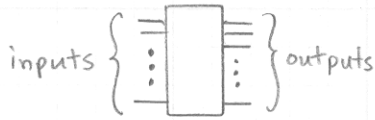


9.6 Programmable Logic Devices

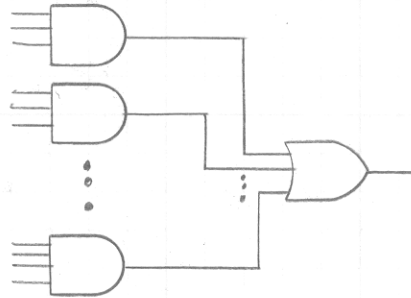
To implement any Boolean expression in circuits, we want:



1 chip

Want outputs to be any function of any inputs  
(could be a very large circuit!)

Instead, settle for restricted set of expressions:

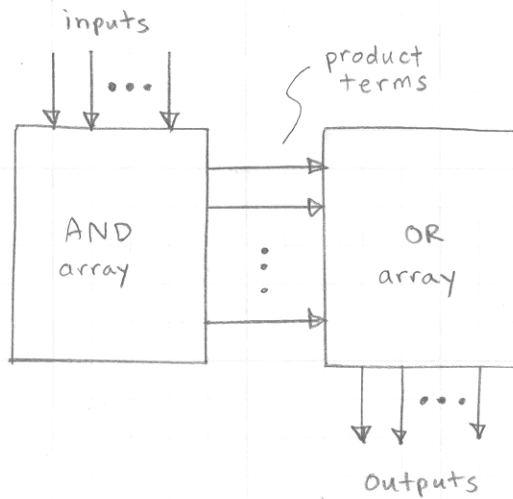


• Realize Sum-of-Products expressions for each output

- Programmable AND inputs
- Programmable OR inputs
- Limited # of inputs
- Limited # of outputs per chip

• Combine several chips to create multi-level circuits for more complex functions.

Programmable Logic Arrays (PLA)



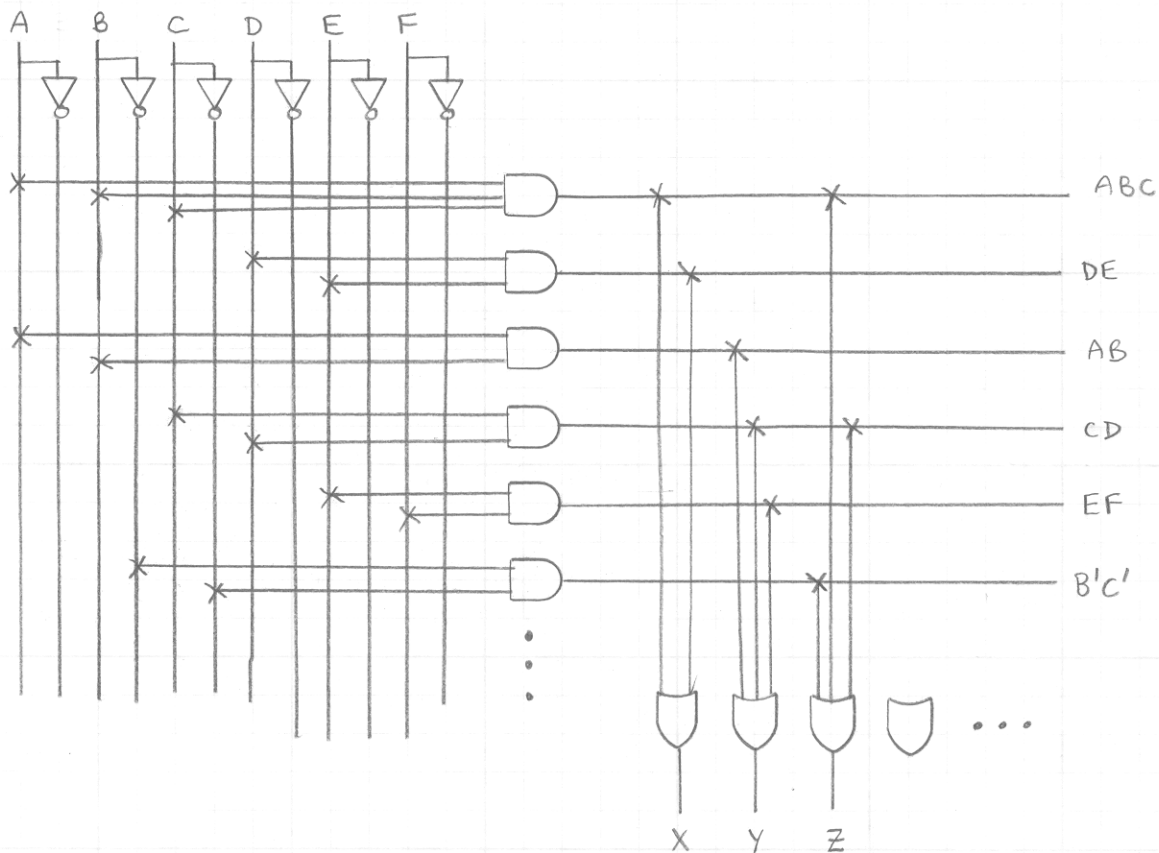
13-782 500 SHEETS, FILLER 5 SQUARE  
42-381 50 SHEETS EYE-EASE 5 SQUARE  
42-382 100 SHEETS EYE-EASE 5 SQUARE  
42-383 200 SHEETS EYE-EASE 5 SQUARE  
42-384 100 RECYCLED WHITE 5 SQUARE  
42-385 200 RECYCLED WHITE 5 SQUARE  
Made in U.S.A.



Ex:  $X = ABC + DE$

$Y = AB + CD + EF$

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



How are the connections made?

Custom chip: Add or leave out diode, transistor, ... at correct intersections

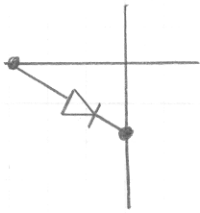
One-time Programmable: Blow "fuse" (create open ckt) or "anti-fuse" (creates short ckt) at manufacturing time or first programming

Programmable (Temporary or Volatile): Loses configuration when power turned off (configuration stored in memory)

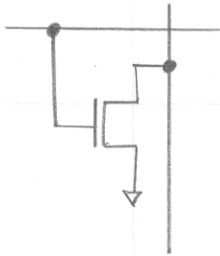
Programmable (Permanent until Erased or Nonvolatile):

Configuration written electrically, erased electrically or with U.V. light.

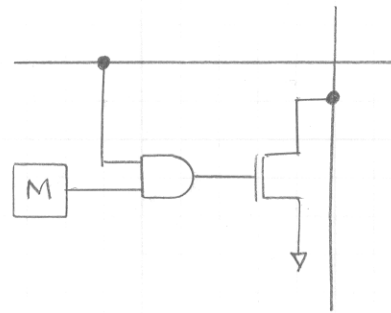
Ex: Possible programmable connections



Diode



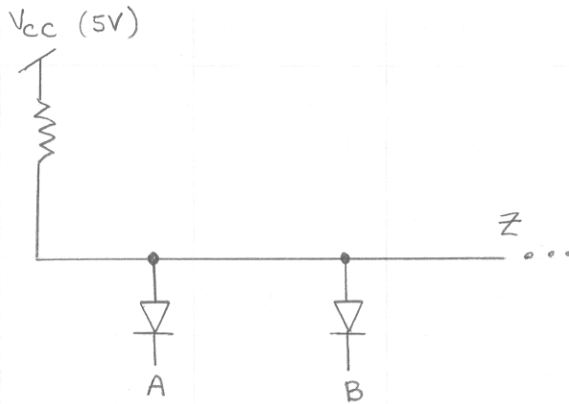
FET



Programmable

Alternative Connections

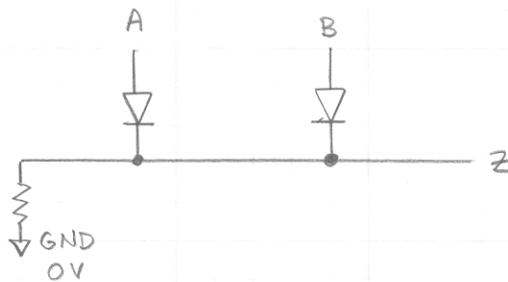
"Wired AND"



$A=1 \rightarrow$  Diodes off,  
 $B=1 \quad Z=1$

$A=0, \rightarrow$  Diode on,  $\Rightarrow$  AND  
 $B=X \quad Z=0$

"Wired OR"

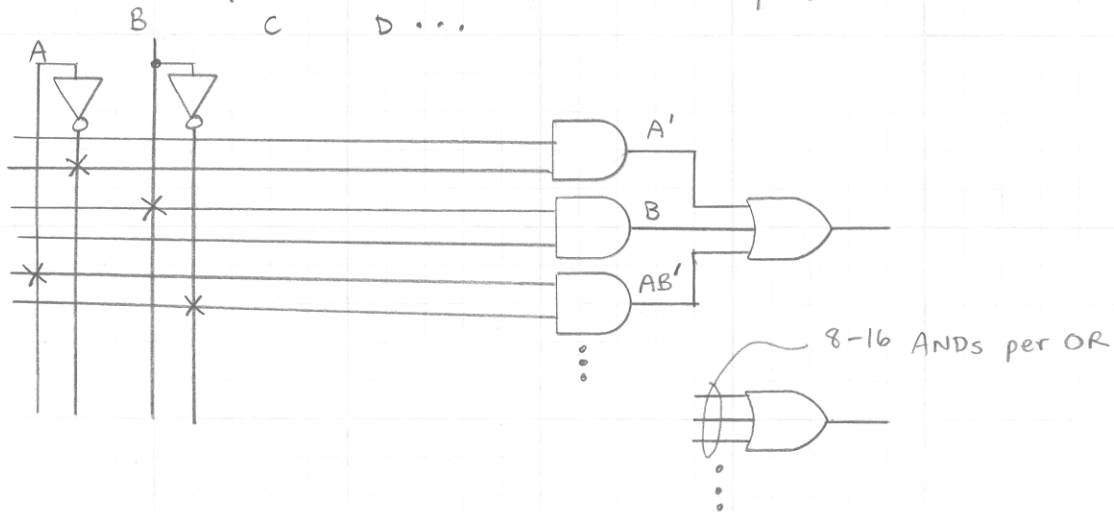


$A=0 \rightarrow$  Diodes off,  
 $B=0 \quad Z=0$

$A=1 \rightarrow$  Diode on,  $\Rightarrow$  OR  
 $B=X \quad$  pulls Z high,  $Z=1$

## Programmable Array Logic

Similar concept to PLA but the OR array is fixed:



Drawback: Cannot share product terms among outputs as with PLAs.

LAB 4 PAL (Generic Array Logic) 22V10

- 11 inputs
- 10 outputs
- 8-16 ANDs per OR output