

4 x 4 REGISTER FILE; 3-STATE

FEATURES

- Simultaneous and independent read and write operations
- Expandable to almost any word size and bit length
- Output capability: bus driver
- ICC category: MSI

GENERAL DESCRIPTION

The 74HC/HCT670 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT670 are 16-bit 3-state register files organized as 4 words of 4 bits each. Separated read and write address inputs (RA, RB and WA, WB) and enable inputs (RE and WE) are available, permitting simultaneous writing into one word location and reading from another location. The 4-bit word to be stored is presented to four data inputs (D0 to D3). The WA and WB inputs determine the location of the stored word. When the WE input is LOW, the data is entered into the addressed location. The addressed location remains transparent to the data while the WE input is LOW. Data supplied at the inputs will be read out in true (non-inverting) form from the 3-state outputs (Q0 to Q3). Dn and Wn inputs are inhibited when WE is HIGH.

Direct acquisition of data stored in any of the four registers is made possible by individual read address inputs (RA and RB). The addressed word appears at the four outputs when the RE is LOW. Data outputs are in the high impedance OFF-state when RE is HIGH. This permits outputs to be tied together to increase the word capacity to very large numbers.

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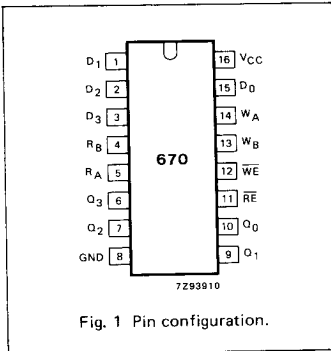


Fig. 1 Pin configuration.

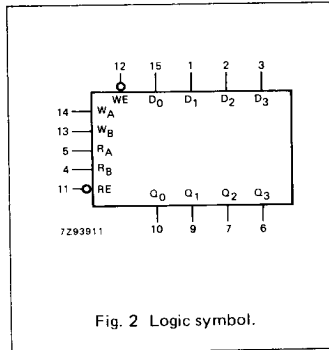


Fig. 2 Logic symbol.

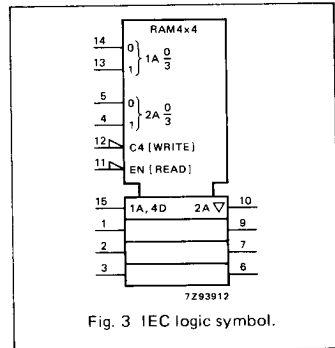


Fig. 3 IEC logic symbol.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
tPHL/ tPLH	propagation delay Dn to Qn	CL = 15 pF VCC = 5 V	23	23	ns
C1	input capacitance		3.5	3.5	pF
CPD	power dissipation capacitance per package	notes 1 and 2	122	124	pF

GND = 0 V; Tamb = 25 °C; tr = tf = 6 ns

Notes

1. CPD is used to determine the dynamic power dissipation (PD in μW):

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

f<sub>i</sub> = input frequency in MHz      C<sub>L</sub> = output load capacitance in pF  
f<sub>o</sub> = output frequency in MHz      V<sub>CC</sub> = supply voltage in V

Σ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs

2. For HC the condition is V<sub>I</sub> = GND to V<sub>CC</sub>  
For HCT the condition is V<sub>I</sub> = GND to V<sub>CC</sub> - 1.5 V

PACKAGE OUTLINES

16-lead DIL; plastic (SOT38Z).

16-lead mini-pack; plastic (SO16; SOT109A).

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
5, 4	RA, RB	read address inputs
8	GND	ground (0 V)
10, 9, 7, 6	Q0 to Q3	data outputs
11	RE	3-state output read enable input (active LOW)
12	WE	write enable input (active LOW)
14, 13	WA, WB	write address inputs
15, 1, 2, 3	D0 to D3	data inputs
16	VCC	positive supply voltage

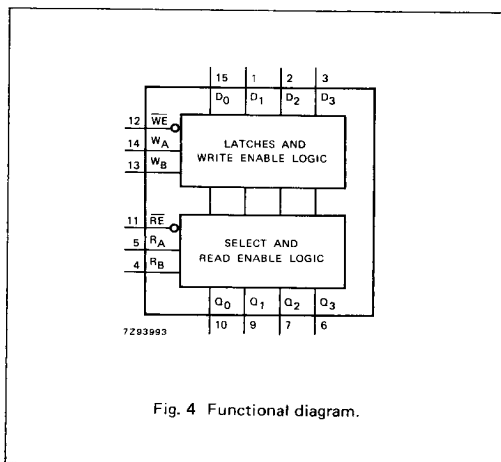


Fig. 4 Functional diagram.

**GENERAL DESCRIPTION (Cont'd)**

Design of the read enable signals for the stacked devices must ensure that there is no overlap in the LOW levels which would cause more than one output to be active at the same time. Parallel expansion to generate n-bit words is accomplished by driving the enable and address inputs of each device in parallel.

**WRITE MODE SELECT TABLE**

OPERATING MODE	INPUTS		INTERNAL LATCHES*
	$\overline{WE}$	$D_n$	
write data	L L	L H	L H
data latched	H	X	no change

\* The write address ( $W_A$  and  $W_B$ ) to the "internal latches" must be stable while  $\overline{WE}$  is LOW for conventional operation.

**READ MODE SELECT TABLE**

OPERATING MODE	INPUTS		OUTPUT
	$\overline{RE}$	INTERNAL LATCHES**	
read	L L	L H	L H
disabled	H	X	Z

\*\* The selection of the "internal latches" by read address ( $R_A$  and  $R_B$ ) are not constrained by  $\overline{WE}$  or  $\overline{RE}$  operation.

H = HIGH voltage level  
L = LOW voltage level  
X = don't care  
Z = high impedance OFF-state

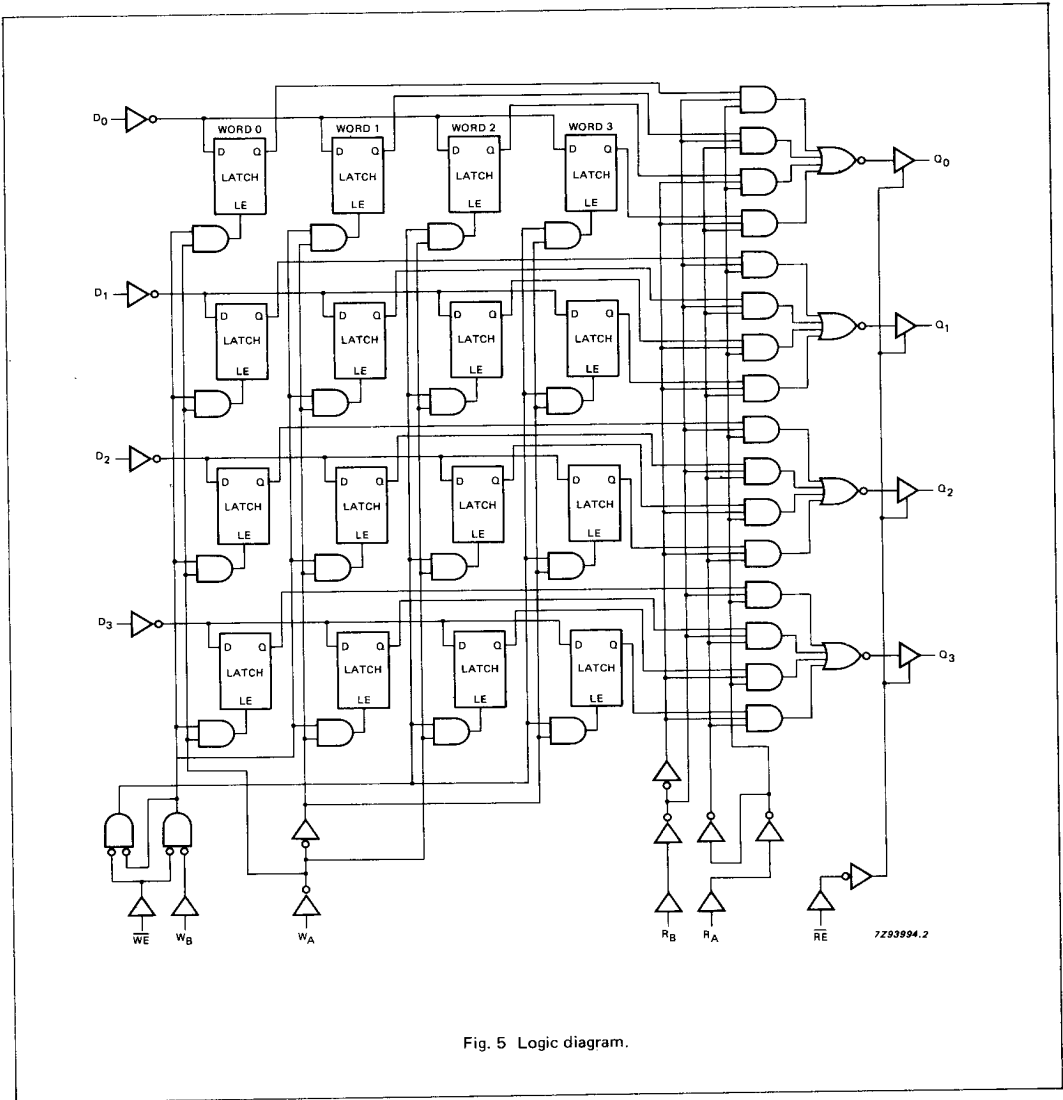


Fig. 5 Logic diagram.

**DC CHARACTERISTICS FOR 74HC**

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: bus driver

I<sub>CC</sub> category: MSI

**AC CHARACTERISTICS FOR 74HC**

GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = 6 ns; C<sub>L</sub> = 50 pF

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS		
		74HC							V <sub>CC</sub> V	WAVEFORMS	
		+25			-40 to +85		-40 to +125				
		min.	typ.	max.	min.	max.	min.				max.
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay R <sub>A</sub> , R <sub>B</sub> to Q <sub>N</sub>		58 21 17	195 39 33		245 49 42		295 59 50	ns	2.0 4.5 6.0	Fig. 6
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay WE to Q <sub>N</sub>		77 28 22	250 50 43		315 63 54		375 75 64	ns	2.0 4.5 6.0	Fig. 7
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay D <sub>N</sub> to Q <sub>N</sub>		74 27 22	250 50 43		315 63 54		375 75 64	ns	2.0 4.5 6.0	Fig. 7
t <sub>PZH</sub> / t <sub>PZL</sub>	3-state output enable time RE to Q <sub>N</sub>		39 14 11	150 30 26		190 38 33		225 45 38	ns	2.0 4.5 6.0	Fig. 9
t <sub>PHZ</sub> / t <sub>PLZ</sub>	3-state output disable time RE to Q <sub>N</sub>		47 17 14	150 30 26		190 38 33		225 45 38	ns	2.0 4.5 6.0	Fig. 9
t <sub>THL</sub> / t <sub>TLH</sub>	output transition time		14 5 4	60 12 10		75 15 13		90 18 15	ns	2.0 4.5 6.0	Fig. 6
t <sub>W</sub>	write enable pulse width LOW	80 16 14	14 5 4		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 8
t <sub>SU</sub>	set-up time D <sub>N</sub> to WE	60 12 10	3 1 1		75 15 13		90 18 15		ns	2.0 4.5 6.0	Fig. 8
t <sub>SU</sub>	set-up time W <sub>A</sub> , W <sub>B</sub> to WE	60 12 10	6 2 2		75 15 13		90 18 15		ns	2.0 4.5 6.0	Fig. 8
t <sub>H</sub>	hold time D <sub>N</sub> to WE	5 5 5	0 0 0		5 5 5		5 5 5		ns	2.0 4.5 6.0	Fig. 8
t <sub>H</sub>	hold time W <sub>A</sub> , W <sub>B</sub> to WE	5 5 5	0 0 0		5 5 5		5 5 5		ns	2.0 4.5 6.0	Fig. 8
t <sub>latch</sub>	latch time WE to R <sub>A</sub> , R <sub>B</sub>	100 20 17	28 10 8		125 25 21		150 30 26		ns	2.0 4.5 6.0	Fig. 8

**DC CHARACTERISTICS FOR 74HCT**

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: bus driver

I<sub>CC</sub> category: MSI

**Note to HCT types**

The value of additional quiescent supply current ( $\Delta I_{CC}$ ) for a unit load of 1 is given in the family specifications. To determine  $\Delta I_{CC}$  per input, multiply this value by the unit load coefficient shown in the table below.

INPUT	UNIT LOAD COEFFICIENT	INPUT	UNIT LOAD COEFFICIENT
D <sub>n</sub>	0.25	R <sub>A</sub>	0.70
WE, W <sub>A</sub>	0.40	R <sub>B</sub>	1.10
W <sub>B</sub>	0.60	RE	1.35

**AC CHARACTERISTICS FOR 74HCT**

GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = 6 ns; C<sub>L</sub> = 50 pF

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS		
		74HCT							V <sub>CC</sub> V	WAVEFORMS	
		+25			-40 to +85		-40 to +125				
		min.	typ.	max.	min.	max.	min.				max.
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay R <sub>A</sub> , R <sub>B</sub> to Q <sub>n</sub>		21	40		50		60	ns	4.5	Fig. 6
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay WE to Q <sub>n</sub>		28	50		63		75	ns	4.5	Fig. 7
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay D <sub>n</sub> to Q <sub>n</sub>		27	50		63		75	ns	4.5	Fig. 7
t <sub>PZH</sub> / t <sub>PZL</sub>	3-state output enable time RE to Q <sub>n</sub>		18	35		44		53	ns	4.5	Fig. 9
t <sub>PHZ</sub> / t <sub>PLZ</sub>	3-state output disable time RE to Q <sub>n</sub>		19	35		44		53	ns	4.5	Fig. 9
t <sub>THL</sub> / t <sub>TLH</sub>	output transition time		5	12		15		18	ns	4.5	Fig. 6
t <sub>W</sub>	write enable pulse width LOW	18	9		23		27		ns	4.5	Fig. 8
t <sub>su</sub>	set-up time D <sub>n</sub> to WE	12	4		15		18		ns	4.5	Fig. 8
t <sub>su</sub>	set-up time W <sub>A</sub> , W <sub>B</sub> to WE	12	-2		15		18		ns	4.5	Fig. 8
t <sub>h</sub>	hold time D <sub>n</sub> to WE	5	-1		5		5		ns	4.5	Fig. 8
t <sub>h</sub>	hold time W <sub>A</sub> , W <sub>B</sub> to WE	5	0		5		5		ns	4.5	Fig. 8
t <sub>latch</sub>	latch time WE to R <sub>A</sub> , R <sub>B</sub>	25	11		31		38		ns	4.5	Fig. 8

AC WAVEFORMS

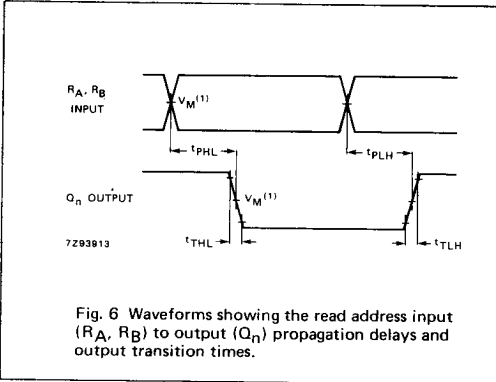


Fig. 6 Waveforms showing the read address input ( $R_A$ ,  $R_B$ ) to output ( $Q_n$ ) propagation delays and output transition times.

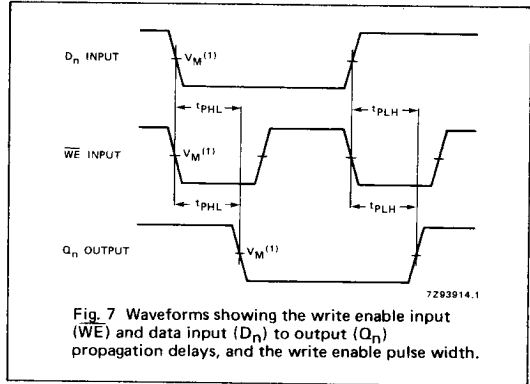
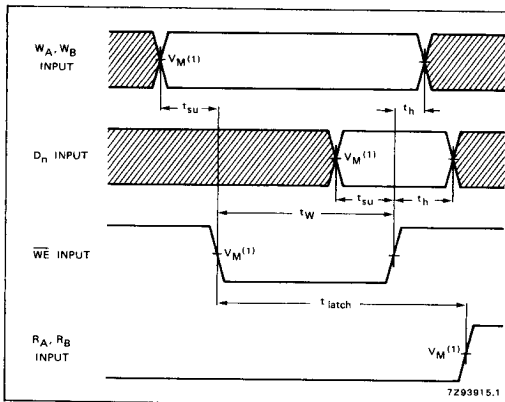


Fig. 7 Waveforms showing the write enable input ( $\overline{WE}$ ) and data input ( $D_n$ ) to output ( $Q_n$ ) propagation delays, and the write enable pulse width.



Note to Fig. 8

The shaded areas indicate when the input is permitted to change for predictable output performance.

The time allowed for the internal output of the latch to assume the state of the new data ( $t_{latch}$ ) is important only when attempting to read from a location immediately after that location has received new data. This parameter is measured from the falling edge of  $\overline{WE}$  to the rising edge of  $R_A$  or  $R_B$ .  $\overline{RE}$  must be LOW.

Fig. 8 Waveforms showing the write address input ( $W_A$ ,  $W_B$ ) and data input ( $D_n$ ) to write enable ( $\overline{WE}$ ) set-up, hold and latch times.

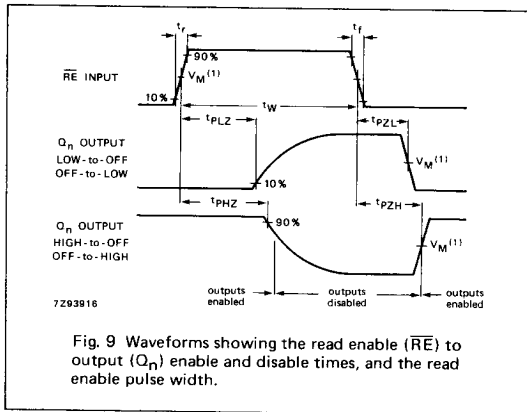


Fig. 9 Waveforms showing the read enable ( $\overline{RE}$ ) to output ( $Q_n$ ) enable and disable times, and the read enable pulse width.

Note to AC waveforms

- (1) HC :  $V_M = 50\%$ ;  $V_I = \text{GND to } V_{CC}$
- HCT:  $V_M = 1.3 \text{ V}$ ;  $V_I = \text{GND to } 3 \text{ V}$ .