

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 ( $\overline{\text{OE}}$ ) 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.

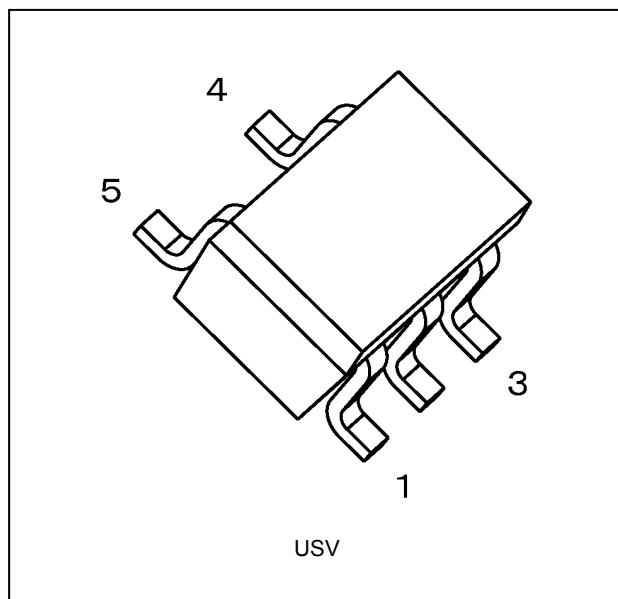
## 3. Features

- (1) AEC-Q100 (rev.H) Grade 1 qualified (Note 1)
- (2) Wide operating temperature range:  $T_{\text{opr}} = -40$  to  $125$  °C (Note 2)
- (3) Operating voltage:  $V_{\text{CC}} = 1.65$  to  $5.5$  V
- (4) ON capacitance:  $C_{\text{IO}} = 10$  pF Switch On (typ.) @  $V_{\text{CC}} = 5.0$  V
- (5) ON resistance:  $R_{\text{ON}} = 4$   $\Omega$  (typ.) @  $V_{\text{CC}} = 4.5$  V,  $V_{\text{IS}} = 0$  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).  $T_{\text{opr}} = -40$  to  $85$  °C for the other devices.

## 4. Packaging

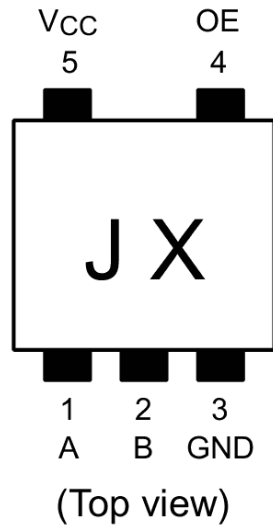


Start of commercial production

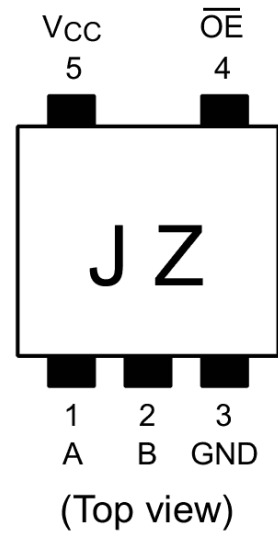
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### 5. Pin Assignment

TC7SB66CFU

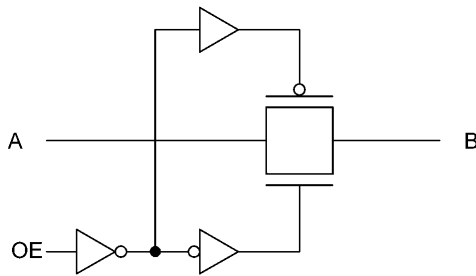


TC7SB67CFU

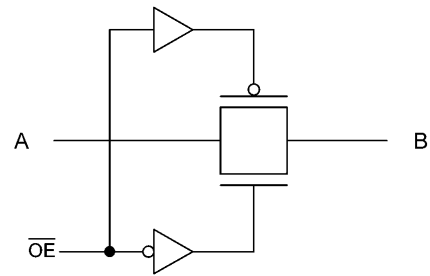


### 6. Block Diagram

TC7SB66CFU



TC7SB67CFU



### 7. Principle of Operation

#### 7.1. Truth Table

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

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

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

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 (Note)

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

### 10. Electrical Characteristics

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

Characteristics	Part Number	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	$0.8 \times V_{CC}$	—	—	V
					2.3 to 5.5	$0.7 \times V_{CC}$	—	—	
Low-level input voltage (OE, $\overline{OE}$ )		$V_{IL}$		—	1.65 to 1.95	—	—	$0.2 \times V_{CC}$	
					2.3 to 5.5	—	—	$0.3 \times V_{CC}$	
Input leakage current (OE, $\overline{OE}$ )		$I_{IN}$		$V_{IN} = 0$ to $5.5$ V	1.65 to 5.5	—	—	$\pm 1.0$	$\mu A$
Switch OFF-state leakage current	TC7SB66-CFU	$I_{SZ}$		A, B = 0 to $V_{CC}$ , OE = GND	1.65 to 5.5	—	—	$\pm 10$	
	TC7SB67-CFU			A, B = 0 to $V_{CC}$ , $\overline{OE} = V_{CC}$	1.65 to 5.5	—	—	$\pm 10$	
ON-resistance		$R_{ON}$	(Note 1), (Note 2)	$V_{IS} = 0$ V, $I_{IS} = 30$ mA	4.5	—	4	7	$\Omega$
				$V_{IS} = 2.4$ 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	
$\Delta I_{CC}$		$V_{IN} = V_{CC} - 0.6$ 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.

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

Characteristics	Part Number	Symbol	Note	Test Condition	$V_{CCB}$ (V)	Min	Typ.	Max	Unit
High-level input voltage (OE, $\overline{OE}$ )		$V_{IH}$		—	1.65 to 1.95	$0.8 \times V_{CC}$	—	—	V
					2.3 to 5.5	$0.7 \times V_{CC}$	—	—	
Low-level input voltage (OE, $\overline{OE}$ )		$V_{IL}$		—	1.65 to 1.95	—	—	$0.2 \times V_{CC}$	
					2.3 to 5.5	—	—	$0.3 \times V_{CC}$	
Input leakage current (OE, $\overline{OE}$ )		$I_{IN}$		$V_{IN} = 0$ to $5.5$ V	1.65 to 5.5	—	—	$\pm 2.0$	$\mu$ A
Switch OFF-state leakage current	TC7SB66- CFU	$I_{SZ}$		A, B = 0 to $V_{CC}$ , OE = GND	1.65 to 5.5	—	—	$\pm 20$	
	TC7SB67- CFU			A, B = 0 to $V_{CC}$ , OE = $V_{CC}$	1.65 to 5.5	—	—	$\pm 20$	
ON-resistance		$R_{ON}$	(Note 1), (Note 2)	$V_{IS} = 0$ V, $I_{IS} = 30$ mA	4.5	—	4	9	$\Omega$
				$V_{IS} = 2.4$ V, $I_{IS} = 30$ mA	4.5	—	5	14	
				$V_{IS} = 4.5$ V, $I_{IS} = 30$ mA	4.5	—	6	12	
				$V_{IS} = 0$ V, $I_{IS} = 24$ mA	3.0	—	5	11	
				$V_{IS} = 3.0$ V, $I_{IS} = 24$ mA	3.0	—	7	16	
				$V_{IS} = 0$ V, $I_{IS} = 8$ mA	2.3	—	6	15	
				$V_{IS} = 2.3$ V, $I_{IS} = 8$ mA	2.3	—	9	21	
				$V_{IS} = 0$ V, $I_{IS} = 4$ mA	1.65	—	8	23	
				$V_{IS} = 1.65$ V, $I_{IS} = 4$ mA	1.65	—	15	33	
				Quiescent supply current		$I_{CC}$		$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$ A	
$\Delta I_{CC}$		$V_{IN} = V_{CC} - 0.6$ V	5.5			—	—	100	

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.

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

Characteristics	Symbol	Note	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	$5.0 \pm 0.5$	—	4	ns
				$3.3 \pm 0.3$	—	6	
				$2.5 \pm 0.2$	—	9	
				$1.8 \pm 0.15$	—	18	
Output disable time	$t_{PLZ}, t_{PHZ}$		See Fig. 11.2.1, 11.2.2, Table 11.2.1	$5.0 \pm 0.5$	—	4.5	
				$3.3 \pm 0.3$	—	7	
				$2.5 \pm 0.2$	—	9	
				$1.8 \pm 0.15$	—	18	

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

Characteristics	Symbol	Note	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	$5.0 \pm 0.5$	—	6	ns
				$3.3 \pm 0.3$	—	8	
				$2.5 \pm 0.2$	—	11	
				$1.8 \pm 0.15$	—	20	
Output disable time	$t_{PLZ}, t_{PHZ}$		See Fig. 11.2.1, 11.2.2, Table 11.2.1	$5.0 \pm 0.5$	—	6.5	
				$3.3 \pm 0.3$	—	9	
				$2.5 \pm 0.2$	—	11	
				$1.8 \pm 0.15$	—	20	

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

Characteristics	Part Number	Symbol	Note	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	
	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	
	TC7SB67CFU			$\overline{OE} = GND$ , $V_{I/O} = 0$ V	5.0	10	

Note: Parameter guaranteed by design.

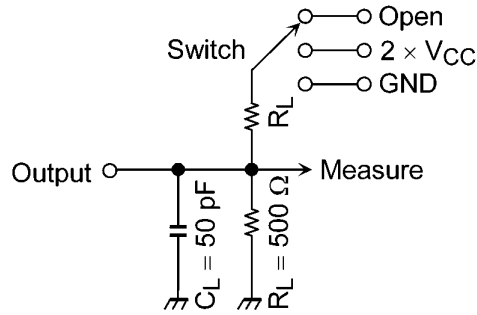


Fig. 11.2.1 AC Test Circuit

Table 11.2.1 Parameter for AC Test Circuit

Parameter	Switch
$t_{PLZ}, t_{PZL}$	$2 \times V_{CC}$
$t_{PHZ}, t_{PZH}$	GND

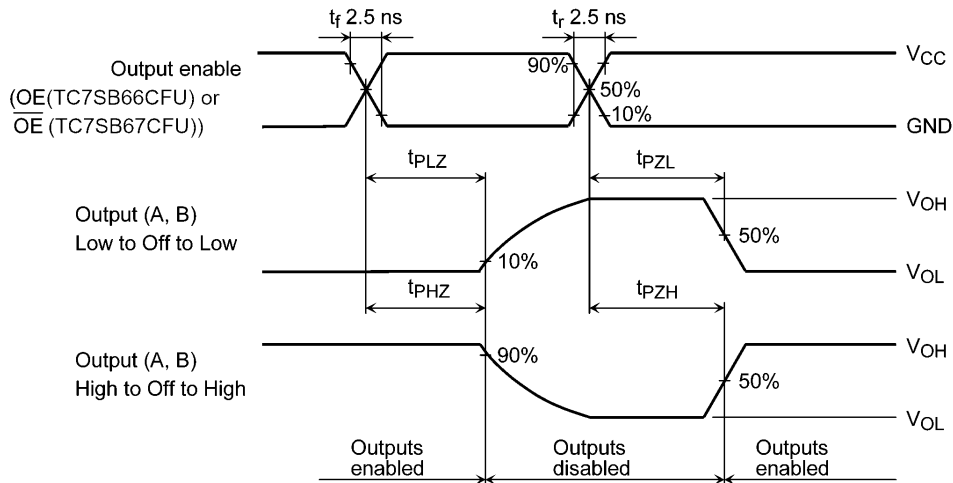


Fig. 11.2.2 AC Waveform  $t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}$

### 11. 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.)

$$t_r/t_{f(out)} \text{ (approx)} = - (C_{I/O} + C_L) \cdot (R_{DRIVE} + R_{ON}) \cdot \ln \left( \frac{(V_{OH} - V_{OL}) \cdot V_M}{(V_{OH} - V_{OL})} \right)$$

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

Calculation example:

$$t_r(out) \text{ (approx)} = - (10 + 15) \text{ E} \cdot 12 \cdot (120 + 4) \cdot \ln \left( \frac{(4.5 - 0) \cdot 2.25}{(4.5 - 0)} \right) \approx 2.1 \text{ ns}$$

Calculation conditions:

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

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

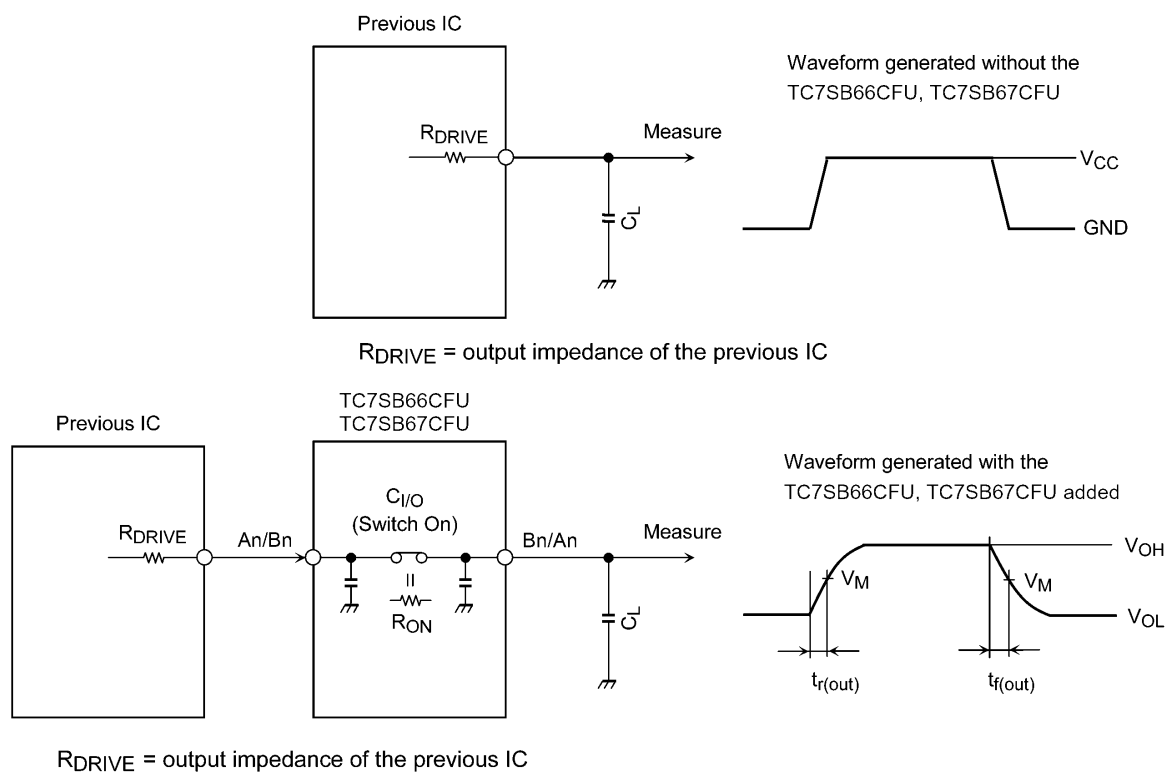


Fig. 11.1 Calculation Circuit

Table 12.1 Calculation Circuit

Characteristics	$V_{CC} = 5.0 \pm 0.5 \text{ V}$	$V_{CC} = 3.3 \pm 0.3 \text{ V}$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$	$V_{CC} = 1.8 \pm 0.15 \text{ V}$
$V_M$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$



## 12. Characteristics Curves (Note)

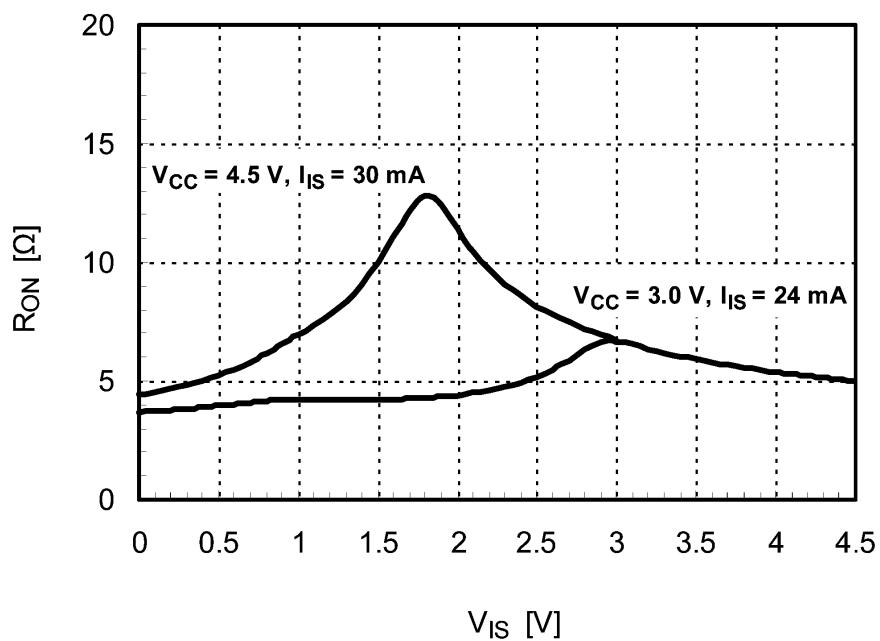
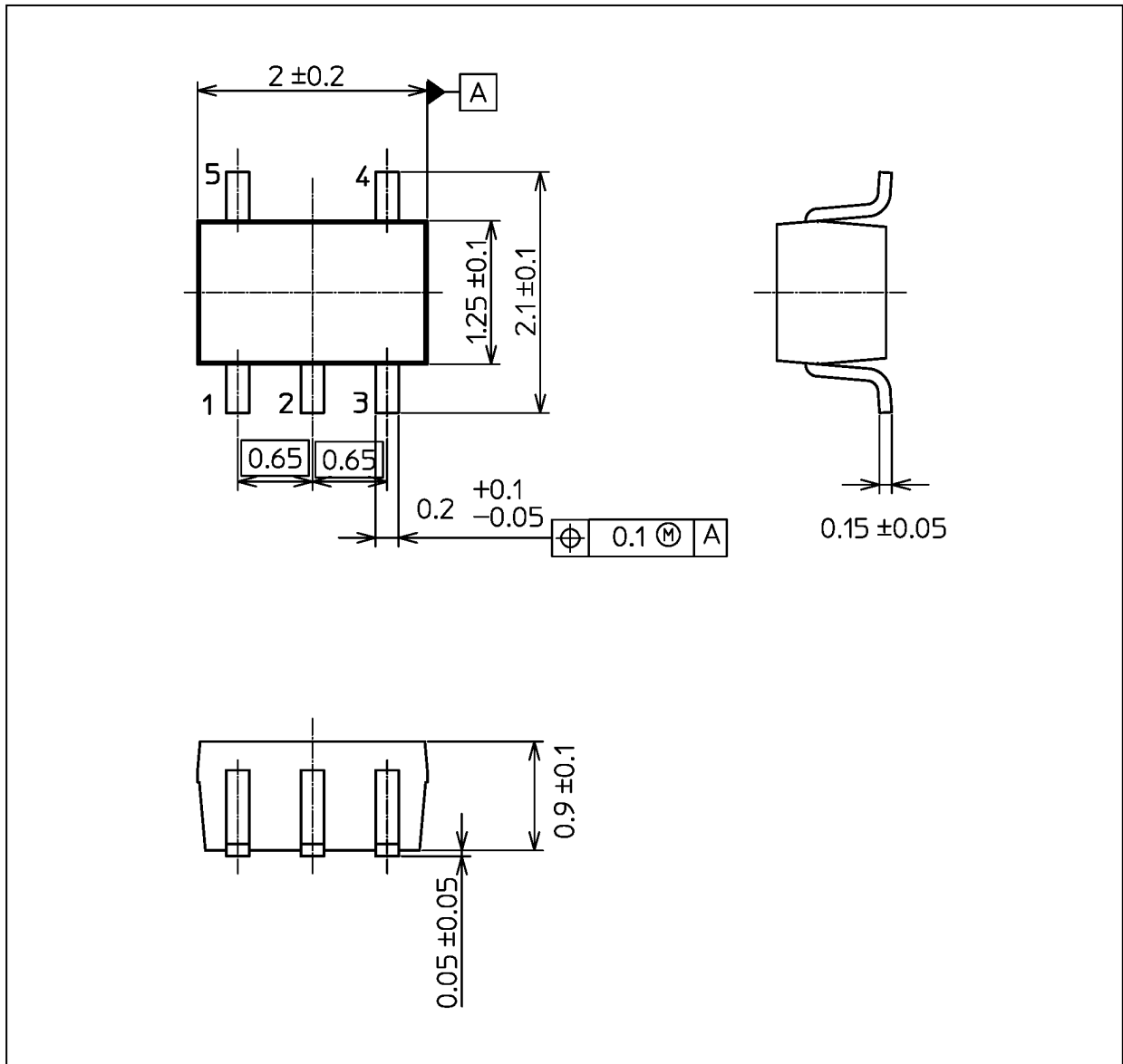


Fig. 12.1  $R_{ON}$  -  $V_{IS}$  (typ.) ( $T_a = 25$  °C)

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

## Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

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

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