

TC7SZ05FE

1. Functional Description

- Inverter (Open Drain)

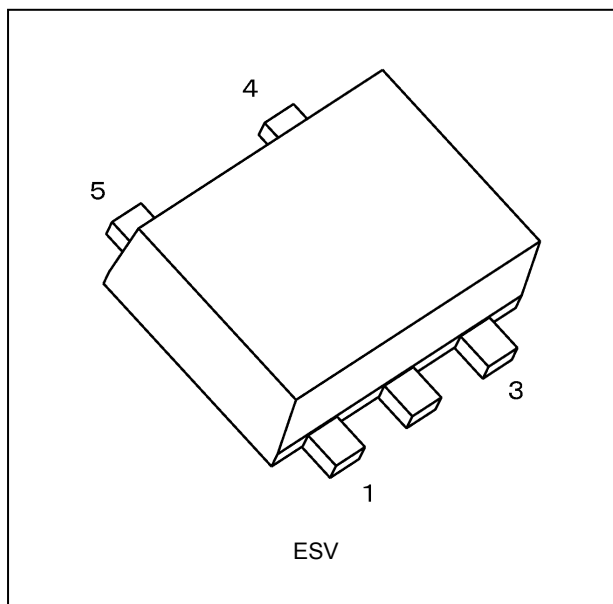
2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to $125\text{ }^{\circ}\text{C}$ (Note 2)
- (3) High output current: $\pm 24\text{ mA}$ (min) at $V_{CC} = 3.0\text{ V}$
- (4) Super high speed operation: $t_{pZL} = 2.3\text{ ns}$ (typ.) at $V_{CC} = 5.0\text{ V}$, $C_L = 50\text{ pF}$
- (5) Operation voltage range: $V_{CC} = 1.65$ to 5.5 V
- (6) 5.5 V tolerant inputs
- (7) 5.5 V power down protection output
- (8) Matches the performance of TC74LCX series when operated at $3.3\text{ V } V_{CC}$

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 J(CT). $T_{opr} = -40$ to $85\text{ }^{\circ}\text{C}$ for the other devices.

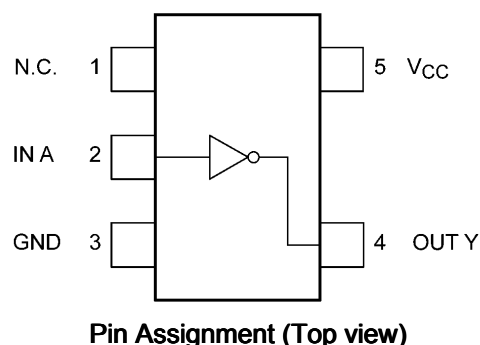
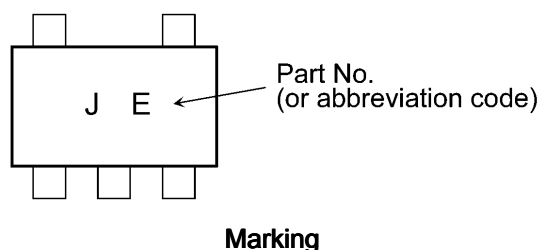
3. Packaging



Start of commercial production

2008-12

4. Marking and Pin Assignment



5. IEC Logic Symbol



6. Truth Table

A	Y
L	Z
H	L

Z: High impedance

7. 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 6.0	V
Input voltage	V_{IN}		-0.5 to 6.0	V
DC output voltage	V_{OUT}	(Note 1)	-0.5 to 6.0	V
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 2)	-20	mA
DC output current	I_{OUT}		50	mA
V_{CC} /ground current	I_{CC}		± 50	mA
Power dissipation	P_D		150	mW
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).

Note 1: I_{OUT} absolute maximum rating must be observed.

Note 2: $V_{OUT} < GND$

8. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}		—	1.65 to 5.5	V
		(Note 1)	—	1.5 to 5.5	
Input voltage	V_{IN}		—	0 to 5.5	V
Output voltage	V_{OUT}		—	0 to 5.5	V
Operating temperature	T_{opr}	(Note 2)	—	-40 to 125	°C
		(Note 3)	—	-40 to 85	
Input rise and fall time	dt/dv		$V_{CC} = 1.8 \pm 0.15 \text{ V}, 2.5 \pm 0.2 \text{ V}$	0 to 20	ns/V
			$V_{CC} = 3.3 \pm 0.3 \text{ V}$	0 to 10	
			$V_{CC} = 5.0 \pm 0.5 \text{ V}$	0 to 5	

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V_{CC} or GND.

Note 1: Data retention only

Note 2: For devices with the ordering part number ending in J(CT).

Note 3: For devices except those with the ordering part number ending in J(CT).

9. Electrical Characteristics

9.1. DC Characteristics (Unless otherwise specified, $T_a = 25^\circ\text{C}$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage	V_{IH}	—		1.65 to 1.95	$V_{CC} \times 0.75$	—	—	V
				2.3 to 5.5	$V_{CC} \times 0.7$	—	—	
Low-level input voltage	V_{IL}	—		1.65 to 1.95	—	—	$V_{CC} \times 0.25$	V
				2.3 to 5.5	—	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 100 \mu\text{A}$	1.65	—	0.0	0.1	V
				2.3	—	0.0	0.1	
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 4 \text{ mA}$	1.65	—	0.08	0.24	
			$I_{OL} = 8 \text{ mA}$	2.3	—	0.1	0.3	
			$I_{OL} = 16 \text{ mA}$	3.0	—	0.15	0.4	
			$I_{OL} = 24 \text{ mA}$	3.0	—	0.22	0.55	
			$I_{OL} = 32 \text{ mA}$	4.5	—	0.22	0.55	
3-state output OFF-state leakage current	I_{OZ}	$V_{IN} = V_{IL}$ $V_{OUT} = 0 \text{ to } 5.5 \text{ V}$		1.65 to 5.5	—	—	± 5	μA
Input leakage current	I_{IN}	$V_{IN} = 5.5 \text{ V or GND}$		0 to 5.5	—	—	± 1	μA
Power-OFF leakage current	I_{OFF}	$V_{IN} \text{ or } V_{OUT} = 5.5 \text{ V}$		0	—	—	1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC} \text{ or GND}$		5.5	—	—	2	μA

9.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		1.65 to 1.95	$V_{CC} \times 0.75$	—	V
				2.3 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		1.65 to 1.95	—	$V_{CC} \times 0.25$	V
				2.3 to 5.5	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 100\text{ }\mu\text{A}$	1.65	—	0.1	V
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	1.65	—	0.24	
			$I_{OL} = 8\text{ mA}$	2.3	—	0.3	
			$I_{OL} = 16\text{ mA}$	3.0	—	0.4	
			$I_{OL} = 24\text{ mA}$	3.0	—	0.55	
			$I_{OL} = 32\text{ mA}$	4.5	—	0.55	
3-state output OFF-state leakage current	I_{OZ}	$V_{IN} = V_{IL}$ $V_{OUT} = 0$ to 5.5 V		1.65 to 5.5	—	± 10	μA
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	± 10	μA
Power-OFF leakage current	I_{OFF}	V_{IN} or $V_{OUT} = 5.5\text{ V}$		0	—	10	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	20	μA

9.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		1.65 to 1.95	$V_{CC} \times 0.75$	—	V
				2.3 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		1.65 to 1.95	—	$V_{CC} \times 0.25$	V
				2.3 to 5.5	—	$V_{CC} \times 0.3$	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 100\text{ }\mu\text{A}$	1.65	—	0.1	V
				2.3	—	0.1	
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	1.65	—	0.7	
			$I_{OL} = 8\text{ mA}$	2.3	—	0.45	
			$I_{OL} = 16\text{ mA}$	3.0	—	0.6	
			$I_{OL} = 24\text{ mA}$	3.0	—	0.8	
			$I_{OL} = 32\text{ mA}$	4.5	—	0.8	
3-state output OFF-state leakage current	I_{OZ}	$V_{IN} = V_{IL}$ $V_{OUT} = 0$ to 5.5 V		1.65 to 5.5	—	± 20	μA
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	± 20	μA
Power-OFF leakage current	I_{OFF}	V_{IN} or $V_{OUT} = 5.5\text{ V}$		0	—	100	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	200	μA

Note: For devices with the ordering part number ending in J(CT).

9.4. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time	t_{PZL}		$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	5.5	9.5	ns
				2.5 ± 0.2		1.2	3.7	5.8	
				3.3 ± 0.3		0.8	2.9	4.4	
				5.0 ± 0.5		0.5	2.3	3.5	
Propagation delay time	t_{PLZ}		$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	4.3	9.5	ns
				2.5 ± 0.2		1.2	2.8	5.8	
				3.3 ± 0.3		0.8	2.1	4.4	
				5.0 ± 0.5		0.5	1.4	3.5	
Input capacitance	C_{IN}		—	0 to 5.5	—	—	4	—	pF
Output capacitance	C_{OUT}		—	0 to 5.5	—	—	8	—	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—	3.3	—	—	20	—	pF
				5.5		—	26	—	

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

9.5. AC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^{\circ}\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

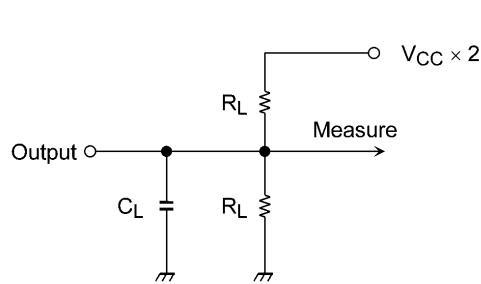
Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PZL}	$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	10.5	ns
			2.5 ± 0.2		1.2	6.4	
			3.3 ± 0.3		0.8	4.8	
			5.0 ± 0.5		0.5	3.9	
Propagation delay time	t_{PLZ}	$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	10.5	ns
			2.5 ± 0.2		1.2	6.4	
			3.3 ± 0.3		0.8	4.8	
			5.0 ± 0.5		0.5	3.9	

9.6. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^{\circ}\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

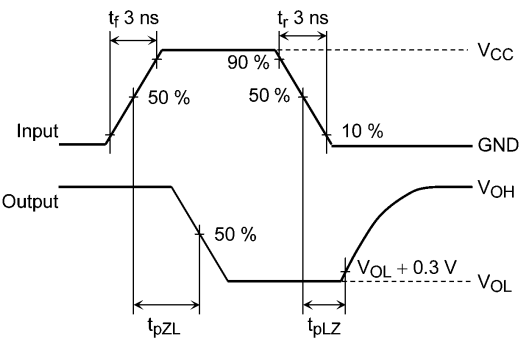
Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PZL}	$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	12.0	ns
			2.5 ± 0.2		1.2	7.5	
			3.3 ± 0.3		0.8	5.5	
			5.0 ± 0.5		0.5	4.5	
Propagation delay time	t_{PLZ}	$R_L = 500\text{ }\Omega$	1.8 ± 0.15	50	1.8	12.0	ns
			2.5 ± 0.2		1.2	7.5	
			3.3 ± 0.3		0.8	5.5	
			5.0 ± 0.5		0.5	4.5	

Note: For devices with the ordering part number ending in J(CT).

9.7. AC Characteristics Measurement Circuit and AC Waveform



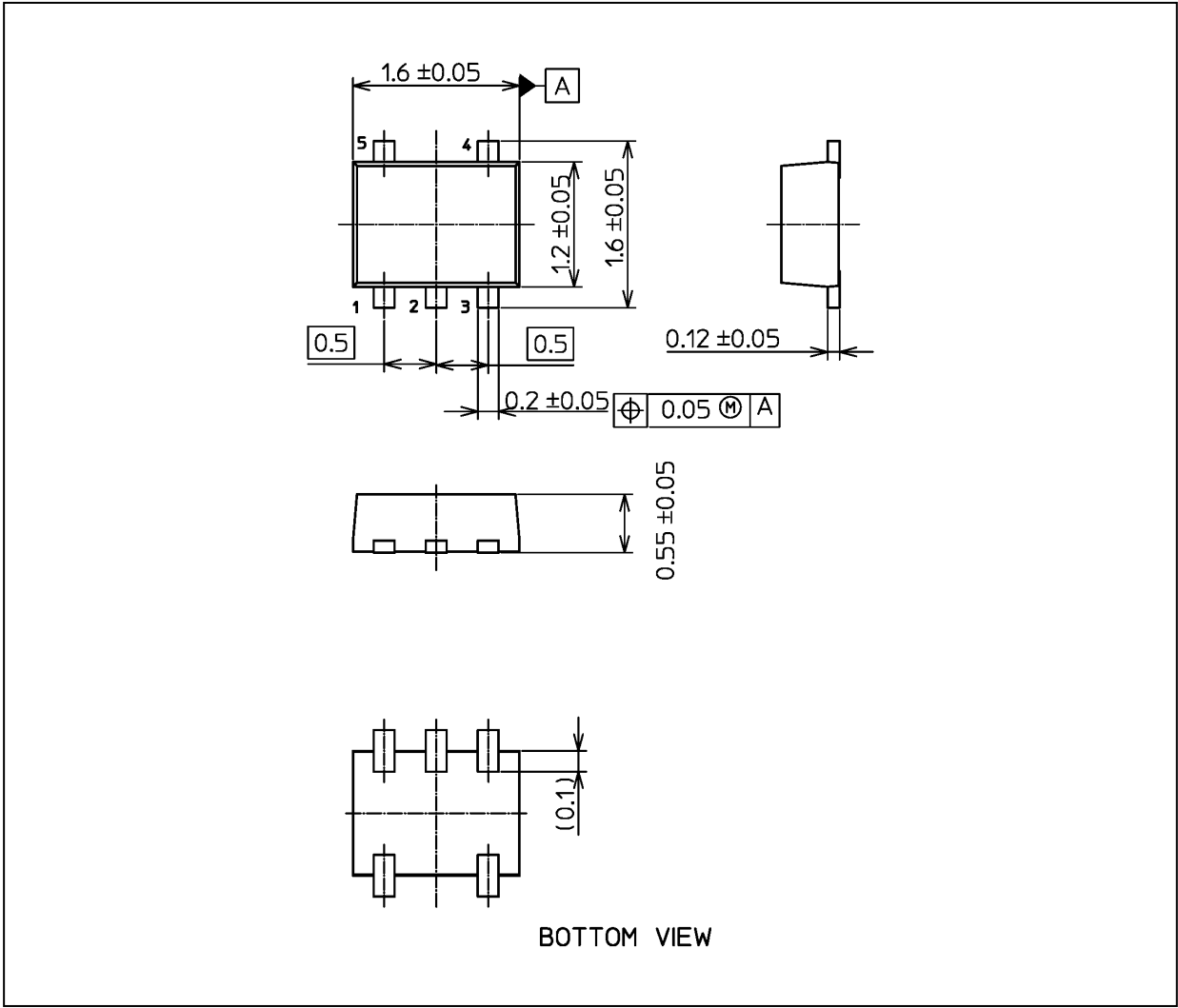
AC Characteristics Measurement Circuit



AC Waveform

Package Dimensions

Unit: mm



Weight: 3.0 mg (typ.)

Package Name(s)
JEDEC: SOT-553
Nickname: ESV

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