

MOSFETs Silicon P-Channel MOS

# SSM6J401TU

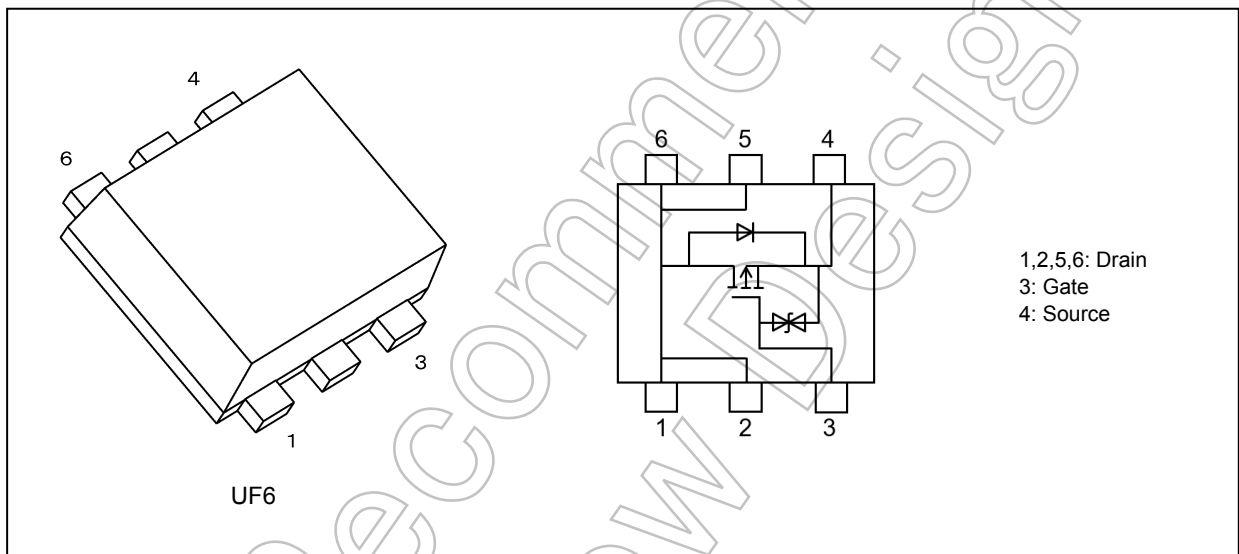
## 1. Applications

- DC-DC Converters
- High-Speed Switching

## 2. Features

- (1) 4.0 V gate drive voltage.
- (2) Low drain-source on-resistance  
 $R_{DS(ON)} = 145 \text{ m}\Omega$  (max) (@ $V_{GS} = -4 \text{ V}$ )  
 $R_{DS(ON)} = 73 \text{ m}\Omega$  (max) (@ $V_{GS} = -10 \text{ V}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2007-07

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

| Characteristics            | Symbol    | Rating     | Unit               |
|----------------------------|-----------|------------|--------------------|
| Drain-source voltage       | $V_{DS}$  | -30        | V                  |
| Gate-source voltage        | $V_{GS}$  | $\pm 20$   | V                  |
| Drain current (DC)         | $I_D$     | -2.5       | A                  |
| Drain current (pulsed)     | $I_{DP}$  | -5.0       |                    |
| Power dissipation (Note 1) | $P_D$     | 500        | mW                 |
| Channel temperature        | $T_{ch}$  | 150        | $^{\circ}\text{C}$ |
| Storage temperature        | $T_{stg}$ | -55 to 150 | $^{\circ}\text{C}$ |

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: Device mounted on a FR4 board.

(25.4 mm × 25.4 mm × 1.6 mm, Cu Pad : 645 mm<sup>2</sup>)

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, $T_a = 25\text{ }^{\circ}\text{C}$ )

| Characteristics                         | Symbol        | Test Condition                                     | Min  | Typ. | Max     | Unit             |
|-----------------------------------------|---------------|----------------------------------------------------|------|------|---------|------------------|
| Gate leakage current                    | $I_{GSS}$     | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 16\text{ V}$ | —    | —    | $\pm 1$ | $\mu\text{A}$    |
| Drain cut-off current                   | $I_{DSS}$     | $V_{DS} = -30\text{ V}$ , $V_{GS} = 0\text{ V}$    | —    | —    | -10     |                  |
| Drain-source breakdown voltage          | $V_{(BR)DSS}$ | $I_D = -1\text{ mA}$ , $V_{GS} = 0\text{ V}$       | -30  | —    | —       | V                |
| Drain-source breakdown voltage (Note 1) | $V_{(BR)DSX}$ | $I_D = -1\text{ mA}$ , $V_{GS} = 20\text{ V}$      | -15  | —    | —       |                  |
| Gate threshold voltage (Note 2)         | $V_{th}$      | $V_{DS} = -5\text{ V}$ , $I_D = -1\text{ mA}$      | -1.2 | —    | -2.6    |                  |
| Drain-source on-resistance (Note 3)     | $R_{DS(ON)}$  | $I_D = -1.5\text{ A}$ , $V_{GS} = -4\text{ V}$     | —    | 85   | 145     | $\text{m}\Omega$ |
|                                         |               | $I_D = -2.0\text{ A}$ , $V_{GS} = -10\text{ V}$    | —    | 53   | 73      |                  |
| Forward transfer admittance (Note 3)    | $ Y_{fs} $    | $V_{DS} = -5\text{ V}$ , $I_D = -2.0\text{ A}$     | 3.1  | 6.2  | —       | S                |

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, $T_a = 25\text{ }^{\circ}\text{C}$ )

| Characteristics                | Symbol    | Test Condition                                                                                                                                                                                                     | Min | Typ. | Max | Unit |
|--------------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = -15\text{ V}$ , $V_{GS} = 0\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                                                                                            | —   | 730  | —   | pF   |
| Reverse transfer capacitance   | $C_{rss}$ |                                                                                                                                                                                                                    | —   | 90   | —   |      |
| Output capacitance             | $C_{oss}$ |                                                                                                                                                                                                                    | —   | 110  | —   |      |
| Switching time (turn-on time)  | $t_{on}$  | $V_{DD} = -15\text{ V}$ , $I_D = -2.0\text{ A}$ ,<br>$V_{GS} = 0\text{ to }-4.0\text{ V}$ , $R_{GS} = 10\text{ }\Omega$<br>Duty $\leq 1\%$ , Input: $t_r$ , $t_f < 5\text{ ns}$<br>Common source, See Chapter 5.3. | —   | 33   | —   | ns   |
| Switching time (turn-off time) | $t_{off}$ |                                                                                                                                                                                                                    | —   | 27   | —   |      |

### 5.3. Switching Time Test Circuit

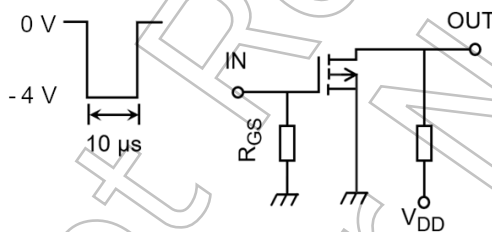


Fig. 5.3.1 Switching Time Test Circuit

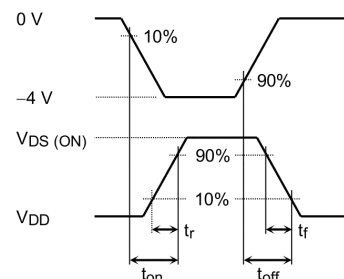


Fig. 5.3.2 Input Waveform/Output Waveform

### 5.4. Gate Charge Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$ )

| Characteristics                                 | Symbol   | Test Condition                                                               | Min | Typ. | Max | Unit |
|-------------------------------------------------|----------|------------------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$    | $V_{DS} = -15\text{ V}$ , $I_D = -2.5\text{ A}$ ,<br>$V_{GS} = -10\text{ V}$ | —   | 16.0 | —   | nC   |
| Gate-source charge                              | $Q_{gs}$ |                                                                              | —   | 12.8 | —   |      |
| Gate-drain charge                               | $Q_{gd}$ |                                                                              | —   | 3.2  | —   |      |

5.5. Source-Drain Characteristics (Unless otherwise specified, T<sub>a</sub> = 25 °C)

| Characteristics                | Symbol           | Test Condition                                 | Min | Typ. | Max | Unit |
|--------------------------------|------------------|------------------------------------------------|-----|------|-----|------|
| Diode forward voltage (Note 1) | V <sub>DSF</sub> | I <sub>DR</sub> = 2.5 A, V <sub>GS</sub> = 0 V | —   | 0.8  | 1.2 | V    |

Note 1: Pulse measurement.

6. Marking

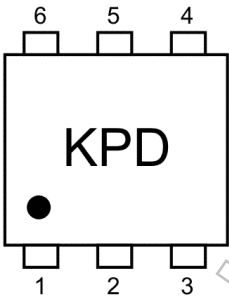


Fig. 6.1 Marking

7. Characteristics Curves (Note)

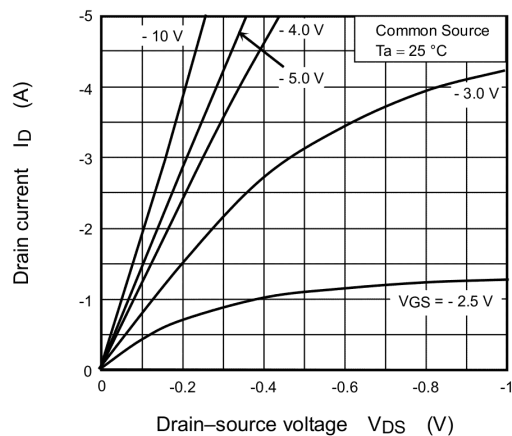


Fig. 7.1  $I_D - V_{DS}$

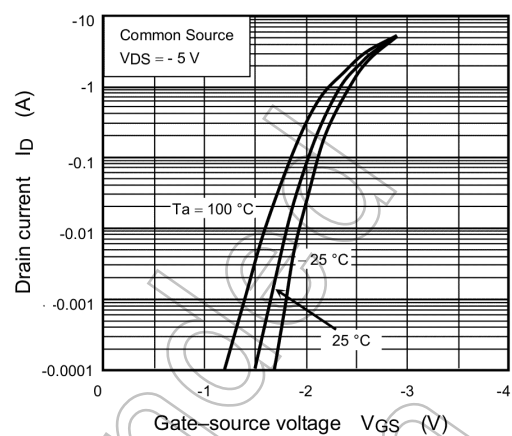


Fig. 7.2  $I_D - V_{GS}$

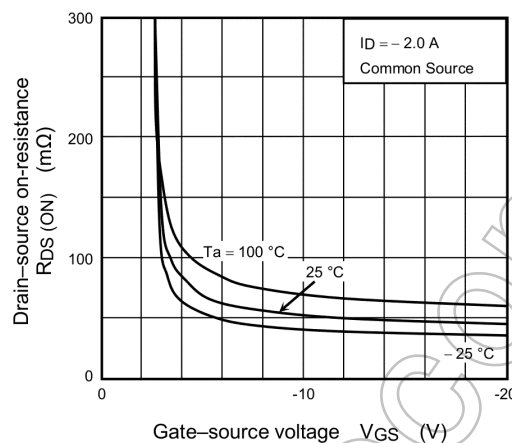


Fig. 7.3  $R_{DS(ON)} - V_{GS}$

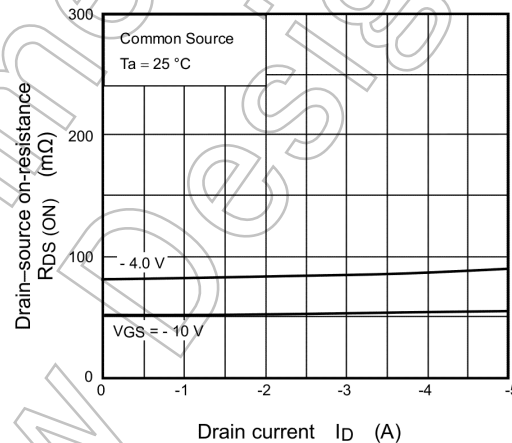


Fig. 7.4  $R_{DS(ON)} - I_D$

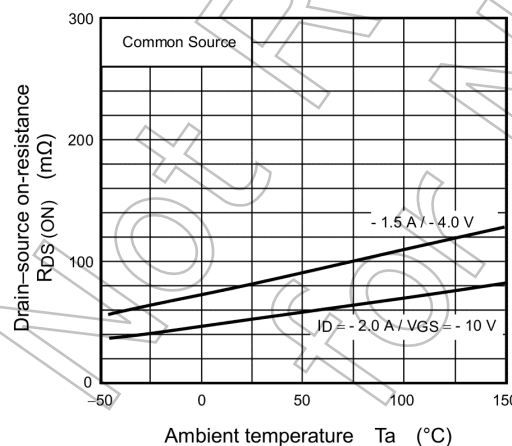


Fig. 7.5  $R_{DS(ON)} - T_a$

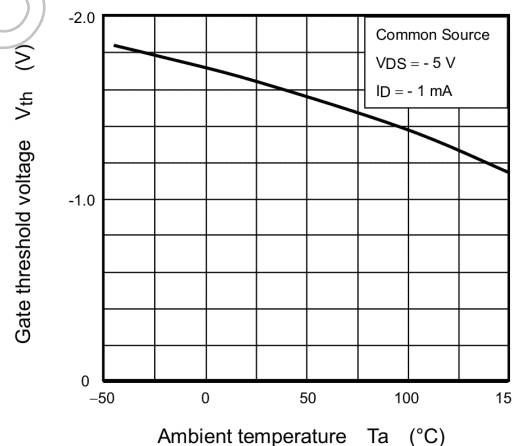


Fig. 7.6  $V_{th} - T_a$

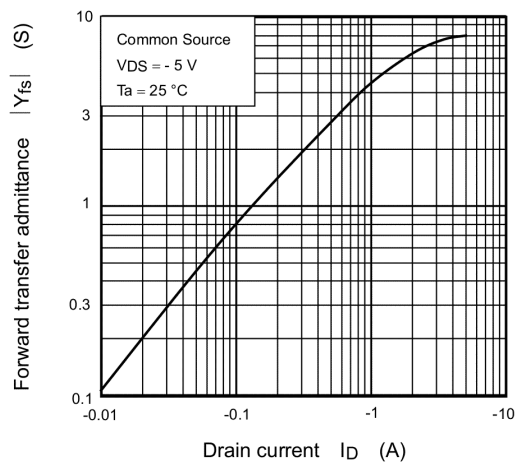


Fig. 7.7  $|Y_{fs}| - I_D$

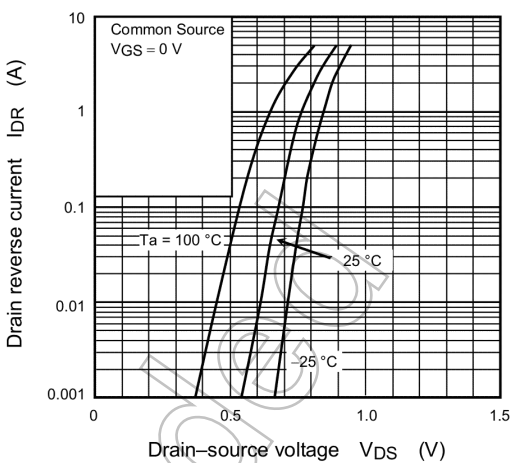


Fig. 7.8  $I_{DR} - V_{DS}$

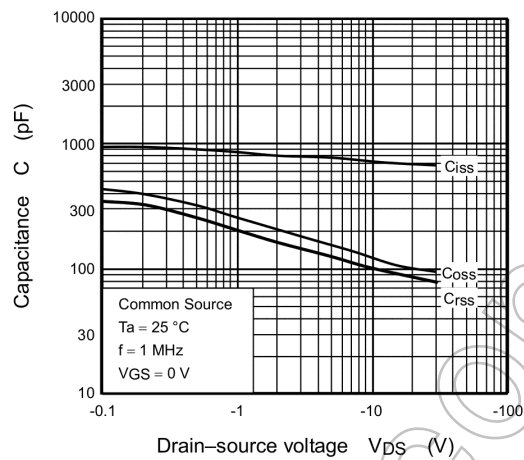


Fig. 7.9  $C - V_{DS}$

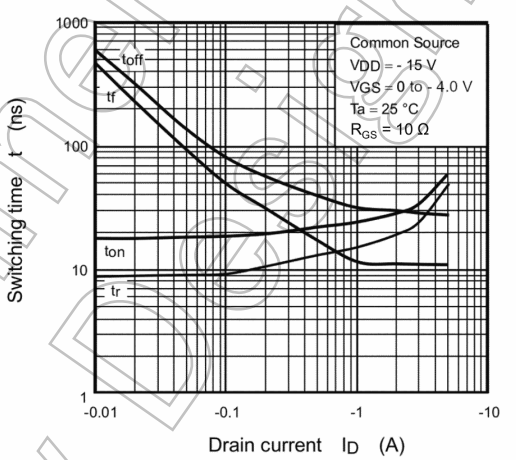


Fig. 7.10  $t - I_D$

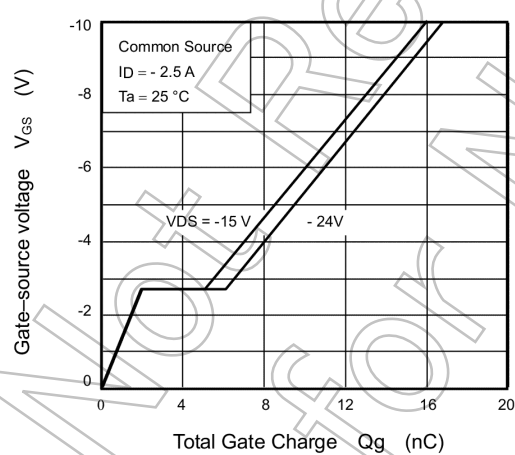


Fig. 7.11 Dynamic Input Characteristics

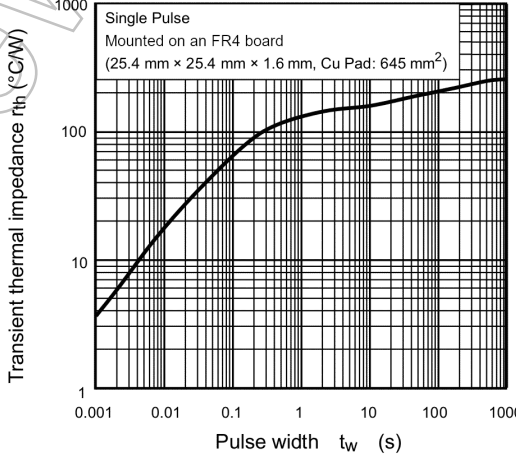


Fig. 7.12  $r_{th} - t_w$

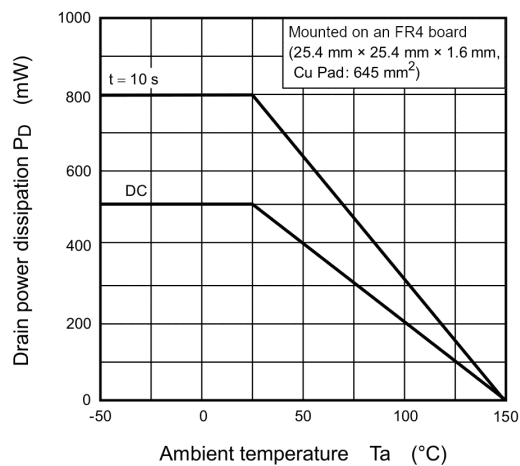


Fig. 7.13  $P_D - T_a$

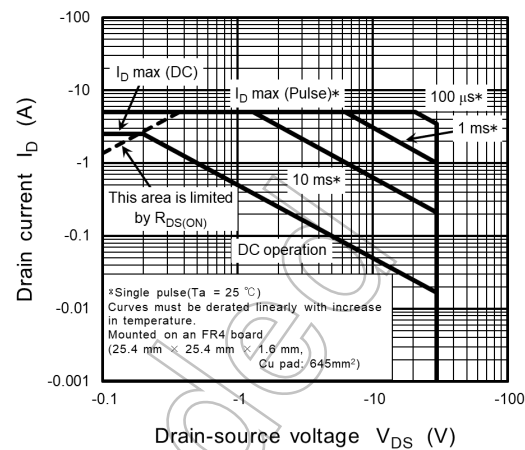
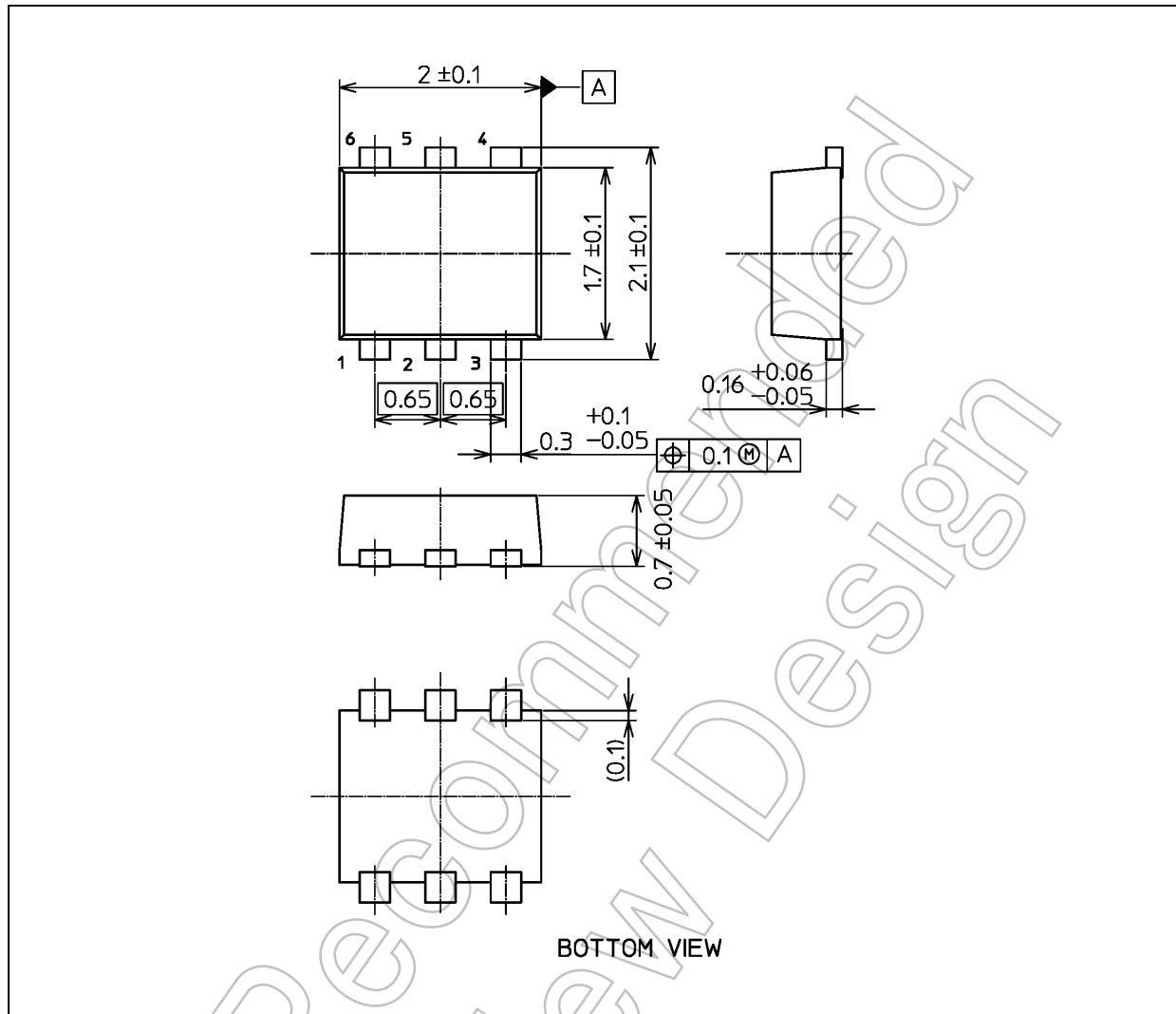


Fig. 7.14 Safe Operating Area

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

## Package Dimensions

Unit: mm



Weight: 7.0 mg (typ.)

|                 |
|-----------------|
| Package Name(s) |
| Nickname: UF6   |

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