

CMOS Digital Integrated Circuits Silicon Monolithic

# TC7MBL3257CFT

## 1. Functional Description

- 4-Bit 1-of-2 Multiplexer/Demultiplexer

## 2. General

The TC7MBL3257CFT is a low-voltage/low-capacitance CMOS 4bit 1-of-2 Multiplexer/Demultiplexer. The low on-resistance of the switch allows connections to be made with minimal propagation delay time.

This device consists of four individual two-inputs multiplexer/demultiplexer with common select input (S) and output enable ( $\overline{OE}$ ). The A input is connected to the B1 or B2 outputs as determined by the combination of both the select input (S) 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.

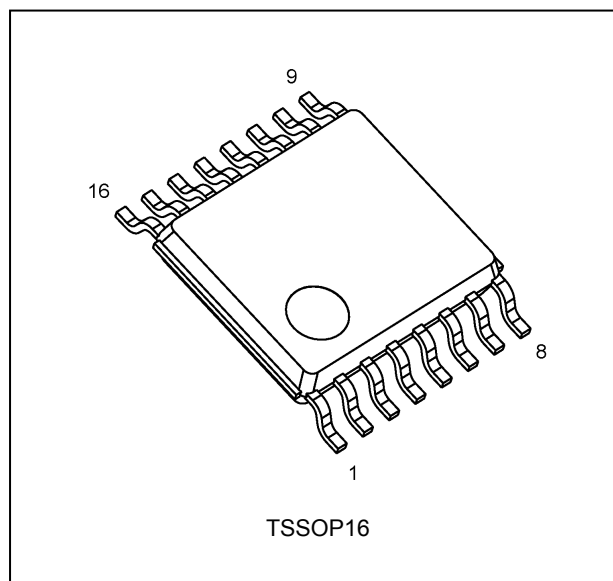
## 3. Features

- (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:  $C_{I/O} = 8$  pF Switch On (typ.) @  $V_{CC} = 3.0$  V
- (5) ON resistance:  $R_{ON} = 8.5$   $\Omega$  (typ.) @  $V_{CC} = 3.0$  V,  $V_{IS} = 0$  V
- (6) Power-down protection for inputs ( $\overline{OE}$ , S 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.

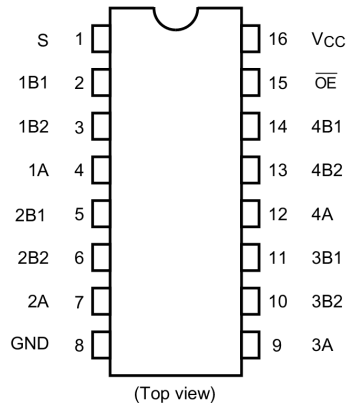
Note 2: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2020.

## 4. Packaging

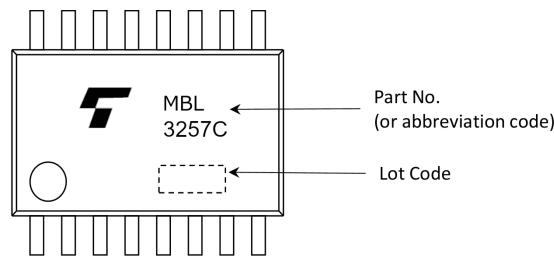


Start of commercial production  
2020-04

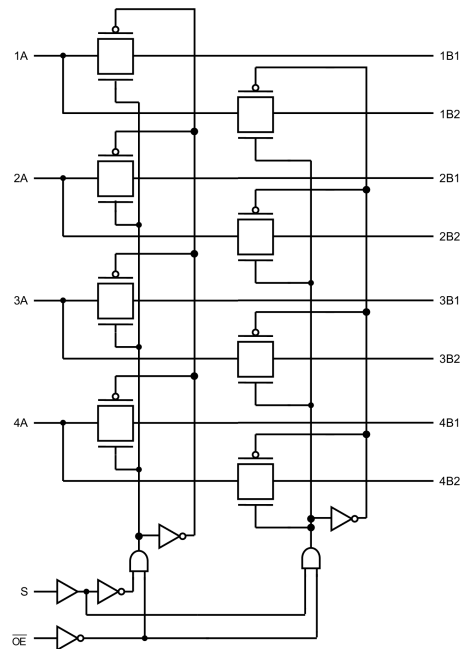
### 5. Pin Assignment



### 6. Marking



### 7. System Diagram



### 8. Truth Table

Inputs OE	Inputs S	Function
L	L	A port = B1 port
L	H	A port = B2 port
H	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	$V_{IN}$			-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	$I_{CC}/I_{GND}$			$\pm 100$	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	$V_{IN}$			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 ( $\overline{OE}$ , S)	$V_{IH}$		—	1.65 to 3.6	$0.7 \times V_{CC}$	—	—	V
Low-level input voltage ( $\overline{OE}$ , S)	$V_{IL}$		—	1.65 to 3.6	—	—	$0.3 \times V_{CC}$	V
Input leakage current ( $\overline{OE}$ , S)	$I_{IN}$		$V_{IN} = 0$ to $3.6$ V	1.65 to 3.6	—	—	$\pm 1.0$	$\mu A$
Power-OFF leakage current	$I_{OFF}$		$\overline{OE}$ , S, A, B = $0$ to $3.6$ V	0	—	—	10	$\mu A$
Switch OFF-state leakage current	$I_{SZ}$		A, B = $0$ V to $V_{CC}$ , $\overline{OE} = V_{CC}$	1.65 to 3.6	—	—	$\pm 1.0$	$\mu A$
ON-resistance	$R_{ON}$	(Note 1), (Note 2)	$V_{IS} = 0$ V, $I_{IS} = 30$ mA	3.0	—	8.5	13	$\Omega$
			$V_{IS} = 3.0$ V, $I_{IS} = 30$ mA	3.0	—	16	24	
			$V_{IS} = 2.4$ V, $I_{IS} = 15$ mA	3.0	—	18	27	
			$V_{IS} = 0$ V, $I_{IS} = 24$ mA	2.3	—	10	15	
			$V_{IS} = 2.3$ V, $I_{IS} = 24$ mA	2.3	—	20	30	
			$V_{IS} = 2.0$ V, $I_{IS} = 15$ mA	2.3	—	23	33	
			$V_{IS} = 0$ V, $I_{IS} = 4$ mA	1.65	—	12	18	
			$V_{IS} = 1.65$ V, $I_{IS} = 4$ mA	1.65	—	26	37	
Quiescent supply current	$I_{CC}$		$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$ A	3.6	—	—	10	$\mu A$

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, S)	$V_{IH}$		—	1.65 to 3.6	$0.7 \times V_{CC}$	—	V
Low-level input voltage (OE, S)	$V_{IL}$		—	1.65 to 3.6	—	$0.3 \times V_{CC}$	V
Input leakage current (OE, S)	$I_{IN}$		$V_{IN} = 0$ to 3.6 V	1.65 to 3.6	—	$\pm 10.0$	$\mu A$
Power-OFF leakage current	$I_{OFF}$		$\overline{OE}$ , S, A, B = 0 to 3.6 V	0	—	40	$\mu A$
Switch OFF-state leakage current	$I_{SZ}$		A, B = 0 V to $V_{CC}$ , $\overline{OE} = V_{CC}$	1.65 to 3.6	—	$\pm 10.0$	$\mu A$
ON-resistance	$R_{ON}$	(Note 1)	$V_{IS} = 0$ V, $I_{IS} = 30$ mA	3.0	—	15	$\Omega$
			$V_{IS} = 3.0$ V, $I_{IS} = 30$ mA	3.0	—	26	
			$V_{IS} = 2.4$ V, $I_{IS} = 15$ mA	3.0	—	30	
			$V_{IS} = 0$ V, $I_{IS} = 24$ mA	2.3	—	17	
			$V_{IS} = 2.3$ V, $I_{IS} = 24$ mA	2.3	—	33	
			$V_{IS} = 2.0$ V, $I_{IS} = 15$ mA	2.3	—	36	
			$V_{IS} = 0$ V, $I_{IS} = 4$ mA	1.65	—	20	
			$V_{IS} = 1.65$ V, $I_{IS} = 4$ mA	1.65	—	39	
Quiescent supply current	$I_{CC}$		$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$ A	3.6	—	40	$\mu A$

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	$3.3 \pm 0.3$	—	6	ns
			$2.5 \pm 0.2$	—	7	
			$1.8 \pm 0.15$	—	11	
Output enable time (S to bus)	$t_{PZL}, t_{PZH}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	6	ns
			$2.5 \pm 0.2$	—	7	
			$1.8 \pm 0.15$	—	11	
Output disable time (OE to bus)	$t_{PLZ}, t_{PHZ}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	6	ns
			$2.5 \pm 0.2$	—	7	
			$1.8 \pm 0.15$	—	11	
Output disable time (S to bus)	$t_{PLZ}, t_{PHZ}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	6	ns
			$2.5 \pm 0.2$	—	7	
			$1.8 \pm 0.15$	—	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	$3.3 \pm 0.3$	—	7	ns
			$2.5 \pm 0.2$	—	8	
			$1.8 \pm 0.15$	—	12	
Output enable time (S to bus)	$t_{PZL}, t_{PZH}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	7	ns
			$2.5 \pm 0.2$	—	8	
			$1.8 \pm 0.15$	—	12	
Output disable time ( $\overline{OE}$ to bus)	$t_{PLZ}, t_{PHZ}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	7	ns
			$2.5 \pm 0.2$	—	8	
			$1.8 \pm 0.15$	—	12	
Output disable time (S to bus)	$t_{PLZ}, t_{PHZ}$	See Fig. 11.6., 11.7.1, Table 11.6.1	$3.3 \pm 0.3$	—	7	ns
			$2.5 \pm 0.2$	—	8	
			$1.8 \pm 0.15$	—	12	

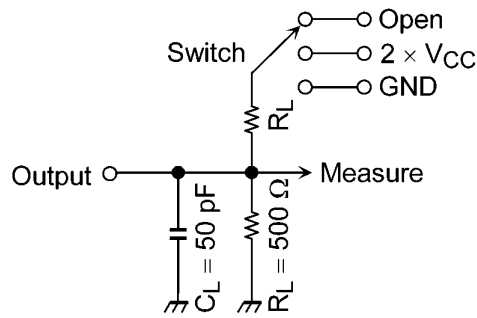
Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2020.

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Input capacitance ( $\overline{OE}$ , S)	$C_{IN}$	$V_{IN} = 0$ V	3.0	4	pF
Switch terminal OFF-capacitance (B1, B2)	$C_{I/O}$	$\overline{OE} = V_{CC}, V_{IS} = 0$ V	3.0	3	pF
Switch terminal OFF-capacitance (A)	$C_{I/O}$	$\overline{OE} = V_{CC}, V_{IS} = 0$ V	3.0	5	pF
Switch terminal ON-capacitance (B1, B2)	$C_{I/O}$	$\overline{OE} = GND, V_{IS} = 0$ V	3.0	8	pF
Switch terminal ON-capacitance (A)	$C_{I/O}$	$\overline{OE} = GND, V_{IS} = 0$ V	3.0	8	pF

Note: Parameter guaranteed by design.

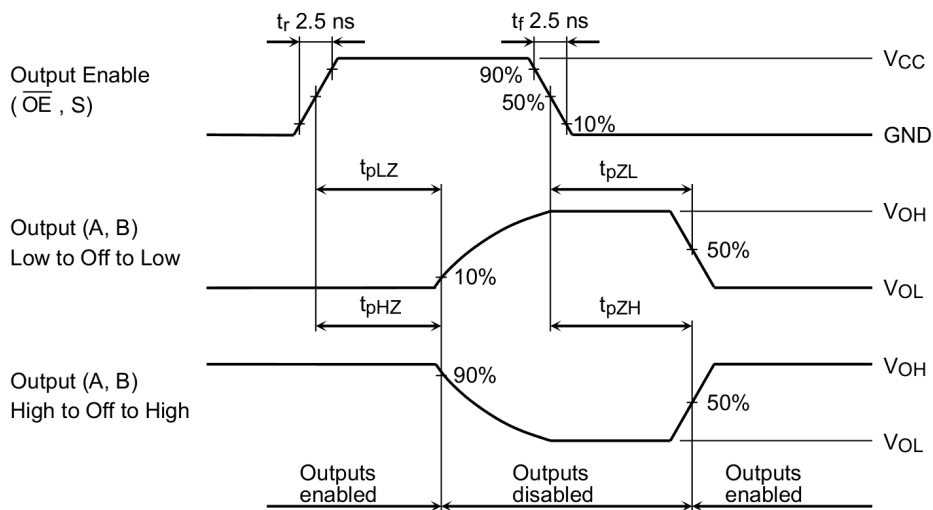
## 11.6. AC Test Circuits



**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 TC7MBL3257CFT.

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.

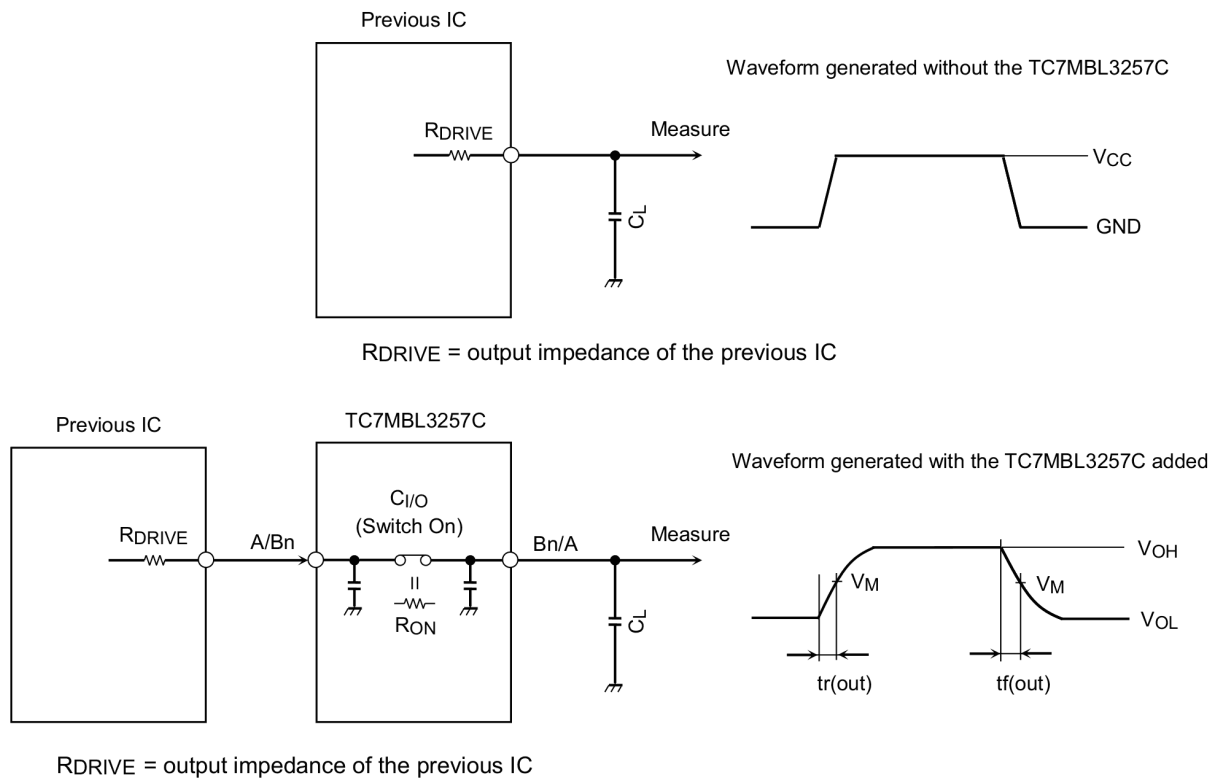
Calculation example:

$$t_{r(out)} \text{ (approx)} = - (8 + 15) \text{ E} \cdot 12 \cdot (120 + 8.5) \cdot \ln \left( \frac{(3.0 - 0) - 1.5}{(3.0 - 0)} \right) \approx 2.1 \text{ ns}$$

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)

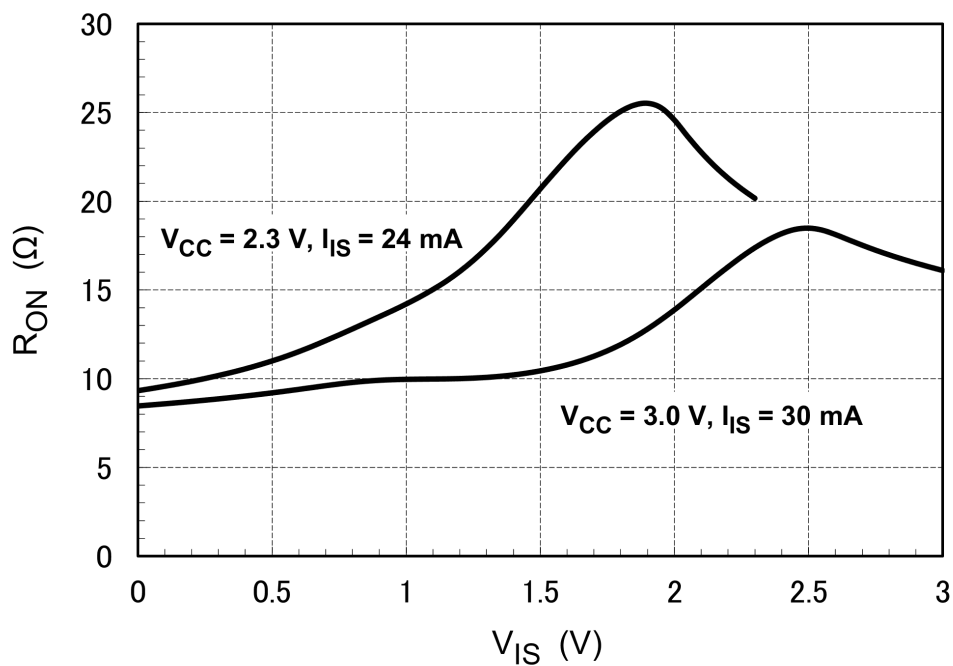
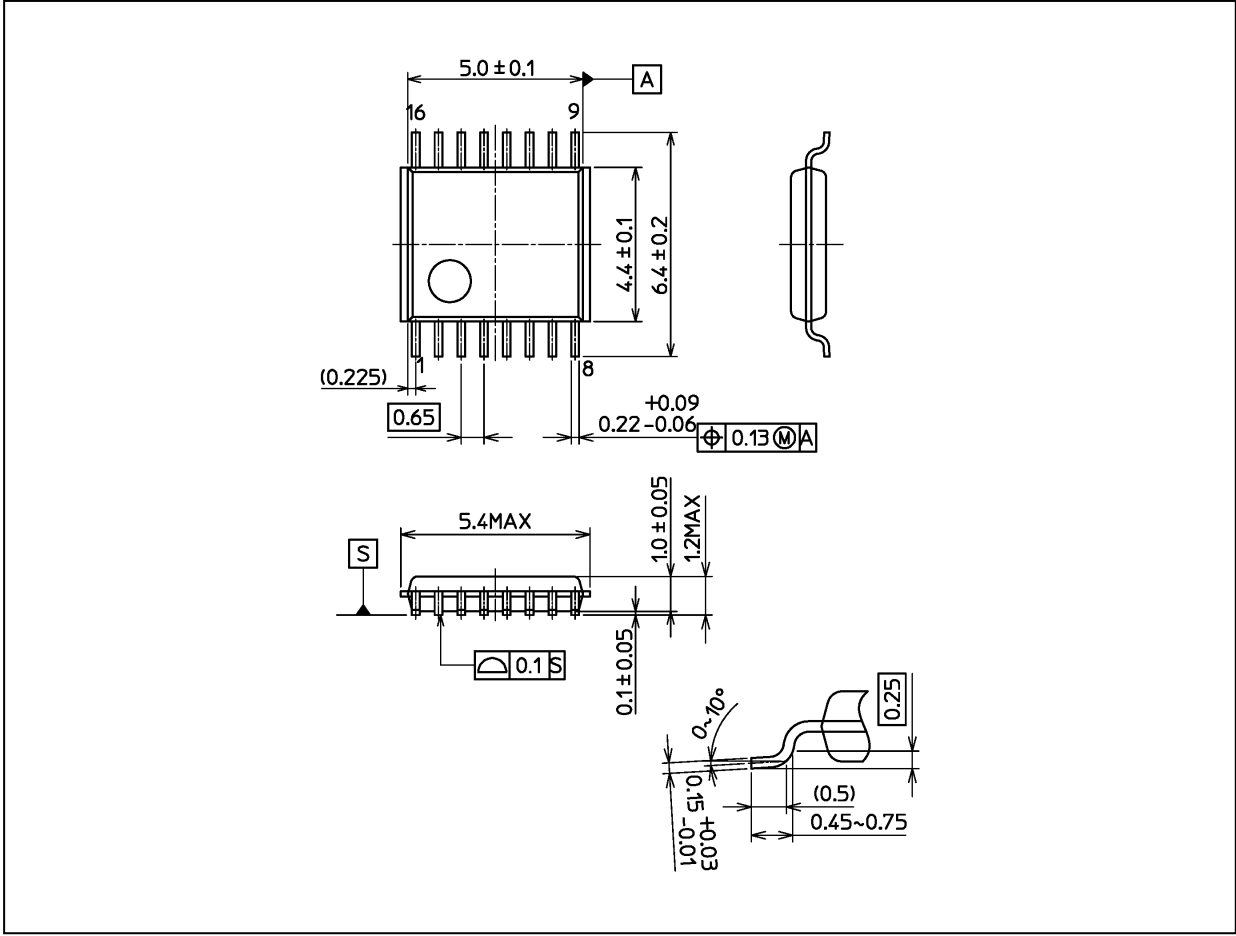


Fig. 13.1  $R_{ON}$  -  $V_{IS}$  (typ.) ( $T_a = 25$  °C)

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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