

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MA244FK

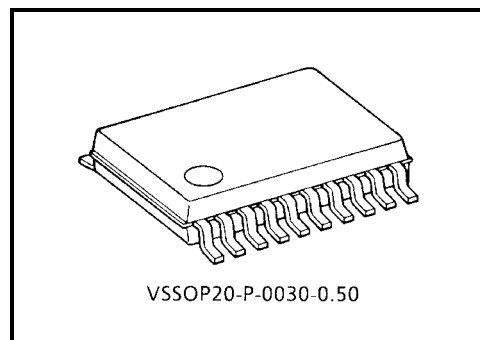
Low-Voltage Octal Bus Buffer with 3.6 V Tolerant Inputs and Outputs

The TC7MA244FK is a high performance CMOS octal bus buffer which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5V, 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 over voltage tolerant inputs and outputs up to 3.6 V.

This device is non-inverting 3-state buffer having four active-low output enables. 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.

All inputs are equipped with protection circuits against static discharge.

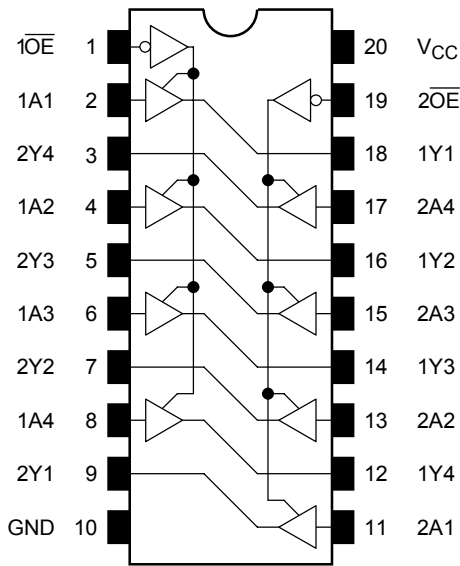


Weight: 0.03 g (typ.)

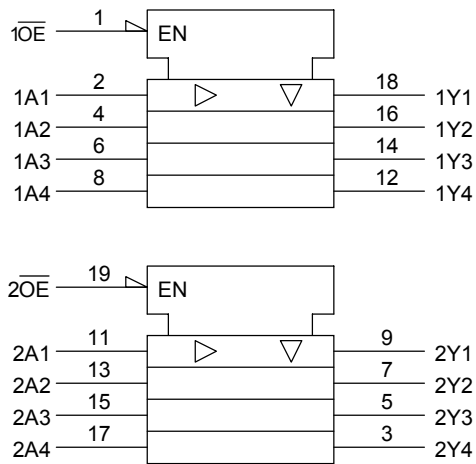
Features

- Low voltage operation: $V_{CC} = 1.2\sim 3.6\text{ V}$
- High speed operation: $t_{pd} = 3.5\text{ ns (max)}$ ($V_{CC} = 3.0\sim 3.6\text{ V}$)
 $t_{pd} = 4.2\text{ ns (max)}$ ($V_{CC} = 2.3\sim 2.7\text{ V}$)
 $t_{pd} = 8.4\text{ ns (max)}$ ($V_{CC} = 1.65\sim 1.95\text{ V}$)
 $t_{pd} = 16.8\text{ ns (max)}$ ($V_{CC} = 1.4\sim 1.6\text{ V}$)
 $t_{pd} = 42.0\text{ ns (max)}$ ($V_{CC} = 1.2\text{ V}$)
- 3.6 V tolerant inputs and outputs.
- Output current: $I_{OH}/I_{OL} = \pm 24\text{ mA (min)}$ ($V_{CC} = 3.0\text{ V}$)
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min)}$ ($V_{CC} = 2.3\text{ V}$)
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min)}$ ($V_{CC} = 1.65\text{ V}$)
 $I_{OH}/I_{OL} = \pm 2\text{ mA (min)}$ ($V_{CC} = 1.4\text{ V}$)
- Latch-up performance: $\pm 300\text{ mA}$
- ESD performance: Machine model $> \pm 200\text{ V}$
Human body model $> \pm 2000\text{ V}$
- Package: VSSOP (US20)
- Power down protection is provided on all inputs and outputs.

Pin Assignment (top view)



IEC Logic Level



Truth Table

Inputs		Outputs
OE	A _n	
L	L	L
L	H	H
H	X	Z

X: Don't care

Z: High impedance

Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	V _{CC}	-0.5~4.6	V
DC input voltage	V _{IN}	-0.5~4.6	V
DC output voltage	V _{OUT}	-0.5~4.6 (Note1)	V
		-0.5~V _{CC} + 0.5 (Note2)	
Input diode current	I _{IK}	-50	mA
Output diode current	I _{OK}	±50 (Note3)	mA
DC output current	I _{OUT}	±50	mA
Power dissipation	P _D	180	mW
DC V _{CC} /ground current	I _{CC} /I _{GND}	±100	mA
Storage temperature	T _{stg}	-65~150	°C

Note1: V_{CC} = 0 V

Note2: High or low state. I_{OUT} absolute maximum rating must be observed.

Note3: V_{OUT} < GND, V_{OUT} > V_{CC}

Recommended Operating Range

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	1.2~3.6	V
Input voltage	V_{IN}	-0.3~3.6	V
Output voltage	V_{OUT}	0~3.6 (Note4)	V
		0~ V_{CC} (Note5)	
Output current	I_{OH}/I_{OL}	± 24 (Note6)	mA
		± 18 (Note7)	
		± 6 (Note8)	
		± 2 (Note9)	
Operating temperature	T_{opr}	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note10)	ns/V

Note4: Off-state

Note5: High or low state

Note6: $V_{CC} = 3.0\sim 3.6$ V

Note7: $V_{CC} = 2.3\sim 2.7$ V

Note8: $V_{CC} = 1.65\sim 1.95$ V

Note9: $V_{CC} = 1.4\sim 1.6$ V

Note10: $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

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

Characteristics		Symbol	Test Condition			Min	Max	Unit
					V _{CC} (V)			
Input voltage	High level	V _{IH}	—		2.7~3.6	2.0	—	V
	Low level	V _{IL}	—		2.7~3.6	—	0.8	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.7~3.6	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	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.7~3.6	—	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} = 0~3.6 V		2.7~3.6	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		2.7~3.6	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.7~3.6	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.7~3.6	—	±20.0	
		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V (per input)		2.7~3.6	—	750	

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

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		2.3~2.7	1.6	—	V
	Low level	V _{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	2.3~2.7	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	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3~2.7	—	0.2	
				I _{OL} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
Input leakage current			V _{IN} = 0~3.6 V		2.3~2.7	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		2.3~2.7	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3~2.7	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.3~2.7	—	±20.0	

DC Characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $1.65 \text{ V} \leq V_{CC} < 2.3 \text{ V}$)

Characteristics		Symbol	Test Condition			Min	Max	Unit	
			V _{CC} (V)						
Input voltage	High level	V _{IH}	—			1.65~2.3	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—			1.65~2.3	—	0.2 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.65~2.3	V _{CC} - 0.2	—	V	
				I _{OH} = -6 mA	1.65	1.25	—		
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.65~2.3	—	0.2		
				I _{OL} = 6 mA	1.65	—	0.3		
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V			1.65~2.3	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V			1.65~2.3	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V			0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND			1.65~2.3	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V			1.65~2.3	—	±20.0	

DC Characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $1.4 \text{ V} \leq V_{CC} < 1.65 \text{ V}$)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.4~1.65	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.4~1.65	—	0.05 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	1.4~1.65	V _{CC} − 0.1	—	V
				I _{OH} = −2 mA	1.4	1.05	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.4~1.65	—	0.05	
				I _{OL} = 2 mA	1.4	—	0.35	
Input leakage current			V _{IN} = 0~3.6 V		1.4~1.65	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		1.4~1.65	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.4~1.65	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.4~1.65	—	±20.0	

DC Characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $1.2 \text{ V} \leq V_{CC} < 1.4 \text{ V}$)

Characteristics		Symbol	Test Condition		$V_{CC} \text{ (V)}$	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.2~1.4	$0.8 \times V_{CC}$	—	V
	Low level	V_{IL}	—		1.2~1.4	—	$0.05 \times V_{CC}$	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -100 \mu\text{A}$	1.2	$V_{CC} - 0.1$	—	V
	Low level	V_{OL}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 100 \mu\text{A}$	1.2	—	0.05	
Input leakage current		I_{IN}	$V_{IN} = 0 \sim 3.6 \text{ V}$		1.2	—	± 5.0	μA
3-state output off-state current		I_{OZ}	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = 0 \sim 3.6 \text{ V}$		1.2	—	± 10.0	μA
Power off leakage current		I_{OFF}	$V_{IN}, V_{OUT} = 0 \sim 3.6 \text{ V}$		0	—	10.0	μA
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC} \text{ or GND}$		1.2	—	20.0	μA
			$V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6 \text{ V}$		1.2	—	± 20.0	

AC Characteristics (Ta = -40~85°C, Input: $t_r = t_f = 2.0$ ns)

Characteristics	Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	$C_L = 15$ pF, $R_L = 2$ k Ω	1.2	3.0	42.0	ns
				1.5 ± 0.1	2.0	16.8	
			$C_L = 30$ pF, $R_L = 500$ Ω	1.8 ± 0.15	1.5	8.4	
				2.5 ± 0.2	0.8	4.2	
				3.3 ± 0.3	0.6	3.5	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	$C_L = 15$ pF, $R_L = 2$ k Ω	1.2	3.0	49.0	ns
				1.5 ± 0.1	2.0	19.6	
			$C_L = 30$ pF, $R_L = 500$ Ω	1.8 ± 0.15	1.5	9.8	
				2.5 ± 0.2	0.8	5.5	
				3.3 ± 0.3	0.6	4.5	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	$C_L = 15$ pF, $R_L = 2$ k Ω	1.2	3.0	29.0	ns
				1.5 ± 0.1	2.0	11.6	
			$C_L = 30$ pF, $R_L = 500$ Ω	1.8 ± 0.15	1.5	5.8	
				2.5 ± 0.2	0.8	3.2	
				3.3 ± 0.3	0.6	3.0	
Output to output skew	t_{osLH} t_{osHL}	(Note11)	$C_L = 15$ pF, $R_L = 2$ k Ω	1.2	—	1.5	ns
				1.5 ± 0.1	—	1.5	
			$C_L = 30$ pF, $R_L = 500$ Ω	1.8 ± 0.15	—	0.5	
				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.

Note11: This parameter is 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)

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 (Note12)	1.8	0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	0.8	
Quiet output minimum dynamic V _{OL}	V _{OLV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note12)	1.8	−0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	−0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	−0.8	
Quiet output minimum dynamic V _{OH}	V _{OHV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note12)	1.8	1.5	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	1.9	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	2.2	

Note12: This parameter is 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 _O	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note13)	1.8, 2.5, 3.3	20	pF

Note13: 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:

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per bit)}$$

AC Test Circuit

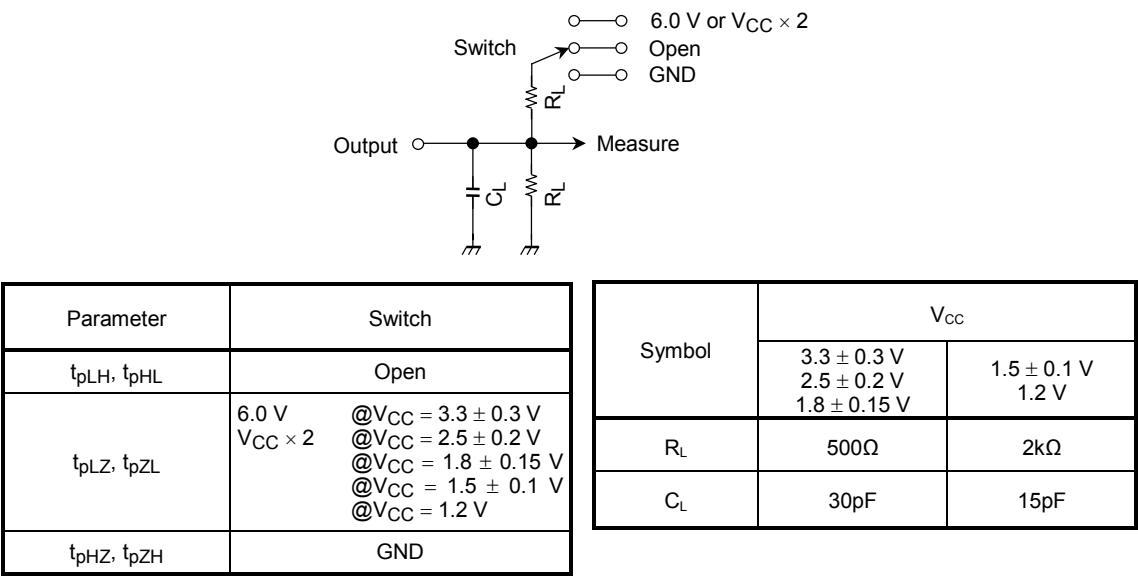


Figure 1

AC Waveform

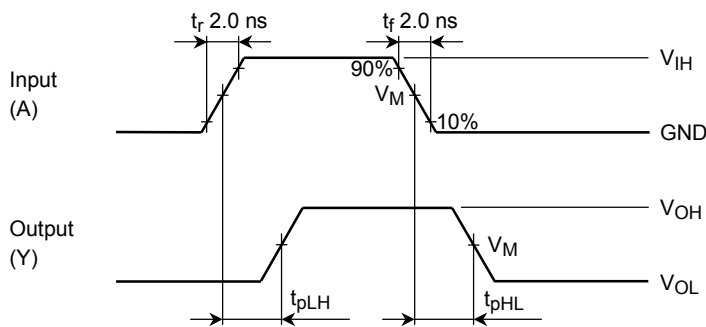


Figure 2 t_{pLH} , t_{pHL}

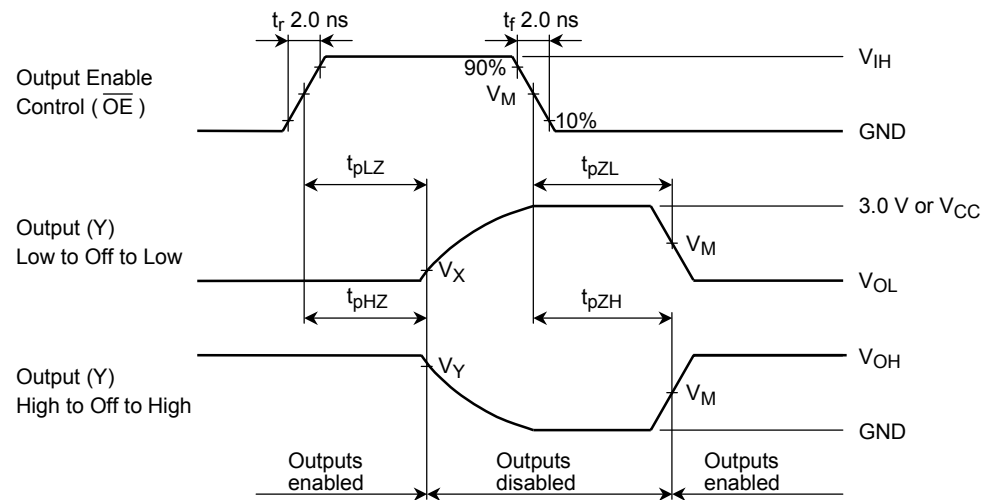


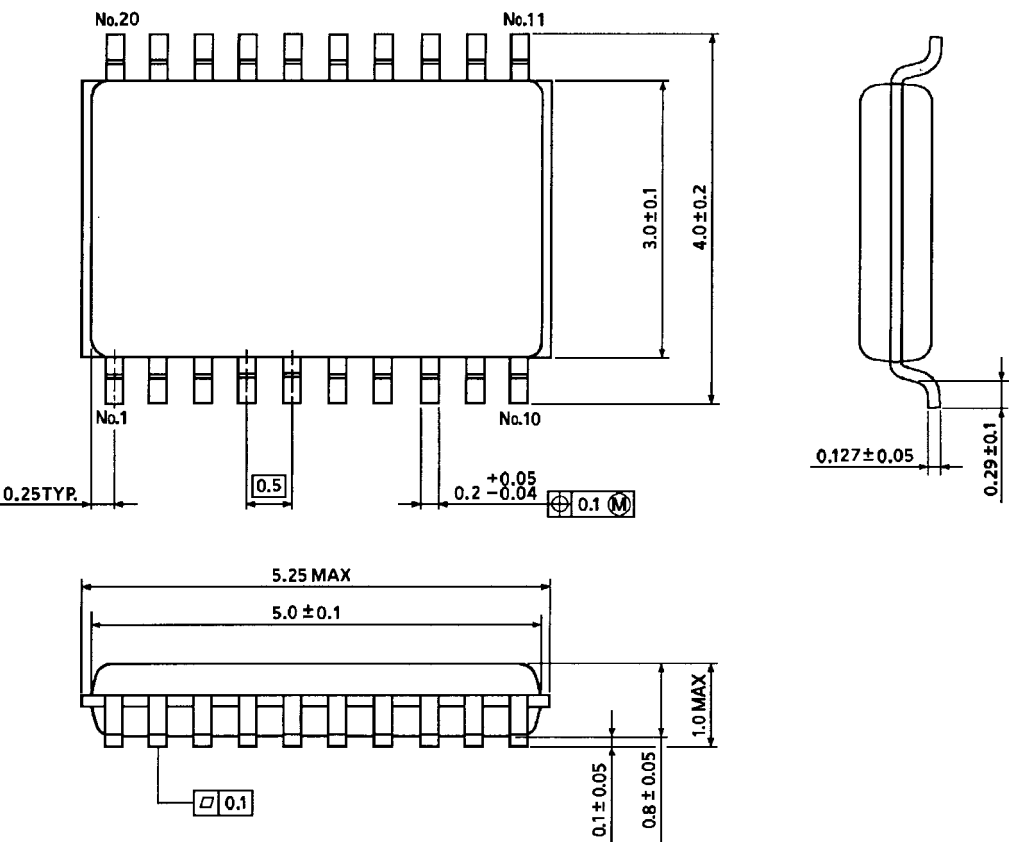
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

Symbol	V_{CC}				
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \pm 0.15 \text{ V}$	$1.5 \pm 0.1 \text{ V}$	1.2 V
V_{IH}	2.7 V	V_{CC}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.1 \text{ V}$	$V_{OL} + 0.1 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.1 \text{ V}$	$V_{OH} - 0.1 \text{ V}$

Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

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