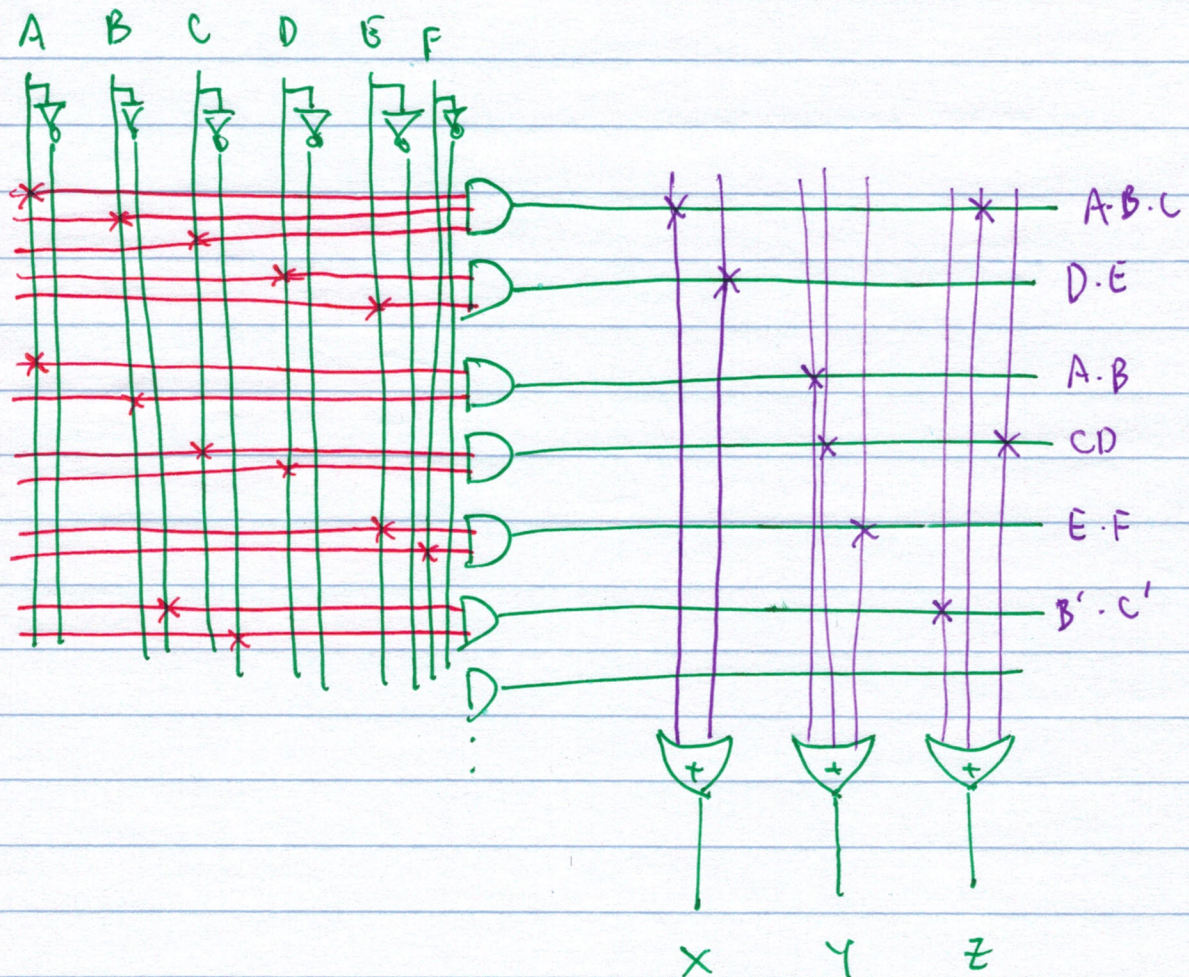


Ex: $X = ABC + DE$

$Y = AB + CD + EF$

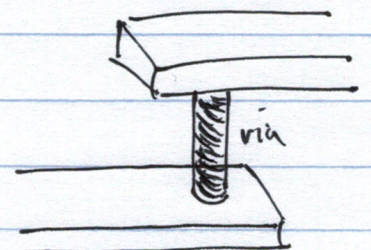
$Z = B'C' + ABC + CD$



How are connections made?

- custom chip - include : diode, transistor, via

- one-time programmable (OTP)
 - fuse or anti-fuse



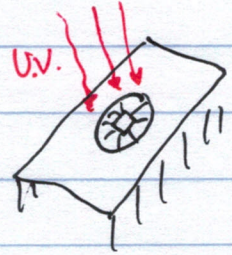
- Programmable

- Temporarily, Volatile : while power is on

- ~~Temporary~~ Permanent until erased, Non-volatile

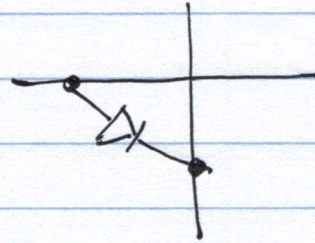
- U.V. light to erase

- Flash

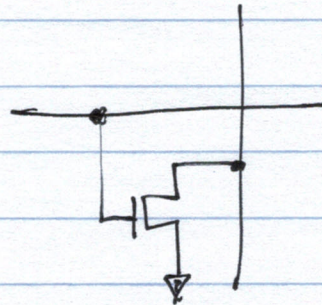


Circuits

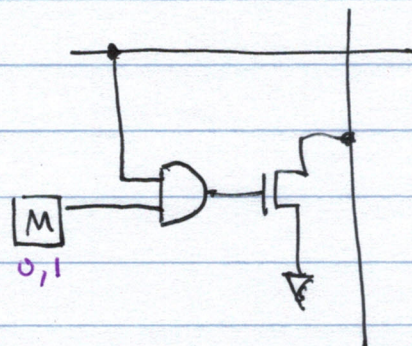
- Diode

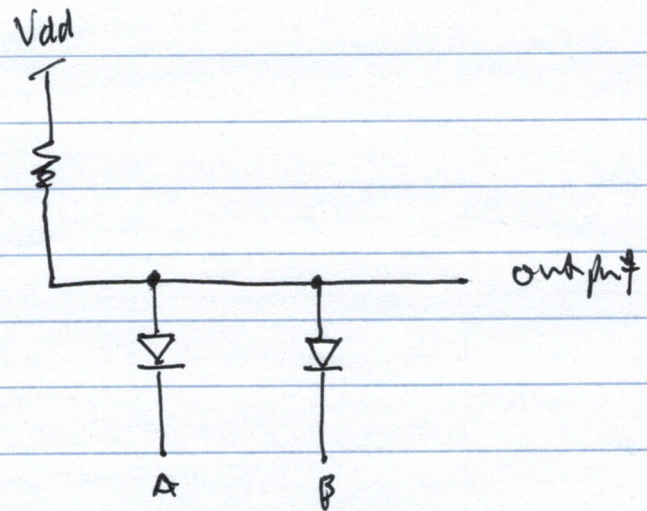


- FET



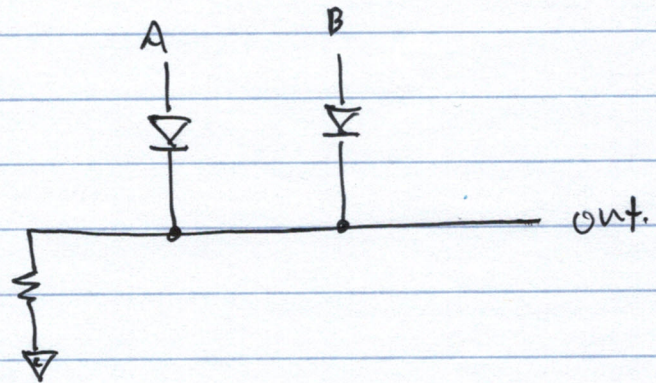
- Programmable



Wired AND

$A=0, B=X \rightarrow out=0$
 $A=X, B=0 \rightarrow out=0$
 $A=1, B=1 \rightarrow out=1$

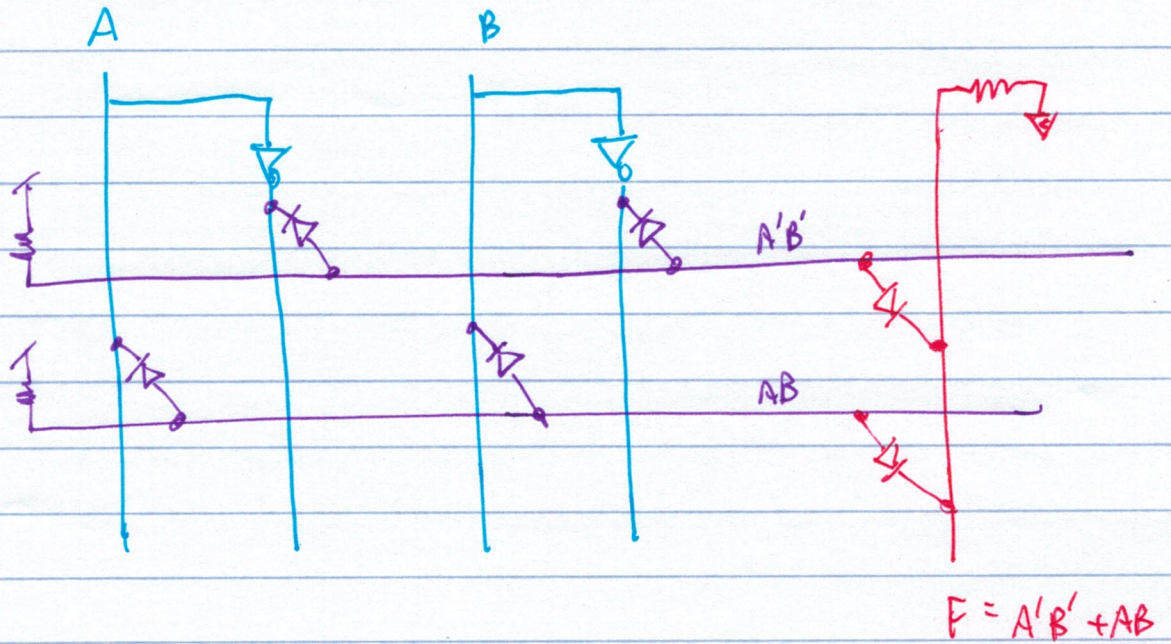
} A & B

Wired OR

$A=1, B=X \rightarrow out=1$
 $A=X, B=1 \rightarrow out=1$
 $A=0, B=0 \rightarrow out=0$

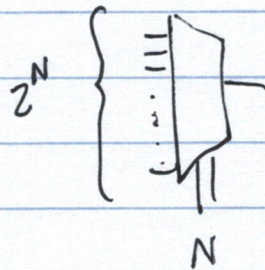
} A OR B

Ex: $F = A'B' + AB$



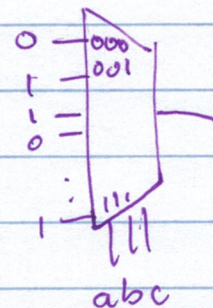
PAL - fixed OR array

• Mux



A) T.T.

a	b	c	z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	1	1	1

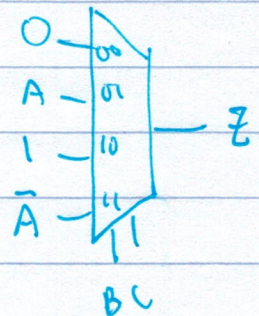
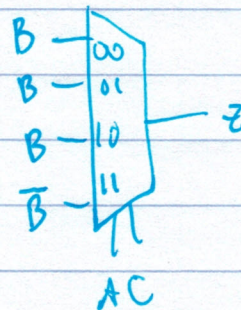
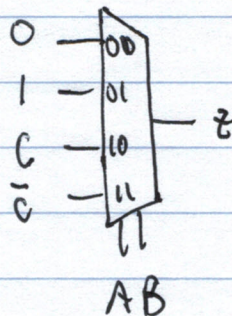


key concept

mux inputs = $2^{\text{Num. of input bits}}$

B) # of max inputs = $\frac{1}{2} \cdot 2^{\text{num of input bits}}$

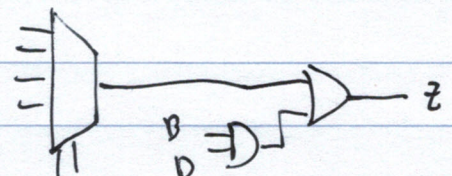
A	B	C	z	
0	0	0	0	} AB=00, z=0
0	0	1	0	
0	1	0	1	} AB=01, z=1
0	1	1	1	
1	0	0	0	} AB=10, z=C
1	0	1	1	
1	1	0	1	} AB=11, z=C̄
1	1	1	0	



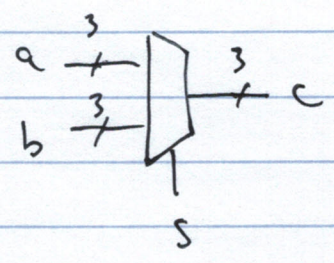
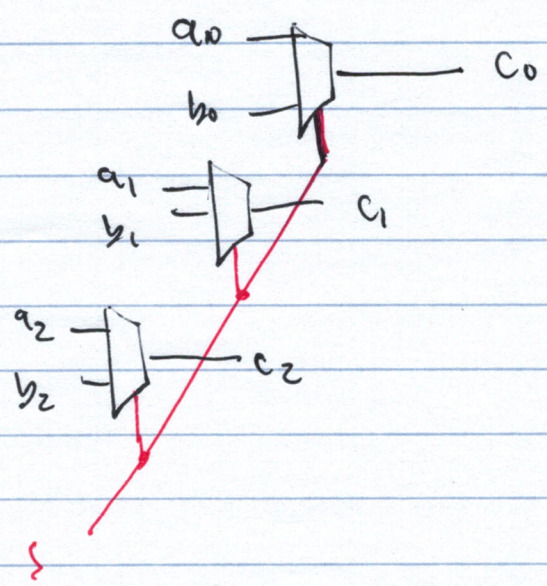
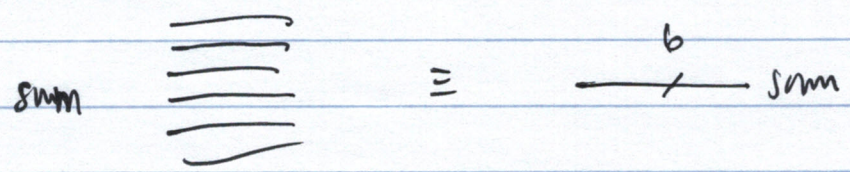
c) see notes

- 2) 1) Find SOP or POS
2) Use mux to implement a sub-term

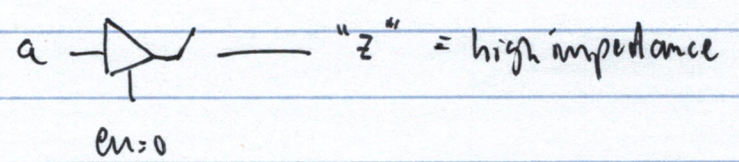
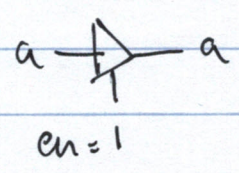
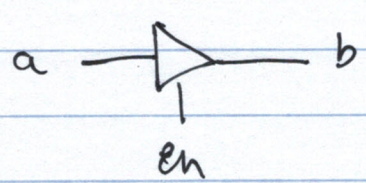
Ex: $z = AC'D + BD$



Bw notation



Three-state buffers

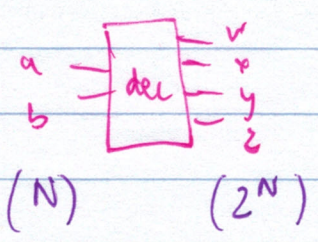


		Transistors per chip	Ex	Cost (high vol.)
SSI	Small Scale Integration	$\sim 10^3$	INV, NAND	\$1
MSI	Medium " "	$\sim 10^3 - 10^4$	adder, counter	\$1.50
LSI	Large " "	$\sim 1M$	simple microcontroller	few \$
VLSE	Very large " "	$\sim 1-10M$	proc, main	\$10+
ULSI	Ultra " "	$\sim 10M-10^8$	SoC, proc	\$10-1000+

cost $\propto \frac{\# \text{ of transistors}}{\text{volume sold}}$

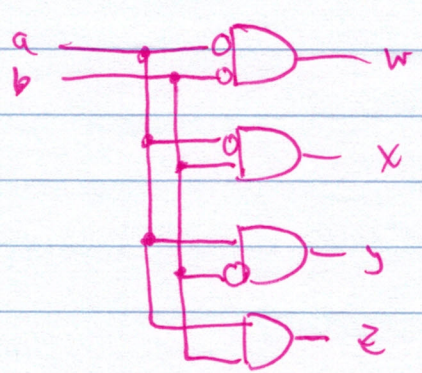
Decoder

2:4 decoder



		0	1	2	3
a	b	w	x	y	z
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Logically equivalent to:

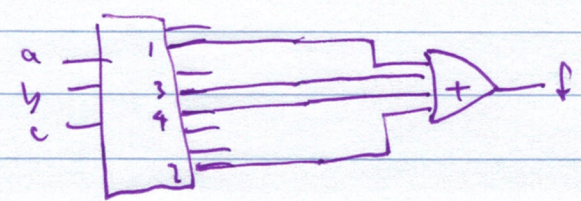


• Only one output high at a time

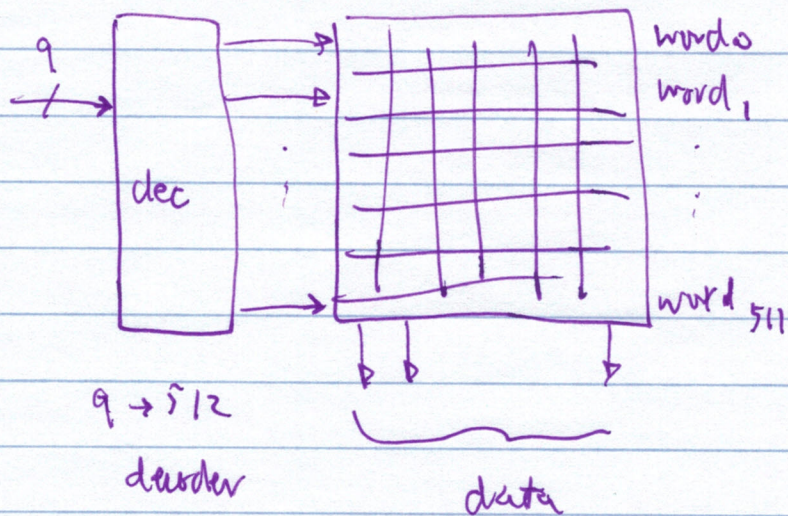
Can use decoder to generate logic

key concept

$$f(a, b, c) = \sum m(1, 3, 4, 7)$$



Array memory



9 inputs
 $2^9 = 512$ outputs