

CMOS Digital Integrated Circuits Silicon Monolithic

# TC4S66F, TC4S66FU

## 1. Functional Description

- Bilateral Switch

## 2. General

TC4S66F, TC4S66FU contains one circuit of bidirectional switches.

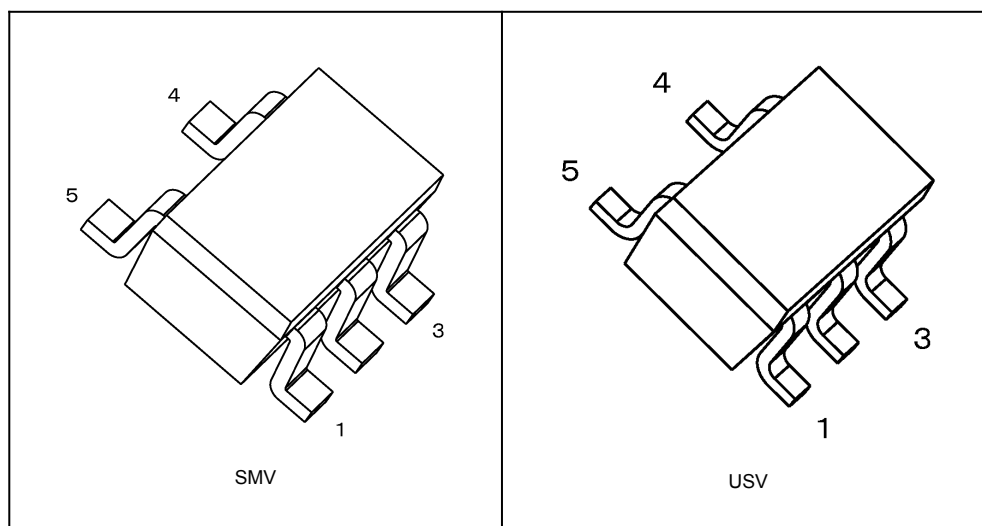
When control input, CONT is set to "H" level, the impedance between input and output of the switch becomes low and when it is set to "L" level, the switch becomes high.

This can be applied for switching of analog signals and digital signals.

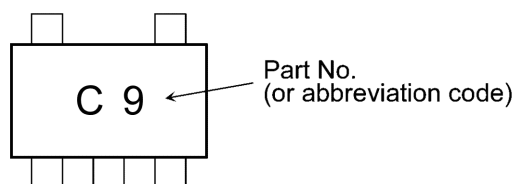
## 3. Features

- ON resistance:  $R_{ON} = 250 \Omega$  (Typ.) at  $V_{DD} - V_{SS} = 5 V$   
 $R_{ON} = 110 \Omega$  (Typ.) at  $V_{DD} - V_{SS} = 10 V$   
 $R_{ON} = 70 \Omega$  (Typ.) at  $V_{DD} - V_{SS} = 15 V$
- OFF resistance:  $R_{OFF}$  (Typ.)  $> 10^9 \Omega$

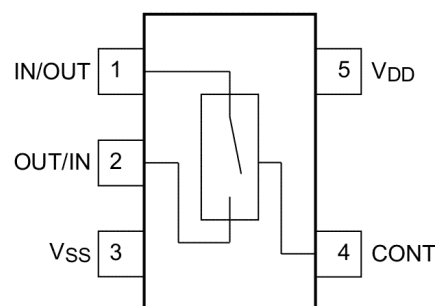
## 4. Packaging



## 5. Marking and Pin Assignment



Marking

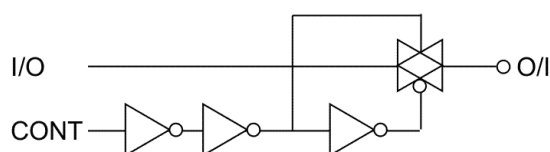


Pin Assignment (Top view)

Start of commercial production

1988-01

## 6. Logic Diagram



## 7. Truth Table

| Control | Impedance between IN/OUT-OUT/IN (Note 1) |
|---------|------------------------------------------|
| H       | $0.5 \text{ to } 5.0 \times 10^2 \Omega$ |
| L       | $> 10^9 \Omega$                          |

Note 1: See electrical characteristics

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

| Characteristics                           | Symbol      | Rating                                  | Unit             |
|-------------------------------------------|-------------|-----------------------------------------|------------------|
| DC Supply voltage                         | $V_{DD}$    | $V_{SS} - 0.5 \text{ to } V_{SS} + 20$  | V                |
| Input voltage                             | $V_{IN}$    | $V_{SS} - 0.5 \text{ to } V_{DD} + 0.5$ |                  |
| Switch I/O voltage.                       | $V_{I/O}$   | $V_{SS} - 0.5 \text{ to } V_{DD} + 0.5$ |                  |
| Power dissipation                         | $P_D$       | 200                                     | mW               |
| Potential difference across I/O during ON | $V_I - V_O$ | $\pm 0.5$                               | V                |
| Input current                             | $I_{IN}$    | $\pm 10$                                | mA               |
| Operation temperature range               | $T_{opr}$   | -40 to 85                               | $^\circ\text{C}$ |
| Storage temperature                       | $T_{stg}$   | -65 to 150                              | $^\circ\text{C}$ |
| Lead temperature (10 s)                   | $T_L$       | 260                                     | $^\circ\text{C}$ |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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 and the operating ranges.

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).

## 9. Operating Ranges ( $V_{SS} = 0 \text{ V}$ )

| Characteristics     | Symbol    | Min | Typ. | Max      | Unit |
|---------------------|-----------|-----|------|----------|------|
| DC Supply voltage   | $V_{DD}$  | 3   | —    | 18       | V    |
| Switch I/O voltage. | $V_{I/O}$ | 0   | —    | $V_{DD}$ | V    |

### 10. Electrical Characteristics

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

| Characteristics           | Symbol    | Test Condition                                                                               | $V_{DD}$ (V) | Min  | Typ.       | Max       | Unit          |
|---------------------------|-----------|----------------------------------------------------------------------------------------------|--------------|------|------------|-----------|---------------|
| High-level input voltage  | $V_{IH}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | 3.5  | 2.75       | —         | V             |
|                           |           |                                                                                              | 10           | 7.0  | 5.50       | —         |               |
|                           |           |                                                                                              | 15           | 11.0 | 8.25       | —         |               |
| Low-level input voltage   | $V_{IL}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | —    | 2.25       | 1.5       |               |
|                           |           |                                                                                              | 10           | —    | 4.5        | 3.0       |               |
|                           |           |                                                                                              | 15           | —    | 6.75       | 4.0       |               |
| ON-resistance             | $R_{ON}$  | $0 \leq V_{IS} \leq V_{DD}$<br>$R_L = 10\text{ k}\Omega$                                     | 5            | —    | 290        | 950       | $\Omega$      |
|                           |           |                                                                                              | 10           | —    | 120        | 250       |               |
|                           |           |                                                                                              | 15           | —    | 85         | 160       |               |
| Power-OFF leakage current | $I_{OFF}$ | $V_{IN} = 18\text{ V}, V_{OUT} = 0\text{ V}$<br>$V_{IN} = 0\text{ V}, V_{OUT} = 18\text{ V}$ | 18           | —    | $\pm 0.1$  | $\pm 100$ | nA            |
|                           |           |                                                                                              | 18           | —    | $\pm 0.1$  | $\pm 100$ |               |
| Quiescent device current  | $I_{DD}$  | $V_{IN} = V_{DD}, V_{SS}$                                                                    | 5            | —    | 0.001      | 0.25      | $\mu\text{A}$ |
|                           |           |                                                                                              | 10           | —    | 0.001      | 0.5       |               |
|                           |           |                                                                                              | 15           | —    | 0.002      | 1.0       |               |
| High level input current  | $I_{IH}$  | $V_{IH} = 18\text{ V}$                                                                       | 18           | —    | $10^{-5}$  | 0.1       | $\mu\text{A}$ |
| Low level input current   | $I_{IL}$  | $V_{IL} = 0\text{ V}$                                                                        | 18           | —    | $-10^{-5}$ | -0.1      |               |

#### 10.2. Electrical Characteristics (Unless otherwise specified, $T_a = -40\text{ }^{\circ}\text{C}$ )

| Characteristics           | Symbol    | Test Condition                                                                               | $V_{DD}$ (V) | Min  | Max       | Unit          |
|---------------------------|-----------|----------------------------------------------------------------------------------------------|--------------|------|-----------|---------------|
| High-level input voltage  | $V_{IH}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | 3.5  | —         | V             |
|                           |           |                                                                                              | 10           | 7.0  | —         |               |
|                           |           |                                                                                              | 15           | 11.0 | —         |               |
| Low-level input voltage   | $V_{IL}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | —    | 1.5       |               |
|                           |           |                                                                                              | 10           | —    | 3.0       |               |
|                           |           |                                                                                              | 15           | —    | 4.0       |               |
| ON-resistance             | $R_{ON}$  | $0 \leq V_{IS} \leq V_{DD}$<br>$R_L = 10\text{ k}\Omega$                                     | 5            | —    | 800       | $\Omega$      |
|                           |           |                                                                                              | 10           | —    | 210       |               |
|                           |           |                                                                                              | 15           | —    | 140       |               |
| Power-OFF leakage current | $I_{OFF}$ | $V_{IN} = 18\text{ V}, V_{OUT} = 0\text{ V}$<br>$V_{IN} = 0\text{ V}, V_{OUT} = 18\text{ V}$ | 18           | —    | $\pm 100$ | nA            |
|                           |           |                                                                                              | 18           | —    | $\pm 100$ |               |
| Quiescent device current  | $I_{DD}$  | $V_{IN} = V_{DD}, V_{SS}$                                                                    | 5            | —    | 0.25      | $\mu\text{A}$ |
|                           |           |                                                                                              | 10           | —    | 0.5       |               |
|                           |           |                                                                                              | 15           | —    | 1.0       |               |
| High level input current  | $I_{IH}$  | $V_{IH} = 18\text{ V}$                                                                       | 18           | —    | 0.1       | $\mu\text{A}$ |
| Low level input current   | $I_{IL}$  | $V_{IL} = 0\text{ V}$                                                                        | 18           | —    | -0.1      |               |

### 10.3. Electrical Characteristics (Unless otherwise specified, $T_a = 85\text{ }^{\circ}\text{C}$ )

| Characteristics           | Symbol    | Test Condition                                                                               | $V_{DD}$ (V) | Min  | Max        | Unit          |
|---------------------------|-----------|----------------------------------------------------------------------------------------------|--------------|------|------------|---------------|
| High-level input voltage  | $V_{IH}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | 3.5  | —          | V             |
|                           |           |                                                                                              | 10           | 7.0  | —          |               |
|                           |           |                                                                                              | 15           | 11.0 | —          |               |
| Low-level input voltage   | $V_{IL}$  | $ I_{IS}  = 10\text{ }\mu\text{A}$                                                           | 5            | —    | 1.5        | V             |
|                           |           |                                                                                              | 10           | —    | 3.0        |               |
|                           |           |                                                                                              | 15           | —    | 4.0        |               |
| ON-resistance             | $R_{ON}$  | $0 \leq V_{IS} \leq V_{DD}$<br>$R_L = 10\text{ k}\Omega$                                     | 5            | —    | 1200       | $\Omega$      |
|                           |           |                                                                                              | 10           | —    | 300        |               |
|                           |           |                                                                                              | 15           | —    | 200        |               |
| Power-OFF leakage current | $I_{OFF}$ | $V_{IN} = 18\text{ V}, V_{OUT} = 0\text{ V}$<br>$V_{IN} = 0\text{ V}, V_{OUT} = 18\text{ V}$ | 18           | —    | $\pm 1000$ | nA            |
|                           |           |                                                                                              | 18           | —    | $\pm 1000$ |               |
| Quiescent device current  | $I_{DD}$  | $V_{IN} = V_{DD}, V_{SS}$                                                                    | 5            | —    | 7.5        | $\mu\text{A}$ |
|                           |           |                                                                                              | 10           | —    | 15         |               |
|                           |           |                                                                                              | 15           | —    | 30         |               |
| High level input current  | $I_{IH}$  | $V_{IH} = 18\text{ V}$                                                                       | 18           | —    | 1.0        | $\mu\text{A}$ |
| Low level input current   | $I_{IL}$  | $V_{IL} = 0\text{ V}$                                                                        | 18           | —    | -1.0       |               |

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

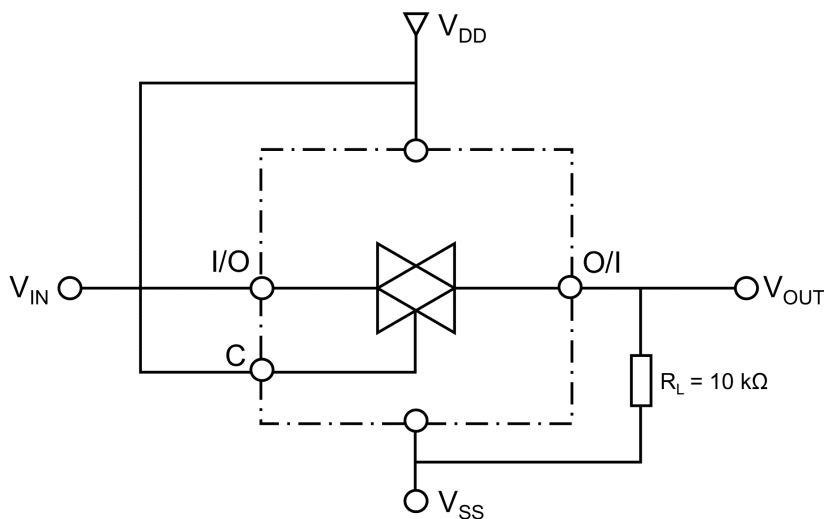
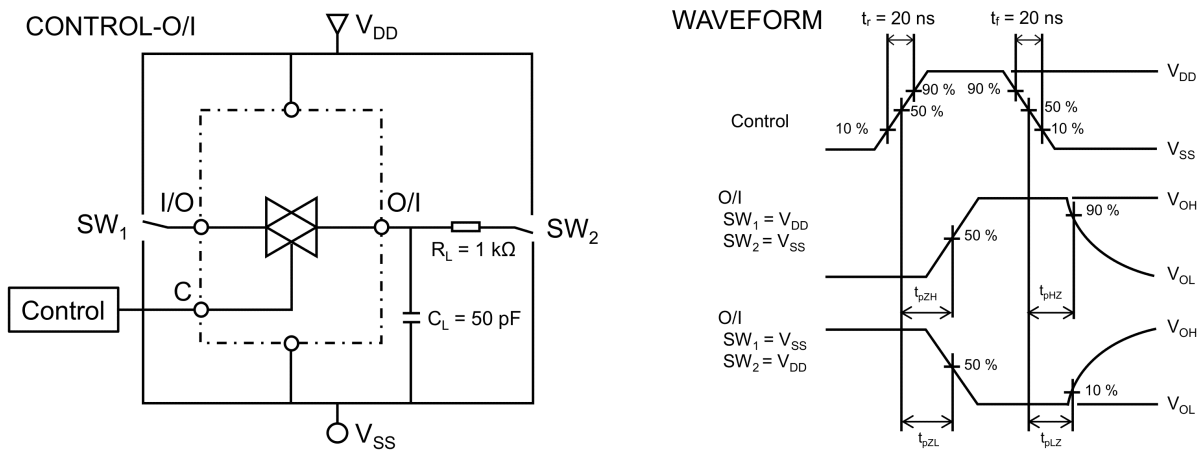
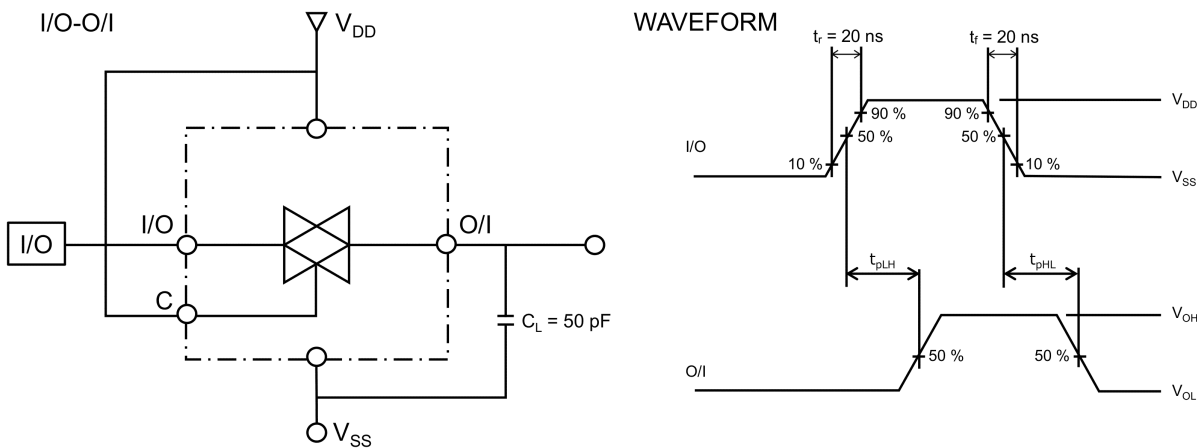
| Characteristics                       | Symbol             | Note     | Test Condition                                                                       | $V_{SS}$ (V) | $V_{DD}$ (V) | Min | Typ. | Max | Unit |
|---------------------------------------|--------------------|----------|--------------------------------------------------------------------------------------|--------------|--------------|-----|------|-----|------|
| Propagation delay time(IN-OUT)        | $t_{PLH}, t_{PHL}$ |          | $C_L = 50\text{ pF}$                                                                 | 0            | 5            | —   | 15   | 40  | ns   |
|                                       |                    |          |                                                                                      | 0            | 10           | —   | 8    | 20  |      |
|                                       |                    |          |                                                                                      | 0            | 15           | —   | 5    | 15  |      |
| Propagation delay time (CONTROL-OUT)  | $t_{PZL}, t_{PZH}$ |          | $R_L = 1\text{ k}\Omega$<br>$C_L = 50\text{ pF}$                                     | 0            | 5            | —   | 55   | 120 | ns   |
|                                       |                    |          |                                                                                      | 0            | 10           | —   | 25   | 40  |      |
|                                       |                    |          |                                                                                      | 0            | 15           | —   | 20   | 30  |      |
| Propagation delay time (CONTROL-OUT)  | $t_{PLZ}, t_{PHZ}$ |          | $R_L = 1\text{ k}\Omega$<br>$C_L = 50\text{ pF}$                                     | 0            | 5            | —   | 45   | 80  | ns   |
|                                       |                    |          |                                                                                      | 0            | 10           | —   | 30   | 70  |      |
|                                       |                    |          |                                                                                      | 0            | 15           | —   | 25   | 60  |      |
| Max. Control input repetition rate    | $f_{MAX(C)}$       |          | $R_L = 1\text{ k}\Omega$<br>$C_L = 50\text{ pF}$                                     | 0            | 5            | —   | 10   | —   | MHz  |
|                                       |                    |          |                                                                                      | 0            | 10           | —   | 12   | —   |      |
|                                       |                    |          |                                                                                      | 0            | 15           | —   | 12   | —   |      |
| Maximum frequency response            | $f_{MAX(I-O)}$     | (Note 1) | $R_L = 1\text{ k}\Omega$<br>$C_L = 50\text{ pF}$                                     | -5           | 5            | —   | 30   | —   |      |
| Total Harmonic Distortion             | THD                | (Note 2) | $R_L = 10\text{ k}\Omega$<br>$f = 1\text{ kHz}$                                      | -5           | 5            | —   | 0.03 | —   | %    |
| Feed through attenuation (SWITCH OFF) | FTH                | (Note 3) | $R_L = 1\text{ k}\Omega$                                                             | -5           | 5            | —   | 600  | —   | kHz  |
| Crosstalk(CONTROL-OUT)                | Xtalk              |          | $R_{IN} = 1\text{ k}\Omega$<br>$R_{OUT} = 10\text{ k}\Omega$<br>$C_L = 15\text{ pF}$ | 0            | 5            | —   | 200  | —   | mV   |
|                                       |                    |          |                                                                                      | 0            | 10           | —   | 400  | —   |      |
|                                       |                    |          |                                                                                      | 0            | 15           | —   | 600  | —   |      |
| Input capacitance                     | $C_{IN}$           |          | Control input                                                                        | —            | —            | —   | 5    | 7.5 | pF   |
|                                       |                    |          | Switch I/O                                                                           | —            | —            | —   | 10   | —   |      |
| Feedthrough capacitance               | $C_{IOS}$          |          | —                                                                                    | —            | —            | —   | 0.5  | —   | pF   |

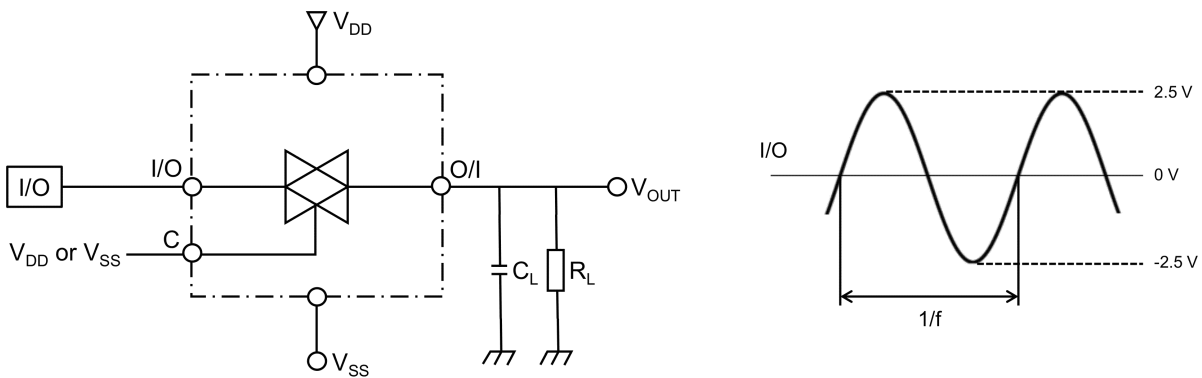
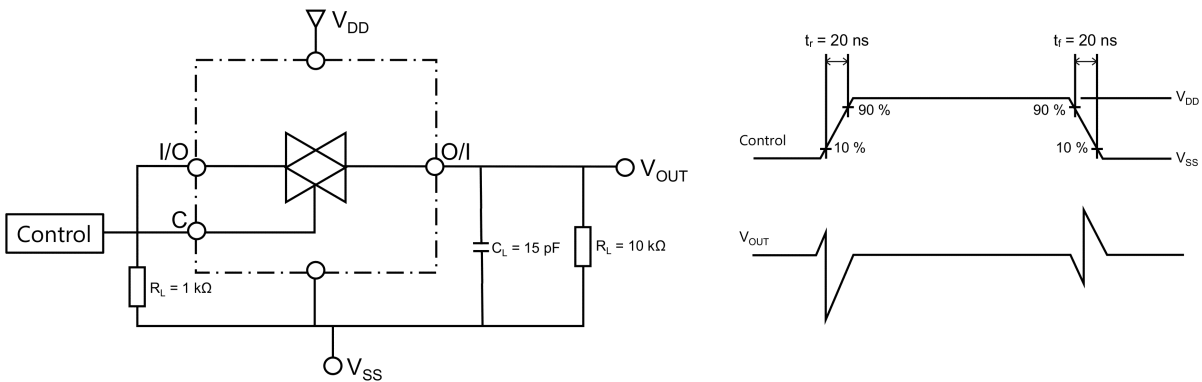
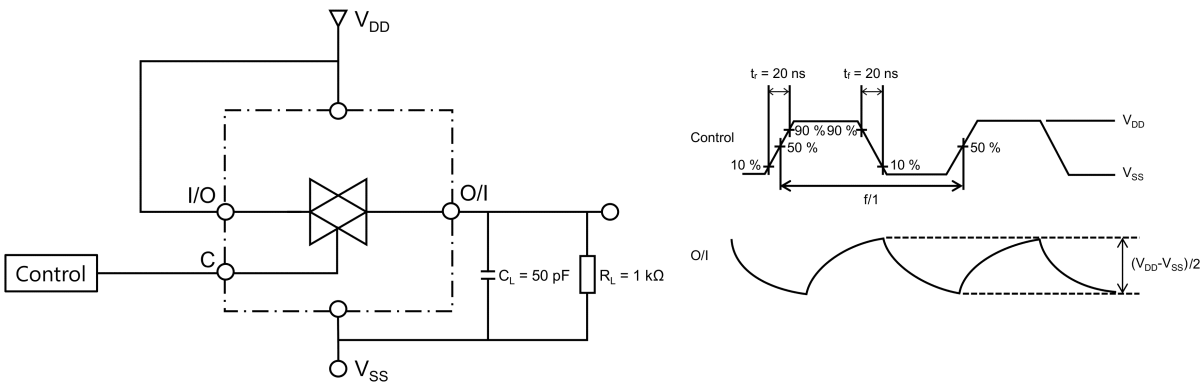
Note 1: The frequency at  $20 \log_{10} V_{OS}/V_{IS} = -3\text{ dB}$  shall be  $f_{MAX(I-O)}$  using sine wave of  $\pm 2.5\text{ Vp-p}$  for  $V_{IS}$ .

Note 2:  $V_{IS}$  shall be sine wave of  $\pm 2.5\text{ V}$ .

Note 3: The frequency at  $20 \log_{10} V_{OS}/V_{IS} = -50\text{ dB}$  shall be the feed through using of  $\pm 2.5\text{ Vp-p}$ .

11.1. Switching Test Circuit

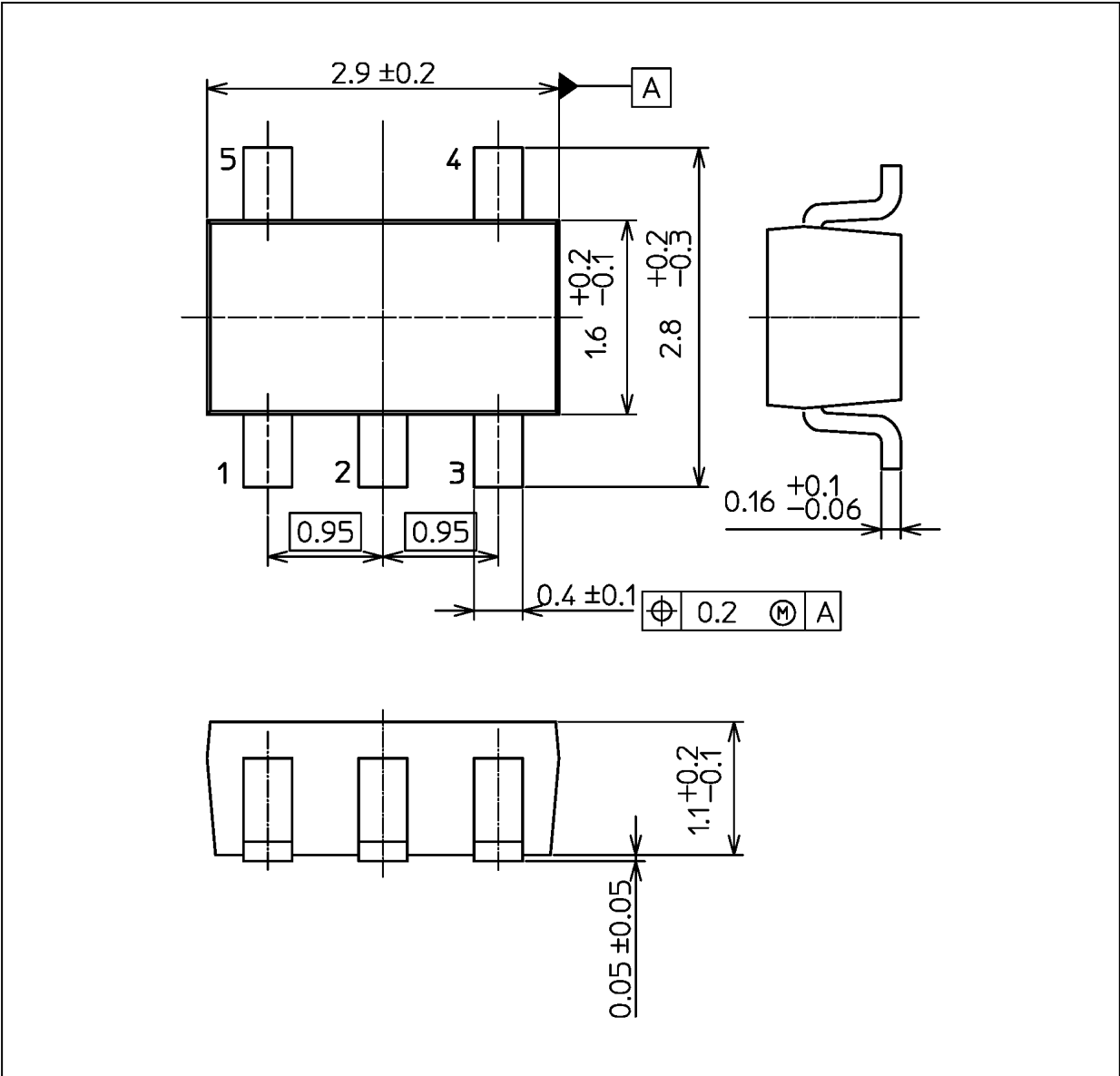




$C_L, R_L$ : Reference to Test Condition

Package Dimensions

Unit: mm

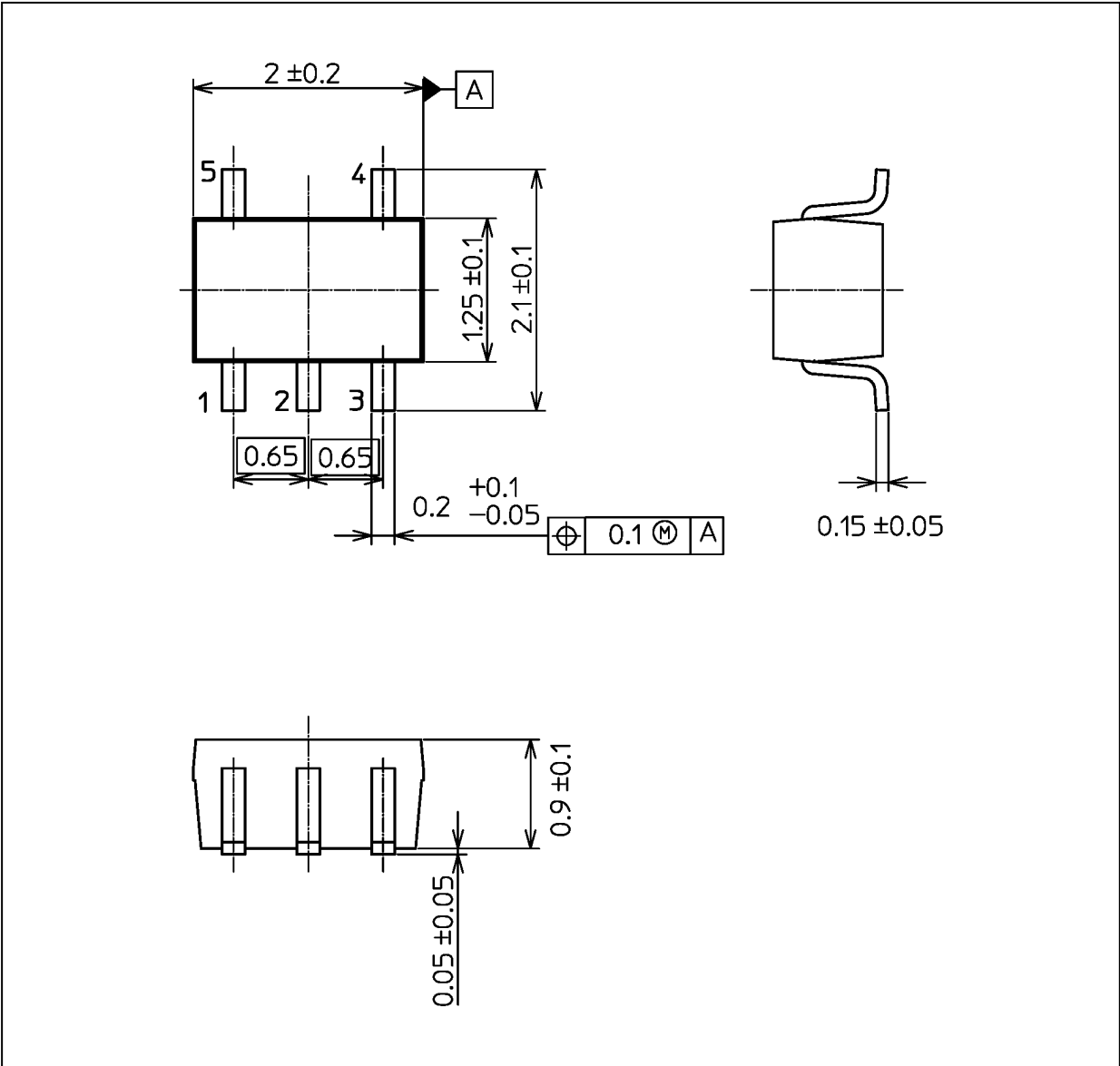


Weight: 14 mg (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-25   |
| Nickname: SMV   |

Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-353  |
| Nickname: USV   |



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