IT COOKBOOK

디지털논리회로

이론, 실습, 시뮬레이션

(Problem Solutions of Chapter 6)

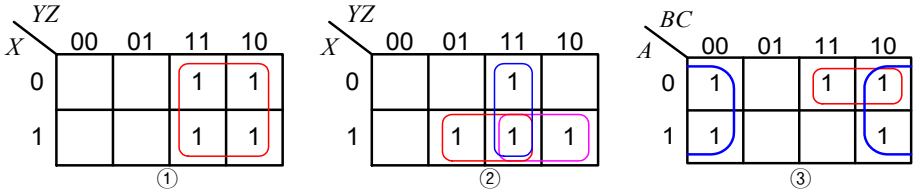
한빛미디어 Hanbit Media, Inc.

1. 3변수 카르노 맵을 이용한 간소화

① $F(X,Y,Z)=\Sigma m(2,3,6,7)=Y$

② $F(X,Y,Z)=\Sigma m(3,5,6,7)=XY+YZ+ZX$

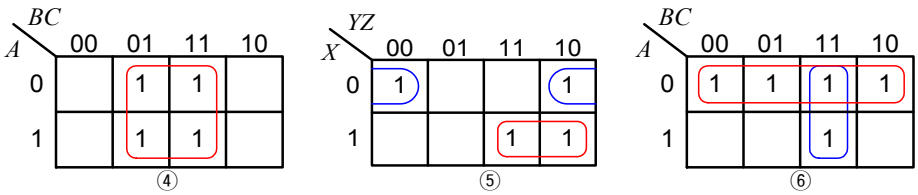
③ $F(A,B,C)=\Sigma m(0,2,3,4,6)=\overline{A}B+\overline{C}$



④ $F(A,B,C)=\Sigma m(1,3,5,7)=C$

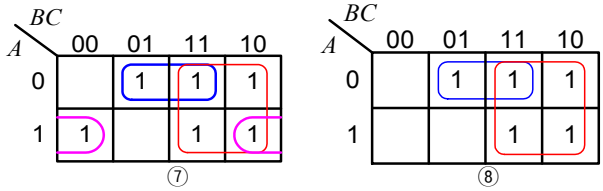
⑤ $F(X,Y,Z)=XY+Y\overline{Z}+\overline{X}\overline{Y}\overline{Z}=XY+\overline{X}\overline{Z}$

⑥ $F(A,B,C)=\overline{A}\overline{B}+BC+\overline{A}B\overline{C}=\overline{A}+BC$

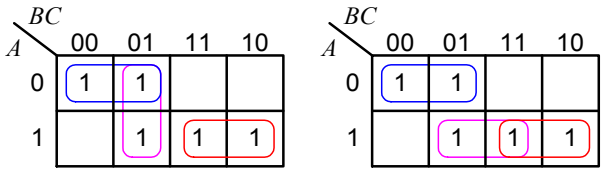


⑦ $F(A,B,C)=\Sigma m(1,2,3,4,6,7)=A\overline{C}+\overline{A}C+B=(A\oplus C)+B$

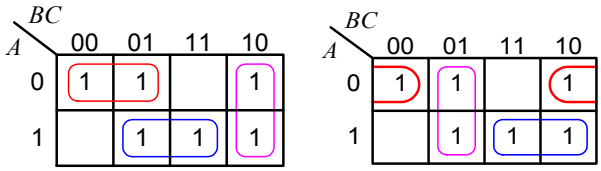
⑧ $F(A,B,C)=\Sigma m(1,2,3,6,7)=B+\overline{A}C$



⑨ $F(A,B,C)=\Sigma m(0,1,5,6,7)=AB+\overline{A}\overline{B}+AC=AB+\overline{A}\overline{B}+\overline{B}C$



⑩ $F(A,B,C)=\Sigma m(0,1,2,5,6,7)=\overline{A}\overline{B}+AC+B\overline{C}=AB+\overline{A}\overline{C}+\overline{B}C$



2. 4변수 카르노 맵을 이용한 간소화

① $F(A,B,C,D)=\Sigma m(0,2,4,5,6,7,8,10,13,15)$

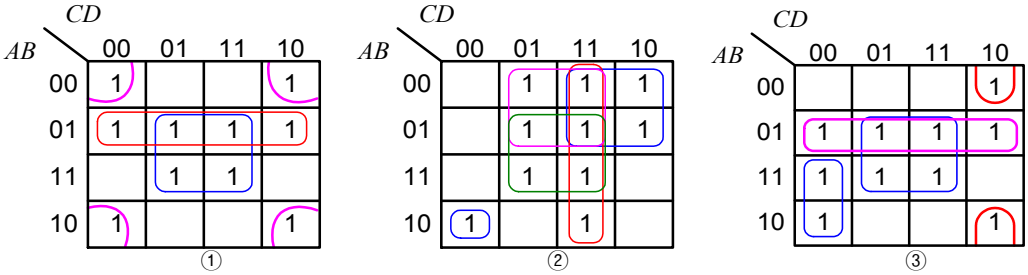
$F(A,B,C,D)=\overline{A}B+BD+\overline{B}\overline{D}$

② $F(A,B,C,D)=\Sigma m(1,2,3,5,6,7,8,11,13,15)$

$F(A,B,C,D)=\overline{A}C+\overline{A}D+BD+CD+A\overline{B}\overline{C}\overline{D}$

③ $F(A,B,C,D)=\Sigma m(2,4,5,6,7,8,10,12,13,15)$

$F(A,B,C,D)=\overline{A}B+BD+A\overline{C}\overline{D}+\overline{B}C\overline{D}$



④ $F(A,B,C,D)=\Sigma m(0,1,2,3,4,5,6,8,9,10,12,15)$

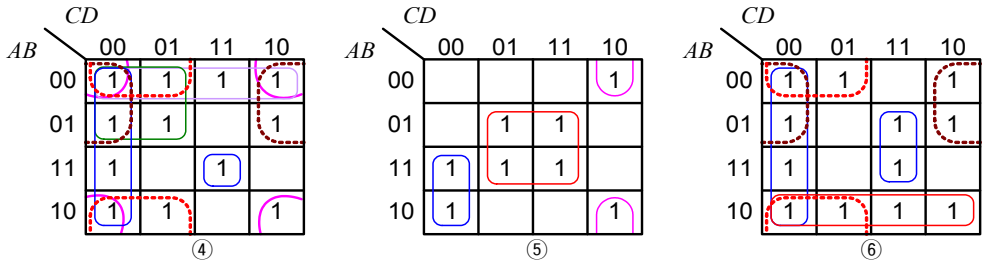
$F(A,B,C,D)=\overline{A}\overline{B}+\overline{A}C+\overline{A}\overline{D}+\overline{B}\overline{C}+\overline{B}\overline{D}+\overline{C}\overline{D}+ABCD$

⑤ $F(A,B,C,D)=\Sigma m(2,5,7,8,10,12,13,15)$

$F(A,B,C,D)=A\overline{C}\overline{D}+BD+\overline{B}C\overline{D}$

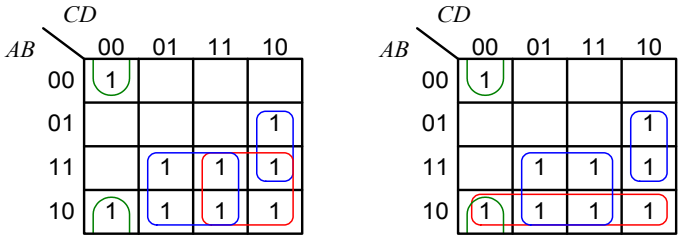
⑥ $F(A,B,C,D)=\Sigma m(0,1,2,4,6,7,8,9,10,11,12,15)$

$F(A,B,C,D)=A\overline{B}+\overline{A}\overline{D}+\overline{B}\overline{C}+CD+BCD$



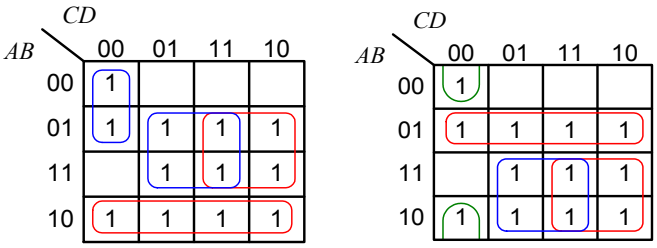
⑦ $F(A,B,C,D)=\Sigma m(0,6,8,9,10,11,13,14,15)$ (2가지 답)

$F(A,B,C,D)=AC+AD+BC\overline{D}+\overline{B}\overline{C}\overline{D}=A\overline{B}+AD+BC\overline{D}+\overline{B}\overline{C}\overline{D}$



⑧ $F(A,B,C,D)=\Sigma m(0,4,5,6,7,8,9,10,11,13,14,15)$ (2가지 답)

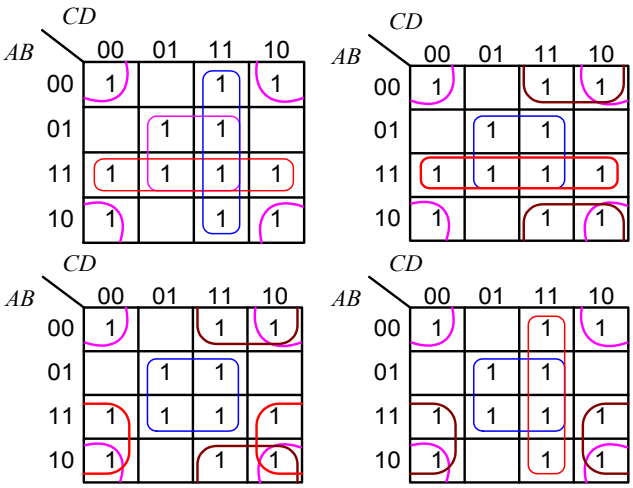
$F(A,B,C,D)=A\overline{B}+BC+BD+\overline{A}\overline{C}\overline{D}=\overline{A}B+AC+AD+\overline{B}\overline{C}\overline{D}$



⑨ $F(A,B,C,D)=\Sigma m(0,2,3,5,7,8,10,11,12,13,14,15)$ (4가지 답)

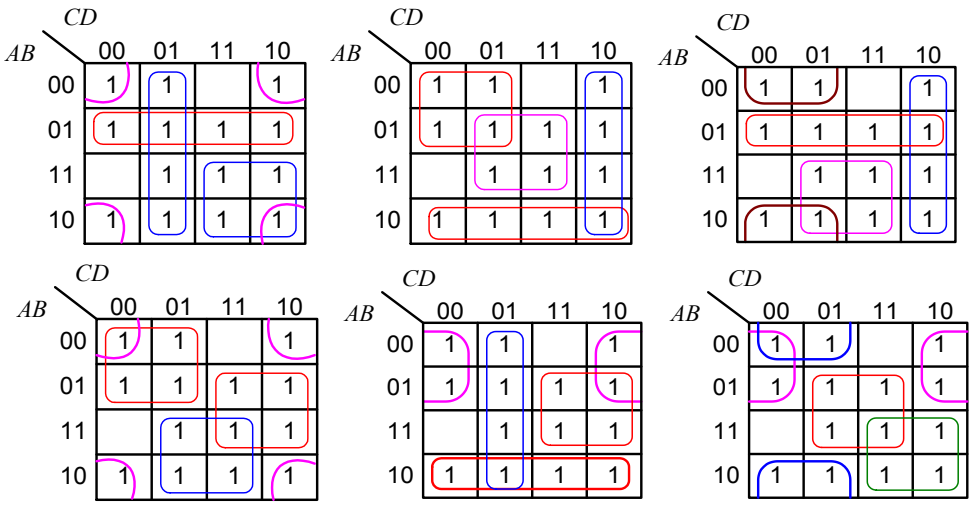
$F(A,B,C,D)=AB+BD+CD+\overline{B}\overline{D}=AB+\overline{B}C+BD+\overline{B}\overline{D}$

$=A\overline{D}+\overline{B}C+BD+\overline{B}\overline{D}=A\overline{D}+BD+\overline{B}\overline{D}+CD$



⑩ $F(A,B,C,D)=\Sigma m(0,1,2,4,5,6,7,8,9,10,11,13,14,15)$ (6가지 답)

$$F(A,B,C,D)=\overline{A}B+AC+\overline{B}\overline{D}+\overline{C}D=A\overline{B}+\overline{A}\overline{C}+BD+C\overline{D}$$
$$=\overline{A}B+AD+\overline{B}\overline{C}+C\overline{D}=\overline{A}\overline{C}+AD+BC+\overline{B}\overline{D}$$
$$=A\overline{B}+\overline{A}\overline{D}+BC+\overline{C}D=AC+BD+\overline{A}\overline{D}+\overline{B}C$$

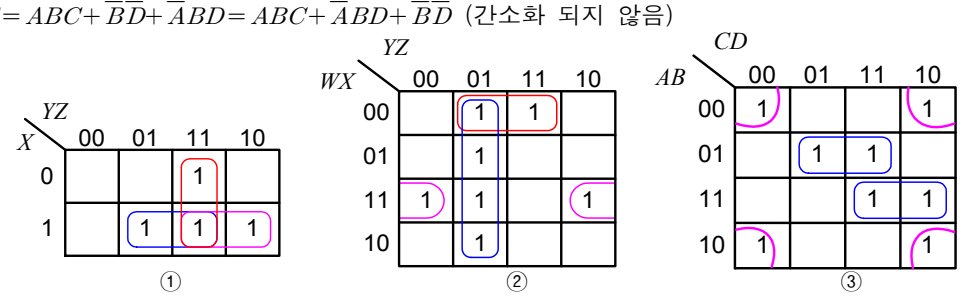


3. 카르노 맵에 의한 간소화

① $F=XY+YZ+X\overline{Y}Z=XY+YZ+XZ$

② $F=\overline{Y}Z+WX\overline{Y}+WX\overline{Z}+\overline{W}\overline{X}Z=\overline{Y}Z+\overline{W}\overline{X}Z+WX\overline{Z}$

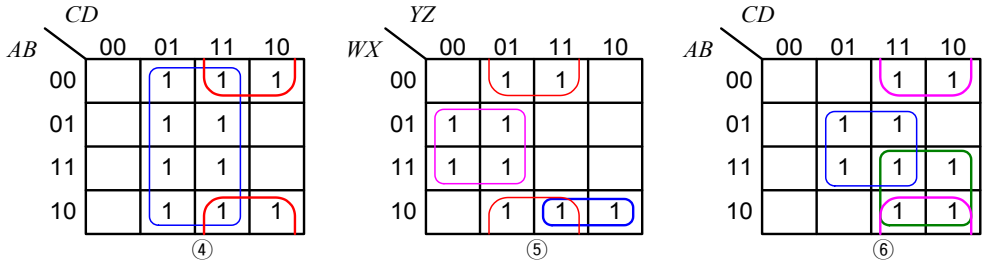
③ $F=ABC+\overline{B}\overline{D}+\overline{A}BD=ABC+\overline{A}BD+\overline{B}\overline{D}$ (간소화 되지 않음)



④ $F=\overline{A}D+BD+\overline{B}C+A\overline{B}D=D+\overline{B}C$

⑤ $F=\overline{X}Z+\overline{W}X\overline{Y}+W(\overline{X}Y+X\overline{Y})=W\overline{X}Y+X\overline{Y}+\overline{X}Z$

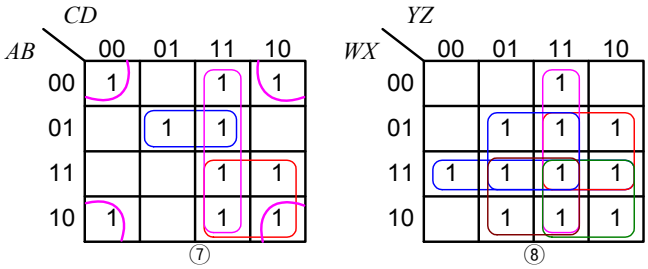
⑥ $F=ABC+CD+B\overline{C}D+\overline{B}C=AC+\overline{B}C+BD$



⑦ $F=A\overline{B}C+\overline{B}\overline{C}\overline{D}+BCD+AC\overline{D}+\overline{A}\overline{B}C+\overline{A}B\overline{C}D=AC+\overline{A}BD+\overline{B}\overline{D}+CD$

⑧ $F=\overline{W}YZ+X\overline{Y}Z+WY+WX\overline{Y}\overline{Z}+WZ+XY\overline{Z}$

$=WX+WY+WZ+XY+XZ+YZ$



4. 무관조건을 고려한 카르노 맵을 이용한 간소화

① $F(A,B,C)=\Sigma m(0,1,2,4,5)+\Sigma d(3,6,7)$

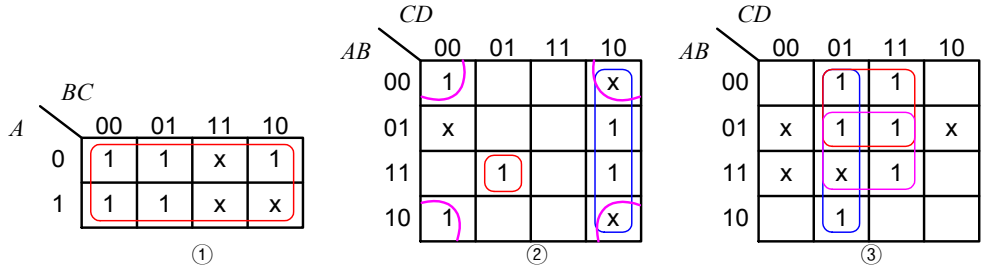
$F(A,B,C)=1$

② $F(A,B,C,D)=\Sigma m(0,6,8,13,14)+\Sigma d(2,4,10)$

$F(A,B,C,D)=\overline{B}\overline{D}+C\overline{D}+AB\overline{C}D$

③ $F(A,B,C,D)=\Sigma m(1,3,5,7,9,15)+\Sigma m(4,6,12,13)$

$F(A,B,C,D)=\overline{A}D+BD+\overline{C}D$

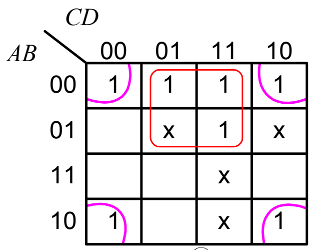


④ $F(A,B,C,D)=\Sigma m(0,1,2,3,7,8,10)+\Sigma d(5,6,11,15)$

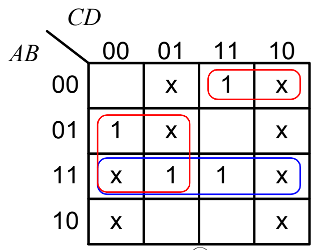
$F(A,B,C,D)=\overline{A}D+\overline{B}\overline{D}$

⑤ $F(A,B,C,D)=\Sigma m(3,4,13,15)+\Sigma d(1,2,5,6,8,10,12,14)$

$F(A,B,C,D)=AB+B\overline{C}+\overline{A}\overline{B}C$



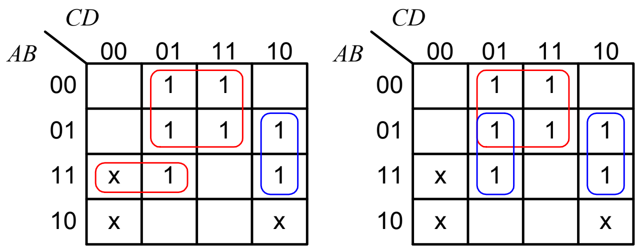
④



⑤

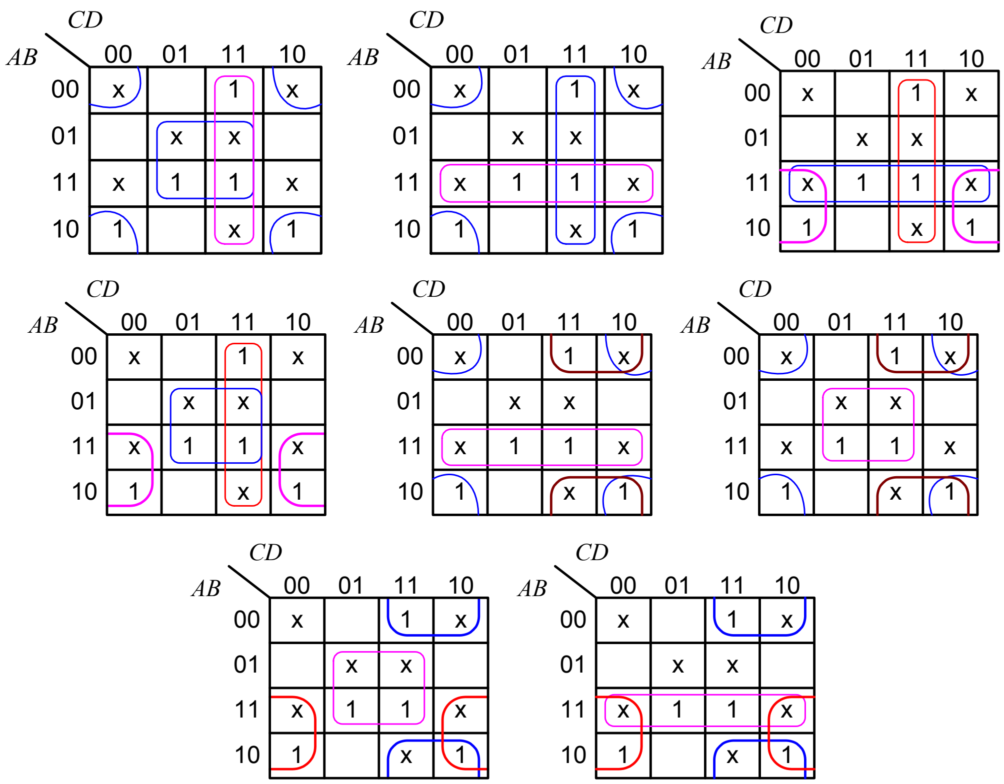
⑥ $F(A,B,C,D) = \Sigma m(1,3,5,6,7,13,14) + \Sigma d(8,10,12)$ (2가지 답)

$F(A,B,C,D) = \overline{A}D + BC\overline{D} + AB\overline{C} = \overline{A}D + BC\overline{D} + B\overline{C}D$



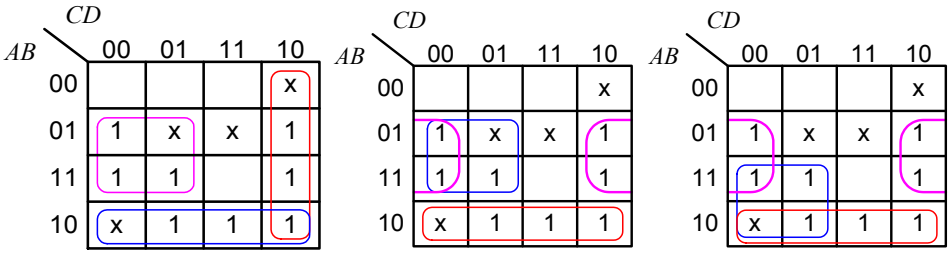
⑦ $F(A,B,C,D) = \Sigma m(3,8,10,13,15) + \Sigma d(0,2,5,7,11,12,14)$ (8가지 답)

$F(A,B,C,D) = BD + \overline{B}\overline{D} + CD = AB + \overline{B}\overline{D} + CD = AB + A\overline{D} + CD = A\overline{D} + BD + CD$
$= AB + \overline{B}C + \overline{B}\overline{D} = \overline{B}C + BD + \overline{B}\overline{D} = A\overline{D} + \overline{B}C + BD = AB + A\overline{D} + \overline{B}C$



⑧ $F(A,B,C,D) = \Sigma m(4,6,9,10,11,12,13,14) + \Sigma d(2,5,7,8)$ (3가지 답)

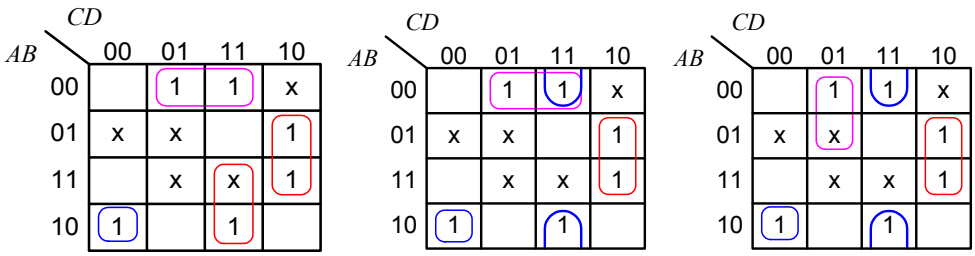
$F(A,B,C,D) = A\overline{B} + B\overline{C} + C\overline{D} = A\overline{B} + B\overline{C} + B\overline{D} = A\overline{B} + A\overline{C} + B\overline{D}$



⑨ $F(A,B,C,D)=\Sigma m(1,3,6,8,11,14)+\Sigma d(2,4,5,13,15)$ (3가지 답)

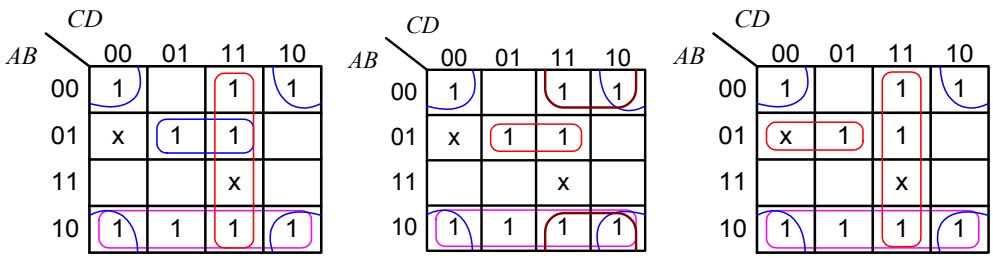
$F(A,B,C,D)=A\overline{C}D+\overline{A}\,\overline{B}D+B\overline{C}\,\overline{D}+A\overline{B}\,\overline{C}\,\overline{D}=\overline{A}\,\overline{B}D+\overline{B}CD+B\overline{C}\,\overline{D}+A\overline{B}\,\overline{C}\,\overline{D}$

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



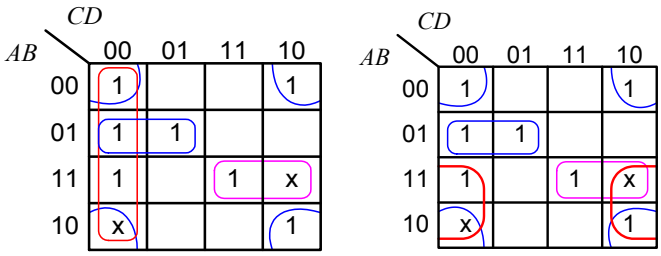
⑩ $F(A,B,C,D)=\Sigma m(0,2,3,5,7,8,9,10,11)+\Sigma d(4,15)$ (3가지 답)

$F(A,B,C,D)=A\overline{B}+\overline{B}\,\overline{D}+CD+\overline{A}BD=A\overline{B}+\overline{B}C+\overline{B}\,\overline{D}+\overline{A}BD=A\overline{B}+\overline{B}\,\overline{D}+CD+\overline{A}B\overline{C}$



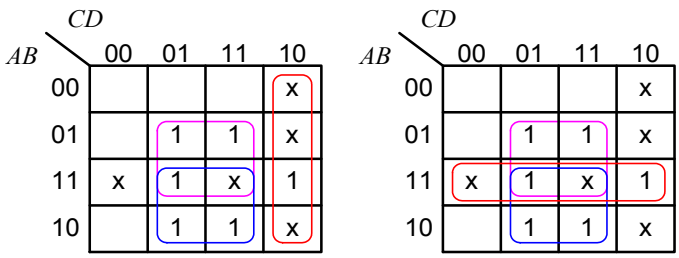
⑪ $F(A,B,C,D)=\Sigma m(0,2,4,5,10,12,15)+\Sigma d(8,14)$ (2가지 답)

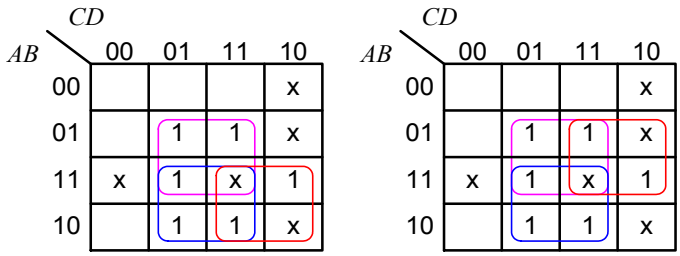
$F(A,B,C,D)=\overline{B}\,\overline{D}+\overline{C}\,\overline{D}+\overline{A}B\overline{C}+ABC=\overline{B}\,\overline{D}+B\overline{D}+\overline{A}B\overline{C}+ABC$



⑫ $F(A,B,C,D)=\Sigma m(5,7,9,11,13,14)+\Sigma d(2,6,10,12,15)$ (4가지 답)

$F(A,B,C,D)=AD+BD+CD=AD+BD+AB=AD+BD+AC=AD+BD+BC$

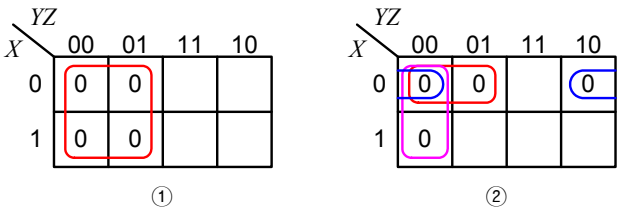




5. POS 형태의 간소화

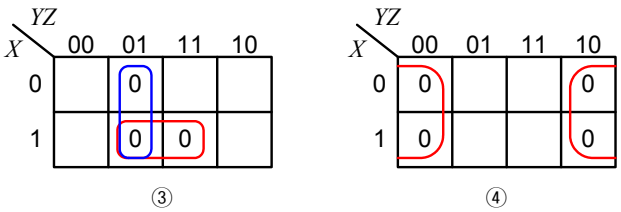
① $F(X,Y,Z)=\Sigma m(2,3,6,7)=Y$

② $F(X,Y,Z)=\Sigma m(3,5,6,7)=(X+Y)(Y+Z)(Z+X)$



③ $F(X,Y,Z)=\Sigma m(0,2,3,4,6)=(Y+\overline{Z})(\overline{X}+\overline{Z})$

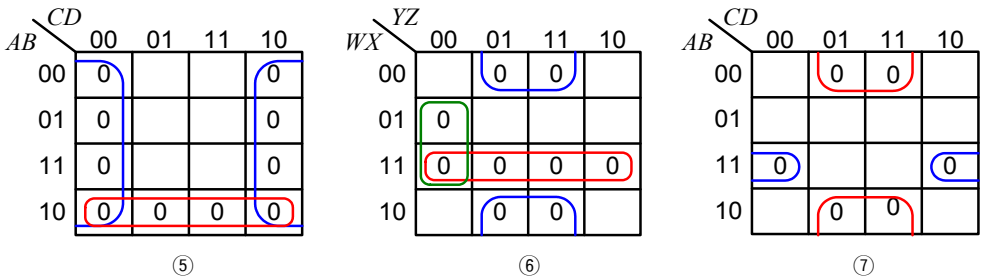
④ $F(X,Y,Z)=\Sigma m(1,3,5,7)=Z$



⑤ $F(A,B,C,D)=\Pi M(1,3,5,7,13,15)=(\overline{A}+B)D$

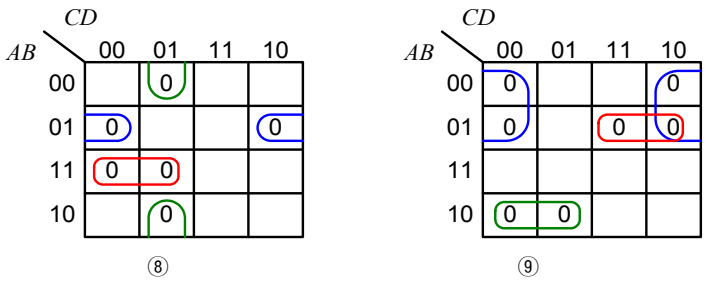
⑥ $F(W,X,Y,Z)=\Sigma m(0,2,5,6,7,8,10)=(\overline{W}+\overline{X})(X+\overline{Z})(\overline{X}+Y+Z)$

⑦ $F(A,B,C,D)=\Sigma m(0,2,4,5,6,7,8,10,13,15)=(B+\overline{D})(\overline{A}+\overline{B}+D)$



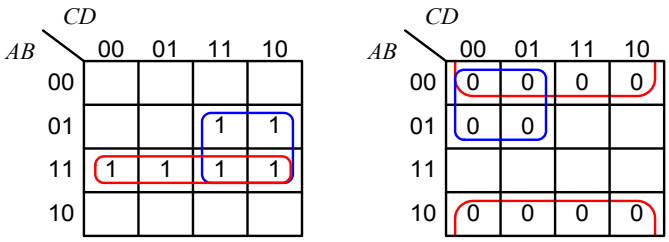
⑧ $F(A,B,C,D)=\Sigma m(0,2,3,5,7,8,10,11,14,15)=(\overline{A}+\overline{B}+C)(A+\overline{B}+D)(B+C+\overline{D})$

⑨ $F(A,B,C,D)=\Sigma m(1,3,5,10,11,12,13,14,15)=(A+D)(A+\overline{B}+\overline{C})(\overline{A}+B+C)$



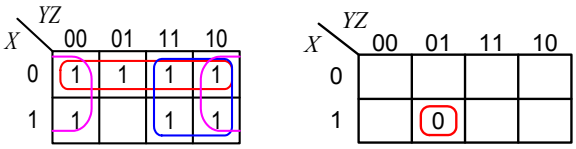
6. SOP와 POS 형태의 간소화

① $F=(AB+C)(B+\overline{C}D)$



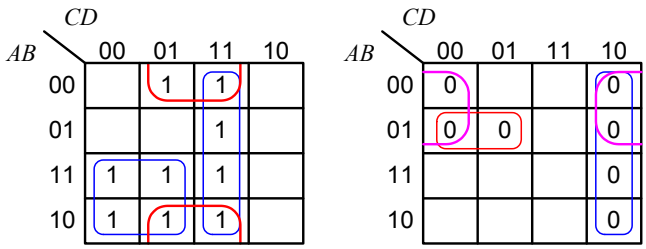
$SOP=AB+BC,\quad POS=\overline{\overline{B}+\overline{A}\,\overline{C}}=B(A+C)$

② $F=\overline{X}+X(X+\overline{Y})(Y+\overline{Z})$



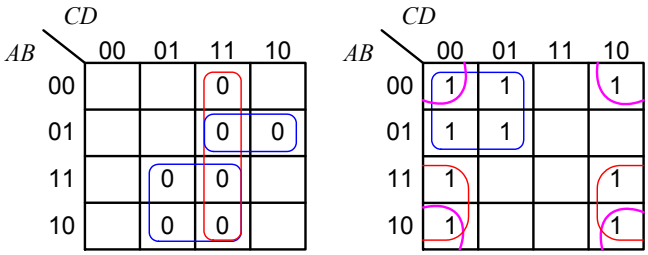
$SOP=\overline{X}+X(X+\overline{Y})(Y+\overline{Z})=\overline{X}+Y+\overline{Z},\qquad POS=\overline{X\overline{Y}Z}=\overline{X}+Y+\overline{Z}$

③ $F=A\overline{C}+\overline{B}D+\overline{A}CD+ABCD$



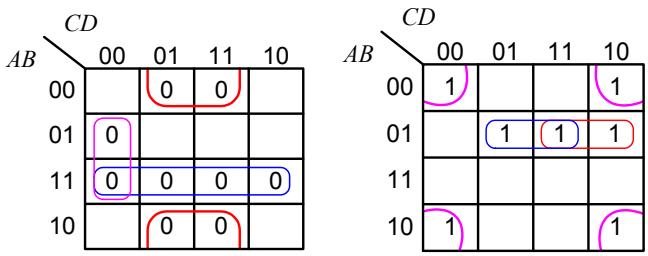
$SOP=A\overline{C}+\overline{B}D+CD$
$POS=(A+D)(\overline{C}+D)(A+\overline{B}+C)$

④ $F=(\overline{A}+\overline{B}+\overline{D})(A+\overline{B}+\overline{C})(\overline{A}+B+\overline{D})(B+\overline{C}+\overline{D})$



$SOP=\overline{A}\,\overline{C}+A\overline{D}+\overline{B}\,\overline{D}$
$POS=(\overline{A}+\overline{D})(\overline{C}+\overline{D})(A+\overline{B}+\overline{C})$

⑤ $F=(\overline{A}+\overline{B}+D)(\overline{A}+\overline{D})(A+B+\overline{D})(A+\overline{B}+C+D)$



$SOP = \overline{A}BC + \overline{A}BD + \overline{B}\overline{D}$
$POS = (\overline{A}+\overline{B})(B+\overline{D})(\overline{B}+C+D)$

7. SOP 표현

① $f = (a+b+c+\overline{d})(b+\overline{c}+d)(a+c)$

$f = \overline{\overline{(a+b+c+\overline{d})(b+\overline{c}+d)(a+c)}} = \overline{a\overline{b}\,\overline{c}d + \overline{b}c\overline{d} + \overline{a}\,\overline{c}} = \overline{\Sigma m(0,1,2,4,5,10)}$
$= \Sigma m(3,6,7,8,9,11,12,13,14,15) = a\overline{c} + bc + cd$

ab \ cd	00	01	11	10
00			1	
01			1	1
11	1	1	1	1
10	1	1	1	

② $f = (\overline{a}+b+\overline{c})(b+\overline{c}+d)(\overline{b}+\overline{d})$

$f = \overline{\overline{(\overline{a}+b+\overline{c})(b+\overline{c}+d)(\overline{b}+\overline{d})}} = \overline{a\overline{b}c + \overline{b}c\overline{d} + bd} = \overline{\Sigma m(2,5,7,10,11,13,15)}$
$= \Sigma m(0,1,3,4,6,8,9,12,14) = \overline{a}\,\overline{b}\,\overline{d} + \overline{b}\,\overline{c} + b\overline{d}$

ab \ cd	00	01	11	10
00	1	1	1	
01	1			1
11	1			1
10	1	1		

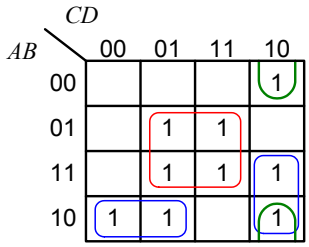
③ $f = (\overline{w}+x)(y+z)(\overline{w}+y)(x+\overline{y}+z)$

$f = \overline{\overline{(\overline{w}+x)(y+z)(\overline{w}+y)(x+\overline{y}+z)}} = \overline{w\overline{x} + \overline{y}\overline{z} + w\overline{y} + \overline{x}y\overline{z}}$
$= \overline{\Sigma m(0,2,4,8,9,10,11,12,13)} = \Sigma m(1,3,5,6,7,14,15) = xy + \overline{w}z$

wx \ yz	00	01	11	10
00		1	1	
01		1	1	1
11			1	1
10				

④ $F = (A+B+C)(\overline{B}+C+D)(A+\overline{B}+D)(B+\overline{C}+\overline{D})$

$F = \overline{\overline{(A+B+C)(\overline{B}+C+D)(A+\overline{B}+D)(B+\overline{C}+\overline{D})}}$
$= \overline{A\,\overline{B}\,\overline{C} + B\overline{C}\overline{D} + \overline{A}B\overline{D} + \overline{B}CD} = \overline{\Sigma m(0,1,3,4,6,11,12)}$
$= \Sigma m(2,5,7,8,9,10,13,14,15) = A\overline{B}\,\overline{C} + AC\overline{D} + \overline{B}C\overline{D} + BD$

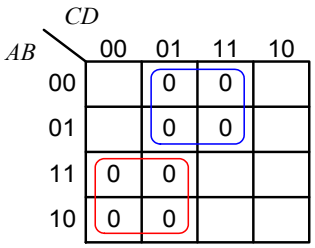


8. SOP를 POS로 변환

① $F = AC + \overline{A}\,\overline{D}$

$F = \underline{A(B+\overline{B})C(D+\overline{D}) + \overline{A}(B+\overline{B})(C+\overline{C})\overline{D}} = \Sigma m(0,2,4,6,10,11,14,15)$

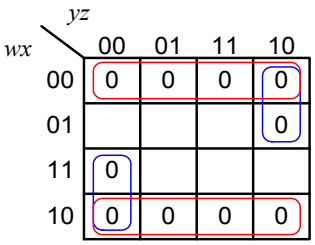
$= \overline{\Pi M(0,2,4,6,10,11,14,15)} = \Pi M(1,3,5,7,8,9,12,13) = (\overline{A}+C)(A+\overline{D})$



② $f = \overline{w}x\overline{y} + wxy + xz$

$f = \overline{w}x\overline{y}(z+\overline{z}) + wxy(z+\overline{z}) + (w+\overline{w})x(y+\overline{y})z = \Sigma m(4,5,7,13,14,15)$

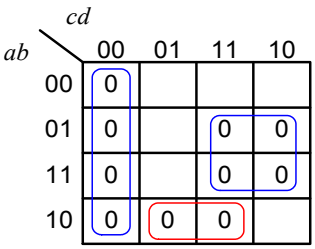
$= \overline{\Pi M(4,5,7,13,14,15)} = \Pi M(0,1,2,3,6,8,9,10,11,12) = x(\overline{w}+y+z)(w+\overline{y}+z)$



③ $f = b\overline{c}d + \overline{a}\,\overline{b}d + \overline{b}c\overline{d}$

$f = \underline{(a+\overline{a})b\overline{c}d + \overline{a}\,\overline{b}(c+\overline{c})d + (a+\overline{a})\overline{b}c\overline{d}} = \Sigma m(1,2,3,5,10,13)$

$= \overline{\Pi M(1,2,3,5,10,13)} = \Pi M(0,4,6,7,8,9,11,12,14,15) = (\overline{a}+b+\overline{d})(\overline{b}+\overline{c})(c+d)$

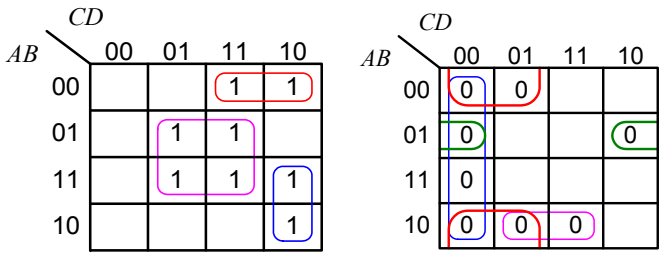


9. SOP 및 POS의 최소항과 최대항 표현

① $F(A,B,C,D) = \Sigma m(2,3,5,7,10,13,14,15)$ (답 : SOP 1개, POS 1개)

$SOP = AC\overline{D} + \overline{A}\,\overline{B}C + BD$

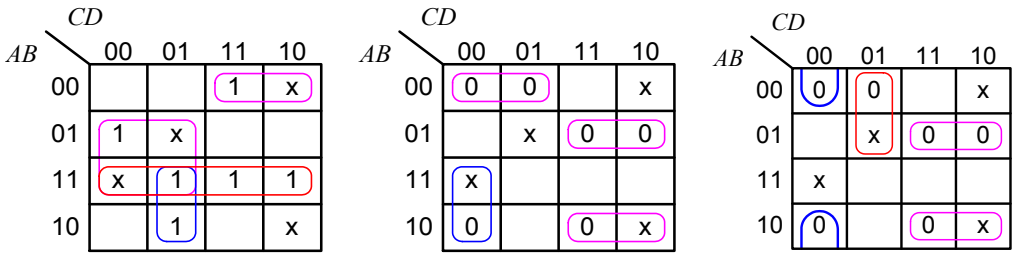
$POS = (\overline{A}+B+\overline{D})(A+\overline{B}+D)(B+C)(C+D)$



② $F(A,B,C,D)=\Sigma m(3,4,9,13,14,15)+\Sigma d(2,5,10,12)$ (답 : SOP 1개, POS 2개)

$SOP=AB+B\overline{C}+A\overline{C}D+\overline{A}\overline{B}C$

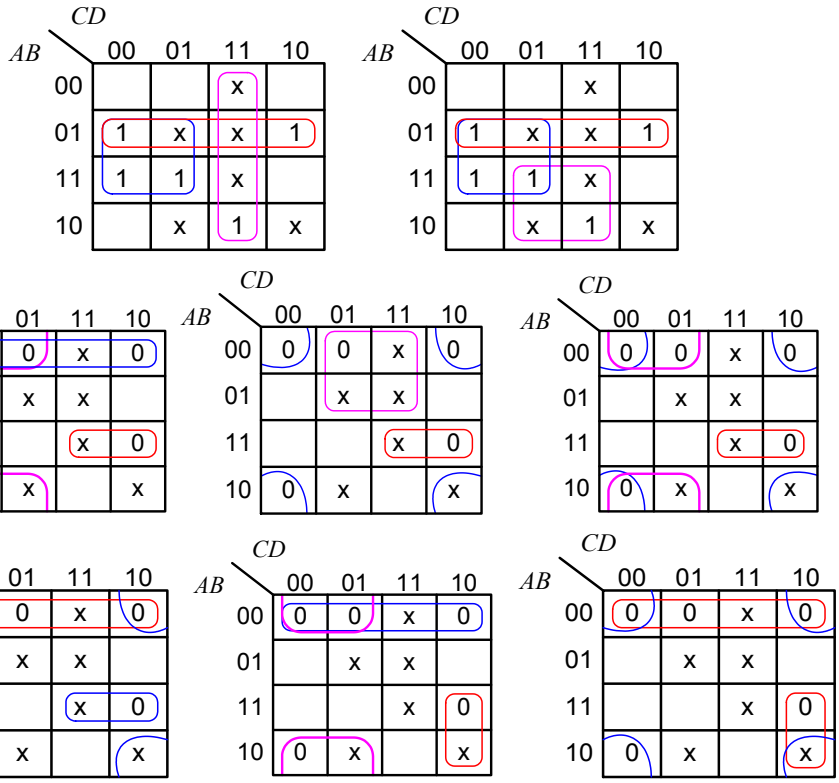
$POS=(B+D)(A+\overline{B}+\overline{C})(\overline{A}+B+\overline{C})(A+C+\overline{D})$
$=(B+D)(A+B+C)(A+\overline{B}+\overline{C})(\overline{A}+B+\overline{C})$

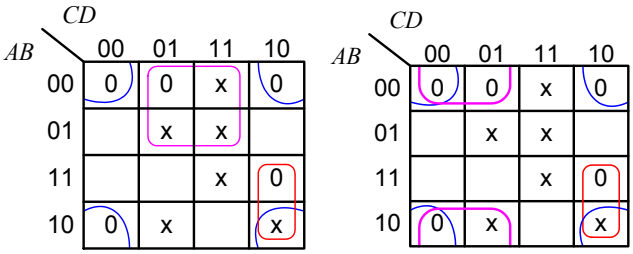


③ $F(A,B,C,D)=\Sigma m(4,6,11,12,13)+\Sigma d(3,5,7,9,10,15)$ (답 : SOP 2개, POS 8개)

$SOP=\overline{A}B+B\overline{C}+CD=\overline{A}B+B\overline{C}+AD$

$POS=(A+B)(B+C)(\overline{A}+\overline{B}+\overline{C})=(A+\overline{D})(B+D)(\overline{A}+\overline{B}+\overline{C})$
$=(B+C)(B+D)(\overline{A}+\overline{B}+\overline{C})=(A+B)(B+D)(\overline{A}+\overline{B}+\overline{C})$
$=(A+B)(B+C)(\overline{A}+\overline{C}+D)=(A+B)(B+D)(\overline{A}+\overline{C}+D)$
$=(A+\overline{D})(B+D)(\overline{A}+\overline{C}+D)=(B+C)(B+D)(\overline{A}+\overline{C}+D)$

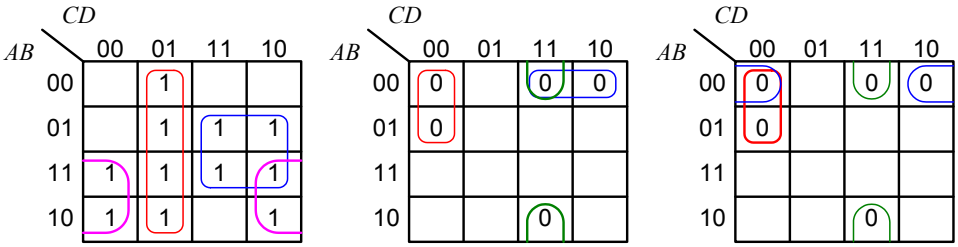




④ $F(A,B,C,D)=\Sigma m(1,5,6,7,8,9,10,12,13,14,15)$ (답 : SOP 1개, POS 2개)

$SOP=A\overline{D}+BC+\overline{C}D$

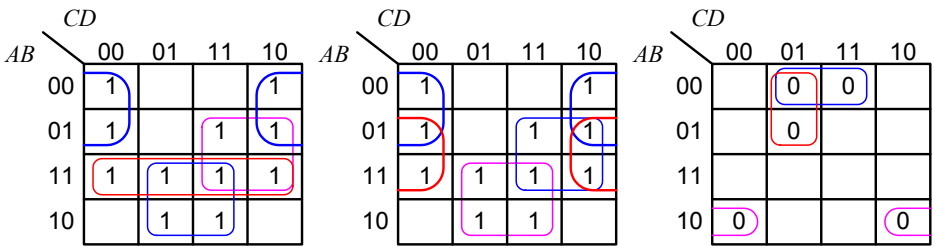
$POS=(A+B+\overline{C})(A+C+D)(B+\overline{C}+\overline{D})=(A+B+D)(A+C+D)(B+\overline{C}+\overline{D})$



⑤ $F(A,B,C,D)=\Sigma m(0,2,4,6,7,9,11,12,13,14,15)$ (답 : SOP 2개, POS 1개)

$SOP=AB+AD+\overline{A}\overline{D}+BC=AD+\overline{A}\overline{D}+BC+B\overline{D}$

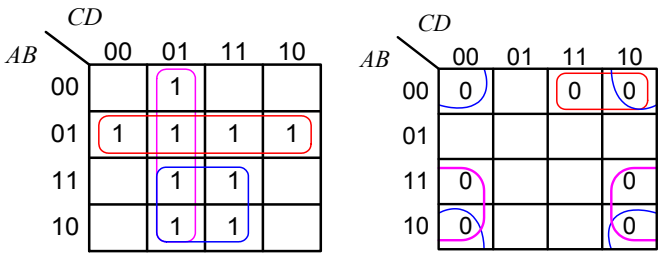
$POS=(A+B+\overline{D})(\overline{A}+B+D)(A+C+\overline{D})$



⑥ $F(A,B,C,D)=\Sigma m(1,4,5,6,7,9,11,13,15)$ (답 : SOP 1개, POS 1개)

$SOP=AD+\overline{A}B+\overline{C}D$

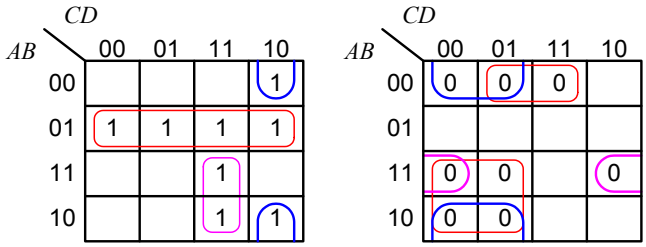
$POS=(\overline{A}+D)(A+B+\overline{C})(B+D)$



⑦ $F(A,B,C,D)=\Sigma m(2,4,5,6,7,10,11,15)$ (답 : SOP 1개, POS 1개)

$SOP=\overline{A}B+ACD+\overline{A}C\overline{D}$

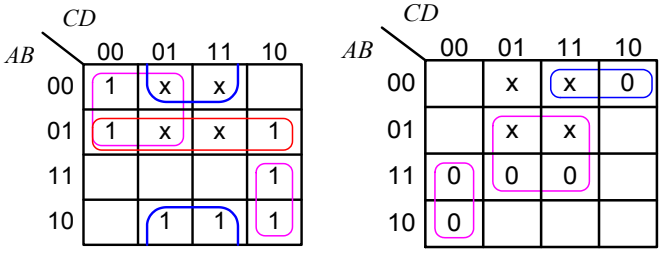
$POS=(\overline{A}+C)(B+C)(\overline{A}+\overline{B}+D)(A+B+\overline{D})$



⑧ $F(A,B,C,D)=\Sigma m(0,4,6,9,10,11,14)+\Sigma d(1,3,5,7)$ (답 : SOP 1개, POS 1개)

$SOP=\overline{A}B+\overline{A}\,\overline{C}+AC\overline{D}+\overline{B}D$

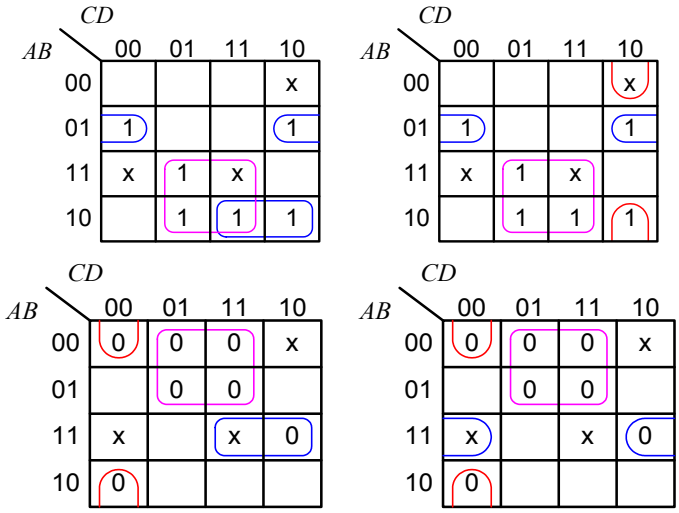
$POS=(A+B+\overline{C})(\overline{A}+C+D)(\overline{B}+\overline{D})$



⑨ $F(A,B,C,D)=\Sigma m(4,6,9,10,11,13)+\Sigma d(2,12,15)$ (답 : SOP 2개, POS 2개)

$SOP=\overline{A}B\overline{D}+A\overline{B}C+AD=\overline{A}B\overline{D}+\overline{B}C\overline{D}+AD$

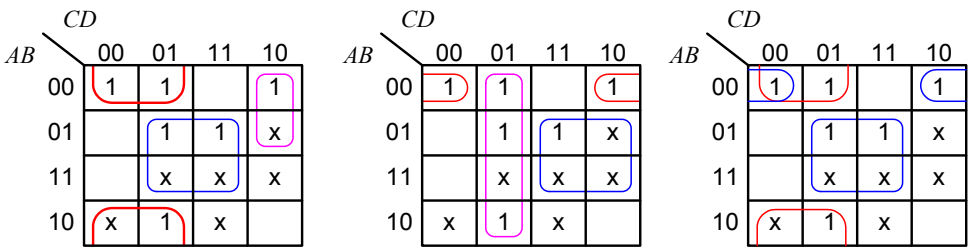
$POS=(A+\overline{D})(B+C+D)(\overline{A}+\overline{B}+\overline{C})=(A+\overline{D})(B+C+D)(\overline{A}+\overline{B}+D)$

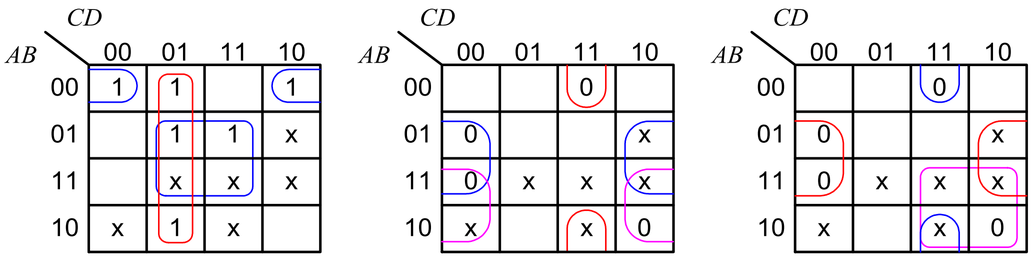


⑩ $F(A,B,C,D)=\Sigma m(0,1,2,5,7,9)+\Sigma d(6,8,11,13,14,15)$ (답 : SOP 4개, POS 2개)

$SOP=BD+\overline{B}\,\overline{C}+\overline{A}C\overline{D}=BC+\overline{C}\,\overline{D}+\overline{A}\,\overline{B}\,\overline{D}=BD+\overline{B}\,\overline{C}+\overline{A}\,\overline{B}\,\overline{D}=BD+\overline{C}D+\overline{A}\,\overline{B}\,\overline{D}$

$POS=(\overline{A}+D)(\overline{B}+D)(B+\overline{C}+D)=(A+\overline{C})(\overline{B}+D)(B+\overline{C}+\overline{D})$

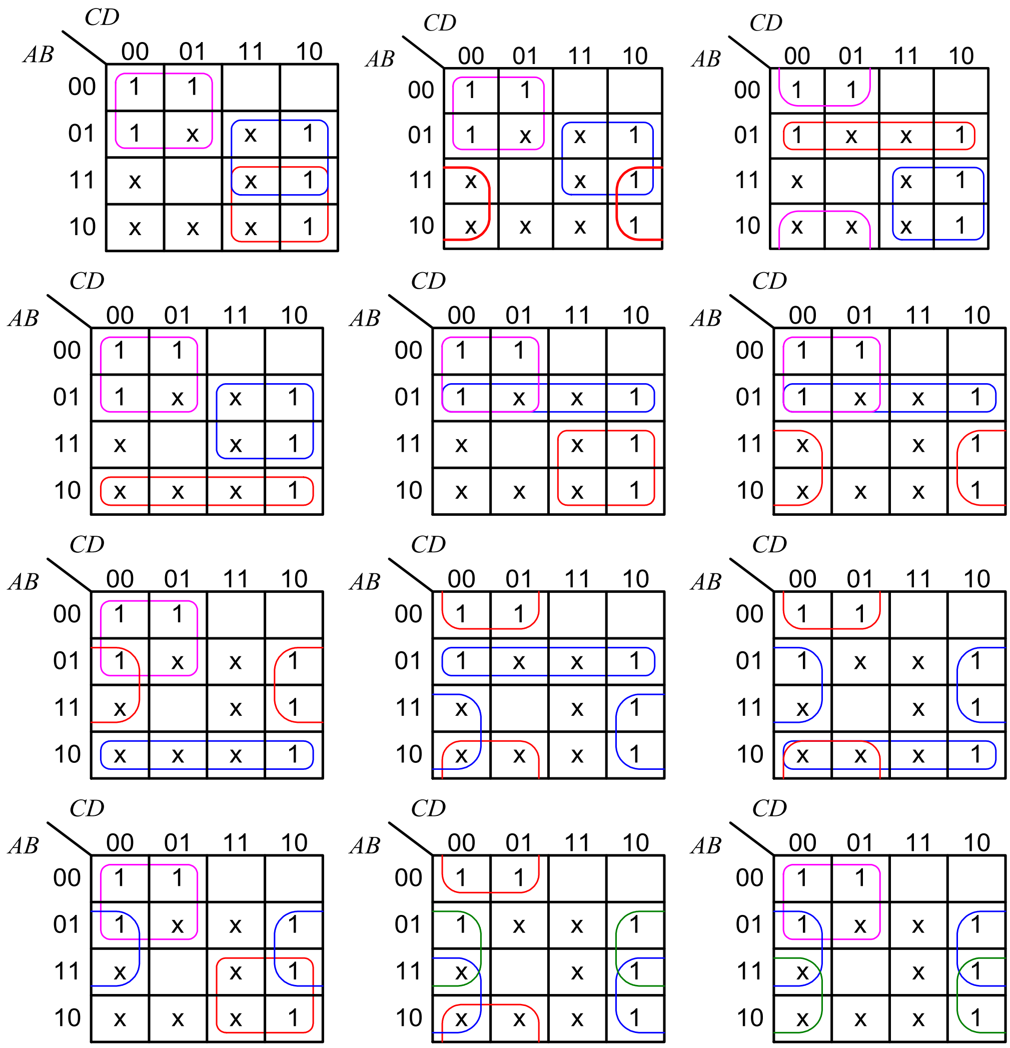


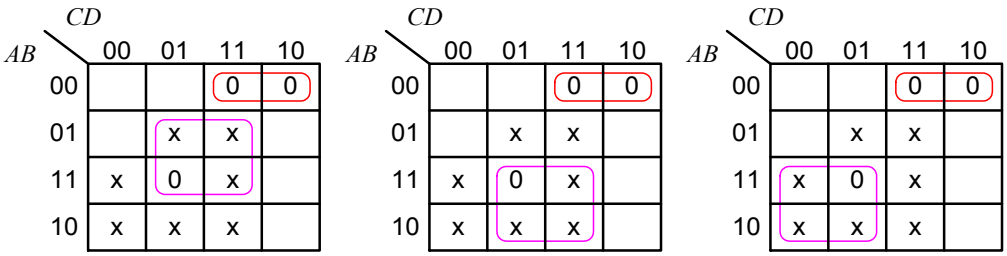


⑪ $F(A,B,C,D) = \Sigma m(0,1,4,6,10,14) + \Sigma d(5,7,8,9,11,12,15)$ (답 : SOP 13개, POS 3개)

$$SOP = AC + \overline{A}\,\overline{C} + BC = \overline{A}\,\overline{C} + A\overline{D} + BC = \overline{A}B + AC + \overline{B}\,\overline{C} = A\overline{B} + \overline{A}\,\overline{C} + BC$$
$$= \overline{A}B + AC + \overline{A}\,\overline{C} = \overline{A}B + \overline{A}\,\overline{C} + A\overline{D} = \overline{A}B + \overline{A}\,\overline{C} + B\overline{D} = \overline{A}B + A\overline{D} + \overline{B}\,\overline{C}$$
$$= A\overline{B} + \overline{B}\,\overline{C} + B\overline{D} = AC + \overline{A}\,\overline{C} + B\overline{D} = A\overline{D} + \overline{B}\,\overline{C} + B\overline{D} = \overline{A}\,\overline{C} + A\overline{D} + B\overline{D}$$

$$POS = (\overline{B} + \overline{D})(A + B + \overline{C}) = (\overline{A} + \overline{D})(A + B + \overline{C}) = (\overline{A} + C)(A + B + \overline{C})$$

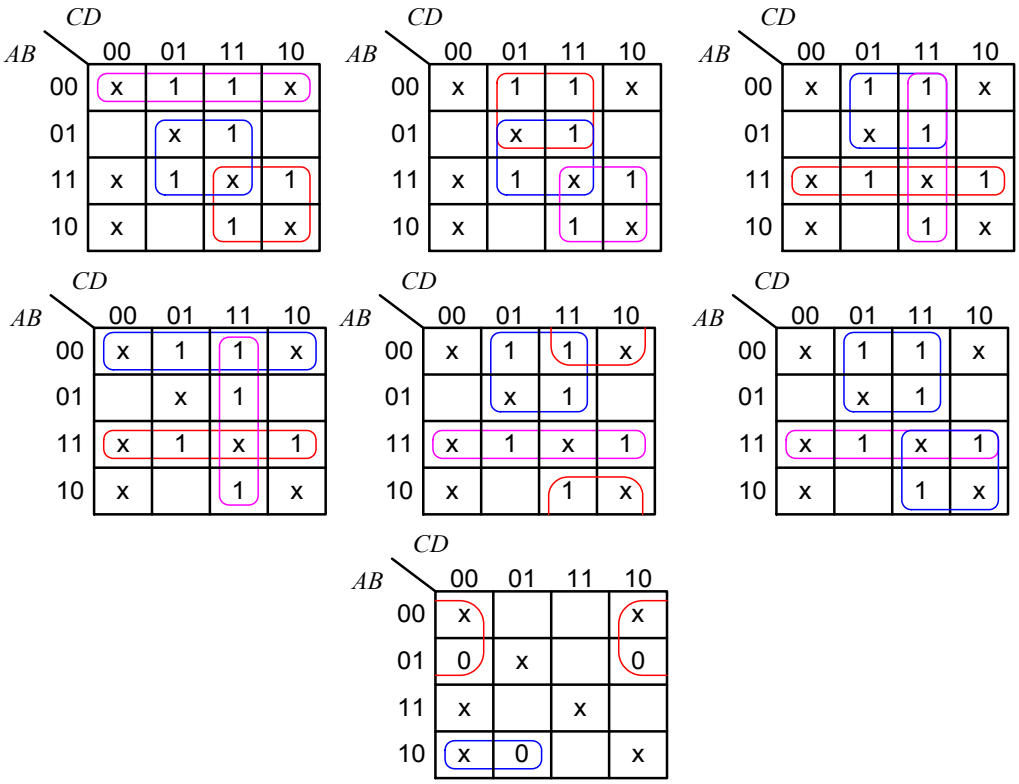




⑫ $F(A,B,C,D)=\Sigma m(1,3,7,11,13,14)+\Sigma d(0,2,5,8,10,12,15)$ (답 : SOP 6개, POS 1개)

$SOP=\overline{A}\,\overline{B}+BD+AC=\overline{A}D+BD+AC=\overline{A}D+AB+CD=AB+\overline{A}\,\overline{B}+CD$
$=AB+\overline{A}D+\overline{B}C=AB+\overline{A}D+AC$

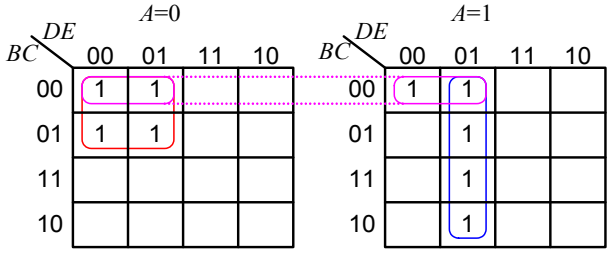
$POS=(A+D)(\overline{A}+B+C)$



10. 5변수 카르노 맵을 이용한 간소화

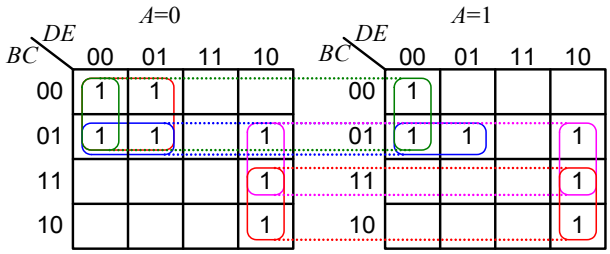
① $F(A,B,C,D,E)=\Sigma m(0,1,4,5,16,17,21,25,29)$

$F(A,B,C,D,E)=\overline{A}\,\overline{B}\,\overline{D}+A\overline{D}E+\overline{B}\,\overline{C}\,\overline{D}$



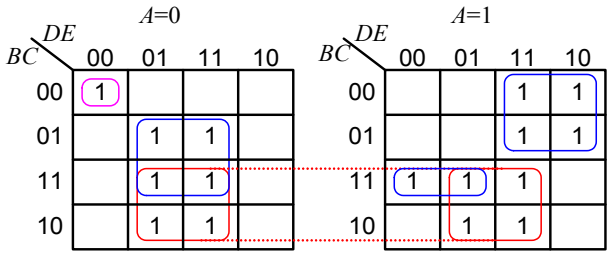
② $F(A,B,C,D,E)=\overline{A}\,\overline{B}C\overline{E}+\overline{A}B\overline{C}\,\overline{D}+\overline{B}\,\overline{D}\,\overline{E}+\overline{B}C\overline{D}+C\overline{D}\,\overline{E}+B\overline{D}\,\overline{E}$

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



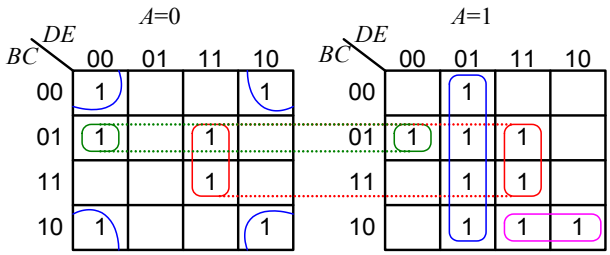
③ $F(A,B,C,D,E)=\Sigma m(0,5,7,9,11,13,15,18,19,22,23,25,27,28,29,31)$

$F(A,B,C,D,E)=BE+A\overline{B}D+\overline{A}CE+ABC\overline{D}+\overline{A}\overline{B}\overline{C}\overline{D}\overline{E}$



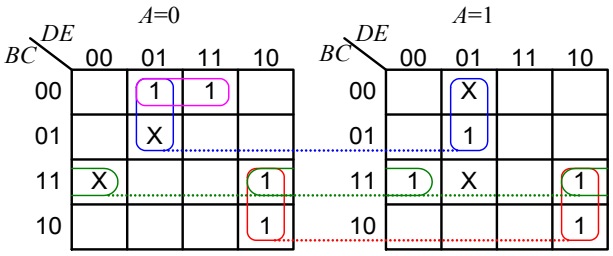
④ $F(A,B,C,D,E)=\Sigma m(0,2,4,7,8,10,15,17,20,21,23,25,26,27,29,31)$

$F(A,B,C,D,E)=\overline{A}\overline{C}\overline{E}+A\overline{D}E+CDE+AB\overline{C}D+\overline{B}C\overline{D}\overline{E}$



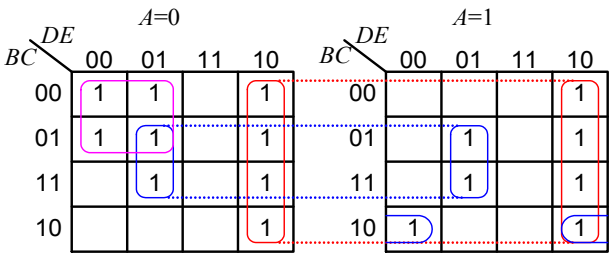
⑤ $F(A,B,C,D,E)=\Sigma m(1,3,10,14,21,26,28,30)+\Sigma d(5,12,17,29)$

$F(A,B,C,D,E)=\overline{B}\overline{D}E+B\overline{D}\overline{E}+BC\overline{E}+\overline{A}\overline{B}\overline{C}E$



⑥ $F(A,B,C,D,E)=\Sigma m(0,1,2,4,5,6,10,13,14,18,21,22,24,26,29,30)$

$F(A,B,C,D,E)=D\overline{E}+\overline{A}\overline{B}\overline{D}+C\overline{D}E+AB\overline{C}\overline{E}$



11. 6변수 카르노 맵을 이용한 간소화

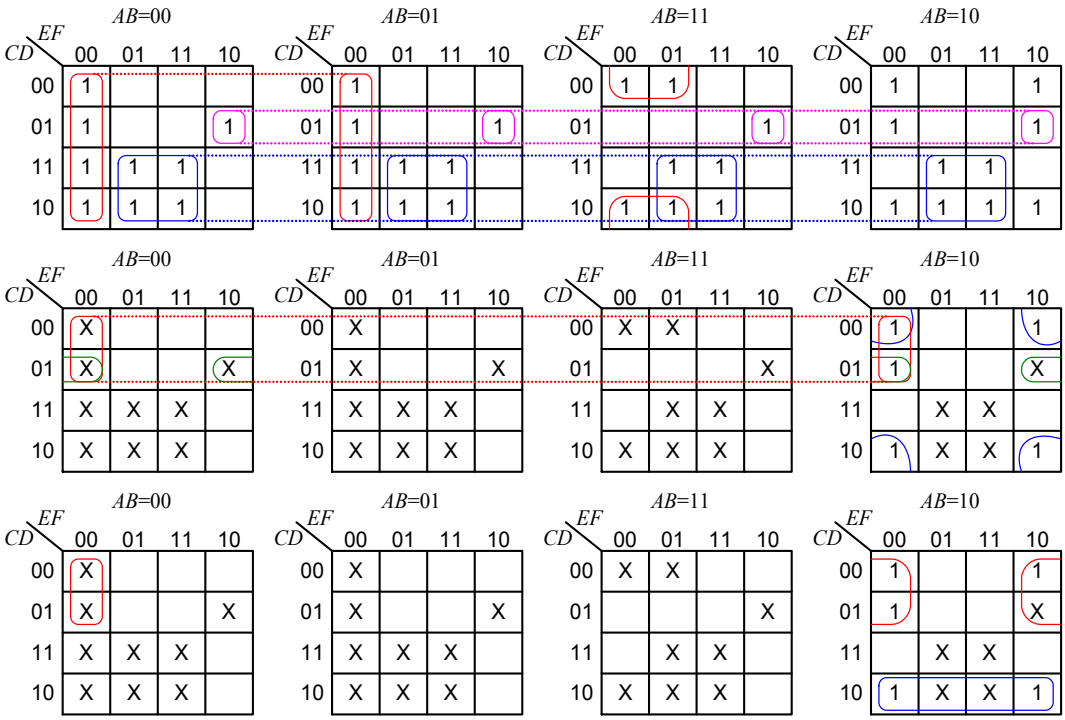
① $F(A,B,C,D,E,F) = \Sigma m(\,0,4,6,8,9,11,12,13,15,16,20,22,24,25,27,28,29,31,32,34,36,38,40,41,42,43,45,47,48,49,54,56,57,59,61,63)$

$F = AB\overline{D}\overline{E} + CF + \overline{C}DE\overline{F} + \overline{A}\overline{E}\overline{F} + A\overline{B}\overline{D}\overline{F} + A\overline{B}\overline{C}F$

$F = AB\overline{D}\overline{E} + CF + \overline{C}DE\overline{F} + \overline{A}\overline{E}\overline{F} + A\overline{B}\overline{D}\overline{F} + \overline{B}\overline{C}E\overline{F}$

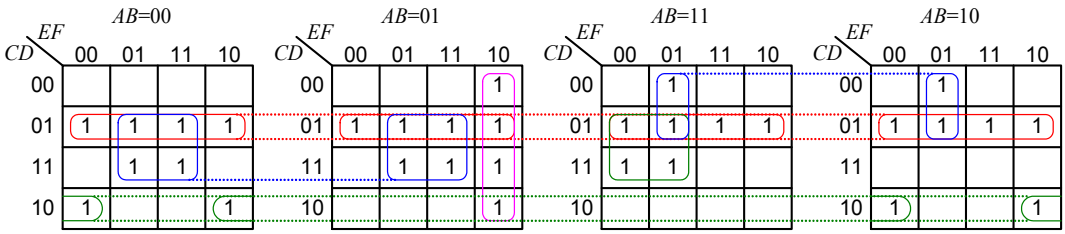
$F = AB\overline{D}\overline{E} + CF + \overline{C}DE\overline{F} + \overline{A}\overline{E}\overline{F} + A\overline{B}\overline{D}\overline{F} + \overline{B}\overline{C}D\overline{F}$

$F = AB\overline{D}\overline{E} + CF + \overline{C}DE\overline{F} + \overline{A}\overline{E}\overline{F} + A\overline{B}\overline{D}\overline{F} + A\overline{B}\overline{C}\overline{D}$



② $F(A,B,C,D,E,F) = \Sigma m(\,4,5,6,7,8,10,13,15,18,20,21,22,23,26,29,30,31,33,36,37,38,39,40,42,49,52,53,54,55,60,61)$

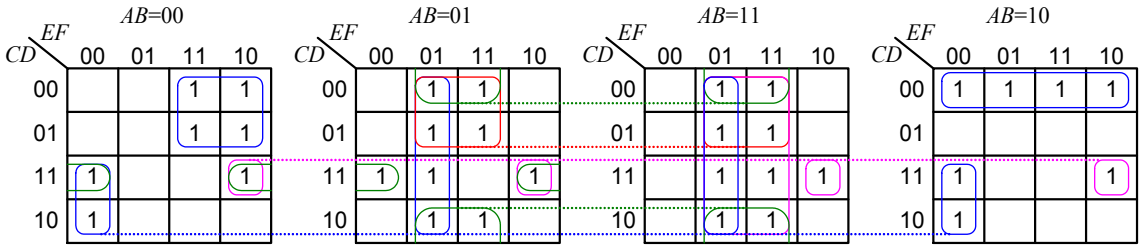
$F = \overline{C}D + \overline{A}DF + \overline{A}BE\overline{F} + ABD\overline{E} + A\overline{C}EF + \overline{B}C\overline{D}F$



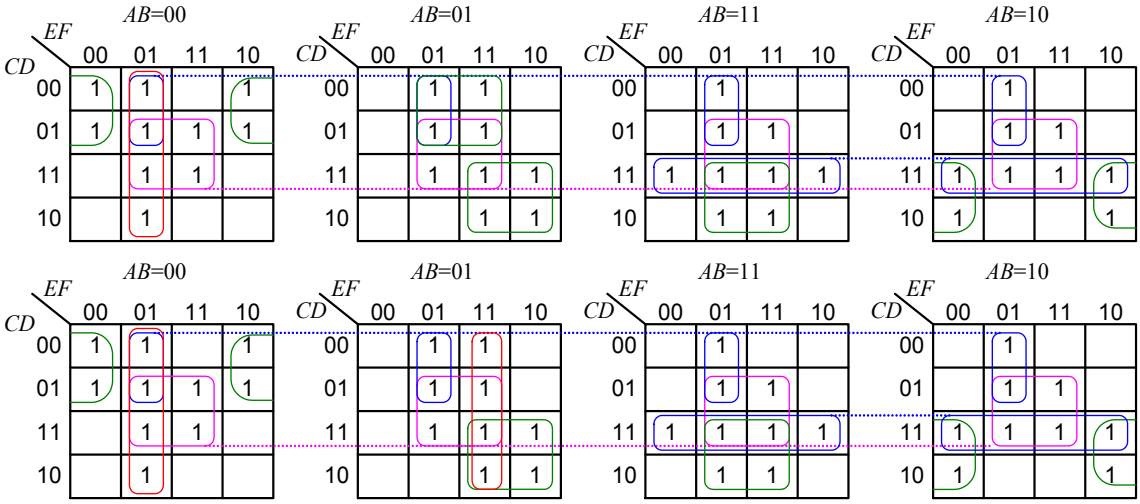
③

$F(A,B,C,D,E,F) = \Sigma m(2,3,6,7,8,12,14,17,19,21,23,25,27,28,29,30,32,33,34,35,40,44,46,49,51,53,55,57,59,61,62,63)$

$= \overline{B}C\overline{E}\overline{F} + B\overline{D}F + B\overline{C}F + \overline{A}\overline{B}\overline{C}E + CDE\overline{F} + A\overline{B}\overline{C}\overline{D} + B\overline{E}F + ABF + \overline{A}CD\overline{F}$

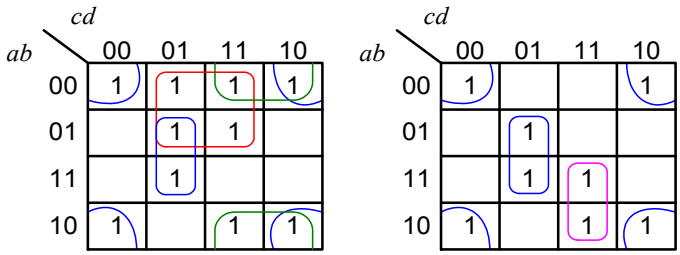


④ $F(A,B,C,D,E,F) = \Sigma m(0,1,2,4,5,6,7,9,13,15,17,19,21,23,26,27,29,30,31,33$
$37,39,40,42,44,45,46,47,49,53,55,57,59,60,61,62,63)$
$= DF + ACD + \overline{C}\overline{E}F + A\overline{B}\overline{C}\overline{F} + A\overline{B}\overline{E}F + A\overline{B}CE + A\overline{B}C\overline{F} + ABCF + \overline{A}\overline{B}CF$
$= DF + ACD + \overline{C}\overline{E}F + A\overline{B}\overline{C}\overline{F} + \overline{A}\overline{B}\overline{E}F + \overline{A}BCE + A\overline{B}C\overline{F} + ABCF + \overline{A}BEF$



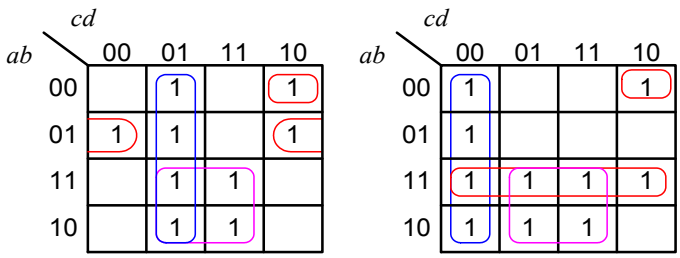
12. 여러 개의 출력함수 표현

① $f(a,b,c,d) = \Sigma m(0,1,2,3,5,7,8,10,11,13), g(a,b,c,d) = \Sigma m(0,2,5,8,10,11,13,15)$, 7개의 게이트

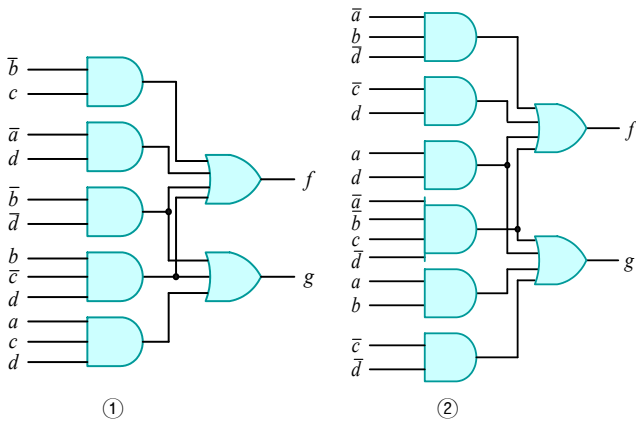


$f = \overline{b}\overline{d} + b\overline{c}d + \overline{a}d + \overline{b}c$ $\quad g = \overline{b}\overline{d} + b\overline{c}d + acd$

② $f(a,b,c,d) = \Sigma m(1,2,4,5,6,9,11,13,15), g(a,b,c,d) = \Sigma m(0,2,4,8,9,11,12,13,14,15)$, 8개의 게이트

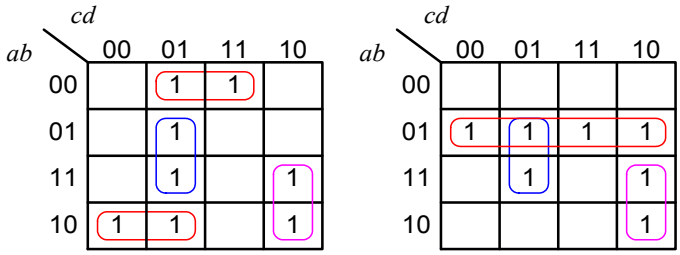


$f = \overline{a}b\overline{d} + \overline{c}d + ad + \overline{a}\overline{b}c\overline{d}$ $\quad g = ab + \overline{c}\overline{d} + ad + \overline{a}\overline{b}c\overline{d}$



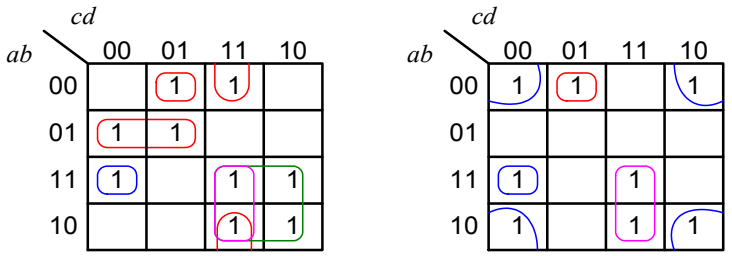
① ②

③ $f(a,b,c,d)=\Sigma m(1,3,5,8,9,10,13,14)$, $g(a,b,c,d)=\Sigma m(4,5,6,7,10,13,14)$, 7개의 게이트

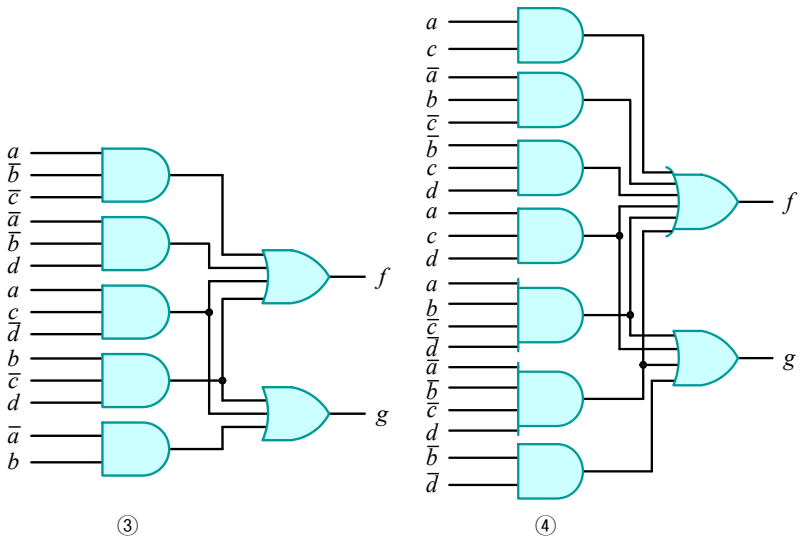


$f=a\bar{b}\bar{c}+\bar{a}\bar{b}d+ac\bar{d}+b\bar{c}d$ $g=\bar{a}b+ac\bar{d}+b\bar{c}d$

④ $f(a,b,c,d)=\Sigma m(1,3,4,5,10,11,12,14,15)$, $g(a,b,c,d)=\Sigma m(0,1,2,8,10,11,12,15)$, 9개의 게이트



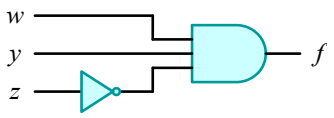
$f=ac+\bar{a}b\bar{c}+\bar{b}cd+acd+ab\bar{c}\bar{d}+\bar{a}\bar{b}\bar{c}d$ $g=\bar{b}\bar{d}+acd+ab\bar{c}\bar{d}+\bar{a}\bar{b}\bar{c}d$



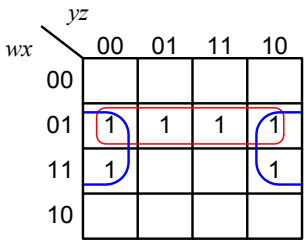
③ ④

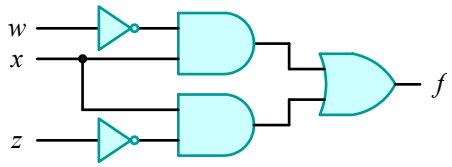
13. 논리회로 간소화

① $f = wy\bar{z} + x\bar{y}(xy + yz) = wy\bar{z}$

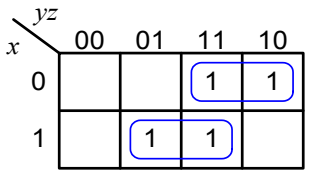


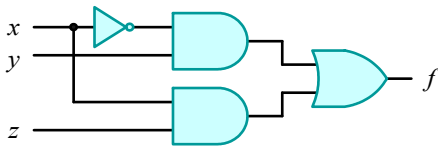
② $f = \bar{w}x + x\bar{z} + \bar{w}x(wyz + \bar{y} + \bar{z}) = \bar{w}x + x\bar{z} + \bar{w}x\bar{y} + \bar{w}x\bar{z} = \bar{w}x + x\bar{z}$



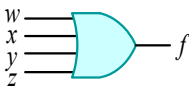


③ $f = \bar{x}yz + \bar{x}y\bar{z} + xz = \bar{x}y + xz$





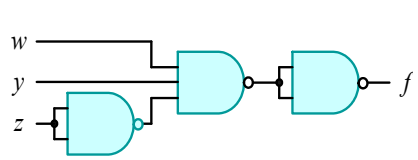
④ $f = (\overline{\overline{w}\overline{x}\overline{y}})y + \overline{\overline{w}\overline{x}\overline{y}} + z = wy + xy + y + w + x + y + z = (w + x + 1)y + w + x + z = w + x + y + z$

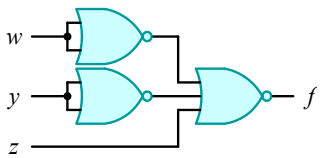


⑤ $F = \overline{\overline{X + \overline{(X+Y)}} + \overline{Y + \overline{(X+Y)}}} = X \odot Y$

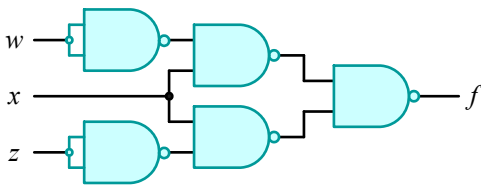
14. 논리회로의 NAND와 NOR 게이트만의 표현

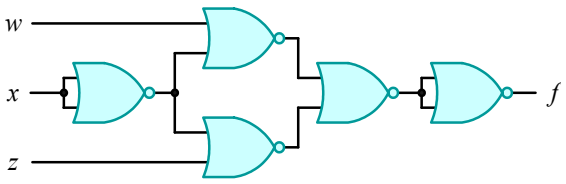
①



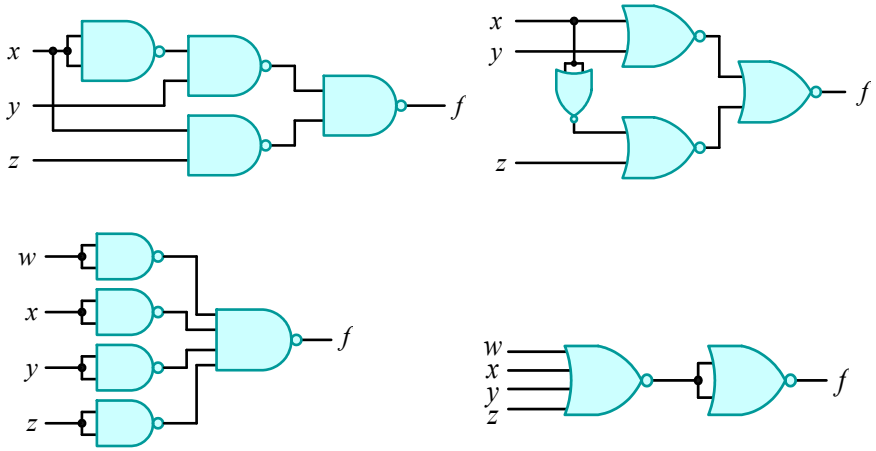


②



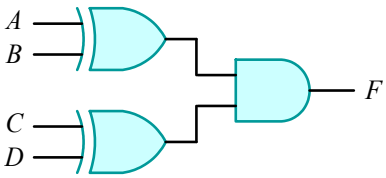


③



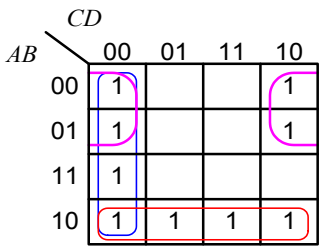
15. 논리식의 XOR와 AND 게이트 표현

$$F = A\overline{B}C\overline{D} + \overline{A}BC\overline{D} + A\overline{B}\overline{C}D + \overline{A}B\overline{C}D = (A\overline{B} + \overline{A}B)C\overline{D} + (A\overline{B} + \overline{A}B)\overline{C}D$$
$$= (A\overline{B} + \overline{A}B)(C\overline{D} + \overline{C}D) = (A \oplus B)(C \oplus D)$$



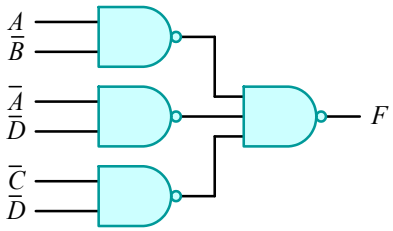
16. 불 대수식의 간략화 및 NAND 게이트만으로의 표현

① $F = A\overline{B} + \overline{C}\overline{D} + \overline{A}C\overline{D} = A\overline{B} + \overline{A}\overline{D} + \overline{C}\overline{D}$



간략화된 논리식을 이중 부정을 하고 드모르간의 정리를 적용하면 다음과 같이 NAND 게이트만으로 나타낼 수 있다.

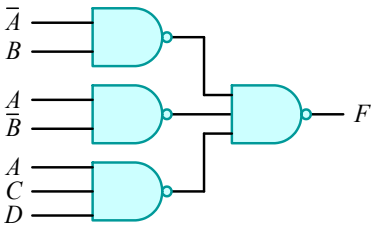
$$F = \overline{\overline{A\overline{B} + \overline{A}\overline{D} + \overline{C}\overline{D}}} = \overline{(A\overline{B})(\overline{A}\overline{D})(\overline{C}\overline{D})}$$



② $F = \overline{A}B + A(\overline{B} + CD) = \overline{A}B + A\overline{B} + ACD$

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

$$F=\overline{\overline{A}B+A\overline{B}+ACD}=\overline{(\overline{A}B)}\,\overline{(A\overline{B})}\,\overline{(ACD)}$$

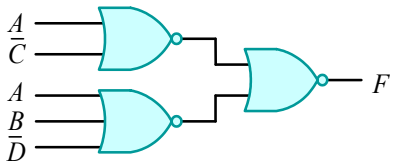


17. 불 대수식의 간략화 및 NOR 게이트만으로의 표현

① $F(A,B,C,D)=A\overline{B}+ABD+AB\overline{D}+\overline{A}\,\overline{C}\,\overline{D}+\overline{A}B\overline{C}$

$POS=(A+\overline{C})(A+B+\overline{D})=\overline{\overline{(A+\overline{C})(A+B+\overline{D})}}=\overline{\overline{(A+\overline{C})}+\overline{(A+B+\overline{D})}}$

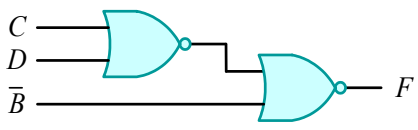
AB \ CD	00	01	11	10
00	1	0	0	0
01	1	1	0	0
11	1	1	1	1
10	1	1	1	1



② $F(A,B,C,D)=BD+BC\overline{D}+A\overline{B}\,\overline{C}\,\overline{D}$

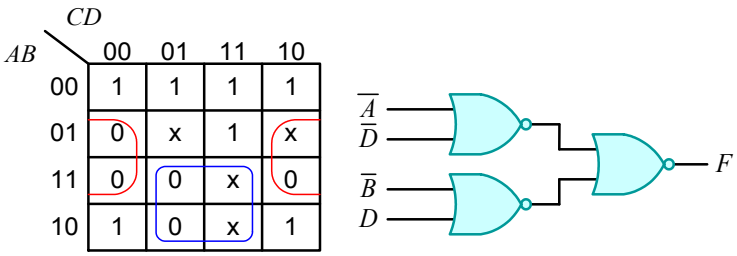
$POS=B(C+D)=\overline{\overline{(A+B)}+\overline{(C+\overline{D})}+\overline{(B+\overline{C})}+\overline{(\overline{B}+C+D)}}$

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



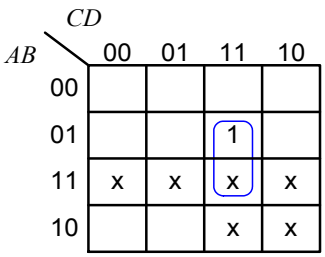
③ $F(A,B,C,D)=\Sigma m(0,1,2,3,7,8,10)+\Sigma d(5,6,11,15)$

$F(A,B,C,D)=(\overline{A}+\overline{D})(\overline{B}+D)=\overline{\overline{(\overline{A}+\overline{D})(\overline{B}+D)}}=\overline{\overline{(\overline{A}+\overline{D})}+\overline{(\overline{B}+D)}}$



18. 논리식의 간략화

입출력 관계를 카르노 맵으로 그려서 정리하면 $Y = BCD$이다.



19. 스위치 회로망의 간략화

N_1		N_2		F
A	B	C	D	
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
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

① $Minterm = \Sigma m(7,10,11,13,14,15)$

$$= \overline{A}BC\overline{D} + \overline{A}BCD + A\overline{B}\overline{C}D + A\overline{B}C\overline{D} + A\overline{B}CD + AB\overline{C}D + ABC\overline{D} + ABCD$$

② $Maxterm = \Pi M(0,1,2,3,4,5,6,8,9,12)$

$$= (A+B+C+D)(A+B+C+\overline{D})(A+B+\overline{C}+D)(A+B+\overline{C}+\overline{D})$$
$$(A+\overline{B}+C+D)(A+\overline{B}+C+\overline{D})(\overline{A}+B+C+D)(\overline{A}+\overline{B}+C+D)$$