CMOS Digital Integrated Circuits Silicon Monolithic

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

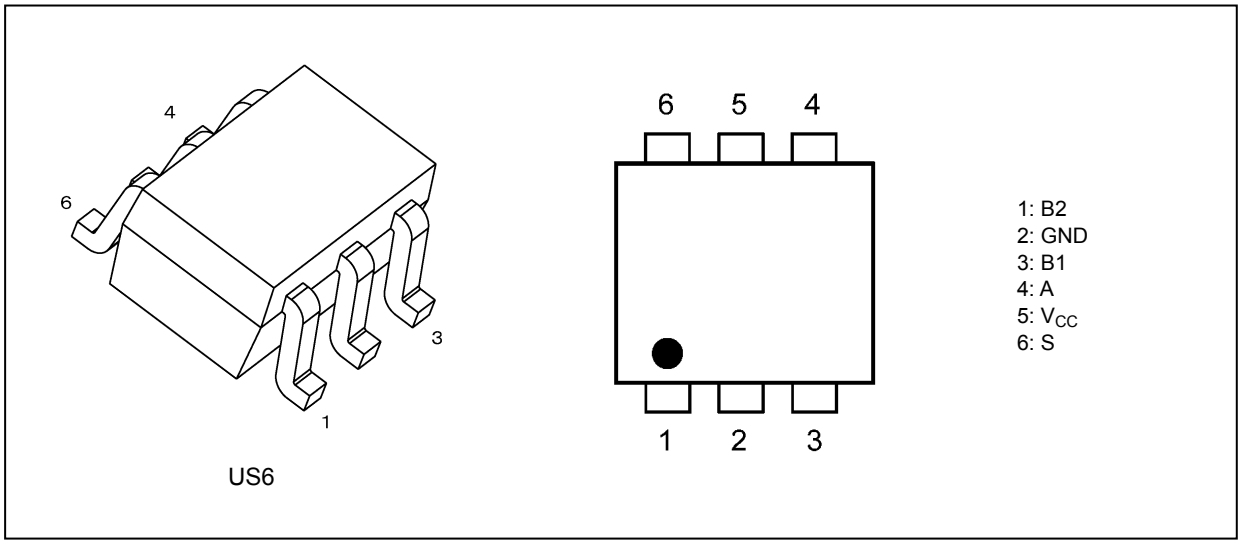
(5) ON resistance: R_{ON} = 4 Ω (typ.) @V_{CC} = 4.5 V, V_{IS} = 0 V

(6) Package: US6

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

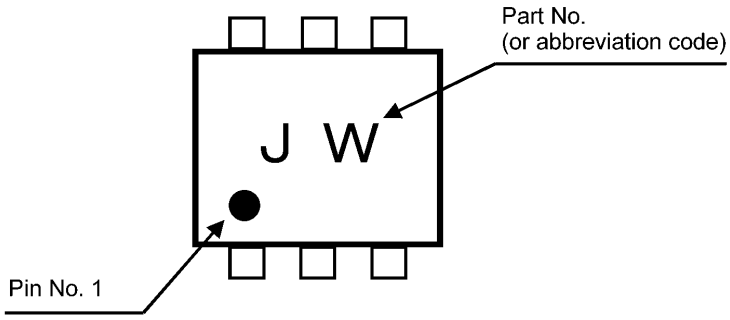
Note 2: For devices with the ordering part number ending in (CT. T_{opr} = -40 to 85 °C for the other devices.

4. Packaging and Pin Assignment

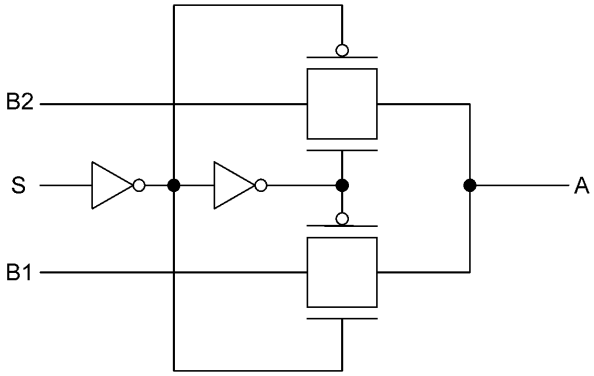


Start of commercial production
2020-09

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 °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}		±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 (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 × V_{CC}	—	—	V
				2.3 to 5.5	0.7 × V_{CC}	—	—	
Low-level input voltage	V_{IL}		—	1.65 to 1.95	—	—	0.2 × V_{CC}	V
				2.3 to 5.5	—	—	0.3 × V_{CC}	
Input leakage current	I_{IN}		V_{IN} = 0 to 5.5 V	1.65 to 5.5	—	—	±1.0	μA
Switch OFF-state leakage current	I_{SZ}		B1, B2 = 0 to V_{CC}	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.

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×V_{CC}	—	V
				2.3 to 5.5	0.7×V_{CC}	—	
Low-level input voltage	V_{IL}		—	1.65 to 1.95	—	0.2×V_{CC}	V
				2.3 to 5.5	—	0.3×V_{CC}	
Input leakage current	I_{IN}		V_{IN} = 0 to 5.5 V	1.65 to 5.5	—	±2.0	μA
Switch OFF-state leakage current	I_{SZ}		B1, B2 = 0 to V_{CC}	1.65 to 5.5	—	±20	
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	
			$_{IS}$ = 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.

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 ± 0.5	—	4	ns
				3.3 ± 0.3	—	6	
				2.5 ± 0.2	—	8	
				1.8 ± 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 ± 0.5	—	4.5	ns
				3.3 ± 0.3	—	7	
				2.5 ± 0.2	—	9	
				1.8 ± 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 ± 0.5	—	6	ns
				3.3 ± 0.3	—	8	
				2.5 ± 0.2	—	10	
				1.8 ± 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 ± 0.5	—	6.5	ns
				3.3 ± 0.3	—	9	
				2.5 ± 0.2	—	11	
				1.8 ± 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.

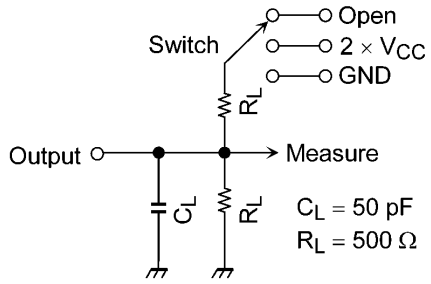


Fig. 10.2.1 AC Test Circuit

Table 10.2.1 Parameter for AC Test Circuit

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

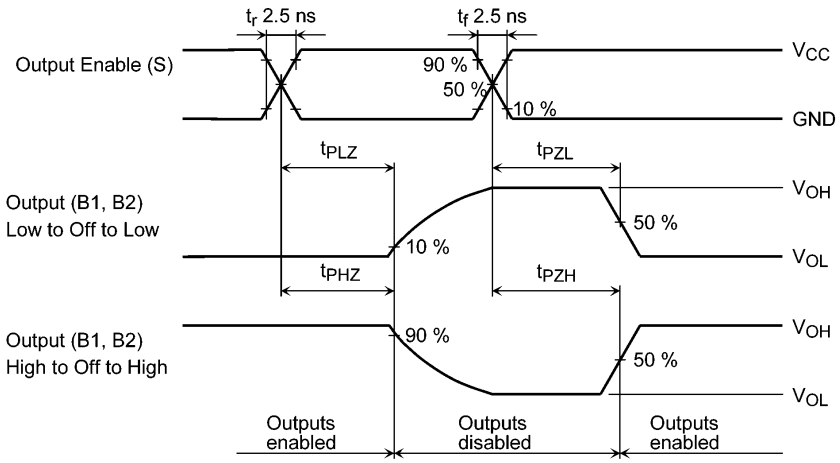


Fig. 10.2.2 AC Waveform t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

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.)

$t_r/t_{f(out)}$ (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) = - (15 + 15) E - 12 · (120 + 4) · ln ((((4.5 - 0) - 2.25) / (4.5 - 0)) ≈ 2.6 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)

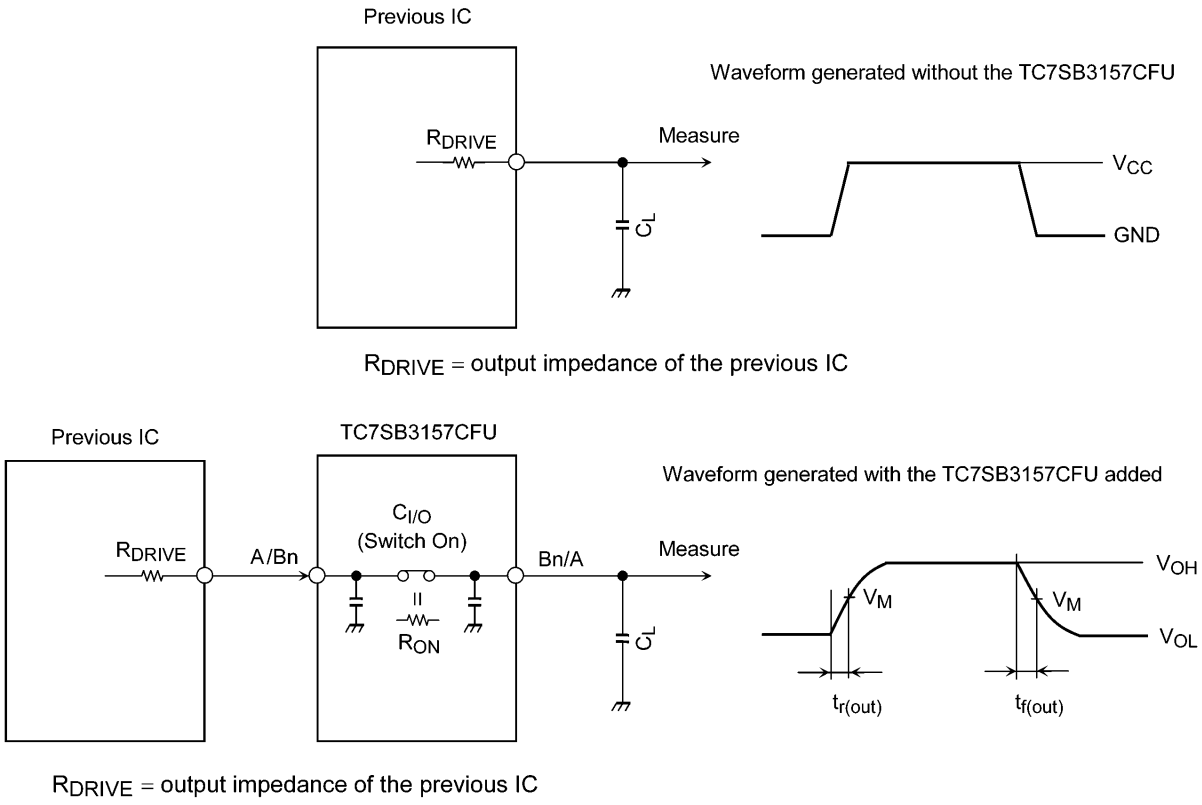


Fig. 11.1 Calculation Circuit

Table 11.1 Calculation Circuit

Characteristics	V_{CC} = 5.0 ± 0.5 V
V_M	V_{CC}/2

12. Characteristics Curves (Note)

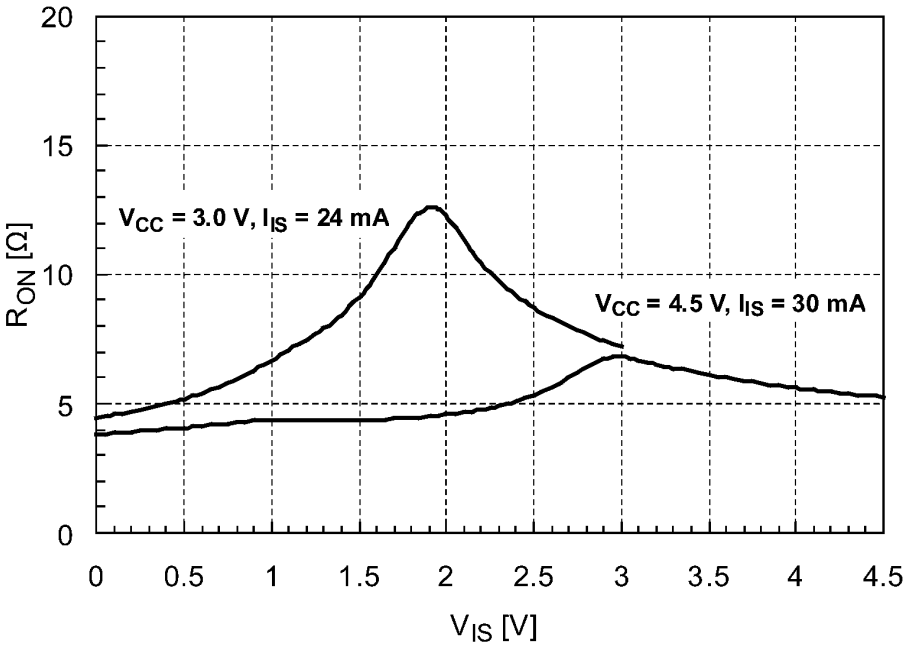
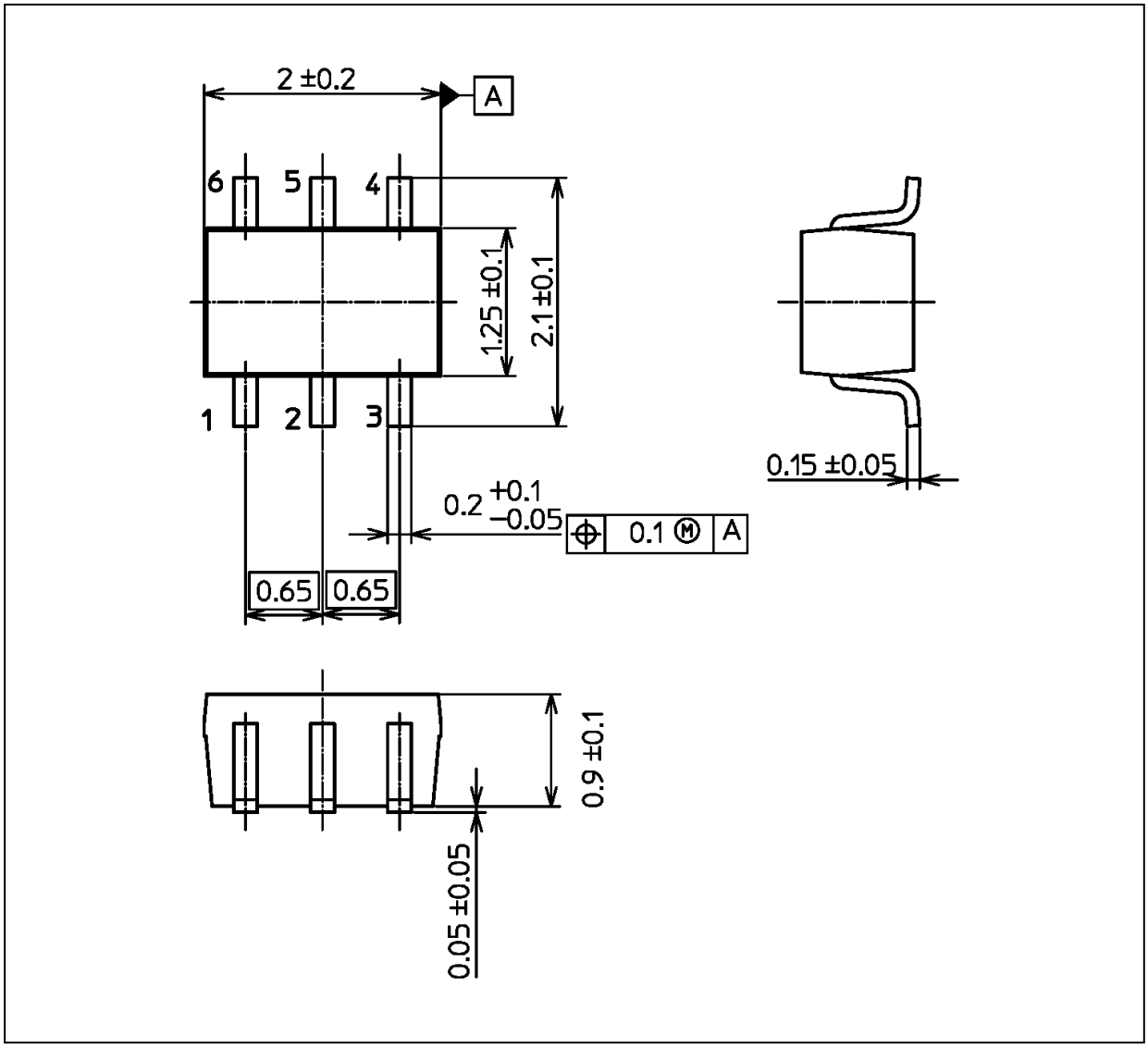


Fig. 12.1 R_{ON} - V_{IS} (typ.) (T_a = 25 °C)

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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