Digital Logic Reduction K-maps – SOP form

Last updated 1/7/25

Digital Logic Reduction – K-maps - SOP

- K-Map reduction process – SOP form
  1. Create and populate an appropriately sized K-map
     - 2x2, 2x4, 4x4
  2. 1's Collection
     - Use as few ovals as possible to cover all the 1's
       - Each oval must only contain 1's
       - Ovals may not be diagonal
       - Each oval should be as large as possible
       - Ovals may wrap around the edges of the map
       - Any 1 in the K-map may be included in multiple circles
  3. Interpret the ovals
     - Individual 1's are interpreted as an AND of all inputs
     - Pairs of 1's will include an x and x-bar term, allowing the input to be removed
     - Quads of 1's will include x, x-bar, y, y-bar, terms, allowing those inputs to be removed
  4. Combine the evaluated ovals as an OR term in the reduced logic expression – SOP form

Digital Logic Reduction – K-maps - SOP

- Example 1
  - Create the K map

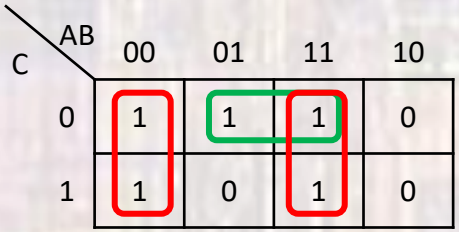
a	b	c	OUT
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

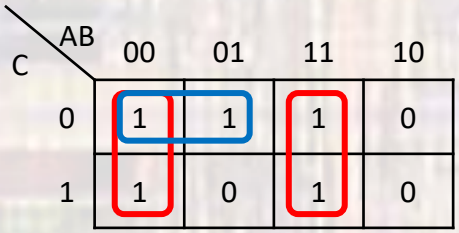
C \ AB	00	01	11	10
0	1	1	1	0
1	1	0	1	0

Digital Logic Reduction – K-maps - SOP

- Example 1
  - Circle groups
    - There may be multiple collection possibilities

a	b	c	OUT
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

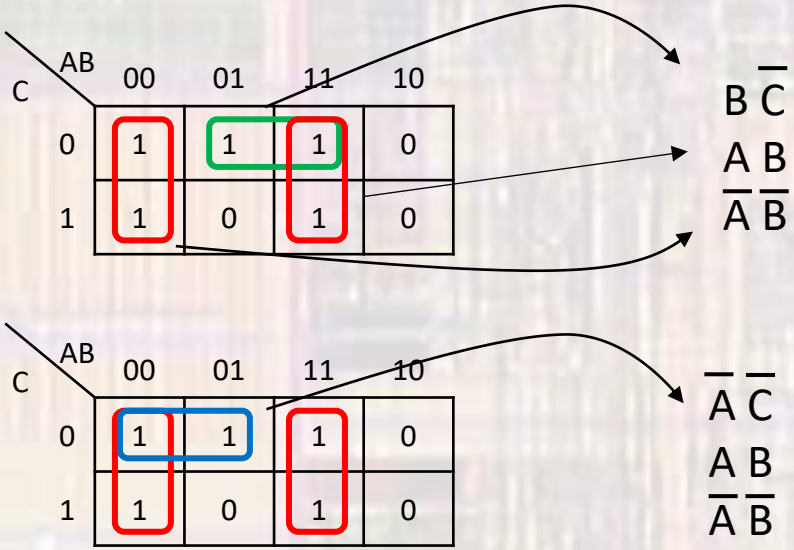




Digital Logic Reduction – K-maps - SOP

- Example 1
  - Interpret

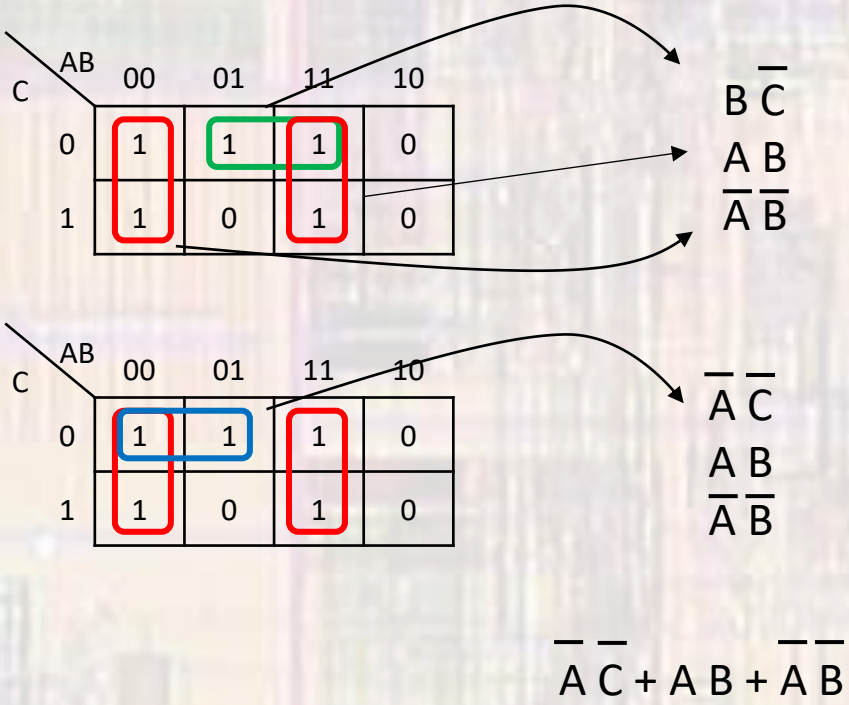
a	b	c	OUT
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1



Digital Logic Reduction – K-maps - SOP

- Example 1
  - Form SOP

a	b	c	OUT
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



Digital Logic Reduction – K-maps - SOP

- Example 2 – create the K-map

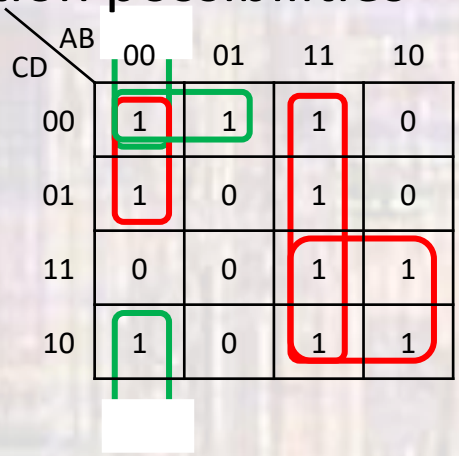
a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

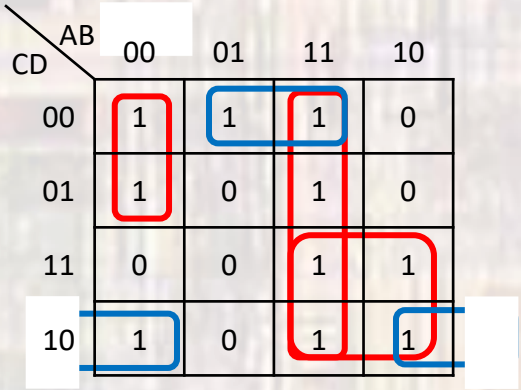
CD \ AB	00	01	11	10
00	1	1	1	0
01	1	0	1	0
11	0	0	1	1
10	1	0	1	1

Digital Logic Reduction – K-maps - SOP

- Example 2 – circle groups
  - There may be multiple collection possibilities

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

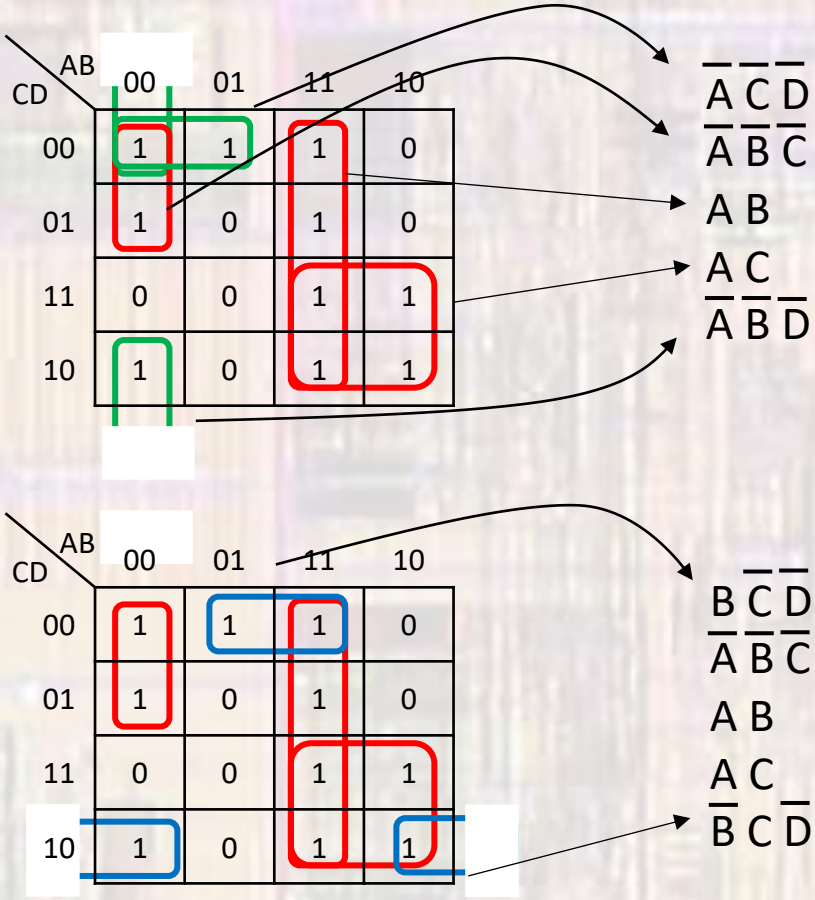




Digital Logic Reduction – K-maps - SOP

- Example 2 - interpret

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

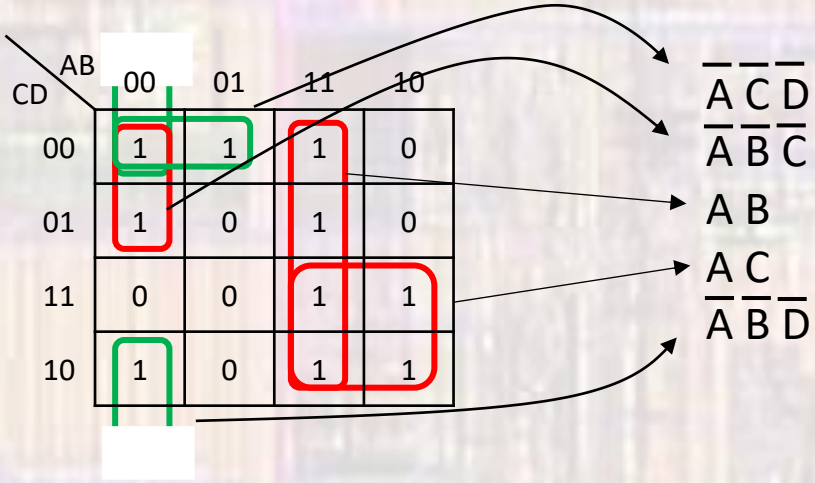


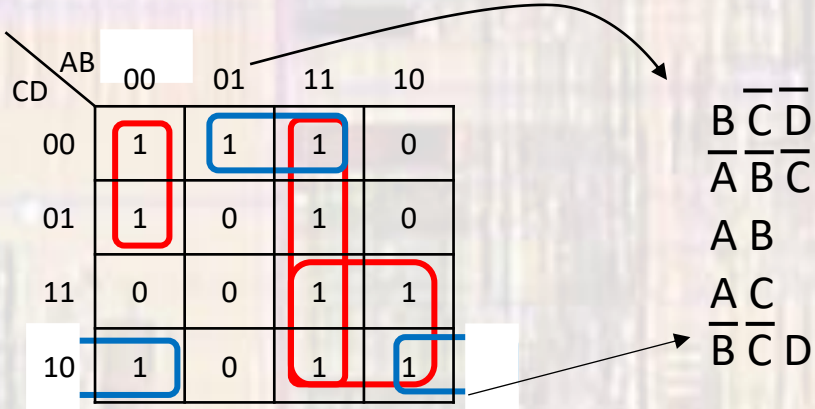
Digital Logic Reduction – K-maps - SOP

- Example 2 – Form SOP

$$\overline{A}\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,\overline{C} + A\,B + A\,C + \overline{A}\,\overline{B}\,\overline{D}$$

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1





$$B\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,\overline{C} + A\,B + A\,C + \overline{B}\,\overline{C}\,D$$

Digital Logic Reduction – K-maps - SOP

- Example 3 – don't cares – create the K-map

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	X
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

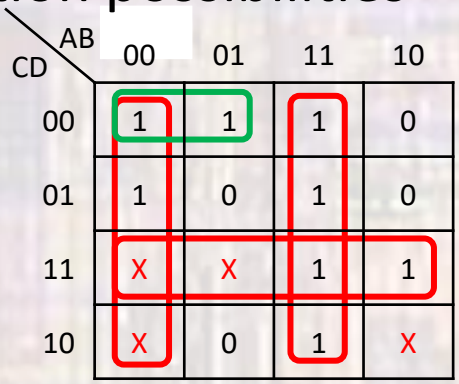
CD \ AB	00	01	11	10
CD	1	1	1	0
01	1	0	1	0
11	X	X	1	1
10	X	0	1	X

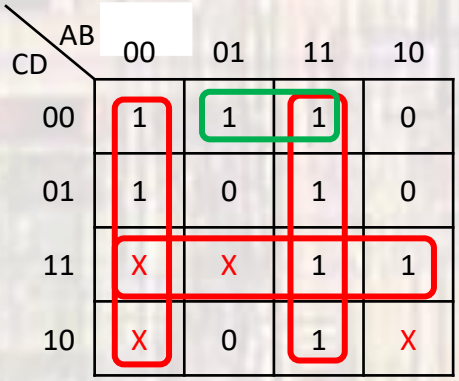
Digital Logic Reduction – K-maps - SOP

- Example 3 – don't cares - circle groups
  - There may be multiple collection possibilities

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	X
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

x's can be treated as 0's or 1's

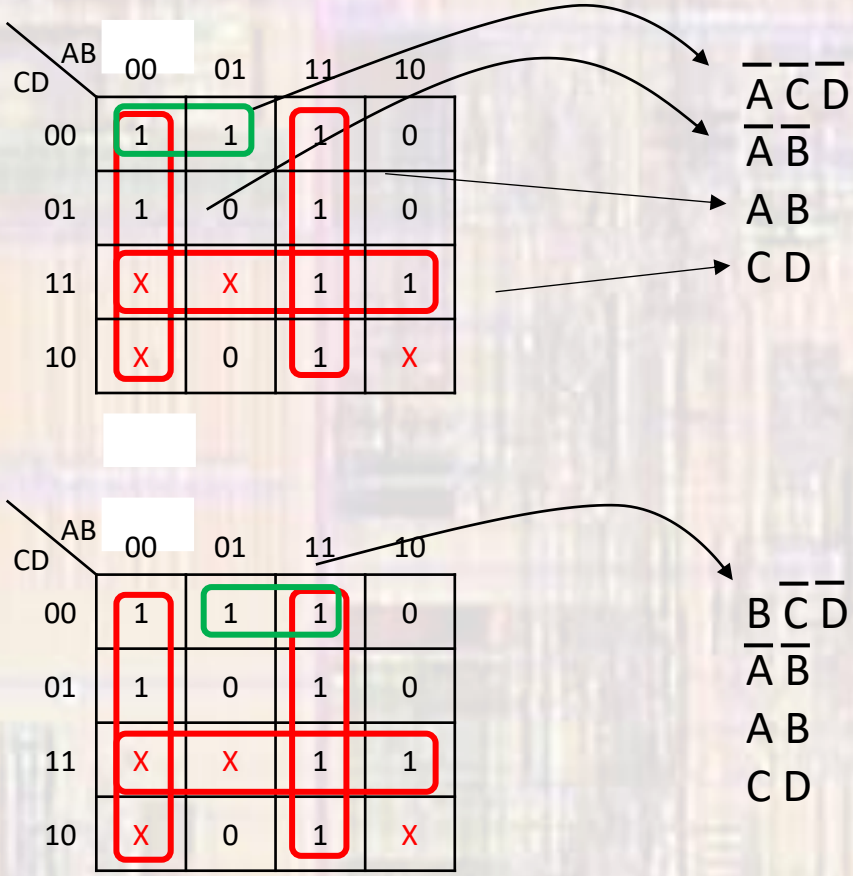




Digital Logic Reduction – K-maps - SOP

- Example 3 – don't cares - interpret

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	X
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1



Digital Logic Reduction – K-maps - SOP

- Example 3 – don't cares – form SOP

a	b	c	d	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	X
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1