

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCX16827FT

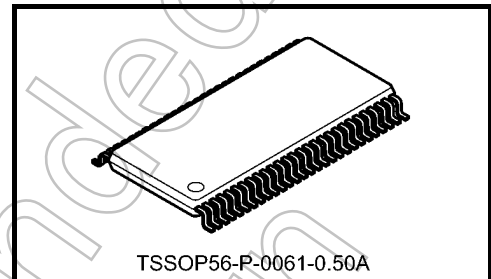
## Low-Voltage 20-Bit Bus Buffer with 3.6-V Tolerant Inputs and Outputs

The TC74VCX16827FT is a high-performance CMOS 20-bit bus buffer. 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.

The TC74VCX16827FT is composed of two 10-bit sections with separate output-enable signals. For either 10-bit buffer section, the two output-enable ( $\overline{1OE1}$  and  $\overline{1OE2}$  or  $\overline{2OE1}$  and  $\overline{2OE2}$ ) inputs must both be low for the corresponding Y outputs to be active. When the 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.

All inputs are equipped with protection circuits against static discharge.



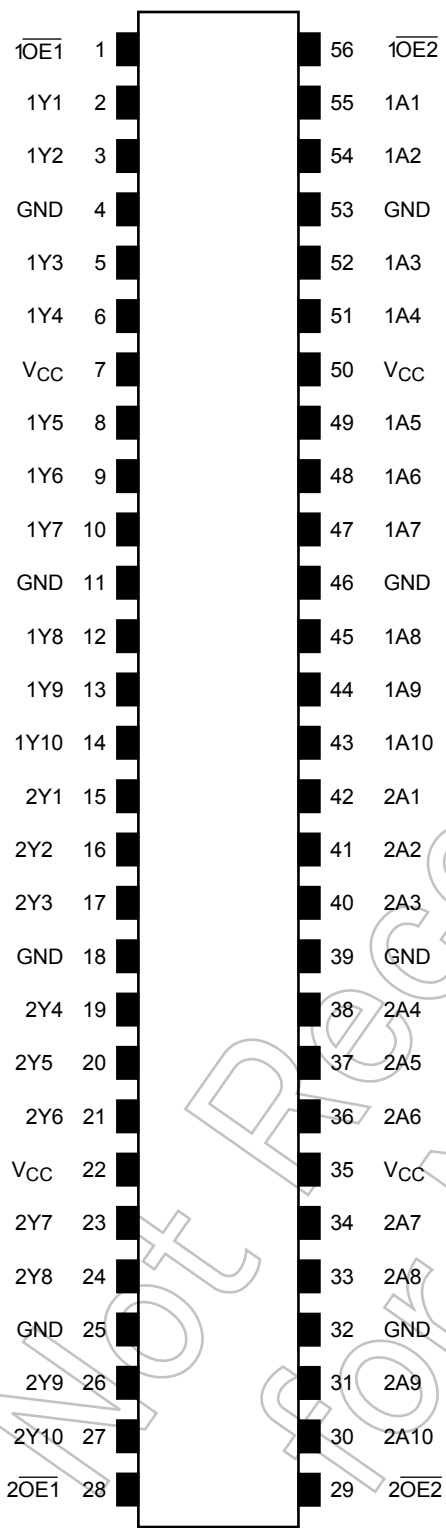
Weight: 0.25 g (typ.)

### Features

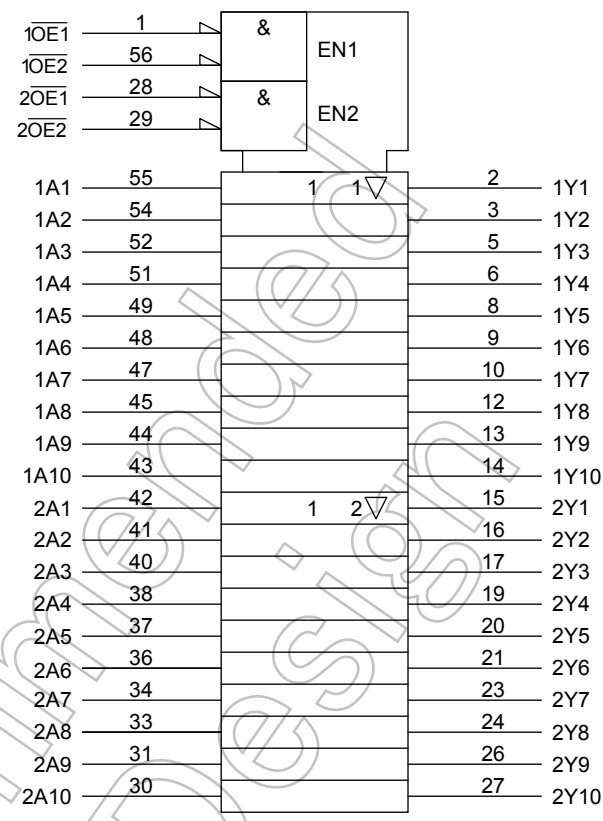
- Low-voltage operation:  $V_{CC} = 1.8$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 2.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
     :  $t_{pd} = 3.0$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)  
     :  $t_{pd} = 6.0$  ns (max) ( $V_{CC} = 1.8$  V)
- Output current:  $I_{OH}/I_{OL} = \pm 24$  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  $\geq \pm 200$  V  
     Human body model  $\geq \pm 2000$  V
- Package: TSSOP
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

Start of commercial production  
1997-11

## Pin Assignment (top view)



## IEC Logic Symbol



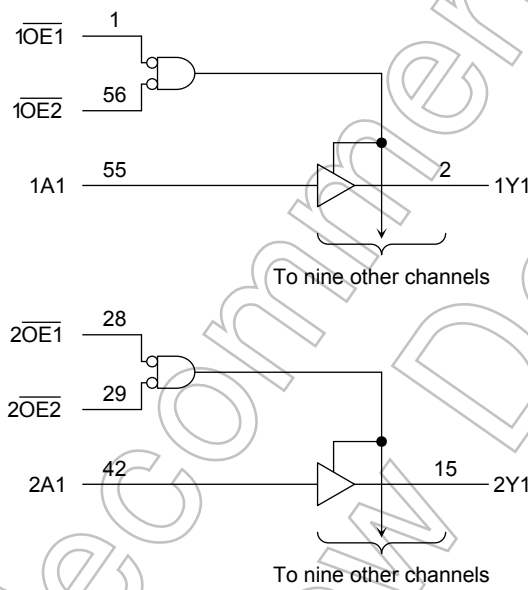
**Truth Table (each 10-bit latch)**

Input			Output Y
$\overline{OE1}$	$\overline{OE2}$	A	
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

X: Don't care

Z: High impedance

**System Diagram**



## Absolute Maximum Ratings (Note 1)

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 1: 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 2: OFF state

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

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

## Operating Ranges (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	1.8 to 3.6	V
		1.2 to 3.6 (Note 2)	
Input voltage	$V_{IN}$	-0.3 to 3.6	V
Output voltage	$V_{OUT}$	0 to 3.6 (Note 3)	V
		0 to $V_{CC}$ (Note 4)	
Output current	$I_{OH}/I_{OL}$	±24 (Note 5)	mA
		±18 (Note 6)	
		±6 (Note 7)	
Operating temperature	$T_{opr}$	-40 to 85	°C
Input rise and fall time	$dt/dv$	0 to 10 (Note 8)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either  $V_{CC}$  or GND.

Note 2: Data retention only

Note 3: OFF state

Note 4: High or low state

Note 5:  $V_{CC} = 3.0$  to 3.6 V

Note 6:  $V_{CC} = 2.3$  to 2.7 V

Note 7:  $V_{CC} = 1.8$  V

Note 8:  $V_{IN} = 0.8$  to 2.0 V,  $V_{CC} = 3.0$  V

**Electrical Characteristics**

**DC Characteristics (Ta = -40 to 85°C, 2.7 V < VCC ≤ 3.6 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.7 to 3.6	2.0	—	V
	L-level	V <sub>IL</sub>	—		2.7 to 3.6	—	0.8	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7 to 3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -12 mA	2.7	2.2	—	
				I <sub>OH</sub> = -18 mA	3.0	2.4	—	
				I <sub>OH</sub> = -24 mA	3.0	2.2	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.7 to 3.6	—	0.2	
				I <sub>OL</sub> = 12 mA	2.7	—	0.4	
				I <sub>OL</sub> = 18 mA	3.0	—	0.4	
				I <sub>OL</sub> = 24 mA	3.0	—	0.55	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.7 to 3.6	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7 to 3.6	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7 to 3.6	—	±20.0	
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V (per input)		2.7 to 3.6	—	750	

**DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ VCC ≤ 2.7 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.3 to 2.7	1.6	—	V
	L-level	V <sub>IL</sub>	—		2.3 to 2.7	—	0.7	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3 to 2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.3	2.0	—	
				I <sub>OH</sub> = -12 mA	2.3	1.8	—	
				I <sub>OH</sub> = -18 mA	2.3	1.7	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.3 to 2.7	—	0.2	
				I <sub>OL</sub> = 12 mA	2.3	—	0.4	
				I <sub>OL</sub> = 18 mA	2.3	—	0.6	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.3 to 2.7	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3 to 2.7	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3 to 2.7	—	±20.0	

**DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ VCC < 2.3 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		1.8 to 2.3	0.7 × V <sub>CC</sub>	—	V
	L-level	V <sub>IL</sub>	—		1.8 to 2.3	—	0.2 × V <sub>CC</sub>	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	1.8	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	1.8	1.4	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	
				I <sub>OL</sub> = 6 mA	1.8	—	0.3	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		1.8	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		1.8	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		1.8	—	±20.0	

**AC Characteristics (Ta = -40 to 85°C, input: t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω) (Note 1)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2			1.8	1.5	6.0	ns
					2.5 ± 0.2	1.0	3.0	
					3.3 ± 0.3	0.8	2.5	
3-state output enable time	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3			1.8	1.5	9.8	ns
					2.5 ± 0.2	1.0	4.9	
					3.3 ± 0.3	0.8	3.8	
3-state output disable time	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3			1.8	1.5	7.6	ns
					2.5 ± 0.2	1.0	4.2	
					3.3 ± 0.3	0.8	3.7	
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note 2)			1.8	—	0.5	ns
					2.5 ± 0.2	—	0.5	
					3.3 ± 0.3	—	0.5	

Note 1: For C<sub>L</sub> = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 2: Parameter guaranteed by design.

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

## Dynamic Switching Characteristics

( $T_a = 25^\circ\text{C}$ , input:  $t_r = t_f = 2.0 \text{ ns}$ ,  $C_L = 30 \text{ pF}$ ,  $R_L = 500 \Omega$ )

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

Note: Parameter guaranteed by design.

## Capacitive Characteristics ( $T_a = 25^\circ\text{C}$ )

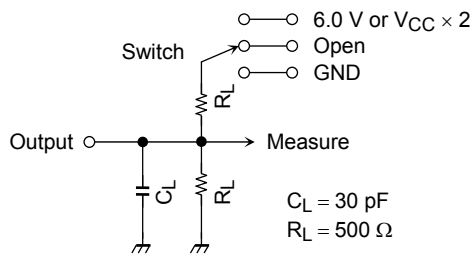
Characteristics	Symbol	Test Condition		Typ.	Unit	
			$V_{CC} \text{ (V)}$			
Input capacitance	$C_{IN}$	—		1.8, 2.5, 3.3	6	pF
Output capacitance	$C_{OUT}$	—		1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	$C_{PD}$	$f_{IN} = 10 \text{ MHz}$	(Note)	1.8, 2.5, 3.3	20	pF

Note:  $C_{PD}$  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:

$$I_{CC \text{ (opr)}} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/20 \text{ (per bit)}$$

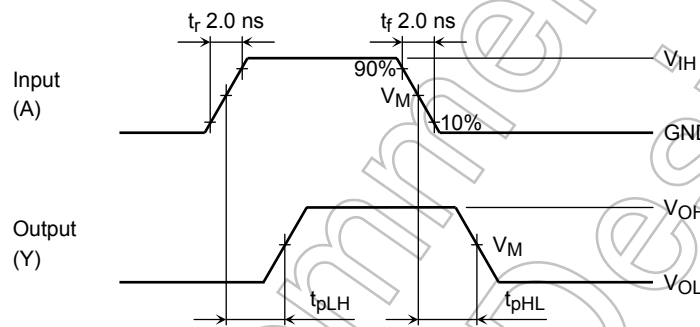
**AC Test Circuit**



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

**Figure 1**

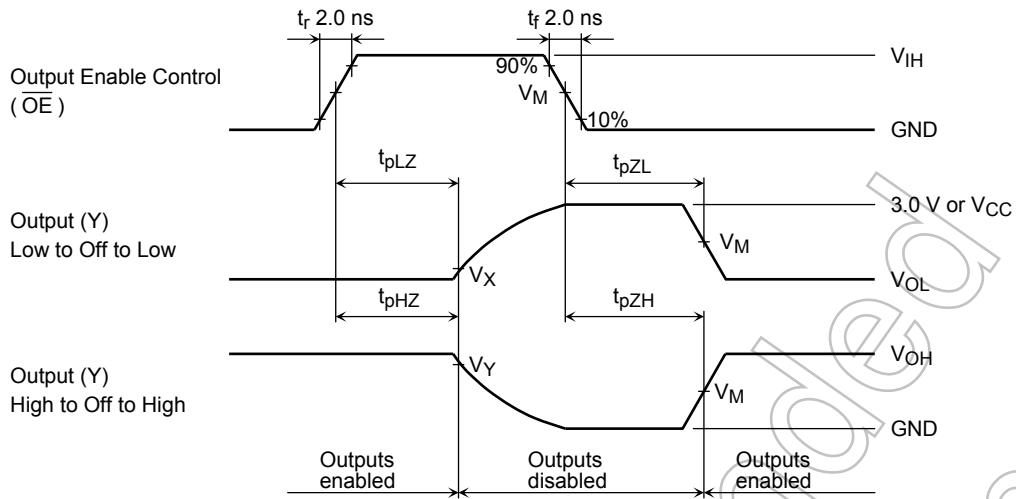
**AC Waveform**



**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**

Not Recommended for New Design





**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

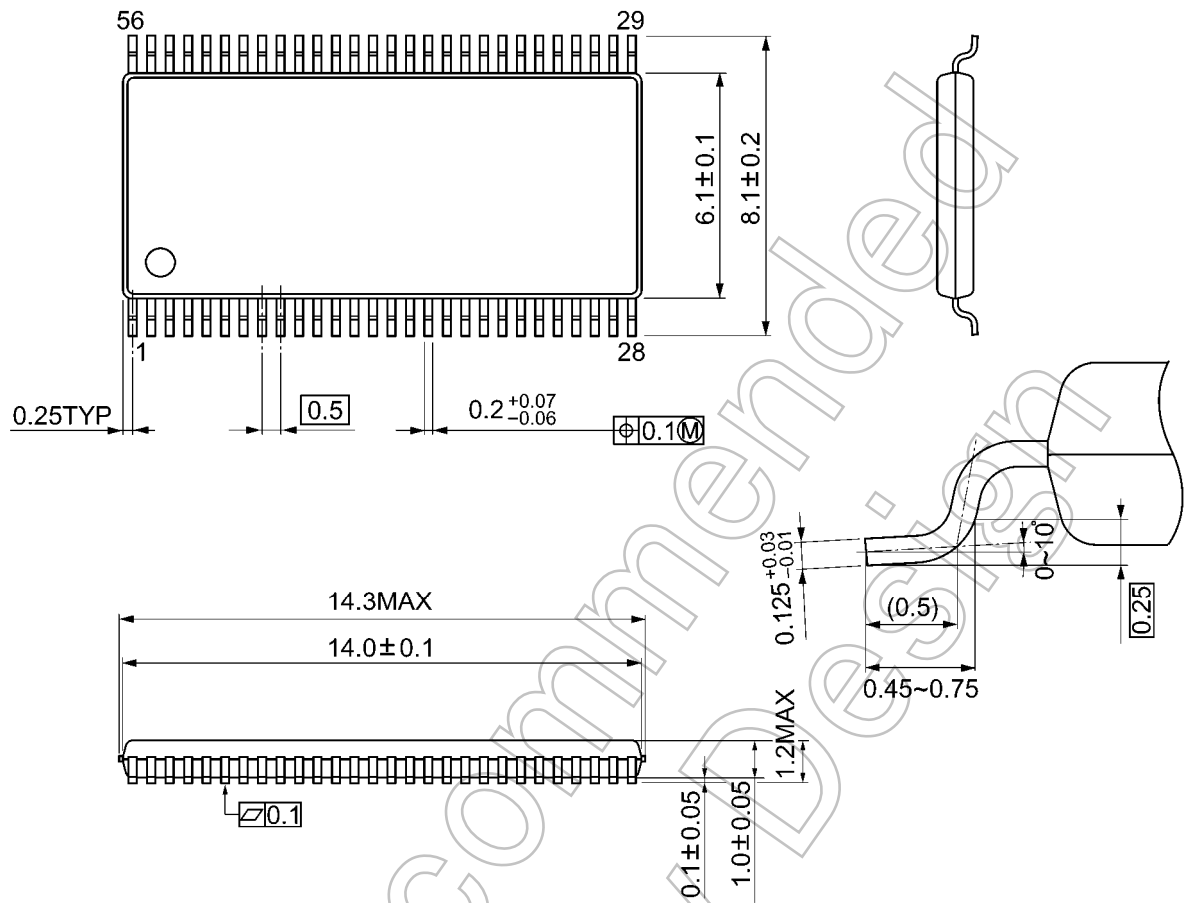
Symbol	$V_{CC}$		
	$3.3 \pm 0.3$ V	$2.5 \pm 0.2$ V	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V
$V_Y$	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V

Not Recommended for New Design

**Package Dimensions**

TSSOP56-P-0061-0.50A

Unit: mm



Weight: 0.25 g (typ.)

Not Recommended for New Design

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