CMOS Digital Integrated Circuits Silicon Monolithic

TC7MBL3125CFT,TC7MBL3126CFT

1. Functional Description

- Low-Voltage, Low-Capacitance Quad Bus Switch

2. General

The TC7MBL3125CFT and TC7MBL3126CFT are a low-voltage/low-capacitance CMOS 4bit Bus Switch. The low on-resistance of the switch allows connections to be made with minimal propagation delay time.

The TC7MBL3125CFT requires the output enable ($\overline{OE}$) input to be set high to place the output into the high impedance state, whereas the TC7MBL3126CFT requires the output enable (OE) input to be set low to place the output into the high impedance.

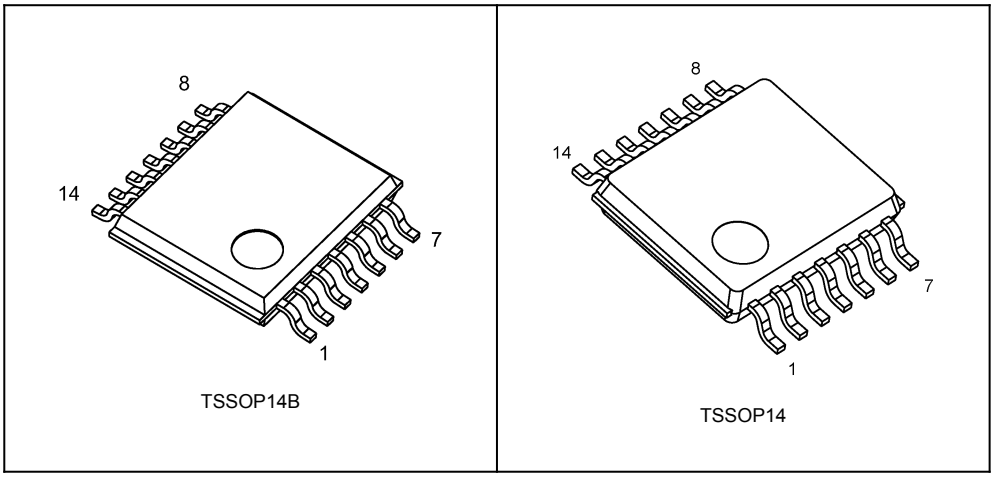
All inputs are equipped with protection circuits against static discharge.

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 3.6 V
(4) ON capacitance: $C_{I/O}$ = 7.5 pF Switch On (typ.) @V_{CC} = 3.0 V
(5) ON resistance: R_{ON} = 6.5 Ω (typ.) @V_{CC} = 3.0 V, V_{IS} = 0 V
(6) Power-down protection for inputs ($\overline{OE}$, OE and I/O)
(7) Package: TSSOP14, TSSOP14B

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.
Note 2: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

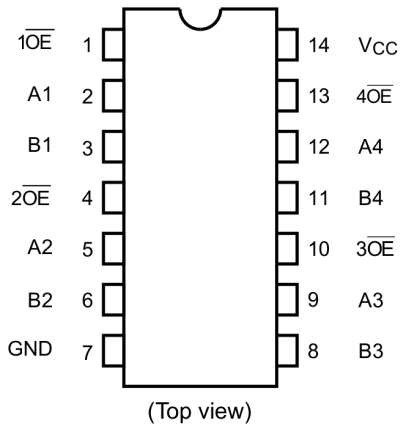
4. Packaging



Start of commercial production
2008-06

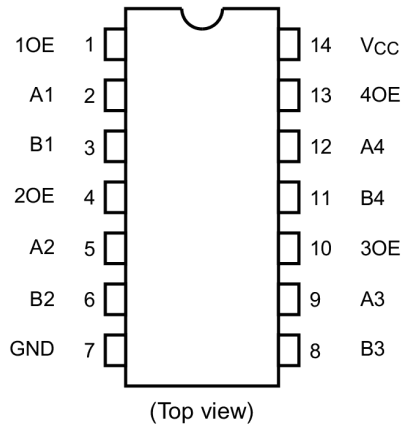
5. Pin Assignment

TC7MBL3125CFT



(Top view)

TC7MBL3126CFT



(Top view)

6. Marking (Note)

TC7MBL3125CFT

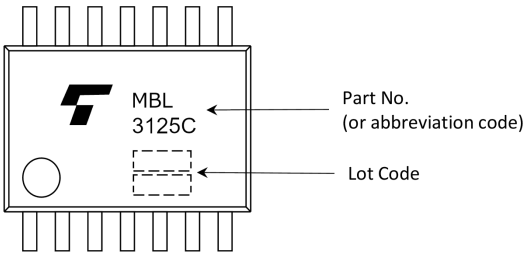


Fig. 6.1 TSSOP14B

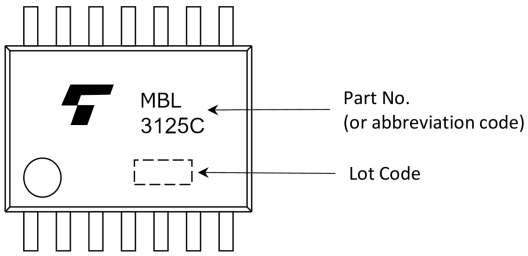


Fig. 6.2 TSSOP14

TC7MBL3126CFT

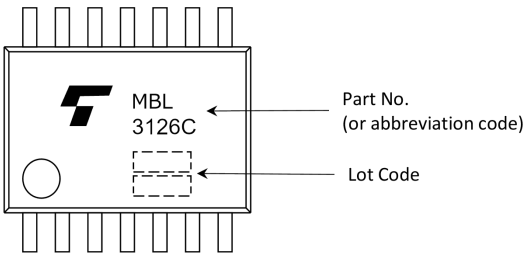


Fig. 6.3 TSSOP14B

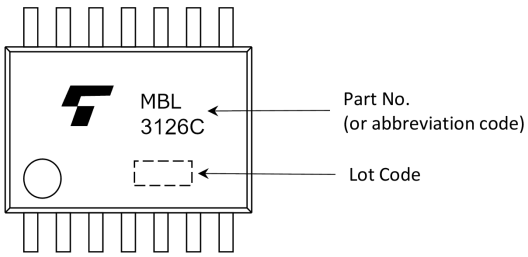
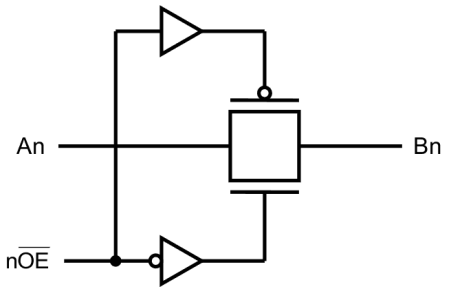


Fig. 6.4 TSSOP14

Note: Package name TSSOP14B for devices with the ordering part number ending in J.

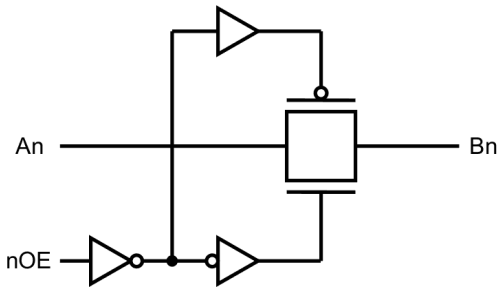
7. System Diagram

TC7MBL3125CFT



(n = 1, 2, 3, 4)

TC7MBL3126CFT



(n = 1, 2, 3, 4)

8. Truth Table

Inputs $\overline{OE}$ (TC7MBL3125CFT)	Inputs OE (TC7MBL3126CFT)	Function
L	H	A port = B port
H	L	Disconnect

9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}			-0.5 to 4.6	V
Input voltage ($\overline{OE}$, OE)	V_{IN}			-0.5 to 4.6	V
Switch I/O voltage	V_S		V_{CC} = 0 V or Switch = Off	-0.5 to 4.6	V
			Switch = On	-0.5 to V_{CC} +0.5	
Clamp diode current	I_{IK}			-50	mA
Switch I/O current	I_S			50	mA
Power dissipation	P_D	(Note 1)		180	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).

Note 1: 180 mW in the range of T_a = -40 to 85 °C. From T_a = 85 to 125 °C a derating factor of -3.25 mW/°C shall be applied until 50 mW.

10. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}			1.65 to 3.6	V
Input voltage ($\overline{OE}$, OE)	V_{IN}			0 to 3.6	V
Switch I/O voltage	V_S		V_{CC} = 0 V or Switch = Off	0 to 3.6	V
			Switch = On	0 to V_{CC}	
Operating temperature	T_{opr}	(Note 1)		-40 to 125	°C
Input rise time	dt/dv			0 to 10	ns/V

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: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

11. Electrical Characteristics

11.1. 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 ($\overline{OE}$, OE)	V_{IH}		—	1.65 to 3.6	0.7 × V_{CC}	—	—	V
Low-level input voltage ($\overline{OE}$, OE)	V_{IL}		—	1.65 to 3.6	—	—	0.3 × V_{CC}	V
Input leakage current ($\overline{OE}$, OE)	I_{IN}		V_{IN} = 0 to 3.6 V	1.65 to 3.6	—	—	±1.0	μA
Power-OFF leakage current	I_{OFF}		$\overline{OE}$, OE, A, B = 0 to 3.6 V	0	—	—	10	μA
Switch OFF-state leakage current	I_{SZ}		A, B = 0 V to V_{CC}, $\overline{OE}$ = V_{CC} (TC7MBL3125CFT), OE = GND (TC7MBL3126CFT)	1.65 to 3.6	—	—	±1.0	μA
ON-resistance	R_{ON}	(Note 1), (Note 2)	V_{IS} = 0 V, I_{IS} = 30 mA	3.0	—	6.5	11	Ω
			V_{IS} = 3.0 V, I_{IS} = 30 mA	3.0	—	11	17	
			V_{IS} = 2.4 V, I_{IS} = 15 mA	3.0	—	13	19	
			V_{IS} = 0 V, I_{IS} = 24 mA	2.3	—	7	11	
			V_{IS} = 2.3 V, I_{IS} = 24 mA	2.3	—	14	21	
			V_{IS} = 2.0 V, I_{IS} = 15 mA	2.3	—	16	23	
			V_{IS} = 0 V, I_{IS} = 4 mA	1.65	—	8	14	
			V_{IS} = 1.65 V, I_{IS} = 4 mA	1.65	—	19	27	
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND, I_{OUT} = 0 A	3.6	—	—	10	μA

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.

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
High-level input voltage ($\overline{OE}$, OE)	V_{IH}		—	1.65 to 3.6	0.7×V_{CC}	—	V
Low-level input voltage ($\overline{OE}$, OE)	V_{IL}		—	1.65 to 3.6	—	0.3×V_{CC}	V
Input leakage current ($\overline{OE}$, OE)	I_{IN}		V_{IN} = 0 to 3.6 V	1.65 to 3.6	—	±10.0	μA
Power-OFF leakage current	I_{OFF}		$\overline{OE}$, OE, A, B = 0 to 3.6 V	0	—	40	μA
Switch OFF-state leakage current	I_{SZ}		A, B = 0 V to V_{CC}, $\overline{OE}$ = V_{CC} (TC7MBL3125CFT), OE = GND (TC7MBL3126CFT)	1.65 to 3.6	—	±10.0	μA
ON-resistance	R_{ON}	(Note 1)	V_{IS} = 0 V, I_{IS} = 30 mA	3.0	—	13	Ω
			V_{IS} = 3.0 V, I_{IS} = 30 mA	3.0	—	19	
			V_{IS} = 2.4 V, I_{IS} = 15 mA	3.0	—	21	
			V_{IS} = 0 V, I_{IS} = 24 mA	2.3	—	13	
			V_{IS} = 2.3 V, I_{IS} = 24 mA	2.3	—	23	
			V_{IS} = 2.0 V, I_{IS} = 15 mA	2.3	—	25	
			V_{IS} = 0 V, I_{IS} = 4 mA	1.65	—	16	
			V_{IS} = 1.65 V, I_{IS} = 4 mA	1.65	—	29	
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND, I_{OUT} = 0 A	3.6	—	40	μA

Note: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

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.

11.3. 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. 11.6.1, 11.7.1, Table 11.6.1	3.3 ± 0.3	—	6	ns
			2.5 ± 0.2	—	7	
			1.8 ± 0.15	—	11	
Output disable time	t_{PLZ},t_{PHZ}	See Fig. 11.6.1, 11.7.1, Table 11.6.1	3.3 ± 0.3	—	6	ns
			2.5 ± 0.2	—	7	
			1.8 ± 0.15	—	11	

11.4. AC Characteristics (Note) (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. 11.6.1, 11.7.1, Table 11.6.1	3.3 ± 0.3	—	7	ns
			2.5 ± 0.2	—	8	
			1.8 ± 0.15	—	12	
Output disable time	t_{PLZ},t_{PHZ}	See Fig. 11.6.1, 11.7.1, Table 11.6.1	3.3 ± 0.3	—	7	ns
			2.5 ± 0.2	—	8	
			1.8 ± 0.15	—	12	

Note: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

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

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	V_{IN} = 0 V	3.0	4	pF
Switch terminal OFF-capacitance	$C_{I/O}$	$\overline{OE}$ = V_{CC}, OE = GND, V_{IS} = 0 V	3.0	3.5	pF
Switch terminal ON-capacitance	$C_{I/O}$	$\overline{OE}$ = GND, OE = V_{CC}, V_{IS} = 0 V	3.0	7.5	pF

Note: Parameter guaranteed by design.

11.6. AC Test Circuits

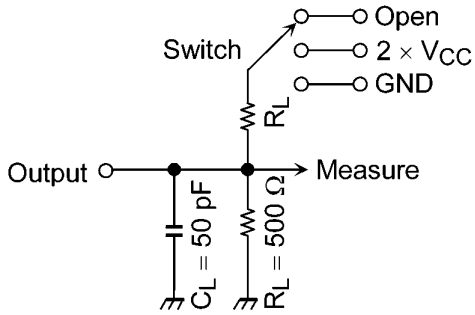


Fig. 11.6.1 AC Test Circuits

Table 11.6.1 Parameter for AC Test Circuit

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

11.7. AC Waveform

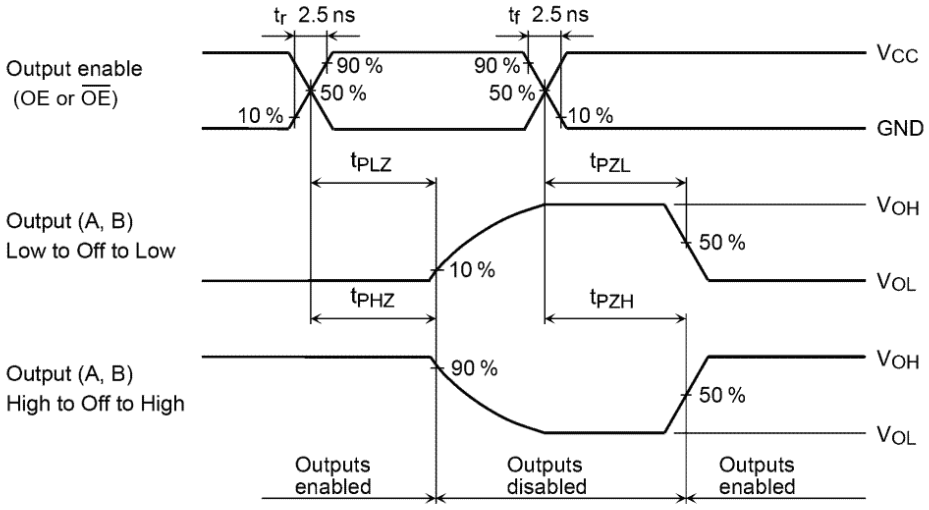


Fig. 11.7.1 AC Waveform t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

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 those of the TC7MBL3125CFT, TC7MBL3126CFT.

The $t_{r(out)}/t_{f(out)}$ values can be approximated as follows. (Fig. 12.1, Table 12.1 shows the calculation circuit.)

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

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

Calculation example:

$$t_{r(out)}\ (\text{approx}) = -(7.5 + 15)\ E-12 \cdot (120 + 6.5) \cdot \ln(((3.0 - 0) - 1.5) / (3.0 - 0)) \approx 2.0\ \text{ns}$$

Calculation conditions:

V_{CC} = 3.0 V, C_L = 15 pF, R_{DRIVE} = 120 Ω (output impedance of the previous IC), V_M = 1.5 V ($V_{CC}/2$)

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

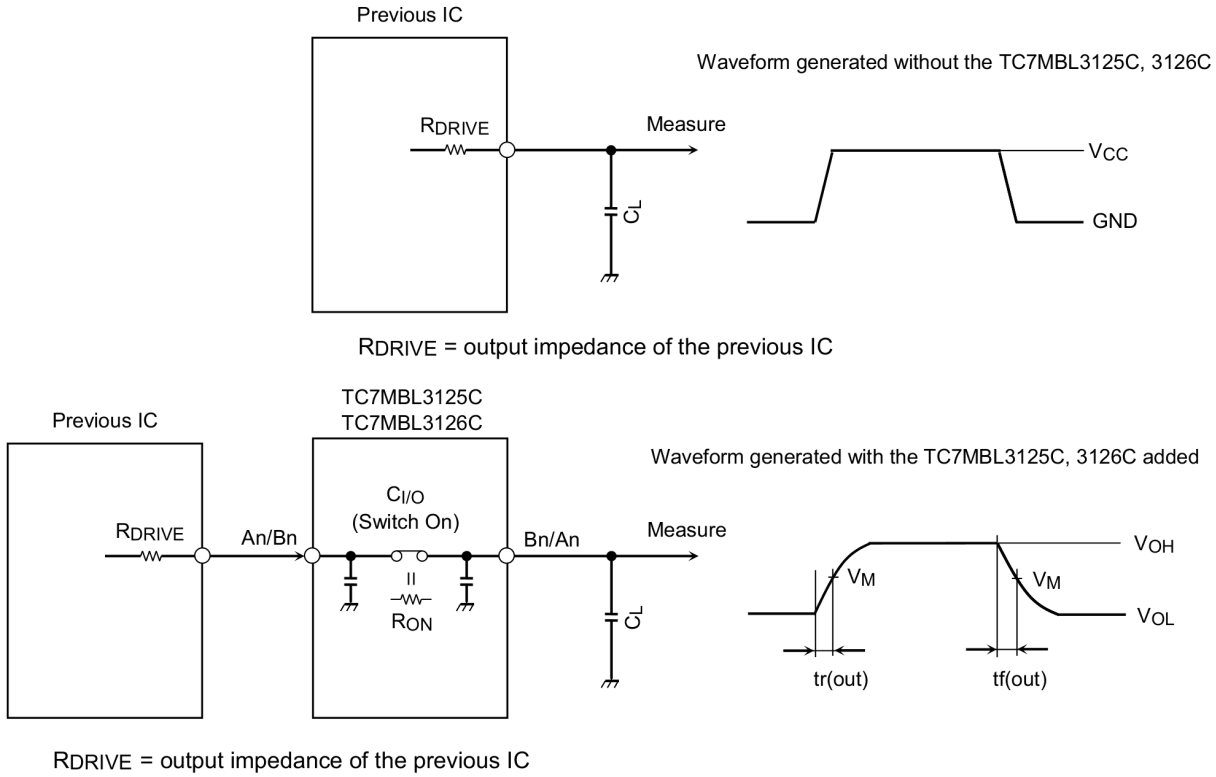


Fig. 12.1 Calculation Circuit

Table 12.1 Calculation Circuit

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

13. Characteristics Curves (Note)

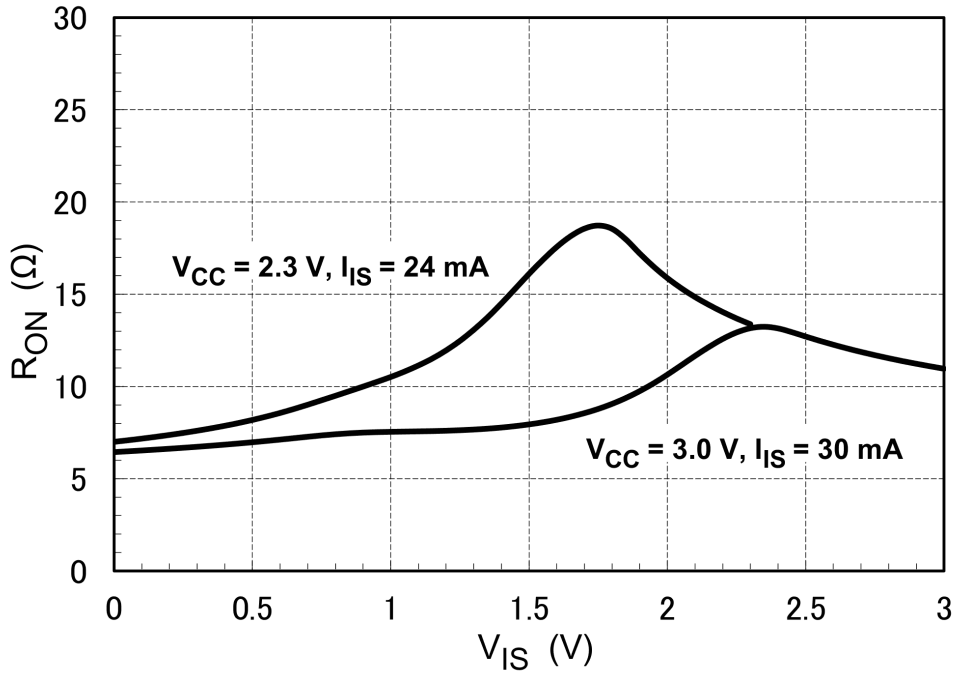
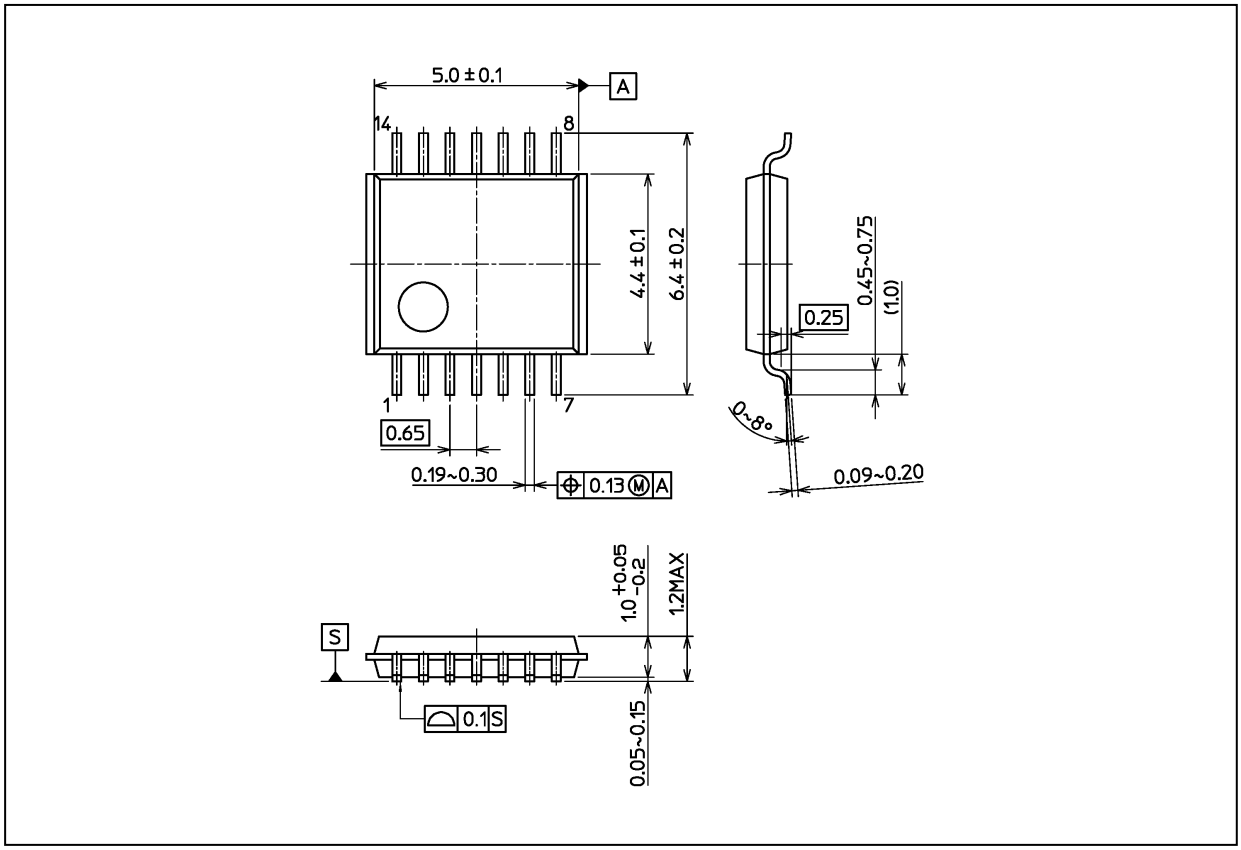


Fig. 13.1 R_{ON} - V_{IS} (typ.) (T_a = 25 °C)

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

Package Dimensions

Unit: mm

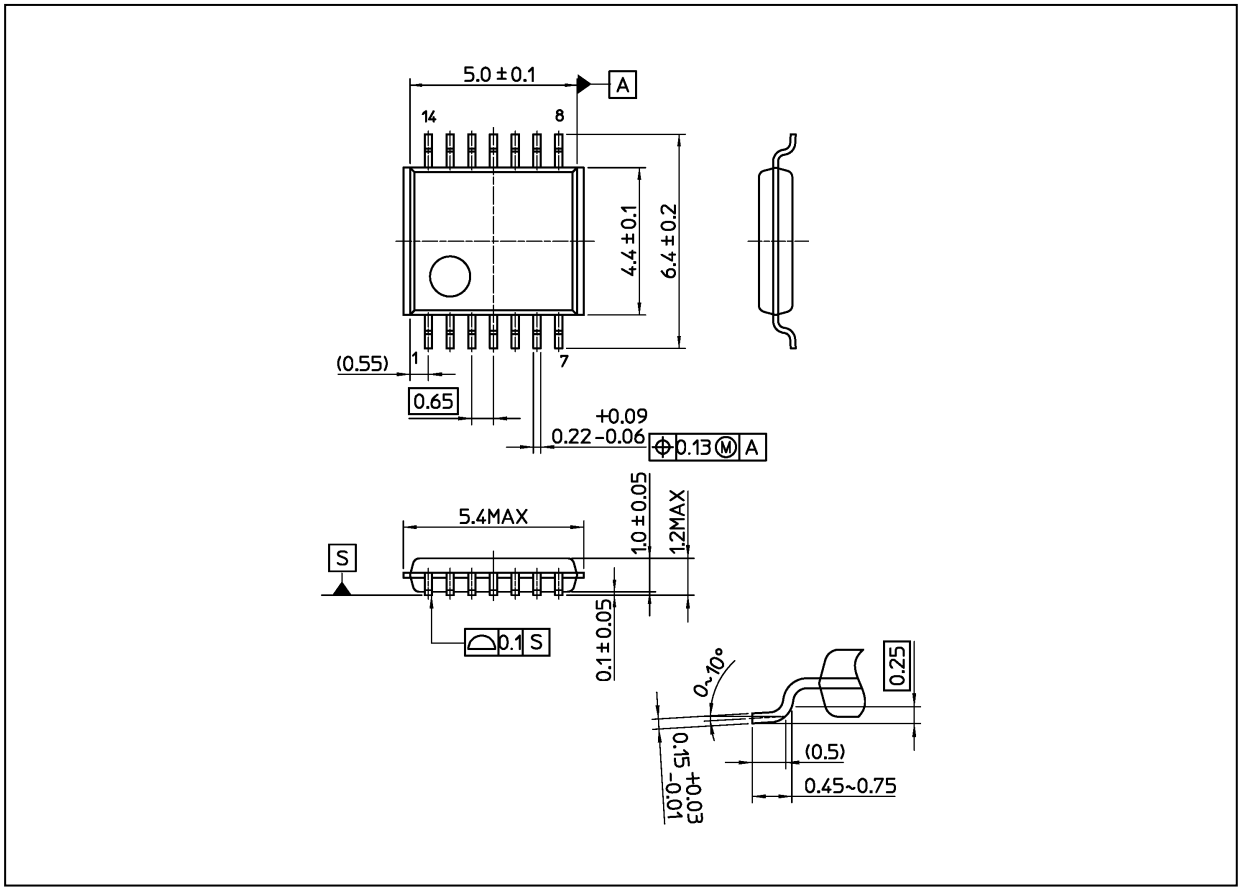


Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

Package Dimensions

Unit: mm



Weight: 0.06 g (typ.)

Package Name(s)
Nickname: TSSOP14

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