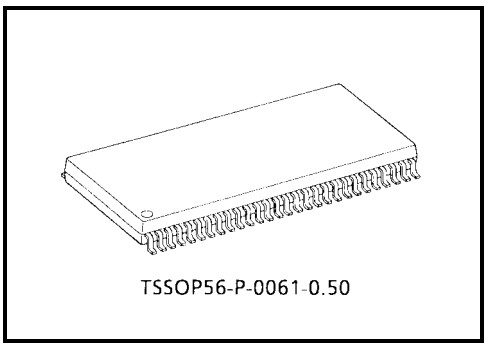
TENTATIVE TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCXHR162543FT

Low-Voltage 16-Bit Registered Transceiver with Bushold



Weight: 0.25 g (typ.)

The TC74VCXHR162543FT is a high-performance CMOS 16-bit registered transceiver. 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.

The TC74VCXHR162543FT can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable ($\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$) and output-enable ($\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$) inputs are provided for each register to permit independent control in either direction of data flow.

The A-to-B enable ($\overline{\text{CEAB}}$) input must be low in order to enter data from A or to output data from B. If $\overline{\text{CEAB}}$ is low and $\overline{\text{LEAB}}$ is low, the A-to-B latches are transparent; a subsequent low-to-high transition of $\overline{\text{LEAB}}$ puts the Alatches in the storage mode. With $\overline{\text{CEAB}}$ and $\overline{\text{OEAB}}$ both low, the 3-state B outputs are active and reflect the data present at the output of the A latches.

Data flow from B to A is similar but requires using the $\overline{\text{CEBA}}$, $\overline{\text{LEBA}}$, and $\overline{\text{OEBA}}$ inputs.

When the $\overline{\text{OE}}$ input is high, the outputs are in a high-impedance state. This device is designed to be used with 3-state memory address drivers, etc.

The 26-Ω series resistor helps reducing output overshoot and undershoot without external resistor.

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.

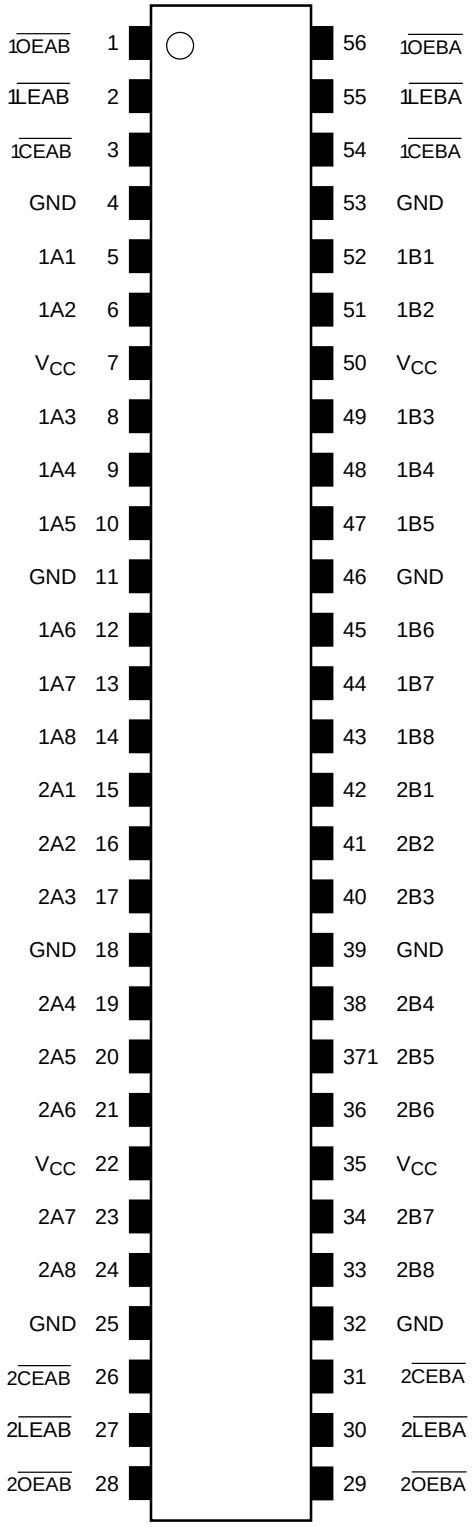
All inputs are equipped with protection circuits against static discharge.

Features

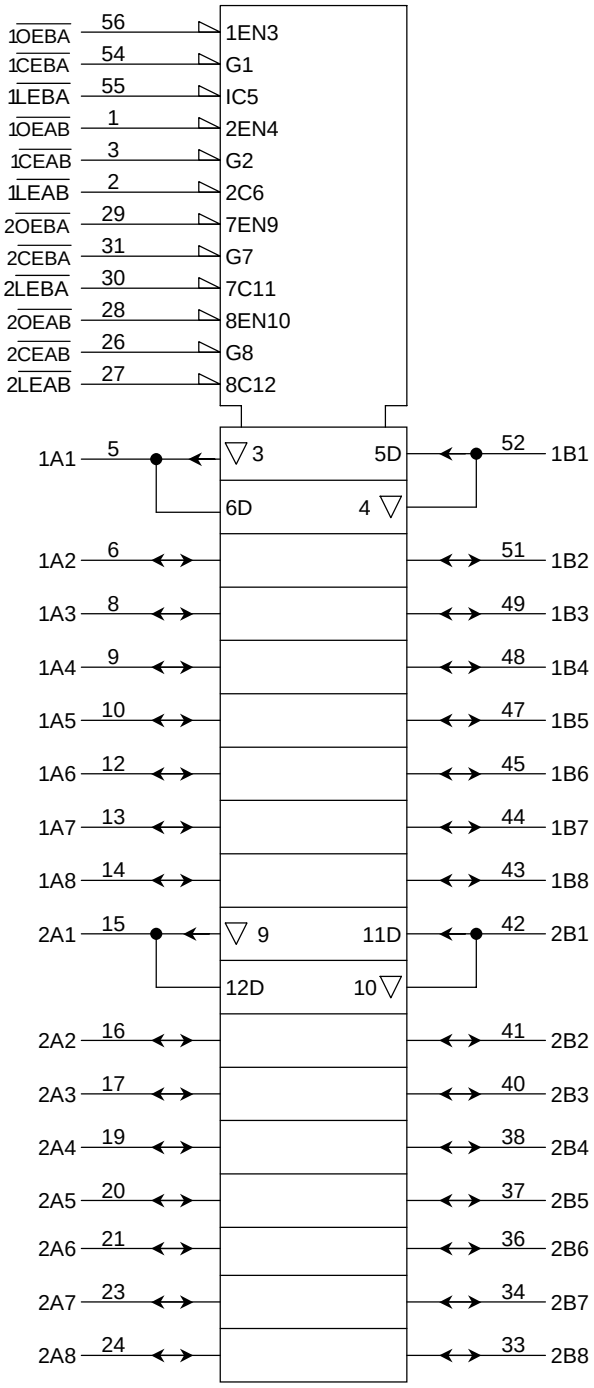
- 26-Ω series resistors on outputs
- Low-voltage operation: V_{CC} = 1.8 to 3.6 V
- Bushold on data inputs eliminating the need for external pull-up/pull-down resistors
- High-speed operation: t_{pd} = 4.4 ns (max) (V_{CC} = 3.0 to 3.6 V)
  : t_{pd} = 5.4 ns (max) (V_{CC} = 2.3 to 2.7 V)
  : t_{pd} = 9.8 ns (max) (V_{CC} = 1.8 V)
- 3.6-V tolerant control inputs
- Output current: I_{OH}/I_{OL} = ±12 mA (min) (V_{CC} = 3.0 V)
  : I_{OH}/I_{OL} = ±8 mA (min) (V_{CC} = 2.3 V)
  : I_{OH}/I_{OL} = ±4 mA (min) (V_{CC} = 1.8 V)
- Latch-up performance: ±300 mA
- ESD performance: Machine model > ±200 V
  : Human body model > ±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 (A bus → B bus each 8-bit latch)

Inputs				Outputs B
$\overline{CEAB}$	$\overline{LEAB}$	$\overline{OEAB}$	A	
H	X	X	X	Z
X	X	H	X	Z
L	H	L	X	B0 (Note 2)
L	L	L	L	L
L	L	L	H	H

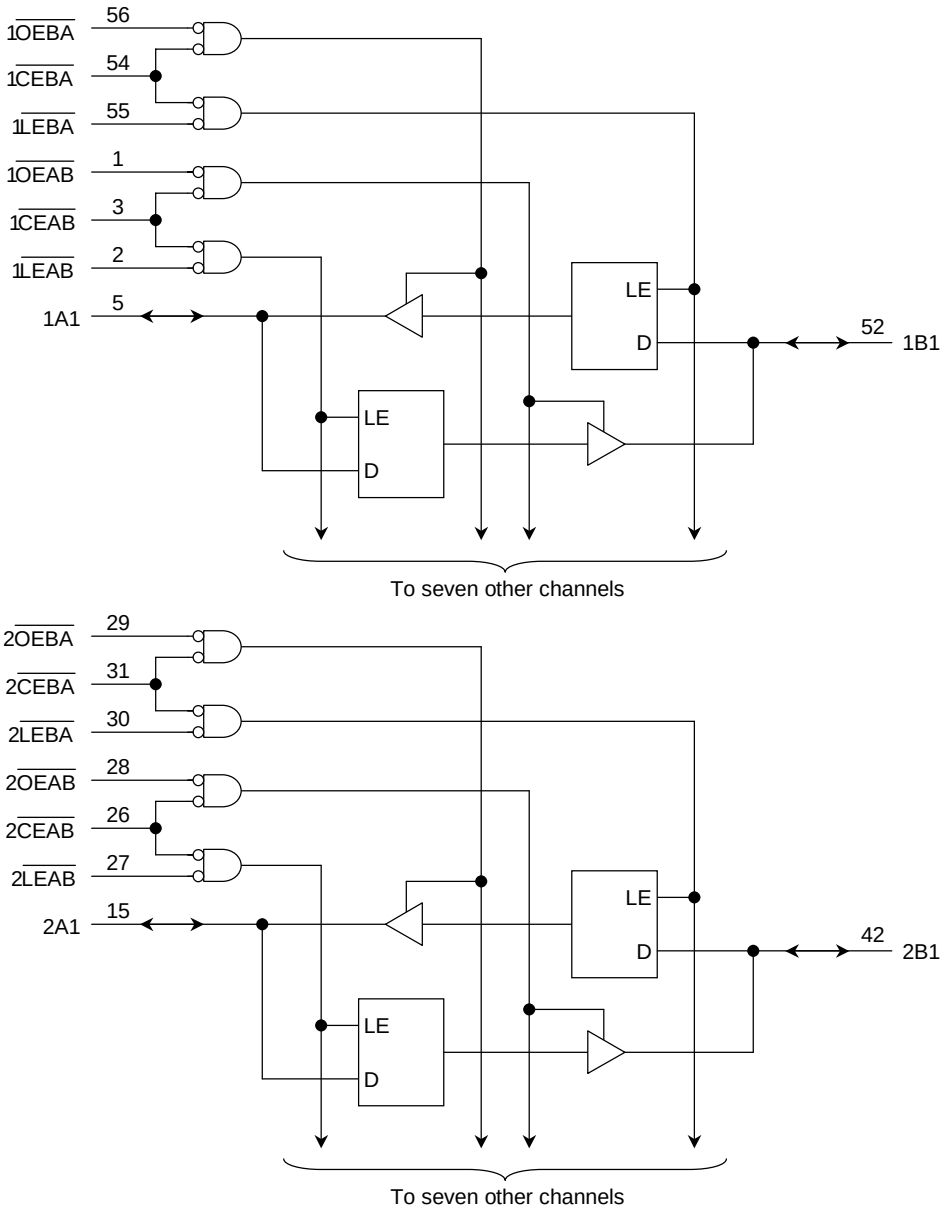
Note 2: Output level before the indicated steady-state input conditions were established.

Truth Table (B bus → A bus each 8-bit latch)

Inputs				Outputs A
$\overline{CEBA}$	$\overline{LEBA}$	$\overline{OEBA}$	B	
H	X	X	X	Z
X	X	H	X	Z
L	H	L	X	A0 (Note 2)
L	L	L	L	L
L	L	L	H	H

Note 2: Output level before the indicated steady-state input conditions were established.

System Diagram



Maximum Ratings

Characteristics		Symbol	Rating	Unit
Power supply voltage		V_{CC}	−0.5 to 4.6	V
DC input voltage	($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, LEBA, CEAB, $\overline{CEBA}$)	V_{IN}	−0.5 to 4.6	V
	(An, Bn)		−0.5 to V_{CC} + 0.5 (Note 3)	
DC output voltage	(An, Bn)	V_{OUT}	−0.5 to V_{CC} + 0.5 (Note 4)	V
Input diode current		I_{IK}	−50	mA
Output diode current		I_{OK}	±50 (Note 5)	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 3: OFF state

Note 4: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 5: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Range (Note 6)

Characteristics		Symbol	Rating	Unit
Power supply voltage		V_{CC}	1.8 to 3.6	V
			1.2 to 3.6 (Note 7)	
Input voltage	($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, LEBA, CEAB, $\overline{CEBA}$)	V_{IN}	−0.3 to 3.6	V
	(An, Bn)		0 to V_{CC} (Note 8)	
Output voltage	(An, Bn)	V_{OUT}	0 to V_{CC} (Note 9)	V
Output current		I_{OH}/I_{OL}	±12 (Note 10)	mA
			±8 (Note 11)	
			±4 (Note 12)	
Operating temperature		T_{opr}	−40 to 85	°C
Input rise and fall time		dt/dv	0 to 10 (Note 13)	ns/V

Note 6: Floating or unused control inputs must be held high or low.

Note 7: Data retention only

Note 8: OFF state

Note 9: High or low state

Note 10: V_{CC} = 3.0 to 3.6 V

Note 11: V_{CC} = 2.3 to 2.7 V

Note 12: V_{CC} = 1.8 V

Note 13: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = −40 to 85°C, 2.7 V < V_{CC} ≦ 3.6 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
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} = −6 mA	2.7	2.2	—	
				I_{OH} = −8 mA	3.0	2.4	—	
				I_{OH} = −12 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} = 6 mA	2.7	—	0.4	
				I_{OL} = 8 mA	3.0	—	0.5	
				I_{OL} = 12 mA	3.0	—	0.8	
Input leakage current ($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, LEBA , CEAB , CEBA)		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 14)		3.6	—	450	μA
			(Note 15)		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 14: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 15: 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		V_{CC} (V)	Min	Max	Unit
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} = –4 mA	2.3	2.0	—	
				I_{OH} = –6 mA	2.3	1.8	—	
				I_{OH} = –8 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} = 6 mA	2.3	—	0.4	
				I_{OL} = 8 mA	2.3	—	0.6	
Input leakage current ($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, LEBA , CEAB , CEBA)		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 14)		2.7	—	300	μA
			(Note 15)		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 14: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 15: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

DC Characteristics (Ta = –40 to 85°C, 1.8 V ≦ V_{CC} < 2.3 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} = –4 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} = 4 mA	1.8	—	0.3	
Input leakage current ($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, LEBA , CEAB , CEBA)		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 14)		1.8	—	200	μA
			(Note 15)		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 14: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 15: 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, $R_L = 500\ \Omega$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time (An, Bn-Bn, An)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	5.4	
			3.3 ± 0.3	0.6	4.4	
Propagation delay time ($\overline{LEAB}$, $\overline{LEBA}$ -Bn, An)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	6.4	
			3.3 ± 0.3	0.6	4.8	
3-state output enable time ($\overline{OEAB}$, $\overline{OEBA}$, $\overline{CEAB}$, $\overline{CEBA}$)	t_{pZL} t_{pZH}	Figure 1, Figure 4	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	5.9	
			3.3 ± 0.3	0.6	4.3	
3-state output disable time ($\overline{OEAB}$, $\overline{OEBA}$, $\overline{CEAB}$, $\overline{CEBA}$)	t_{pLZ} t_{pHZ}	Figure 1, Figure 4	1.8	1.5	8.8	ns
			2.5 ± 0.2	0.8	4.9	
			3.3 ± 0.3	0.6	4.3	
Minimum pulse width ($\overline{LEAB}$, $\overline{LEBA}$, $\overline{CEAB}$, $\overline{CEBA}$)	$t_{W\ (L)}$	Figure 1, Figure 2, Figure 3	1.8	4.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum setup time (An, Bn-$\overline{LE}$, $\overline{CE}$)	t_s	Figure 1, Figure 2, Figure 3	1.8	2.5	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum hold time (An, Bn-$\overline{LE}$, $\overline{CE}$)	t_h	Figure 1, Figure 2, 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 16)	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 16: 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 17)	1.8	0.15	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note 17)	2.5	0.25	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note 17)	3.3	0.35	
Quiet output minimum dynamic V_{OL}	V_{OLV}	V_{IH} = 1.8 V, V_{IL} = 0 V (Note 17)	1.8	−0.15	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note 17)	2.5	−0.25	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note 17)	3.3	−0.35	
Quiet output minimum dynamic V_{OH}	V_{OHV}	V_{IH} = 1.8 V, V_{IL} = 0 V (Note 17)	1.8	1.55	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note 17)	2.5	2.05	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note 17)	3.3	2.65	

Note 17: Parameter guaranteed by design.

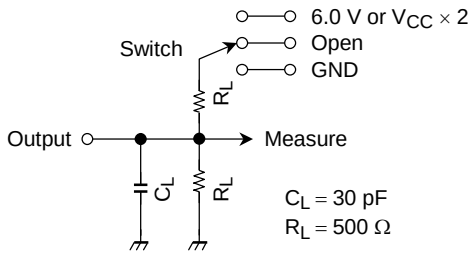
Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	($\overline{OEAB}$, $\overline{OEBA}$, $\overline{LEAB}$, $\overline{LEBA}$, $\overline{CEAB}$, $\overline{CEBA}$)	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 18)	1.8, 2.5, 3.3	20	pF

Note 18: 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:

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

AC Test Circuit



Parameter	Switch	
t_{pLH}, t_{pHL}	Open	
t_{pLZ}, t_{pZL}	6.0 V $V_{CC} \times 2$	@V_{CC} = 3.3 ± 0.3 V @V_{CC} = 2.5 ± 0.2 V @V_{CC} = 1.8 V
t_{pHZ}, t_{pZH}	GND	

Figure 1

AC Waveform

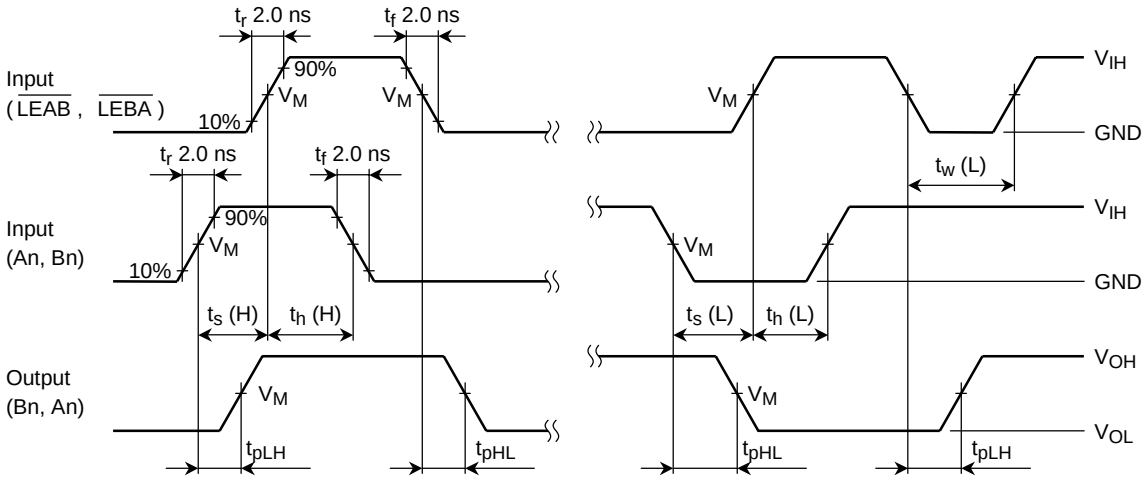


Figure 2 t_{pLH}, t_{pHL}, t_w, t_s, t_h

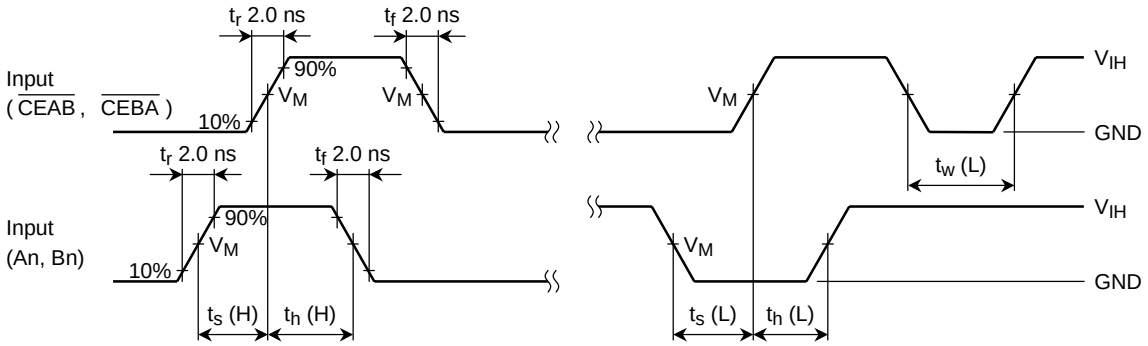


Figure 3 t_w, t_s, t_h

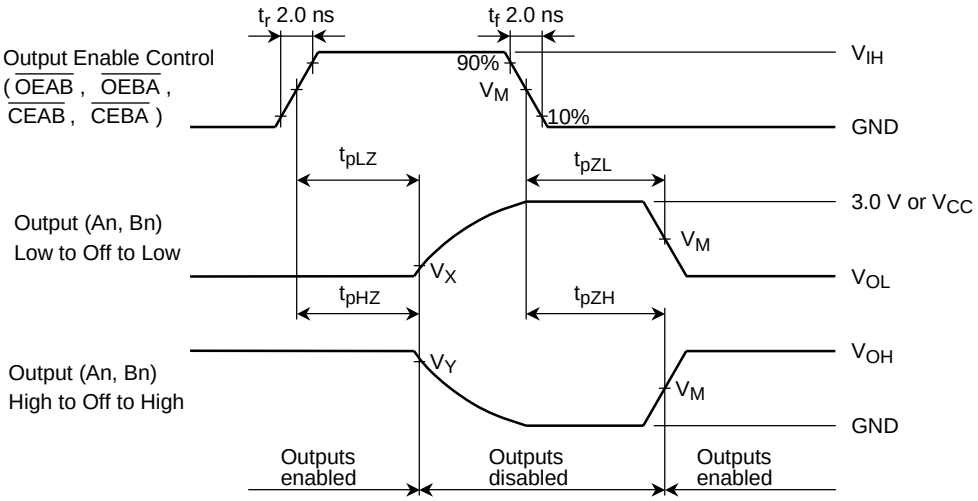
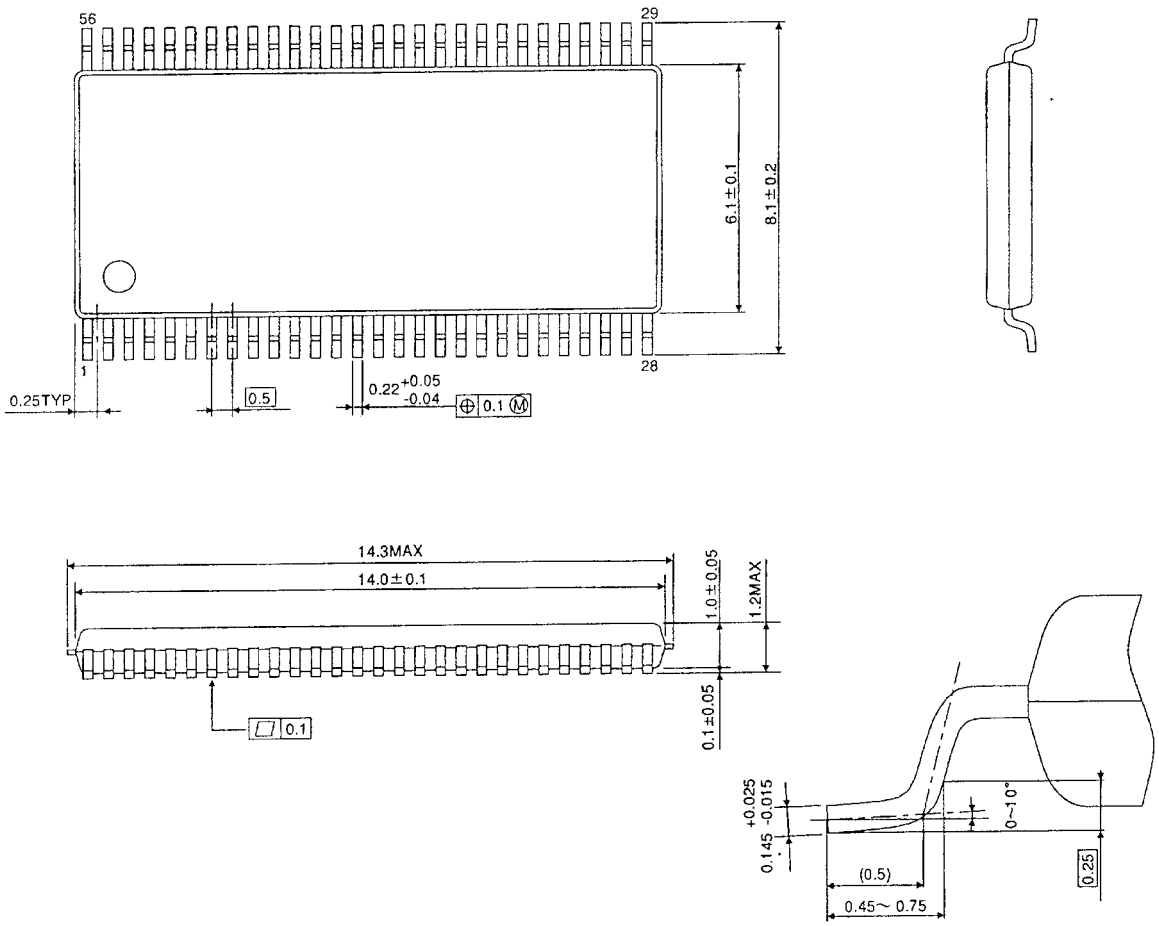


Figure 4 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 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 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V
V_Y	V_{OH} − 0.3 V	V_{OH} − 0.15 V	V_{OH} − 0.15 V

Package Dimensions

TSSOP56-P-0061-0.50 Unit : mm



Weight: 0.25 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.