

MOSFETs Silicon N-channel MOS (U-MOS<sup>III</sup>-H)

# TPH4R003NL

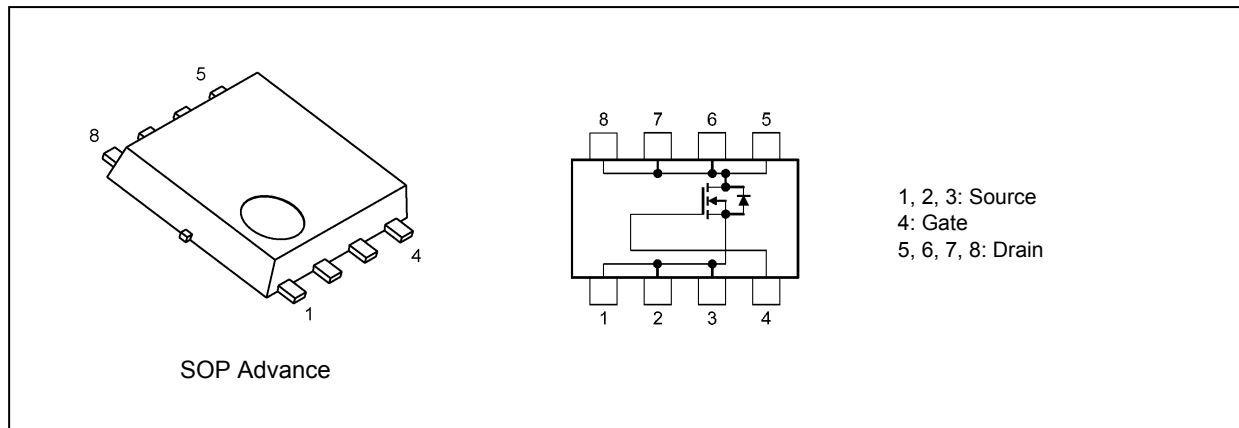
## 1. Applications

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

## 2. Features

- (1) High-speed switching
- (2) Small gate charge:  $Q_{SW} = 3.9 \text{ nC}$  (typ.)
- (3) Low drain-source on-resistance:  $R_{DS(ON)} = 4.9 \text{ m}\Omega$  (typ.) ( $V_{GS} = 4.5 \text{ V}$ )
- (4) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 30 \text{ V}$ )
- (5) Enhancement mode:  $V_{th} = 1.3 \text{ to } 2.3 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.2 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2013-08

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

| Characteristics  | Symbol    | Rating     | Unit               |
|--|-----------|------------|--------------------|
| Drain-source voltage   | $V_{DS}$  | 30         | V                  |
| Gate-source voltage  | $V_{GS}$  | $\pm 20$   |                    |
| Drain current (DC) (Silicon limit) (Note 1), (Note 2)              | $I_D$     | 68         | A                  |
| Drain current (DC) ( $T_c = 25\text{ }^{\circ}\text{C}$ ) (Note 1) | $I_D$     | 40         |                    |
| Drain current (pulsed) ( $t = 1\text{ ms}$ ) (Note 1)              | $I_{DP}$  | 177        |                    |
| Power dissipation ( $T_c = 25\text{ }^{\circ}\text{C}$ )           | $P_D$     | 36         | W                  |
| Power dissipation ( $t = 10\text{ s}$ ) (Note 3)                   | $P_D$     | 2.8        |                    |
| Power dissipation ( $t = 10\text{ s}$ ) (Note 4)                   | $P_D$     | 1.6        |                    |
| Single-pulse avalanche energy (Note 5)                             | $E_{AS}$  | 62         | mJ                 |
| Avalanche current  | $I_{AR}$  | 40         | 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 ( $T_c = 25\text{ }^{\circ}\text{C}$ ) | $R_{th(ch-c)}$ | 3.47 | $^{\circ}\text{C/W}$ |
| Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 3)      | $R_{th(ch-a)}$ | 44.6 |                      |
| Channel-to-ambient thermal resistance ( $t = 10\text{ s}$ ) (Note 4)      | $R_{th(ch-a)}$ | 78.1 |                      |

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

Note 2: Limited by silicon chip capability. Package limit is 60 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:  $V_{DD} = 24\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 30\text{ }\mu\text{H}$ ,  $I_{AR} = 40\text{ A}$

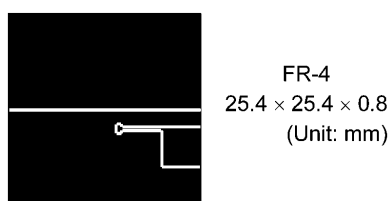


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

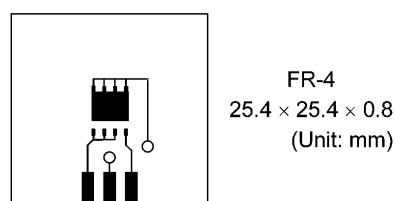


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

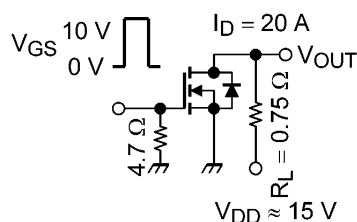
## 6. Electrical Characteristics

### 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          | $I_{DSS}$     | $V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$     | —   | —    | 10        |                  |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$       | 30  | —    | —         | V                |
|                                | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}$ , $V_{GS} = -20\text{ V}$     | 15  | —    | —         |                  |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 0.2\text{ mA}$     | 1.3 | —    | 2.3       |                  |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 4.5\text{ V}$ , $I_D = 9.5\text{ A}$     | —   | 4.9  | 6.2       | $\text{m}\Omega$ |
|                                |               | $V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$       | —   | 3.4  | 4.0       |                  |

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

| Characteristics                | Symbol    | Test Condition  | Min | Typ. | Max  | Unit        |
|--------------------------------|-----------|---|-----|------|------|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | —   | 1110 | 1400 | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |   | —   | 39   | 88   |             |
| Output capacitance             | $C_{oss}$ |   | —   | 640  | —    |             |
| Gate resistance                | $r_g$     | —   | —   | 1.2  | 1.8  | $\Omega$    |
| 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   | —    |             |



Duty  $\leq 1\%$ ,  $t_w = 10\text{ }\mu\text{s}$

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) | $Q_g$     | $V_{DD} \approx 15\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 40\text{ A}$  | —   | 14.8 | —   | nC   |
|   |           | $V_{DD} \approx 15\text{ V}$ , $V_{GS} = 4.5\text{ V}$ , $I_D = 40\text{ A}$ | —   | 6.8  | —   |      |
| Gate-source charge 1                            | $Q_{gs1}$ | $V_{DD} \approx 15\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 40\text{ A}$  | —   | 3.7  | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |  | —   | 1.9  | —   |      |
| Gate switch charge                              | $Q_{SW}$  |  | —   | 3.9  | —   |      |

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

| Characteristics                         | Symbol    | Test Condition                                 | Min | Typ. | Max  | Unit |
|---|-----------|--|-----|------|------|------|
| Reverse drain current (pulsed) (Note 6) | $I_{DRP}$ | —  | —   | —    | 177  | A    |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 40\text{ A}$ , $V_{GS} = 0\text{ V}$ | —   | —    | -1.2 | V    |

Note 6: Ensure that the channel temperature does not exceed  $150\text{ }^{\circ}\text{C}$ .

## 7. Marking

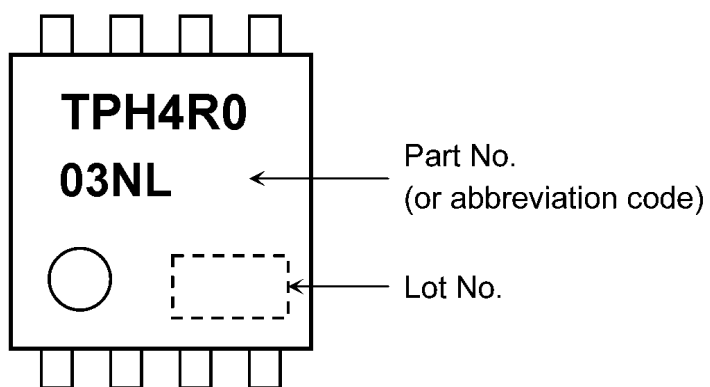


Fig. 7.1 Marking

## 8. Characteristics Curves (Note)

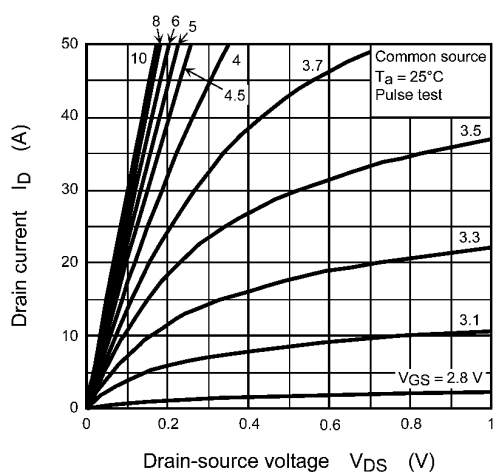


Fig. 8.1  $I_D - V_{DS}$

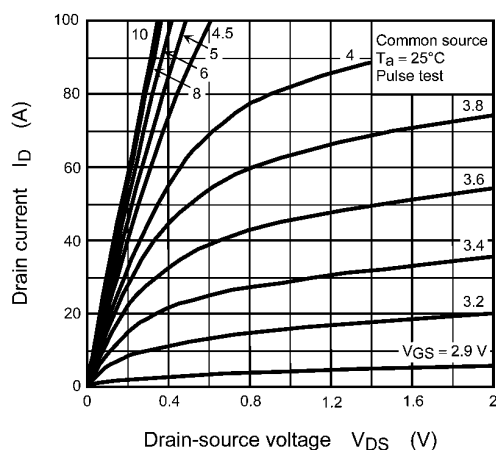


Fig. 8.2  $I_D - V_{DS}$

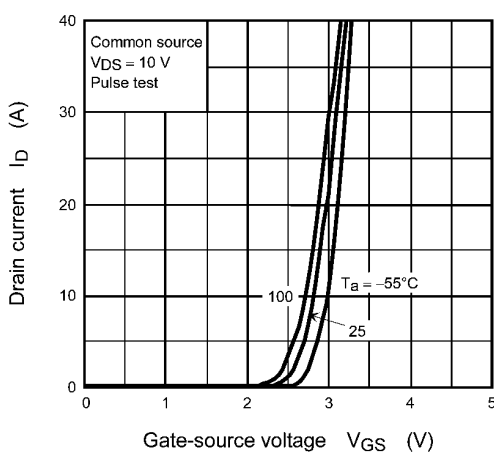


Fig. 8.3  $I_D - V_{GS}$

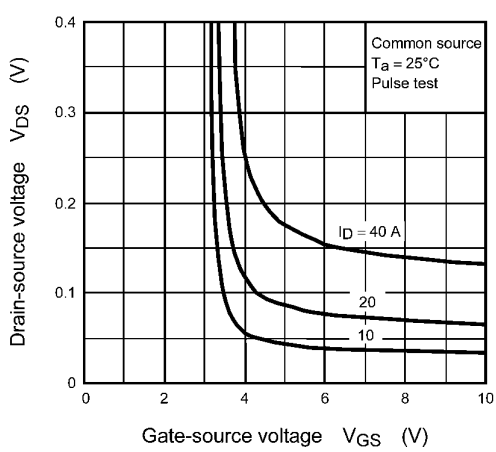


Fig. 8.4  $V_{DS} - V_{GS}$

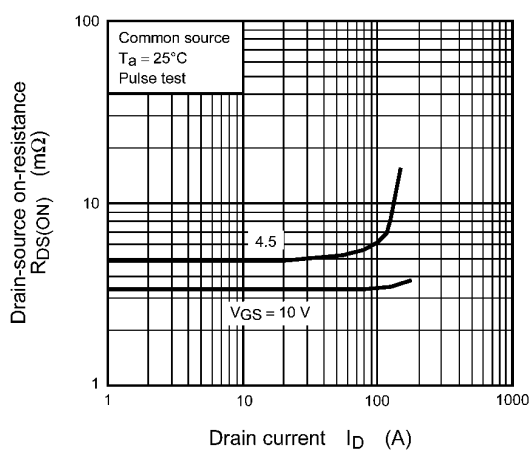


Fig. 8.5  $R_{DS(ON)} - I_D$

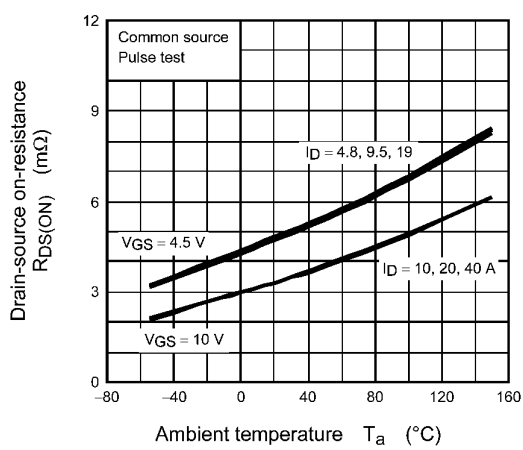


Fig. 8.6  $R_{DS(ON)} - T_a$

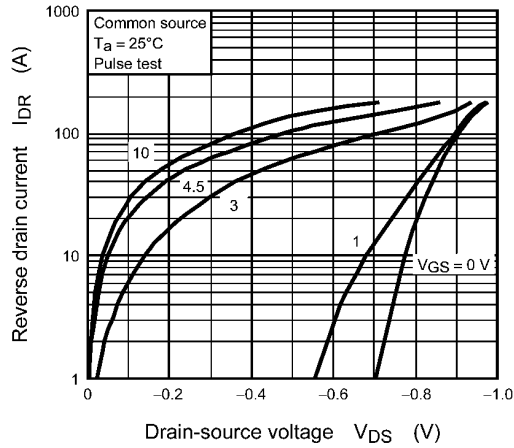


Fig. 8.7  $I_{DR} - V_{DS}$

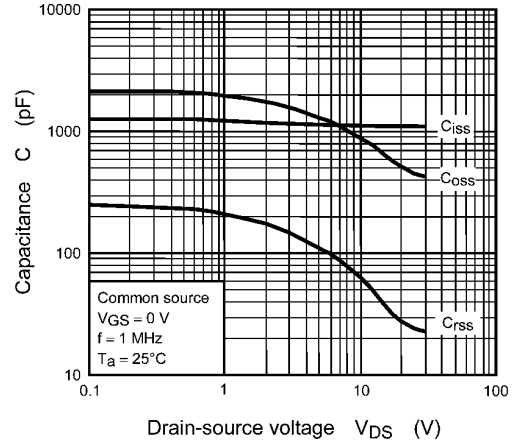


Fig. 8.8 Capacitance -  $V_{DS}$

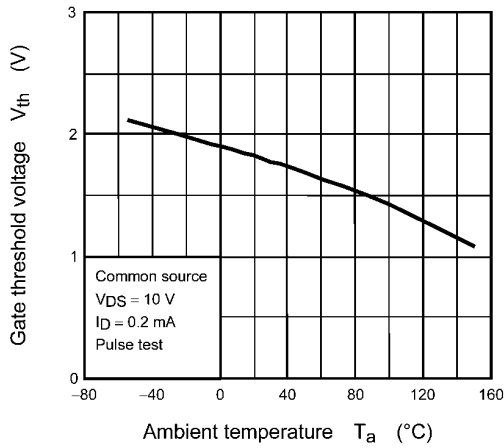


Fig. 8.9  $V_{th} - T_a$

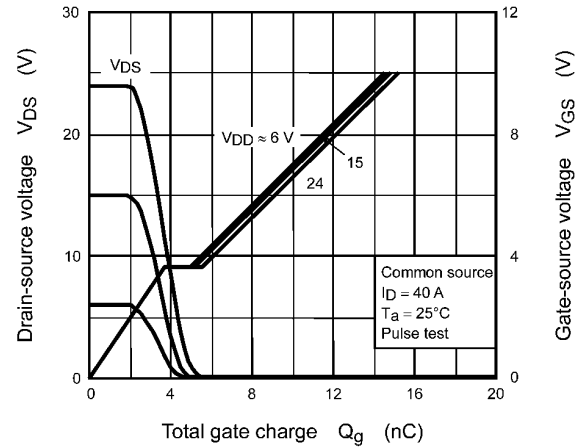


Fig. 8.10 Dynamic Input/Output Characteristics

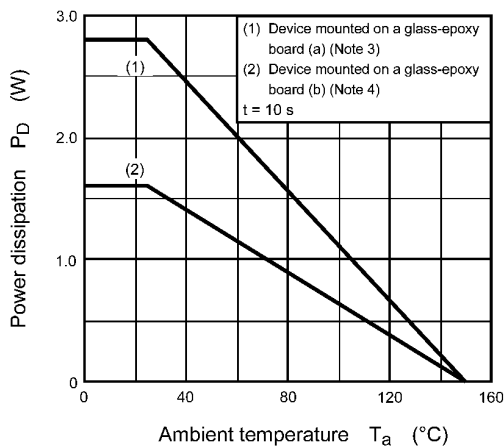


Fig. 8.11  $P_D - T_a$   
(Guaranteed Maximum)

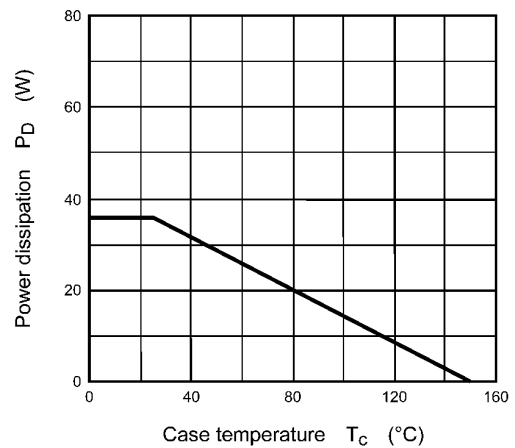
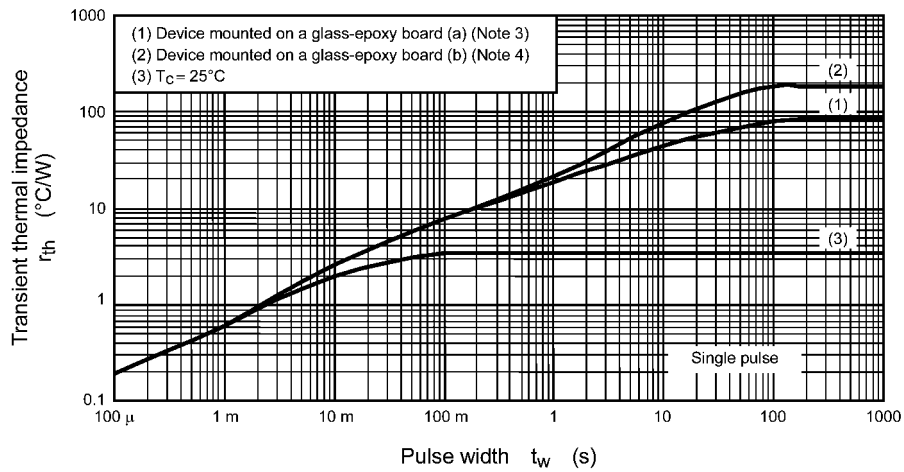
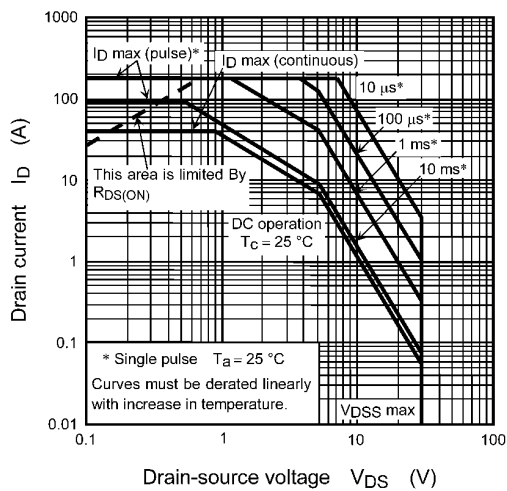


Fig. 8.12  $P_D - T_c$   
(Guaranteed Maximum)



**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: 0.070 g (typ.)

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



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