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

# XSM6K376NW

## 1. Applications

- Power Management Switches
- DC-DC Converters

## 2. Features

(1) 1.8-V gate drive voltage.

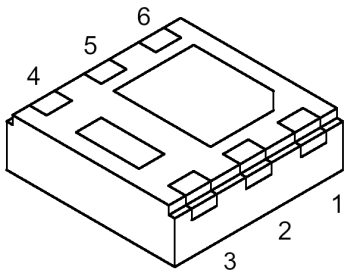
(2) Low drain-source on-resistance

: $R_{DS(ON)}$ = 56 mΩ (max) (@$V_{GS}$ = 4.5 V)

$R_{DS(ON)}$ = 72 mΩ (max) (@$V_{GS}$ = 2.5 V)

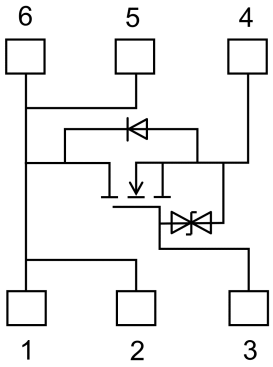
$R_{DS(ON)}$ = 109 mΩ (max) (@$V_{GS}$ = 1.8 V)

## 3. Packaging and Pin Assignment




Bottom View

DFN2020B(WF)




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

Start of commercial production
2025-04

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

| Characteristics | | | Symbol | Rating | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DSS}$ | 30 | V |
| Gate-source voltage | | | $V_{GSS}$ | 12/-8 | |
| Drain current (DC) | | (Note 1) | $I_D$ | 4.0 | A |
| Drain current (pulsed) | (t ≤ 10 ms) | (Note 1), (Note 2) | $I_{DP}$ | 10 | |
| Power dissipation | | (Note 3) | $P_D$ | 1.51 | W |
| Power dissipation | (t ≤ 10 s) | (Note 3) | $P_D$ | 3.3 | |
| Single-pulse avalanche energy | | (Note 4) | $E_{AS}$ | 4.2 | mJ |
| Single-pulse avalanche current | | | $I_{AS}$ | 4.0 | A |
| Channel temperature | | | $T_{ch}$ | 150 | °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).

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

Note 2: Pulse width (PW) ≤ 10 ms, duty ≤ 1%

Note 3: Device mounted on an FR4 board. (25.4 mm × 25.4 mm × 1.6 mm ,Cu pad: 645 $mm^2$)

Note 4: $V_{DD}$ = 24 V, $T_{ch}$ = 25 °C (initial), L = 0.2 mH, $R_G$ = 25 Ω, $I_{AS}$ = 4.0 A

Note: The MOSFETs in this device are sensitive to electrostatic discharge. When handling this device, the worktables, operators, soldering irons and other objects should be protected against anti-static discharge.

Note: The channel-to-ambient thermal resistance, $R_{th(ch-a)}$, and the drain power dissipation, $P_D$, vary according to the board material, board area, board thickness and pad area. When using this device, be sure to take heat dissipation fully into account.

# 5. Electrical Characteristics

## 5.1. Static Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate leakage current | (Note 3) | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = 10/-8 V | — | — | ±10 | μA |
| Drain cut-off current | (Note 3) | $I_{DSS}$ | $V_{DS}$ = 24 V, $V_{GS}$ = 0 V | — | — | 1 | |
| Drain-source breakdown voltage | (Note 3) | $V_{(BR)DSS}$ | $I_D$ = 1 mA, $V_{GS}$ = 0 V | 30 | — | — | V |
| Drain-source breakdown voltage | (Note 1), (Note 3) | $V_{(BR)DSX}$ | $I_D$ = 1 mA, $V_{GS}$ = -8 V | 22 | — | — | |
| Gate threshold voltage | (Note 2), (Note 3) | $V_{th}$ | $V_{DS}$ = 3 V, $I_D$ = 1 mA | 0.40 | — | 1.00 | |
| Drain-source on-resistance | (Note 3) | $R_{DS(ON)}$ | $I_D$ = 2.0 A, $V_{GS}$ = 4.5 V | — | 45 | 56 | mΩ |
| | | | $I_D$ = 1.0 A, $V_{GS}$ = 2.5 V | — | 55 | 72 | |
| | | | $I_D$ = 0.5 A, $V_{GS}$ = 1.8 V | — | 69 | 109 | |

Note 1: 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.

Note 2: Let $V_{th}$ be the voltage applied between gate and source that causes the drain current ($I_D$) to below (1 mA for this device). Then, for normal switching operation, $V_{GS(ON)}$ must be higher than $V_{th}$, and $V_{GS(OFF)}$ must be lower than $V_{th}$. This relationship can be expressed as: $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$.
Take this into consideration when using the device.

Note 3: Pulse measurement.

## 5.2. Dynamic Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 10 V , $V_{GS}$ = 0 V, f = 1 MHz | — | 200 | — | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 13 | — | |
| Output capacitance | $C_{oss}$ | | — | 40 | — | |
| Switching time (turn-on time) | $t_{on}$ | See Fig. 5.2.1 | — | 9 | — | ns |
| Switching time (turn-off time) | $t_{off}$ | | — | 9.5 | — | |

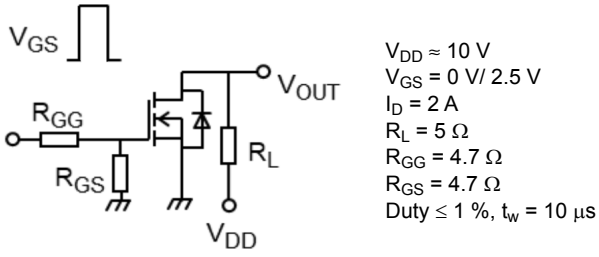



**Fig. 5.2.1 Switching Time Test Circuit**

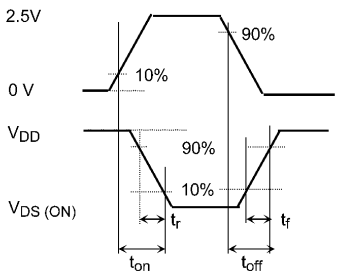



**Fig. 5.2.2 Input Waveform/Output Waveform**

### 5.3. Gate Charge Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge (gate-source plus gate-drain) | $Q_g$ | $V_{DD}$ = 10 V, $I_D$ = 2.4 A, $V_{GS}$ = 4.5 V | — | 2.2 | — | nC |
| Gate-source charge 1 | $Q_{gs1}$ | | — | 0.5 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 0.9 | — | |

### 5.4. Source-Drain Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Diode forward voltage | (Note 1) | $V_{DSF}$ | $I_{DR}$ = 4 A, $V_{GS}$ = 0 V | — | -0.8 | -1.2 | V |

Note 1: Pulse measurement.

## 6. Marking

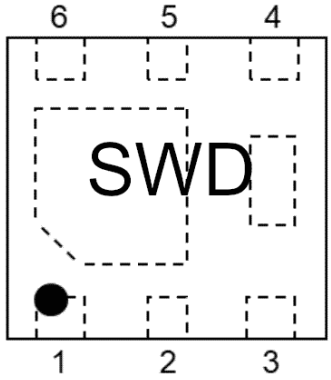



Fig. 6.1 Marking

## 7. Characteristics Curves (Note)

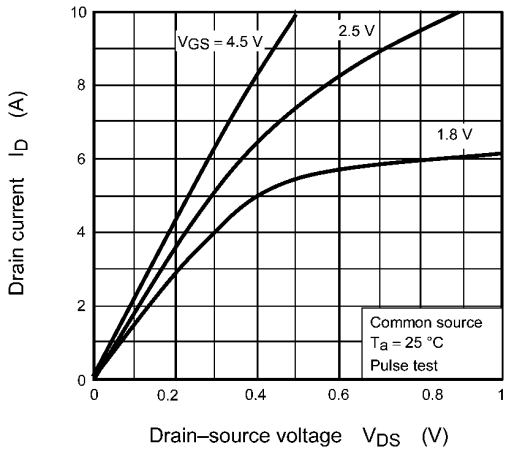



Fig. 7.1 $I_D$ - $V_{DS}$

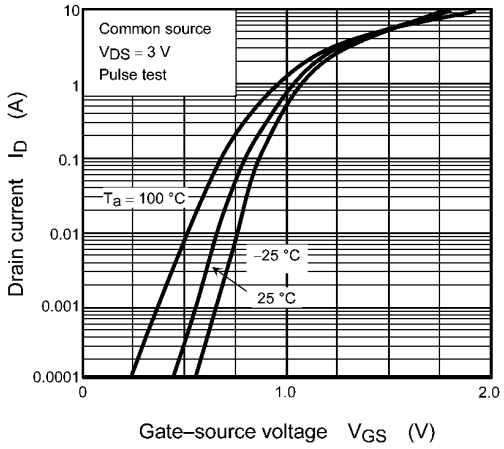



Fig. 7.2 $I_D$ - $V_{GS}$

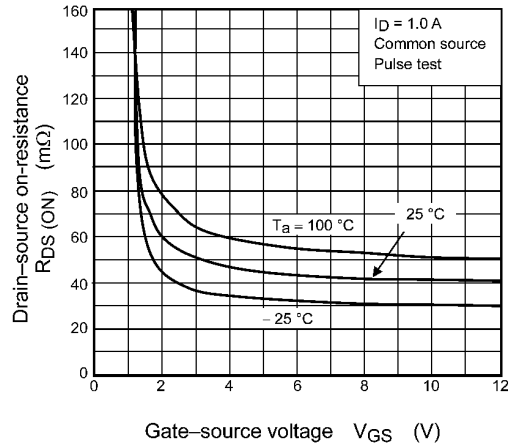



Fig. 7.3 $R_{DS(ON)}$ - $V_{GS}$

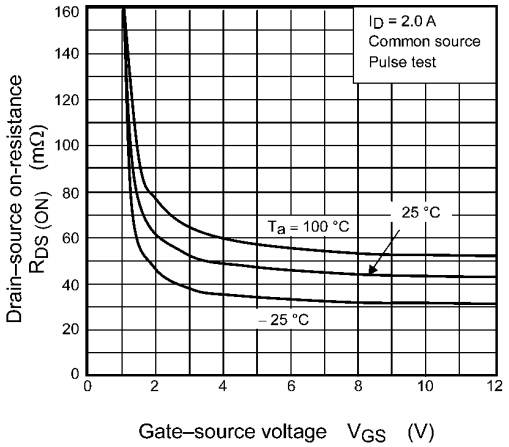



Fig. 7.4 $R_{DS(ON)}$ - $V_{GS}$

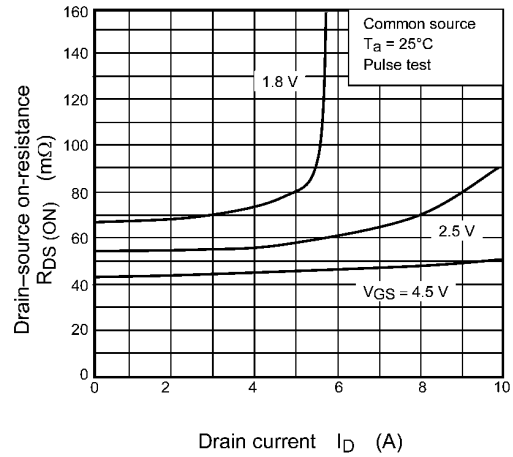



Fig. 7.5 $R_{DS(ON)}$ - $I_D$

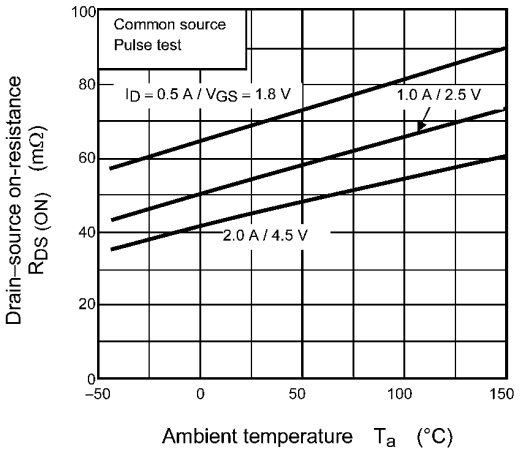



Fig. 7.6 $R_{DS(ON)}$ - $T_a$

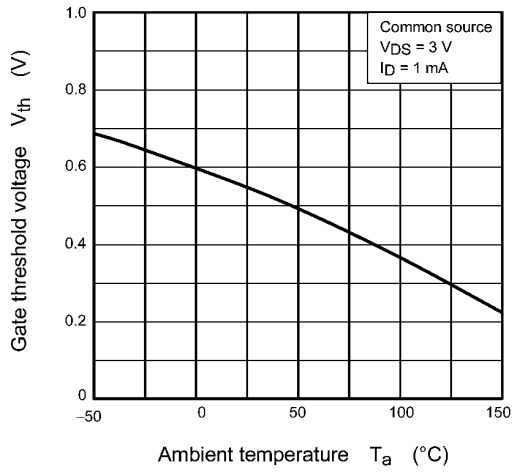



Fig. 7.7 $V_{th}$ - $T_a$

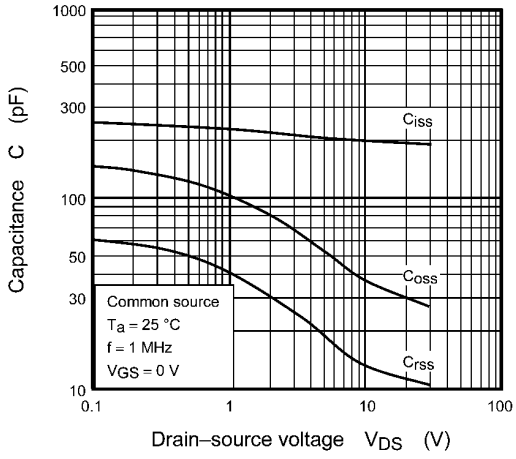



Fig. 7.8 C - $V_{DS}$

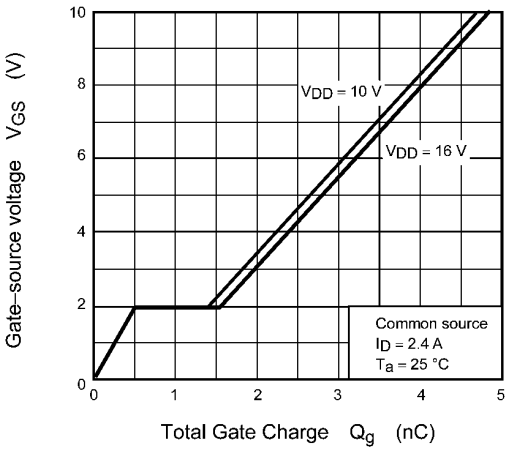



Fig. 7.9 Dynamic Input Characteristics

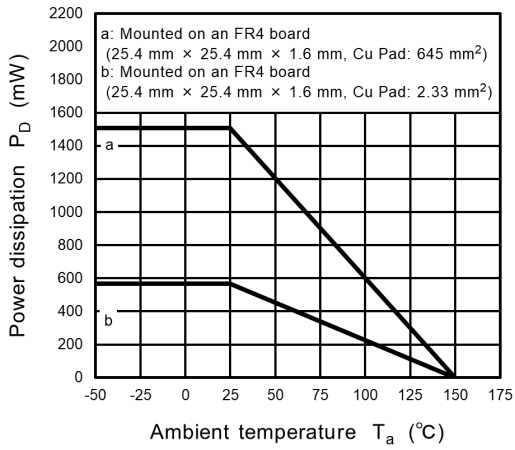



Fig. 7.10 $P_D$ - $T_a$

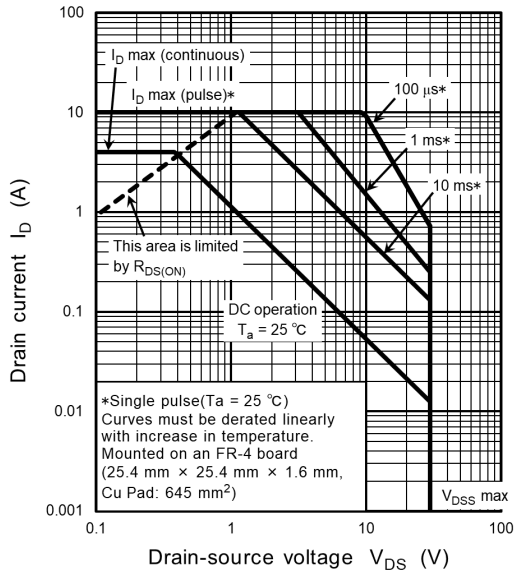



Fig. 7.11 Safe_Operating_Area

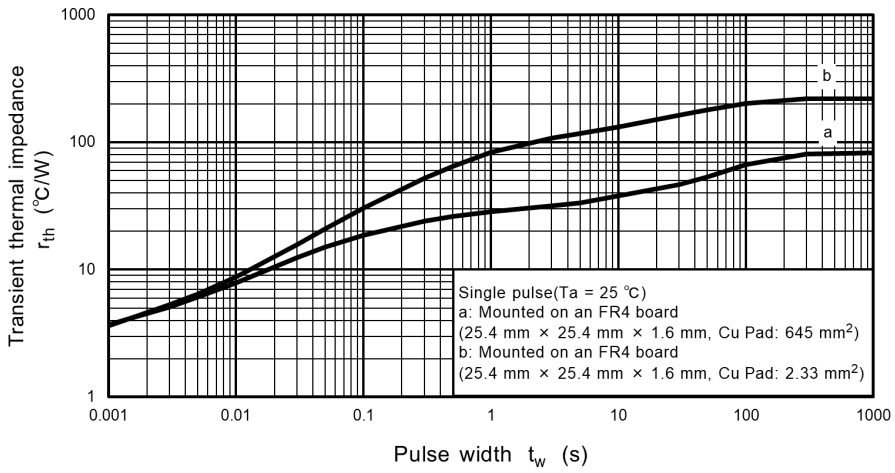
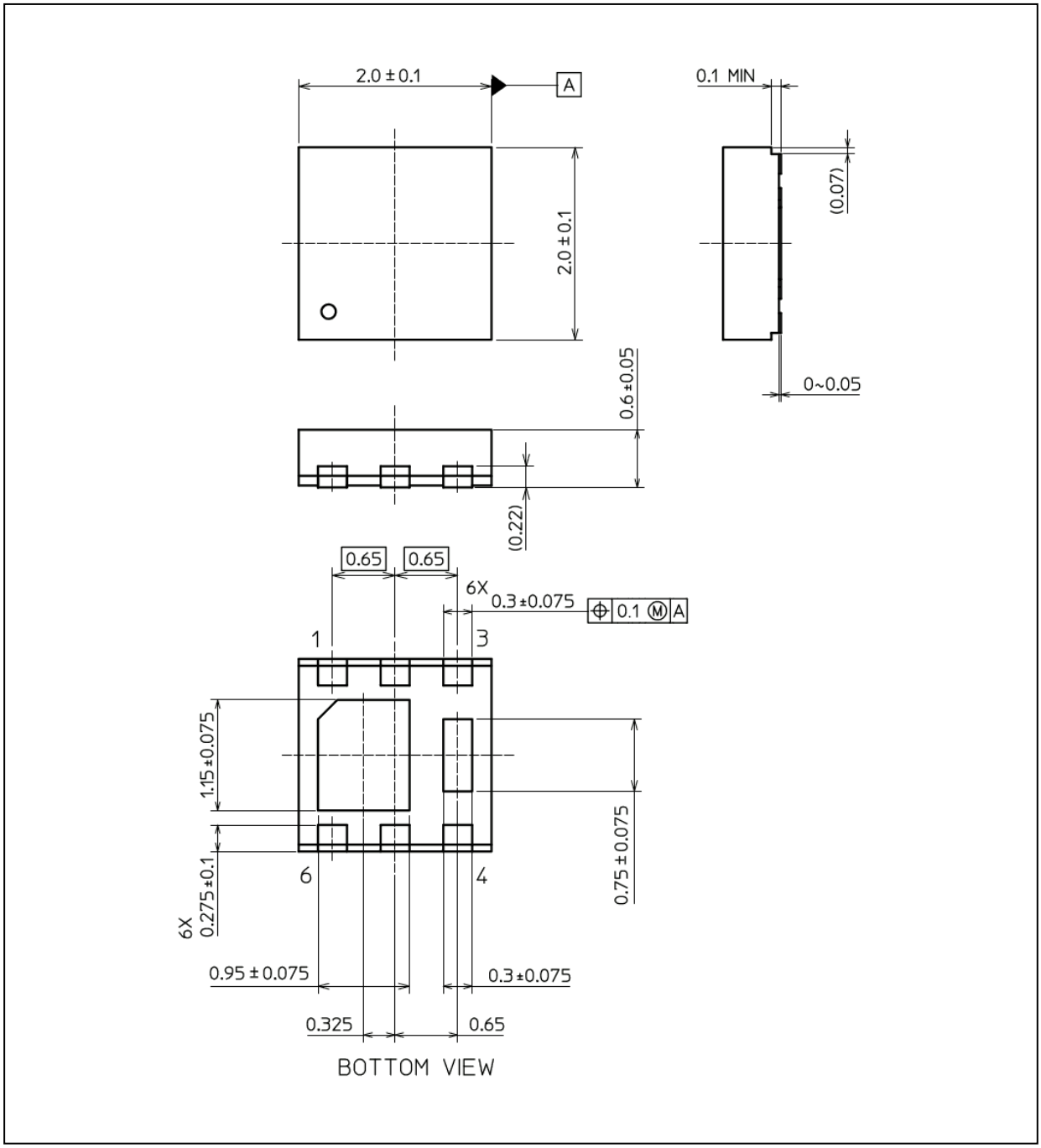



**Fig. 7.12 $r_{th}$ - $t_w$**

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

## Package Dimensions

Unit: mm




Weight: 8.0 mg (typ.)

| Package Name(s) |
|---|
| JEDEC: SOT-1220 |
| Nickname: DFN2020B(WF) |

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