

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.

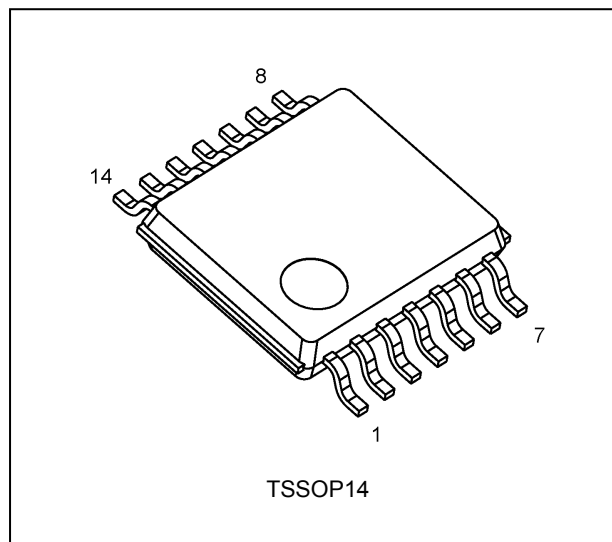
3. Features

- (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

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

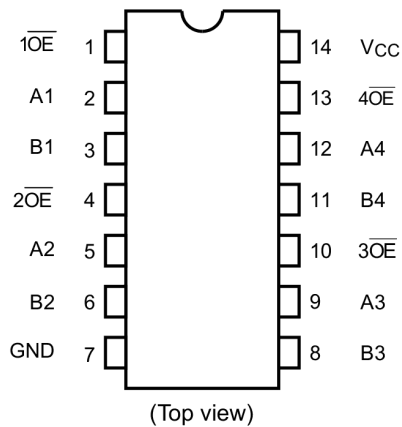


Start of commercial production

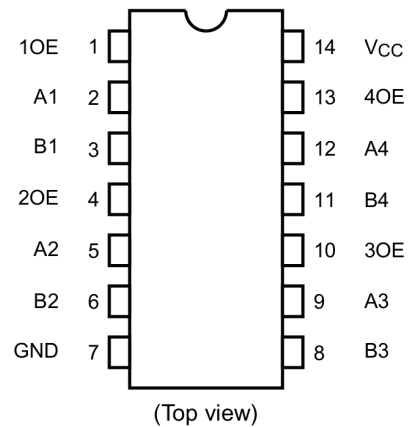
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5. Pin Assignment

TC7MBL3125CFT

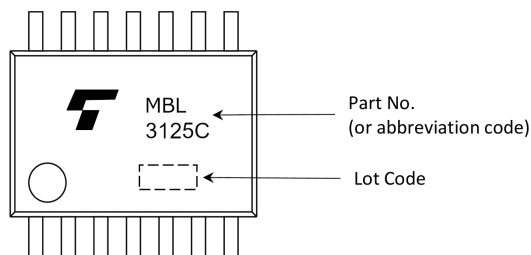


TC7MBL3126CFT

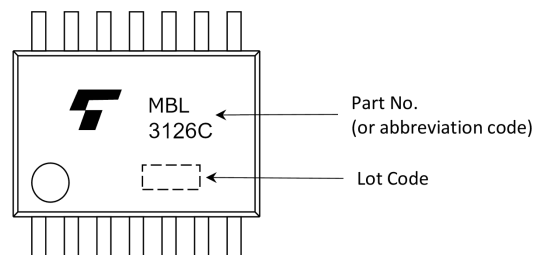


6. Marking

TC7MBL3125CFT

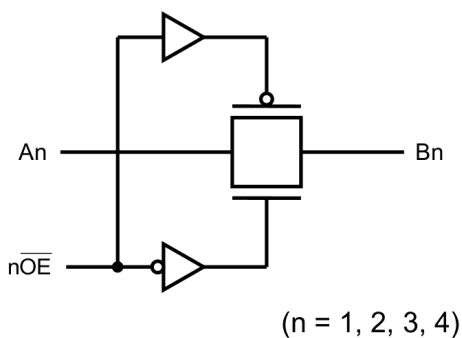


TC7MBL3126CFT

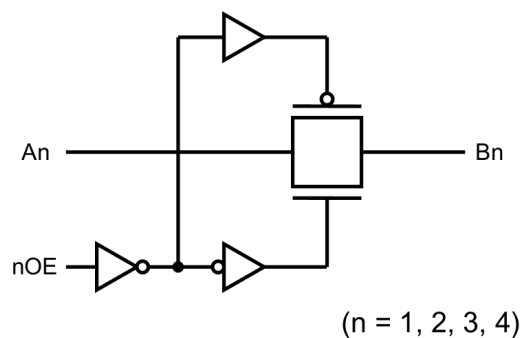


7. System Diagram

TC7MBL3125CFT



TC7MBL3126CFT



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 | $0.7 \times V_{CC}$ | — | — | V |
| Low-level input voltage (\overline{OE} , OE) | V_{IL} | | — | 1.65 to 3.6 | — | — | $0.3 \times V_{CC}$ | 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} , 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 | $0.7 \times V_{CC}$ | — | V |
| Low-level input voltage (\overline{OE} , OE) | V_{IL} | | — | 1.65 to 3.6 | — | $0.3 \times V_{CC}$ | 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., 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., 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., 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., 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

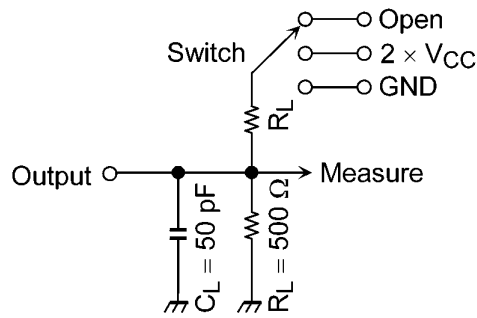


Table 11.6.1 Parameter for AC Test Circuit

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

11.7. AC Waveform

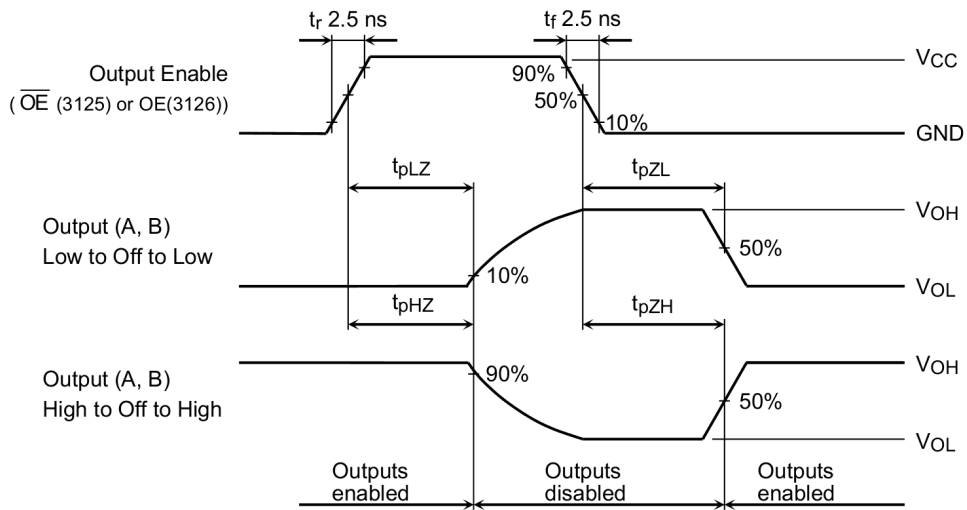


Fig. 11.7.1 AC Waveform $t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}$

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.)

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

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

Calculation example:

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

Calculation conditions:

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

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

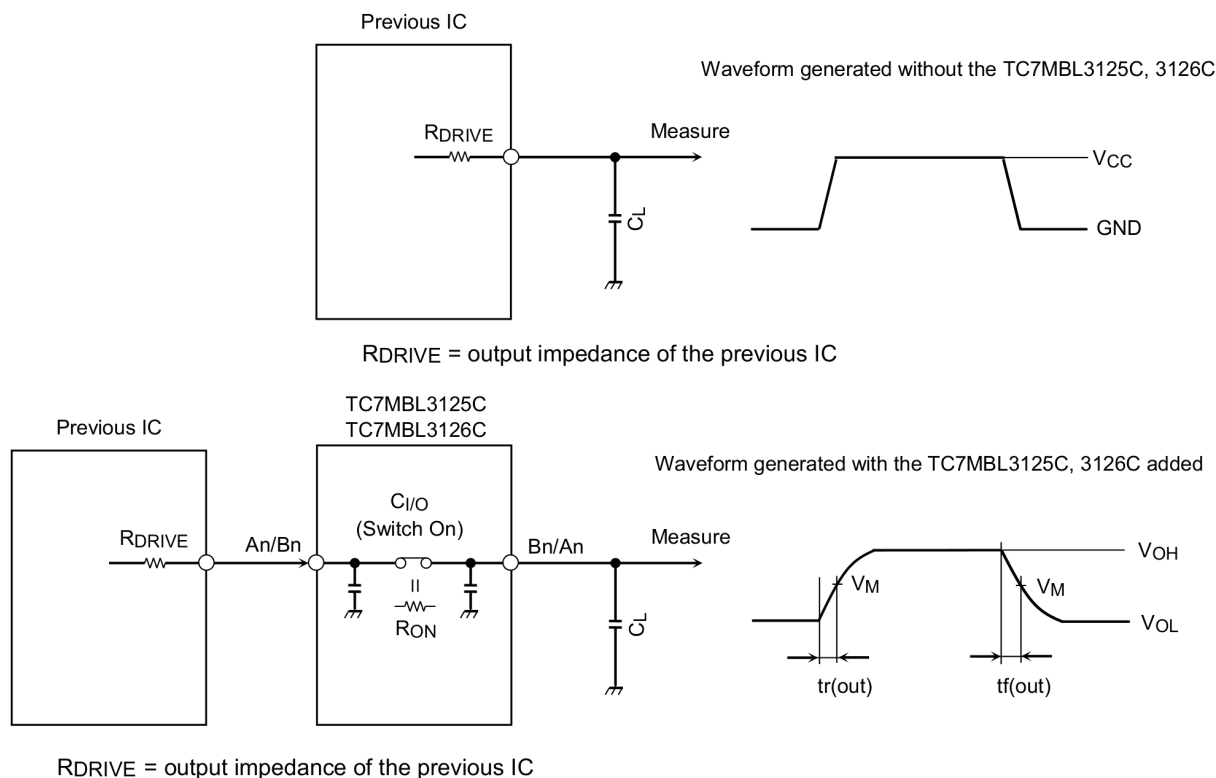


Fig. 12.1 Calculation Circuit

Table 12.1 Calculation Circuit

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

13. Characteristics Curves (Note)

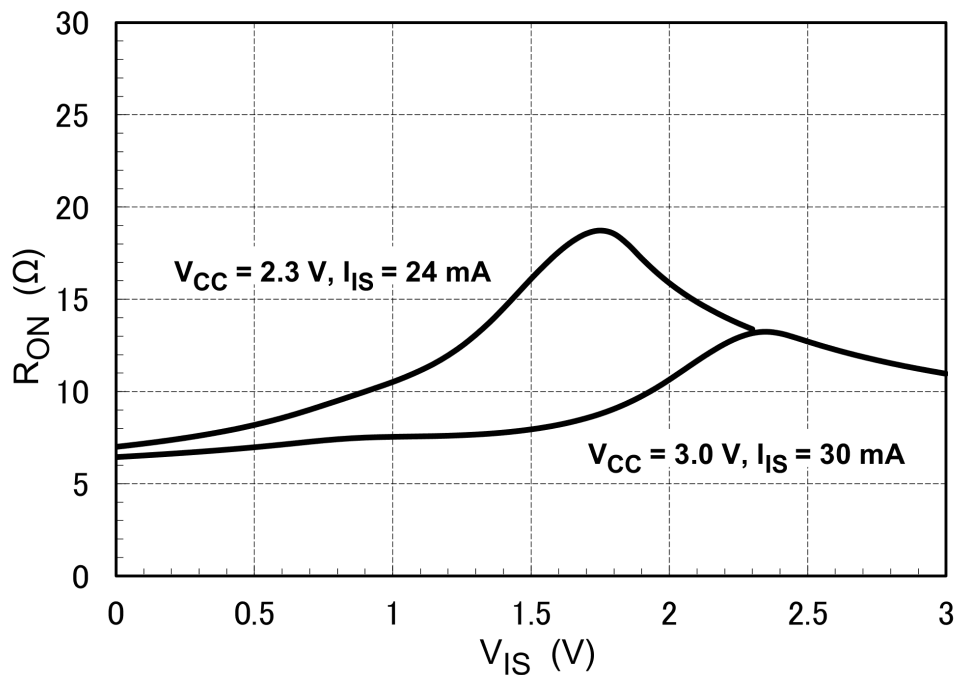
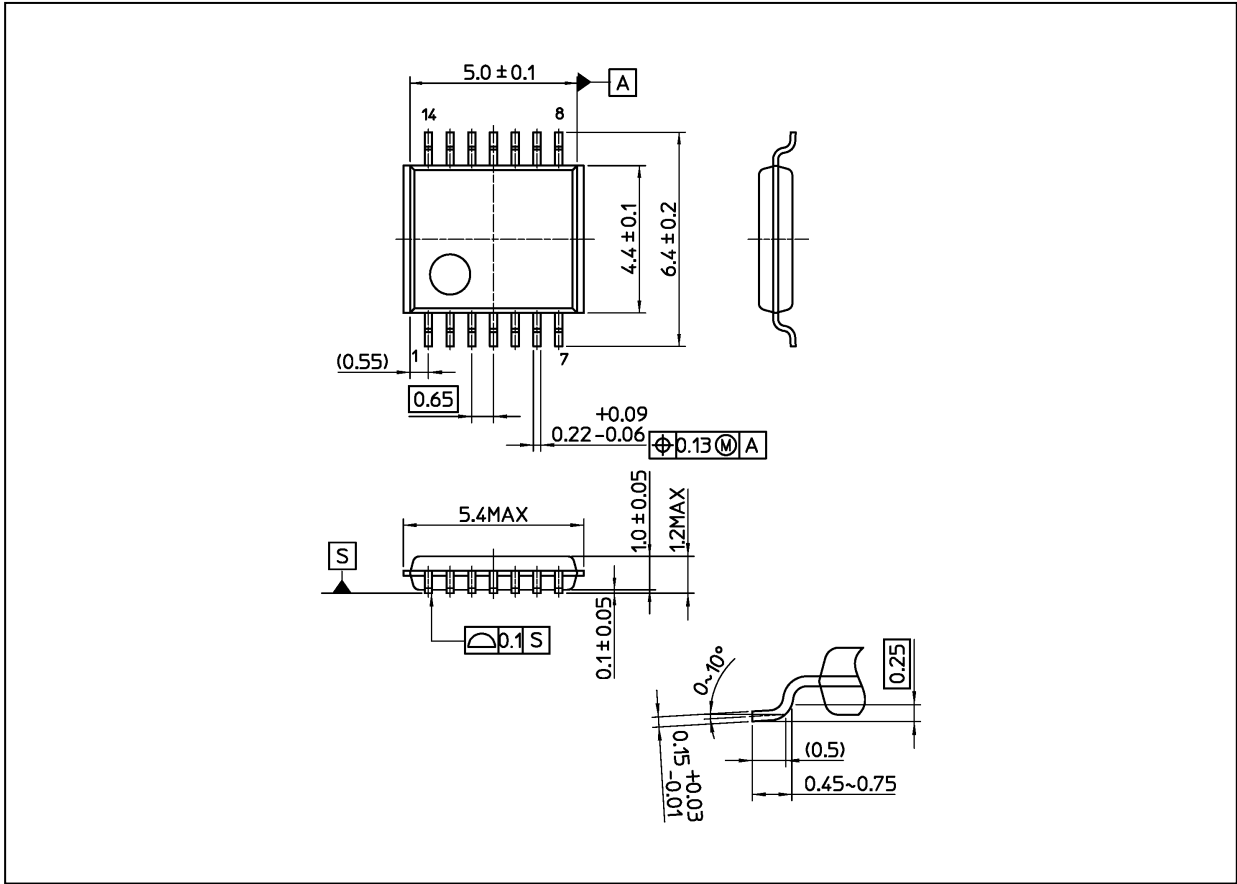


Fig. 13.1 $R_{ON} - V_{IS}$ (typ.) ($T_a = 25\text{ }^\circ\text{C}$)

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

Package Dimensions

Unit: mm



Weight: 0.06 g (typ.)

| |
|-------------------|
| Package Name(s) |
| Nickname: TSSOP14 |

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[QS32X384Q1G](#) [QS3VH126QG](#)