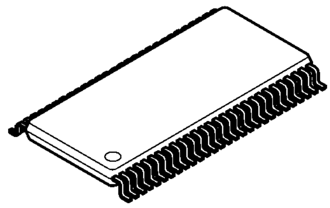
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCX162821FT

Low-Voltage 20-Bit D-Type Flip-Flop with 3.6-V Tolerant Inputs and Outputs


TSSOP56-P-0061-0.50A

Weight: 0.25 g (typ.)

The TC74VCX162821FT is a high-performance CMOS 20-bit D-type flip-flop. 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 device is byte controlled with each byte functioning identically, but independent of the other. Control pins can be shorted together to obtain full 20-bit operation. The following description applies to each byte. The twenty flip-flops will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CK) transition. When the $\overline{OE}$ 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.

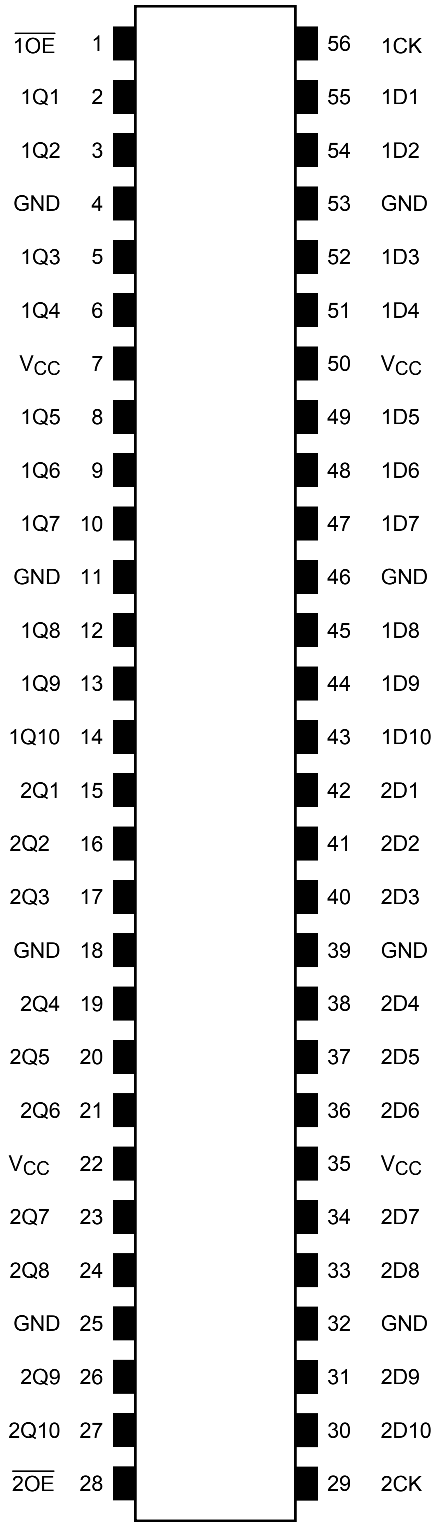
The 26-Ω series resistor helps reducing output overshoot and undershoot without external resistor.

All inputs are equipped with protection circuits against static discharge.

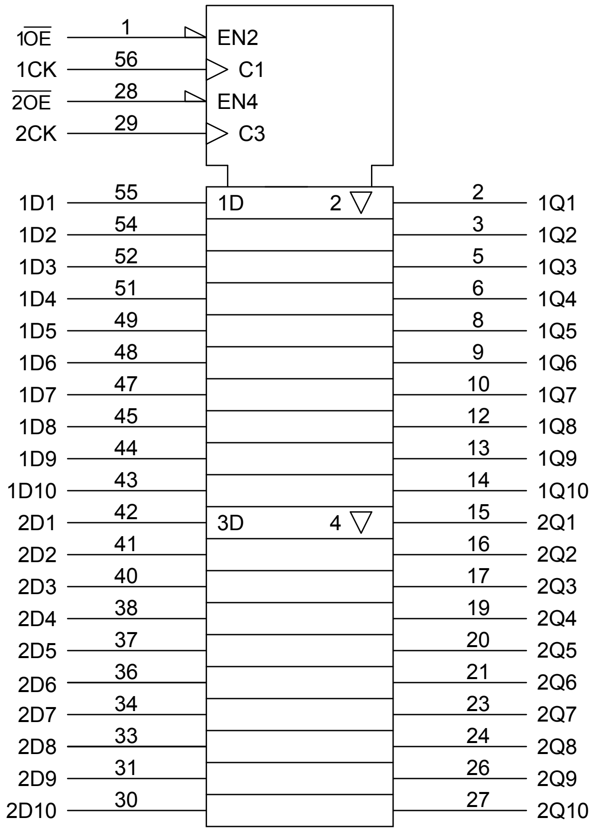
Features

- 26-Ω series resistors on outputs.
- Low-voltage operation: V_{CC} = 1.8 to 3.6 V
- High-speed operation: t_{pd} = 4.4 ns (max) (V_{CC} = 3.0 to 3.6 V)
  : t_{pd} = 5.8 ns (max) (V_{CC} = 2.3 to 2.7 V)
  : t_{pd} = 9.8 ns (max) (V_{CC} = 1.8 V)
- 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
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

Inputs			Outputs
$1\overline{OE}$	1CK	1D1-1D10	1Q1-1Q10
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

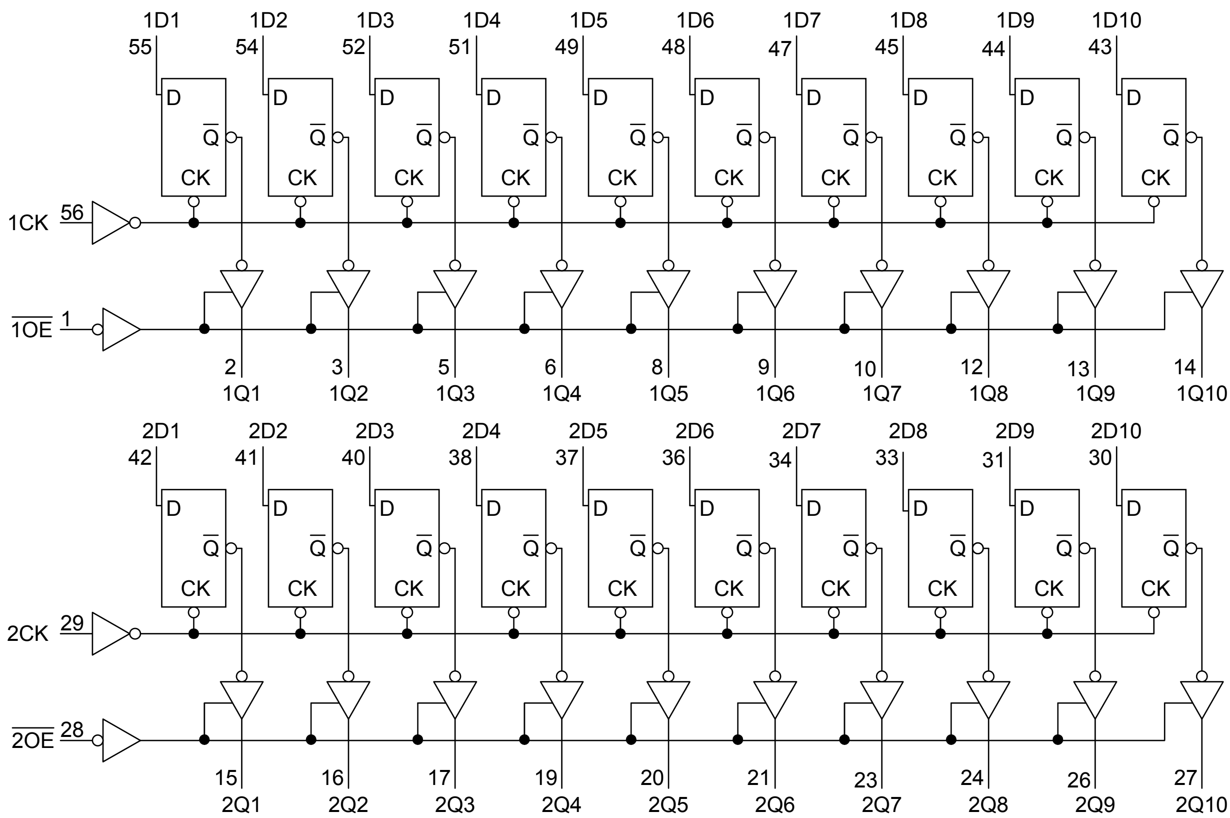
Inputs			Outputs
$2\overline{OE}$	2CK	2D1-2D10	2Q1-2Q10
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

X: Don't care

Z: High impedance

Qn: No change

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}	±12 (Note 5)	mA
		±8 (Note 6)	
		±4 (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 VCC 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 < 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	—	0.55	
				I_{OL} = 12 mA	3.0	—	0.8	
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 I_{CC} per input		ΔI_{CC}	$V_{IH} = V_{CC}$ – 0.6 V		2.7 to 3.6	—	750	

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		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 (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		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, $R_L = 500\ \Omega$) (Note 1)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Maximum clock frequency	f_{max}	Figure 1, Figure 2	1.8	100	—	MHz
			2.5 ± 0.2	200	—	
			3.3 ± 0.3	250	—	
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	5.8	
			3.3 ± 0.3	0.6	4.4	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	5.7	
			3.3 ± 0.3	0.6	4.2	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	1.8	1.5	8.8	ns
			2.5 ± 0.2	0.8	4.9	
			3.3 ± 0.3	0.6	4.2	
Minimum pulse width (CK)	$t_{W (H)}$ $t_{W (L)}$	Figure 1, Figure 2	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 2	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 2	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 2)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

Note 1: For $C_L = 50$ 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
(Ta = 25°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500\ \Omega$)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	0.15	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	0.25	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	0.35	
Quiet output minimum dynamic V_{OL}	V_{OLV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	−0.15	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	−0.25	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	−0.35	
Quiet output minimum dynamic V_{OH}	V_{OHV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	1.55	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	2.05	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	2.65	

Note: Parameter guaranteed by design.

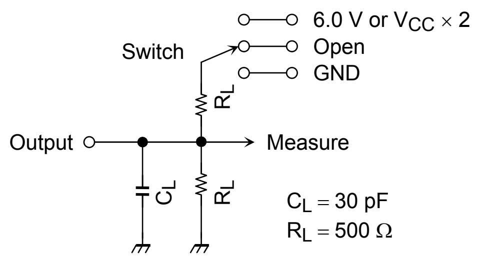
Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C_{IN}	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C_O	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C_{PD}	$f_{IN} = 10$ 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:

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

AC Test Circuit



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

Figure 1

AC Waveform

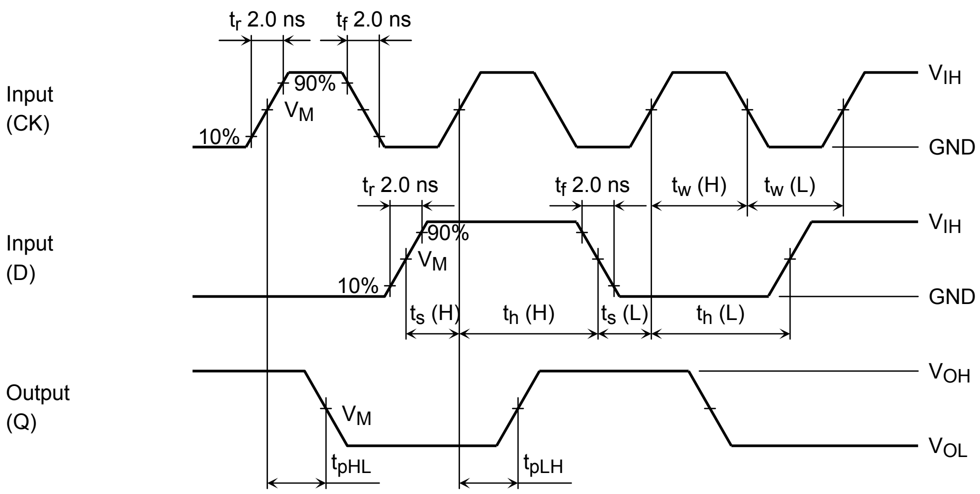


Figure 2 t_{pLH}, t_{pHL}, t_w, t_s, t_h

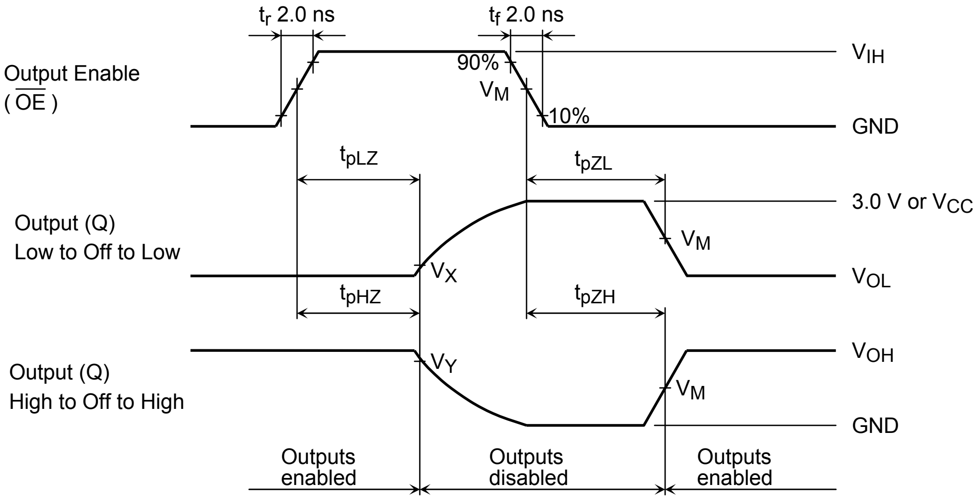
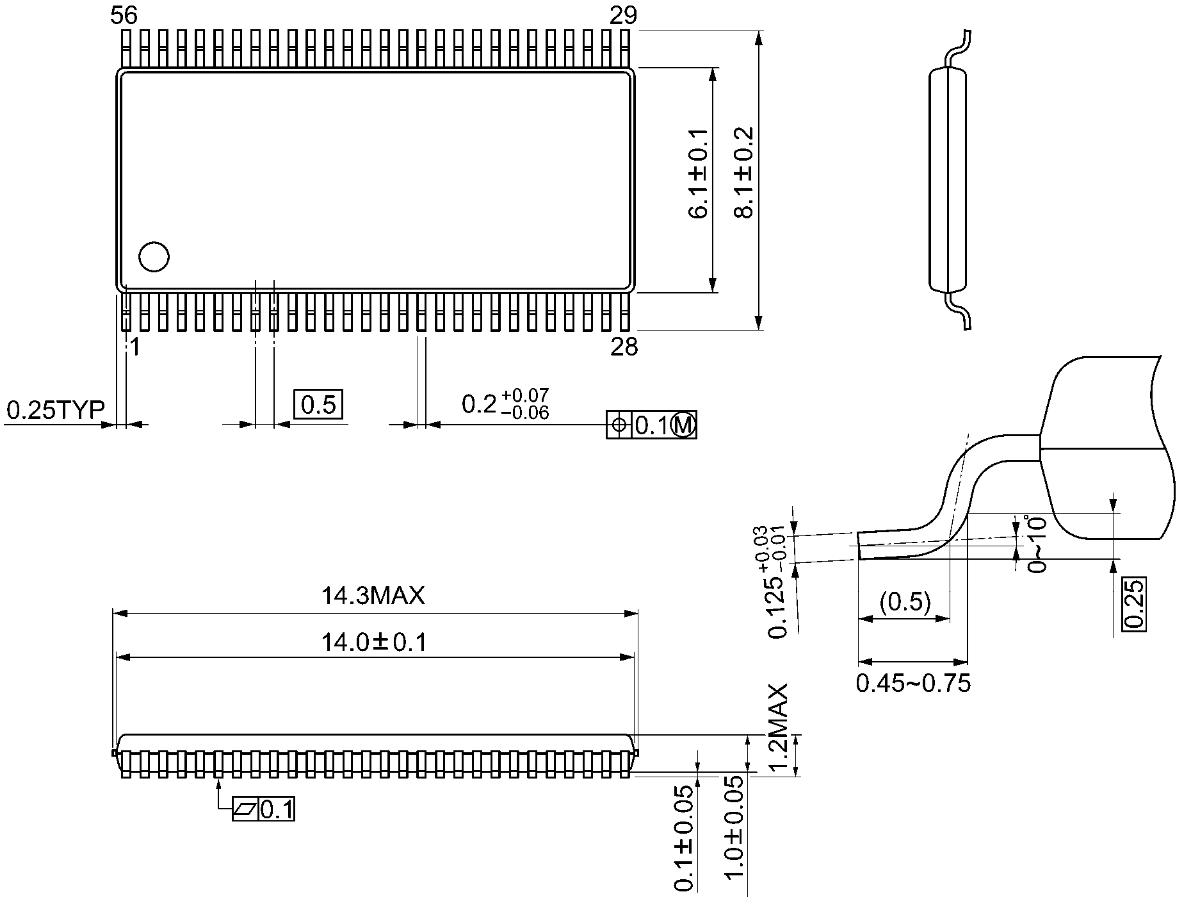


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

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-0061-0.50A Unit: mm



Weight: 0.25 g (typ.)

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