

TC7MBL3253CFT

1. Functional Description

- Dual 1-of-4 FET Multiplexer/Demultiplexer

2. General

The TC7MBL3253CFT is a low-voltage/low-capacitance CMOS dual 1-of-4 Multiplexer/Demultiplexer. The low on-resistance of the switch allows connections to be made with minimal propagation delay time.

This device consists of two individual four-inputs multiplexer/demultiplexer with common select input (S1, S0) and output enable (\overline{OE}). The A input is connected to the B1 to B4 outputs as determined by the combination of both the select input (S1, S0) and output enable (\overline{OE}). When the output enable (\overline{OE}) input is held at "H" level, the switches are open regardless of the state of the select inputs, and a high-impedance state exists between the switches.

All inputs are equipped with protection circuits against static discharge.

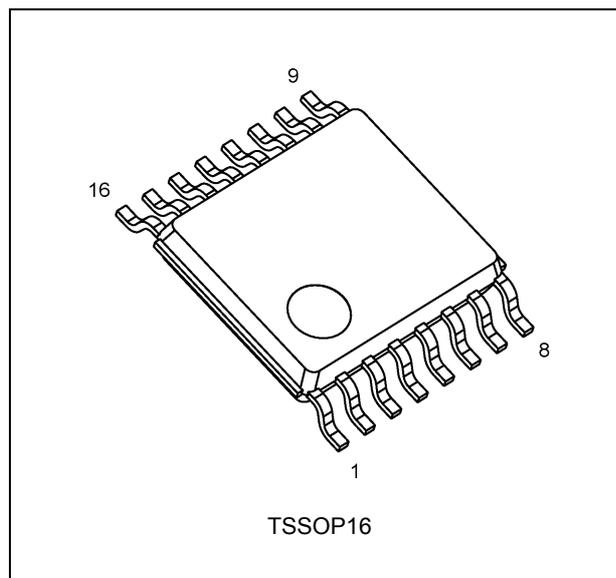
3. Features

- (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: $C_{I/O} = 13$ pF Switch On (typ.) @ $V_{CC} = 3.0$ V
- (5) ON resistance: $R_{ON} = 9$ Ω (typ.) @ $V_{CC} = 3.0$ V, $V_{IS} = 0$ V
- (6) Power-down protection for inputs (\overline{OE} , S1, S0 and I/O)
- (7) Package: TSSOP16

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

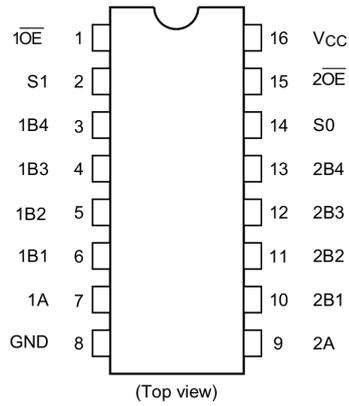
Note 2: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

4. Packaging

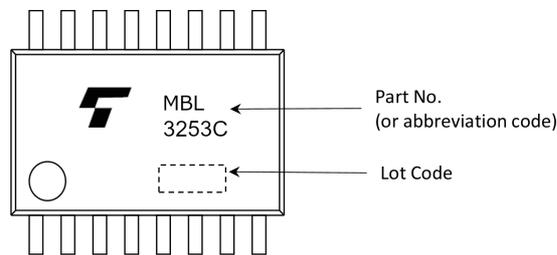


Start of commercial production
2020-04

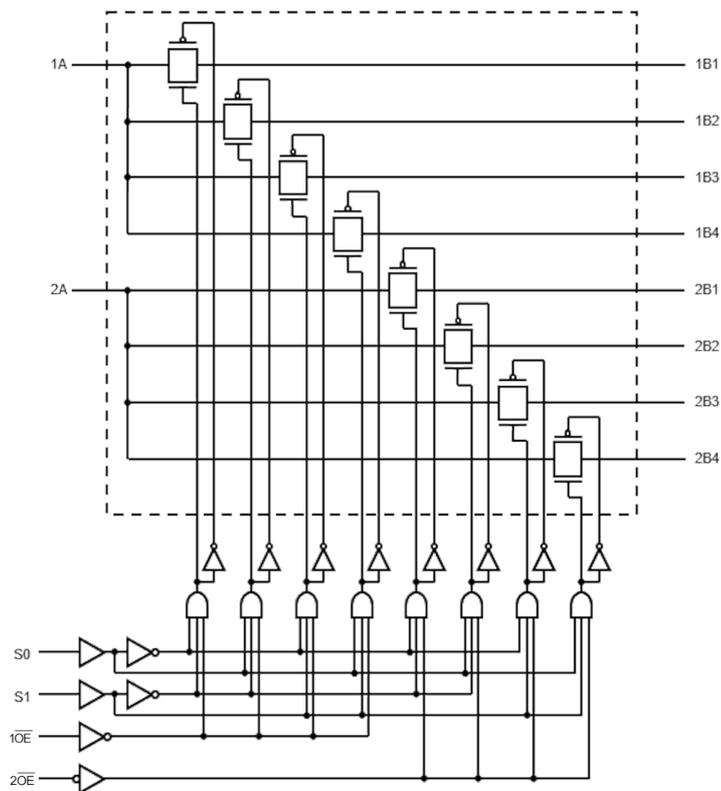
5. Pin Assignment



6. Marking



7. System Diagram



8. Truth Table

| Inputs OE | Inputs S1 | Inputs S0 | Function |
|--------------|--------------|--------------|------------------|
| L | L | L | A port = B1 port |
| L | L | H | A port = B2 port |
| L | H | L | A port = B3 port |
| L | H | H | A port = B4 port |
| H | X | X | Disconnect |

X: Don't care

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} , S1, S0) | 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 | $^{\circ}C$ |

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 $^{\circ}C$. From $T_a = 85$ to 125 $^{\circ}C$ a derating factor of -3.25 mW/ $^{\circ}C$ 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} , S1, S0) | 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 | $^{\circ}C$ |
| 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 $T_{opr} = -40$ $^{\circ}C$ to 125 $^{\circ}C$ 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} , S1, S0) | V_{IH} | | — | 1.65 to 3.6 | $0.7 \times V_{CC}$ | — | — | V |
| Low-level input voltage (\overline{OE} , S1, S0) | V_{IL} | | — | 1.65 to 3.6 | — | — | $0.3 \times V_{CC}$ | V |
| Input leakage current (\overline{OE} , S1, S0) | 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} , S, A, B = 0 to 3.6 V | 0 | — | — | 10 | μA |
| Switch OFF-state leakage current | I_{SZ} | | A, B = 0 V to V_{CC} , $\overline{OE} = V_{CC}$ | 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 | — | 9 | 13 | Ω |
| | | | $V_{IS} = 3.0$ V, $I_{IS} = 30$ mA | 3.0 | — | 18 | 24 | |
| | | | $V_{IS} = 2.4$ V, $I_{IS} = 15$ mA | 3.0 | — | 20 | 28 | |
| | | | $V_{IS} = 0$ V, $I_{IS} = 24$ mA | 2.3 | — | 10 | 15 | |
| | | | $V_{IS} = 2.3$ V, $I_{IS} = 24$ mA | 2.3 | — | 23 | 32 | |
| | | | $V_{IS} = 2.0$ V, $I_{IS} = 15$ mA | 2.3 | — | 25 | 35 | |
| | | | $V_{IS} = 0$ V, $I_{IS} = 4$ mA | 1.65 | — | 12 | 18 | |
| | | | $V_{IS} = 1.65$ V, $I_{IS} = 4$ mA | 1.65 | — | 29 | 40 | |
| 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 (OE, S1, S0) | V_{IH} | | — | 1.65 to 3.6 | $0.7 \times V_{CC}$ | — | V |
| Low-level input voltage (OE, S1, S0) | V_{IL} | | — | 1.65 to 3.6 | — | $0.3 \times V_{CC}$ | V |
| Input leakage current (OE, S1, S0) | I_{IN} | | $V_{IN} = 0$ to 3.6 V | 1.65 to 3.6 | — | ± 10.0 | μA |
| Power-OFF leakage current | I_{OFF} | | OE, S, A, B = 0 to 3.6 V | 0 | — | 40 | μA |
| Switch OFF-state leakage current | I_{SZ} | | A, B = 0 V to V_{CC} , OE = V_{CC} | 1.65 to 3.6 | — | ± 10.0 | μA |
| ON-resistance | R_{ON} | (Note 1) | $V_{IS} = 0$ V, $I_{IS} = 30$ mA | 3.0 | — | 15 | Ω |
| | | | $V_{IS} = 3.0$ V, $I_{IS} = 30$ mA | 3.0 | — | 26 | |
| | | | $V_{IS} = 2.4$ V, $I_{IS} = 15$ mA | 3.0 | — | 31 | |
| | | | $V_{IS} = 0$ V, $I_{IS} = 24$ mA | 2.3 | — | 17 | |
| | | | $V_{IS} = 2.3$ V, $I_{IS} = 24$ mA | 2.3 | — | 34 | |
| | | | $V_{IS} = 2.0$ V, $I_{IS} = 15$ mA | 2.3 | — | 38 | |
| | | | $V_{IS} = 0$ V, $I_{IS} = 4$ mA | 1.65 | — | 20 | |
| | | | $V_{IS} = 1.65$ V, $I_{IS} = 4$ mA | 1.65 | — | 42 | |
| 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 (OE to bus) | 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 enable time (S1, S0 to bus) | 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 (OE to bus) | 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 | |
| Output disable time (S1, S0 to bus) | 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 (\overline{OE} to bus) | 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 enable time (S1, S0 to bus) | 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 (\overline{OE} to bus) | 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 | |
| Output disable time (S1, S0 to bus) | 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 (\overline{OE} , S1, S0) | C_{IN} | $V_{IN} = 0$ V | 3.0 | 5 | pF |
| Switch terminal OFF-capacitance (Bn) | $C_{I/O}$ | $\overline{OE} = V_{CC}, V_{IS} = 0$ V | 3.0 | 4 | pF |
| Switch terminal OFF-capacitance (A) | $C_{I/O}$ | $\overline{OE} = V_{CC}, V_{IS} = 0$ V | 3.0 | 9 | pF |
| Switch terminal ON-capacitance (Bn) | $C_{I/O}$ | $\overline{OE} = GND, V_{IS} = 0$ V | 3.0 | 13 | pF |
| Switch terminal ON-capacitance (A) | $C_{I/O}$ | $\overline{OE} = GND, V_{IS} = 0$ V | 3.0 | 13 | pF |

Note: Parameter guaranteed by design.

11.6. AC Test Circuits

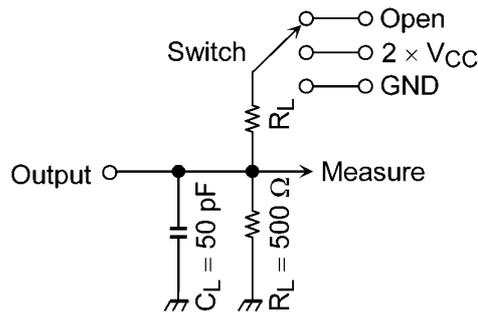


Table 11.6.1 Parameter for AC Test Circuit

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

11.7. AC Waveform

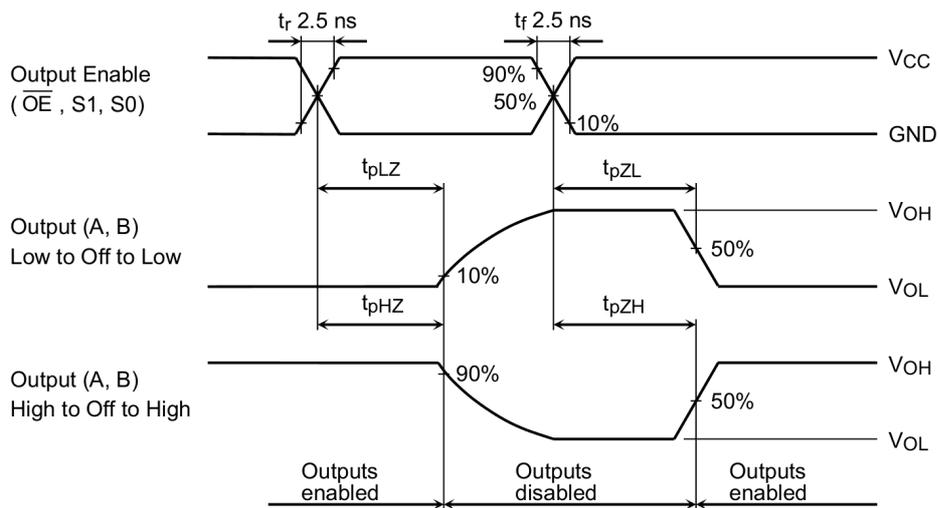


Fig. 11.7.1 AC Waveform $t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}$

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 TC7MBL3253CFT.

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:

$$t_{r(out)} \text{ (approx)} = - (13 + 15) \text{ E} - 12 \cdot (120 + 9) \cdot \ln \left(\frac{(3.0 - 0) - 1.5}{(3.0 - 0)} \right) \approx 2.5 \text{ ns}$$

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)

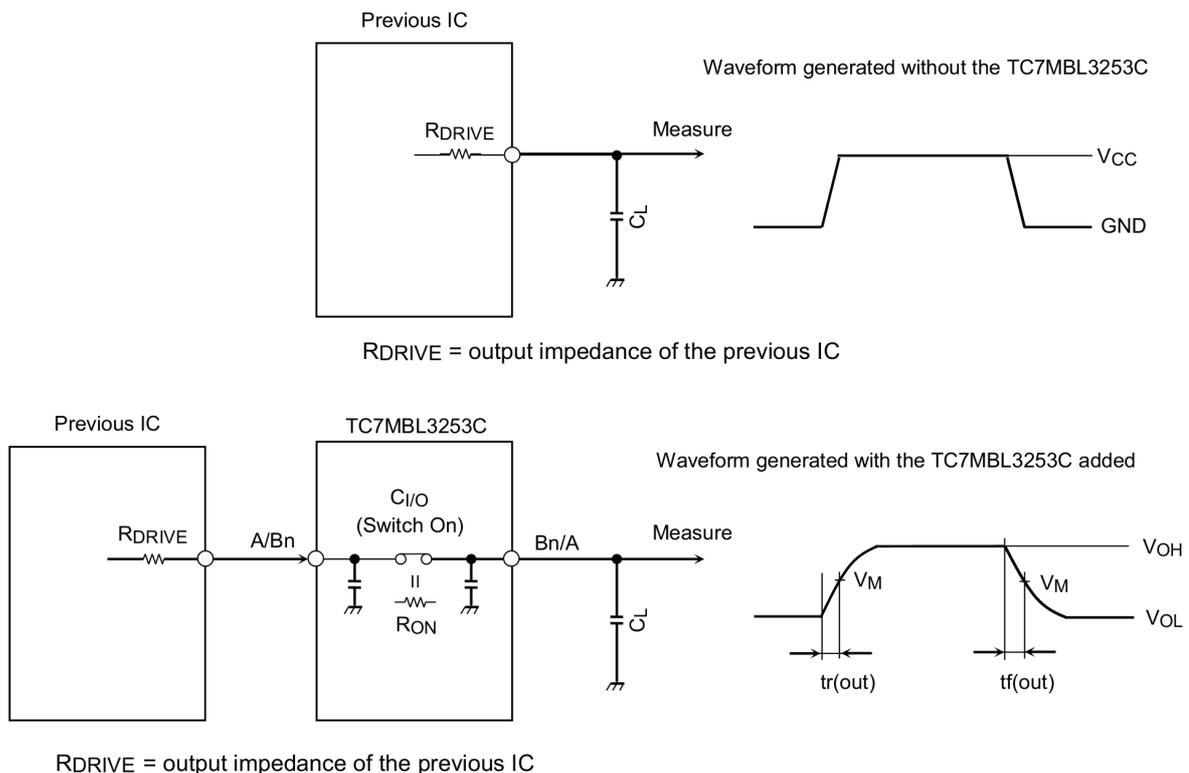


Fig. 12.1 Calculation Circuit

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)

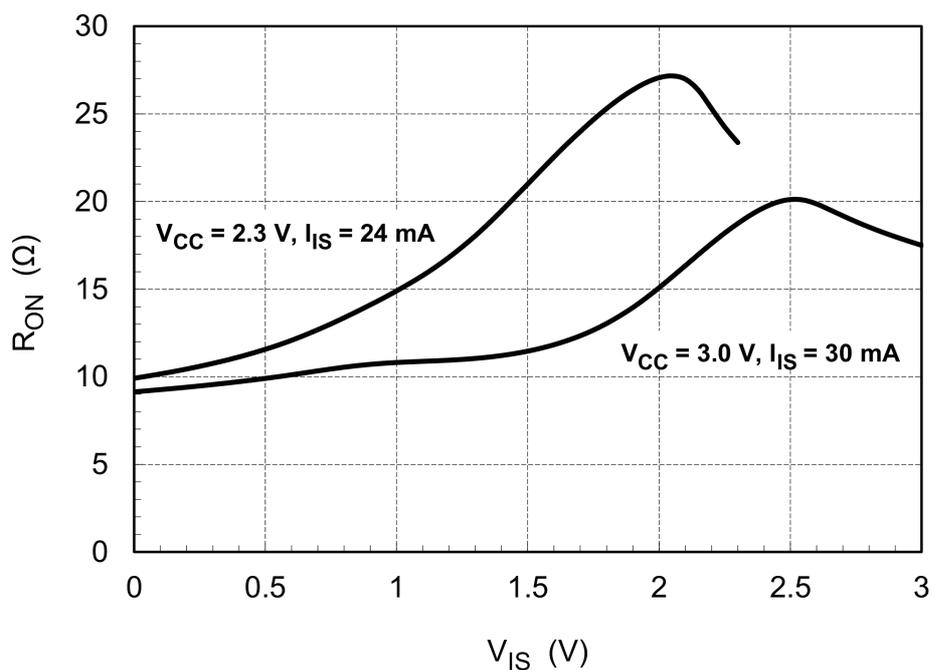
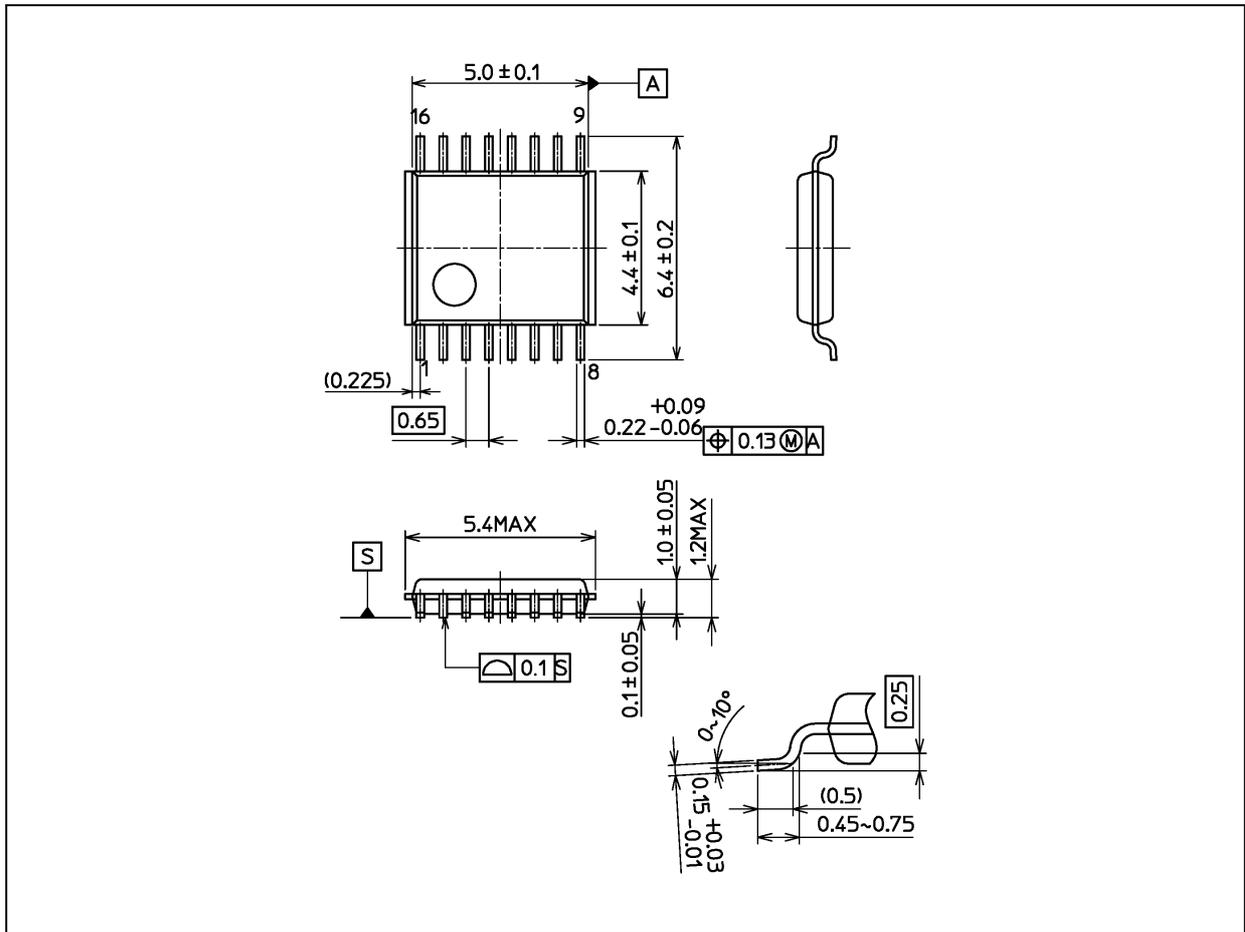


Fig. 13.1 $R_{ON} - V_{IS}$ (typ.) ($T_a = 25 \text{ }^\circ\text{C}$)

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: TSSOP16 |

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[PI5C3384QE](#) [PI3CH281QE](#) [QS3VH16244PAG8](#) [PI3C3306LE](#) [PI5C3245LE](#) [PI3CH400LE](#) [PI3B3245LEX](#) [PI3B3245LE](#) [PI3C3306LEX](#)
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[QS32X384Q1G](#) [QS3VH126QG](#)