

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

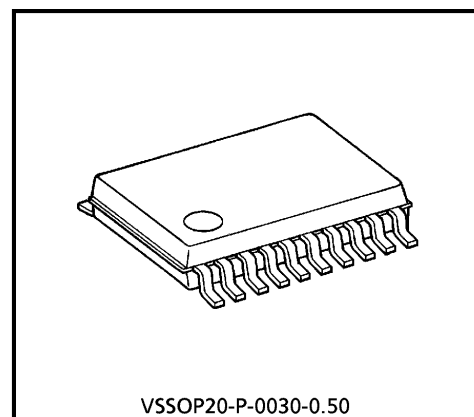
TC7MA541FK

LOW-VOLTAGE OCTAL BUS BUFFER WITH 3.6 V TOLERANT INPUTS AND OUTPUTS

The TC7MA541FK is a high performance CMOS OCTAL BUS BUFFER. Designed for use in 1.8, 2.5 or 3.3 Volt 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 a non-inverting 3-state buffer having two active-low output enables. When either $\overline{OE}1$ or $\overline{OE}2$ are high, the terminal outputs are in the 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.



VSSOP20-P-0030-0.50

Weight : 0.03 g (typ.)

Features

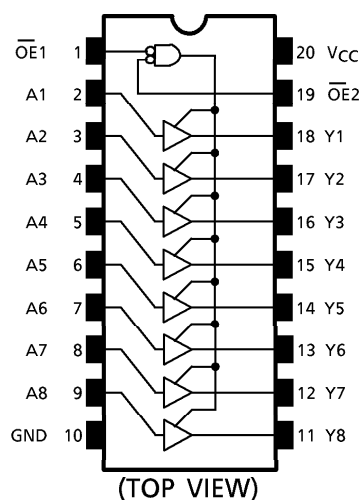
- Low Voltage Operation : $V_{CC} = 1.8 \sim 3.6 \text{ V}$
- High Speed Operation : $t_{pd} = 3.5 \text{ ns (max) at } V_{CC} = 3.0 \sim 3.6 \text{ V}$
 $t_{pd} = 4.2 \text{ ns (max) at } V_{CC} = 2.3 \sim 2.7 \text{ V}$
 $t_{pd} = 8.4 \text{ ns (max) at } V_{CC} = 1.8 \text{ V}$
- 3.6 V Tolerant inputs and output.
- Output Current : $I_{OH}/I_{OL} = \pm 24 \text{ mA (min) at } V_{CC} = 3.0 \text{ V}$
 $I_{OH}/I_{OL} = \pm 18 \text{ mA (min) at } V_{CC} = 2.3 \text{ V}$
 $I_{OH}/I_{OL} = \pm 6 \text{ mA (min) at } V_{CC} = 1.8 \text{ V}$
- Latch-up Performance : $\pm 300 \text{ mA}$
- ESD Performance : Human Body Model $> \pm 2000 \text{ V}$
Machine Model $> \pm 200 \text{ V}$
- Package : VSSOP (US20)
- Power Down Protection is provided on all inputs and outputs.
- Supports live insertion / withdrawal (Note 1)

(Note 1): To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

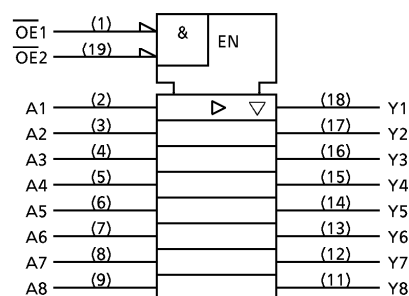
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Pin Assignment



IEC Logic Symbol



Truth Table

INPUTS			OUTPUTS
OE1	OE2	An	
H	X	X	Z
X	H	X	Z
L	L	H	H
L	L	L	L

X : Don't Care

Z : High Impedance

Maximum Ratings

PARAMETER	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 (Note 1)	V
		-0.5~ V_{CC} + 0.5 (Note 2)	
Input Diode Current	I_{IK}	-50	mA
Output Diode Current	I_{OK}	±50 (Note 3)	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

(Note 1): Off-State

(Note 2): High or Low State. I_{OUT} absolute maximum rating must be observed.(Note 3): $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Range

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	1.8~3.6	V
		1.2~3.6 (Note 4)	
Input Voltage	V_{IN}	-0.3~3.6	V
Output Voltage	V_{OUT}	0~3.6 (Note 5)	V
		0~ V_{CC} (Note 6)	
Output Current	I_{OH}/I_{OL}	± 24 (Note 7)	mA
		± 18 (Note 8)	
		± 6 (Note 9)	
Operating Temperature	T_{opr}	-40~85	°C
Input Rise And Fall Time	dt/dv	0~10 (Note 10)	ns/V

(Note 4): Data Retention Only

(Note 5): Off-State

(Note 6): High or Low State

(Note 7): $V_{CC} = 3.0\sim 3.6$ V(Note 8): $V_{CC} = 2.3\sim 2.7$ V(Note 9): $V_{CC} = 1.8$ V(Note 10): $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

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

PARAMETER		SYMBOL	TEST CONDITION		V _{CC} (V)	Min	Max	UNIT
Input Voltage	"H" Level	V _{IH}			2.7~3.6	2.0	—	V
	"L" Level	V _{IL}			2.7~3.6	—	0.8	
Output Voltage	"H" 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	—	
	"L" 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	
Increase In I _{CC} Per Input		ΔI _{CC}	V _{IH} = V _{CC} − 0.6 V		2.7~3.6	—	750	μA

Electrical Characteristics

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

PARAMETER		SYMBOL	TEST CONDITION		Min	Max	UNIT	
			V _{CC} (V)					
Input Voltage	“H” Level	V _{IH}	2.3~2.7		1.6	—	V	
	“L” Level	V _{IL}	2.3~2.7		—	0.7		
Output Voltage	“H” 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		
	“L” 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		I _{IN}	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		

Electrical Characteristics

DC characteristics (Ta = -40~85°C, 1.8 V ≤ V_{CC} < 2.3 V)

PARAMETER		SYMBOL	TEST CONDITION			Min	Max	UNIT	
			V _{CC} (V)						
Input Voltage	“H” Level	V _{IH}	1.8~2.3			0.7 × V _{CC}	—	V	
	“L” Level	V _{IL}	1.8~2.3			—	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} = 0~3.6 V			1.8	—	± 5.0	μA
3-State Output Off-State Current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V			1.8	—	± 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			1.8	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V			1.8	—	± 20.0	

AC characteristics (Ta = -40~85°C, Input t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω)

PARAMETER		SYMBOL	TEST CONDITION		V _{CC} (V)	Min	Max	UNIT
Propagation Delay Time		t _{pLH} t _{pHL}	(Fig.1, 2)		1.8	1.5	8.4	ns
					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}	(Fig.1, 3)		1.8	1.5	9.8	ns
					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}	(Fig.1, 3)		1.8	1.5	6.5	ns
					2.5 ± 0.2	0.8	3.6	
					3.3 ± 0.3	0.6	3.3	
Output To Output Skew		t _{osLH} t _{osHL}	(Note 11)		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 11): 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 $t_r = t_f = 2.0\text{ ns}$, $C_L = 30\text{ pF}$)

PARAMETER	SYMBOL	TEST CONDITION	V_{CC} (V)	Typ.	UNIT
Quiet Output Maximum Dynamic V_{OL}	V_{OLP}	$V_{IH} = 1.8\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	1.8	0.25	V
		$V_{IH} = 2.5\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	2.5	0.6	
		$V_{IH} = 3.3\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	3.3	0.8	
Quiet Output Minimum Dynamic V_{OL}	V_{OLV}	$V_{IH} = 1.8\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	1.8	-0.25	V
		$V_{IH} = 2.5\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	2.5	-0.6	
		$V_{IH} = 3.3\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	3.3	-0.8	
Quiet Output Minimum Dynamic V_{OH}	V_{OHV}	$V_{IH} = 1.8\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	1.8	1.5	V
		$V_{IH} = 2.5\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	2.5	1.9	
		$V_{IH} = 3.3\text{ V}$, $V_{IL} = 0\text{ V}$ (Note 12)	3.3	2.2	

(Note 12): Parameter guaranteed by design.

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

PARAMETER	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}	$f_{IN} = 10\text{ MHz}$ (Note 13)	1.8, 2.5, 3.3	20	pF

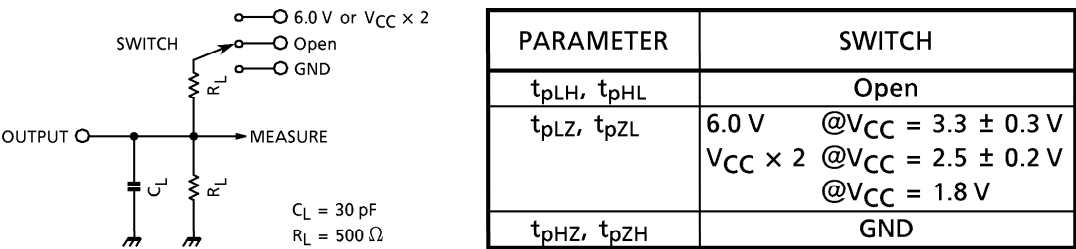
(Note 13): C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

Test Circuit

Fig.1



AC Waveform

Fig.2 t_{pLH}, t_{pHL}

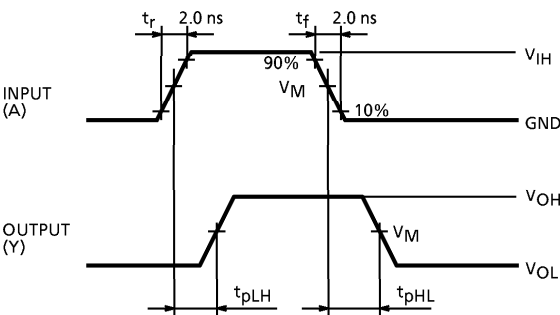
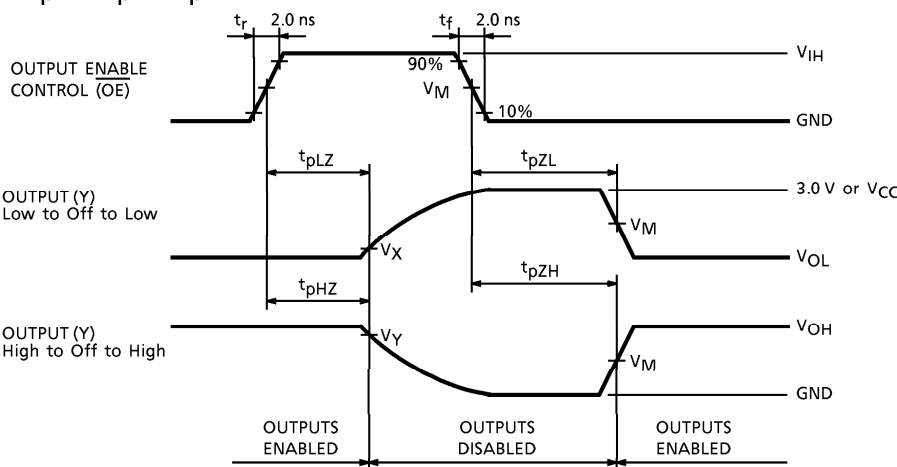


Fig.3 $t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}$

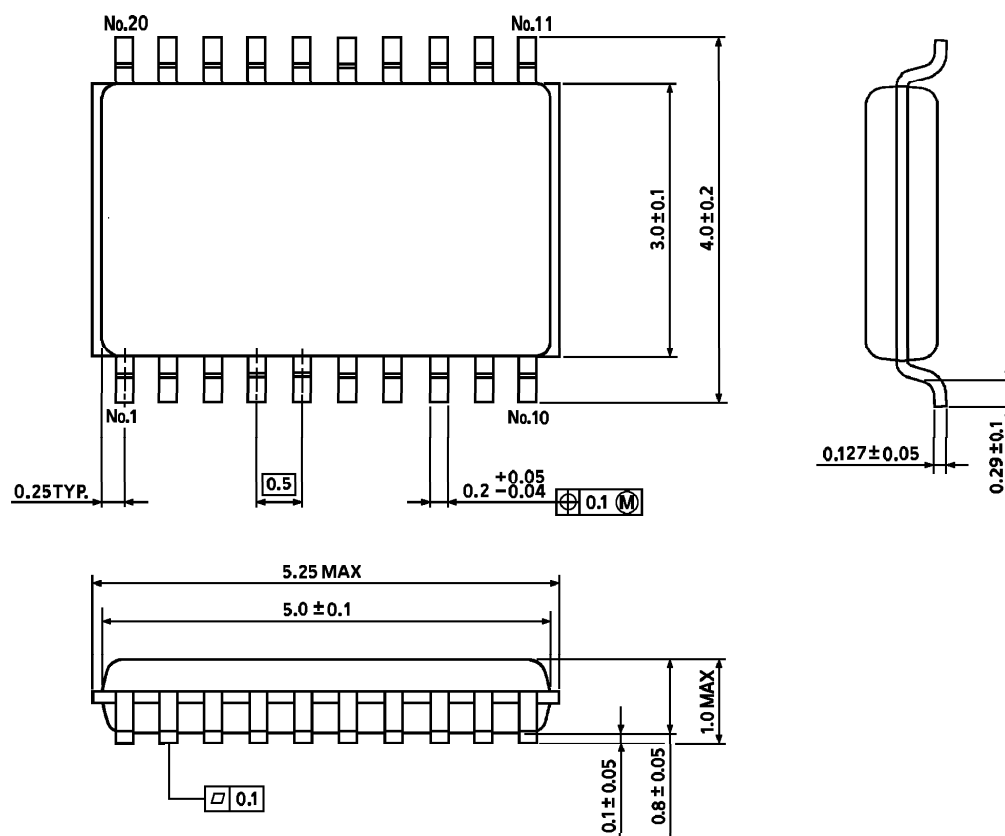


SYMBOL	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC} / 2$	$V_{CC} / 2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

Outline Drawing

VSSOP20-P-0030-0.50

Unit : mm



Weight : 0.03 g (typ.)