

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

## TPHR7404PU

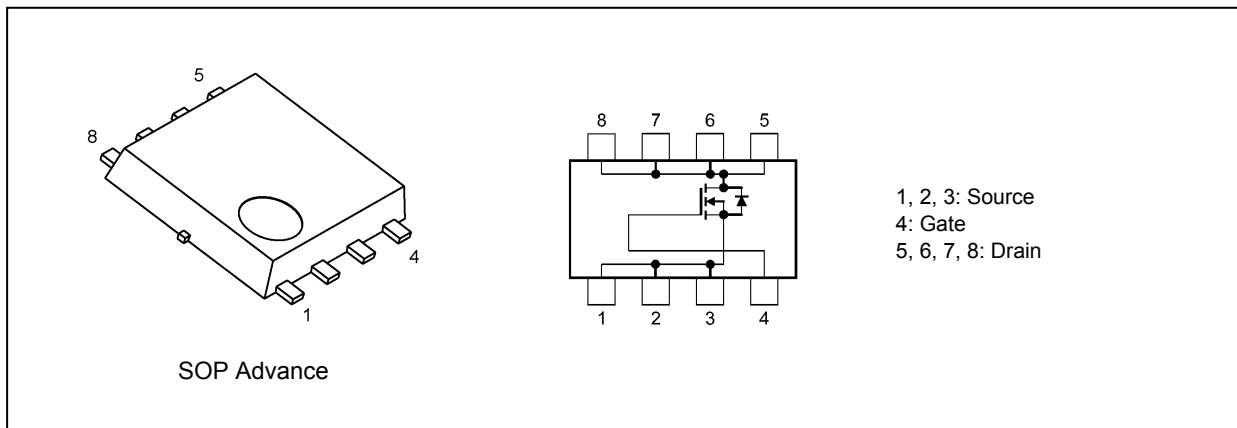
### 1. Applications

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

### 2. Features

- (1) High-speed switching
- (2) Small gate charge:  $Q_{SW} = 34 \text{ nC (typ.)}$
- (3) Small output charge:  $Q_{OSS} = 90 \text{ nC (typ.)}$
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 0.51 \text{ m}\Omega \text{ (typ.) (} V_{GS} = 10 \text{ V)}$
- (5) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A (max) (} V_{DS} = 40 \text{ V)}$
- (6) Enhancement mode:  $V_{th} = 2.0 \text{ to } 3.0 \text{ V (} V_{DS} = 10 \text{ V, } I_D = 1.0 \text{ mA)}$

### 3. Packaging and Internal Circuit



Start of commercial production

2020-09

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	40	V
Gate-source voltage	$V_{GSS}$	$\pm 20$	
Drain current (DC) ( $T_c = 25\text{ }^\circ\text{C}$ ) (Note 1)	$I_D$	150	A
Drain current (DC) (Silicon limit) (Note 1), (Note 2)	$I_D$	400	
Drain current (pulsed) ( $t = 100\text{ }\mu\text{s}$ ) (Note 1)	$I_{DP}$	500	
Power dissipation ( $T_c = 25\text{ }^\circ\text{C}$ )	$P_D$	210	W
Power dissipation (Note 3)	$P_D$	3.0	
Power dissipation (Note 4)	$P_D$	0.96	
Single-pulse avalanche energy (Note 5)	$E_{AS}$	298	mJ
Single-pulse avalanche current (Note 5)	$I_{AS}$	110	A
Channel temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	

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.).

Note: In this product, radiation resistance and cosmic ray resistance are not designed, and these natural environmental factors may affect reliability.

In addition, radiation from the constituent materials of the product also becomes a natural environmental factor which may affect reliability.

### 5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance ( $T_c = 25\text{ }^\circ\text{C}$ )	$R_{th(ch-c)}$	0.71	$^\circ\text{C}/\text{W}$
Channel-to-ambient thermal resistance (Note 3)	$R_{th(ch-a)}$	50	
Channel-to-ambient thermal resistance (Note 4)	$R_{th(ch-a)}$	156	

Note 1: Ensure that the channel temperature does not exceed  $175\text{ }^\circ\text{C}$ .

Note 2: Limited by package limit.

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:  $V_{DD} = 32\text{ V}$ ,  $T_{ch} = 25\text{ }^\circ\text{C}$  (initial),  $L = 19\text{ }\mu\text{H}$ ,  $I_{AS} = 110\text{ A}$

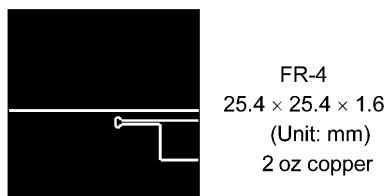


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

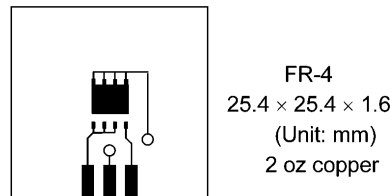


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

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	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 0.1$	$\mu\text{A}$
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
Drain-source breakdown voltage (Note 6)	$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	25	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 1.0\text{ mA}$	2.0	—	3.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 6\text{ V}, I_D = 50\text{ A}$	—	0.72	1.17	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	0.51	0.74	

Note 6: 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	$C_{iss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	6960	9000	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	130	—	
Output capacitance	$C_{oss}$		—	2060	—	
Gate resistance	$r_g$	—	—	3	4.5	$\Omega$
Switching time (rise time)	$t_r$	See Fig. 6.2.1	—	12	—	ns
Switching time (turn-on time)	$t_{on}$		—	29	—	
Switching time (fall time)	$t_f$		—	30	—	
Switching time (turn-off time)	$t_{off}$		—	103	—	

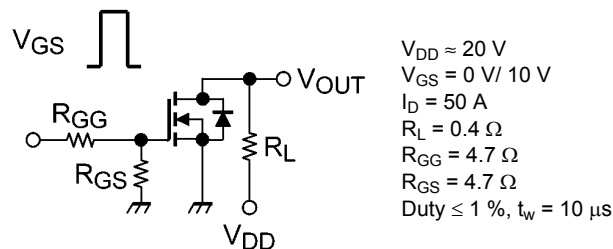


Fig. 6.2.1 Switching Time Test Circuit

### 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)	$Q_g$	$V_{DD} \approx 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	98	—	nC
		$V_{DD} \approx 20\text{ V}, V_{GS} = 6\text{ V}, I_D = 50\text{ A}$	—	62	—	
Gate-source charge 1	$Q_{gs1}$	$V_{DD} \approx 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 50\text{ A}$	—	32	—	
Gate-drain charge	$Q_{gd}$		—	18	—	
Gate switch charge	$Q_{SW}$		—	34	—	
Output charge	$Q_{oss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	90	—	

## 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 (pulsed) (Note 7)	$I_{DRP}$	$t = 100\ \mu\text{s}$	—	—	500	A
Diode forward voltage	$V_{DSF}$	$I_{DR} = 150\ \text{A}, V_{GS} = 0\ \text{V}$	—	—	-1.2	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 37.5\ \text{A}, V_{GS} = 0\ \text{V},$ $-dI_{DR}/dt = 100\ \text{A}/\mu\text{s}$	—	60	—	ns
Reverse recovery charge	$Q_{rr}$		—	68	—	nC

Note 7: Ensure that the channel temperature does not exceed  $175\text{ }^\circ\text{C}$ .

## 7. Marking

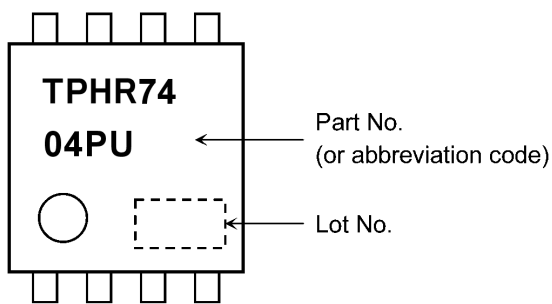


Fig. 7.1 Marking

## 8. Characteristics Curves (Note)

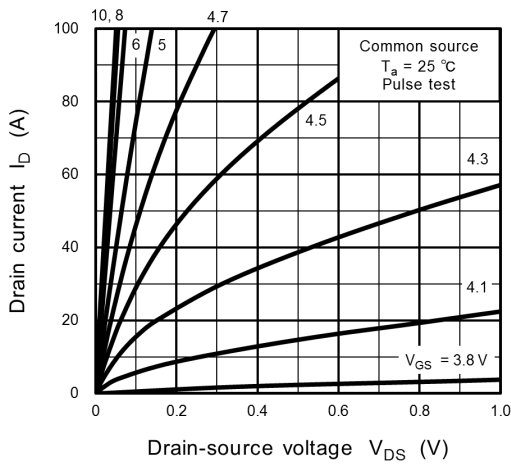


Fig. 8.1  $I_D - V_{DS}$

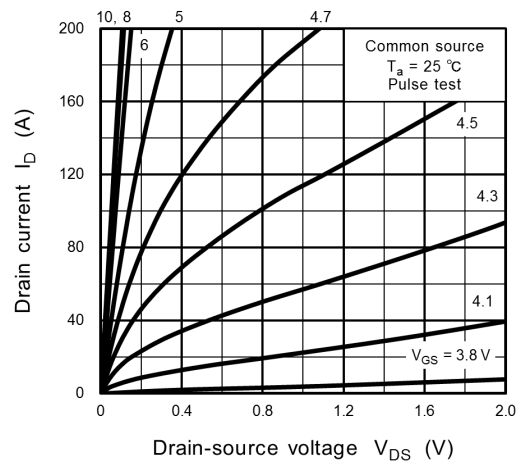


Fig. 8.2  $I_D - V_{DS}$

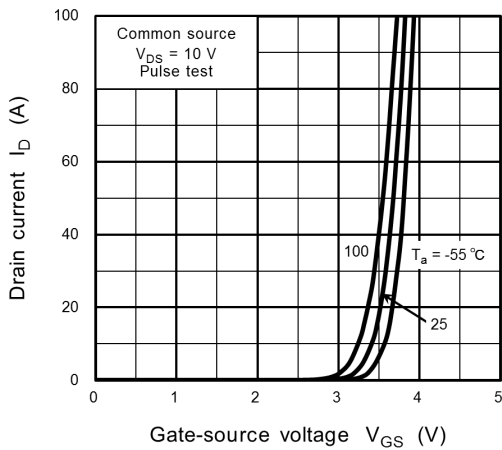


Fig. 8.3  $I_D - V_{GS}$

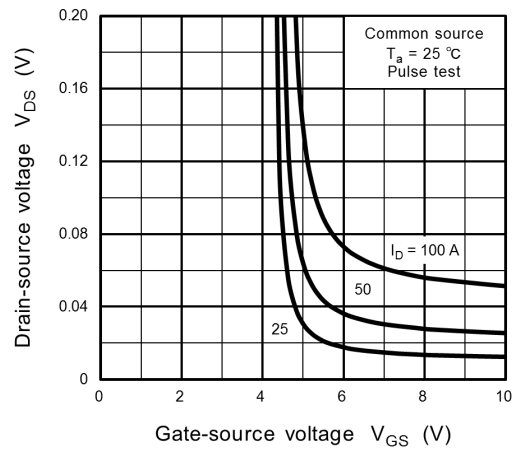


Fig. 8.4  $V_{DS} - V_{GS}$

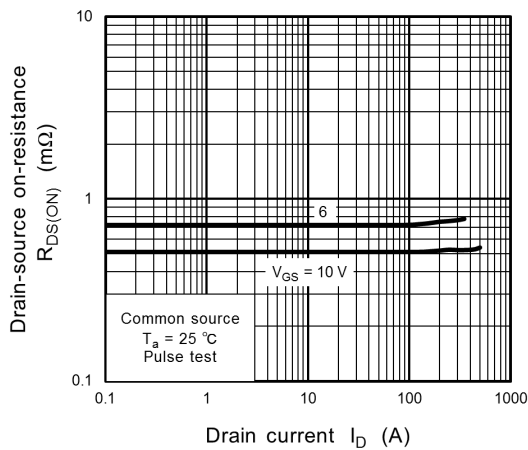


Fig. 8.5  $R_{DS(ON)} - I_D$

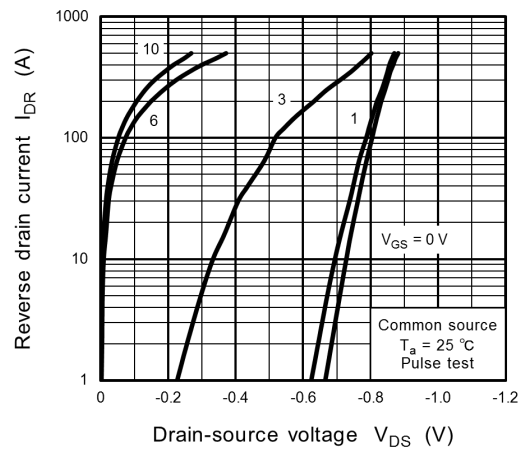
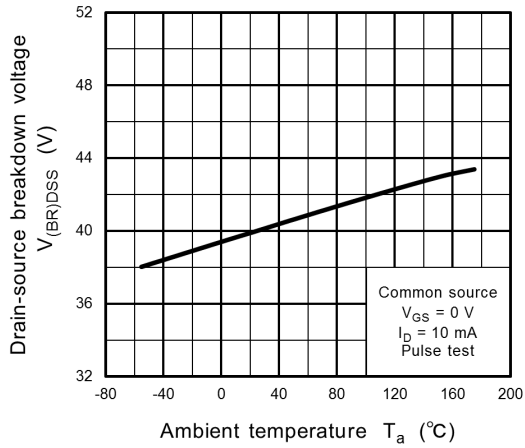
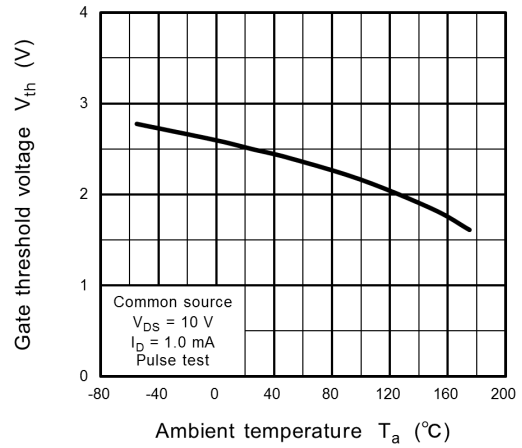


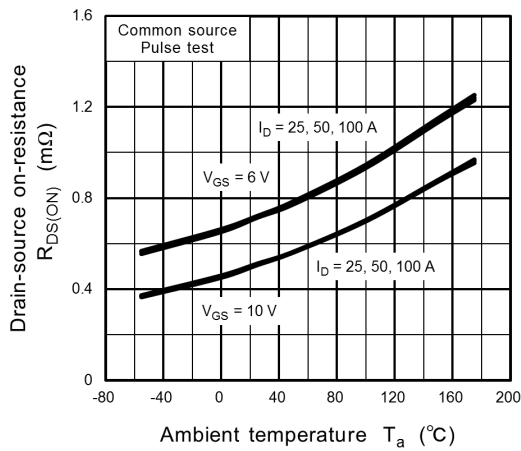
Fig. 8.6  $I_{DR} - V_{DS}$



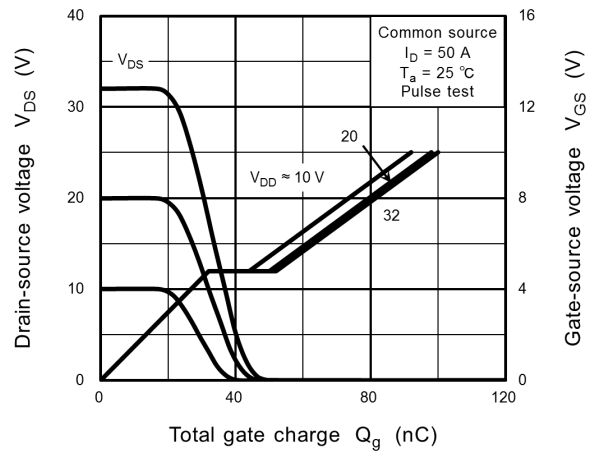
**Fig. 8.7**  $V_{(BR)DSS} - T_a$



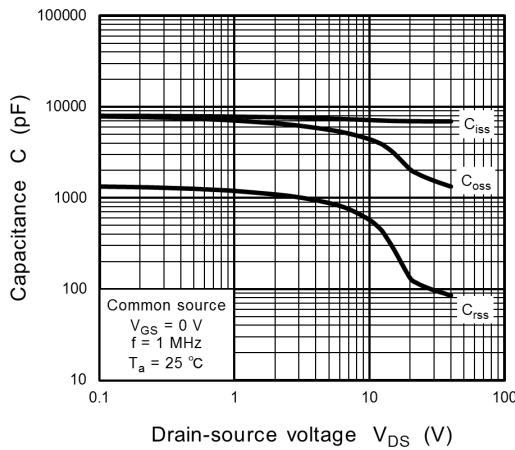
**Fig. 8.8**  $V_{th} - T_a$



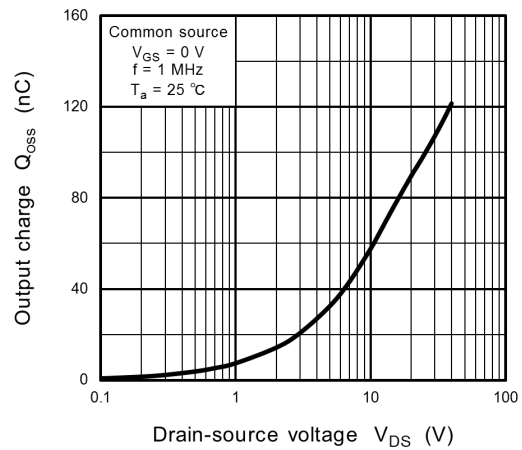
**Fig. 8.9**  $R_{DS(ON)} - T_a$



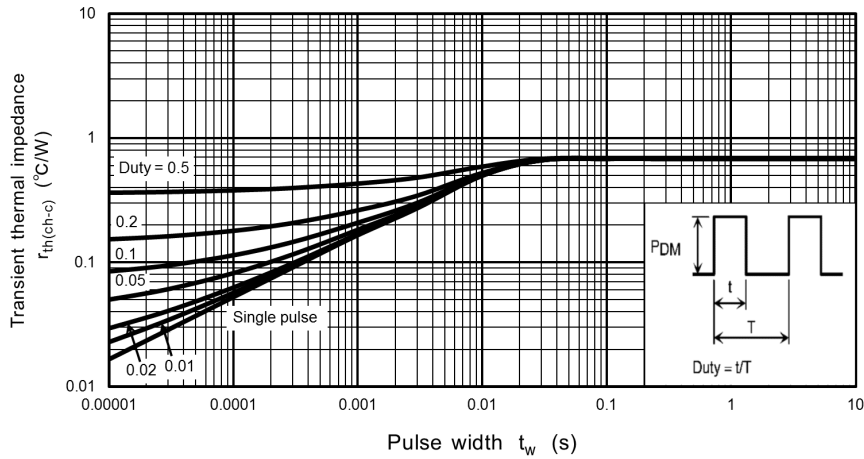
**Fig. 8.10** Dynamic Input/Output Characteristics



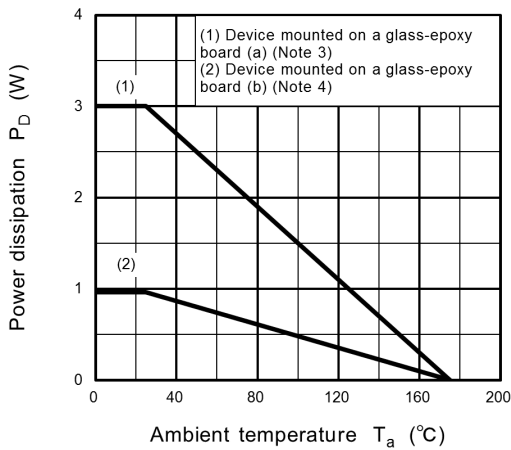
**Fig. 8.11** Capacitance -  $V_{DS}$



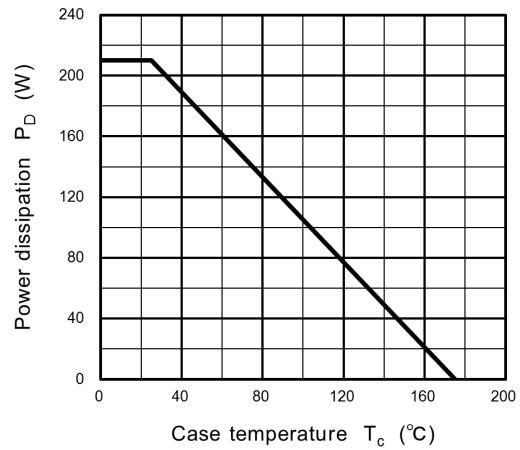
**Fig. 8.12**  $Q_{oss} - V_{DS}$



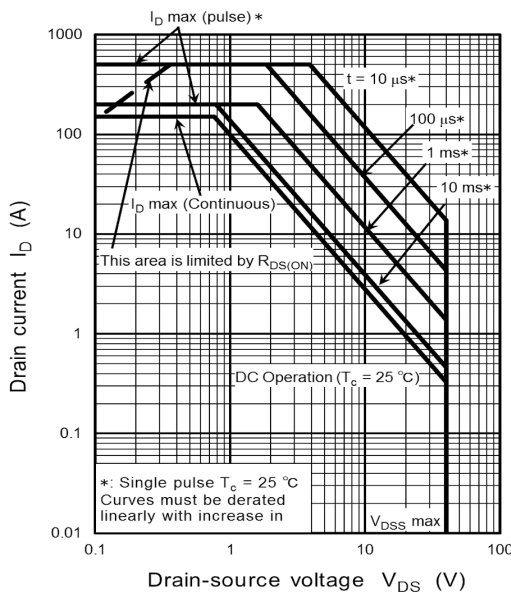
**Fig. 8.13  $r_{th} - t_w$**   
(Guaranteed Maximum)



**Fig. 8.14  $P_D - T_a$**   
(Guaranteed Maximum)



**Fig. 8.15  $P_D - T_c$**   
(Guaranteed Maximum)

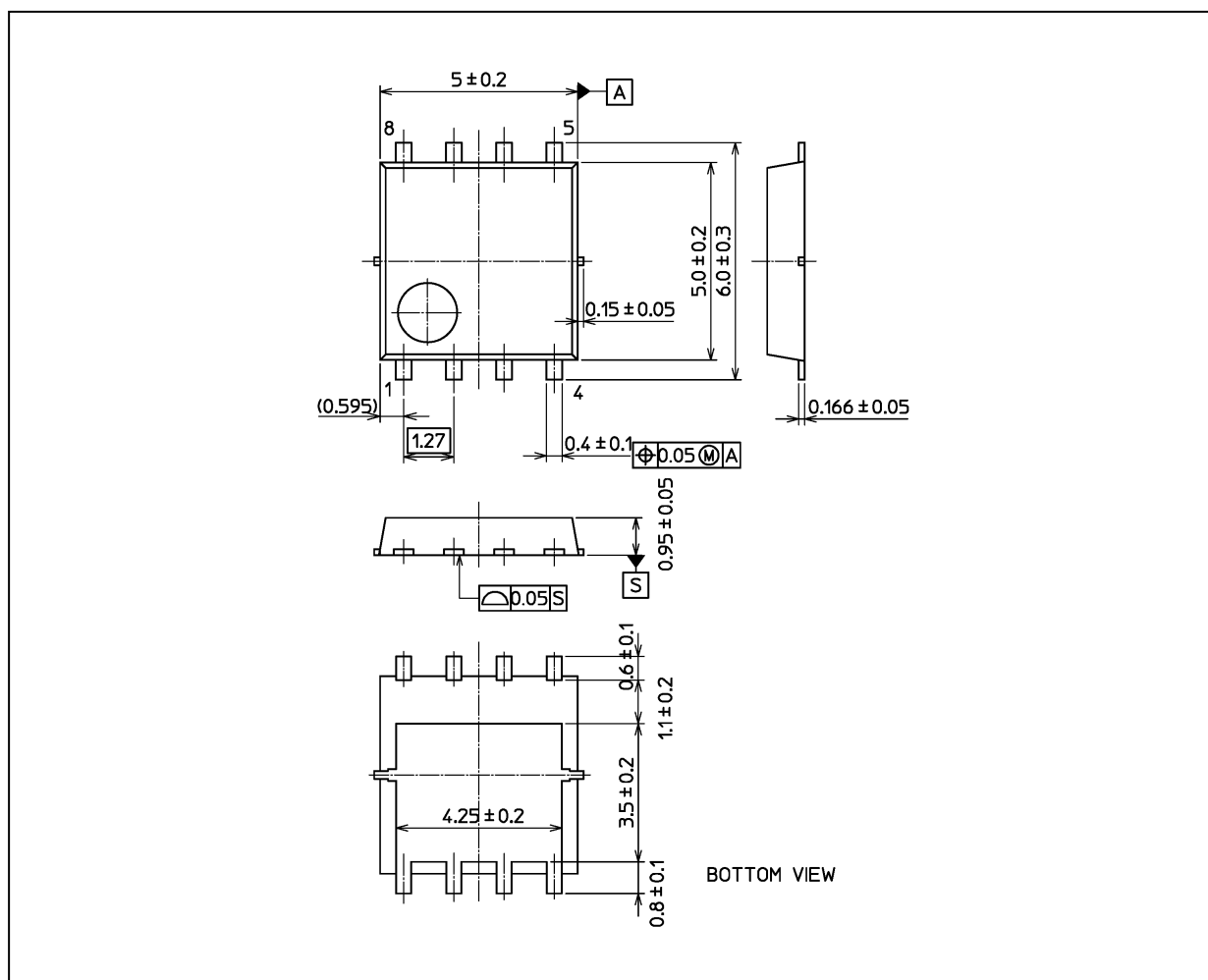


**Fig. 8.16 Safe Operating Area**  
(Guaranteed Maximum)

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

## Package Dimensions

Unit: mm



Weight: 0.087 g (typ.)

Package Name(s)
TOSHIBA: 2-5Q1S
Nickname: SOP Advance



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