K-Map → Minimization techique.

↳ Gray code. ⟶

	Binary	Gray
0	0 0	0 0
1	0 1	0 1
2	1 0	1 1
3	1 1	1 0

Binary → Gray

B = 1 0 1 1 1

G = 1 1 1 0 0

Gray 1 1 1 0 0

Binary 1 0 1 1 1 → 10111

K-Map.

A \ B	0 $\bar{B}$	1 B
0 $\bar{A}$	00	01
1 A	10	11

A \ BC	00 $\bar{B}\bar{C}$ 0	01 $\bar{B}C$ 1	11 BC 3	10 $B\bar{C}$ 2
0 $\bar{A}$				
1 A				

	00 $\bar{C}\bar{D}$	01 $\bar{C}D$	11 CD	10 $C\bar{D}$
00 $\bar{A}\bar{B}$	0	1	3	2
01 $\bar{A}B$	4	5	7	6
11 AB	12	13	15	14
10 $A\bar{B}$	8	9	11	10

we have to find neighbor.
when only 1 bit is different

No diagonal relation if more than 1 bit diff.

$AB + \bar{A}B$

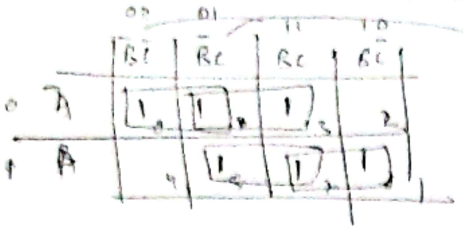
	$\bar{B}$	B
$\bar{A}$		1
A		1

→ Common is B Ans

~~F = AC + B̄ + BD + BC~~

$f(A,B,C) = \Sigma m(0,1,3,5,6,7)$

$\bar{A}\bar{B}\bar{C},\ \bar{A}\bar{B}C,\ \bar{A}BC,\ A\bar{B}C,\ AB\bar{C},\ ABC$



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

$\bar{A}\bar{B} + AB + \underbrace{(\bar{A}+A)}_{1}C$

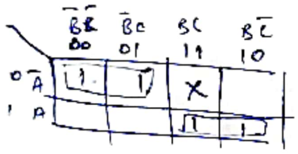
$\bar{A}\bar{B} + AB + C$

★ Least no. of groups and large groups possible.

larger group → lesser variable.

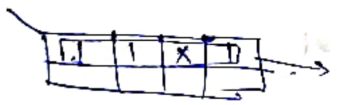
Don't Care → Combination of inputs on which o/p may or may not depend

$f(A,B,C) = \Sigma m(0,1,6,7) + \Sigma d(3)$



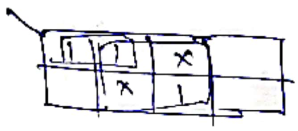
$\bar{A}\bar{B} + AB$

$\Sigma m(0,1,2) + \Sigma d(3)$



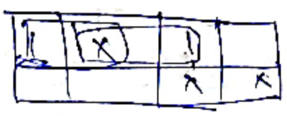
$\bar{A}$

$\Sigma m(0,1,7) + \Sigma(3,5)$

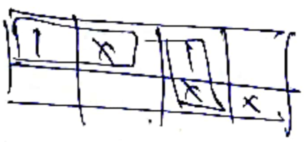


$\bar{A}\bar{B} + BC$

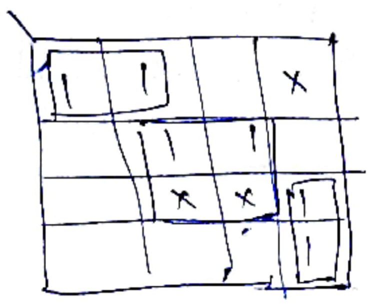
★.



✓ $\bar{A}\bar{B} + \bar{A}C$

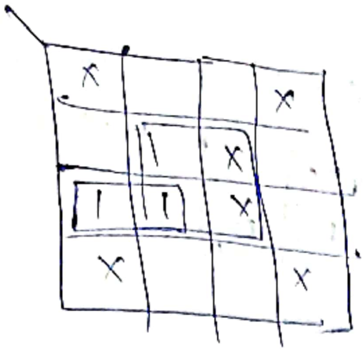


$\bar{A}\bar{B} + BC$ ✗

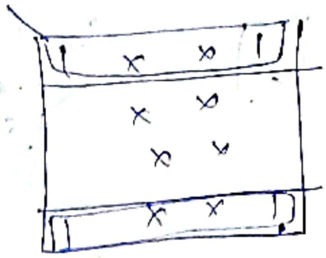


$\bar{A}\bar{B}\bar{C} + BD + AC\bar{D}$

Scanned with OKEN Scanner

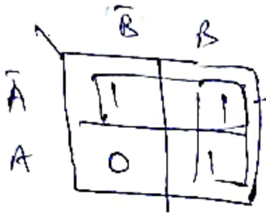


1 quad
1 pair.



$f(A,B) = \bar{A}\bar{B} + \bar{A}B + AB = \Sigma m(0,1,3)$

$= \bar{A}\cdot\bar{B}\cdot 1 + \bar{A}B\cdot 1 + A\bar{B}\cdot 0 + AB\cdot 1$



$\rightarrow \bar{A}\cdot 1 + B\cdot 1$

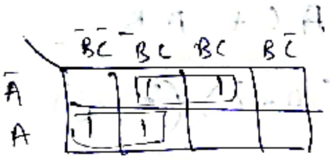
$= \bar{A} + B$

$f(A,B,C) = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}$

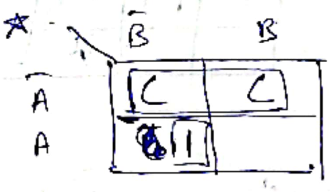
↓ To standard canonical form

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

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

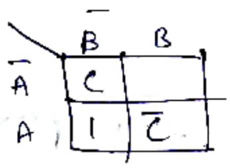


$\rightarrow A\bar{B} + \bar{A}C$



$\bar{A}\cdot C + A\bar{B}$ Ans

6

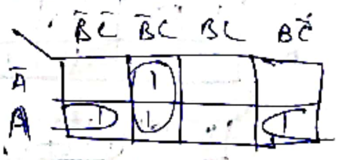


function is

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

↓

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



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

Boolean Alg

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

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

$= \bar{B}C(\bar{A}+A) + A\bar{B}\bar{C} + AB\bar{C}$

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

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

or

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

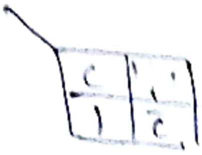
$= \bar{B}[\bar{A}C + A] + A[\bar{B} + B\bar{C}]$

$= \cancel{\bar{B}[\bar{A}A + AC]}$

$= \bar{B}[(\bar{A}+A)(A+C)] + A[(\bar{B}+B)(\bar{B}+\bar{C})]$

$= \bar{B}[A+C] + A[\bar{B}+\bar{C}]$

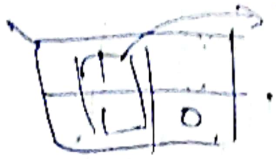
$= \bar{B}C + A\bar{C}$



Case-1 $C = 0$

$\to A\bar{C}$

$C = 1$



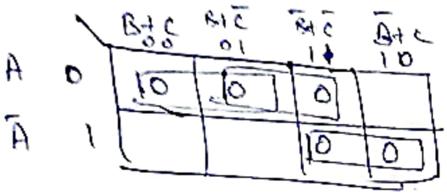
$\to \bar{B} \cdot C$

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

POS

$F(A,B,C) = \Pi M(0,1,3,6,7)$

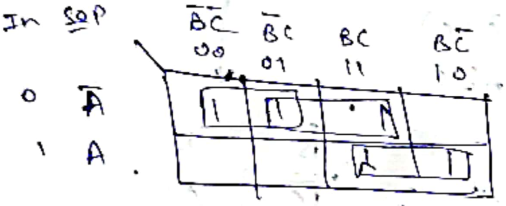
$= (A+B+C)(A+B+\bar{C})(A+\bar{B}+\bar{C})(\bar{A}+\bar{B}+C)(\bar{A}+\bar{B}+\bar{C})$



$(A+B+0)(A+\bar{C}+0)(\bar{A}+\bar{B}+0)$

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

In SOP



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

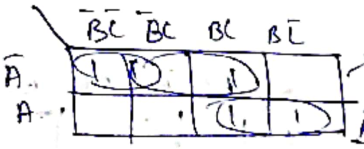
$\overline{\qquad\qquad\qquad\qquad}$

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

Implicants - Prime Implicants - Essential Prime Implicants

↳ Terms in common

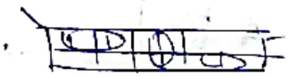
$f(A,B,C) = \Sigma m(0,1,3,6,7)$



→ 3 pair

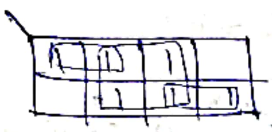
Total implicants = 5 → No. of terms

$\bar{A}\bar{B} + AB + \bar{A}C$ → Reduced PI (RPI)



→ 3 pair = 4 pair. As $\bar{A}BC = 1$ can pair in two ways. And rest are same

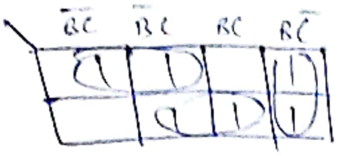
$\bar{A}\bar{B} + AB + BC$



Implicants = 6 ∴ EPI = $\{\bar{A}\bar{B} + AB\}$

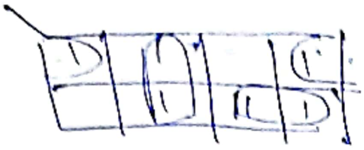
PI = 3 → EPI = $\{\bar{A}\bar{B}, C, AB\}$

∴ Total no. of possible ways to form pair is Prime I



$\rightarrow \bar{A}\bar{B} + AC + B\bar{C}$

No common.

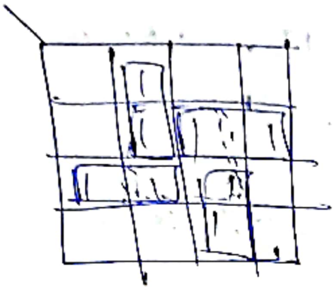


$\bar{A}\bar{C} + \bar{B}C + AB$

$\therefore$ PI = 6

I = 6.

EPI = 0, No term in common



I = 8

PI = 4 + 1 = 5

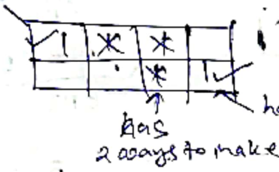
If only one answer is possible all is EPI.

EPI = 4

$\langle \bar{A}CD, \bar{A}BC, ACD, AB\bar{C} \rangle$

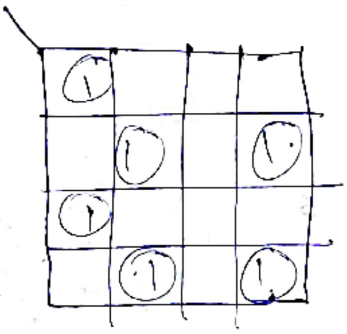
But after making 1's group by don't make small group inside it

EPI can also be checked by the no. of 1's can have only 1 possibility to make pair.



= EPI = 2.

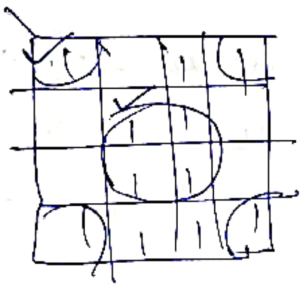
★.



I = 6

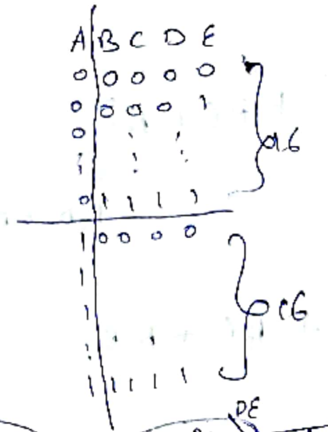
PI = 6

EPI = 6.

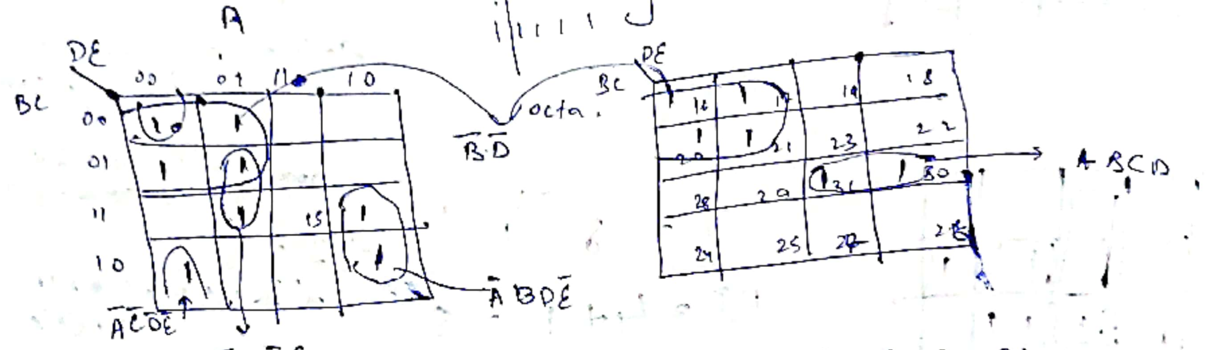


$\bar{B}\bar{D}$, BD EPI.

5 variable K-Map.



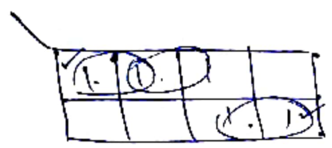
A

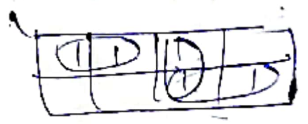


In octa 3 variable reduced

0, 1, 4, 5, 8, 10, 13, 14, 16, 17, 20, 21, 30, 31

∴ $\bar{B}\bar{D} + \bar{A}\bar{C}\bar{D}\bar{E} + \bar{A}C\bar{D}E + \bar{A}BD\bar{E} + ABCD$.





$\underbrace{\bar{A}\bar{B} + AB}_{EPI} + \underbrace{\bar{A}C}_{SPI}$ this is RPI

$\underbrace{\bar{A}\bar{B} + AB}_{EPI} + \underbrace{BC}_{RPI}$ or this is SPI

I = 5 PI = 4 EPI = 2

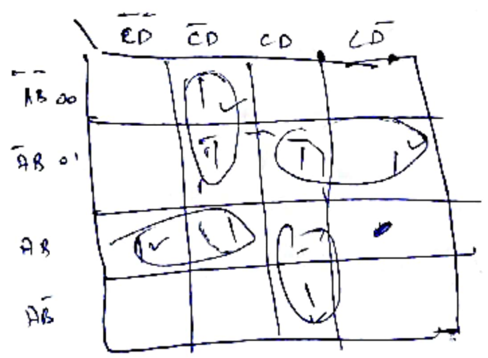
PI = ⟨$\underbrace{\bar{A}\bar{B}, AB}_{EPI}$, $\bar{A}C$, BC⟩

Selective PI = 1

Reduced PI = 1

Reduced PI means not common.

SPI is Answer having 2 part. EPI & SPI
(common part) (In answer but not common)



I = 8

PI = 5 ⟨$\bar{A}\bar{C}D$, $\bar{A}B\bar{C}$, $AB\bar{C}$, ACD, BD⟩

EPI = 4 ⟨$\bar{A}\bar{C}D$, $\bar{A}BC$, $AB\bar{C}$, ACD⟩ Ans er also.

∴ SPI = 0 No SPI.

RPI = 1 ⟨BD⟩ ...

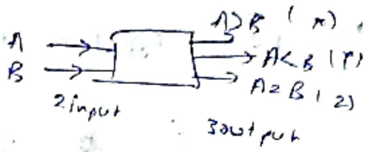
Combinational Circuit

- Circuit without feedback or memory.
- Static Circuit.

Steps

1. Find the no. of inputs & outputs.
2. Write the truth table.
3. Write the Logical Expression.
4. Minimization.
5. Hardware Implementation.

1. Design a one bit Comparator.



Step 2.

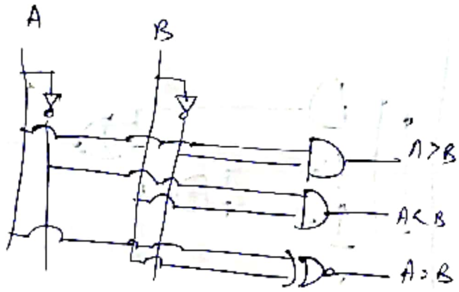
	A	B	A>B X	A<B Y	A=B Z
$\bar{A}\bar{B}$	0	0	0	0	1
$\bar{A}B$	0	1	0	1	0
$A\bar{B}$	1	0	1	0	0
AB	1	1	0	0	1

$\therefore X = A\bar{B}$ $\quad Y = \bar{A}B$ $\quad Z = \bar{A}\bar{B} + AB$

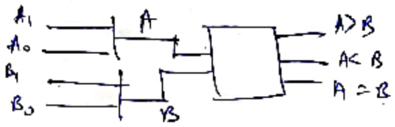
$= A \odot B$

Step 4 No minimization possible

5



2 Design a 2 bit Comparator.



	A_1	A_0	B_1	B_0	A>B X	A<B Y	A=B Z	
0	0	0	0	0	0	0	1	z
1	0	0	0	1	0	1	0	
2	0	0	1	0	0	1	0	
3	0	0	1	1	0	1	0	
4	0	1	0	0	1	0	0	x
5	0	1	0	1	0	0	1	z
6	0	1	1	0	0	1	0	
7	0	1	1	1	0	1	0	
8	1	0	0	0	1	0	0	x
9	1	0	0	1	1	0	0	x
10	1	0	1	0	0	0	1	z
11	1	0	1	1	0	1	0	
12	1	1	0	0	1	0	0	x
13	1	1	0	1	1	0	0	x
14	1	1	1	0	1	0	0	x
15	1	1	1	1	0	0	1	z

☆ $X = \Sigma m(4, 8, 9, 12, 13, 14)$

$Y = \Sigma m(1, 2, 3, 6, 7, 11, \cancel{15})$

$Z = \Sigma m(0, 5, 10, 15)$

Total 16 combination. 2^4

equal values = 4

$X > Y = X < Y = 16 - 4/2$

$= 6$

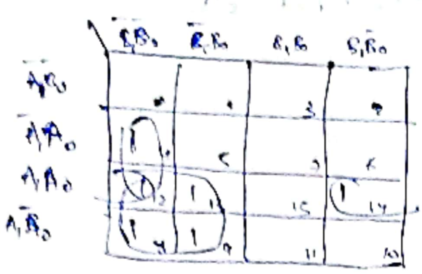
0 1 2 3 4
↓ ↓ ↓ ↓ ↓
1+1+2+4+8

$\boxed{\text{For 4 bit } 1+1+2=4}$

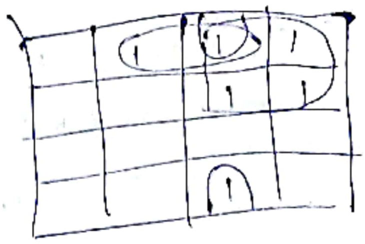
1 ← 00 00
1 — 01 01
2 { 10 10
11 11

Minimization.

X



Y



$A_1\bar{B}_1 + A_0\bar{B}_1\bar{B}_0 + A_1A_0\bar{B}_0$

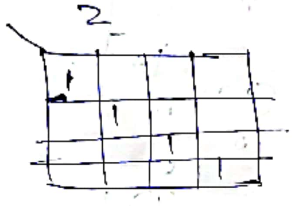
$X = A_1\bar{B}_1 + A_0B_0(A_1+\bar{B}_1)$

$\bar{A}_1B_1 + \bar{A}_1\bar{A}_0B_0 + \bar{A}_0B_1B_0$

$Y = \bar{A}_1B_1 + B_0\bar{A}_0(\bar{A}_1+B_1)$

Z =

Z

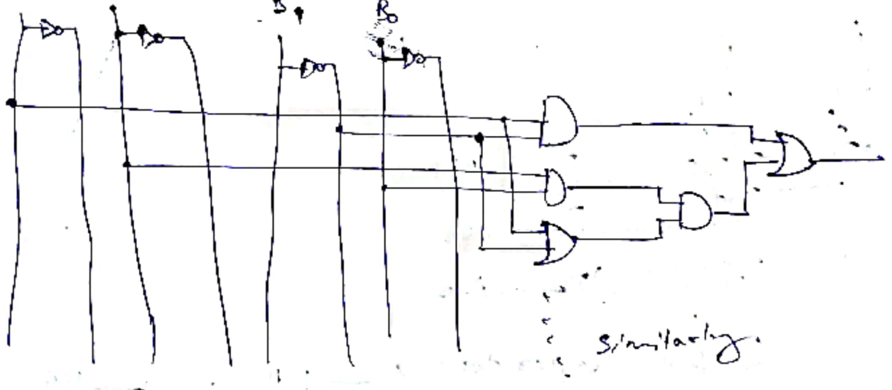


$\rightarrow \bar{A}_1\bar{A}_0\bar{B}_1\bar{B}_0 + \bar{A}_1A_0\bar{B}_1B_0$

$+ A_1A_0B_1B_0 + A_1\bar{A}_0B_1\bar{B}_0$

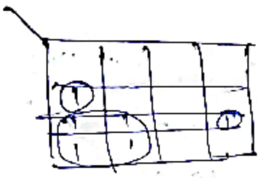
$\rightarrow \bar{A}_1\bar{B}_1(\bar{A}_0\bar{B}_0 + A_0B_0) + A_1B_1(A_0B_0$

$Z = (A_1 \odot B_1)(A_0 \odot B_0)$



Similarly.

Short cut:



$A_1\bar{B}_1 + \bar{A}_1A_0\bar{B}_1\bar{B}_0 + A_1A_0B_1\bar{B}_0$

$\Rightarrow A_1\bar{B}_1 + (A_1\odot B_1)A_0\bar{B}_0 \longrightarrow X \quad A>B$

Similarly $Y = \bar{A}_1B_1 + (A_1\odot B_1)\bar{A}_0B_0$

Main Shortcut:

A → A_1, A_0 B → B_1, B_0

A_1	A_0	B_1	B_0
5	4	4	9
4	9	4	7

★ when smaller bar is given

4 > 2
A B
n B.

$X (A>B) = MSB$.
↓
$A_1 \bar{B}_1$

MSB = MSB than LSB's
↓
$(A_1 \odot B)(A_0 \bar{B}_0)$ must be smaller bar '–' must there.

$Y (A<B) = \underbrace{\bar{A}_1 B_1} + \underbrace{(A_1 \odot B)(\bar{A}_1 B_0)}$

52 69
$A_1 > B_1$
∴ $\bar{A}_1 B_1$

Example 42 47
2>7
$A_0 > B_0$ ∴ $\bar{A}_0 B_0$

$Z (A=B) = 42 = 42$.

∴ $(A_1 \odot B_1)(A_0 \odot B_0)$

For 3 bit.

A → A_2, A_1, A_0 B → B_2, B_1, B_0

$A>B$ $A_2 \bar{B}_2 + (A_2 \odot B)A_1 \bar{B}_1 + (A_2 \odot B_2)(A_2 \odot B_2) A_0 \bar{B}_0$

when $A_n = B_n$

# 1 bit comparator.		2 bit	3 bit	n bit
Total combination =	4	16	64	2^{2n}
equal condition =	2	4	8	2^n
Un equal =	2	12	56	$2^{2n}-2^n$
Greater = Less Condition =	1	6	28	$(2^{2n}-2^n)/2$

★. A → 3 bit B → 2bit

A>B?

A_2	A_1	A_0	B_1	B_0
0	0	0	0	0
0	0	0	0	1
0	0	0	1	0
0	0	0	1	1
0	0	1	0	0
0	1	1	1	1
1	0	0	0	0
1	1			
1				
1				

16 → compair between $A_1 A_0$ & $B_1 B_0$
Basically 2 bit compair.
combination $2^4 = 16$
equal $= 2^2 = 4$
∴ $A>B = (16-4)/2$
$= 6$

2^5 combination. = 32

16 : Allways A>B

∴ A>B
16+6
= 22

#

$A \to 5$ bit

$B \to 3$ bit

A	B	
0 0 0 0 0	0 0 0	
0 0 0 0 0	0 0 1	128
1		
0 1 0 0 0	1 0 0 0	
1		
0 1 1 1 1		
1 0 0 0 0	0 0 0	
1	1 1 1	128
1	1 1 1 1	
1 1 1 1 1	1 1 1 1	

Total combination $= 2^{5+3} = 256$.

$A_4 > B_4 \to 256/2 = 128$.

$A_3 > B_3 \to 128/2 = 64$.

Now $A_2 A_1 A_0 > B_2 B_1 B_0$

Basically 3 bit comparison

$\therefore$ Total combo $= 2^{3+3} = 2^6 = 64$

equal $2^3 = 8$

$A > B = (64-8)/2 \Rightarrow 56/2$

$= 28$

$\therefore$ $\underline{\underline{A > B}}$ $128 + 64 + 28 = 220$