

TENTATIVE

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCXH16646FT

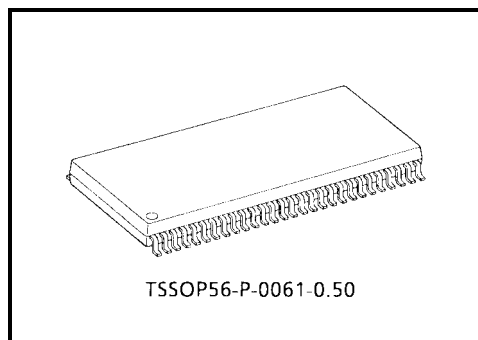
Low-Voltage 16-Bit Bus Transceiver/Register with Bushold

The TC74VCXH16646FT is a high-performance CMOS 16-bit bus transceiver/register. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

This device is bus transceiver with 3-state outputs, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the internal registers.

The A, B data inputs include active bushold circuitry, eliminating the need for external pull-up resisisors to hold unused or floating data inputs at a valid logic level.

All inputs are equipped with protection circuits against static discharge.



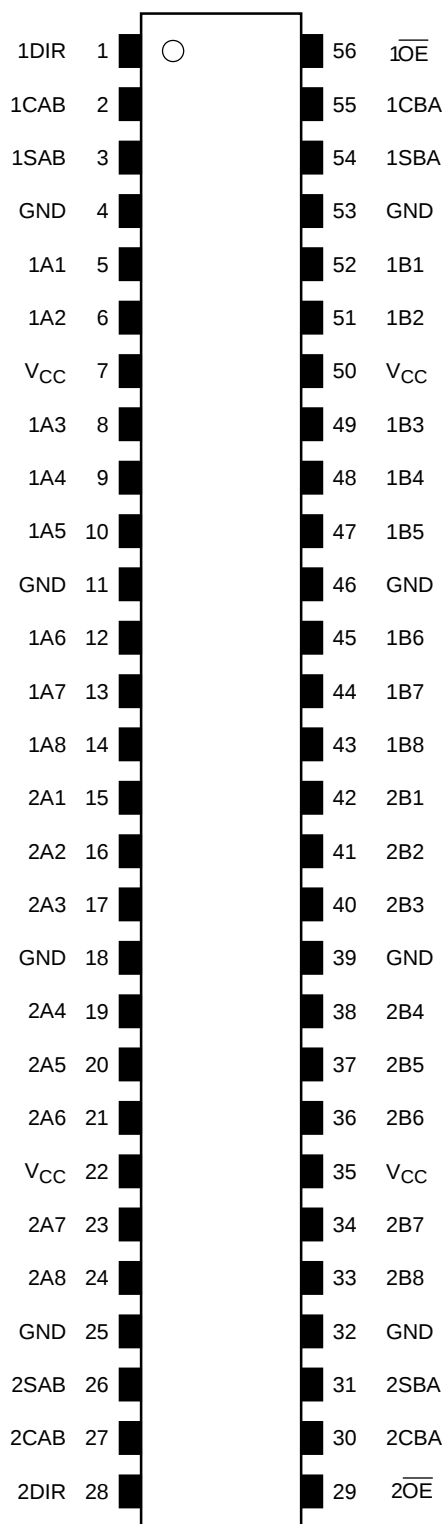
Weight: 0.25 g (typ.)

Features

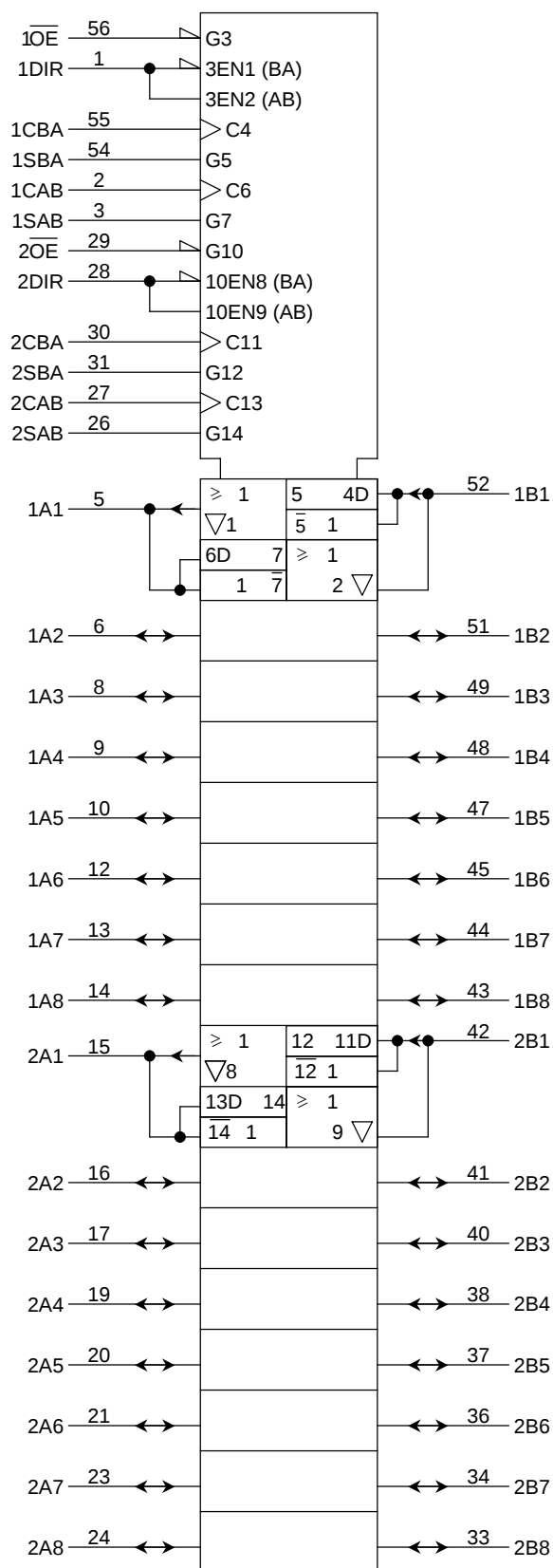
- Low-voltage operation: $V_{CC} = 1.8$ to 3.6 V
- Bushold on data inputs eliminating the need for external pull-up/pull-down resistors
- High-speed operation : $t_{pd} = 2.9$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 3.5$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
: $t_{pd} = 7.0$ ns (max) ($V_{CC} = 1.8$ V)
- 3.6-V tolerant control inputs
- Output current: $I_{OH}/I_{OL} = \pm 24$ mA (min) ($V_{CC} = 3.0$ V)
: $I_{OH}/I_{OL} = \pm 18$ mA (min) ($V_{CC} = 2.3$ V)
: $I_{OH}/I_{OL} = \pm 6$ mA (min) ($V_{CC} = 1.8$ V)
- Latch-up performance: ± 300 mA
- ESD performance: Machine model $> \pm 200$ V
: Human body model $> \pm 2000$ V
- Package: TSSOP (thin shrink small outline package)

Note 1: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

Control Inputs						Bus		Function
$\overline{OE}$	DIR	CAB	CBA	SAB	SBA	A	B	
H	X	X*	X*	X	X	Input	Input	The output functions of A and B Busses are disabled.
				X	X	Z	Z	Both A and B Busses are used as inputs to the internal flip-flops. Data on the Bus will be stored on the rising edge of the Clock.
L	H	X*	X*	L	X	Input	Output	The data on the A bus are displayed on the B bus.
						L	L	
						H	H	
			X*	L	X	L	L	The data on the A bus are displayed on the B Bus, and are stored into the A storage flip-flops on the rising edge of CAB.
						H	H	
		X*	X*	H	X	X	Qn	The data in the A storage flip-flops are displayed on the B Bus.
L	L		X*	H	X	L	L	The data on the A Bus are stored into the A storage flip-flops on the rising edge of CAB, and the stored data propagate directly onto the B Bus.
						H	H	
		X*	X*	X	L	Output	Input	The data on the B Bus are displayed on the A bus.
						L	L	
						H	H	
		X*		X	L	L	L	The data on the B Bus are displayed on the A Bus, and are stored into the B storage flip-flops on the rising edge of CBA.
						H	H	
L	L	X*	X*	X	H	Qn	X	The data in the B storage flip-flops are displayed on the A Bus.
		X*		X	H	L	L	The data on the B Bus are stored into the B storage flip-flops on the rising edge of CBA, and the stored data propagate directly onto the A Bus.
						H	H	
		X*		X	H			

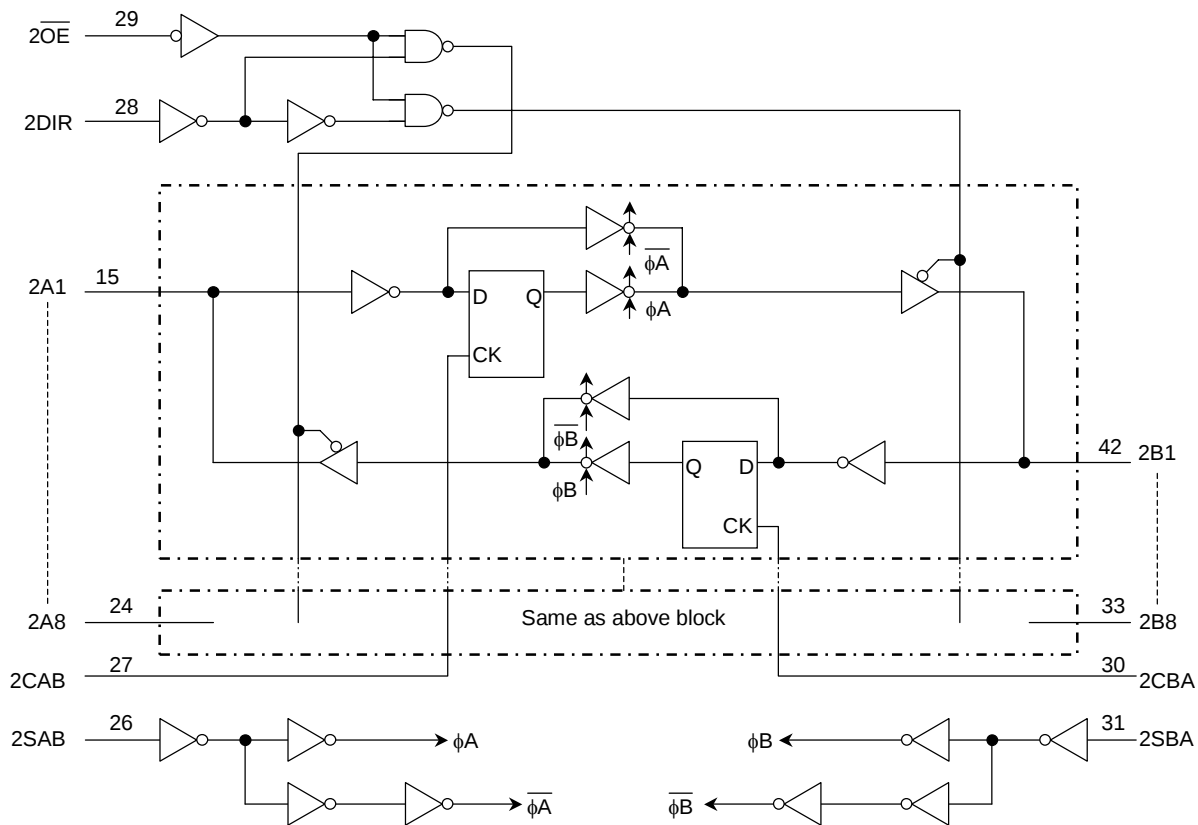
X: Don't care

Z: High impedance

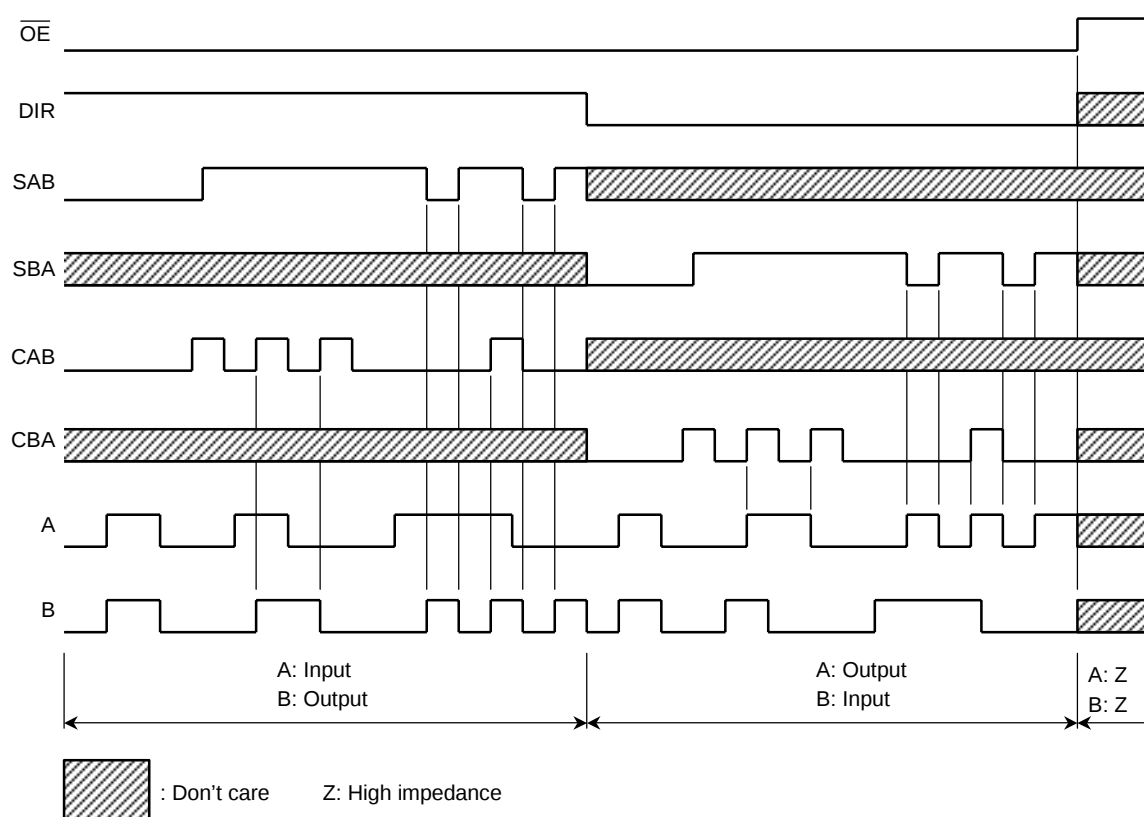
Qn: The data stored into the internal flip-flops by most recent low to high transition of the clock inputs.

*: The clocks are not internally with either $\overline{OE}$ or DIR.

Therefore, data on the A and/or B busses may be clocked into the storage flip-flops at any time.



Timing Chart



Maximum Ratings

Characteristics		Symbol	Rating	Unit
Power supply voltage		V_{CC}	-0.5 to 4.6	V
DC input voltage	(DIR, $\overline{OE}$, CAB, CBA, SAB, SBA)	V_{IN}	-0.5 to 4.6	V
	(An, Bn)		-0.5 to $V_{CC} + 0.5$ (Note 2)	
DC output voltage	(An, Bn)	V_{OUT}	-0.5 to $V_{CC} + 0.5$ (Note 3)	V
Input diode current		I_{IK}	-50	mA
Output diode current		I_{OK}	± 50 (Note 4)	mA
Output current		I_{OUT}	± 50	mA
Power dissipation		P_D	400	mW
DC V_{CC} /ground current per supply pin		I_{CC}/I_{GND}	± 100	mA
Storage temperature		T_{stg}	-65 to 150	°C

Note 2: OFF state

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Range (Note 5)

Characteristics		Symbol	Rating	Unit
Power supply voltage		V_{CC}	1.8 to 3.6	V
			1.2 to 3.6 (Note 6)	
Input voltage	(DIR, $\overline{OE}$, CAB, CBA, SAB, SBA)	V_{IN}	-0.3 to 3.6	V
	(An, Bn)		0 to V_{CC} (Note 7)	
Output voltage	(An, Bn)	V_{OUT}	0 to V_{CC} (Note 8)	V
Output current		I_{OH}/I_{OL}	± 24 (Note 9)	mA
			± 18 (Note 10)	
			± 6 (Note 11)	
Operating temperature		T_{opr}	-40 to 85	°C
Input rise and fall time		dt/dv	0 to 10 (Note 12)	ns/V

Note 5: Floating or unused control inputs must be held high or low.

Note 6: Data retention only

Note 7: OFF state

Note 8: High or low state

Note 9: $V_{CC} = 3.0$ to 3.6 V

Note 10: $V_{CC} = 2.3$ to 2.7 V

Note 11: $V_{CC} = 1.8$ V

Note 12: $V_{IN} = 0.8$ to 2.0 V, $V_{CC} = 3.0$ V

Electrical Characteristics
DC Characteristics ($T_a = -40$ to 85°C , $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

Characteristics		Symbol	Test Condition			Min	Max	Unit
			V _{CC} (V)					
Input voltage	H-level	V _{IH}	—		2.7 to 3.6	2.0	—	V
	L-level	V _{IL}	—		2.7 to 3.6	—	0.8	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	2.7 to 3.6	V _{CC} − 0.2	—	V
				I _{OH} = −12 mA	2.7	2.2	—	
				I _{OH} = −18 mA	3.0	2.4	—	
				I _{OH} = −24 mA	3.0	2.2	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.7 to 3.6	—	0.2	
				I _{OL} = 12 mA	2.7	—	0.4	
				I _{OL} = 18 mA	3.0	—	0.4	
				I _{OL} = 24 mA	3.0	—	0.55	
Input leakage current (DIR, $\overline{\text{OE}}$, CAB, CBA, SAB, SBA)		I _{IN}	V _{IN} = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
Bushold input minimum drive hold current		I _I (HOLD)	V _{IN} = 0.8 V		3.0	75	—	μA
			V _{IN} = 2.0 V		3.0	−75	—	
Bushold input over-drive current to change state		I _I (OD)	(Note 13)		3.6	—	450	μA
			(Note 14)		3.6	—	−450	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = V _{CC} or GND		2.7 to 3.6	—	±10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.7 to 3.6	—	20.0	μA
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} − 0.6 V		2.7 to 3.6	—	750	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ V_{CC} ≤ 2.7 V)

Characteristics		Symbol	Test Condition		Min	Max	Unit	
			V _{CC} (V)					
Input voltage	H-level	V _{IH}	—		2.3 to 2.7	1.6	—	V
	L-level	V _{IL}	—		2.3 to 2.7	—	0.7	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3 to 2.7	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	2.3	2.0	—	
				I _{OH} = -12 mA	2.3	1.8	—	
				I _{OH} = -18 mA	2.3	1.7	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3 to 2.7	—	0.2	
				I _{OL} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
Input leakage current (DIR, $\overline{\text{OE}}$, CAB, CBA, SAB, SBA)		I _{IN}	V _{IN} = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
Bushold input minimum drive hold current		I _I (HOLD)	V _{IN} = 0.7 V		2.3	45	—	μA
			V _{IN} = 1.6 V		2.3	-45	—	
Bushold input over-drive current to change state		I _I (OD)	(Note 13)		2.7	—	300	μA
			(Note 14)		2.7	—	-300	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = V _{CC} or GND		2.3 to 2.7	—	±10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3 to 2.7	—	20.0	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

DC Characteristics ($T_a = -40$ to 85°C , $1.8\text{ V} \leq V_{CC} < 2.3\text{ V}$)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	H-level	V _{IH}	—		1.8 to 2.3	0.7 × V _{CC}	—	V
	L-level	V _{IL}	—		1.8 to 2.3	—	0.2 × V _{CC}	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	1.8	V _{CC} − 0.2	—	V
				I _{OH} = −6 mA	1.8	1.4	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.8	—	0.2	
				I _{OL} = 6 mA	1.8	—	0.3	
Input leakage current (DIR, $\overline{\text{OE}}$, CAB, CBA, SAB, SBA)		I _{IN}	V _{IN} = 0 to 3.6 V		1.8	—	±5.0	μA
Bushold input minimum drive hold current		I _I (HOLD)	V _{IN} = 0.36 V		1.8	25	—	μA
			V _{IN} = 1.26 V		1.8	−25	—	
Bushold input over-drive current to change state		I _I (OD)	(Note 13)		1.8	—	200	μA
			(Note 14)		1.8	—	−200	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = V _{CC} or GND		1.8	—	±10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.8	—	20.0	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

AC Characteristics (Ta = -40 to 85°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500$ Ω)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Min	Max	Unit
Maximum clock frequency	$f_{\max}$	Figure 1, Figure 3	1.8	100	—	MHz
			2.5 ± 0.2	200	—	
			3.3 ± 0.3	250	—	
Propagation delay time (An, Bn-Bn, An)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	7.0	ns
			2.5 ± 0.2	0.8	3.5	
			3.3 ± 0.3	0.6	2.9	
Propagation delay time (CAB, CBA-Bn, An)	t_{pLH} t_{pHL}	Figure 1, Figure 3	1.8	1.5	8.8	ns
			2.5 ± 0.2	0.8	4.4	
			3.3 ± 0.3	0.6	3.2	
Propagation delay time (SAB, SBA-Bn, An)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	8.8	ns
			2.5 ± 0.2	0.8	4.4	
			3.3 ± 0.3	0.6	3.5	
Output enable time ($\overline{OE}$, DIR-An, Bn)	t_{pZL} t_{pZH}	Figure 1, Figure 4, Figure 5	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	4.9	
			3.3 ± 0.3	0.6	3.8	
Output disable time ($\overline{OE}$, DIR-An, Bn)	t_{pLZ} t_{pHZ}	Figure 1, Figure 4, Figure 5	1.8	1.5	7.6	ns
			2.5 ± 0.2	0.8	4.2	
			3.3 ± 0.3	0.6	3.7	
Minimum pulse width	t_w (H) t_w (L)	Figure 1, Figure 3	1.8	4.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum setup time	t_s	Figure 1, Figure 3	1.8	2.5	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum hold time	t_h	Figure 1, Figure 3	1.8	1.0	—	ns
			2.5 ± 0.2	1.0	—	
			3.3 ± 0.3	1.0	—	
Output to output skew	t_{osLH} t_{osHL}	(Note 15)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.

Note 15: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

Dynamic Switching Characteristics
(Ta = 25°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500 \Omega$)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V _{OL}	V _{OLP}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note 16)	1.8	0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 16)	2.5	0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 16)	3.3	0.8	
Quiet output minimum dynamic V _{OL}	V _{OLV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note 16)	1.8	−0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 16)	2.5	−0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 16)	3.3	−0.8	
Quiet output minimum dynamic V _{OH}	V _{OHV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note 16)	1.8	1.5	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 16)	2.5	1.9	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 16)	3.3	2.2	

Note 16: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
Input capacitance	C _{IN}	(DIR, $\overline{OE}$, CAB, CBA, SAB, SBA)	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	C _{I/O}	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note 17)	1.8, 2.5, 3.3	20	pF

 Note 17: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16 \text{ (per bit)}$$

AC Test Circuit

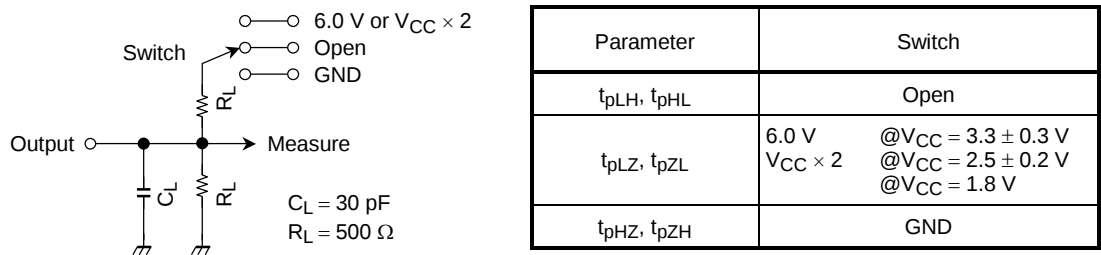


Figure 1

AC Waveform

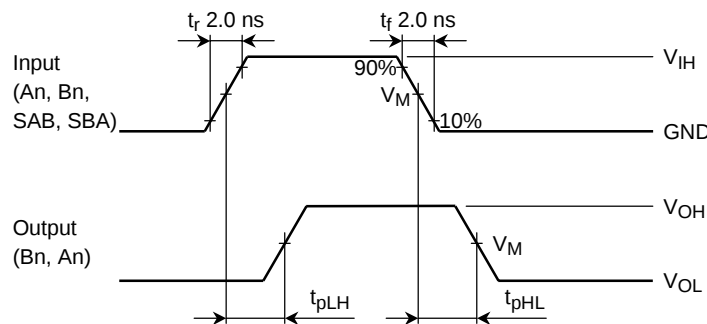


Figure 2 t_{pLH} , t_{pHL}

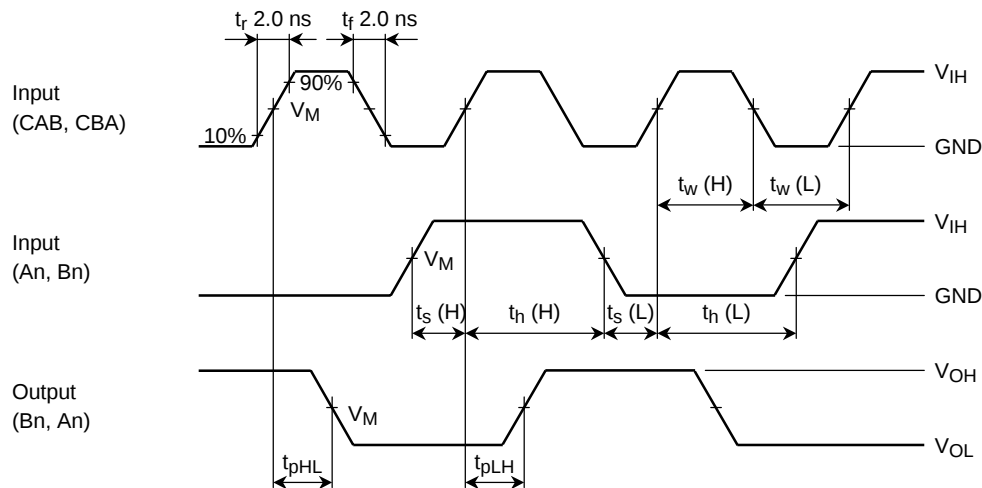


Figure 3 t_{pLH} , t_{pHL} , t_w , t_s , t_h

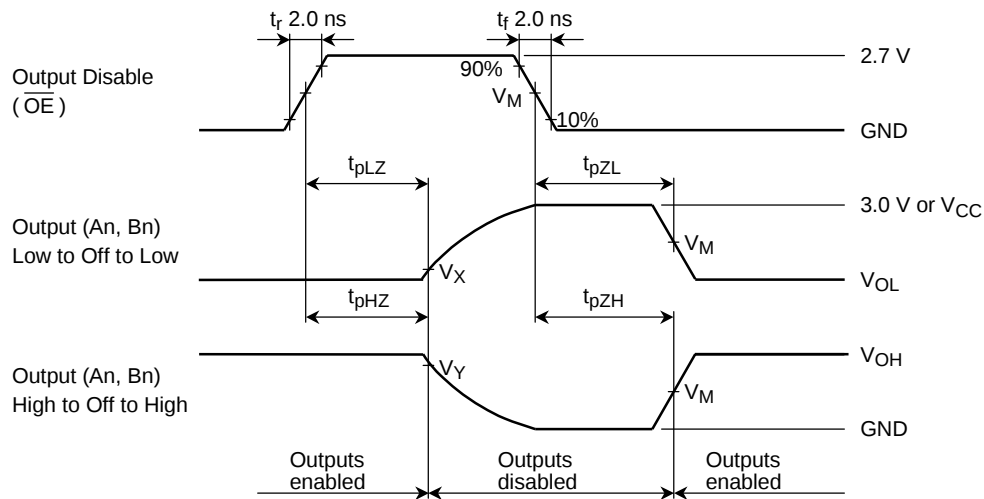


Figure 4 t_{pLZ} , t_{pH} , t_{pZ} , t_{pZH}

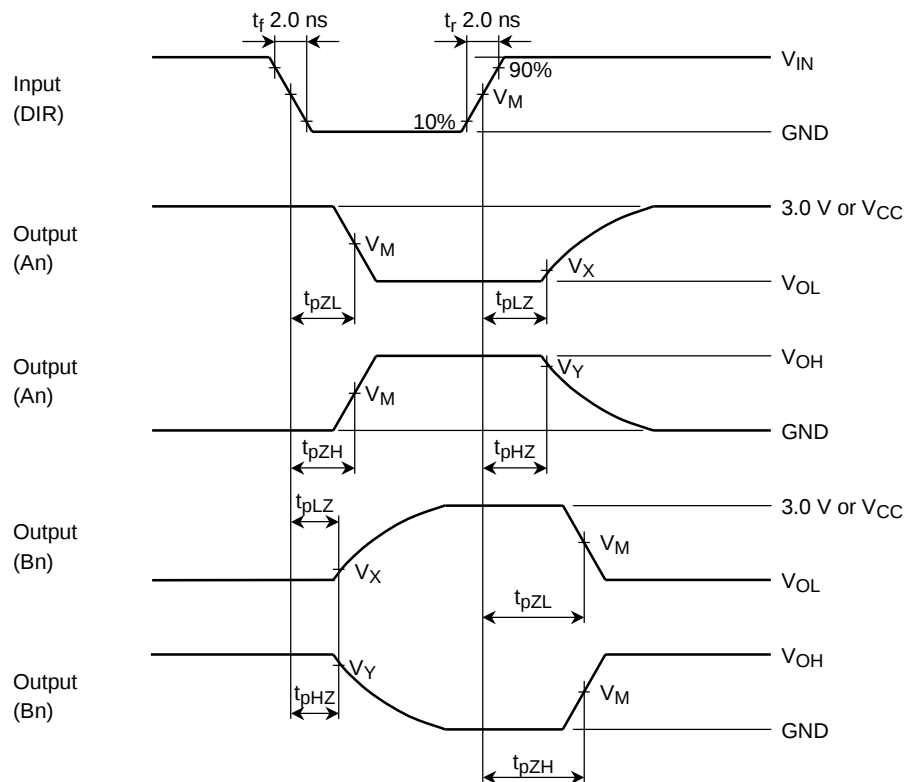


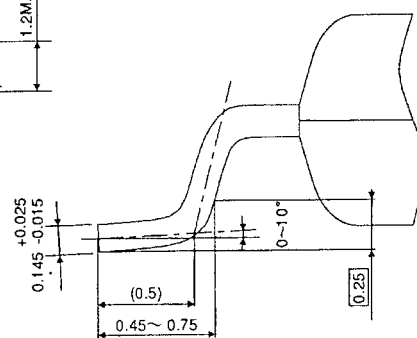
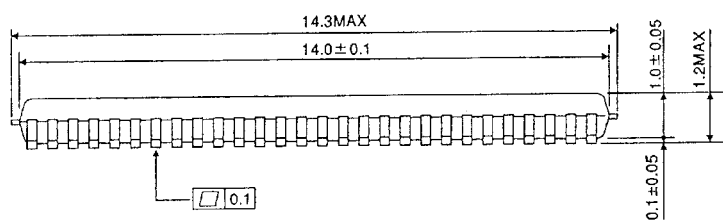
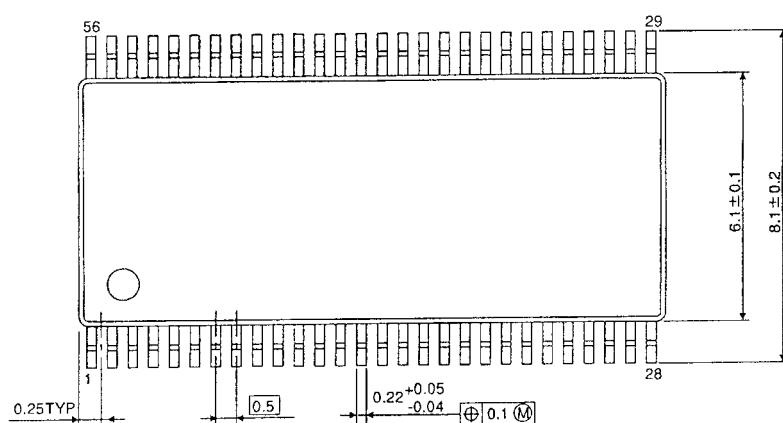
Figure 5 t_{pLZ} , t_{pH} , t_{pZ} , t_{pZH}

Symbol	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

Package Dimensions

TSSOP56-P-0061-0.50

Unit : mm



Weight: 0.25 g (typ.)

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000707EBA

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