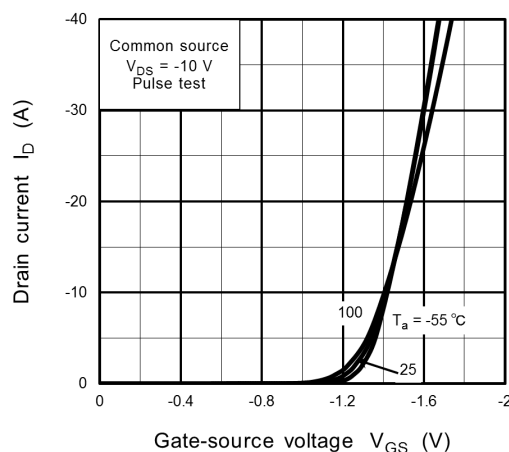
# 8. Characteristics Curves (Note)



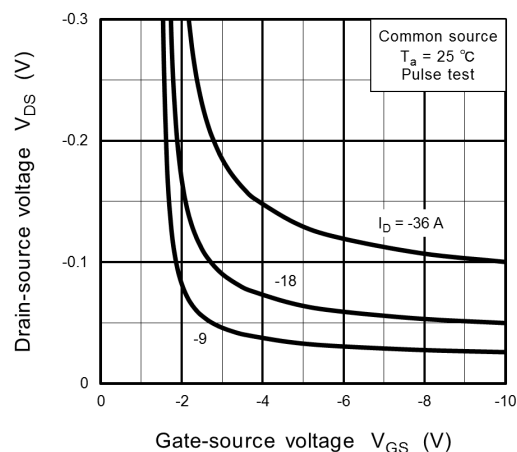
**Fig. 8.1  $I_D - V_{DS}$**



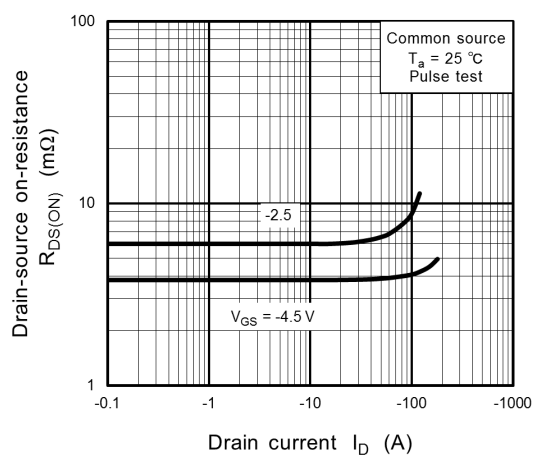
**Fig. 8.2  $I_D - V_{DS}$**



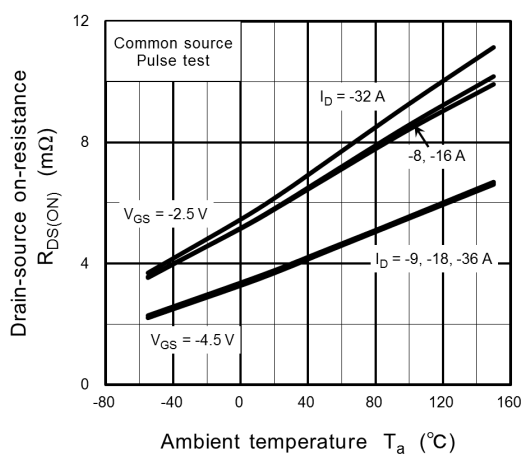
**Fig. 8.3  $I_D - V_{GS}$**



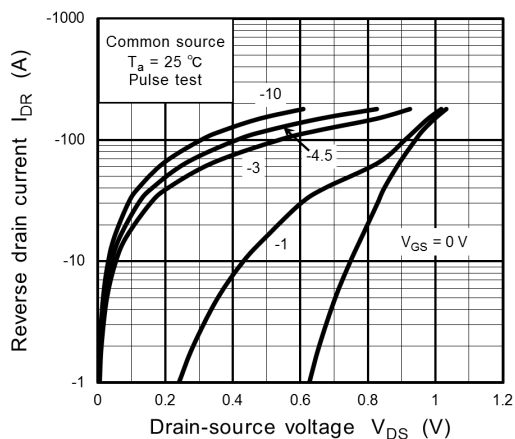
**Fig. 8.4  $V_{DS} - V_{GS}$**



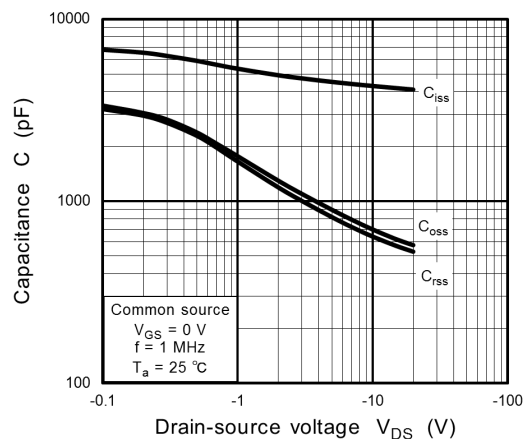
**Fig. 8.5  $R_{DS(ON)} - I_D$**



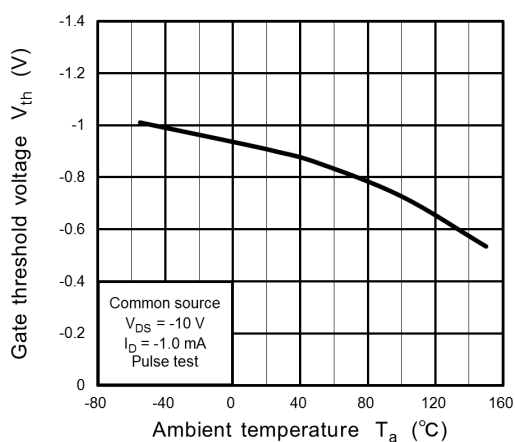
**Fig. 8.6  $R_{DS(ON)} - T_a$**



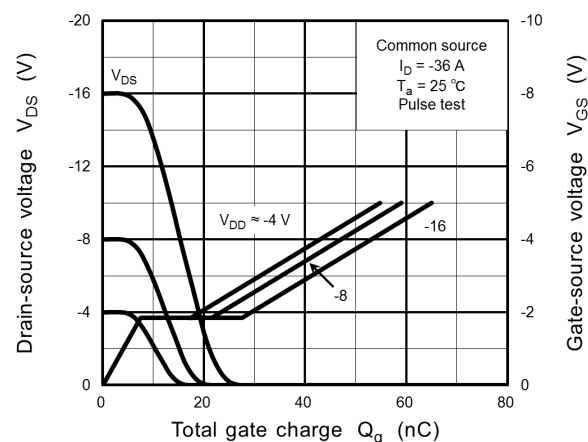
**Fig. 8.7  $I_{DR} - V_{DS}$**



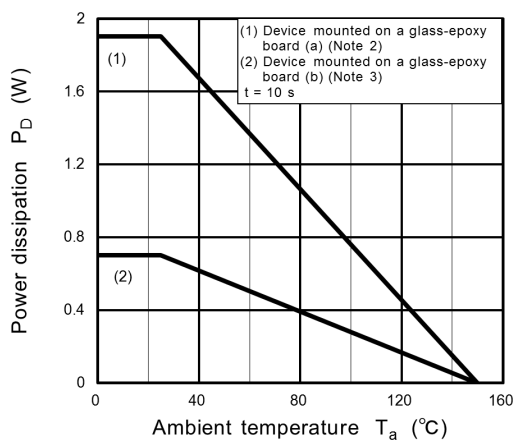
**Fig. 8.8 Capacitance -  $V_{DS}$**



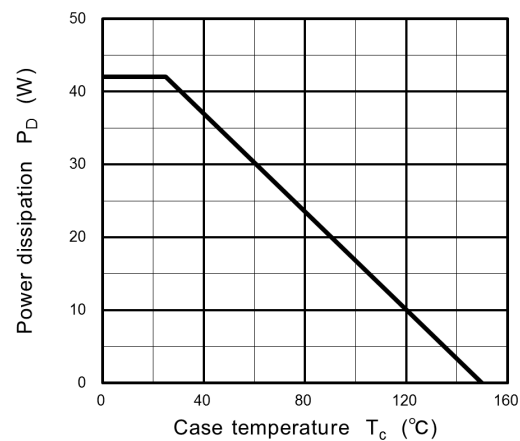
**Fig. 8.9  $V_{th} - T_a$**



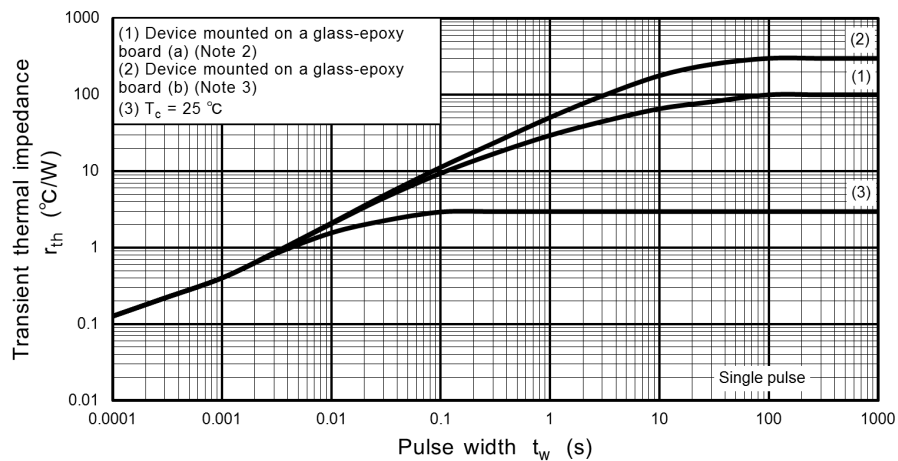
**Fig. 8.10 Dynamic Input/Output Characteristics**



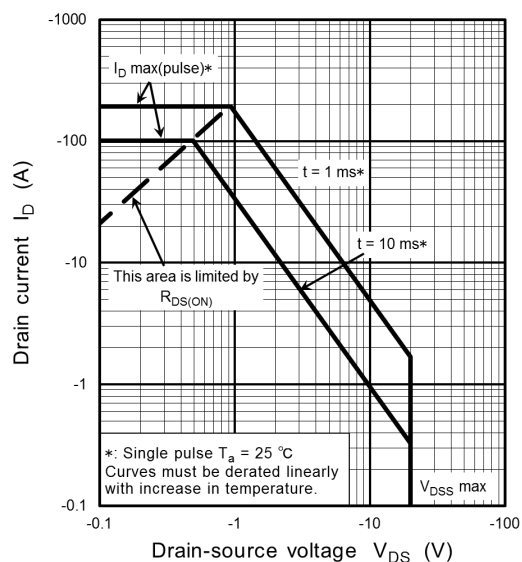
**Fig. 8.11  $P_D - T_a$   
(Guaranteed Maximum)**



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



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

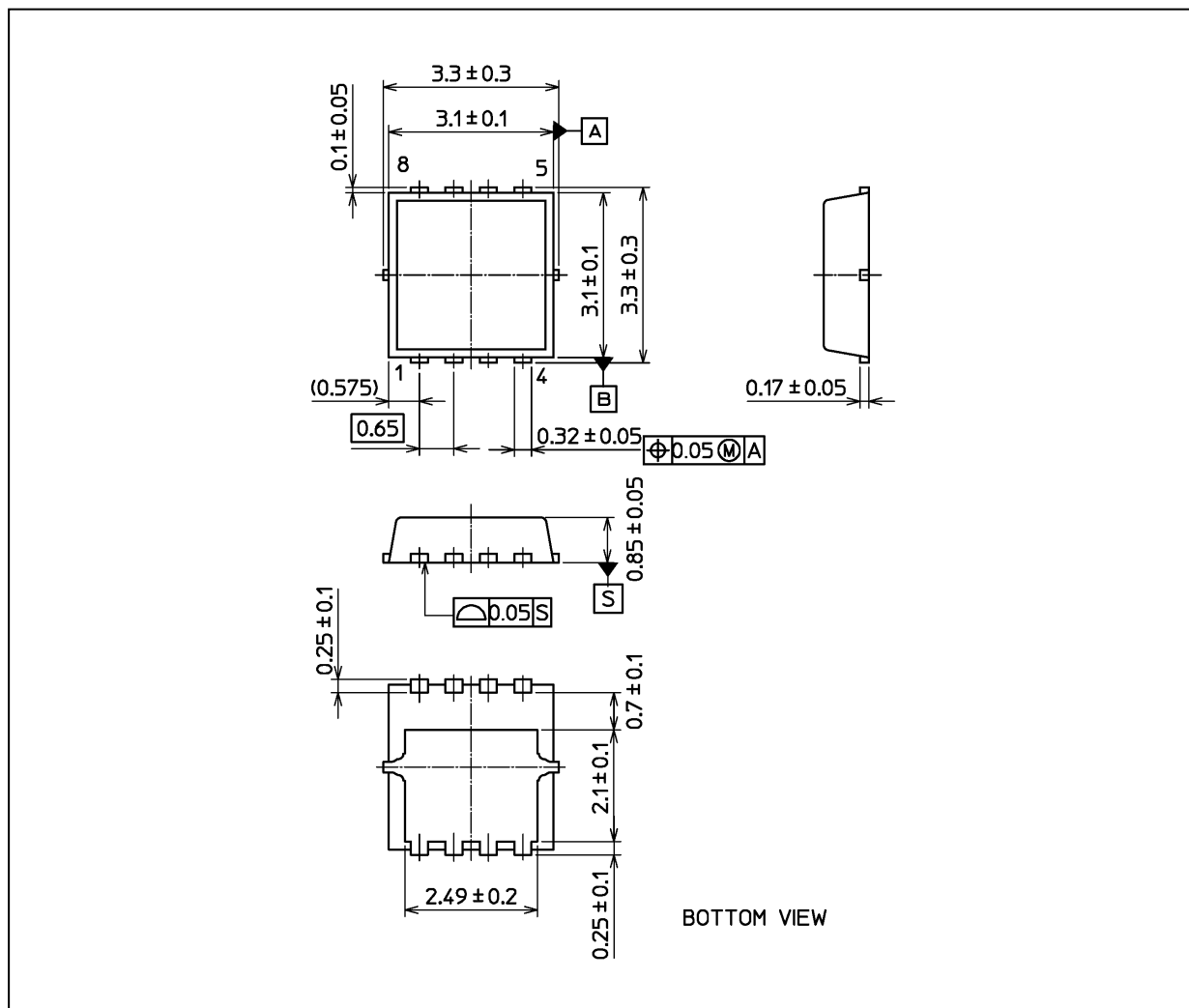


**Fig. 8.14 Safe Operating Area**  
**(Guaranteed Maximum)**

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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