HEX INVERTER

FEATURES

- **Output capability: standard**
- **I_{CC} category: SSI**

GENERAL DESCRIPTION

The 74HCU04 is a high-speed Si-gate CMOS device and is pin compatible with low power Schottky TTL (LSTTL). It is specified in compliance with JEDEC standard no. 7A.

The 74HCU04 is a general purpose hex inverter. Each of the six inverters is a single stage.

FUNCTION TABLE

INPUT	OUTPUT
nA	nY
L H	H L

H = HIGH voltage level
L = LOW voltage level

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
t_{PHL}/ t_{PLH}	propagation delay nA to nY	C_L = 15 pF V_{CC} = 5 V	5	ns
C_I	input capacitance		3.5	pF
C_{PD}	power dissipation capacitance per inverter	note 1	10	pF

GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns

Note

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz
f_o = output frequency in MHz
$\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs
C_L = output load capacitance in pF
V_{CC} = supply voltage in V

ORDERING INFORMATION/PACKAGE OUTLINES

PC74HCU04P: 14-lead DIL; plastic (SOT-27).
PC74HCU04T: 14-lead mini-pack; plastic (SO-14; SOT-108A).

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1, 3, 5, 9, 11, 13	1A to 6A	data inputs
2, 4, 6, 8, 10, 12	1Y to 6Y	data outputs
7	GND	ground (0 V)
14	V_{CC}	positive supply voltage

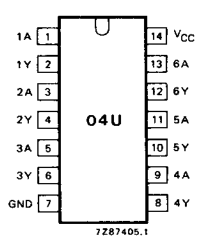

Fig. 1 Pin configuration.

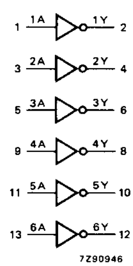

Fig. 2 Logic symbol.

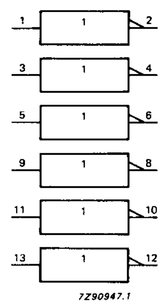

Fig. 3 IEC logic symbol.

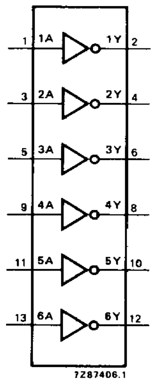

Fig. 4 Functional diagram.

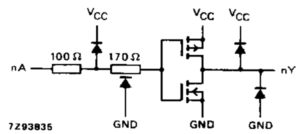

Fig. 5 Schematic diagram (one inverter).

DC CHARACTERISTICS FOR 74HCU

Voltages are referenced to GND (ground = 0 V)

SYMBOL	PARAMETER	T_{amb} (°C) 74HCU +25 min.	typ.	max.	-40 to +85 min.	max.	-40 to +125 min.	max.	UNIT	V_{CC} V	V_I	OTHER
V_{IH}	HIGH level input voltage	1.7 3.6 4.8	1.4 2.6 3.4		1.7 3.6 4.8		1.7 3.6 4.8		V	2.0 4.5 6.0		
V_{IL}	LOW level input voltage		0.6 1.9 2.6	0.3 0.9 1.2		0.3 0.9 1.2		0.3 0.9 1.2	V	2.0 4.5 6.0		
V_{OH}	HIGH level output voltage	1.8 4.0 5.5	2.0 4.5 6.0		1.8 4.0 5.5		1.8 4.0 5.5		V	2.0 4.5 6.0	V_{IH} or V_{IL}	$-I_O$ = 20 μA $-I_O$ = 20 μA $-I_O$ = 20 μA
V_{OH}	HIGH level output voltage	3.98 5.48	4.32 5.81		3.84 5.34		3.7 5.2		V	4.5 6.0	V_{CC} or GND	$-I_O$ = 4.0 mA $-I_O$ = 5.2 mA
V_{OL}	LOW level output voltage		0 0 0	0.2 0.5 0.5		0.2 0.5 0.5		0.2 0.5 0.5	V	2.0 4.5 6.0	V_{IH} or V_{IL}	I_O = 20 μA I_O = 20 μA I_O = 20 μA
V_{OL}	LOW level output voltage		0.15 0.16	0.26 0.26		0.33 0.33		0.4 0.4	V	4.5 6.0	V_{CC} or GND	I_O = 4.0 mA I_O = 5.2 mA
$\pm I_I$	input leakage current			0.1		1.0		1.0	μA	6.0	V_{CC} or GND	
I_{CC}	quiescent supply current			2.0		20.0		40.0	μA	6.0	V_{CC} or GND	I_O = 0

AC CHARACTERISTICS FOR 74HCU

GND = 0 V; $t_r = t_f = 6$ ns; $C_L = 50$ pF

SYMBOL	PARAMETER	T_{amb} (°C) 74HCU +25 min.	typ.	max.	−40 to +85 min.	max.	−40 to +125 min.	max.	UNIT	TEST CONDITIONS V_{CC} V	WAVEFORMS
t_{PHL}/ t_{PLH}	propagation delay nA to nY		19 7 6	70 14 12		90 18 15		105 21 18	ns	2.0 4.5 6.0	Fig. 6
t_{THL}/ t_{TLH}	output transition time		19 7 6	75 15 13		95 19 16		110 22 19	ns	2.0 4.5 6.0	Fig. 6

AC WAVEFORMS

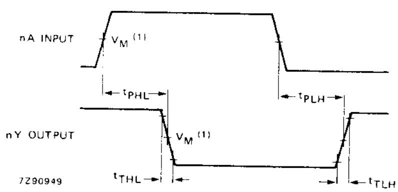

Fig. 6 Waveforms showing the data input (nA) to data output (nY) propagation delays and the output transition times.

Note to AC waveforms

(1) $V_M = 50\%$; V_I = GND to V_{CC}.

TYPICAL TRANSFER CHARACTERISTICS

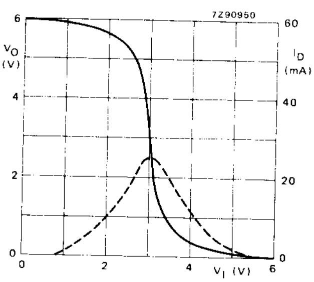

Fig. 7

—— V_O; − − − − I_D (drain current)
$I_O = 0$; $V_{CC} = 6.0$ V.

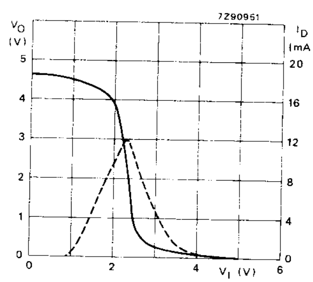

Fig. 8

—— V_O; − − − − I_D (drain current)
$I_O = 0$; $V_{CC} = 4.5$ V.

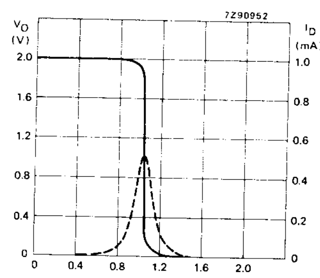

Fig. 9

—— V_O; − − − − I_D (drain current)
$I_O = 0$; $V_{CC} = 2.0$ V.

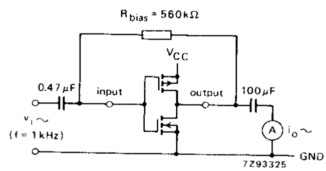

Fig. 10 Test set-up for measuring forward transconductance $g_{fs} = di_o/dv_i$ at v_o is constant (see also graph Fig. 11).

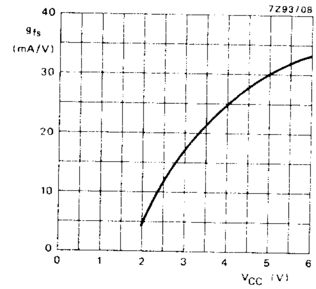

Fig. 11 Typical forward transconductance g_{fs} as a function of the supply voltage V_{CC} at T_{amb} = 25 °C.

APPLICATION INFORMATION

Some applications for the "HCU04" are:

- Linear amplifier (see Fig. 12)
- In crystal oscillator designs (see Fig. 13)
- Astable multivibrator (see Fig. 14)

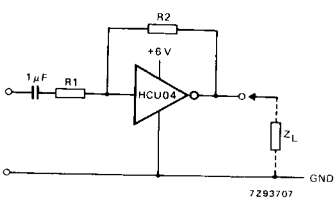

Fig. 12 HCU04 used as a linear amplifier.

Note to Fig. 12

$Z_L > 10\ k\Omega$; A_{OL} = 20 (typ.)

$$A_u = -\frac{A_{OL}}{1 + \frac{R1}{R2}(1 + A_{OL})};$$

V_O max (p-p) $\approx V_{CC} - 2$ V centered at ½ V_{CC}

$3\ k\Omega \leqslant R1, R2 \leqslant 1\ M\Omega$

Typical unity gain bandwidth product is 5 MHz.

C_I (see Fig. 15)

A_{OL} = open loop amplification

A_u = voltage amplification

APPLICATION INFORMATION (Cont'd)

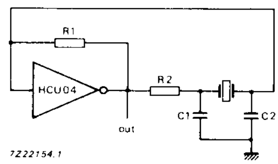

Fig. 13 Crystal oscillator configuration.

Note to Fig. 13

C_1 = 47 pF (typ.)
C_2 = 33 pF (typ.)
R_1 = 1 to 10 MΩ (typ.)

R_2 optimum value depends on the frequency and required stability against changes in V_{CC} or average minimum I_{CC} (I_{CC} is typically 5 mA at V_{CC} = 5 V and f = 10 MHz).

OPTIMUM VALUE FOR R_2

FREQUENCY (MHz)	R_2 (kΩ)	OPTIMUM FOR
3	1 8	minimum required I_{CC} minimum influence due to change in V_{CC}
6	1 4.7	minimum I_{CC} minimum influence by V_{CC}
10	1 8	minimum I_{CC} minimum influence by V_{CC}
14	1 4.7	minimum I_{CC} minimum influence by V_{CC}
> 14	replace R_2 by C_3 with a typical value of 35 pF	

EXTERNAL COMPONENTS FOR RESONATOR (f < 1 MHz)

FREQUENCY (kHz)	R_1 (MΩ)	R_2 (kΩ)	C_1 (pF)	C_2 (pF)
10 to 15.9	22	220	56	20
16 to 24.9	22	220	56	10
25 to 54.9	22	100	56	10
55 to 129.9	22	100	47	5
130 to 199.9	22	47	47	5
200 to 349.9	10	47	47	5
350 to 600	10	47	47	5

Where:

All values given are typical and must be used as an initial set-up.

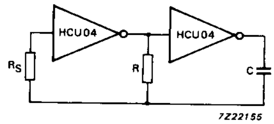

Fig. 14 HCU04 used as an astable multivibrator

Note to Fig. 14

$f = \frac{1}{T} \approx \frac{1}{2.2\ RC}$.

$R_S \approx 2 \times R$.

The average I_{CC} (mA) is approximately 3.5 + 0.05 x f (MHz) x C (pF) at V_{CC} = 5.0 V (for more information refer to DESIGNERS GUIDE).

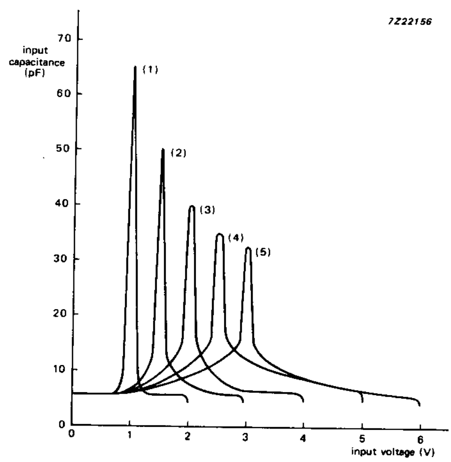

Fig. 15 Typical input capacitance as a function of input voltage.

Note to Fig. 15

1. V_{CC} = 2.0 V.
2. V_{CC} = 3.0 V.
3. V_{CC} = 4.0 V.
4. V_{CC} = 5.0 V.
5. V_{CC} = 6.0 V.

Note to Application information

All values given are typical unless otherwise specified.