



---

Examination : Mid - Session 1                                  Year : 2003  
Date : 2 Augus 2003    Time : 9.00-12.00  
Subject : 240-205 Digital Systems and Logic Design      Room : A201,  
    A203, A401

---

### **NOTE**

- There are 7 questions 16 pages(not include cover). Answer all questions
- All questions are of different values.
- Calculator, textbooks and hand-out are prohibited.
- Every answer must be clear and show how to get the answer.
- All answers must be given in ink.
- Unless otherwise indicated, pencils should only be used for graphical work.

Student ID : \_\_\_\_\_ Name : \_\_\_\_\_ Section : \_\_\_\_\_

Question	1	2	3	4	5	6	7
Scores							

1. Answer the following questions:

- (a) A pulse waveform with a frequency of 100 kHz is applied to the input of a counter. During 10 ms how many pulses are counted. (2 marks)

Answer \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- (b) Using a logic probe and pulser, you make the observations indicated in Figure 1. Determine the gate failure. (2 marks)

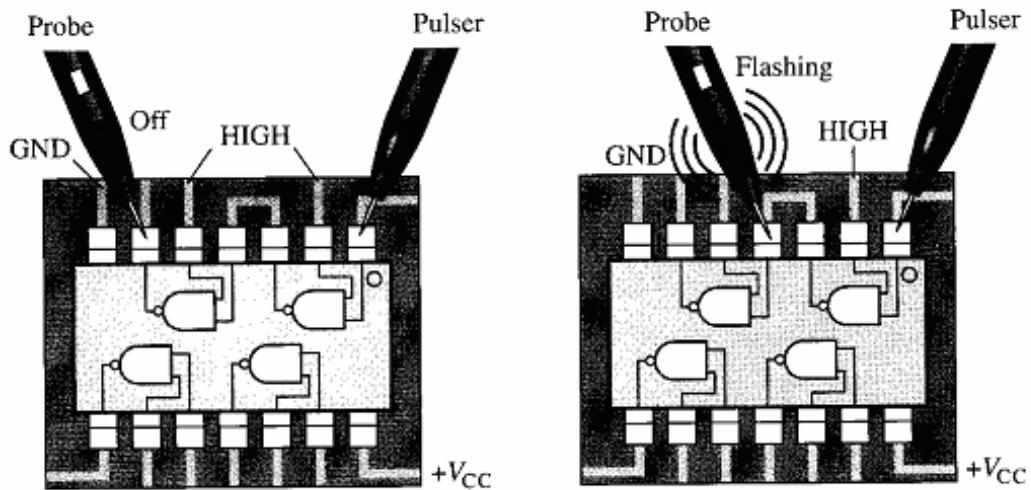


Figure 1

Answer \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Student ID :

Name:

2

(c) Multiply the 2's Complement number : 01100110 x 11001010  
(4 marks)

## Answer

(d) Add the BCD numbers : 01100111 + 01011001 (3 marks)

## Answer

Student ID :

Name:

3

(e) Divide the 2' Complement number : 10001001.011 ÷ 00101001.01 , the answer must be expressed by using 7 bits plus a sign bit. (4 marks)

## Answer



2. Determine the exact maximum propagation delay from IN to OUT of the circuit in Figure 2 for both LOW-to-HIGH and HIGH-to-LOW transitions, using the information given in Appendix at test condition  $C_L = 15 \text{ pF}$ . (3 marks)

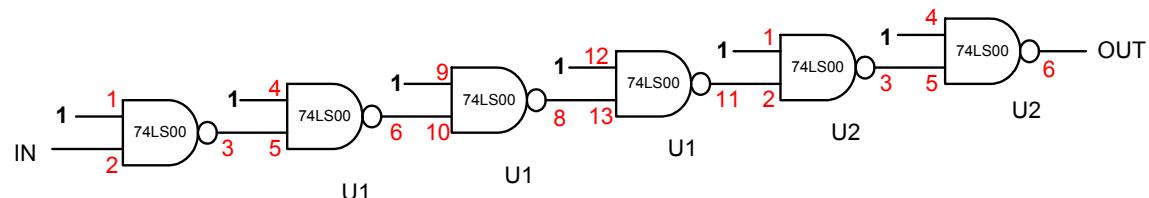


Figure 2

## Answer



Student ID :

Name:

4

3. Convert the expression  $\overline{A}C(\overline{A}\overline{B}\overline{D}) + \overline{A}\overline{B}\overline{C}\overline{D} + A\overline{B}C$  to standard product - of - sum (POS) forms. (4 marks)

## Answer

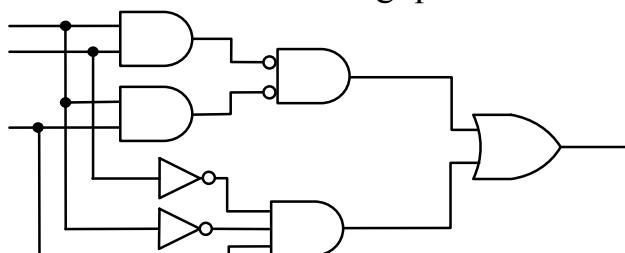


Figure 3

(a) Simplify the circuit using Boolean algebra (3 marks)

## Answer

Student ID :

Name:

5

(b) Develop the truth table

(2 marks)

## Answer

5. Use Karnaugh map to simplify the expression (3 marks)  
 $X = \overline{DCB}A + \overline{DCB}\bar{A} + DC\bar{B}A + DC\bar{B}\bar{A} + DC\bar{B}A + DC\bar{B}\bar{A}$

6. In a certain manufacturing process, a conveyor belt will shut down whenever specific conditions occur. These conditions are monitored and reflected by the states of four logic signals as follows: signal A will be HIGH whenever the conveyor belt speed is too fast; signal B will be HIGH whenever the collection bin at the end of the belt is full; signal C will be HIGH when the belt tension is too high; signal D will be HIGH when the manual override it off. A logic circuit is needed to generate a signal X when conditions A and B exist simultaneously or whenever conditions C and D exist simultaneously. Design the circuit that be implemented with a minimum number of ICs. ICs are available in Appendix. (10 marks)

## Answer

7. Design logic circuits that decode a binary coded decimal (BCD) number and activate the appropriate digits on the 7-Segment display in Figure 4 (a). Figure 4 (b) illustrates this method of digital display for each of the ten digits by using a red segment to represent one that is energized. To produce a 1, segments b and c are energized; to produce a 2, segments a,b,g,e, and d are used; and so on (20 marks)

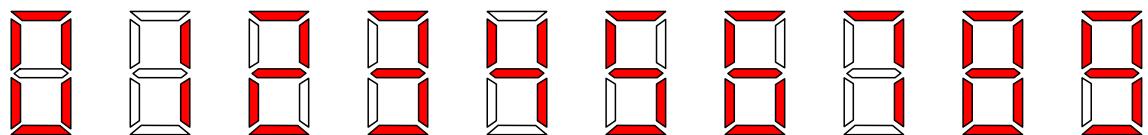
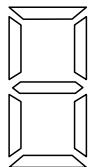


Figure 4

Student ID :

Name:

8

## Appendix



August 1998  
Revised March 2000

DM74LS00 Quad 2-Input NAND Gate

### DM74LS00 Quad 2-Input NAND Gate

#### General Description

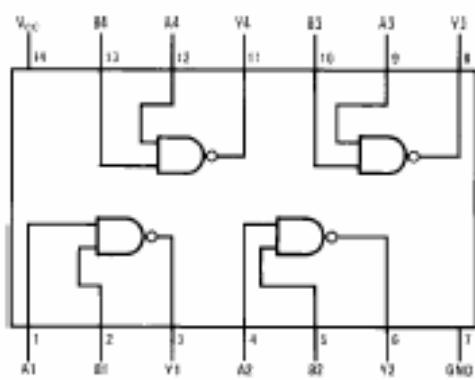
This device contains four independent gates each of which performs the logic NAND function.

#### Ordering Code:

Order Number	Package Number	Package Description
DM74LS00M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
DM74LS006U	M14D	14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
DM74LS00N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Device also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Connection Diagram



#### Function Table

$$Y = \overline{AB}$$

Inputs		Output
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

H = HIGH Logic Level

L = LOW Logic Level

DM74LS00

**Absolute Maximum Ratings**(Note 1)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	-65°C to +150°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Recommended Operating Conditions**

Symbol	Parameter	Min	Nom	Max	Units
V <sub>CC</sub>	Supply Voltage	4.75	5	5.25	V
V <sub>H</sub>	HIGH Level Input Voltage	2			V
V <sub>L</sub>	LOW Level Input Voltage			0.8	V
I <sub>OH</sub>	HIGH Level Output Current			-0.4	mA
I <sub>OL</sub>	LOW Level Output Current			8	mA
T <sub>A</sub>	Free Air Operating Temperature	0		70	°C

**Electrical Characteristics**

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>l</sub> = -18 mA			-1.5	V
V <sub>OH</sub>	HIGH Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max, V <sub>L</sub> = Max	2.7	3.4		V
V <sub>OL</sub>	LOW Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max, V <sub>H</sub> = Min I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min		0.35	0.5	V
I <sub>l</sub>	Input Current @ Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V			0.1	mA
I <sub>H</sub>	HIGH Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V			20	µA
I <sub>L</sub>	LOW Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V			-0.38	mA
I <sub>SC</sub>	Short Circuit Output Current	V <sub>CC</sub> = Max (Note 3)	-20		-100	mA
I <sub>CH</sub>	Supply Current with Outputs HIGH	V <sub>CC</sub> = Max		0.8	1.8	mA
I <sub>CL</sub>	Supply Current with Outputs LOW	V <sub>CC</sub> = Max		2.4	4.4	mA

Note 2: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.

**Switching Characteristics**at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C

Symbol	Parameter	R <sub>L</sub> = 2 kΩ				Units	
		C <sub>L</sub> = 15 pF		C <sub>L</sub> = 50 pF			
		Min	Max	Min	Max		
t <sub>PH</sub>	Propagation Delay Time LOW-to-HIGH Level Output	3	10	4	15	ns	
t <sub>PL</sub>	Propagation Delay Time HIGH-to-LOW Level Output	3	10	4	15	ns	



March 1998

## DM74LS08

### Quad 2-Input AND Gates

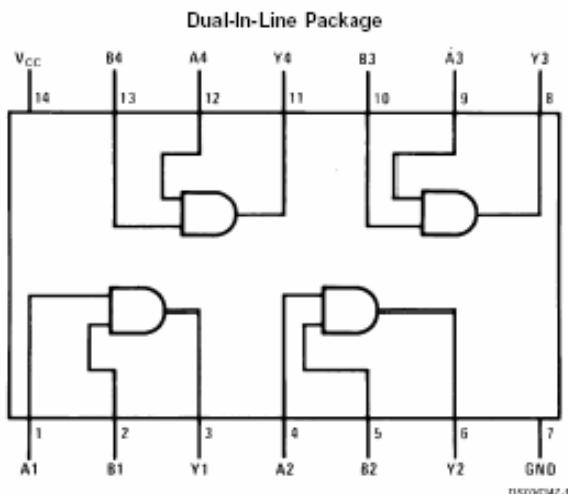
#### General Description

This device contains four independent gates each of which performs the logic AND function.

#### Features

- Alternate Military/Aerospace device (54LS08) is available. Contact a Fairchild Semiconductor Sales Office/Distributor for specifications.

#### Connection Diagram



Order Number 54LS08DMQB, 54LS08FMQB, 54LS08LMQB, DM54LS08J, DM54LS08W, DM74LS08M or DM74LS08N  
See NS Package Number E20A, J14A, M14A, N14A or W14B

#### Function Table

$$Y = AB$$

Inputs		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

H = High Logic Level  
L = Low Logic Level

<b>Absolute Maximum Ratings</b> (Note 1)		DM54LS and 54LS	-55°C to +125°C
Supply Voltage	7V	DM74LS	0°C to +70°C
Input Voltage	7V	Storage Temperature Range	-65°C to +150°C
Operating Free Air Temperature Range			

### Recommended Operating Conditions

Symbol	Parameter	DM54LS08			DM74LS08			Units
		Min	Nom	Max	Min	Nom	Max	
V <sub>CC</sub>	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V <sub>IH</sub>	High Level Input Voltage	2			2			V
V <sub>IL</sub>	Low Level Input Voltage			0.7			0.8	V
I <sub>OH</sub>	High Level Output Current			-0.4			-0.4	mA
I <sub>OL</sub>	Low Level Output Current			4			8	mA
T <sub>A</sub>	Free Air Operating Temperature	-55		125	0		70	°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

### Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ (Note 2)	Max	Units
		Min	Max				
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>I</sub> = -18 mA				-1.5	V
V <sub>OH</sub>	High Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max, V <sub>IH</sub> = Min	DM54	2.5	3.4		V
			DM74	2.7	3.4		
V <sub>OL</sub>	Low Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max, V <sub>IL</sub> = Max	DM54		0.25	0.4	
			DM74		0.35	0.5	V
		I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min	DM74		0.25	0.4	
I <sub>I</sub>	Input Current @ Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V				0.1	mA
I <sub>IH</sub>	High Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V				20	µA
I <sub>IL</sub>	Low Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V				-0.36	mA
I <sub>OS</sub>	Short Circuit Output Current	V <sub>CC</sub> = Max (Note 3)	DM54	-20		-100	
			DM74	-20		-100	mA
I <sub>COH</sub>	Supply Current with Outputs High	V <sub>CC</sub> = Max			2.4	4.8	mA
I <sub>COL</sub>	Supply Current with Outputs Low	V <sub>CC</sub> = Max			4.4	8.8	mA

### Switching Characteristics

at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C (See Section 1 for Test Waveforms and Output Load)

Symbol	Parameter	R <sub>L</sub> = 2 kΩ				Units	
		C <sub>L</sub> = 15 pF		C <sub>L</sub> = 50 pF			
		Min	Max	Min	Max		
t <sub>PLH</sub>	Propagation Delay Time Low to High Level Output	4	13	6	18	ns	
t <sub>PHL</sub>	Propagation Delay Time High to Low Level Output	3	11	5	18	ns	

Note 2: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.



March 1995

## DM74LS32 Quad 2-Input OR Gates

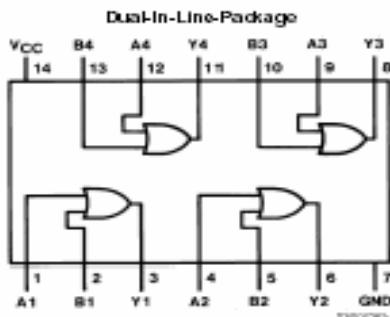
### General Description

This device contains four independent gates each of which performs the logic OR function.

### Features

- Alternate Military/Aerospace device (54LS32) is available. Contact a Fairchild Semiconductor Sales Officer/Distributor for specifications.

### Connection Diagram



Order Number 54LS32DMQB, 54LS32FMQB, 54LS32LMQB,  
DM54LS32J, DM54LS32W, DM74LS32M or DM74LS32N  
See Package Number E20A, J14A, M14A, N14A or W14B

### Function Table

$$Y = A + B$$

Inputs		Output
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	H

H = High Logic Level  
L = Low Logic Level

Absolute Maximum Ratings (Note 1)			DM54LS and 54LS			-55°C to +125°C		
Supply Voltage	7V <th>DM74LS</th> <th data-cs="3" data-kind="parent">Storage Temperature Range</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th> <th data-cs="3" data-kind="parent">0°C to +70°C</th> <th data-kind="ghost"></th> <th data-kind="ghost"></th>	DM74LS	Storage Temperature Range			0°C to +70°C		
Input Voltage	7V					-65°C to +150°C		
Operating Free Air Temperature Range								

### Recommended Operating Conditions

Symbol	Parameter	DM54LS32			DM74LS32			Units
		Min	Nom	Max	Min	Nom	Max	
V <sub>CC</sub>	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V <sub>H</sub>	High Level Input Voltage	2			2			V
V <sub>L</sub>	Low Level Input Voltage			0.7			0.6	V
I <sub>OH</sub>	High Level Output Current			-0.4			-0.4	mA
I <sub>OL</sub>	Low Level Output Current			4			8	mA
T <sub>A</sub>	Free Air Operating Temperature	-55	125	0			70	°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

### Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ (Note 2)	Max	Units
		Min	Max				
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>I</sub> = -15 mA				-1.5	V
V <sub>DH</sub>	High Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max	DM54	2.5	3.4		V
V <sub>DL</sub>	Low Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max	DM54		0.25	0.4	V
		V <sub>L</sub> = Max	DM74		0.35	0.5	
		I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min	DM74		0.25	0.4	
I <sub>I</sub>	Input Current @ Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V				0.1	mA
I <sub>IH</sub>	High Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V				20	μA
I <sub>IL</sub>	Low Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V				-0.36	mA
I <sub>os</sub>	Short Circuit Output Current	V <sub>CC</sub> = Max (Note 3)	DM54	-20		-100	mA
I <sub>OAH</sub>	Supply Current with Outputs High	V <sub>CC</sub> = Max			3.1	6.2	mA
I <sub>OAL</sub>	Supply Current with Outputs Low	V <sub>CC</sub> = Max			4.9	9.8	mA

### Switching Characteristics

at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C

Symbol	Parameter	R <sub>L</sub> = 2 kΩ				Units	
		C <sub>L</sub> = 15 pF		C <sub>L</sub> = 50 pF			
		Min	Max	Min	Max		
t <sub>PLH</sub>	Propagation Delay Time Low to High Level Output	3	11	4	15	ns	
t <sub>PHL</sub>	Propagation Delay Time High to Low Level Output	3	11	4	15	ns	

Note 2: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.



May 1986  
Revised March 2000

## DM74LS02

### Quad 2-Input NOR Gate

#### General Description

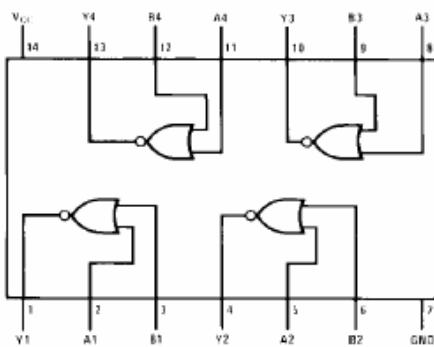
This device contains four independent gates each of which performs the logic NOR function.

#### Ordering Code:

Order Number	Package Number	Package Description
DM74LS02M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
DM74LS02SJ	M14D	14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
DM74LS02N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Connection Diagram



#### Function Table

$$Y = \overline{A + B}$$

Inputs		Output
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

H = HIGH Logic Level

L = LOW Logic Level

DM74LS02

**Absolute Maximum Ratings**(Note 1)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	-65°C to +150°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Recommended Operating Conditions**

Symbol	Parameter	Min	Nom	Max	Units
V <sub>CC</sub>	Supply Voltage	4.75	5	5.25	V
V <sub>IH</sub>	HIGH Level Input Voltage	2			V
V <sub>IL</sub>	LOW Level Input Voltage			0.8	V
I <sub>OH</sub>	HIGH Level Output Current			-0.4	mA
I <sub>OL</sub>	LOW Level Output Current			8	mA
T <sub>A</sub>	Free Air Operating Temperature	0		70	°C

**Electrical Characteristics**

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>	HIGH Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max, V <sub>IL</sub> = Max	2.7	3.4		V
V <sub>OL</sub>	LOW Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max, V <sub>IH</sub> = Min		0.35	0.5	V
		I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min		0.25	0.4	
I <sub>I</sub>	Input Current @ Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V			0.1	mA
I <sub>IH</sub>	HIGH Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V			20	μA
I <sub>IL</sub>	LOW Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V			-0.40	mA
I <sub>OS</sub>	Short Circuit Output Current	V <sub>CC</sub> = Max (Note 3)	-20		-100	mA
I <sub>OCH</sub>	Supply Current with Outputs HIGH	V <sub>CC</sub> = Max		1.6	3.2	mA
I <sub>OCL</sub>	Supply Current with Outputs LOW	V <sub>CC</sub> = Max		2.8	5.4	mA

Note 2: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.

**Switching Characteristics**at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C

Symbol	Parameter	R <sub>L</sub> = 2 kΩ				Units	
		C <sub>L</sub> = 15 pF		C <sub>L</sub> = 50 pF			
		Min	Max	Min	Max		
t <sub>PLH</sub>	Propagation Delay Time LOW-to-HIGH Level Output		13		18	ns	
t <sub>PHL</sub>	Propagation Delay Time HIGH-to-LOW Level Output		10		15	ns	

กรุงศรีฯ