

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

# XPH2R404PS

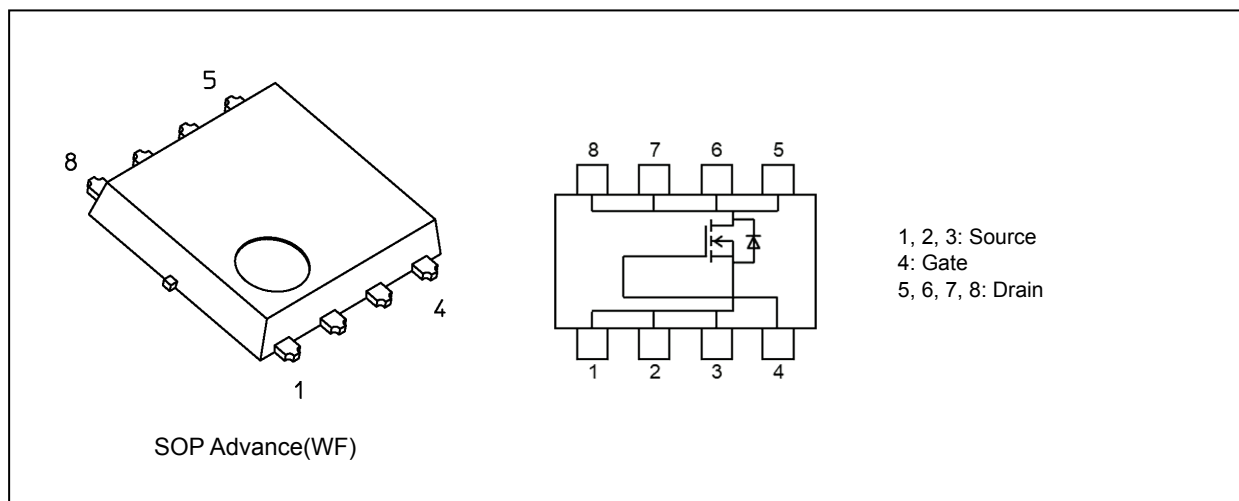
## 1. Applications

- Automotive
- Motor Drivers
- Switching Voltage Regulators

## 2. Features

- (1) AEC-Q101 qualified
- (2) Small, thin package
- (3) Low drain-source on-resistance:  $R_{DS(ON)} = 1.8 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (4) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 40 \text{ V}$ )
- (5) Enhancement mode:  $V_{th} = 2.0$  to  $3.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.3 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2022-04

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

| Characteristics                                          | Symbol    | Rating     | Unit               |
|----------------------------------------------------------|-----------|------------|--------------------|
| Drain-source voltage                                     | $V_{DS}$  | 40         | V                  |
| Gate-source voltage                                      | $V_{GS}$  | +20/-8     |                    |
| Drain current (DC) (Note 1)                              | $I_D$     | 90         | A                  |
| Drain current (pulsed) (Note 1)                          | $I_{DP}$  | 180        |                    |
| Power dissipation ( $T_c = 25\text{ }^{\circ}\text{C}$ ) | $P_D$     | 93         | W                  |
| Power dissipation ( $t = 10\text{ s}$ ) (Note 2)         |           | 3.0        |                    |
| Power dissipation ( $t = 10\text{ s}$ ) (Note 3)         |           | 0.96       |                    |
| Single-pulse avalanche energy (Note 4)                   | $E_{AS}$  | 87         | mJ                 |
| Single-pulse avalanche current                           | $I_{AS}$  | 45         | A                  |
| Channel temperature (Note 5)                             | $T_{ch}$  | 175        | $^{\circ}\text{C}$ |
| Storage temperature (Note 5)                             | $T_{stg}$ | -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.).

### 5. Thermal Characteristics

| Characteristics                                                          | Symbol         | Max | Unit                 |
|--------------------------------------------------------------------------|----------------|-----|----------------------|
| Channel-to-case thermal impedance ( $T_c = 25\text{ }^{\circ}\text{C}$ ) | $Z_{th(ch-c)}$ | 1.6 | $^{\circ}\text{C/W}$ |
| Channel-to-ambient thermal impedance ( $t = 10\text{ s}$ ) (Note 2)      | $Z_{th(ch-a)}$ | 50  |                      |
| Channel-to-ambient thermal impedance ( $t = 10\text{ s}$ ) (Note 3)      | $Z_{th(ch-a)}$ | 156 |                      |

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

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:  $V_{DD} = 32\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 33\text{ }\mu\text{H}$ ,  $R_G = 25\text{ }\Omega$ ,  $I_{AS} = 45\text{ A}$

Note 5: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

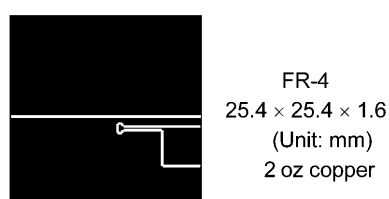


Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)

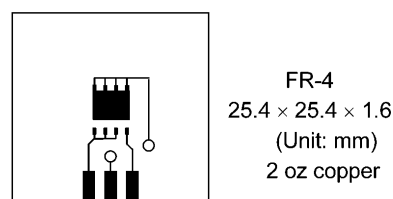


Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

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           | $I_{GSS}$     | $V_{GS} = +20/-8\text{ V}$ , $V_{DS} = 0\text{ V}$ | —   | —    | $\pm 1$ | $\mu\text{A}$    |
| 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                |
|                                | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}$ , $V_{GS} = -8\text{ V}$      | 20  | —    | —       |                  |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 0.3\text{ mA}$     | 2.0 | —    | 3.0     |                  |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 6\text{ V}$ , $I_D = 45\text{ A}$        | —   | 2.5  | 4.1     | $\text{m}\Omega$ |
|                                |               | $V_{GS} = 10\text{ V}$ , $I_D = 45\text{ A}$       | —   | 1.8  | 2.4     |                  |

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

| Characteristics                | Symbol    | Test Condition                                                      | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|---------------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = 10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | —   | 2500 | —   | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                                     | —   | 190  | —   |             |
| Output capacitance             | $C_{oss}$ |                                                                     | —   | 1600 | —   |             |
| Gate resistance                | $r_g$     |                                                                     | —   | 2.6  | 5.2 | $\Omega$    |
| Switching time (rise time)     | $t_r$     | See Fig. 6.2.1                                                      | —   | 24   | —   | ns          |
| Switching time (turn-on time)  | $t_{on}$  |                                                                     | —   | 36   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                                     | —   | 22   | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                                     | —   | 79   | —   |             |

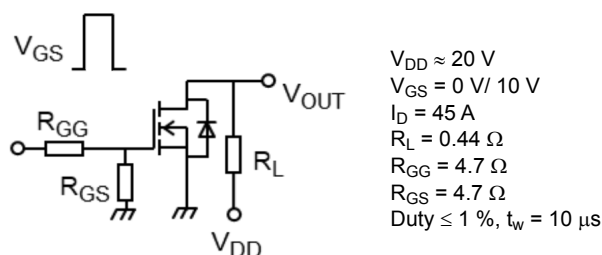


Fig. 6.2.1 Switching Time Test Circuit

### 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) | $Q_g$     | $V_{DD} \approx 32\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 90\text{ A}$ | —   | 40   | —   | nC   |
| Gate-source charge 1                            | $Q_{gs1}$ |                                                                             | —   | 15   | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |                                                                             | —   | 7    | —   |      |

### 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) | $I_{DRP}$ | —                                              | —   | —    | 180  | A    |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 90\text{ A}$ , $V_{GS} = 0\text{ V}$ | —   | —    | -1.2 | V    |

Note 6: Ensure that the channel temperature does not exceed  $175\text{ }^{\circ}\text{C}$ .

## 7. Marking

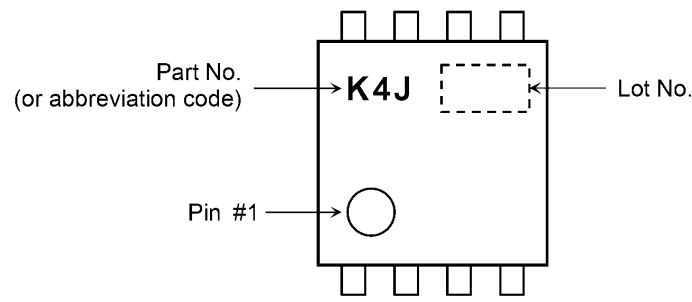
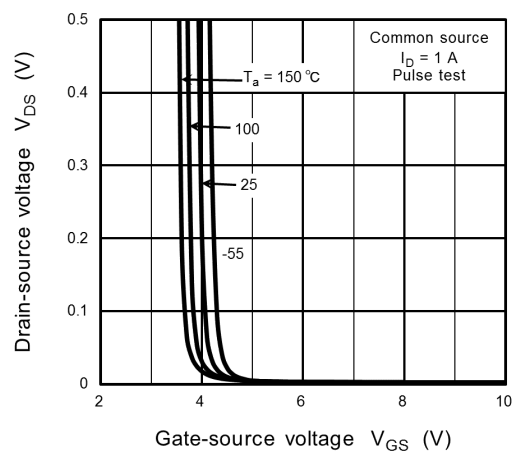
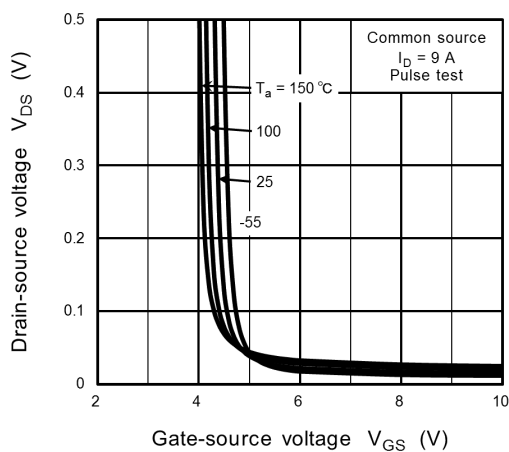
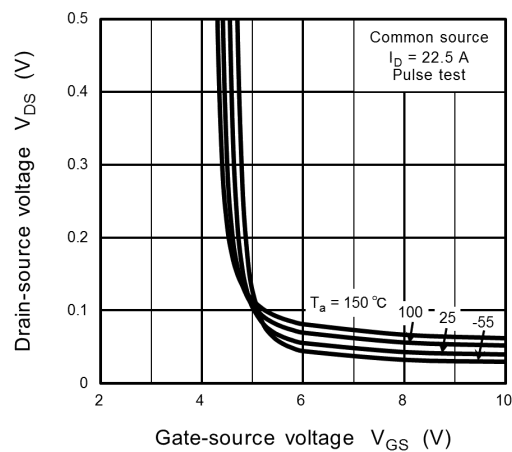
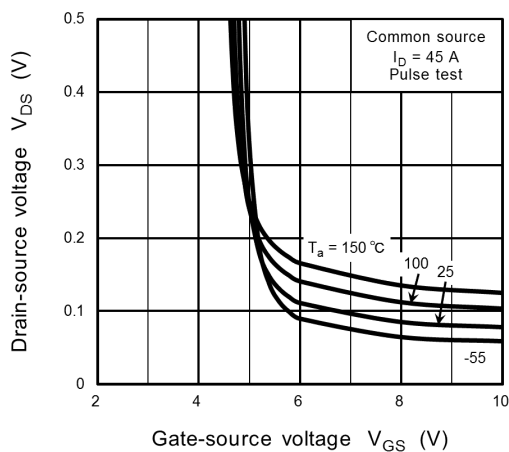
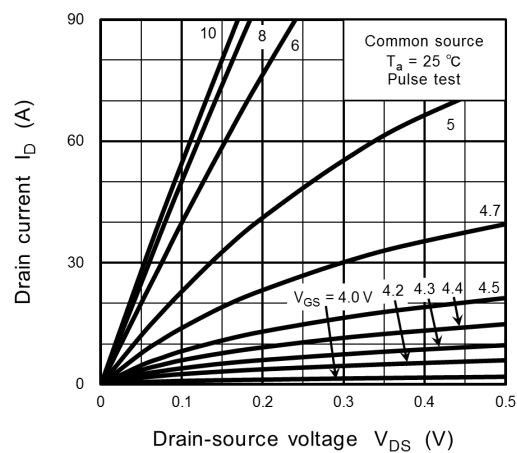
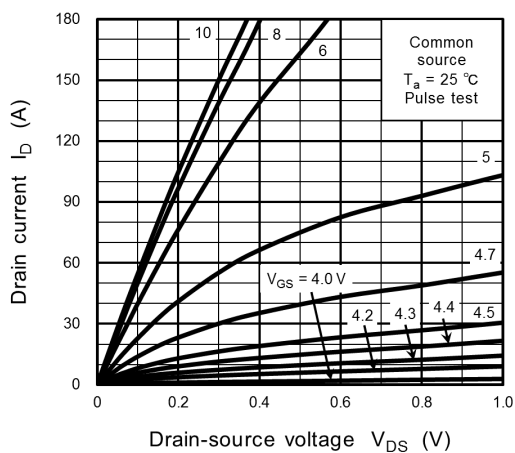


Fig. 7.1 Marking

8. Characteristics Curves (Note)



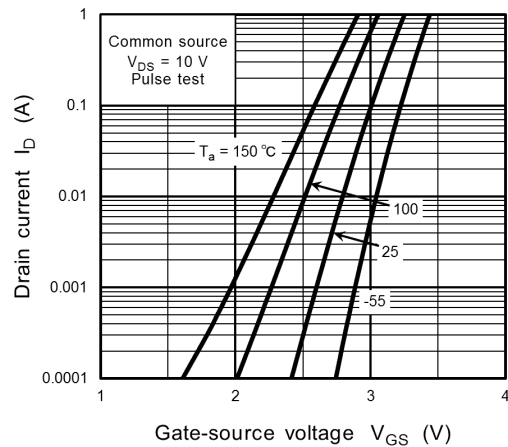


Fig. 8.7  $I_D - V_{GS}$

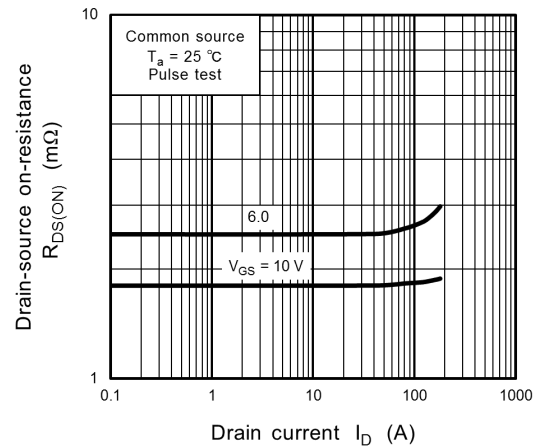


Fig. 8.8  $R_{DS(ON)} - I_D$

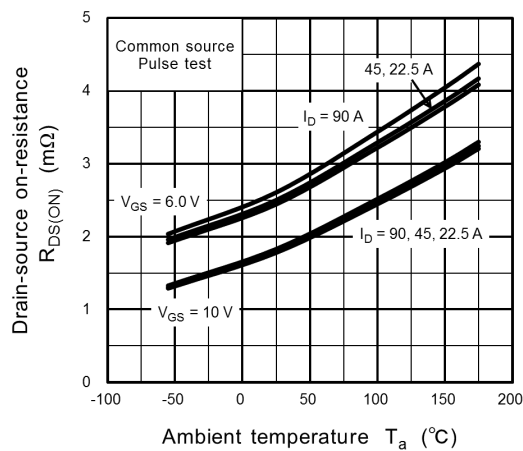


Fig. 8.9  $R_{DS(ON)} - T_a$

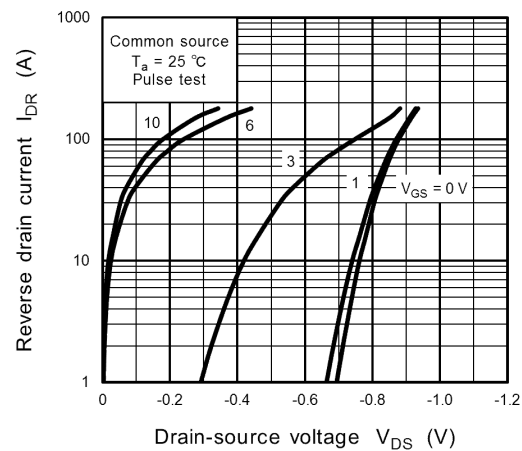


Fig. 8.10  $I_{DR} - V_{DS}$

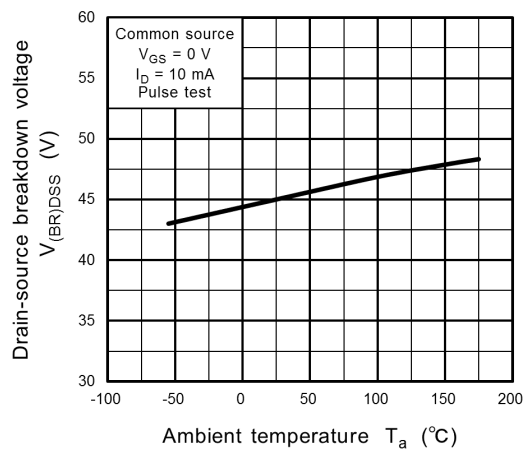


Fig. 8.11  $V_{(BR)DSS} - T_a$

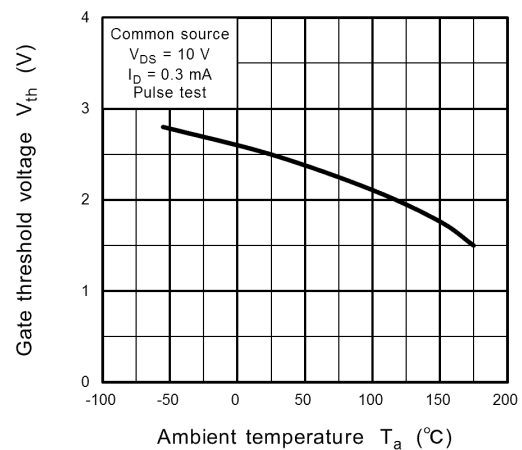


Fig. 8.12  $V_{th} - T_a$

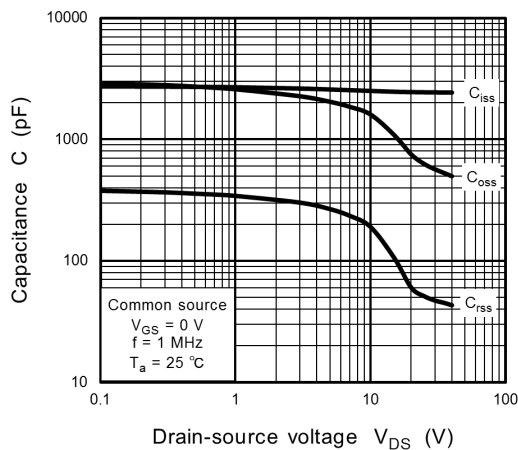


Fig. 8.13 Capacitance -  $V_{DS}$

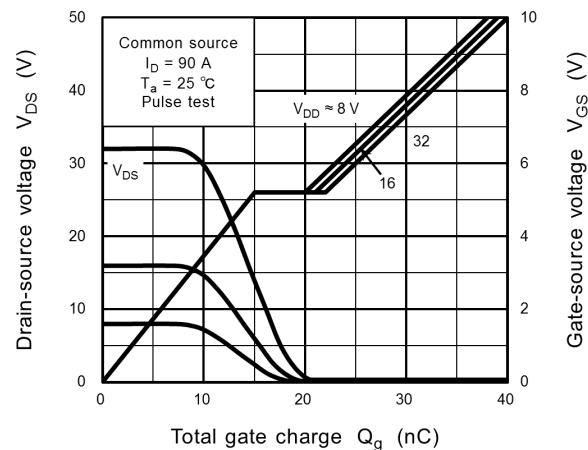


Fig. 8.14 Dynamic Input/Output Characteristics

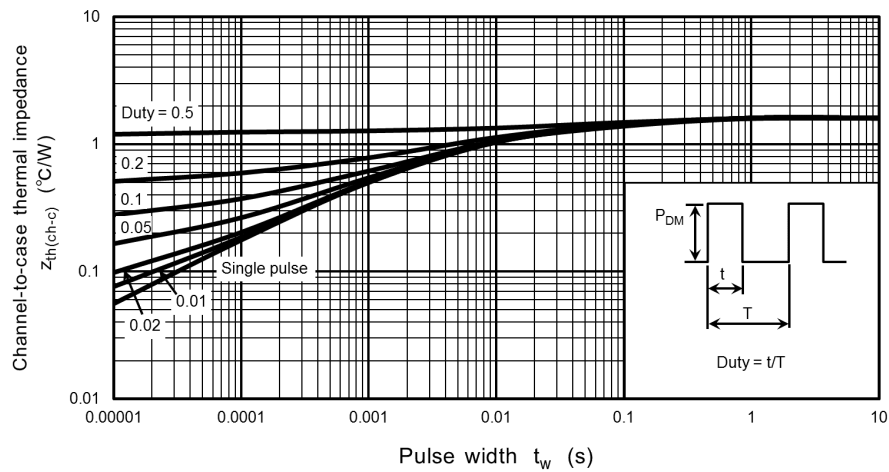


Fig. 8.15  $z_{th(ch-c)} - t_w$   
(Guaranteed Maximum)

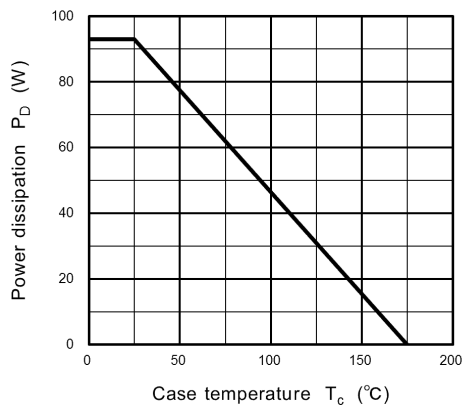


Fig. 8.16  $P_D - T_c$   
(Guaranteed Maximum)

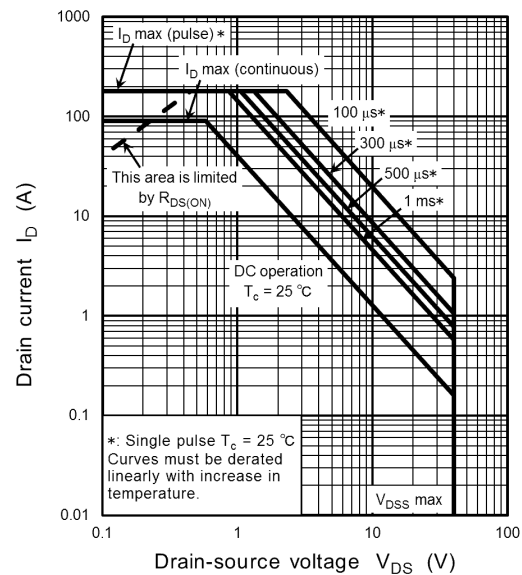
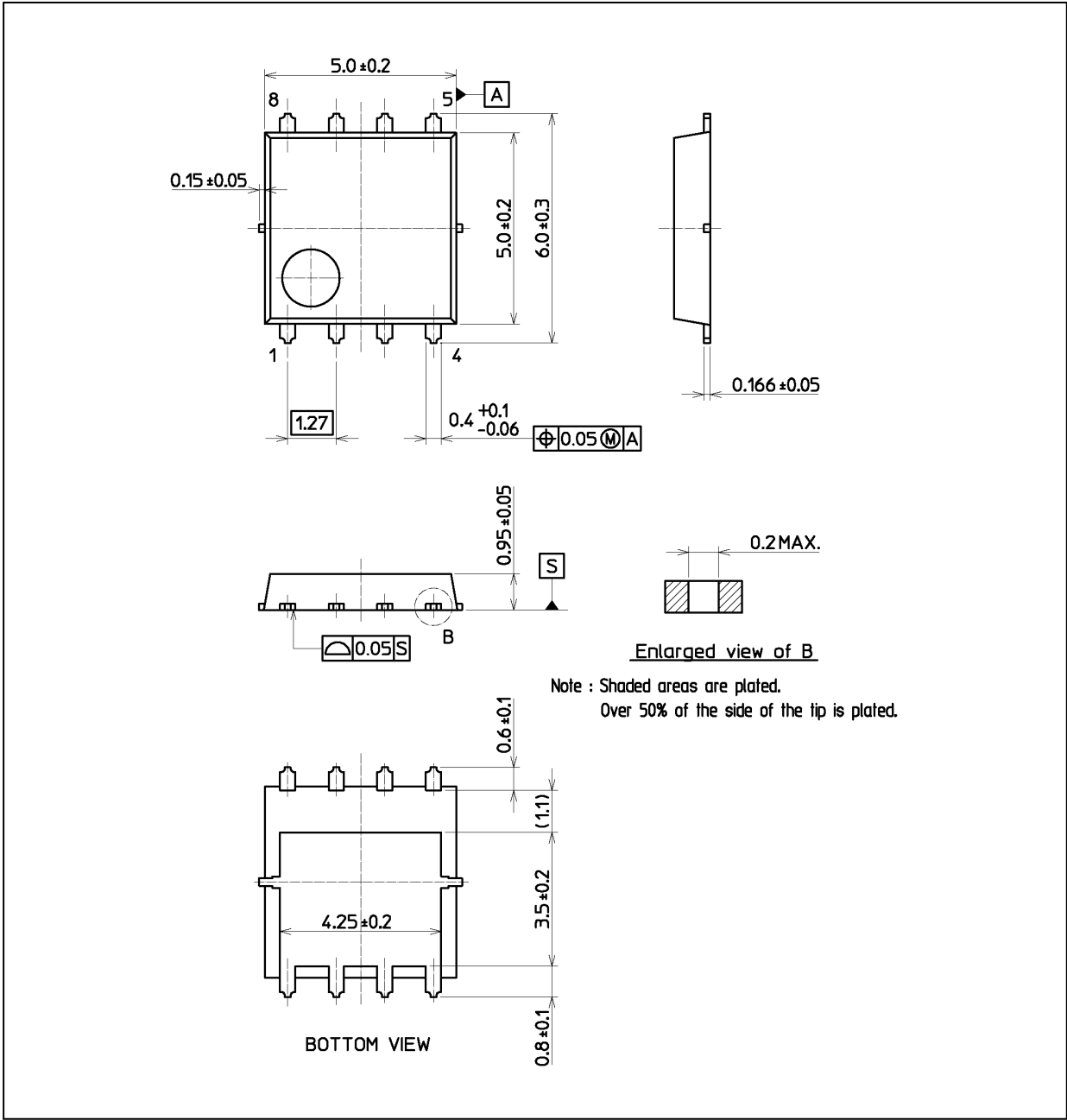


Fig. 8.17 Safe Operating Area  
(Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

| Package Name(s)           |
|---------------------------|
| TOSHIBA: 2-5Q4A           |
| Nickname: SOP Advance(WF) |

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