

# TC7SB3157CFU

## 1. Functional Description

- Single 1-of-2 Multiplexer/Demultiplexer

## 2. General

The TC7SB3157CFU is a high-speed CMOS single 1-of-2 multiplexer/demultiplexer. The low ON resistance of the switch allows connections to be made with minimal propagation delay time.

This device is 1 to 2 multiplexer/demultiplexer controlled by the select input (S). The A input is connected to B1 or B2 output based on the selection of Control input (S).

All inputs are equipped with protection circuits against static discharge.

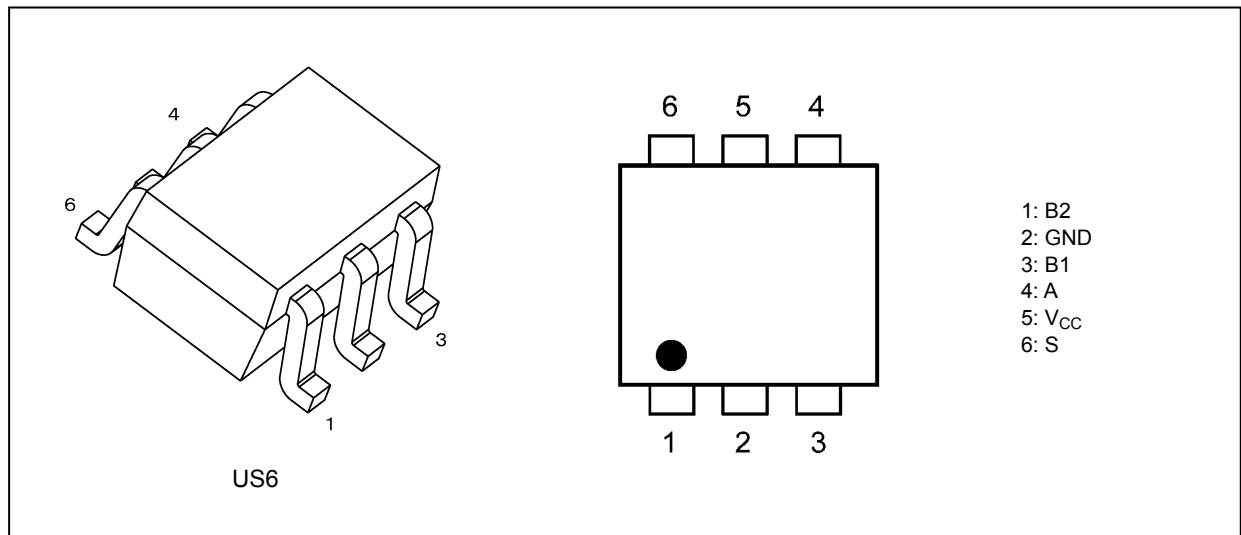
## 3. Features

- (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:  $C_{I/O} = 15$  pF Switch On (typ.) @  $V_{CC} = 5.0$  V
- (5) ON resistance:  $R_{ON} = 4$   $\Omega$  (typ.) @  $V_{CC} = 4.5$  V,  $V_{IS} = 0$  V
- (6) Package: US6

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.

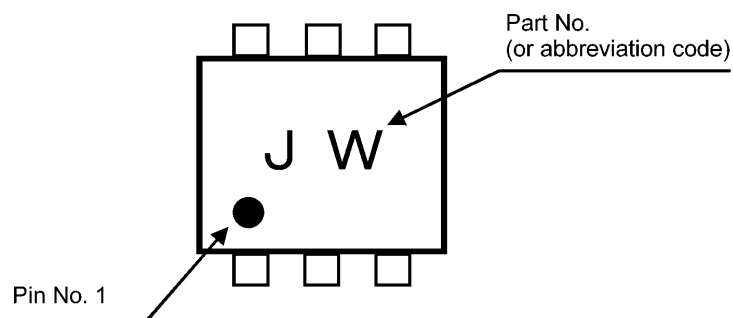
## 4. Packaging and Pin Assignment



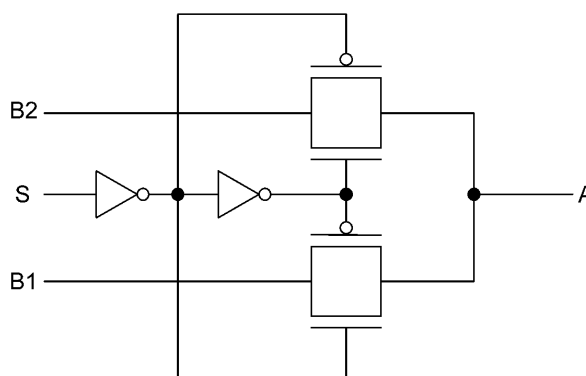
Start of commercial production

2020-09

### 5. Marking



### 6. Block Diagram



### 7. Principle of Operation

#### 7.1. Truth Table

Inputs S	Function
L	A port = B1 port
H	A port = B2 port

### 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 (S)	$V_{IN}$		-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 (S)	$V_{IN}$		0 to 5.5	
Switch I/O voltage	$V_S$		0 to $V_{CC}$	
Operating temperature	$T_{opr}$	(Note 1)	-40 to 125	°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 inputs and bus 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	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Typ.	Max	Unit
High-level input voltage	$V_{IH}$		—	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	$V_{IL}$		—	1.65 to 1.95	—	—	$0.2 \times V_{CC}$	V
				2.3 to 5.5	—	—	$0.3 \times V_{CC}$	
Input leakage current	$I_{IN}$		$V_{IN} = 0$ to $5.5$ V	1.65 to 5.5	—	—	$\pm 1.0$	$\mu A$
Switch OFF-state leakage current	$I_{SZ}$		B1, B2 = $0$ to $V_{CC}$	1.65 to 5.5	—	—	$\pm 10$	$\mu A$
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	5.5	—	—	10	$\mu A$
	$\Delta I_{CC}$		$V_{IN} = V_{CC} - 0.6$ 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	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$		—	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	$V_{IL}$		—	1.65 to 1.95	—	$0.2 \times V_{CC}$	V
				2.3 to 5.5	—	$0.3 \times V_{CC}$	
Input leakage current	$I_{IN}$		$V_{IN} = 0$ to $5.5$ V	1.65 to 5.5	—	$\pm 2.0$	$\mu A$
Switch OFF-state leakage current	$I_{SZ}$		B1, B2 = $0$ to $V_{CC}$	1.65 to 5.5	—	$\pm 20$	
ON-resistance	$R_{ON}$	(Note 1)	$V_{IS} = 0$ V, $I_{IS} = 30$ mA	4.5	—	9	$\Omega$
			$V_{IS} = 2.4$ 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	
			$I_{IS} = 0$ 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	$\mu A$
	$\Delta I_{CC}$		$V_{IN} = V_{CC} - 0.6$ 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.

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
3-state output enable time	$t_{PZL}/t_{PZH}$		See Fig. 10.2.1, 10.2.2, Table 10.2.1.	$5.0 \pm 0.5$	—	4	ns
				$3.3 \pm 0.3$	—	6	
				$2.5 \pm 0.2$	—	8	
				$1.8 \pm 0.15$	—	16	
3-state output disable time	$t_{PLZ}/t_{PHZ}$		See Fig. 10.2.1, 10.2.2, Table 10.2.1.	$5.0 \pm 0.5$	—	4.5	ns
				$3.3 \pm 0.3$	—	7	
				$2.5 \pm 0.2$	—	9	
				$1.8 \pm 0.15$	—	16	

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
3-state output enable time	$t_{PZL}/t_{PZH}$		See Fig. 10.2.1, 10.2.2, Table 10.2.1.	$5.0 \pm 0.5$	—	6	ns
				$3.3 \pm 0.3$	—	8	
				$2.5 \pm 0.2$	—	10	
				$1.8 \pm 0.15$	—	18	
3-state output disable time	$t_{PLZ}/t_{PHZ}$		See Fig. 10.2.1, 10.2.2, Table 10.2.1.	$5.0 \pm 0.5$	—	6.5	ns
				$3.3 \pm 0.3$	—	9	
				$2.5 \pm 0.2$	—	11	
				$1.8 \pm 0.15$	—	18	

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Input capacitance	$C_{IN}$	(Note 1)	$V_{IN} = 0$ V	5.0	4	pF
Switch terminal OFF-capacitance (B port)	$C_{I/O}$		$V_{I/O} = 0$ V	5.0	5	
Switch terminal ON-capacitance (A port)				5.0	15	
Switch terminal ON-capacitance (B port)				5.0	15	

Note 1: Parameter guaranteed by design.

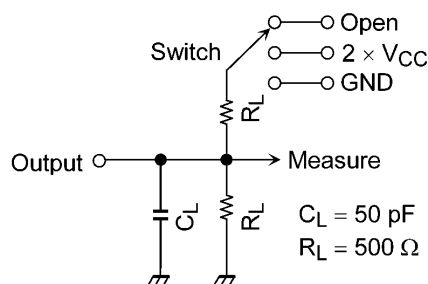


Fig. 10.2.1 AC Test Circuit

Table 10.2.1 Parameter for AC Test Circuit

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

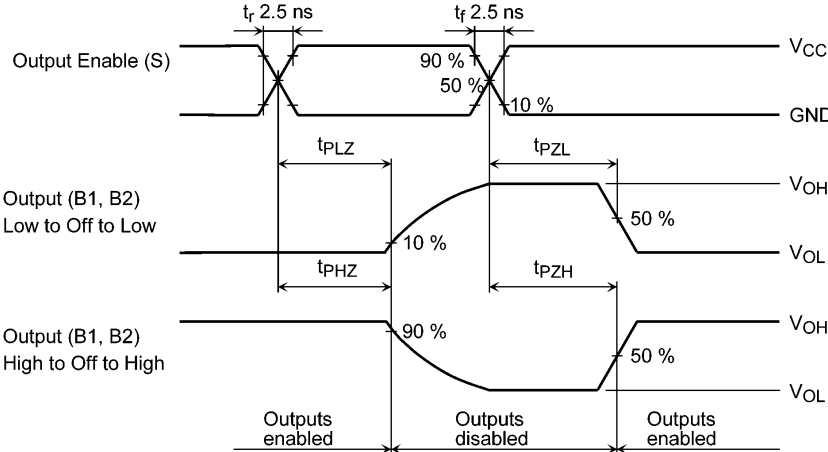


Fig. 10.2.2 AC Waveform  $t_{PLZ}$ ,  $t_{PHZ}$ ,  $t_{PZL}$ ,  $t_{PZH}$

### 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 TC7SB3157CFU

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

(Figure 11.1, Table 11.1 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:

$$t_{r(out)} \text{ (approx)} = - (15 + 15) \text{ E} - 12 \cdot (120 + 4) \cdot \ln \left( \frac{(4.5 - 0) \cdot 2.25}{(4.5 - 0)} \right) \approx 2.6 \text{ ns}$$

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)

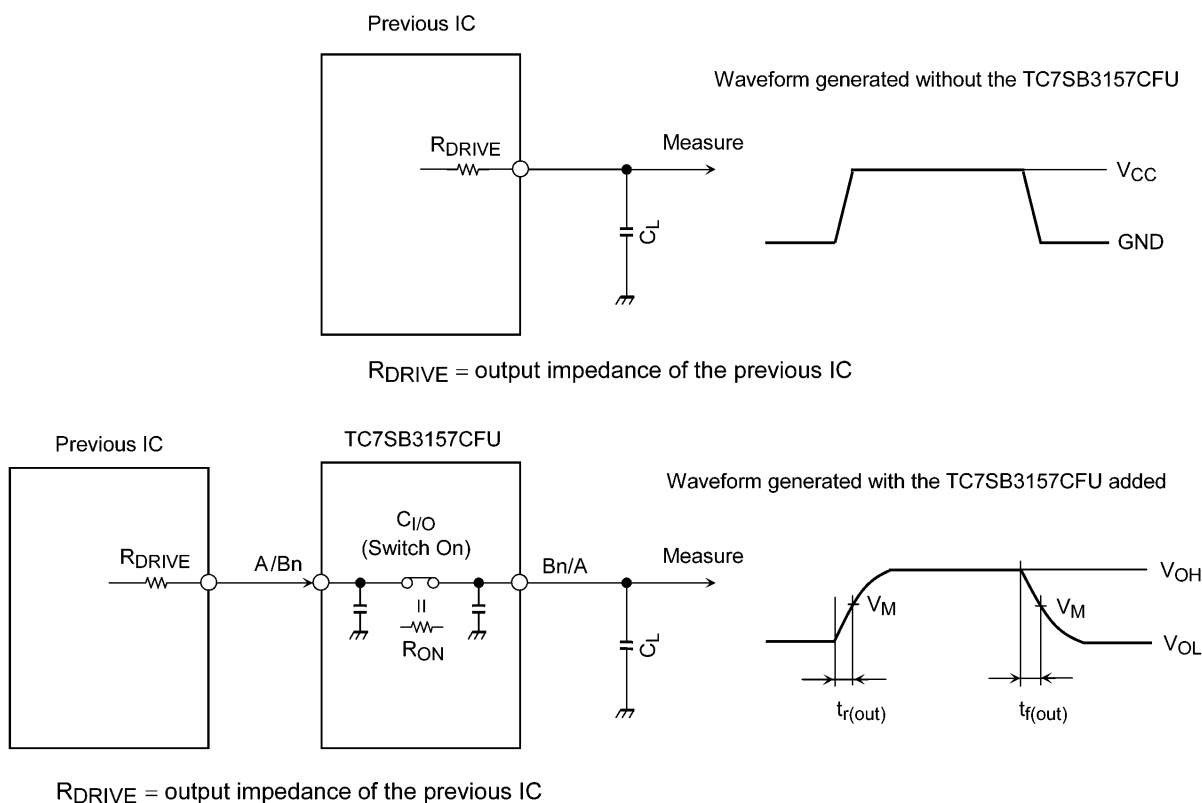


Fig. 11.1 Calculation Circuit

Table 11.1 Calculation Circuit

Characteristics	$V_{CC} = 5.0 \pm 0.5 \text{ V}$
$V_M$	$V_{CC}/2$

## 12. Characteristics Curves (Note)

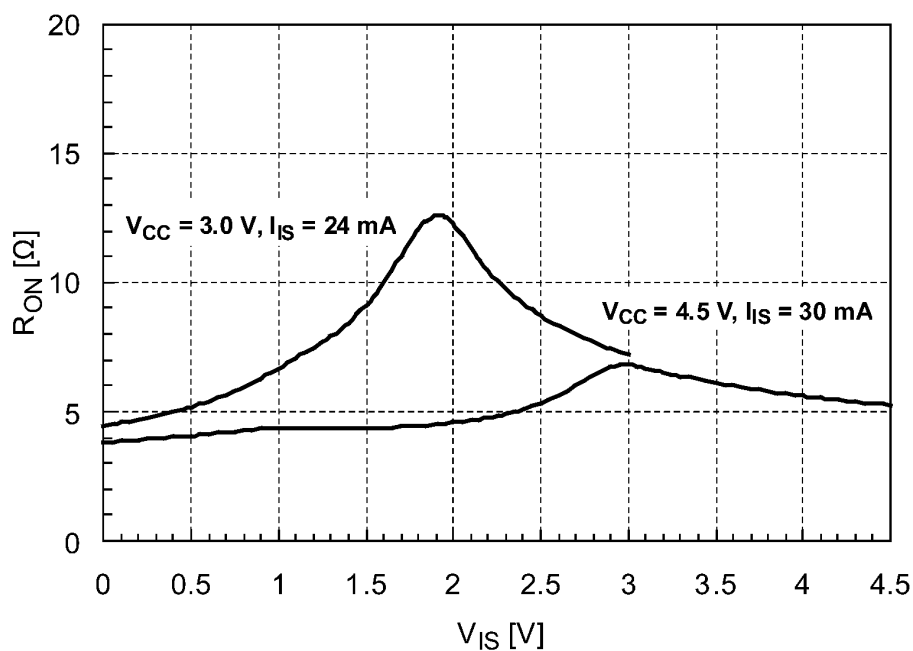
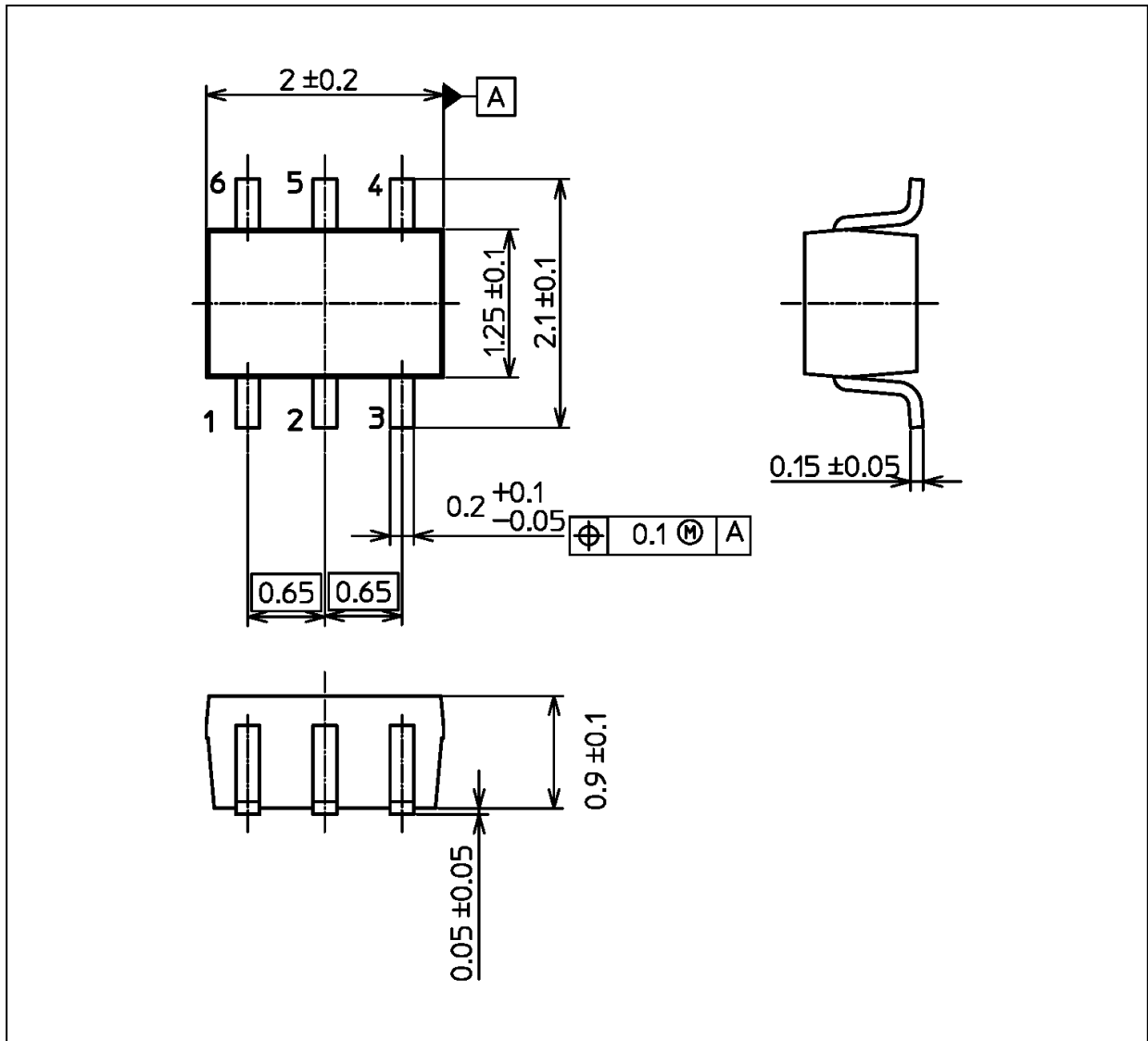


Fig. 12.1  $R_{ON}$  -  $V_{IS}$  (typ.) ( $T_a = 25$  °C)

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

## Package Dimensions

Unit: mm



Weight: 0.007 g (typ.)

Package Name(s)
JEDEC: SOT-363
Nickname: US6

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