

# NAND Logic

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

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

$$AB = \overline{\overline{A} \cdot \overline{B}}$$

$$\overline{AB} = \overline{\overline{A} \cdot \overline{B}}$$

$$\overline{A}\overline{B} = \overline{\overline{A}} \cdot \overline{\overline{B}}$$



# NOR Logic

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

$S_1, S_0$

00

01

10

11

ABS, S<sub>0</sub> | FG

0000 00

0001 00

0010 00

0011 00

0100 10

0101 10

0110 10

0111 10

1000 00

1001 00

1010 00

1011 00

1100 10

1101 10

1110 10

1111 10

A+B	A	B	$\bar{A}$	$\bar{B}$	A+B	AB	$\bar{A}B$	$A\bar{B}$	$\bar{A}\bar{B}$	$\overline{AB}$	$\overline{A+B}$	$\overline{A+B}$	$\overline{A+B}$
1	0	0	1	1	0	0	0	0	1	1	1	0	1
0	0	1	1	0	1	0	1	0	0	1	1	0	1
0	1	0	0	1	1	0	0	1	0	1	0	1	1
0	1	1	0	0	1	1	0	0	0	0	1	1	0
0	0	0	1	1	1	1	0	0	0	0	0	1	0
0	0	1	1	0	1	0	1	0	0	1	1	0	1
0	1	0	0	1	1	0	0	1	0	0	1	1	0
0	1	1	0	0	1	0	1	0	0	0	1	1	0
1	0	0	0	0	1	0	0	0	1	1	1	0	1
0	1	0	0	0	1	0	1	0	0	1	1	0	1
0	0	1	0	0	1	0	0	1	0	1	1	0	1
0	0	0	1	0	1	1	0	0	0	0	1	1	0
0	0	0	0	1	1	1	0	0	0	0	0	1	1
0	0	1	0	1	1	0	1	0	0	1	1	0	1
0	1	0	1	0	1	0	0	1	0	0	1	1	0
0	1	1	0	1	1	0	0	1	0	0	1	1	0
1	0	0	0	0	0	1	0	0	1	1	1	0	1
0	0	1	0	0	0	1	0	1	0	1	1	0	1
0	0	0	1	0	0	1	0	0	1	1	1	0	1
0	0	0	0	1	0	1	1	0	0	0	1	1	0
0	0	1	0	1	0	1	0	1	0	0	1	1	0
0	1	0	1	0	0	0	1	0	0	1	1	0	1
0	1	1	0	1	0	0	0	1	0	0	1	1	0
1	0	0	0	0	0	0	1	0	1	1	1	0	1
0	0	1	0	0	0	0	1	0	1	1	1	0	1
0	0	0	1	0	0	0	1	0	0	1	1	0	1
0	0	0	0	1	0	0	1	1	0	0	1	1	0
0	0	1	0	1	0	0	1	0	1	0	1	1	0
0	1	0	1	0	0	0	0	1	0	1	1	0	1
0	1	1	0	1	0	0	0	0	1	0	1	1	0
1	0	0	0	0	0	0	0	1	1	1	1	0	1
0	0	1	0	0	0	0	0	1	1	1	1	0	1
0	0	0	1	0	0	0	0	1	0	1	1	0	1
0	0	0	0	1	0	0	0	1	1	0	1	1	0
0	0	1	0	1	0	0	0	1	0	1	1	0	1
0	1	0	1	0	0	0	0	0	1	1	1	0	1
0	1	1	0	1	0	0	0	0	0	1	1	0	1
1	0	0	0	0	0	0	0	0	1	1	1	1	0
0	0	1	0	0	0	0	0	0	1	1	1	1	0
0	0	0	1	0	0	0	0	0	1	0	1	1	0
0	0	0	0	1	0	0	0	0	1	1	0	1	0
0	0	1	0	1	0	0	0	0	1	0	1	1	0
0	1	0	1	0	0	0	0	0	0	1	1	1	0
0	1	1	0	1	0	0	0	0	0	0	1	1	0

CL2-4

ABC'D	fgh	E
0000	100	0
0001	011	1
0010	010	1
0011	010	1
0100	001	1
0101	001	1
0110	001	1
0111	001	1
1000	000	1
1001	111	1
1010	111	1
1011	111	1
1100	000	1
1101	000	1
1110	000	1
1111	111	1

$$F = \overline{ABC'D}$$

$$g = \overline{ABC'D} + \overline{ABC'D} + \overline{ABC'D} = \overline{ABD} + \overline{ABC}$$

$$h = \overline{ACD} + \overline{AB}$$

ABC	FGE	
000	100	
001	101	
010	011	
011	011	
100	001	
101	101	
110	001	
111	101	

$$F = \overline{AB} + AB + C$$

$$A \oplus B + C$$

$$G = \overline{ABC}$$

$$E = C + B + A = \overline{ABC}$$

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<u>ABC</u>	<u>FG</u>	<u><math>C_{in}</math></u>	<u>AB</u>	<u>FG</u>	<u><math>C_{out}</math></u>	<u><math>I_b(x+1)</math></u>	<u><math>C_{in}</math></u>	<u>AB</u>	<u>CD</u>	<u>FG</u>	<u><math>C_{out}</math></u>	<u><math>C_{out}</math></u>
000	00	0	0	00	00	0	0	00	00	00	00	0
001	01	0	1	00	01	0	0	00	01	00	00	0
010	10	0	0	01	10	0	0	00	10	00	00	0
011	11	0	1	10	00	-	0	00	11	00	00	0
100	00	1	1	10	01	-	0	01	00	00	00	0
101	01	1	0	11	10	0	0	01	00	00	00	0
110	10	1	1	11	11	1	0	01	10	00	00	0
111	11	1	1	11	11	1	0	10	10	11	11	1

~~⊕~~  $F = \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$   
 $= \bar{A}B + AB = B$

$G = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + ABC$   
 $= \bar{A}C + AC = C_{in}$

$C_{out} = A$

<u>ABC</u>	<u>FG</u>	<u><math>C_{out}</math></u>	$\rightarrow \log_2(x+1)$
000	00	0	$\log_2(0+1) = 0$
001	01	0	$\log_2(1+1) = 1$
010	01	0	$\log_2(2+1) = 1.5$
011	10	0	$\log_2(3+1) = 2$
100	10	0	$\log_2(4+1) = 3$
101	10	0	
110	10	0	
111	00	1	

<u>AB</u>	<u>F</u>	<u><math>C_{out}</math></u>	$\log_2(x+1)$
00	0	0	$\log_2(0+1) = 0$
01	1	0	$\log_2(1+1) = 1$
10	1	0	$\log_2(2+1) = 2$
11	0	1	$\log_2(4+1) = 3$

<u>AB</u>	<u>FG buffer</u>
00	00
01	01
10	10
11	11

$ABCD$

<u>ABCD</u>	<u>FG</u>	<u><math>C_{out}</math></u>	$\log_2(x+1)$
0000	00	0	0
0001	01	0	1
0010	01	0	1.5
0011	10	0	2
0100	10	0	2.5
0101	10	0	3
0110	11	0	3.5
0111	00	1	4
1000	11	0	4.5
1001	11	0	5
1010	11	0	5.5
1011	01	1	6
1100	11	0	6.5
1101	10	1	7
1110	11	0	7.5
1111	11	1	8

<u>CAB</u>	<u>FG</u>	<u><math>C_{out}</math></u>
000	00	0
001	00	0
010	01	0
011	10	0
100	11	1
101	11	1
110	11	1
111	11	1

$$\bar{A}\bar{B} + \bar{A}B + A\bar{B} + AB$$

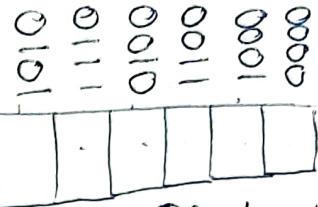
$$\bar{A} + A = 1$$

	1	2	3	
ABC	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	F
000	00	0	0	0
001	01	0	0	0
010	10	0	0	0
011	11	0	0	0
100	00	0	1	0
101	01	0	1	1
110	10	0	1	1
111	11	0	1	1

3-1 MUX

$$\rightarrow \bar{B}S_2\bar{S}_0 + A\bar{S}_1S_0 + \cancel{S_2}S_1S_0C$$

abcd



A	B	F
0	0	0
0	1	1
1	0	0
1	1	1

$$\bar{A}B + AB = B$$

A	B	F
XOR	0	0
OR	0	1
	1	1
	1	0

0	1	2
3	4	5
6	7	8

A	X	Y
0	0	1
1	1	0

$$\bar{A} = \bar{x}y$$

$$A = x\bar{y}$$

1	2	3
4	5	6
7	8	9

AB	A	B	X	Y
01 - 0100 1110	0	0	0	0
10 - 0101 1000*	0	1	1	0

ABC	M <sub>000</sub> , M <sub>011</sub>	XYZ
000	000	000
001	001	001
010	010	010
011	011	011
100	100	100
101	101	101
110	110	110
111	111	111

ABS	F
000	0
001	0
010	0
011	0
100	0
101	0
110	0
111	0

$$F = \cancel{A} \cancel{B} \cancel{S} \cancel{A} \cancel{B} \cancel{S} \cancel{A} \cancel{B} \cancel{S}$$

$$= \cancel{A} \cancel{B} \cancel{S} \cancel{A} \cancel{B} \cancel{S}$$

$$= \cancel{A} \cancel{B} \cancel{S} \cancel{A} \cancel{B} \cancel{S}$$

ABC	F
000	0
001	0
010	0
011	0
100	0
101	0
110	0
111	0

$$AB = x\bar{y}$$

$$A\bar{B} = \bar{x}y$$

AB	X	Y
00	0	0
01	0	1
10	1	0
11	0	0

$$AB = \bar{x}y$$

$$A\bar{B} = x\bar{y}$$

$$M_0 = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}C + ABC$$

$$AC + AC = C$$

$$F = \bar{A}BS + A\bar{B}\bar{S} + AB\bar{S} + ABS$$

$$= BS + A\bar{S}$$

ABC	FG
000	00
001	11
010	10
011	00
100	01
101	00
110	00
111	00

$$F = \bar{A}\bar{B}C + \bar{A}B\bar{C} = \bar{A} \& (B \oplus C)$$

$$G = \bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C} = \bar{B} \& (A \oplus C)$$

A	S	F	G
0	0	0	0
0	1	0	0
1	0	1	0
1	1	0	1

$$F = \bar{A}S$$

$$G = AS$$

ABC	FG
000	00
001	01
010	10
011	00
100	11
101	00
110	00
111	00

$$F = \bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C} = \bar{C} \& (A \oplus B)$$

$$G = \bar{A}\bar{B}C + A\bar{B}C = \bar{B} \& (A \oplus C)$$

$$ABCD \quad FGH = \log_2(x+1)$$

ABCD	FGH
0000	000
0001	001
0010	001
0011	010
0100	010
0101	010
0110	010
0111	011
1000	011
1001	011
1010	011
1011	011
1100	011
1101	011
1110	011
1111	100

AND 0 0000

A	B	$S_2 S_1 S_0$
0	0	000
0	1	001
1	0	010
1	1	011
		100
		101
		110
		111

OR 1 001

XOR 2 010

NAND 3 011

NOR 4 ~~000~~ 100

XNOR 5 101

6 110

7 111

AND 001

OR 000

XOR

$$H = \bar{A}\bar{B}CD + \bar{B}\bar{C}D + \bar{B}C\bar{D} + A\bar{B} + A\bar{C}$$

$$+ AD$$

$$G = \bar{B}CD + \bar{A}B + A\bar{C} + AD$$

$$F = ABCD$$

# ~~Exam 3 notes~~

$$f'(c) = \frac{f(b)-f(a)}{b-a} \quad f'(g(x)) \cdot g'(x)$$

$$\begin{aligned} g &= \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} \\ &= \bar{A}\bar{B}\bar{D}(\bar{C}+C) + \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{D}(\bar{C}+C) \\ &= \bar{A}\bar{B}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{D} \\ &= BD + \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} \\ &= \bar{A}\bar{B}C + BD + AD\bar{C} \end{aligned}$$

$$\begin{aligned} f &= A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} \\ &= A\bar{B}\bar{C} + A\bar{B}\bar{C} \\ &= AC = \bar{\bar{A}\bar{C}} \quad \text{---} \quad \text{---} \quad \text{---} \quad \text{---} \end{aligned}$$

$$\bar{A} + \bar{B} = \bar{AB}, \quad \bar{A} = \bar{AA} = \bar{A} + 0$$

$$A + \bar{B} = \bar{A}\bar{B}, \quad \bar{A} + B = \bar{AB}$$

$$AA = A$$

$$\bar{AA} = \bar{A}$$

AND & NAND table

A	B	AB	$\bar{AB}$	$\bar{A}$	$\bar{B}$	$\bar{A}\bar{B}$	NOR $\bar{AB}$
0	0	0	1	1	1	1	1
1	0	0	1	0	1	0	0
1	1	1	0	0	1	0	0
0	1	0	1	1	0	1	1

$$\bar{A} + \bar{B} + \bar{C} = \bar{AB} + \bar{C} = \bar{A} + \bar{BC} = \bar{ABC}$$

$$\bar{A} + \bar{B} + C = \bar{ABC}$$

$$A + \bar{B} + \bar{C} = \bar{ABC}$$

$$A + B + \bar{C} = \bar{ABC}$$

$$ABC = \bar{ABC}, AB = \bar{AB}$$

$$ABC = \bar{ABC}$$

$$A\bar{B}C = \bar{ABC}$$

$$\bar{A} + \bar{B}$$

|

|

|

0

$$\bar{A}\bar{B} = \bar{A} + \bar{B}$$

$$\bar{A}\bar{B} + A\bar{B} = A \oplus B = \bar{A}\bar{B} + \bar{A}\bar{B} = (\bar{A}\bar{B})(\bar{A}\bar{B}) \text{ XOR}$$

$$\bar{A}\bar{B} + AB = A \odot B = \bar{A}\bar{B} = (\bar{A}\bar{B})(\bar{A}\bar{B}) = (\bar{A}\bar{B})(\bar{A}\bar{B}) = (\bar{A}\bar{B})(\bar{A}\bar{B}) \text{ XNOR}$$

A	B	$A \oplus B$	$A \odot B$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

ABCD	X'YZW	Quotient	Rm	e	numer	denom	quot	rem	c
0110	0000	0000	0000	1	1011	0000	0000	0000	0000
0110	0001	0110	0000	0	1011	0001	0000	0000	0000
0110	0010	0011	0000	0	1011	0010	0000	0000	0000
0110	0011	0010	0000	0	1011	0011	0000	0000	0000
0110	0100	0001	0010	0	1011	0100	0000	0000	0000
0110	0101	0001	0001	0	1011	0101	0000	0000	0000
0110	0110	0001	0000	0	1011	0110	0000	0000	0000
0110	0111	0000	0110	0	1011	0111	0000	0000	0000
0110	1000	0000	0110	0	1011	1000	0000	0000	0000
0110	1001			0	1011	1001	0000	0000	0000
0110	1010			0	1011	1010	0000	0000	0000
0110	1011	F0H		0	1011	1011	0000	0000	0000
0110	1100			0	1011	1100	0000	0000	0000
0110	1101			0	1011	1101	0000	0000	0000
0110	1110			0	1011	1110	0000	0000	0000
0110	1111			0	1011	1111	0000	0000	0000
0111	0000	0000	0000	0	1100	0000	0000	0000	0000
0111	0001	0111	0000	0	1100	0001	0000	0000	0000
0111	0010			0	1100	0010	0000	0000	0000
0111	0011			0	1100	0011	0000	0000	0000
0111	0100			0	1100	0100	0000	0000	0000
0111	0101			0	1100	0101	0000	0000	0000
0111	0110			0	1100	0110	0000	0000	0000
0111	0111			0	1100	0111	0000	0000	0000
0111	1000			0	1100	1000	0000	0000	0000
0111	1001			0	1100	1001	0000	0000	0000
0111	1010			0	1100	1010	0000	0000	0000
0111	1011			0	1100	1011	0000	0000	0000
0111	1100			0	1100	1100	0000	0000	0000
0111	1101			0	1100	1101	0000	0000	0000
0111	1110			0	1100	1110	0000	0000	0000
0111	1111			0	1100	1111	0000	0000	0000
1000	0000			0	1101	0000	0000	0000	0000
1000	0001			0	1101	0001	0000	0000	0000
1000	0010			0	1101	0010	0000	0000	0000
1000	0011			0	1101	0011	0000	0000	0000
1000	0100			0	1101	0100	0000	0000	0000
1000	0101			0	1101	0101	0000	0000	0000
1000	0110			0	1101	0110	0000	0000	0000
1000	0111			0	1101	0111	0000	0000	0000
1000	1000			0	1101	1000	0000	0000	0000
1000	1001			0	1101	1001	0000	0000	0000
1000	1010			0	1101	1010	0000	0000	0000
1000	1011	F0H		0	1101	1011	0000	0000	0000
1000	1100			0	1101	1100	0000	0000	0000
1000	1101			0	1101	1101	0000	0000	0000
1000	1110			0	1101	1110	0000	0000	0000
1000	1111			0	1101	1111	0000	0000	0000
1001	0000			0	1110	0000	0000	0000	0000
1001	0001			0	1110	0001	0000	0000	0000
1001	0010			0	1110	0010	0000	0000	0000
1001	0011			0	1110	0011	0000	0000	0000
1001	0100			0	1110	0100	0000	0000	0000
1001	0101			0	1110	0101	0000	0000	0000
1001	0110			0	1110	0110	0000	0000	0000
1001	0111			0	1110	0111	0000	0000	0000
1001	1000			0	1110	1000	0000	0000	0000
1001	1001			0	1110	1001	0000	0000	0000
1001	1010			0	1110	1010	0000	0000	0000
1001	1011			0	1110	1011	0000	0000	0000
1001	1100			0	1110	1100	0000	0000	0000
1001	1101			0	1110	1101	0000	0000	0000
1001	1110			0	1110	1110	0000	0000	0000
1001	1111			0	1110	1111	0000	0000	0000
1010	0000			0	1111	0000	0000	0000	0000
1010	0001			0	1111	0001	0000	0000	0000
1010	0010			0	1111	0010	0000	0000	0000
1010	0011			0	1111	0011	0000	0000	0000
1010	0100			0	1111	0100	0000	0000	0000
1010	0101			0	1111	0101	0000	0000	0000
1010	0110			0	1111	0110	0000	0000	0000
1010	0111			0	1111	0111	0000	0000	0000
1010	1000			0	1111	1000	0000	0000	0000
1010	1001			0	1111	1001	0000	0000	0000
1010	1010			0	1111	1010	0000	0000	0000
1010	1011			0	1111	1011	0000	0000	0000
1010	1100			0	1111	1100	0000	0000	0000
1010	1101			0	1111	1101	0000	0000	0000
1010	1110			0	1111	1110	0000	0000	0000
1010	1111			0	1111	1111	0000	0000	0000

$$\begin{array}{r} \text{G} \\ \times \text{F} \\ \hline \text{A} \rightarrow = \text{B} \\ \hline \end{array}$$

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$$\begin{array}{c|ccccc} GT & \cancel{AB} & A & B \\ \hline \cancel{AB} & 0 & 0 & - & 0 \\ 0 & 0 & - & 0 & - \\ 0 & 0 & - & 0 & - \end{array}$$

$L$	$T$	$A$	$B$	$A < B$	$\frac{0}{0-0}$
-----	-----	-----	-----	---------	-----------------

Max	$\rightarrow$	F	Q	--	--
		A B	Q Q	Q Q	Q Q

Min $\rightarrow \infty$		F			ABC	
A	B	0	0	0	-	AND
0	0	0	0	1	-	
0	1	0	1	1	1	
1	0	1	0	1	1	
1	1	1	1	1	1	

ABCD	EFGH	XYZW	MNOP	?	0001	0000	0000	0000	1
0000	0000	0000	0000	0	0011	0001	0011	0000	0
0000	0001	0000	0000	0	0011	0010	0001	0001	0
0000	0010	0000	0000	0	0011	0011	0001	0000	0
0000	0011	0000	0000	0	0011	0100	0000	0011	0
0000	0100	0000	0000	0	0011	0101	0000	0011	0
0000	0101	0000	0000	0	0011	0110	0000	0011	0
0000	0110	0000	0000	0	0011	0111	0000	0011	0
0000	0111	0000	0000	0	0011	1000	0000	0011	0
0000	1000	0000	0000	0	0011	1001	0000	0011	0
0000	1001	0000	0000	0	0011	1010	0000	0011	0
0000	1010	0000	0000	0	0011	1011	0000	0011	0
0000	1011	0000	0000	0	0011	1100	0000	0011	0
0000	1100	0000	0000	0	0011	1101	0000	0011	0
0000	1101	0000	0000	0	0011	1110	0000	0011	0
0000	1110	0000	0000	0	0011	1111	0000	0011	0
0000	1111	0000	0000	0	0100	00000	0000	0000	01
0001	00000	0000	0000	1	0100	00001	0100	0000	0
0001	00001	0001	0000	0	0100	00011	0100	0000	0
0001	00010	0006	0000	0	0100	00010	0010	0000	0
0001	00011	0000	0000	0	0100	00111	0001	0001	0
0001	00100	0000	0001	0	0100	0100	0001	0000	0
0001	00101	0000	0001	0	0100	0101	0000	0100	0
0001	00110	0000	0001	0	0100	0110	0000	0100	0
0001	00111	0000	0001	0	0100	0111	0000	0100	0
0001	01000	0000	0001	0	0100	0100	0001	0000	0
0001	01001	0000	0001	0	0100	0101	0000	0100	0
0001	01010	0000	0001	0	0100	01010	0000	0100	0
0001	01011	0000	0001	0	0100	01011	0000	0100	0
0001	01100	0000	0001	0	0100	1000	0000	0100	0
0001	01101	0000	0001	0	0100	1001	0000	0100	0
0001	01110	0000	0001	0	0100	1100	0000	0100	0
0001	01111	0000	0001	0	0100	1111	0000	0100	0
0010	00000	0000	0000	1	0101	00000	0	0	1
0010	00001	0010	0000	0	0101	00001	0101	0000	0
0010	00010	0001	0000	0	0101	0010	0010	0001	0
0010	00011	0000	0010	0	0101	0011	0001	0010	0
0010	01000	0000	0010	0	0101	0100	0001	0001	0
0010	01001	0000	0010	0	0101	0101	0001	0000	0
0010	01010	0000	0010	0	0101	0110	0000	0101	0
0010	01011	0000	0010	0	0101	0111	0000	0101	0
0010	10000	0000	0010	0	0101	1000	0000	0101	0
0010	10001	0000	0010	0	0101	1001	0000	0101	0
0010	10100	0000	0010	0	0101	1010	0000	0101	0
0010	10111	0000	0010	0	0101	1011	0000	0101	0
0010	11000	0000	0010	0	0101	1100	0000	0101	0
0010	11011	0000	0010	0	0101	1101	0000	0101	0
0010	11110	0000	0010	0	0101	1110	0000	0101	0
0010	11111	0000	0010	0	0101	1111	0000	0101	0

~~AB~~

~~CD~~

P<sub>1</sub> P<sub>2</sub>  
f g

00 invalid  
01 rock  
10 paper  
11 scissors

00	00	00
01	01	00
10	10	00
11	11	00

rock

$$\begin{array}{ccc} 01 & 10 & 01 \\ 01 & 11 & 10 \end{array} \quad \bar{A}\bar{B}C\bar{D} = \bar{F}g \ 2$$

$$\bar{A}\bar{B}C\bar{D} = \bar{F}g \ 1$$

paper

$$\begin{array}{ccc} 10 & 01 & 10 \\ 10 & 11 & 01 \end{array} \quad A\bar{B}\bar{C}D = F\bar{g} \ 1$$

$$A\bar{B}\bar{C}D = \bar{F}g \ 2$$

scissors

$$\begin{array}{ccc} 11 & 01 & 01 \\ 11 & 10 & 10 \end{array} \quad A\bar{B}\bar{C}D = \bar{F}g \ 2$$

$$A\bar{B}C\bar{D} = F\bar{g} \ 1$$

$$\bar{A}\bar{B}C\bar{D} + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} = F$$

$$BC(\bar{A}D + A\bar{D}) + A\bar{B}\bar{C}D$$

A ⊕ D

$$\bar{A}\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}D = g$$

$$\bar{A}\bar{B}C\bar{D} + AD(\bar{B}C + B\bar{C}) = g$$

B ⊕ C



A	B	S	F
0	0	0	0

0	1	0	1	$\bar{A}\bar{B}\bar{S} + A\bar{B}S + ABS$
1	0	1	1	$\bar{A}\bar{B}\bar{S} + AS$
1	1	1	0	

$A B C D$	$E F G H$	$X Y Z W$	$f$	$e$
0000	0000	0 0 0 0	1	=
1111	0000	0 0 0 0	1	$= \bar{E} \bar{F} \bar{G} \bar{H} = e$
0000	0001	0 0 0 0		
1111		A B C D		$= A B C D$
0001		0 0 0 1	$\bar{A} \bar{B} \bar{C} \bar{D} + \bar{E} \bar{F} \bar{G} \bar{H} = f$	
0010		0 0 1 0		
0011		0 0 1 1		
0100		0 1 0 0		
0101		0 1 0 1		
0110		0 1 1 0		
0111		0 1 1 1		
1000				
1001		A B C D	F G E	A B C D F G E
1010		0 0 0 0	0 0 1	1 1 0 1 1 1 0
1011		0 0 0 1	0 0 0	1 1 1 0 0 1 0
1100		0 0 1 0	0 0 0	1 1 1 1 0 1 0
1101		0 0 1 1	0 0 0	
1110		0 1 0 0	0 0 1	$\bar{A} \bar{B} \bar{C} \bar{D} + \bar{A} \bar{B} \bar{C} \bar{D} + \bar{A} \bar{B} \bar{C} \bar{D} +$
1111		0 1 0 1	0 1 0	$\bar{A} \bar{B} \bar{C} \bar{D} = E = \bar{C} \bar{D}$
		0 1 1 0	0 0 0	$\bar{A} \bar{B} \bar{C} \bar{D} + \bar{A} \bar{B} \bar{C} \bar{D} + \bar{A} \bar{B} \bar{C} \bar{D} + \bar{A} \bar{B} \bar{C} \bar{D}$
		0 1 1 1	0 0 0	$+ A B C D = G = \bar{B} \bar{C} \bar{D} + A C \bar{D} + A B C$
		1 0 0 0	0 0 1	
		1 0 0 1	1 0 0	$\bar{A} \bar{B} \bar{C} \bar{D} + A B \bar{C} \bar{D} = F = A \bar{C} \bar{D}$
		1 0 1 0	0 1 0	
		1 0 1 1	0 0 0	
		1 1 0 0	0 0 1	