

# TPC8228-H

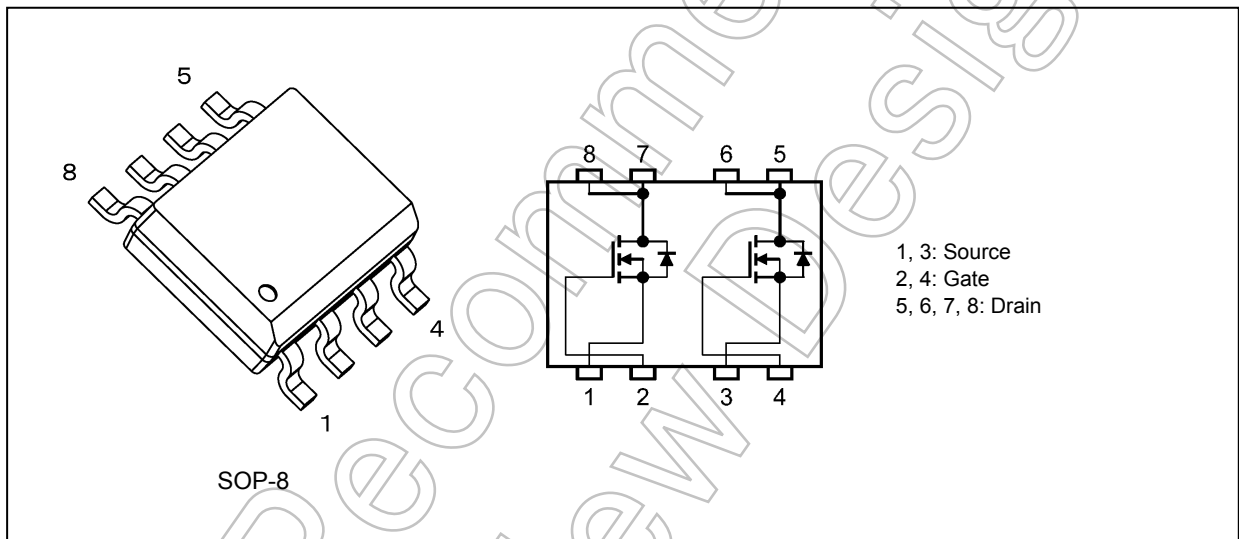
## 1. Applications

- DC-DC Converters
- CCFL Inverters

## 2. Features

- (1) Small, thin package
- (2) High-speed switching
- (3) Small gate charge:  $Q_{SW} = 2.6 \text{ nC}$  (typ.)
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 38 \text{ m}\Omega$  (typ.)
- (5) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 60 \text{ V}$ )
- (6) Enhancement mode:  $V_{th} = 1.3 \text{ to } 2.3 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.1 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2012-05

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	60	V
Gate-source voltage	$V_{GSS}$	$\pm 20$	
Drain current (DC) (Note 1)	$I_D$	3.8	A
Drain current (pulsed) (Note 1)	$I_{DP}$	15.2	
Power dissipation (single operation) ( $t = 10$ s) (Note 2), (Note 4)	$P_{D(1)}$	1.5	W
Power dissipation (per device for dual operation) ( $t = 10$ s) (Note 2), (Note 5)	$P_{D(2)}$	1.1	
Power dissipation (single operation) ( $t = 10$ s) (Note 3), (Note 4)	$P_{D(1)}$	0.75	
Power dissipation (per device for dual operation) ( $t = 10$ s) (Note 3), (Note 5)	$P_{D(2)}$	0.45	
Single-pulse avalanche energy (Note 6)	$E_{AS}$	10	mJ
Avalanche current	$I_{AR}$	3.8	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-ambient thermal resistance (single operation) ( $t = 10$ s) (Note 2), (Note 4)	$R_{th(ch-a)(1)}$	83.3	$^\circ\text{C}/\text{W}$
Channel-to-ambient thermal resistance (per device for dual operation) ( $t = 10$ s) (Note 2), (Note 5)	$R_{th(ch-a)(2)}$	113	
Channel-to-ambient thermal resistance (single operation) ( $t = 10$ s) (Note 3), (Note 4)	$R_{th(ch-a)(1)}$	166	
Channel-to-ambient thermal resistance (per device for dual operation) ( $t = 10$ s) (Note 3), (Note 5)	$R_{th(ch-a)(2)}$	277	

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

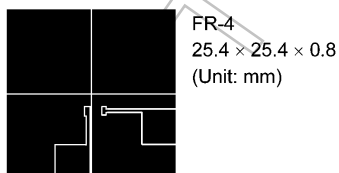
Note 2: Device mounted on a glass-epoxy board (a), Figure 5.1

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

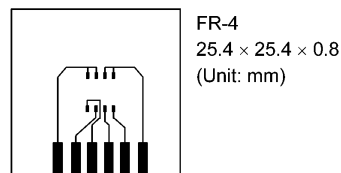
Note 4: Power dissipation and thermal resistance values per device with the other device being off (During single operation, power is supplied to only one of the two devices.)

Note 5: Power dissipation and thermal resistance values per device for dual operation (During dual operation, power is evenly supplied to both devices.)

Note 6:  $V_{DD} = 24$  V,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 1.0$  mH,  $I_{AR} = 3.8$  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**

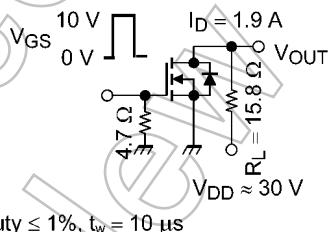
**6.1. Static Characteristics ( $T_a = 25^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 0.1$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	60	—	—	V
Drain-source breakdown voltage (Note 7)	$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	43	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 0.1\text{ mA}$	1.3	—	2.3	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}, I_D = 1.9\text{ A}$	—	43	64	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}, I_D = 1.9\text{ A}$	—	38	57	

Note 7: 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 ( $T_a = 25^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	640	—	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	25	—	
Output capacitance	$C_{oss}$		—	90	—	
Gate resistance	$r_g$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 5\text{ MHz}$	—	3.2	4.6	$\Omega$
Switching time (rise time)	$t_r$	See Figure 6.2.1.	—	1.8	—	ns
Switching time (turn-on time)	$t_{on}$		—	6.7	—	
Switching time (fall time)	$t_f$		—	1.8	—	
Switching time (turn-off time)	$t_{off}$		—	18	—	



**Fig. 6.2.1 Switching Time Test Circuit**

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

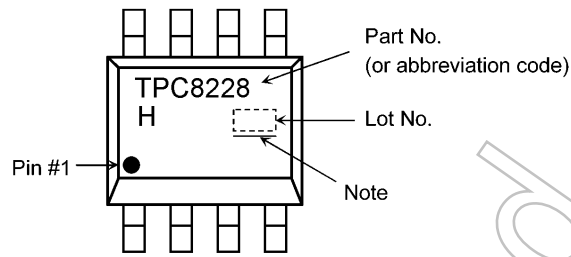
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 48\text{ V}, V_{GS} = 10\text{ V}, I_D = 3.8\text{ A}$	—	11	—	nC
		$V_{DD} \approx 48\text{ V}, V_{GS} = 5\text{ V}, I_D = 3.8\text{ A}$	—	5.7	—	
Gate-source charge 1	$Q_{gs1}$	$V_{DD} \approx 48\text{ V}, V_{GS} = 10\text{ V}, I_D = 3.8\text{ A}$	—	2.1	—	
Gate-drain charge	$Q_{gd}$		—	1.8	—	
Gate switch charge	$Q_{sw}$		—	2.6	—	

**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 8)	$I_{DRP}$	—	—	—	15.2	A
Diode forward voltage	$V_{DSF}$	$I_{DR} = 3.8\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.2	V

Note 8: Ensure that the channel temperature does not exceed  $150^\circ\text{C}$ .

**7. Marking (Note)**



**Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

Not underlined: [[Pb]]/INCLUDES > MCV

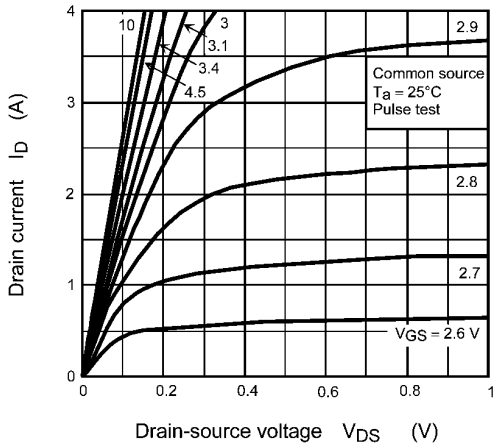
Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

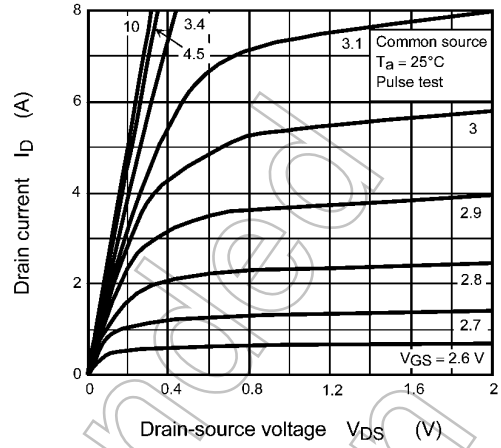
The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Not Recommended for New Design

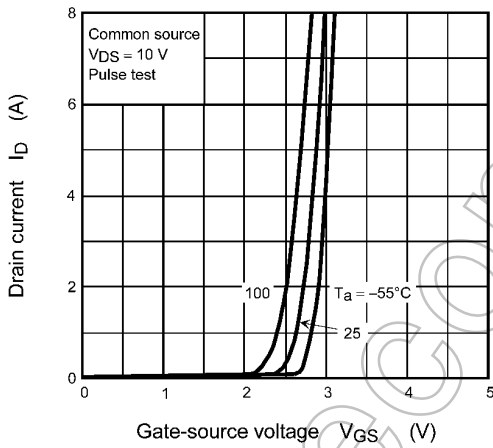
**8. Characteristics Curves (Note)**



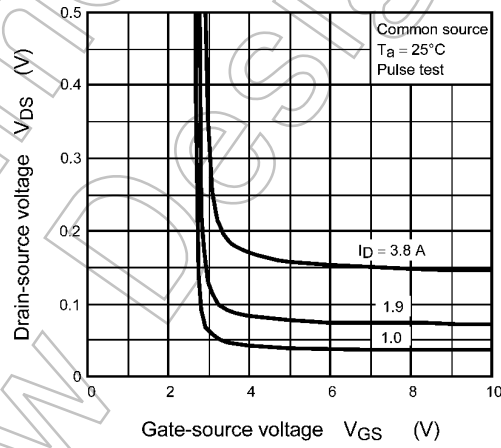
**Fig. 8.1  $I_D - V_{DS}$**



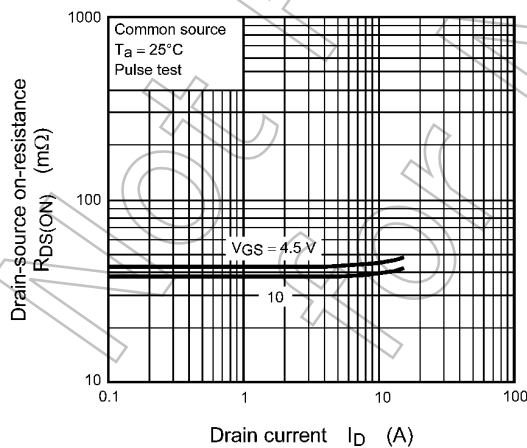
**Fig. 8.2  $I_D - V_{DS}$**



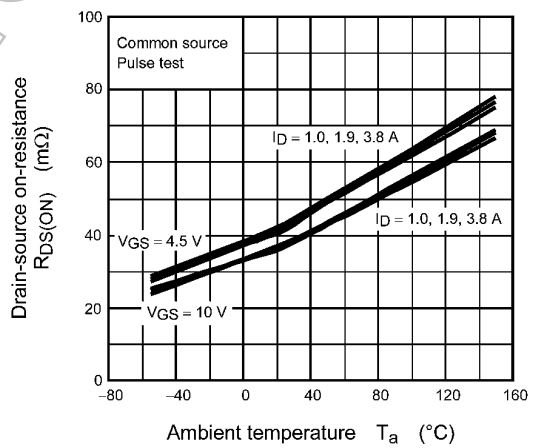
**Fig. 8.3  $I_D - V_{GS}$**



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



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



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

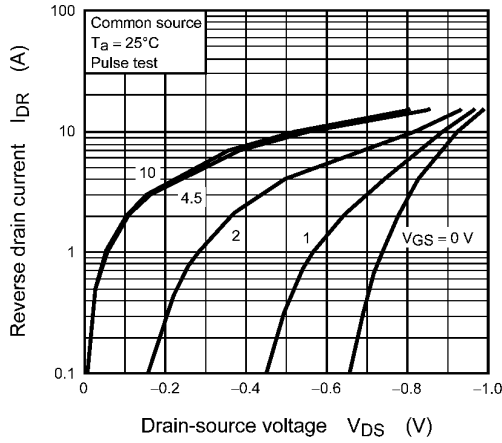


Fig. 8.7  $I_{DR} - V_{DS}$

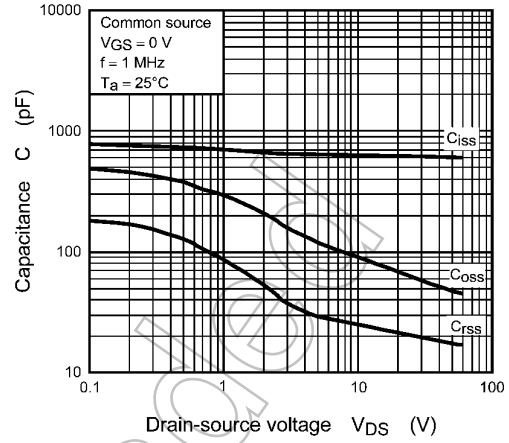


Fig. 8.8 Capacitance -  $V_{DS}$

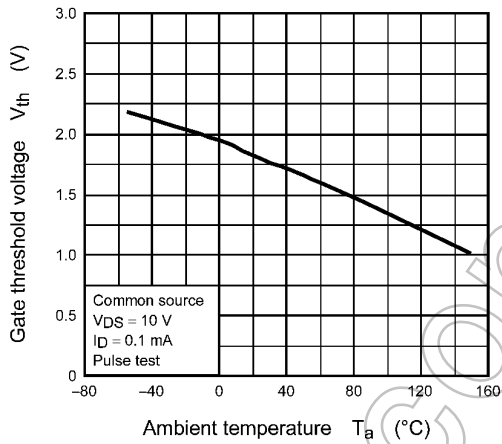


Fig. 8.9  $V_{th} - T_a$

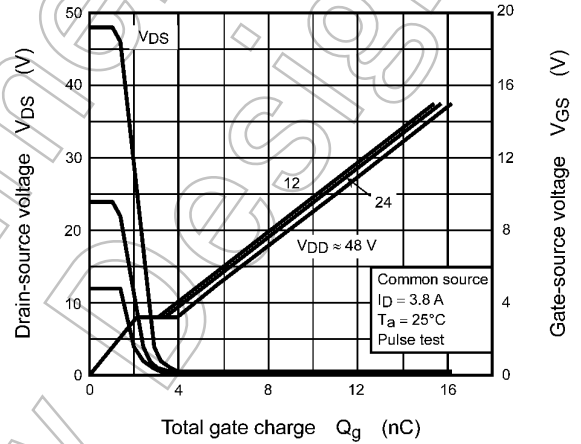


Fig. 8.10 Dynamic Input/Output Characteristics

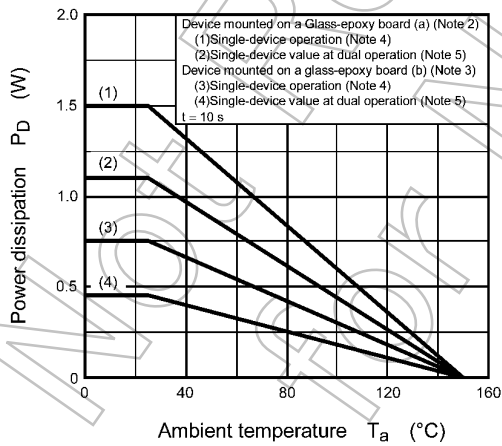
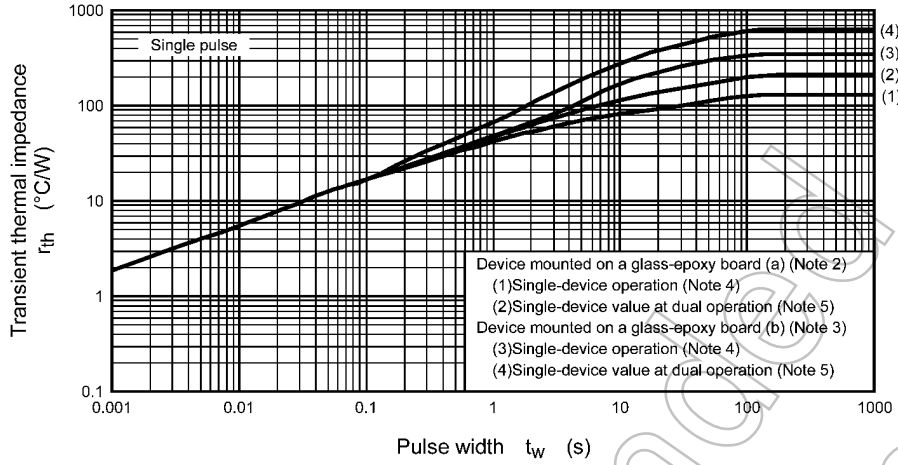
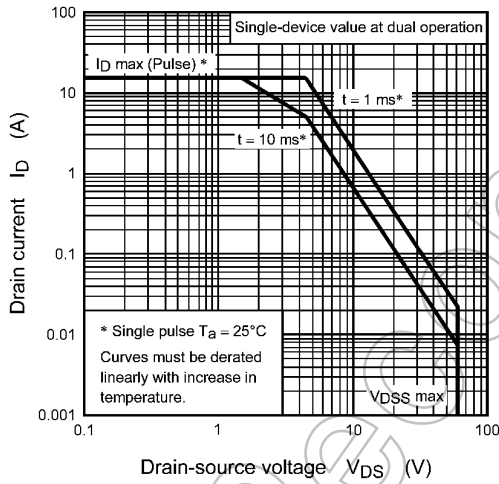


Fig. 8.11  $P_D - T_a$   
 (Guaranteed Maximum)



**Fig. 8.12  $r_{th} - t_w$**   
**(Guaranteed Maximum)**

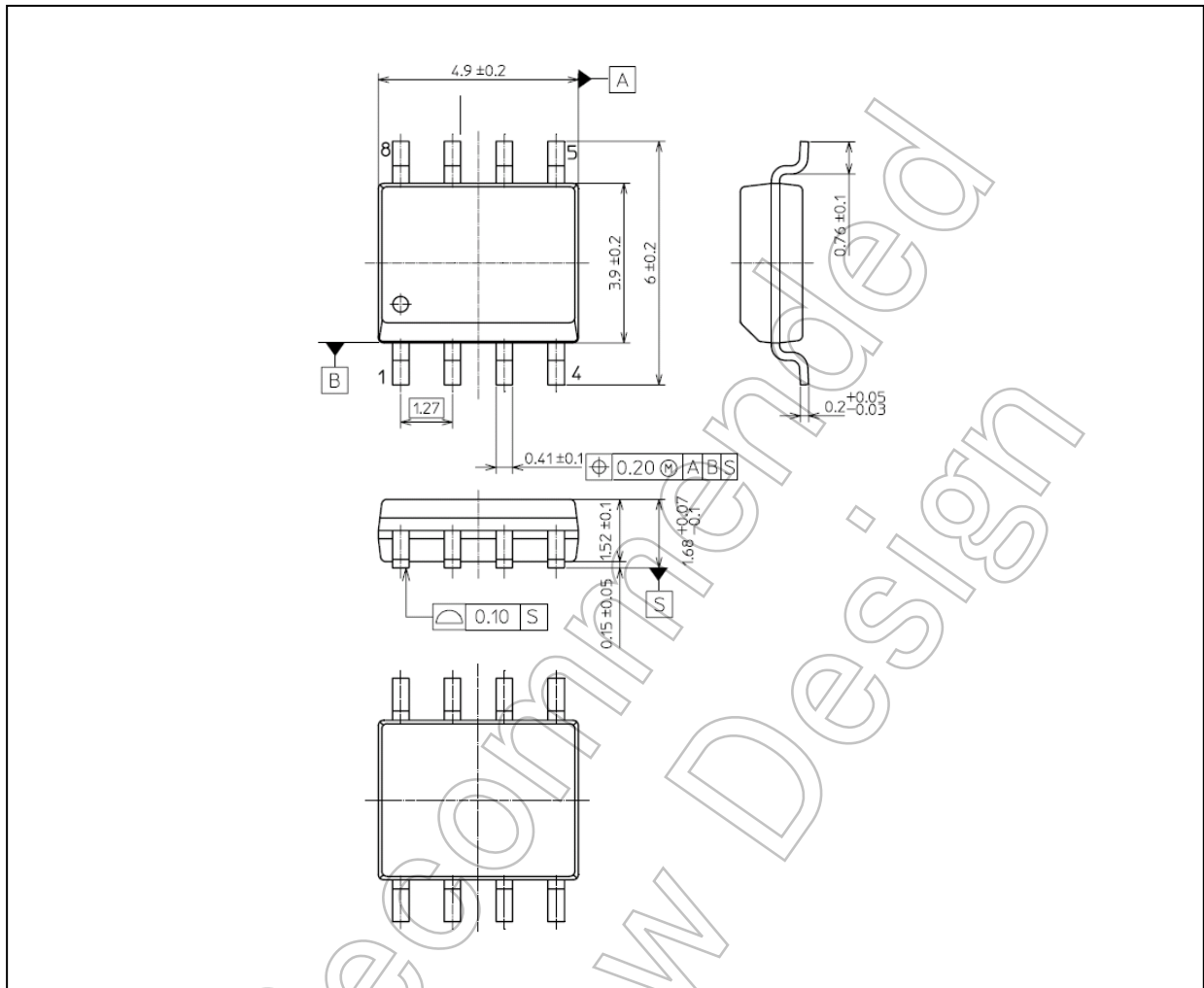


**Fig. 8.13 Safe Operating Area**  
**(Guaranteed Maximum)**

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

**Package Dimensions**

Unit: mm



Weight: 0.085 g (typ.)

Package Name(s)
TOSHIBA: 2-5R1S
Nickname: SOP-8



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