CMOS Digital Integrated Circuits Silicon Monolithic

TC7SB66CFU,TC7SB67CFU

1. Functional Description

- Low-Capacitance Single Bus Switch (analog)

2. General

The TC7SB66CFU and TC7SB67CFU are low ON-resistance, high-speed CMOS 1-bit bus switches. These bus switches allow connections or disconnections to be made with minimal propagation delay while maintaining Low power dissipation which is the feature of CMOS.

TC7SB66CFU requires the output enable (OE) input to be set low to place the output into the high impedance state,whereas the TC7SB67CFU requires the output enable ($\overline{OE}$) input to be set high to place the output into the high impedance.

These Bus switches consist of P-MOS and N-MOS structure, meaning these devices are suitable for analog signal transmission.

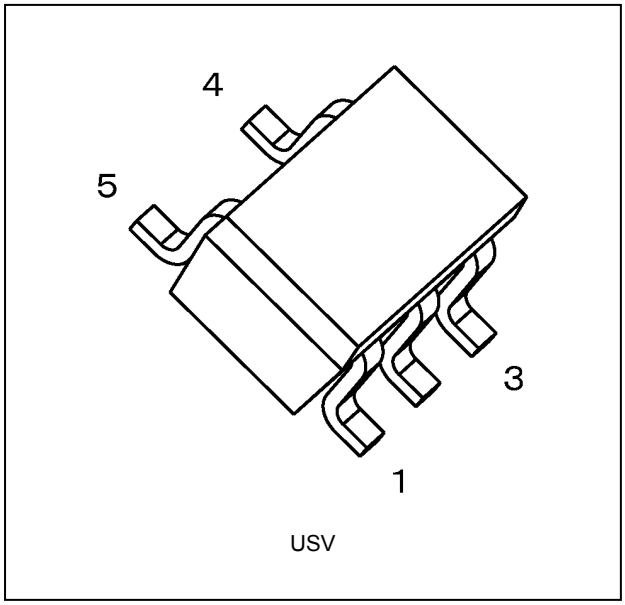
All inputs are equipped with protector circuits to protect the device from static discharge.

3. Features

(1) AEC-Q100 (rev.H) Grade 1 qualified (Note 1)
(2) Wide operating temperature range: T_{opr} = -40 to 125 °C (Note 2)
(3) Operating voltage: V_{CC} = 1.65 to 5.5 V
(4) ON capacitance: $C_{I/O}$ = 10 pF Switch On (typ.) @V_{CC} = 5.0 V
(5) ON resistance: R_{ON} = 4 Ω (typ.) @V_{CC} = 4.5 V, V_{IS} = 0 V
(6) Package: USV

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.
Note 2: For devices with the ordering part number ending in (CT. T_{opr} = -40 to 85 °C for the other devices.

4. Packaging



USV

Start of commercial production
2020-09

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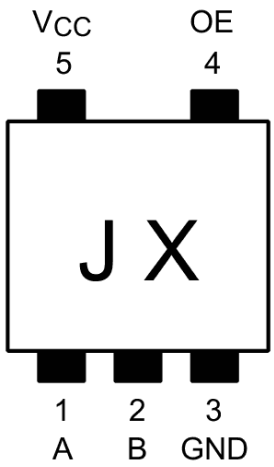
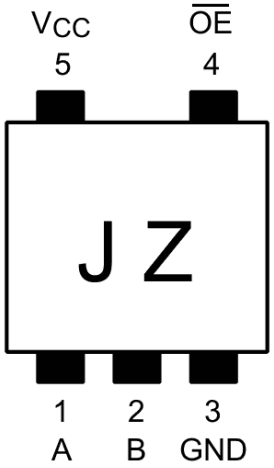
5. Pin Assignment

TC7SB66CFU



(Top view)

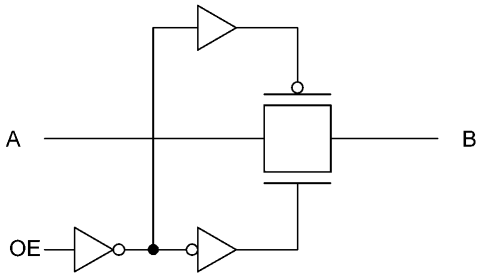
TC7SB67CFU



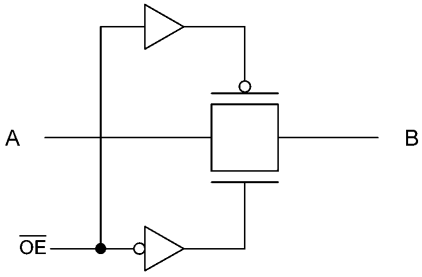
(Top view)

6. Block Diagram

TC7SB66CFU



TC7SB67CFU



7. Principle of Operation

7.1. Truth Table

Input OE (TC7SB66CFU)	Input $\overline{OE}$ (TC7SB67CFU)	Function
H	L	A port = B port
L	H	Disconnect

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

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	-0.5 to 7.0	V
Input voltage (OE, $\overline{OE}$)	V_{IN}	-0.5 to 7.0	V
Switch I/O voltage	V_S	-0.5 to V_{CC} +0.5	V
Clamp diode current	I_{IK}	-50	mA
Switch I/O current	I_S	50	mA
Power dissipation	P_D	200	mW
V_{CC}/ground current	I_{CC}/I_{GND}	±100	mA
Storage temperature	T_{stg}	-65 to 150	°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 (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		1.65 to 5.5	V
Input voltage (OE, $\overline{OE}$)	V_{IN}		0 to 5.5	V
Switch I/O voltage	V_S		0 to V_{CC}	V
Operating temperature	T_{opr}	(Note 1)	-40 to 125	°C
		(Note 2)	-40 to 85	
Input rise time	dt/dv		0 to 10	ns/V
Input fall time			0 to 10	

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused control inputs must be tied to either V_{CC} or GND.
Note 1: For devices with the ordering part number ending in (CT.
Note 2: For devices except those with the ordering part number ending in (CT.

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10. Electrical Characteristics

10.1. DC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage (OE, $\overline{OE}$)	V_{IH}		—	1.65 to 1.95	0.8 × V_{CC}	—	—	V
				2.3 to 5.5	0.7 × V_{CC}	—	—	
Low-level input voltage (OE, $\overline{OE}$)	V_{IL}		—	1.65 to 1.95	—	—	0.2 × V_{CC}	V
				2.3 to 5.5	—	—	0.3 × V_{CC}	
Input leakage current (OE, $\overline{OE}$)	I_{IN}		V_{IN} = 0 to 5.5 V	1.65 to 5.5	—	—	±1.0	μA
Switch OFF-state leakage current	I_{SZ}		A, B = 0 to V_{CC}, OE = GND (TC7SB66CFU) $\overline{OE}$ = V_{CC} (TC7SB67CFU)	1.65 to 5.5	—	—	±10	μA
ON-resistance	R_{ON}	(Note 1), (Note 2)	V_{IS} = 0 V, I_{IS} = 30 mA	4.5	—	4	7	Ω
			V_{IS} = 2.4 V, I_{IS} = 30 mA	4.5	—	5	12	
			V_{IS} = 4.5 V, I_{IS} = 30 mA	4.5	—	6	10	
			V_{IS} = 0 V, I_{IS} = 24 mA	3.0	—	5	9	
			V_{IS} = 3.0 V, I_{IS} = 24 mA	3.0	—	7	14	
			V_{IS} = 0 V, I_{IS} = 8 mA	2.3	—	6	12	
			V_{IS} = 2.3 V, I_{IS} = 8 mA	2.3	—	9	18	
			V_{IS} = 0 V, I_{IS} = 4 mA	1.65	—	8	20	
			V_{IS} = 1.65 V, I_{IS} = 4 mA	1.65	—	15	30	
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND, I_{OUT} = 0 A	5.5	—	—	10	μA
	ΔI_{CC}		V_{IN} = V_{CC} - 0.6 V	5.5	—	—	50	

Note 1: All typical values are at T_a = 25 °C.

Note 2: Measured by the voltage drop between A and B pins at the indicated current through the switch. On-resistance is determined by the lower of the voltages on the two (A or B) pins.

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10.2. DC Characteristics (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
High-level input voltage (OE, $\overline{OE}$)	V_{IH}		—	1.65 to 1.95	0.8 × V_{CC}	—	V
				2.3 to 5.5	0.7 × V_{CC}	—	
Low-level input voltage (OE, $\overline{OE}$)	V_{IL}		—	1.65 to 1.95	—	0.2 × V_{CC}	V
				2.3 to 5.5	—	0.3 × V_{CC}	
Input leakage current (OE, $\overline{OE}$)	I_{IN}		V_{IN} = 0 to 5.5 V	1.65 to 5.5	—	±2.0	μA
Switch OFF-state leakage current	I_{SZ}		A, B = 0 to V_{CC}, $\overline{OE}$ = GND (TC7SB66CFU) $\overline{OE}$ = V_{CC} (TC7SB67CFU)	1.65 to 5.5	—	±20	μA
ON-resistance	R_{ON}	(Note 1)	V_{IS} = 0 V, I_{IS} = 30 mA	4.5	—	9	Ω
			V_{IS} = 2.4 V, I_{IS} = 30 mA	4.5	—	14	
			V_{IS} = 4.5 V, I_{IS} = 30 mA	4.5	—	12	
			V_{IS} = 0 V, I_{IS} = 24 mA	3.0	—	11	
			V_{IS} = 3.0 V, I_{IS} = 24 mA	3.0	—	16	
			V_{IS} = 0 V, I_{IS} = 8 mA	2.3	—	15	
			V_{IS} = 2.3 V, I_{IS} = 8 mA	2.3	—	21	
			V_{IS} = 0 V, I_{IS} = 4 mA	1.65	—	23	
			V_{IS} = 1.65 V, I_{IS} = 4 mA	1.65	—	33	
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND, I_{OUT} = 0 A	5.5	—	100	μA
	ΔI_{CC}		V_{IN} = V_{CC} - 0.6 V	5.5	—	100	

Note 1: Measured by the voltage drop between A and B pins at the indicated current through the switch. On-resistance is determined by the lower of the voltages on the two (A or B) pins.

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10.3. AC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Output enable time	t_{PZL},t_{PZH}	See Fig. 11.2.1, 11.2.2, Table 11.2.1	5.0 ± 0.5	—	4	ns
			3.3 ± 0.3	—	6	
			2.5 ± 0.2	—	9	
			1.8 ± 0.15	—	18	
Output disable time	t_{PLZ},t_{PHZ}	See Fig. 11.2.1, 11.2.2, Table 11.2.1	5.0 ± 0.5	—	4.5	ns
			3.3 ± 0.3	—	7	
			2.5 ± 0.2	—	9	
			1.8 ± 0.15	—	18	

10.4. AC Characteristics (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Output enable time	t_{PZL},t_{PZH}	See Fig. 11.2.1, 11.2.2, Table 11.2.1	5.0 ± 0.5	—	6	ns
			3.3 ± 0.3	—	8	
			2.5 ± 0.2	—	11	
			1.8 ± 0.15	—	20	
Output disable time	t_{PLZ},t_{PHZ}	See Fig. 11.2.1, 11.2.2, Table 11.2.1	5.0 ± 0.5	—	6.5	ns
			3.3 ± 0.3	—	9	
			2.5 ± 0.2	—	11	
			1.8 ± 0.15	—	20	

10.5. Capacitive Characteristics (Note) (Unless otherwise specified, T_a = 25 °C)

Characteristics	Part Number	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance (OE, $\overline{OE}$)		C_{IN}	V_{IN} = 0 V	5.0	4	pF
Switch terminal OFF-capacitance	TC7SB66CFU	$C_{I/O}$	OE = GND, $V_{I/O}$ = 0 V	5.0	5	pF
	TC7SB67CFU		$\overline{OE}$ = V_{CC}, $V_{I/O}$ = 0 V	5.0	5	
Switch terminal ON-capacitance	TC7SB66CFU	$C_{I/O}$	OE = V_{CC}, $V_{I/O}$ = 0 V	5.0	10	pF
	TC7SB67CFU		$\overline{OE}$ = GND, $V_{I/O}$ = 0 V	5.0	10	

Note: Parameter guaranteed by design.

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11. AC Test Circuit

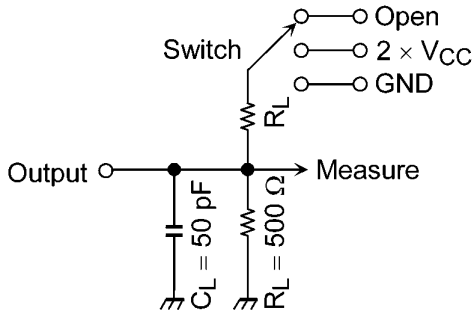

Fig. 11.2.1 AC Test Circuit

Table 11.2.1 Parameter for AC Test Circuit

Parameter	Switch
t_{PLZ}, t_{PZL}	2 × V_{CC}
t_{PHZ}, t_{PZH}	GND

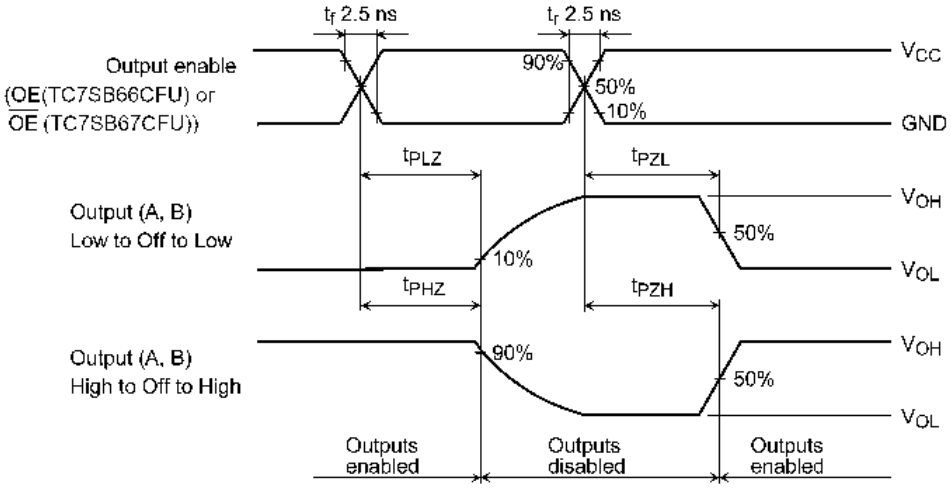

Fig. 11.2.2 AC Waveform t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

12. Rise and Fall Time (t_r/t_f)

The $t_{r(out)}$ and $t_{f(out)}$ values of the output signals are affected by the CR time constant of the input, which consists of the switch terminal capacitance ($C_{I/O}$) and the on-resistance (R_{ON}) of the input.

In practice, the $t_{r(out)}$ and $t_{f(out)}$ values are also affected by the circuit's capacitance and resistance components other than the capacitance of TC7SB66CFU, TC7SB67CFU

The $t_r/t_{f(out)}$ values can be approximated as follows.

(Figure 12.1, Table 12.1 shows the test circuit.)

$t_r/t_{f(out)}$ (approx) = - ($C_{I/O}$ + C_L) · (R_{DRIVE} + R_{ON}) · ln (((V_{OH} - V_{OL}) - V_M) / (V_{OH} - V_{OL}))

Where, R_{DRIVE} is the output impedance of the previous-stage circuit.

Calculation example:

t_r(out) (approx) = - (10 + 15) E - 12 · (120 + 4) · ln (((4.5 - 0) - 2.25) / (4.5 - 0)) = ≈2.1 ns

Calculation conditions:

V_{CC} = 4.5 V, C_L = 15 pF, R_{DRIVE} = 120 Ω (output impedance of the previous IC), V_M = 2.25 V (V_{CC}/2)

Output of the previous IC = digital (i.e., high-level voltage = V_{CC}, low-level voltage = GND)

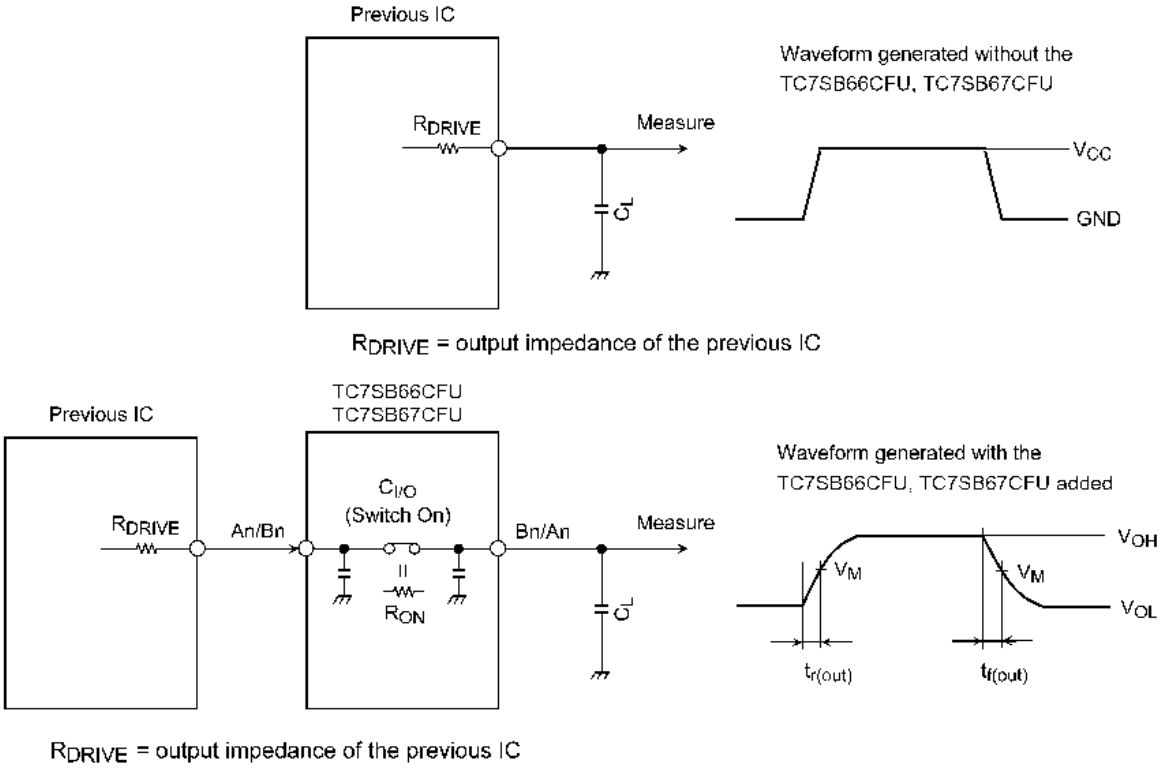

Fig. 12.1 Calculation Circuit

Table 12.1 Calculation Circuit

Characteristics	V_{CC} = 5.0 ± 0.5 V	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 0.15 V
V_M	V_{CC}/2	V_{CC}/2	V_{CC}/2	V_{CC}/2

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13. Characteristics Curves (Note)

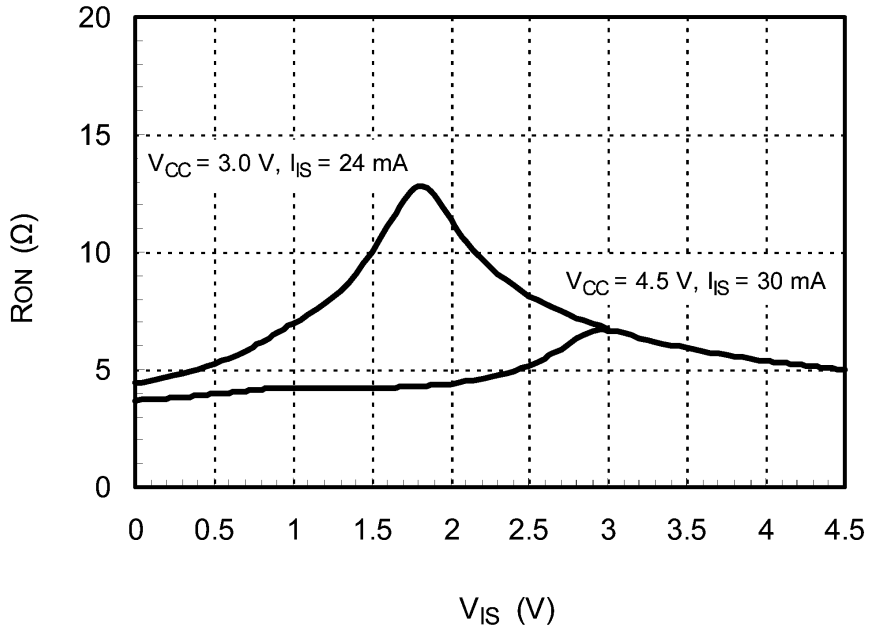

Fig. 13.1 R_{ON} - V_{IS} (typ.) (T_a = 25 °C)

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

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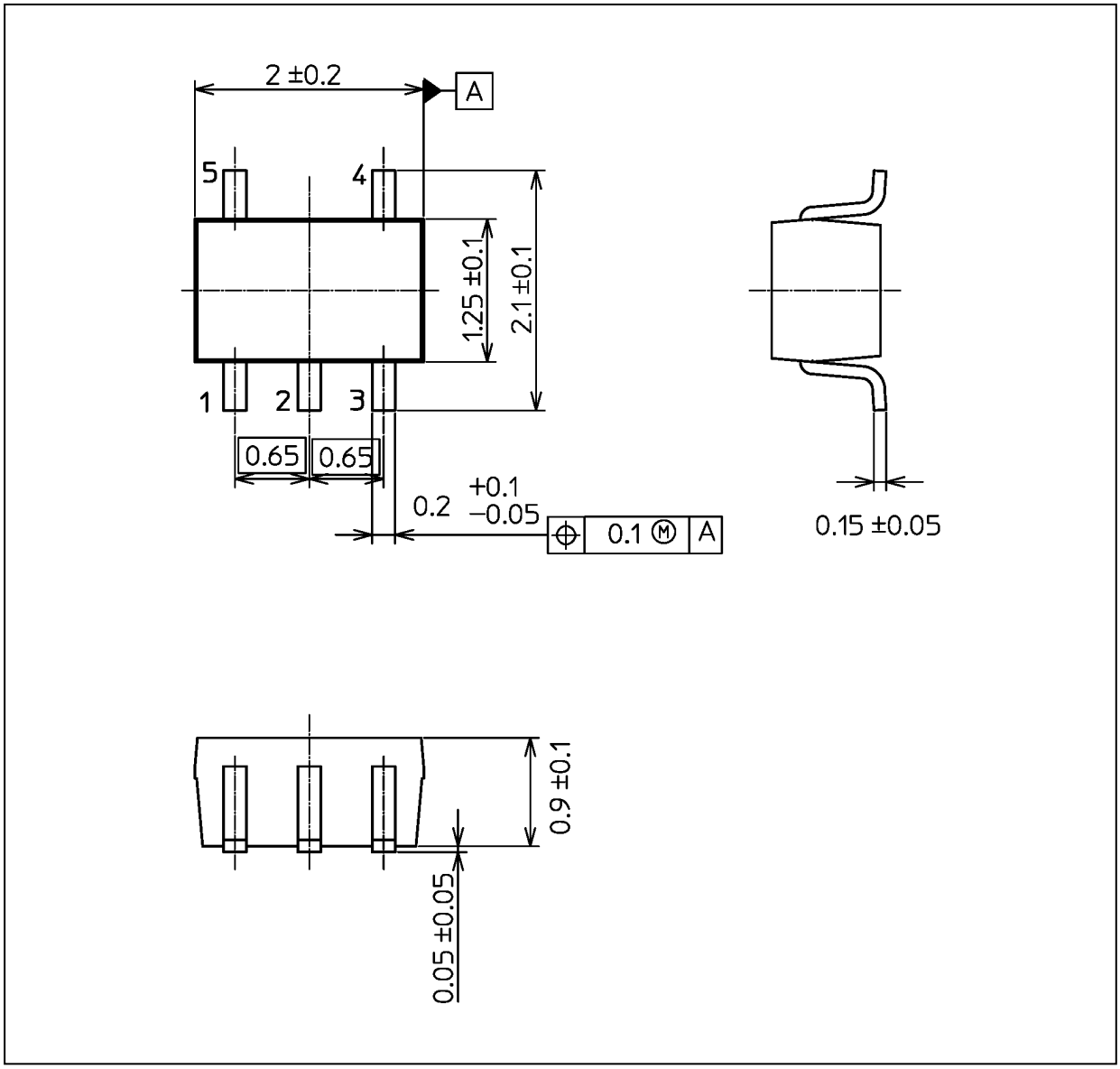
Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

Package Name(s)
Nickname: USV

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