

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCX16835FT

Low-Voltage 18-Bit Universal Bus Driver with 3.6-V Tolerant Inputs and Outputs

The TC74VCX16835FT is a high-performance CMOS 18-bit universal bus driver. 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.

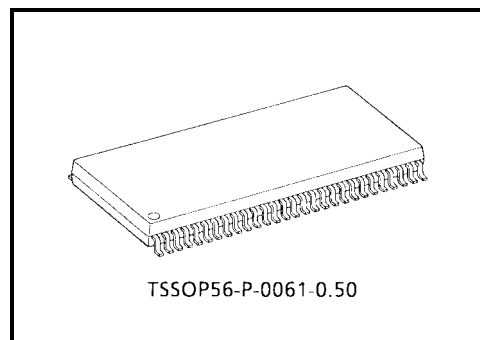
It is also designed with overvoltage tolerant inputs and outputs up to 3.6 V.

Data flow from A to Y is controlled by the output-enable ($\overline{OE}$) input.

The device operates in the transparent mode when the latch-enable (LE) input is high. When LE is low, the A data is latched if the clock (CK) input is held at a high or low logic level. If LE is low, the A data is stored in the latch/flip-flop on the low-to-high transition of CK.

When $\overline{OE}$ is high, the outputs are in the high-impedance state.

All inputs are equipped with protection circuits against static discharge.

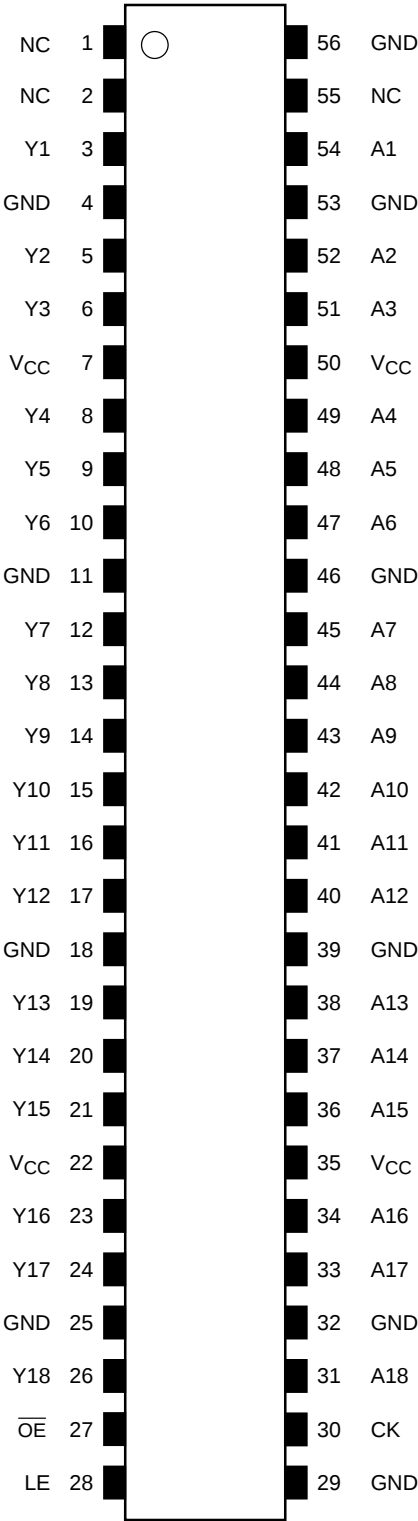


Weight: 0.25 g (typ.)

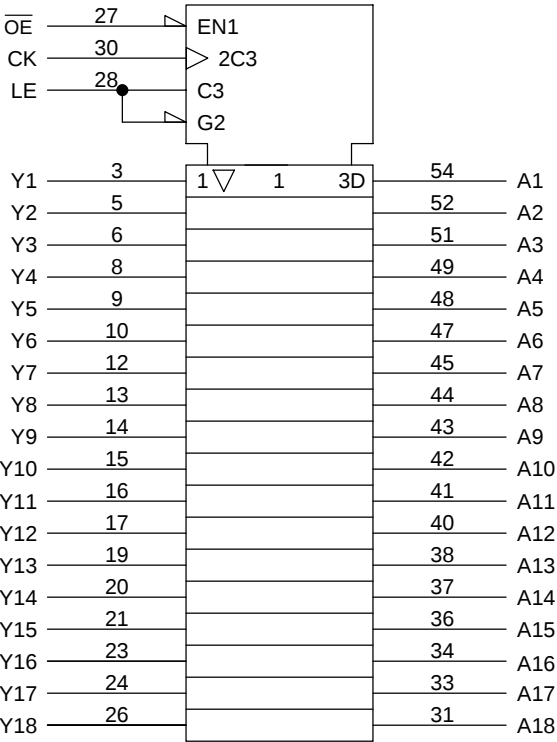
Features

- Low-voltage operation: $V_{CC} = 1.8$ to 3.6 V
- High-speed operation: $t_{pd} = 3.3$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 4.2$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
: $t_{pd} = 8.4$ ns (max) ($V_{CC} = 1.8$ V)
- 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)
- 3.6-V tolerant function and power-down protection is provided on all inputs and outputs

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

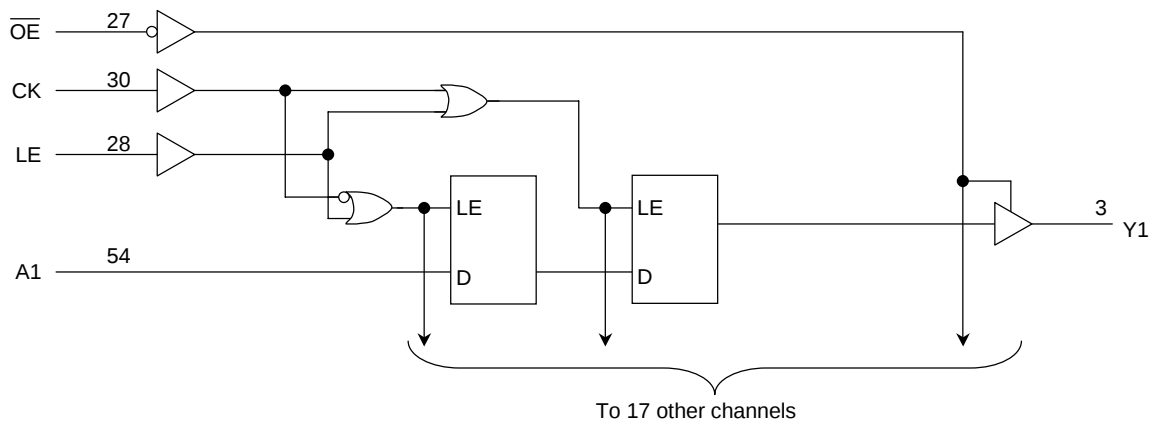
Inputs				Outputs Y
$\overline{OE}$	LE	CK	A	
H	X	X	X	Z
L	H	X	L	L
L	H	X	H	H
L	L		L	L
L	L		H	H
L	L	H	X	Y0 (Note 1)
L	L	L	X	Y0 (Note 1)

X: Don't care

Z: High impedance

Note 1: Output level before the indicated steady-state input conditions were established, provided that CK was high or low before LE went low.

System Diagram



Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5 to 4.6	V
DC input voltage	V_{IN}	−0.5 to 4.6	V
DC output voltage	V_{OUT}	−0.5 to 4.6 (Note 2)	V
		−0.5 to $V_{CC} + 0.5$ (Note 3)	
Input diode current	I_{IK}	−50	mA
Output diode current	I_{OK}	±50 (Note 4)	mA
DC 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

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	1.8 to 3.6	V
		1.2 to 3.6 (Note 5)	
Input voltage	V_{IN}	−0.3 to 3.6	V
Output voltage	V_{OUT}	0 to 3.6 (Note 6)	V
		0 to V_{CC} (Note 7)	
Output current	I_{OH}/I_{OL}	±24 (Note 8)	mA
		±18 (Note 9)	
		±6 (Note 10)	
Operating temperature	T_{opr}	−40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 11)	ns/V

Note 5: Data retention only

Note 6: OFF state

Note 7: High or low state

Note 8: $V_{CC} = 3.0$ to 3.6 V

Note 9: $V_{CC} = 2.3$ to 2.7 V

Note 10: $V_{CC} = 1.8$ V

Note 11: $V_{IN} = 0.8$ 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		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} = -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		I _{IN}	V _{IN} = 0 to 3.6 V	2.7 to 3.6	—	±5.0	μA	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V	2.7 to 3.6	—	±10.0	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V	0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND	2.7 to 3.6	—	20.0	μA	
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V	2.7 to 3.6	—	±20.0		
Increase in ICC per input		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V	2.7 to 3.6	—	750		

DC Characteristics ($T_a = -40$ to 85°C , $2.3\text{ V} \leq V_{CC} \leq 2.7\text{ V}$)

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} = -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		I _{IN}	V _{IN} = 0 to 3.6 V	2.3 to 2.7	—	±5.0	μA	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V	2.3 to 2.7	—	±10.0	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V	0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND	2.3 to 2.7	—	20.0	μA	
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V	2.3 to 2.7	—	±20.0		

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

Characteristics		Symbol	Test Condition			Min	Max	Unit	
			V _{CC} (V)						
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		I _{IN}	V _{IN} = 0 to 3.6 V			1.8	—	±5.0	μA
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V			1.8	—	±10.0	μA
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V			0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND			1.8	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V			1.8	—	±20.0	

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-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	8.4	ns
			2.5 ± 0.2	0.8	4.2	
			3.3 ± 0.3	0.6	3.3	
Propagation delay time (CK-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 3	1.8	2.0	9.2	ns
			2.5 ± 0.2	1.5	5.2	
			3.3 ± 0.3	1.4	4.2	
Propagation delay time (LE-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 4	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	4.9	
			3.3 ± 0.3	0.6	3.8	
Output enable time	t_{pZL} t_{pZH}	Figure 1, 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	t_{pLZ} t_{pHZ}	Figure 1, Figure 5	1.8	1.5	7.6	ns
			2.5 ± 0.2	0.8	4.5	
			3.3 ± 0.3	0.6	3.9	
Minimum pulse width	t_W (H) t_W (L)	Figure 1, Figure 3, Figure 4	1.8	4.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum setup time (An-CK, An-LE)	t_s	Figure 1, Figure 3, Figure 4	1.8	2.5	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum hold time (An-CK, An-LE)	t_h	Figure 1, Figure 3, Figure 4	1.8	1.0	—	ns
			2.5 ± 0.2	0.7	—	
			3.3 ± 0.3	0.7	—	
Output to output skew	t_{osLH} t_{osHL}	(Note 12)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

Note 12: Parameter guaranteed by design.

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

AC Characteristics (Ta = 0 to 85°C, input: $t_r = t_f = 2.0$ ns, $C_L = 0$ pF, $R_L = 500$ Ω)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Min	Max	Unit
Propagation delay time (An-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 2 (Note 13)	3.3 ± 0.15	0.9	2.0	ns
Propagation delay time (CK-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 3 (Note 13)	3.3 ± 0.15	1.5	2.9	ns
Propagation delay time (LE-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 4 (Note 13)	3.3 ± 0.15	0.7	2.6	ns
Output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 5 (Note 13)	3.3 ± 0.15	0.7	2.6	ns
Output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 5 (Note 13)	3.3 ± 0.15	0.7	2.7	ns
Minimum setup time (An-CK, An-LE)	t_s	Figure 1, Figure 3, Figure 4 (Note 13)	3.3 ± 0.15	1.5	—	ns
Minimum hold time (An-CK, An-LE)	t_h	Figure 1, Figure 3, Figure 4 (Note 13)	3.3 ± 0.15	0.7	—	ns

Note 13: TOSHIBA SPICE simulation data.

AC Characteristics (Ta = 0 to 85°C, input: $t_r = t_f = 2.0$ ns, $C_L = 50$ pF, $R_L = 500$ Ω)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Min	Max	Unit
Propagation delay time (An-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 2	3.3 ± 0.15	1.0	3.6	ns
Propagation delay time (CK-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 3	3.3 ± 0.15	1.7	4.5	ns
Propagation delay time (LE-Yn)	t_{pLH} t_{pHL}	Figure 1, Figure 4	3.3 ± 0.15	1.0	4.1	ns
Output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 5	3.3 ± 0.15	1.0	4.1	ns
Output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 5	3.3 ± 0.15	1.0	4.2	ns
Minimum setup time (An-CK, An-LE)	t_s	Figure 1, Figure 3, Figure 4	3.3 ± 0.15	1.5	—	ns
Minimum hold time (An-CK, An-LE)	t_h	Figure 1, Figure 3, Figure 4	3.3 ± 0.15	0.7	—	ns

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 14)	1.8	0.35	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 14)	2.5	0.7	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 14)	3.3	0.9	
Quiet output minimum dynamic V _{OL}	V _{OLV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note 14)	1.8	−0.35	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 14)	2.5	−0.7	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 14)	3.3	−0.9	
Quiet output minimum dynamic V _{OH}	V _{OHV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note 14)	1.8	1.3	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note 14)	2.5	1.7	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note 14)	3.3	2.0	

Note 14: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
Input capacitance	C _{IN}	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C _{OUT}	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note 15)	1.8, 2.5, 3.3	20	pF

 Note 15: 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:

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/18 \text{ (per bit)}$$

AC Test Circuit

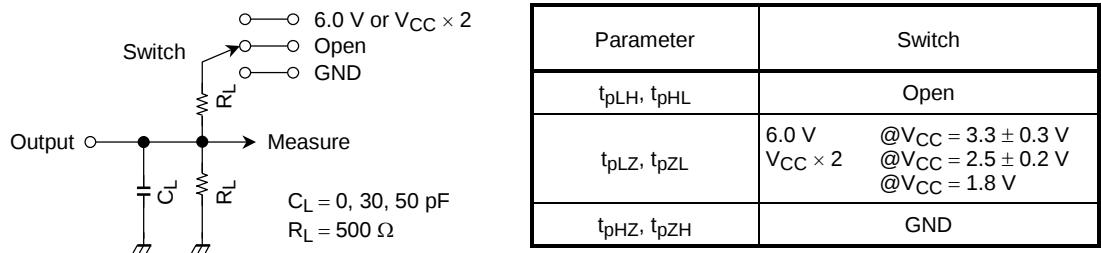


Figure 1

AC Waveform

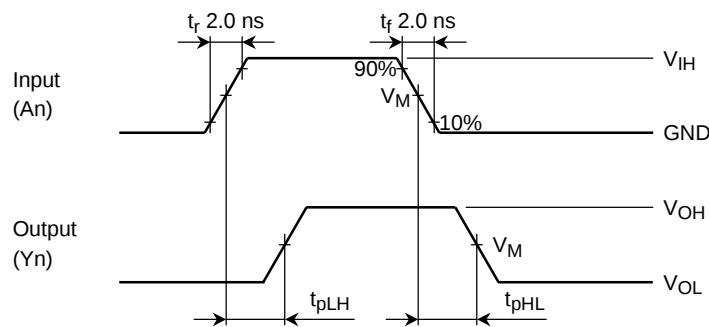


Figure 2 t_{pLH}, t_{pHL}

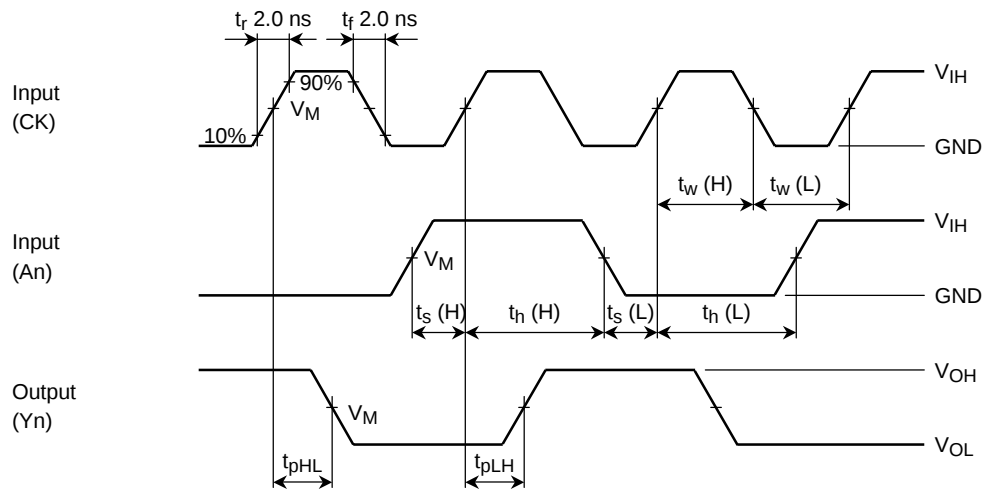


Figure 3 $t_{pLH}, t_{pHL}, t_w, t_s, t_h$

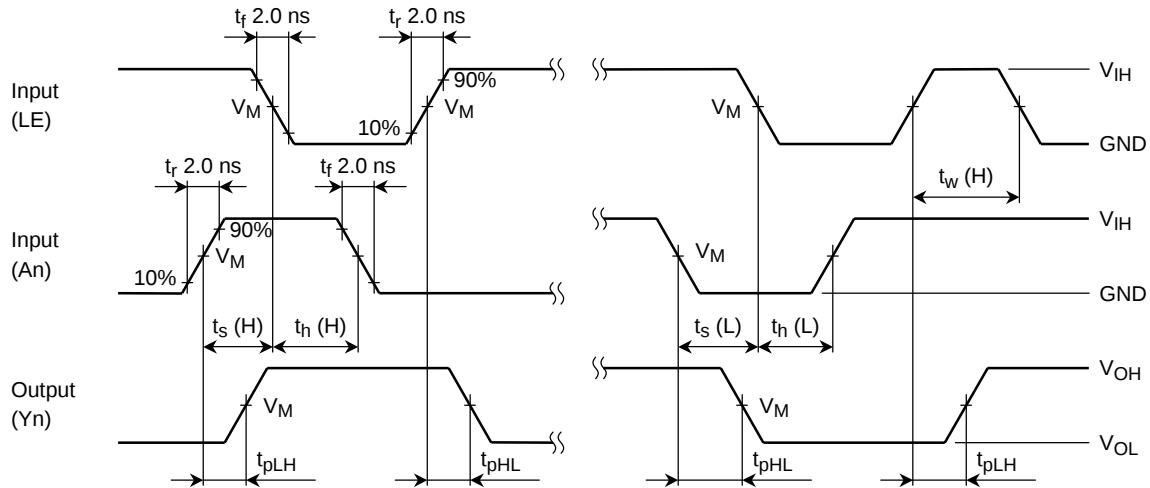


Figure 4 t_{pLH} , t_{pHL} , t_w , t_s , t_h

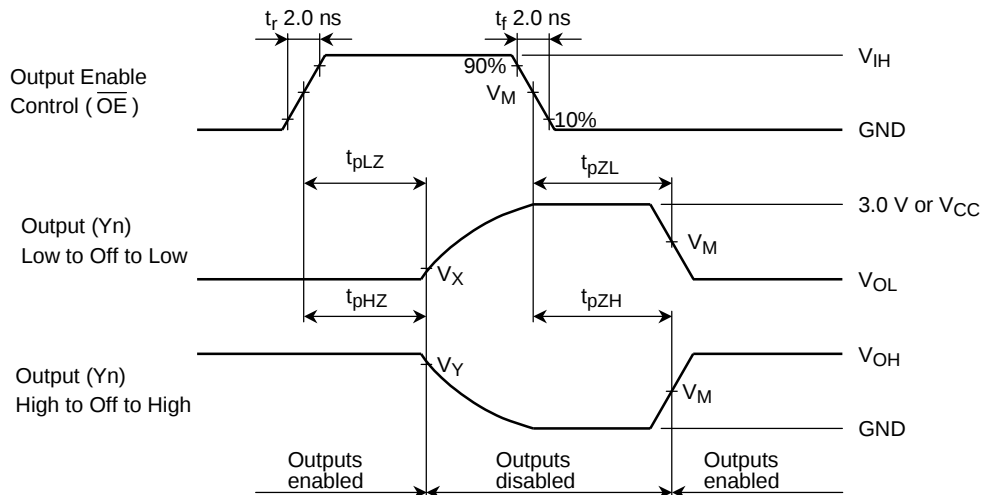


Figure 5 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

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	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

IBIS Characteristics (typ.)

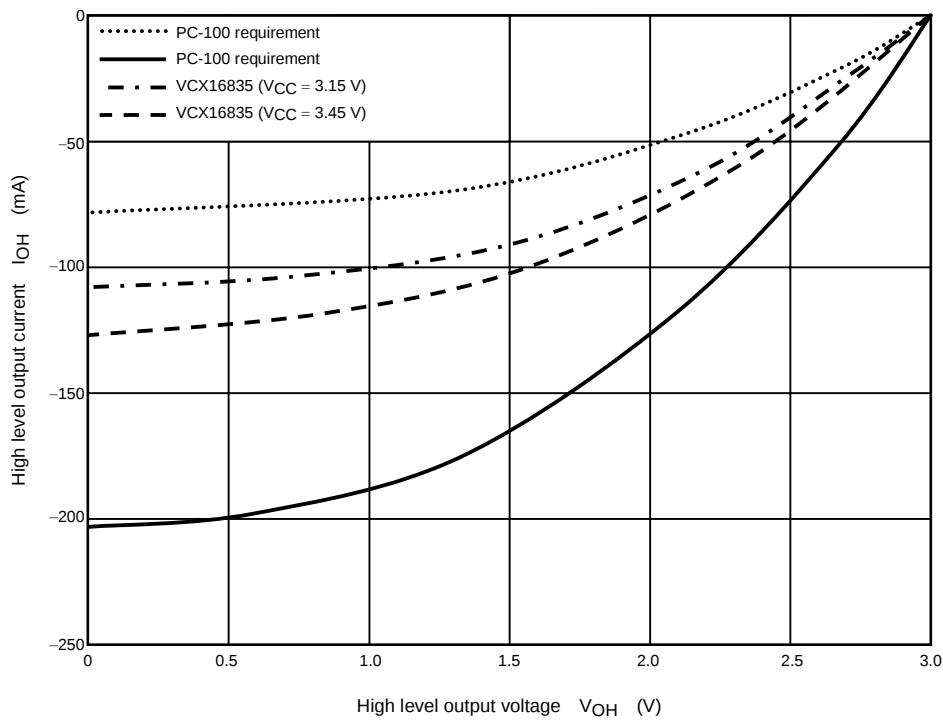


Figure 6 I/V Characteristics-Pullup

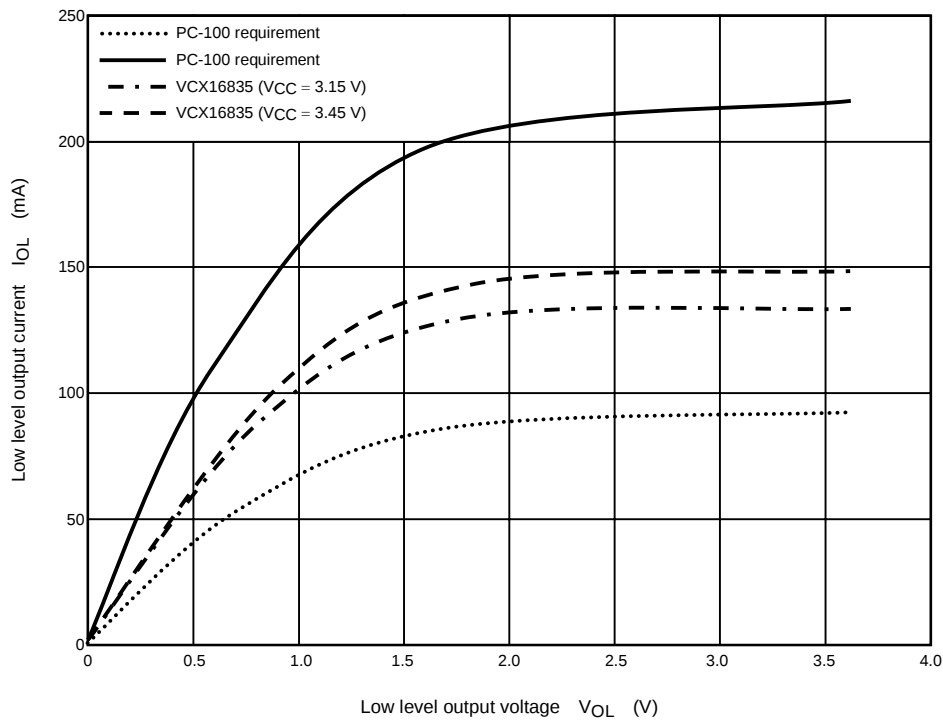
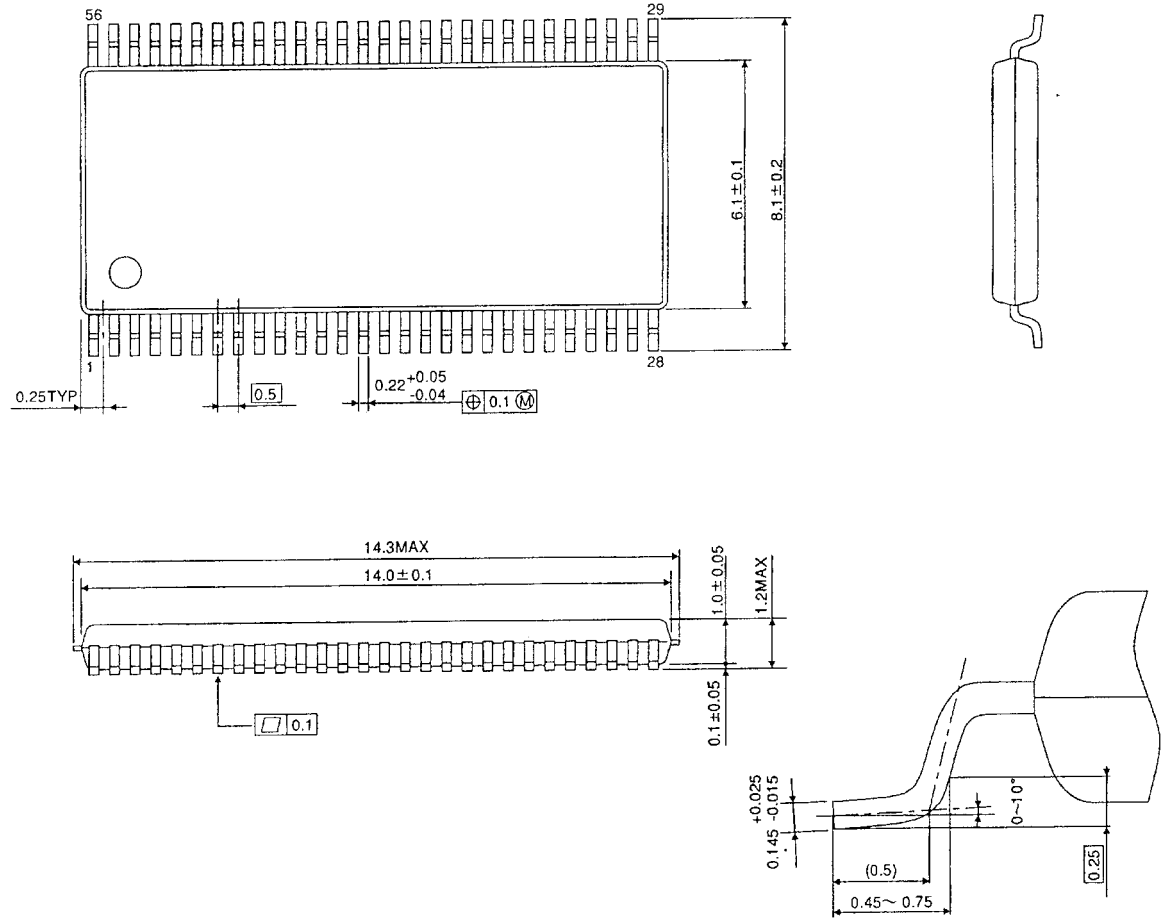


Figure 7 I/V Characteristics-Pulldown

Package Dimensions

TSSOP56-P-0061-0.50

Unit : mm



Weight: 0.25 g (typ.)

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