

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING



Examination : Mid - Session 1
Date : 2 August 2003
Subject : 240-205 Digital Systems and Logic Design

Year : 2003
Time : 9.00-12.00
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)

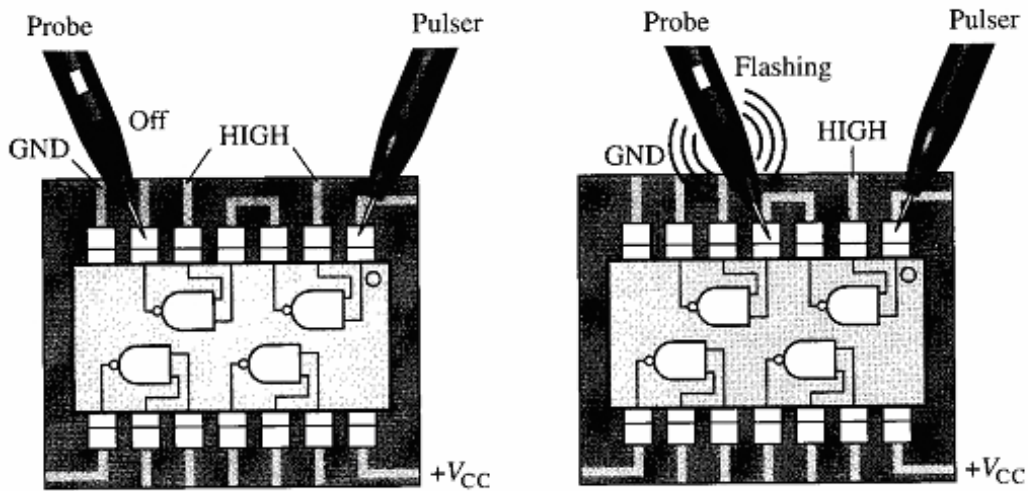


Figure 1

Answer _____

3. Convert the expression $\overline{AC}(\overline{ABD}) + \overline{ABCD} + \overline{ABC}$ to standard product - of - sum (POS) forms. (4 marks)

Answer _____

4. Using Figure 3 to answer the following questions.

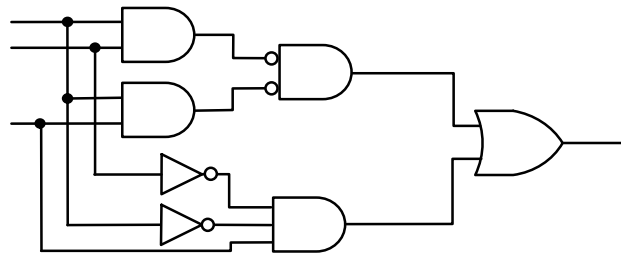



Figure 3

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

Answer _____

Appendix



FAIRCHILD
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August 1996
Revised March 2000

DM74LS00 Quad 2-Input NAND Gate

DM74LS00

Quad 2-Input NAND Gate

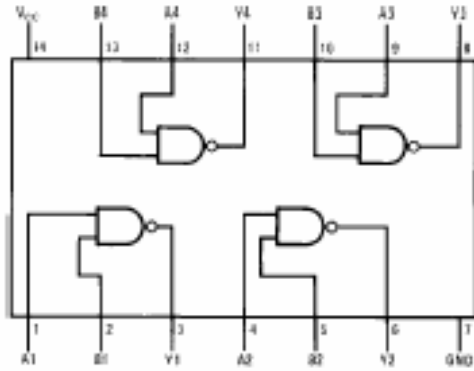
General Description
This device contains four independent gates each of which performs the logic NAND function.

Ordering Code:

Order Number	Package Number	Package Description
DM74LS00M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
DM74LS00SJ	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

Devices 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

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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_{CC}	Supply Voltage	4.75	5	5.25	V
V_{IH}	HIGH Level Input Voltage	2			V
V_{IL}	LOW Level Input Voltage			0.8	V
I_{OH}	HIGH Level Output Current			-0.4	mA
I_{OL}	LOW Level Output Current			8	mA
T_A	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_I	Input Clamp Voltage	$V_{CC} = \text{Min}$, $I_I = -18 \text{ mA}$			-1.5	V
V_{OH}	HIGH Level Output Voltage	$V_{CC} = \text{Min}$, $I_{OH} = \text{Max}$, $V_{IL} = \text{Max}$	2.7	3.4		V
V_{OL}	LOW Level Output Voltage	$V_{CC} = \text{Min}$, $I_{OL} = \text{Max}$, $V_{IH} = \text{Min}$		0.35	0.5	V
I_I	Input Current @ Max Input Voltage	$V_{CC} = \text{Max}$, $V_I = 7V$			0.1	mA
I_{IH}	HIGH Level Input Current	$V_{CC} = \text{Max}$, $V_I = 2.7V$			20	μA
I_{IL}	LOW Level Input Current	$V_{CC} = \text{Max}$, $V_I = 0.4V$			-0.38	mA
I_{OS}	Short Circuit Output Current	$V_{CC} = \text{Max}$ (Note 3)	-20		-100	mA
I_{CCH}	Supply Current with Outputs HIGH	$V_{CC} = \text{Max}$		0.8	1.6	mA
I_{CCL}	Supply Current with Outputs LOW	$V_{CC} = \text{Max}$		2.4	4.4	mA

Note 2: All typicals are at $V_{CC} = 5V$, $T_A = 25^\circ\text{C}$.

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

Switching Characteristics

at $V_{CC} = 5V$ and $T_A = 25^\circ\text{C}$

Symbol	Parameter	$R_L = 2 \text{ k}\Omega$				Units
		$C_L = 15 \text{ pF}$		$C_L = 50 \text{ pF}$		
		Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time LOW-to-HIGH Level Output	3	10	4	15	ns
t_{PLL}	Propagation Delay Time HIGH-to-LOW Level Output	3	10	4	15	ns



March 1998

DM74LS08

Quad 2-Input AND Gates

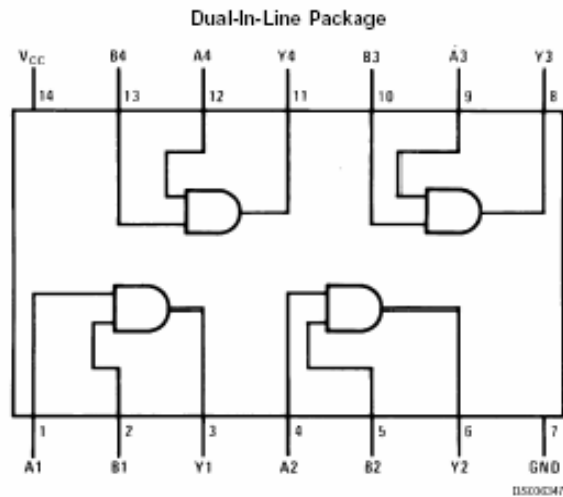
General Description

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

DM74LS08 Quad 2-Input AND Gates

Absolute Maximum Ratings (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_{CC}	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage	2			2			V
V_{IL}	Low Level Input Voltage			0.7			0.8	V
I_{OH}	High Level Output Current			-0.4			-0.4	mA
I_{OL}	Low Level Output Current			4			8	mA
T_A	Free Air Operating Temperature	-55		125	0		70	°C
<p>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.</p>								
Electrical Characteristics								
over recommended operating free air temperature range (unless otherwise noted)								
Symbol	Parameter	Conditions		Min	Typ (Note 2)	Max	Units	
V_I	Input Clamp Voltage	$V_{CC} = \text{Min}, I_I = -18 \text{ mA}$				-1.5	V	
V_{OH}	High Level Output Voltage	$V_{CC} = \text{Min}, I_{OH} = \text{Max}, V_{IH} = \text{Min}$	DM54	2.5	3.4		V	
			DM74	2.7	3.4			
V_{OL}	Low Level Output Voltage	$V_{CC} = \text{Min}, I_{OL} = \text{Max}, V_{IL} = \text{Max}$	DM54		0.25	0.4	V	
			DM74		0.35	0.5		
			DM74		0.25	0.4		
I_I	Input Current @ Max Input Voltage	$V_{CC} = \text{Max}, V_I = 7V$				0.1	mA	
I_{IH}	High Level Input Current	$V_{CC} = \text{Max}, V_I = 2.7V$				20	µA	
I_{IL}	Low Level Input Current	$V_{CC} = \text{Max}, V_I = 0.4V$				-0.36	mA	
I_{OS}	Short Circuit Output Current	$V_{CC} = \text{Max}$ (Note 3)	DM54	-20		-100	mA	
			DM74	-20		-100		
I_{OCH}	Supply Current with Outputs High	$V_{CC} = \text{Max}$			2.4	4.8	mA	
I_{OCL}	Supply Current with Outputs Low	$V_{CC} = \text{Max}$			4.4	8.8	mA	
Switching Characteristics								
at $V_{CC} = 5V$ and $T_A = 25^\circ\text{C}$ (See Section 1 for Test Waveforms and Output Load)								
Symbol	Parameter	$R_L = 2 \text{ k}\Omega$				Units		
		$C_L = 15 \text{ pF}$		$C_L = 50 \text{ pF}$				
		Min	Max	Min	Max			
t_{PLH}	Propagation Delay Time Low to High Level Output	4	13	6	18	ns		
t_{PHL}	Propagation Delay Time High to Low Level Output	3	11	5	18	ns		
<p>Note 2: All typicals are at $V_{CC} = 5V, T_A = 25^\circ\text{C}$.</p> <p>Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.</p>								



March 1995

DM74LS32 Quad 2-Input OR Gates

DM74LS32 Quad 2-Input OR Gates

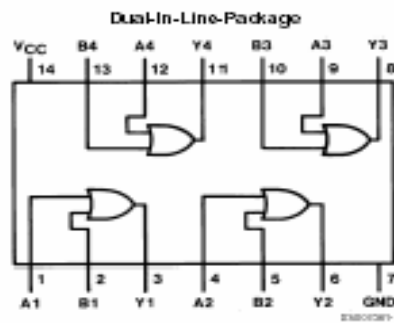
General Description

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 Office/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	DM74LS	Storage Temperature Range		-55°C to +125°C		0°C to +70°C		-65°C to +150°C	
Supply Voltage		7V									
Input Voltage		7V									
Operating Free Air Temperature Range											

Recommended Operating Conditions								
Symbol	Parameter	DM54LS32			DM74LS32			Units
		Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage	2			2			V
V_{IL}	Low Level Input Voltage			0.7			0.8	V
I_{OH}	High Level Output Current			-0.4			-0.4	mA
I_{OL}	Low Level Output Current			4			5	mA
T_A	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	
V_I	Input Clamp Voltage	$V_{CC} = \text{Min}, I_I = -15 \text{ mA}$			-1.5	V	
V_{OH}	High Level Output Voltage	$V_{CC} = \text{Min}, I_{OH} = \text{Max}$	DM54	2.5	3.4	V	
		$V_{IH} = \text{Min}$	DM74	2.7	3.4		
V_{OL}	Low Level Output Voltage	$V_{CC} = \text{Min}, I_{OL} = \text{Max}$	DM54		0.25	V	
		$V_{IL} = \text{Max}$	DM74		0.35		
		$I_{OL} = 4 \text{ mA}, V_{CC} = \text{Min}$	DM74		0.25		0.4
I_I	Input Current @ Max Input Voltage	$V_{CC} = \text{Max}, V_I = 7V$			0.1	mA	
I_{IH}	High Level Input Current	$V_{CC} = \text{Max}, V_I = 2.7V$			20	μA	
I_{IL}	Low Level Input Current	$V_{CC} = \text{Max}, V_I = 0.4V$			-0.36	mA	
I_{OS}	Short Circuit Output Current	$V_{CC} = \text{Max}$	DM54	-20		-100	mA
		(Note 3)	DM74	-20		-100	
I_{OCH}	Supply Current with Outputs High	$V_{CC} = \text{Max}$			3.1	6.2	mA
I_{OCL}	Supply Current with Outputs Low	$V_{CC} = \text{Max}$			4.9	9.0	mA

Switching Characteristics						
at $V_{CC} = 5V$ and $T_A = 25^\circ\text{C}$						
Symbol	Parameter	$R_L = 2 \text{ k}\Omega$				Units
		$C_L = 15 \text{ pF}$		$C_L = 50 \text{ pF}$		
		Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time Low to High Level Output	3	11	4	15	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	3	11	4	15	ns

Note 2: All typicals are at $V_{CC} = 5V, T_A = 25^\circ\text{C}$.

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



May 1986
Revised March 2000

DM74LS02 Quad 2-Input NOR Gate

DM74LS02

Quad 2-Input NOR Gate

General Description

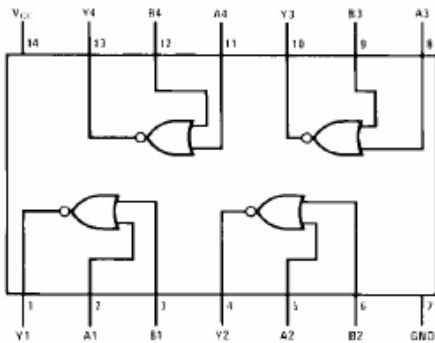
This device contains four independent gates each of which performs the logic NOR function.

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 _{CC}	Supply Voltage	4.75	5	5.25	V
V _{IH}	HIGH Level Input Voltage	2			V
V _{IL}	LOW Level Input Voltage			0.8	V
I _{OH}	HIGH Level Output Current			-0.4	mA
I _{OL}	LOW Level Output Current			8	mA
T _A	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 _I	Input Clamp Voltage	V _{CC} = Min, I _I = -18 mA			-1.5	V
V _{OH}	HIGH Level Output Voltage	V _{CC} = Min, I _{OH} = Max, V _{IL} = Max	2.7	3.4		V
V _{OL}	LOW Level Output Voltage	V _{CC} = Min, I _{OL} = Max, V _{IH} = Min		0.35	0.5	V
I _I	Input Current @ Max Input Voltage	I _{OL} = 4 mA, V _{CC} = Min		0.25	0.4	mA
I _{IH}	HIGH Level Input Current	V _{CC} = Max, V _I = 7V			20	μA
I _{IL}	LOW Level Input Current	V _{CC} = Max, V _I = 0.4V			-0.40	mA
I _{OS}	Short Circuit Output Current	V _{CC} = Max (Note 3)	-20		-100	mA
I _{OCH}	Supply Current with Outputs HIGH	V _{CC} = Max		1.6	3.2	mA
I _{OCL}	Supply Current with Outputs LOW	V _{CC} = Max		2.8	5.4	mA

Note 2: All typicals are at V_{CC} = 5V, T_A = 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_{CC} = 5V and T_A = 25°C

Symbol	Parameter	R _L = 2 kΩ				Units
		C _L = 15 pF		C _L = 50 pF		
		Min	Max	Min	Max	
t _{PLH}	Propagation Delay Time LOW-to-HIGH Level Output		13		18	ns
t _{PHL}	Propagation Delay Time HIGH-to-LOW Level Output		10		15	ns

กระดาษทด