

# TPC6009-H

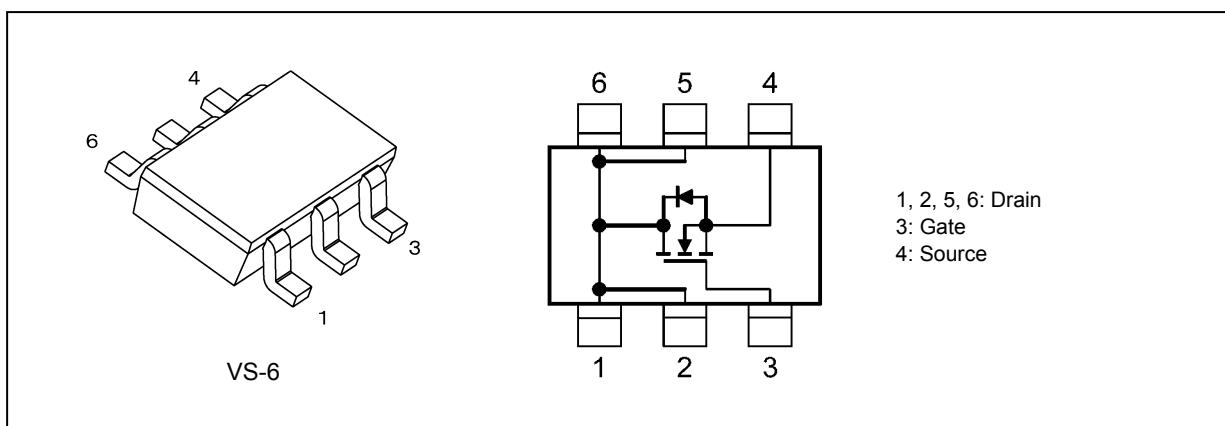
## 1. Applications

- High-Efficiency DC-DC Converters
- Notebook PCs
- Mobile Handsets

## 2. Features

- (1) Small, thin package
- (2) High-speed switching
- (3) Small gate charge:  $Q_{SW} = 1.0 \text{ nC (typ.)}$
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 66 \text{ m}\Omega \text{ (typ.)}$  ( $V_{GS} = 4.5 \text{ V}$ )
- (5) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A (max)}$  ( $V_{DS} = 40 \text{ V}$ )
- (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



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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DS}$	40	V
Gate-source voltage	$V_{GS}$	$\pm 20$	
Drain current (DC) (Note 1)	$I_D$	5.3	A
Drain current (pulsed) (Note 1)	$I_{DP}$	21.2	
Power dissipation (t = 5 s) (Note 2)	$P_D$	2.2	W
Power dissipation (t = 5 s) (Note 3)	$P_D$	0.7	W
Single-pulse avalanche energy (Note 4)	$E_{AS}$	5.21	mJ
Avalanche current	$I_{AR}$	5.3	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

2010-02

## 5. Thermal Characteristics

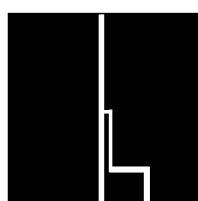
Characteristics			Symbol	Max	Unit
Channel-to-ambient thermal resistance	(t = 5 s)	(Note 2)	$R_{th(ch-a)}$	56.8	°C/W
Channel-to-ambient thermal resistance	(t = 5 s)	(Note 3)	$R_{th(ch-a)}$	178	°C/W

Note 1: Ensure that the channel temperature does not exceed 150°C.

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

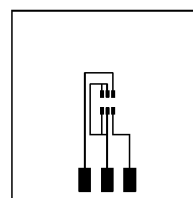
Note 3: Device mounted on a glass-epoxy board (b), Figure 5.2

Note 4:  $V_{DD} = 24\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 0.2\text{ mH}$ ,  $R_G = 1\ \Omega$ ,  $I_{AR} = 5.3\text{ A}$



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.

## 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	$I_{DSS}$	$V_{DS} = 40\text{ V}$ , $V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$	40	—	—	V
	$V_{(BR)DSX}$	$I_D = 10\text{ mA}$ , $V_{GS} = -20\text{ V}$	25	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}$ , $I_D = 0.1\text{ mA}$	1.3	—	2.3	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}$ , $I_D = 2.7\text{ A}$	—	66	98	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}$ , $I_D = 2.7\text{ A}$	—	53	81	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	225	290	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	13	21	
Output capacitance	$C_{oss}$		—	54	—	
Gate resistance	$r_g$	$V_{DS} = 10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 5\text{ MHz}$	—	4.7	7.1	$\Omega$
Switching time (rise time)	$t_r$	See Figure 6.2.1.	—	2.2	—	$\text{ns}$
Switching time (turn-on time)	$t_{on}$		—	6.8	—	
Switching time (fall time)	$t_f$		—	1.7	—	
Switching time (turn-off time)	$t_{off}$		—	11	—	

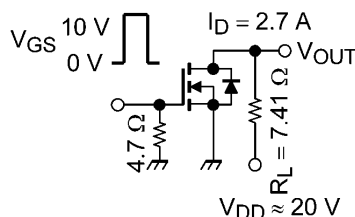


Fig. 6.2.1 Switching Time Test Circuit

### 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)	$Q_g$	$V_{DD} \approx 32\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 5.3\text{ A}$	—	4.7	—	$\text{nC}$
		$V_{DD} \approx 32\text{ V}$ , $V_{GS} = 5\text{ V}$ , $I_D = 5.3\text{ A}$	—	2.6	—	
Gate-source charge 1	$Q_{gs1}$	$V_{DD} \approx 32\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 5.3\text{ A}$	—	0.8	—	
Gate-drain charge	$Q_{gd}$		—	1.3	—	
Gate switch charge	$Q_{sw}$		—	1.0	—	

### 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)	$I_{DRP}$	—	—	—	21.2	A
Diode forward voltage	$V_{DSF}$	$I_{DR} = 5.3\text{ A}$ , $V_{GS} = 0\text{ V}$	—	—	-1.2	V

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

## 7. Marking

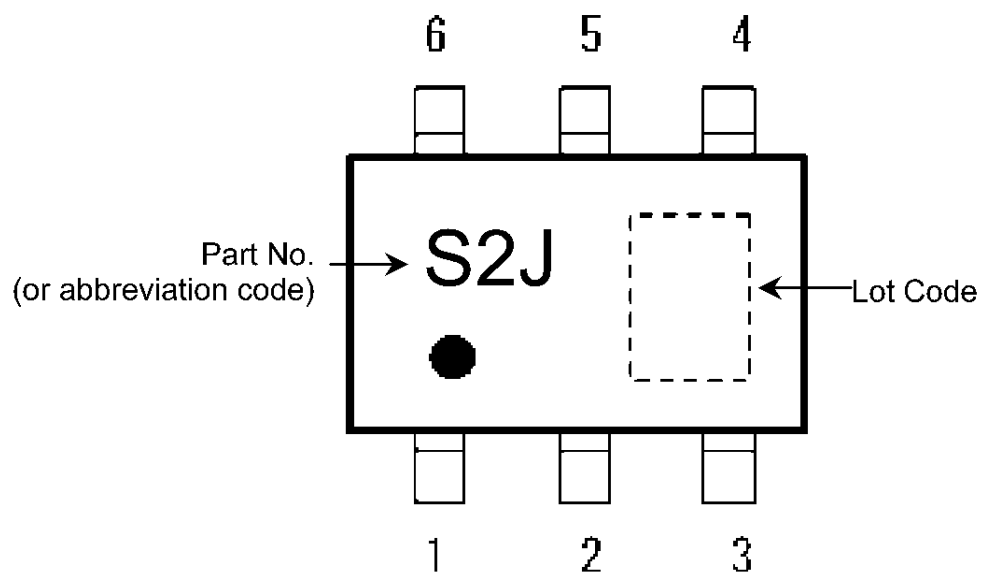
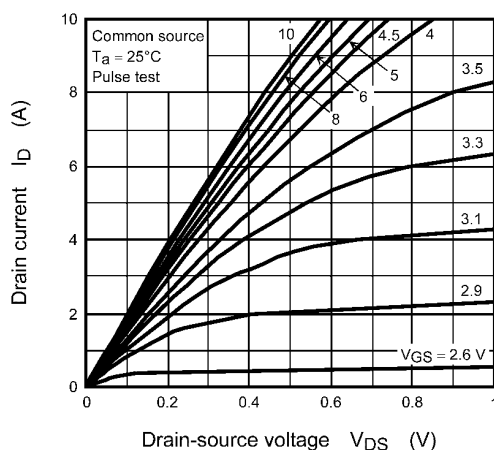
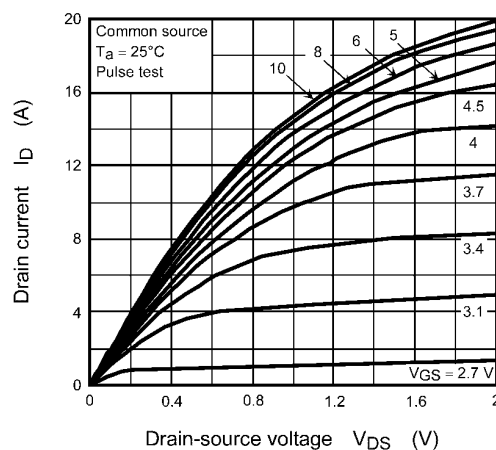


Fig. 7.1 Marking

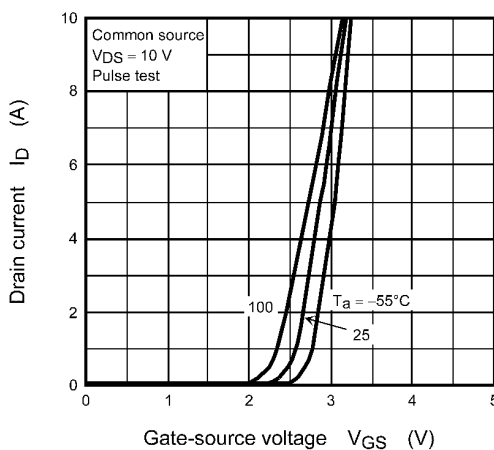
# 8. Characteristics Curves (Note)



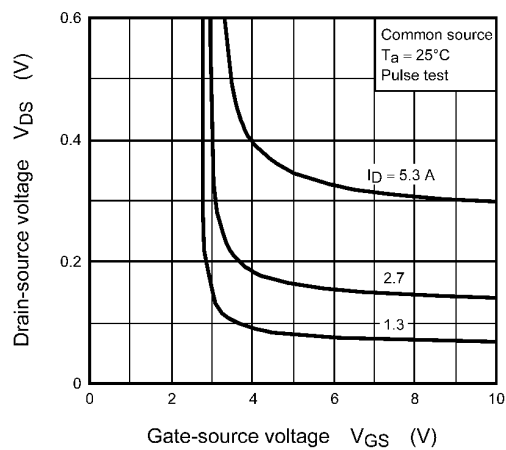
**Fig. 8.1  $I_D - V_{DS}$**



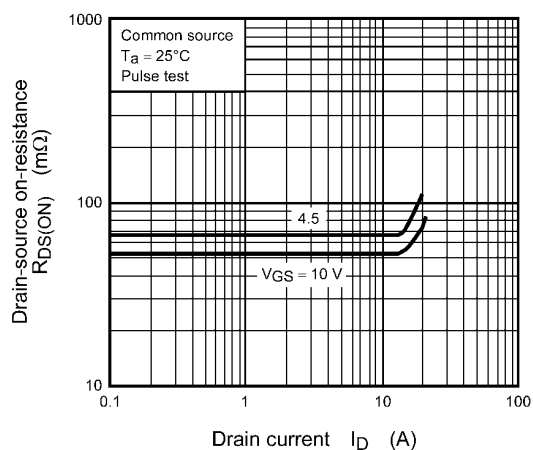
**Fig. 8.2  $I_D - V_{DS}$**



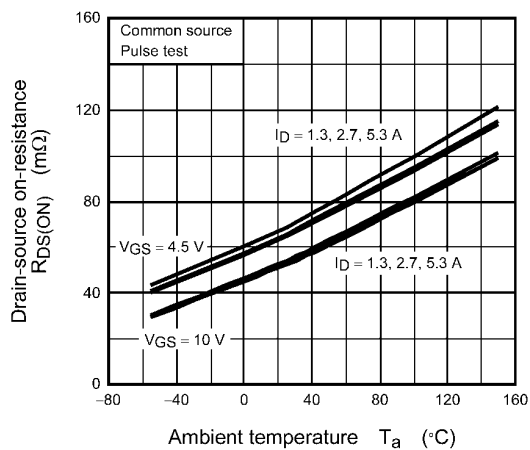
**Fig. 8.3  $I_D - V_{GS}$**



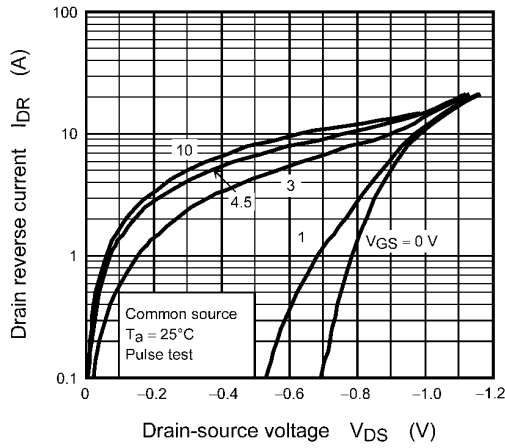
**Fig. 8.4  $V_{DS} - V_{GS}$**



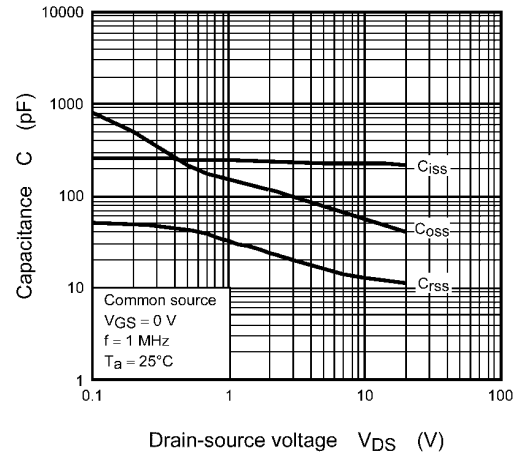
**Fig. 8.5  $R_{DS(ON)} - I_D$**



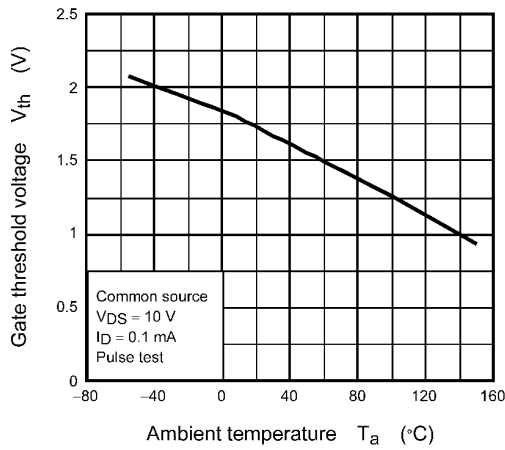
**Fig. 8.6  $R_{DS(ON)} - T_a$**



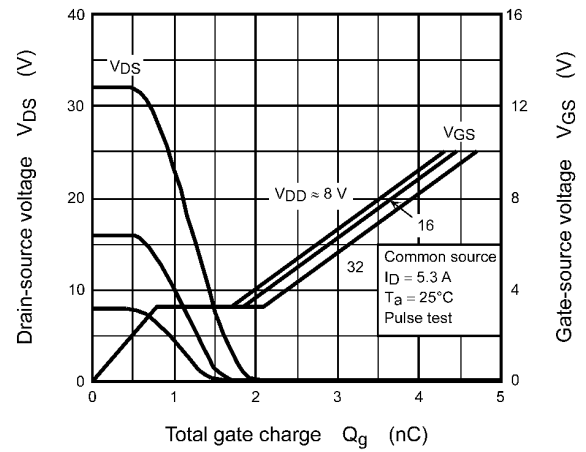
**Fig. 8.7  $I_{DR} - V_{DS}$**



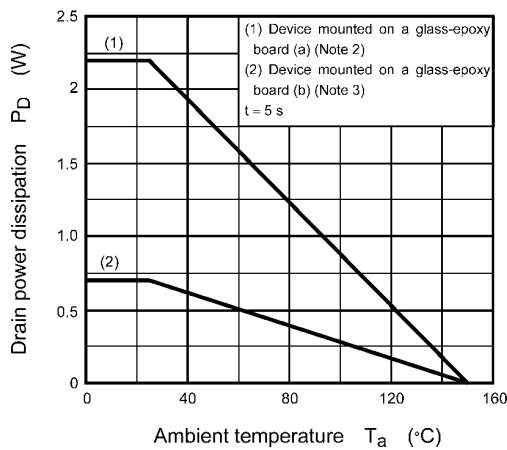
**Fig. 8.8 Capacitance -  $V_{DS}$**



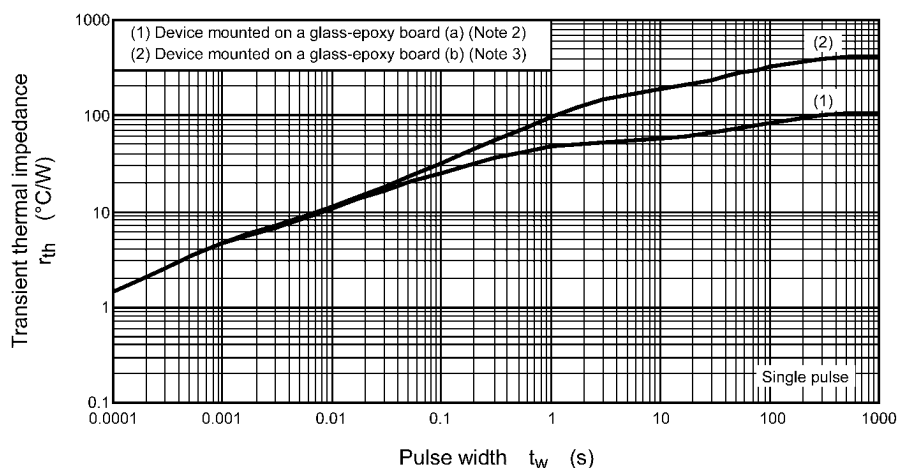
**Fig. 8.9  $V_{th} - T_a$**



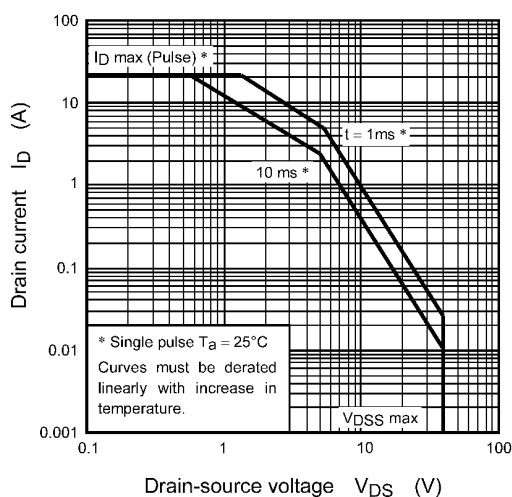
**Fig. 8.10 Dynamic Input/Output Characteristics**



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



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

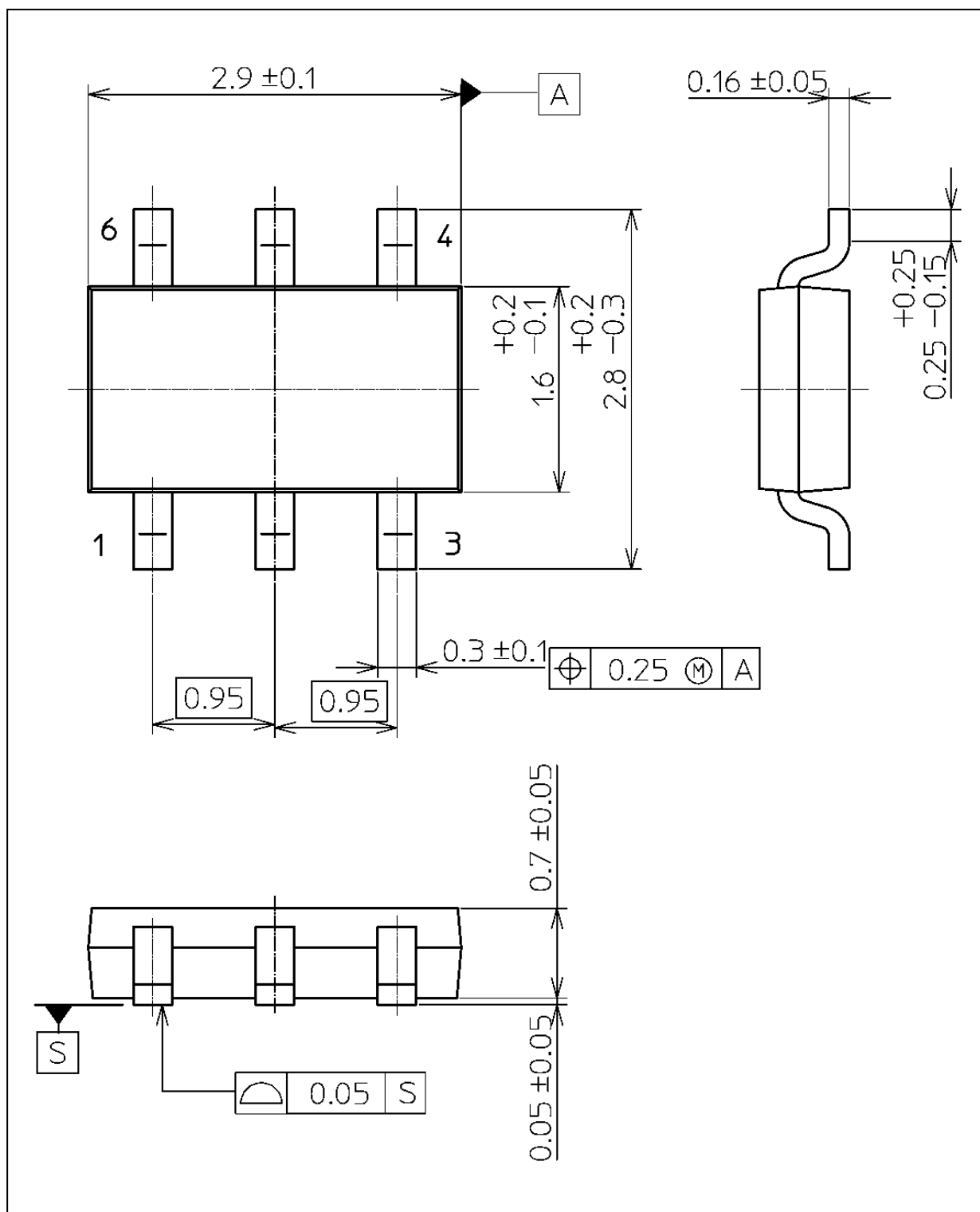


**Fig. 8.13 Safe Operating Area**  
(Guaranteed Maximum)

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

## Package Dimensions

Unit: mm



Weight: 0.011 g (typ.)

Package Name(s)
TOSHIBA: 2-3T1S
Nickname: VS-6



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