

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.

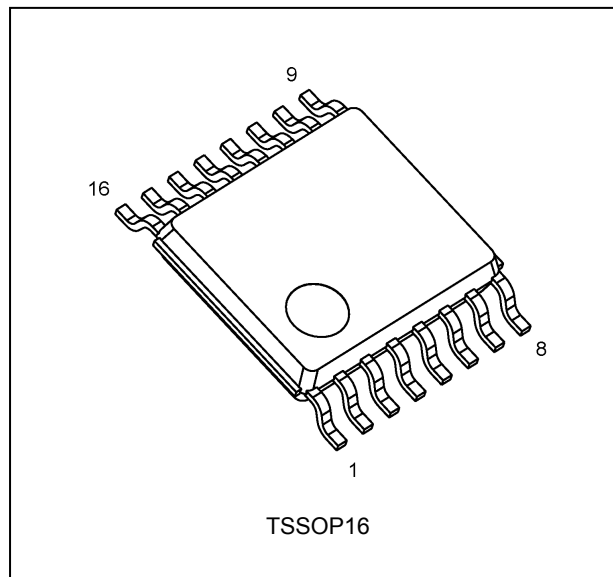
All inputs are equipped with protection circuits against static discharge.

3. Features

- (1) Wide operating temperature range: $T_{opr} = -40$ to 125 °C (Note 1)
- (2) Operating voltage: $V_{CC} = 1.65$ to 3.6 V
- (3) ON capacitance: $C_{I/O} = 13$ pF Switch On (typ.) @ $V_{CC} = 3.0$ V
- (4) ON resistance: $R_{ON} = 9$ Ω (typ.) @ $V_{CC} = 3.0$ V, $V_{I/O} = 0$ V
- (5) ESD performance: MM $\geq \pm 200$ V, HBM $\geq \pm 2000$ V
- (6) Power-down protection for inputs (\overline{OE} , S1, S0 and I/O)
- (7) Package: TSSOP16

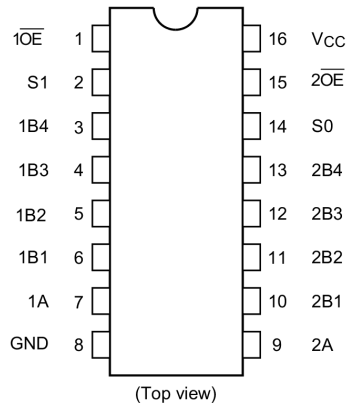
Note 1: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

4. Packaging

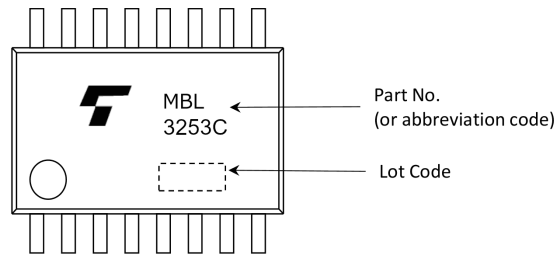


Start of commercial production
2020-04

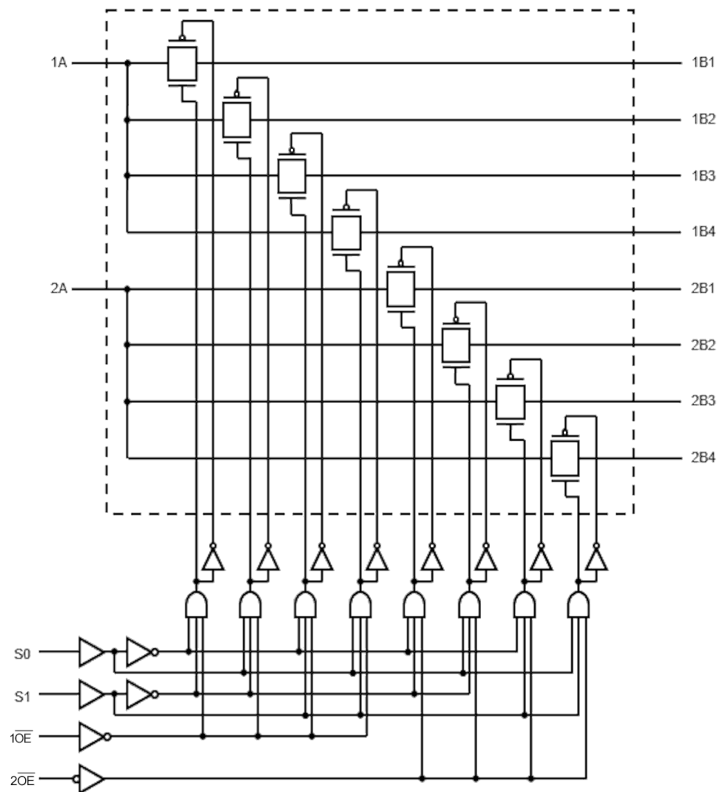
5. Pin Assignment



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	μ A
Power-OFF leakage current	I_{OFF}		\overline{OE} , S, A, B = 0 to 3.6 V	0	—	—	10	μ A
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	μ A
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	μ 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, 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

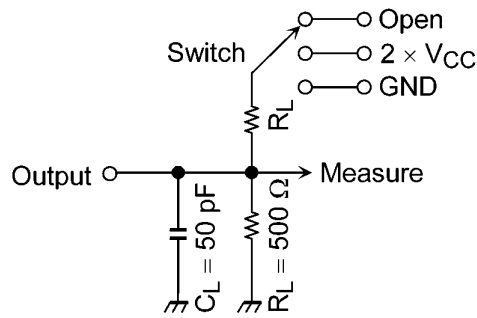


Table 11.6.1 Parameter for AC Test Circuit

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

11.7. AC Waveform

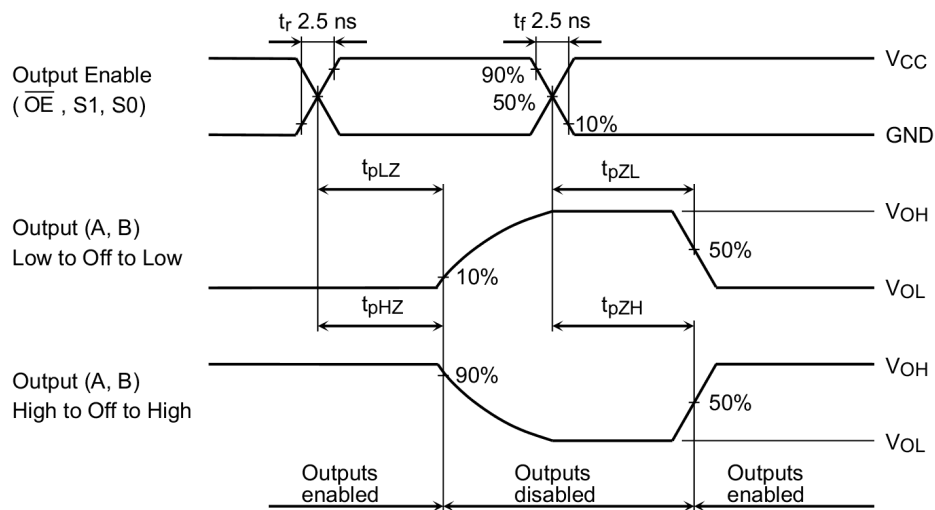


Fig. 11.7.1 AC Waveform $t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}$

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.)

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

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

Calculation example:

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

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)

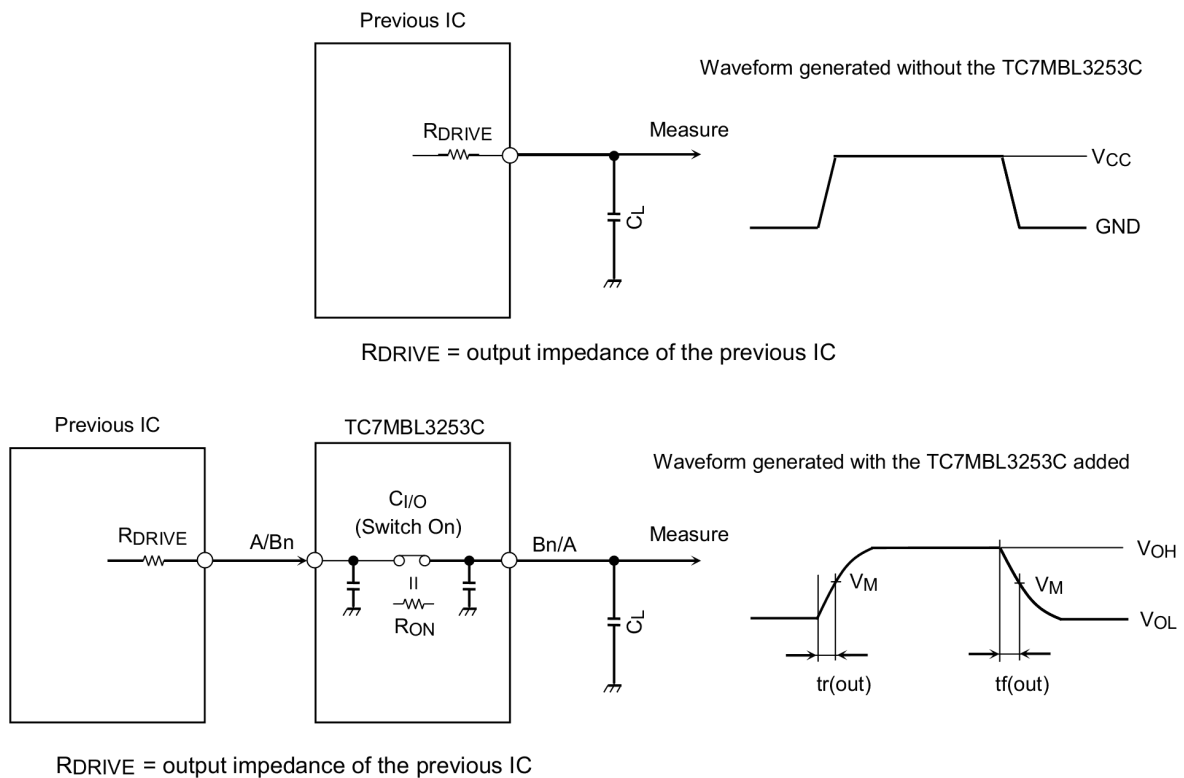


Fig. 12.1 Calculation Circuit

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)

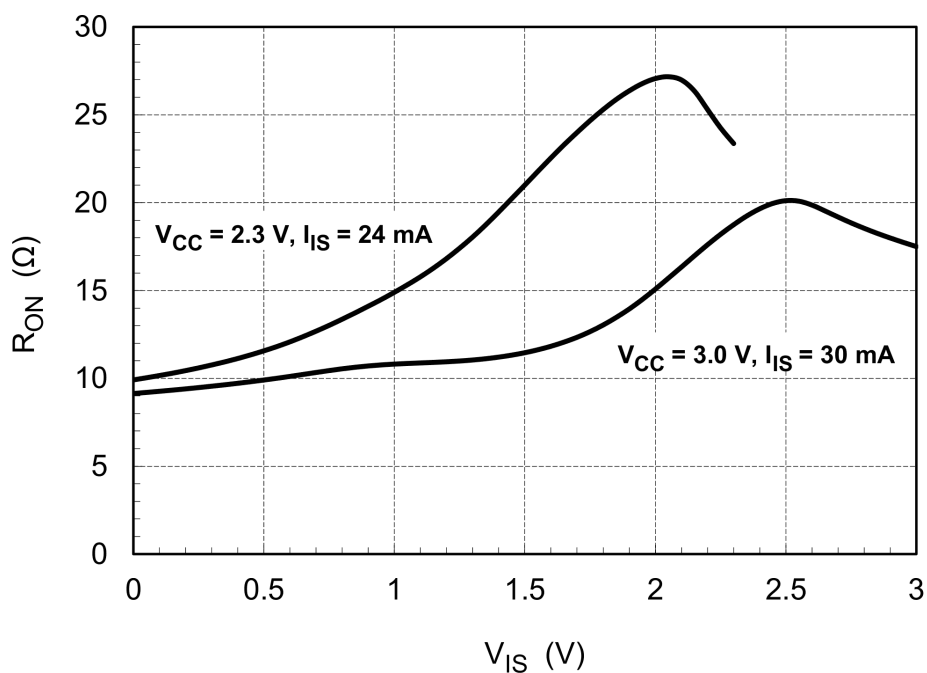


Fig. 13.1 $R_{ON} - V_{IS}$ ($T_a = 25$ °C)

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

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