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

# XPH2R106NC

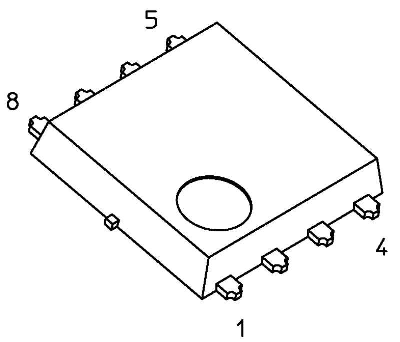
## 1. Applications

- Automotive
- Motor Drivers
- Switching Voltage Regulators

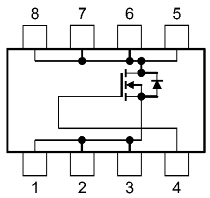
## 2. Features

(1) AEC-Q101 qualified
(2) Small, thin package
(3) Low drain-source on-resistance: $R_{DS(ON)}$ = 1.7 mΩ (typ.) ($V_{GS}$ = 10 V)
(4) Low leakage current: $I_{DSS}$ = 10 μA (max) ($V_{DS}$ = 60 V)
(5) Enhancement mode: $V_{th}$ = 1.5 to 2.5 V ($V_{DS}$ = 10 V, $I_D$ = 1.0 mA)

## 3. Packaging and Internal Circuit




SOP Advance(WF)




1, 2, 3: Source
4: Gate
5, 6, 7, 8: Drain

Start of commercial production
2020-11

## 4. Absolute Maximum Ratings (Note) ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | | | Symbol | Rating | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DSS}$ | 60 | V |
| Gate-source voltage | | | $V_{GSS}$ | ±20 | |
| Drain current (DC) | | (Note 1) | $I_D$ | 110 | A |
| Drain current (pulsed) | | (Note 1) | $I_{DP}$ | 330 | |
| Power dissipation | ($T_c$ = 25 °C) | | $P_D$ | 170 | W |
| Power dissipation | (t = 10 s) | (Note 2) | | 3.0 | |
| Power dissipation | (t = 10 s) | (Note 3) | | 0.96 | |
| Single-pulse avalanche energy | | (Note 4) | $E_{AS}$ | 256 | mJ |
| Single-pulse avalanche current | | | $I_{AS}$ | 110 | A |
| Channel temperature | | (Note 5) | $T_{ch}$ | 175 | °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 °C) | | $z_{th(ch-c)}$ | 0.88 | °C/W |
| Channel-to-ambient thermal impedance | (t = 10 s) | (Note 2) | $z_{th(ch-a)}$ | 50 | |
| Channel-to-ambient thermal impedance | (t = 10 s) | (Note 3) | $z_{th(ch-a)}$ | 156 | |

Note 1: Ensure that the channel temperature does not exceed 175 °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: $V_{DD}$ = 48 V, $T_{ch}$ = 25 °C (initial), L = 16.3 μH, $R_G$ = 25 Ω, $I_{AS}$ = 110 A
Note 5: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

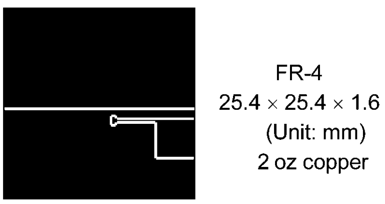



**Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)**

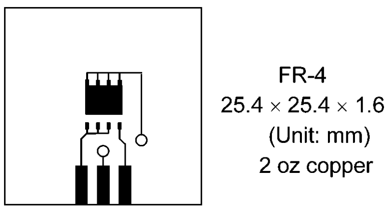



**Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)**

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

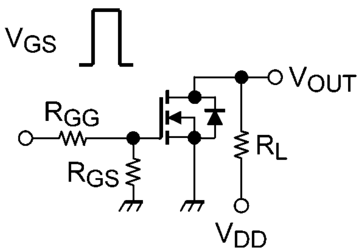
# 6. Electrical Characteristics

## 6.1. Static Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Gate leakage current | $I_{GSS}$ | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | — | — | ±1 | μA |
| Drain cut-off current | $I_{DSS}$ | $V_{DS}$ = 60 V, $V_{GS}$ = 0 V | — | — | 10 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D$ = 10 mA, $V_{GS}$ = 0 V | 60 | — | — | V |
| | $V_{(BR)DSX}$ | $I_D$ = 10 mA, $V_{GS}$ = -20 V | 40 | — | — | |
| Gate threshold voltage | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 1.0 mA | 1.5 | — | 2.5 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS}$ = 4.5 V, $I_D$ = 55 A | — | 2.5 | 4.1 | mΩ |
| | | $V_{GS}$ = 10 V, $I_D$ = 55 A | — | 1.7 | 2.1 | |

## 6.2. Dynamic Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 10 V, $V_{GS}$ = 0 V, f = 1 MHz | — | 6900 | — | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 250 | — | |
| Output capacitance | $C_{oss}$ | | — | 3200 | — | |
| Gate resistance | $r_g$ | | — | 2.6 | 5.2 | Ω |
| Switching time (rise time) | $t_r$ | See Fig. 6.2.1 | — | 27 | — | ns |
| Switching time (turn-on time) | $t_{on}$ | | — | 57 | — | |
| Switching time (fall time) | $t_f$ | | — | 32 | — | |
| Switching time (turn-off time) | $t_{off}$ | | — | 135 | — | |




$V_{DD}$ ≈ 30 V
$V_{GS}$ = 0 V/ 10 V
$I_D$ = 55 A
$R_L$ = 0.55 Ω
$R_{GG}$ = 4.7 Ω
$R_{GS}$ = 4.7 Ω
Duty ≤ 1 %, $t_w$ = 10 μs

**Fig. 6.2.1 Switching Time Test Circuit**

## 6.3. Gate Charge Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge (gate-source plus gate-drain) | $Q_g$ | $V_{DD}$ ≈ 48 V, $V_{GS}$ = 10 V, $I_D$ = 110 A | — | 104 | — | nC |
| Gate-source charge 1 | $Q_{gs1}$ | | — | 28 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 16 | — | |

## 6.4. Source-Drain Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Reverse drain current (pulsed) (Note 6) | $I_{DRP}$ | — | — | — | 330 | A |
| Diode forward voltage | $V_{DSF}$ | $I_{DR}$ = 110 A, $V_{GS}$ = 0 V | — | — | -1.2 | V |

Note 6: Ensure that the channel temperature does not exceed 175 °C.

## 7. Marking

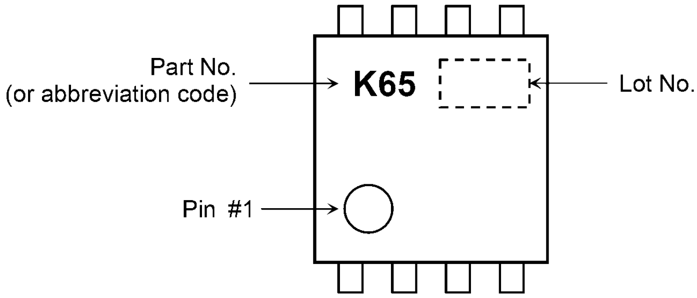



**Fig. 7.1 Marking**

## 8. Characteristics Curves (Note)

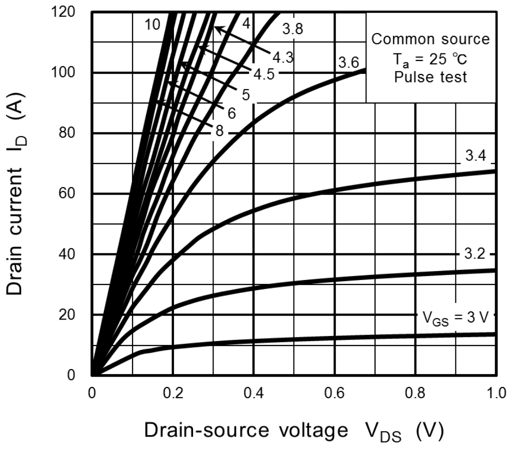



**Fig. 8.1 $I_D$ - $V_{DS}$**

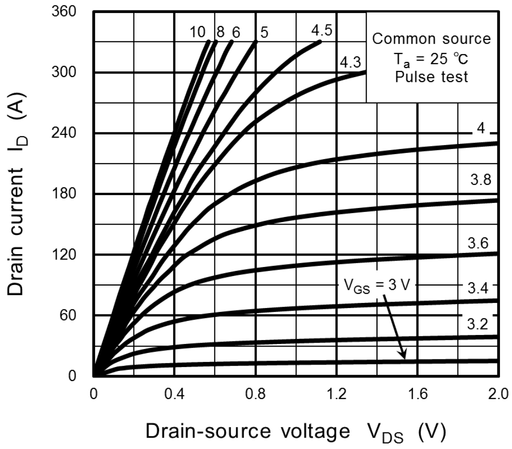



**Fig. 8.2 $I_D$ - $V_{DS}$**

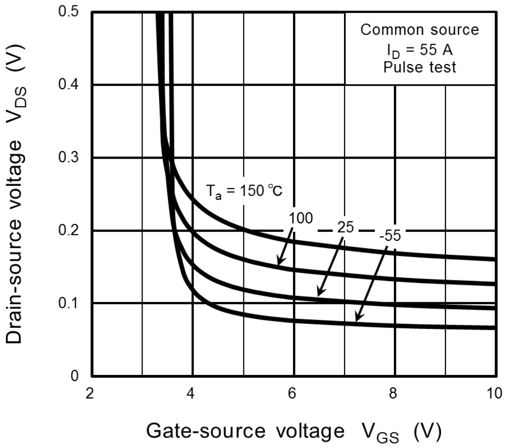



**Fig. 8.3 $V_{DS}$ - $V_{GS}$**

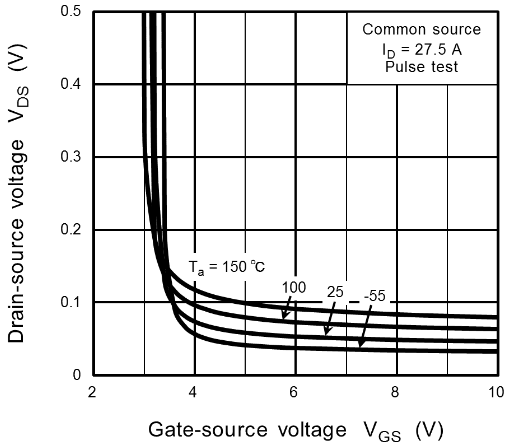



**Fig. 8.4 $V_{DS}$ - $V_{GS}$**

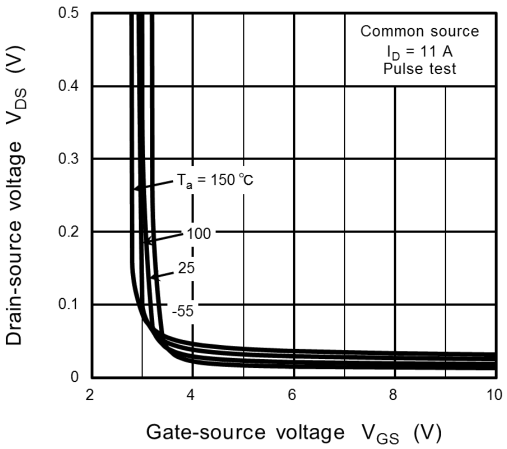



**Fig. 8.5 $V_{DS}$ - $V_{GS}$**

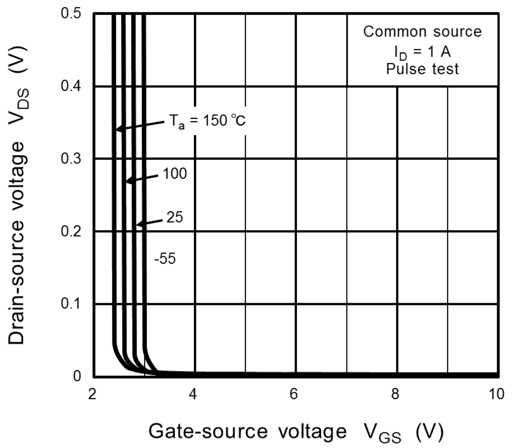



**Fig. 8.6 $V_{DS}$ - $V_{GS}$**

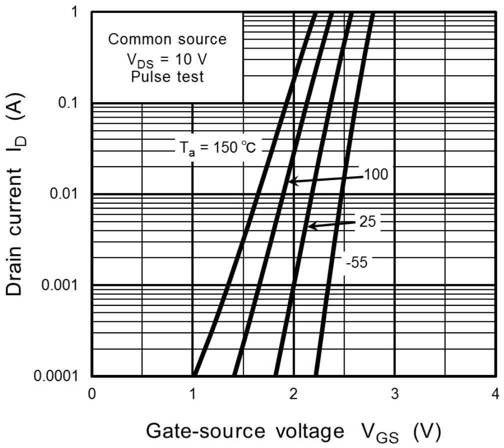



Fig. 8.7 $I_D$ - $V_{GS}$

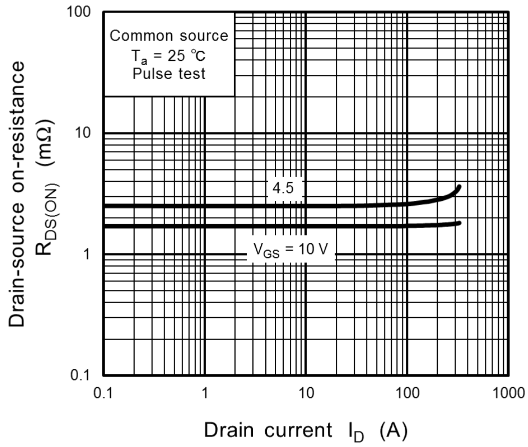



Fig. 8.8 $R_{DS(ON)}$ - $I_D$

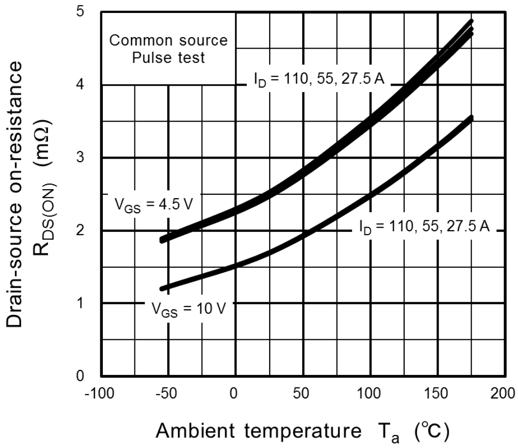



Fig. 8.9 $R_{DS(ON)}$ - $T_a$

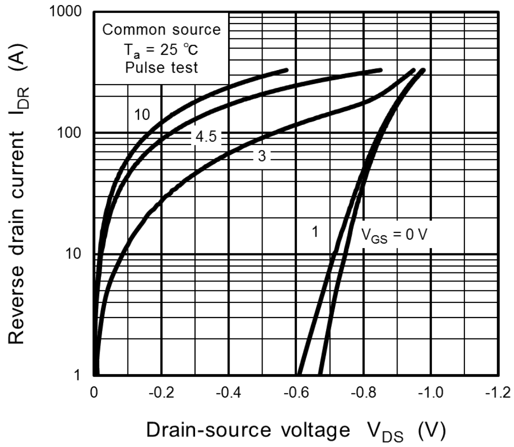



Fig. 8.10 $I_{DR}$ - $V_{DS}$

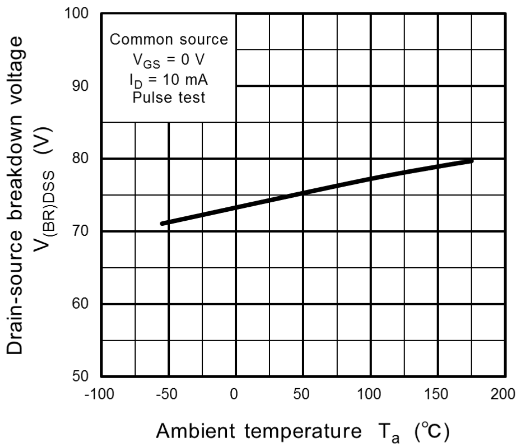



Fig. 8.11 $V_{(BR)DSS}$ - $T_a$

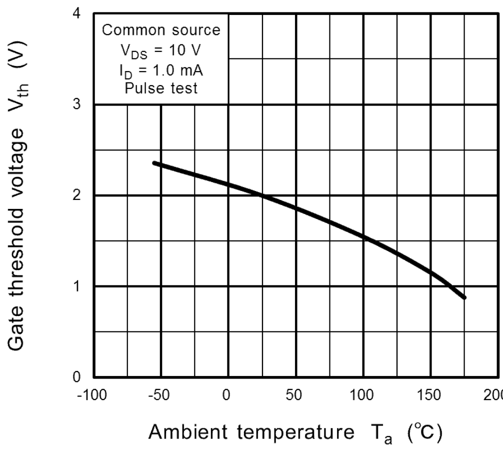



Fig. 8.12 $V_{th}$ - $T_a$

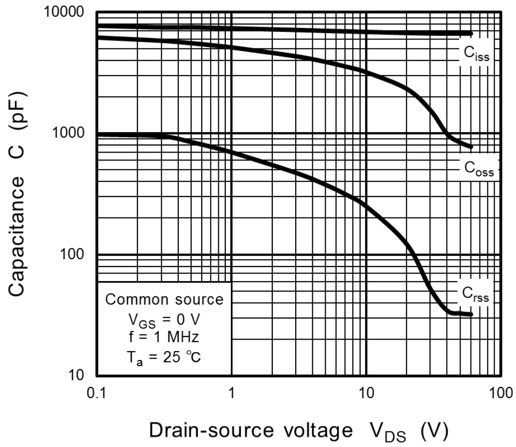



**Fig. 8.13 Capacitance - $V_{DS}$**

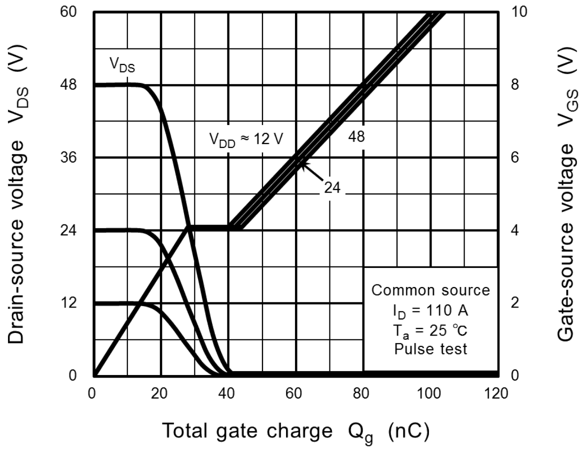



**Fig. 8.14 Dynamic Input/Output Characteristics**

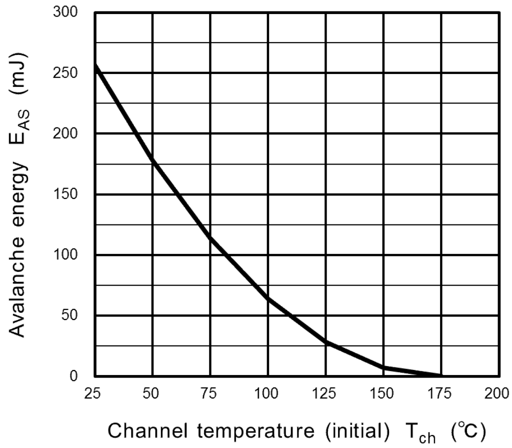
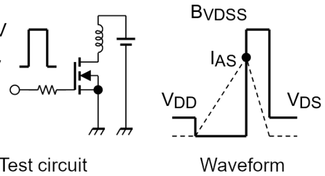



**Fig. 8.15 $E_{AS}$ - $T_{ch}$(Guaranteed Maximum)**




$R_G$ = 25 Ω
$V_{DD}$ = 48 V, L = 16.3 μH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I_{AS}^2 \cdot \left( \frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

**Fig. 8.16 Test Circuit/Waveform**

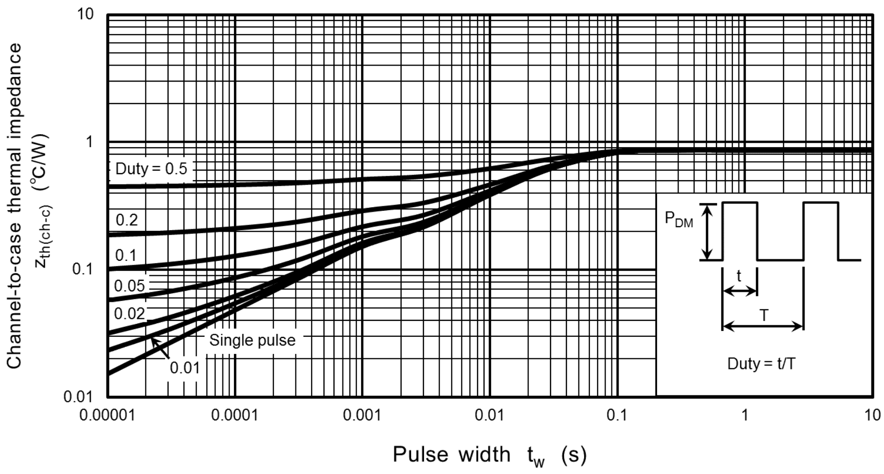



**Fig. 8.17 $z_{th(ch-c)}$ - $t_w$**
**(Guaranteed Maximum)**

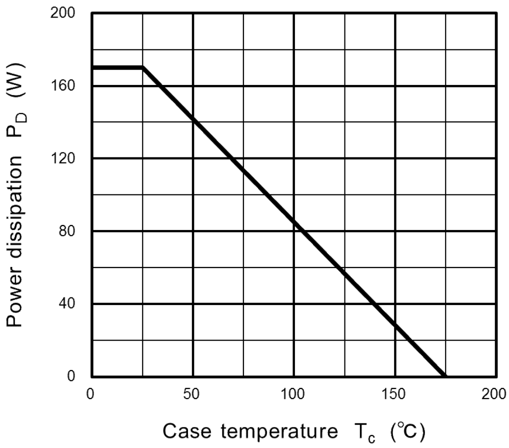



**Fig. 8.18 $P_D$ - $T_c$**
**(Guaranteed Maximum)**

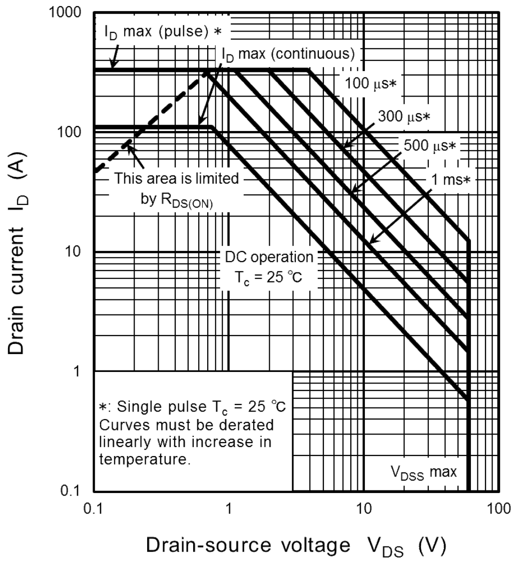
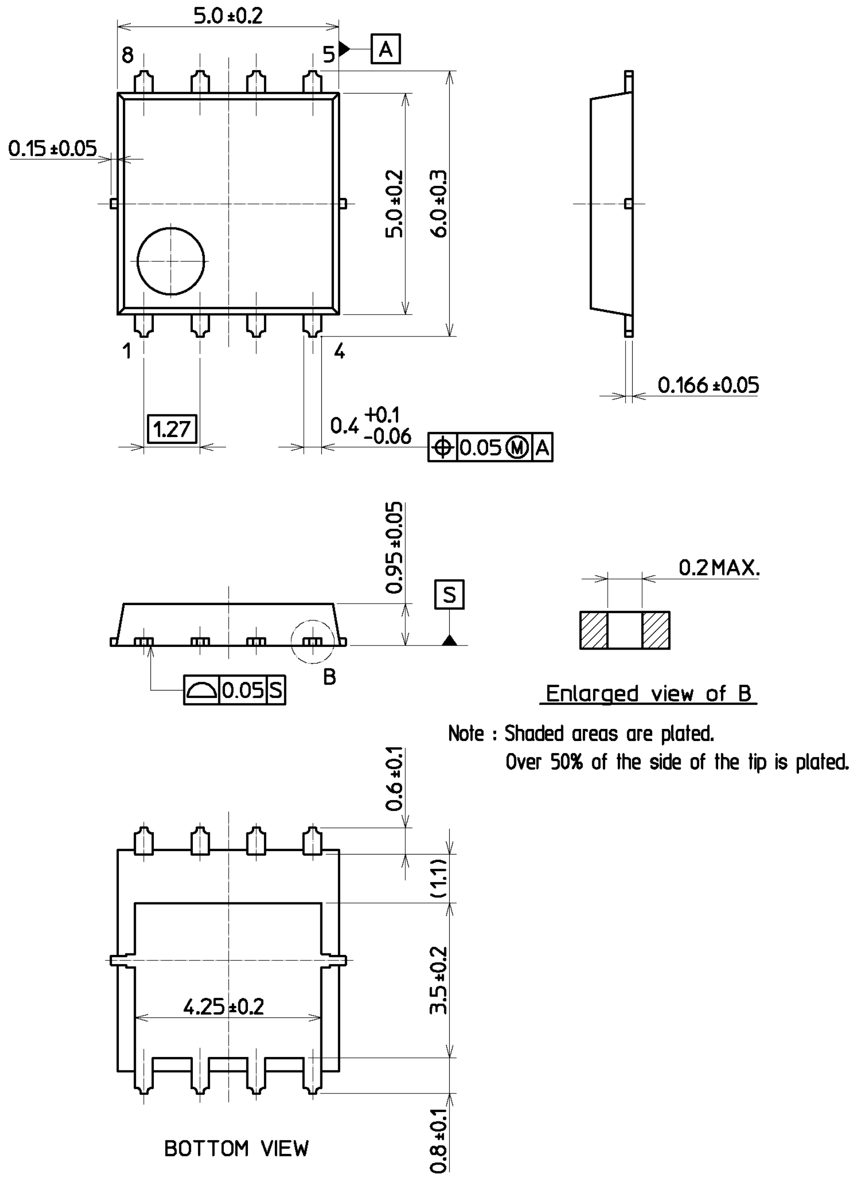



**Fig. 8.19 Safe Operating Area**
**(Guaranteed Maximum)**

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

## Package Dimensions

Unit: mm




Weight: 0.083 g (typ.)

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

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