

TENTATIVE

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC74VCX04FT

LOW-VOLTAGE HEX INVERTER

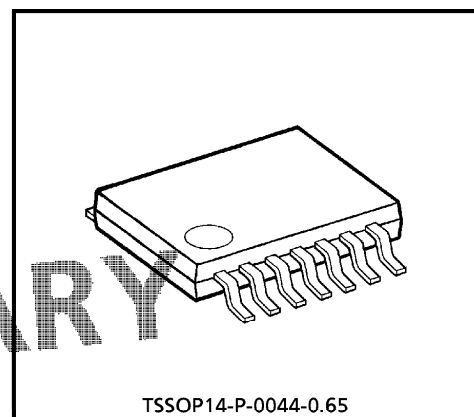
WITH 3.6 V TOLERANT INPUTS AND OUTPUTS

The TC74VCX04FT is a high performance CMOS INVERTER.

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.

All inputs are equipped with protection circuits against static discharge.



Weight : 0.06 g (Typ.)

FEATURES

- Low Voltage Operation: $V_{CC} = 1.8 \sim 3.6 \text{ V}$
- High Speed Operation : $t_{pd} = 2.8 \text{ ns (max) at } V_{CC} = 3.0 \sim 3.6 \text{ V}$
 $t_{pd} = 3.7 \text{ ns (max) at } V_{CC} = 2.3 \sim 2.7 \text{ V}$
 $t_{pd} = 7.4 \text{ ns (max) at } V_{CC} = 1.8 \text{ V}$
- 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 : TSSOP
(Thin Shrink Small Outline Package)
- Power Down Protection is provided on all inputs and outputs.

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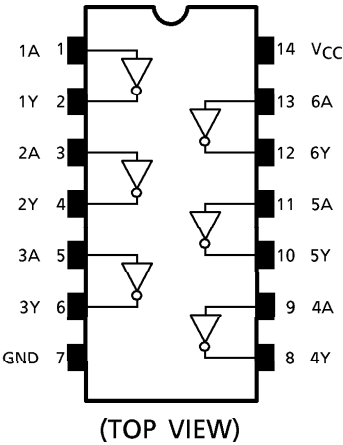
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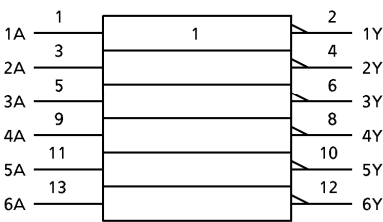
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PIN ASSIGNMENT



IEC LOGIC SYMBOL



TRUTH TABLE

INPUTS	OUTPUTS
A	Y
L	H
H	L

PRELIMINARY

MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	$-0.5 \sim 4.6$	V
DC Input Voltage	V_{IN}	$-0.5 \sim 4.6$	V
DC Output Voltage	V_{OUT}	$-0.5 \sim 4.6$ (Note 1)	V
		$-0.5 \sim V_{CC} + 0.5$ (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}	$-65 \sim 150$	$^{\circ}C$

(Note 1): $V_{CC} = 0\text{ V}$

(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): $V_{CC} = 0\text{ V}$

(Note 6): High or Low State

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

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 _{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}	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	
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} ≤ 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		V _{CC} (V)	MIN	MAX	UNIT
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 _{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}	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
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} ≤ 3.6 V		2.3~2.7	—	± 20.0	

PRELIMINARY

ELECTRICAL CHARACTERISTICSDC characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $1.8\text{ V} \leq V_{CC} < 2.3\text{ V}$)

PARAMETER		SYMBOL	TEST CONDITION		V _{CC} (V)	MIN	MAX	UNIT
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 _{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}	I _{OL} = 100 μA	1.8	—	0.2	
				I _{OL} = 6 mA	1.8	—	0.3	
Input Leakage Current		I _{IIN}	V _{IN} = 0~3.6 V		1.8	—	± 5.0	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} ≤ 3.6 V		1.8	—	± 20.0	

PRELIMINARYAC characteristics ($T_a = -40 \sim 85^\circ\text{C}$, Input $t_r = t_f = 2.0\text{ ns}$, $C_L = 30\text{ pF}$, $R_L = 500\text{ }\Omega$)

PARAMETER		SYMBOL	TEST CONDITION		V_{CC} (V)	MIN	MAX	UNIT
Propagation Delay Time		t_{pLH} t_{pHL}	(Fig.1, 2)		1.8	1.0	7.4	ns
					2.5 ± 0.2	0.8	3.7	
					3.3 ± 0.3	0.6	2.8	
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 $C_L = 50\text{ pF}$, 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 ($T_a = 25^\circ\text{C}$)

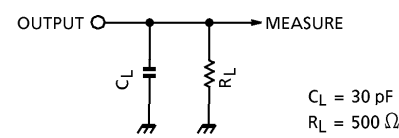
PARAMETER	SYMBOL	TEST CONDITION		TYP.	UNIT
Input Capacitance	C_{IN}	—	1.8, 2.5, 3.3	6	pF
Power Dissipation Capacitance	C_{PD}	$f_{IN} = 10\text{ MHz}$ (Note 13)	1.8, 2.5, 3.3	20	pF

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

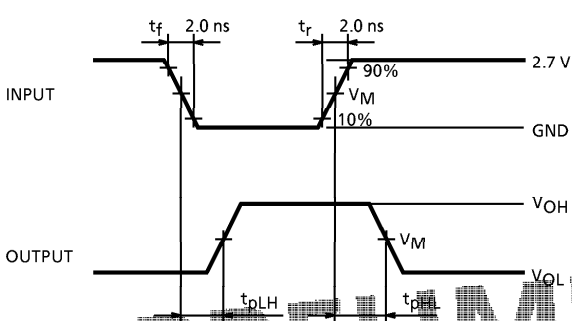
Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per gate)}$$

TEST CIRCUIT
Fig.1



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

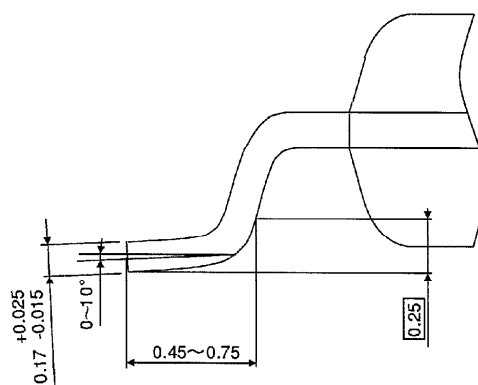
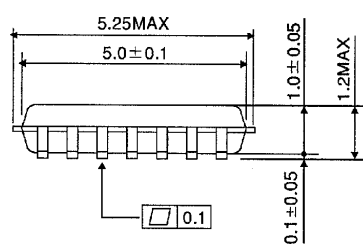
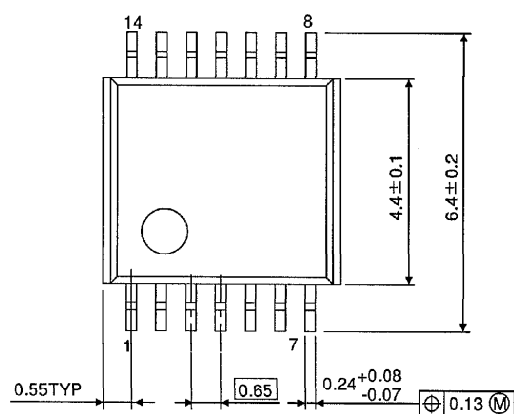


SYMBOL	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 V
V_{IH}	2.7V	V_{CC}	V_{CC}
V_M	1.5V	$V_{CC}/2$	$V_{CC}/2$

OUTLINE DRAWING

TSSOP14-P-0044-0.65

Unit : mm



Weight : 0.06 g (Typ.)