MOSFETs Silicon P-Channel MOS (U-MOSⅥ)

# SSM6J503NU

## 1. Applications

- Power Management Switches

## 2. Features

(1) 1.5-V drive

(2) Low drain-source on-resistance

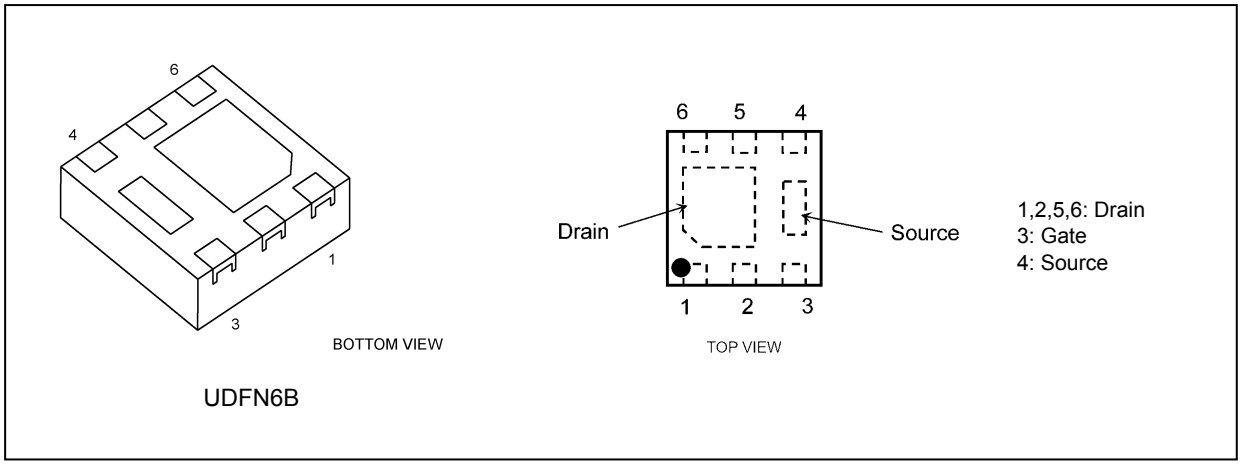
: $R_{DS(ON)}$ = 89.6 mΩ (max) (@$V_{GS}$ = -1.5 V)

$R_{DS(ON)}$ = 57.9 mΩ (max) (@$V_{GS}$ = -1.8 V)

$R_{DS(ON)}$ = 41.7 mΩ (max) (@$V_{GS}$ = -2.5 V)

$R_{DS(ON)}$ = 32.4 mΩ (max) (@$V_{GS}$ = -4.5 V)

## 3. Packaging and Pin Assignment




UDFN6B

Start of commercial production
2010-11

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

| Characteristics | | | Symbol | Rating | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DSS}$ | -20 | V |
| Gate-source voltage | | | $V_{GSS}$ | ±8 | V |
| Drain current (DC) | | (Note 1) | $I_D$ | -6.0 | A |
| Drain current (pulsed) | | (Note 1), (Note 2) | $I_{DP}$ | -24.0 | |
| Power dissipation | | (Note 3) | $P_D$ | 1.25 | W |
| Power dissipation | t ≤ 10 s | (Note 3) | | 2 | |
| Channel temperature | | | $T_{ch}$ | 150 | °C |
| Storage temperature | | | $T_{stg}$ | -55 to 150 | °C |

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 a FR4 board.
(25.4 mm × 25.4 mm × 1.6 mm, Cu Pad : 645 mm²)

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. Thermal Characteristics

| Characteristics | | Symbol | Max | Unit |
|---|---|---|---|---|
| Channel-to-ambient thermal resistance | (Note 1) | $R_{th(ch-a)}$ | 100 | °C/W |

Note 1: Device mounted on an 25.4 mm × 25.4 mm × 1.6 mm FR4 glass epoxy board (Cu pad: 645 mm²)

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# 6. Electrical Characteristics

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

| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate leakage current | | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ±8 V | — | — | ±1 | μA |
| Drain cut-off current | | $I_{DSS}$ | $V_{DS}$ = -20 V, $V_{GS}$ = 0 V | — | — | -1 | μA |
| Drain-source breakdown voltage | | $V_{(BR)DSS}$ | $I_D$ = -1 mA, $V_{GS}$ = 0 V | -20 | — | — | V |
| Drain-source breakdown voltage | (Note 1) | $V_{(BR)DSX}$ | $I_D$ = -1 mA, $V_{GS}$ = 5 V | -15 | — | — | |
| Gate threshold voltage | (Note 2) | $V_{th}$ | $V_{DS}$ = -3 V, $I_D$ = -1 mA | -0.3 | — | -1.0 | V |
| Drain-source on-resistance | (Note 3) | $R_{DS(ON)}$ | $I_D$ = -3.0 A, $V_{GS}$ = -4.5 V | — | 27.7 | 32.4 | mΩ |
| | | | $I_D$ = -2.5 A, $V_{GS}$ = -2.5 V | — | 33.1 | 41.7 | |
| | | | $I_D$ = -1.5 A, $V_{GS}$ = -1.8 V | — | 40.6 | 57.9 | |
| | | | $I_D$ = -0.5 A, $V_{GS}$ = -1.5 V | — | 48.6 | 89.6 | |
| Forward transfer admittance | (Note 3) | $\|Y_{fs}\|$ | $V_{DS}$ = -3 V, $I_D$ = -1.0 A | 4.5 | 9.1 | — | S |

Note 1: If a forward 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.

## 6.2. 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 | — | 840 | — | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 99 | — | |
| Output capacitance | $C_{oss}$ | | — | 118 | — | |
| Switching time (turn-on time) | $t_{on}$ | $V_{DD}$ = -10 V, $I_D$ = -2.0 A, $V_{GS}$ = 0 to -2.5 V, $R_{GS}$ = 4.7 Ω Duty ≤ 1%, Input: $t_r$, $t_f$ < 5 ns Common source, See Chapter 6.3. | — | 32 | — | ns |
| Switching time (turn-off time) | $t_{off}$ | | — | 107 | — | |

## 6.3. Switching Time Test Circuit

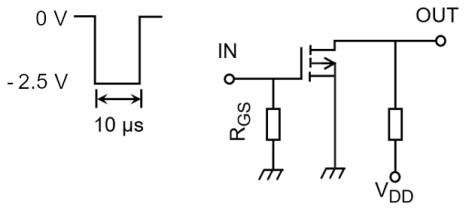



Fig. 6.3.1 Switching Time Test Circuit

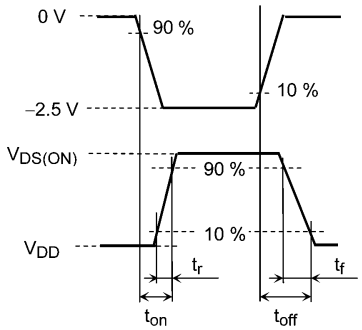



Fig. 6.3.2 Input Waveform/Output Waveform

## 6.4. 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, $I_D$ = -4.0 A, $V_{GS}$ = -4.5 V | — | 12.8 | — | nC |
| Gate-source charge 1 | $Q_{gs1}$ | | — | 1.4 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 3.0 | — | |

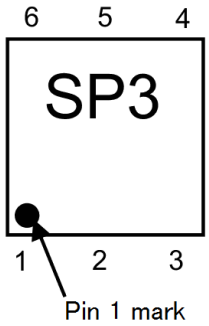
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### 6.5. Source-Drain Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

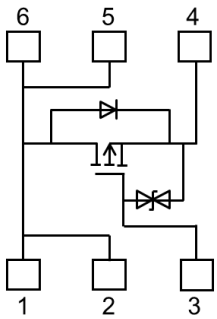
| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Diode forward voltage | (Note 1) | $V_{DSF}$ | $I_{DR}$ = 4.0 A, $V_{GS}$ = 0 V | — | 0.78 | 1.2 | V |

Note 1: Pulse measurement.

## 7. Marking




## 8. Internal Circuit




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## 9. Characteristics Curves (Note)

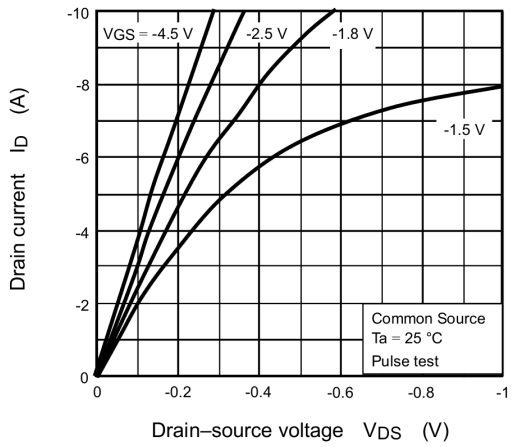



Fig. 9.1 $I_D$ - $V_{DS}$

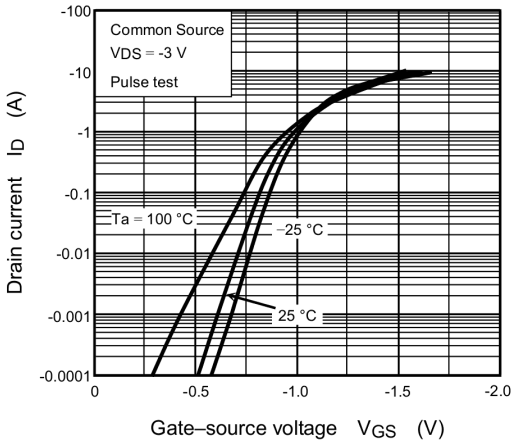



Fig. 9.2 $I_D$ - $V_{GS}$

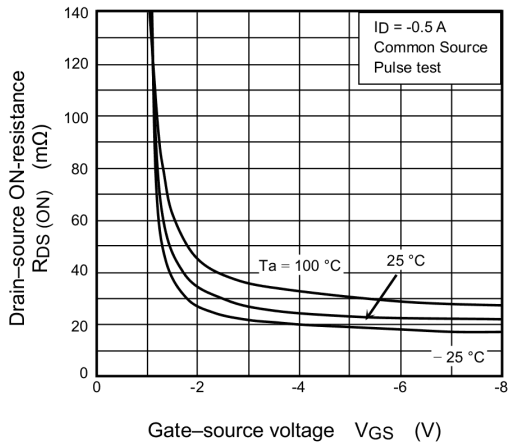



Fig. 9.3 $R_{DS(ON)}$ - $V_{GS}$

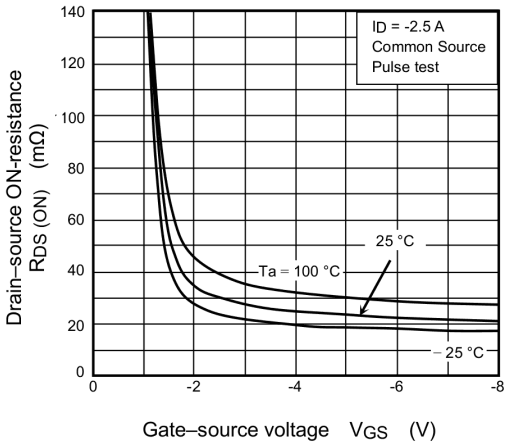



Fig. 9.4 $R_{DS(ON)}$ - $V_{GS}$

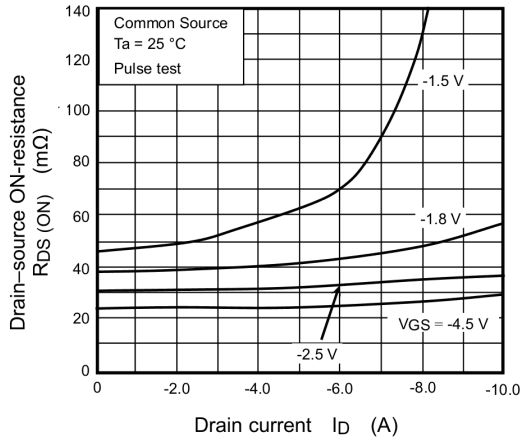



Fig. 9.5 $R_{DS(ON)}$ - $I_D$

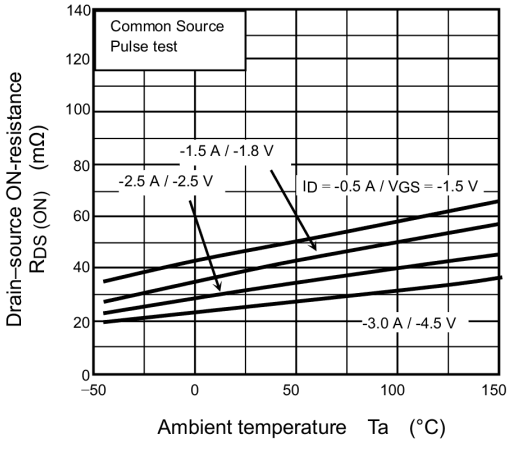



Fig. 9.6 $R_{DS(ON)}$ - $T_a$

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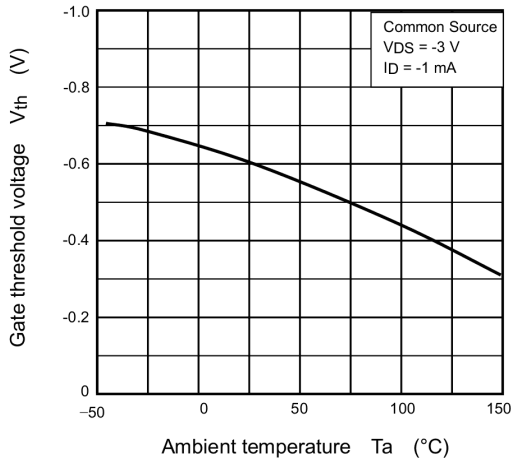



Fig. 9.7 $V_{th}$ - $T_a$

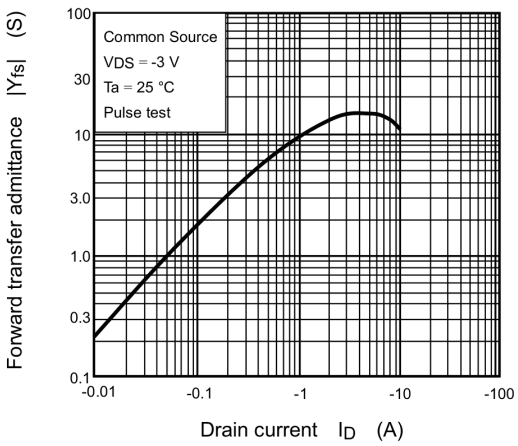



Fig. 9.8 $|Y_{fs}|$ - $I_D$

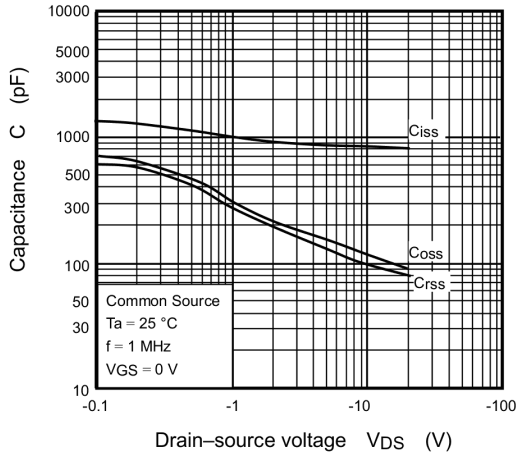



Fig. 9.9 C - $V_{DS}$

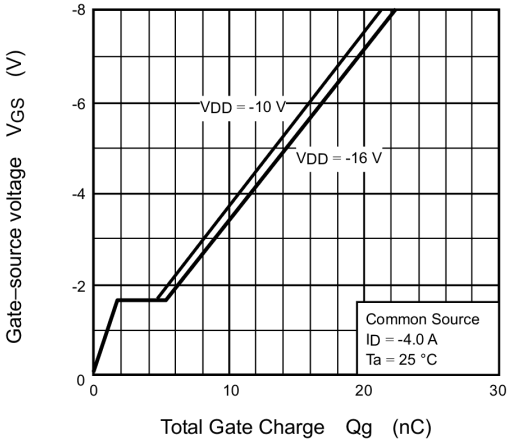



Fig. 9.10 Dynamic Input Characteristics

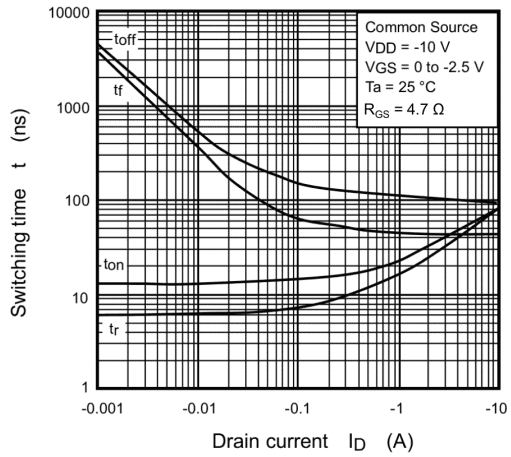



Fig. 9.11 t - $I_D$

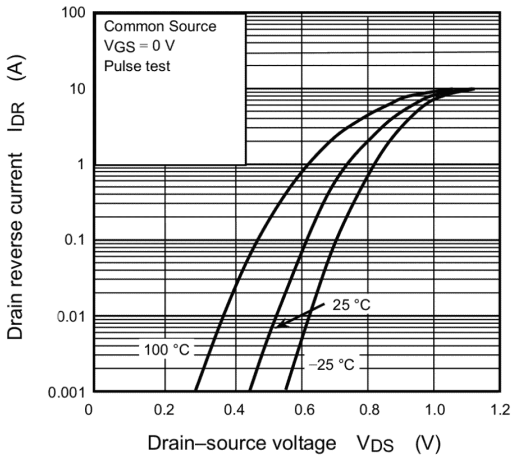



Fig. 9.12 $I_{DR}$ - $V_{DS}$

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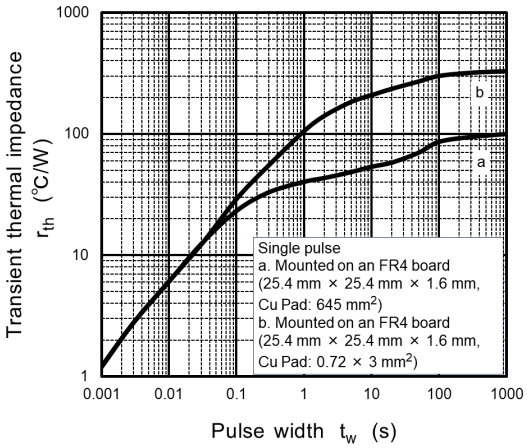



**Fig. 9.13 $r_{th}$ - $t_w$**

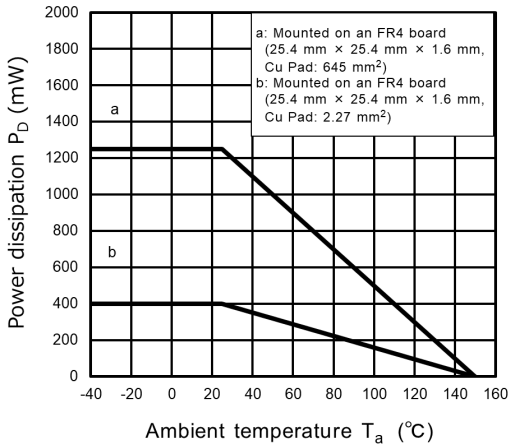



**Fig. 9.14 $P_D$ - $T_a$**

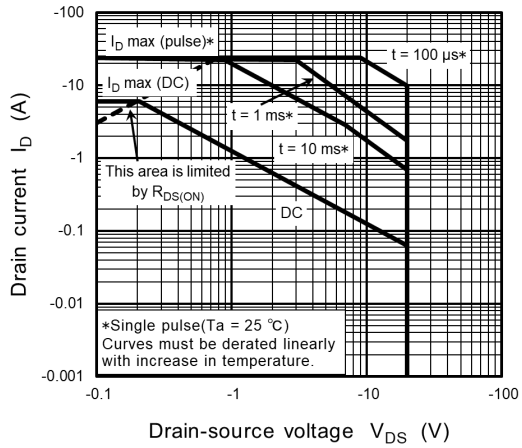
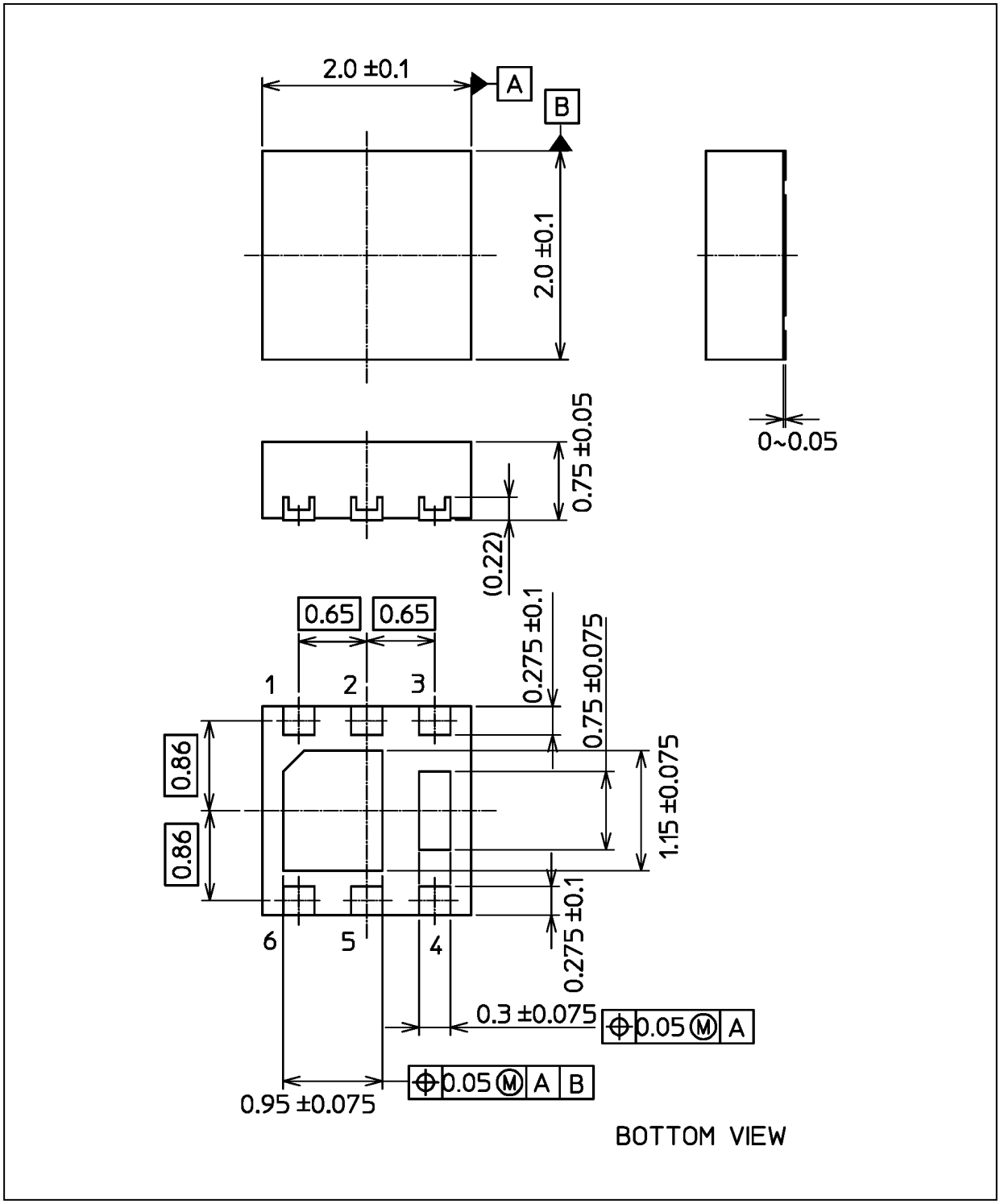



**Fig. 9.15 Safe Operating Area**

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

## Package Dimensions

Unit: mm




Weight: 8.5 mg (typ.)

| Package Name(s) |
| --- |
| Nickname: UDFN6B |

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