

## \* Chosen Characters

rhym 47

## \* Truth Table

w	x	y	a	b	c	d	e	f	g
0	0	0	0	0	0	0	1	0	1
0	0	1	0	0	1	0	1	1	1
0	1	0	0	1	1	1	0	1	1
0	1	1	0	0	0	1	1	1	1
1	0	0	0	0	1	0	1	1	1
1	0	1	1	0	1	0	1	0	1
1	1	0	0	1	1	0	0	1	1
1	1	1	1	1	1	0	0	0	0

## Sum of Minterms (SOM)

$$a \rightarrow \Sigma(5, 7)$$

$$= w\bar{x}y + wx y$$

$$b \rightarrow \Sigma(2, 6, 7)$$

$$= \bar{w}x\bar{y} + wx\bar{y} + wx y$$

$$c \rightarrow \Sigma(1, 2, 4, 5, 6, 7)$$

$$= \bar{w}\bar{x}y + \bar{w}x\bar{y} + w\bar{x}\bar{y} + w\bar{x}y + wx\bar{y} + wx y$$

$$d \rightarrow \Sigma(2, 3)$$

$$= \bar{w}x\bar{y} + \bar{w}xy$$

$$e \rightarrow \Sigma(0, 1, 3, 4, 5)$$

$$= \bar{w}\bar{x}\bar{y} + \bar{w}\bar{x}y + \bar{w}x\bar{y} + w\bar{x}\bar{y} + w\bar{x}y$$

$$f \rightarrow \Sigma(1, 2, 3, 4, 6)$$

$$= \bar{w}\bar{x}y + \bar{w}x\bar{y} + \bar{w}xy + w\bar{x}\bar{y} + wx\bar{y}$$

$$g \rightarrow \Sigma(0, 1, 2, 3, 4, 5, 6)$$

$$= \bar{w}\bar{x}\bar{y} + \bar{w}\bar{x}y + \bar{w}x\bar{y} + \bar{w}xy + w\bar{x}\bar{y} + w\bar{x}y + wx\bar{y}$$

### Product of Maxterms (POM)

$$a \rightarrow \Pi(0, 1, 2, 3, 4, 6)$$

$$= (w+x+y)(w+x+\bar{y})(w+\bar{x}+y)(w+\bar{x}+\bar{y})(\bar{w}+x+y)(\bar{w}+\bar{x}+y)$$

$$b \rightarrow \Pi(0, 1, 3, 4, 5)$$

$$= (w+x+y)(w+x+\bar{y})(w+\bar{x}+\bar{y})(\bar{w}+x+y)(\bar{w}+x+\bar{y})$$

$$c \rightarrow \Pi(0, 3)$$

$$= (w+x+y)(w+\bar{x}+\bar{y})$$

$$d \rightarrow \Pi(0, 1, 4, 5, 6, 7)$$

$$= (w+x+y)(w+x+\bar{y})(\bar{w}+x+y)(\bar{w}+x+\bar{y})(\bar{w}+\bar{x}+y)(\bar{w}+\bar{x}+\bar{y})$$

$$e \rightarrow \pi(2, 6, 7)$$

$$= (\omega + \bar{x} + y)(\bar{\omega} + \bar{x} + y)(\bar{\omega} + \bar{x} + \bar{y})$$

$$f \rightarrow \pi(0, 5, 7)$$

$$= (\omega + x + y)(\bar{\omega} + x + \bar{y})(\bar{\omega} + \bar{x} + \bar{y})$$

$$g \rightarrow \pi(7)$$

$$= (\bar{\omega} + \bar{x} + \bar{y})$$

### Standard Sum of Products (SOP)

a:

$\omega x \backslash y$	$\bar{y}$	$y$
$\bar{\omega} \bar{x}$	0	0
$\bar{\omega} x$	0	0
$\omega x$	0	1
$\omega \bar{x}$	0	1

$$a = \omega y$$

b:

$\omega x \backslash y$	$\bar{y}$	$y$
$\bar{\omega} \bar{x}$	0	0
$\bar{\omega} x$	1	0
$\omega x$	1	1
$\omega \bar{x}$	0	0

$$b = x\bar{y} + \omega x$$

c:

$\omega x \backslash y$	$\bar{y}$	$y$
$\bar{\omega} \bar{x}$	0	1
$\bar{\omega} x$	1	0
$\omega x$	1	1
$\omega \bar{x}$	1	1

$$c = \omega + x\bar{y} + \bar{x}y$$

$$= \omega + x \oplus y$$

d:

$\omega x \backslash y$	$\bar{y}$	$y$
$\bar{\omega} \bar{x}$	0	0
$\bar{\omega} x$	1	1
$\omega x$	0	0
$\omega \bar{x}$	0	0

$$d \Rightarrow \bar{\omega} x$$



e:

$wx \backslash y$	$\bar{y}$	$y$
$\bar{w}\bar{x}$	1	1
$\bar{w}x$	0	1
$wx$	0	0
$w\bar{x}$	1	1

$$e = \bar{x} + \bar{w}y$$

f:

$wx \backslash y$	$\bar{y}$	$y$
$\bar{w}\bar{x}$	0	1
$\bar{w}x$	1	1
$wx$	1	0
$w\bar{x}$	1	0

$$\begin{aligned} f &= \bar{w}y + \bar{w}x + w\bar{y} + x\bar{y} \\ &= \bar{w}x + w \oplus y + x\bar{y} \\ &= x(\bar{w} + \bar{y}) \oplus w \oplus y \end{aligned}$$

g:

$wx \backslash y$	$\bar{y}$	$y$
$\bar{w}\bar{x}$	1	1
$\bar{w}x$	1	1
$wx$	1	0
$w\bar{x}$	1	1

$$g = \bar{w} + \bar{y} + \bar{x}$$

# Standard Product of Sums (POS)

a:

$wx \backslash y$	$y$	$\bar{y}$
$w+x$	0	0
$w+\bar{x}$	0	0
$\bar{w}+\bar{x}$	0	1
$\bar{w}+x$	0	1

~~$$a = y(w+\bar{y})$$~~

~~$$a = (\bar{y})(w)$$~~

$$a = y(w+x)(w+\bar{x})$$

b:

$wx \backslash y$	$y$	$\bar{y}$
$w+x$	0	0
$w+\bar{x}$	1	0
$\bar{w}+\bar{x}$	1	1
$\bar{w}+x$	0	0

$$b = (w+\bar{y})(w+x)(\bar{w}+x)$$

d:

$wx \backslash y$	$y$	$\bar{y}$
$w+x$	0	0
$w+\bar{x}$	1	1
$\bar{w}+\bar{x}$	0	0
$\bar{w}+x$	0	0

$$d = (w+x)(\bar{w}+\bar{x})(\bar{w}+x)$$

c:

$wx \backslash y$	$y$	$\bar{y}$
$w+x$	0	1
$w+\bar{x}$	1	0
$\bar{w}+\bar{x}$	1	1
$\bar{w}+x$	1	1

$$c = (w+x+y)(w+\bar{x}+\bar{y})$$

$e:$

$wx \mid y$	$y$	$\bar{y}$
$w+x$	1	1
$w+\bar{x}$	0	1
$\bar{w}+\bar{x}$	0	0
$\bar{w}+x$	1	1

$$e = (\bar{x} + y)(\bar{w} + x)$$

$f:$

$wx \mid y$	$y$	$\bar{y}$
$w+x$	0	1
$w+\bar{x}$	1	1
$\bar{w}+\bar{x}$	1	0
$\bar{w}+x$	1	0

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

$g:$

$wx \mid y$	$y$	$\bar{y}$
$w+x$	1	1
$w+\bar{x}$	1	1
$\bar{w}+\bar{x}$	1	0
$\bar{w}+x$	1	1

$$g = (\bar{w} + \bar{x} + \bar{y})$$

## NAND gate formal equation

$$a: wy$$

$$= \overline{\overline{wy}}$$

$$b: x\bar{y} + wx$$

$$= \overline{\overline{x\bar{y} + wx}}$$

$$= (\overline{x\bar{y}})(\overline{wx})$$

or

$$c: w + x\bar{y} + \bar{x}y$$

$$= \overline{\overline{w + x\bar{y} + \bar{x}y}}$$

$$= (\bar{w})(\overline{x\bar{y}})(\overline{\bar{x}y})$$

$$d: \bar{w}x$$

$$= \overline{\overline{\bar{w}x}}$$

$$e: \bar{x} + \bar{w}y$$

$$= \overline{\overline{\bar{x} + \bar{w}y}}$$

$$= (\overline{\bar{x}})(\overline{\bar{w}y})$$

$$= x(\overline{\bar{w}y})$$

$$f: \bar{w}y + \bar{w}x + w\bar{y} + x\bar{y}$$

$$= \overline{\overline{\bar{w}y + \bar{w}x + w\bar{y} + x\bar{y}}}$$

$$= (\overline{\bar{w}y})(\overline{\bar{w}x})(\overline{w\bar{y}})(\overline{x\bar{y}})$$

$$g: \bar{w} + \bar{y} + \bar{x}$$

$$= \overline{\overline{\bar{w} + \bar{y} + \bar{x}}}$$

$$= \overline{\bar{w} \bar{y} \bar{x}}$$

$$= w y x$$



# NOR gate formal equation

a:  $w y$

$$= \overline{\overline{w y}}$$

$$= \overline{\overline{w} + \overline{y}}$$

b:  $x \overline{y} + w x$

$$= \overline{\overline{x \overline{y} + w x}}$$

$$= \overline{(x \overline{y}) (\overline{w x})}$$

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

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

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

c:  $\overline{w + x \overline{y} + x y}$

$$= \overline{\overline{w} (\overline{x \overline{y}}) (\overline{x y})}$$

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

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

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

d:  $\overline{w x}$

$$= \overline{\overline{w x}}$$

$$= \overline{\overline{\overline{w} + \overline{x}}}$$

$$= \overline{w + x}$$

e:  $\overline{x + \overline{w y}}$

$$= \overline{\overline{x + \overline{w y}}}$$

$$= \overline{(\overline{x}) (\overline{\overline{w y}})}$$

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

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

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

f:  $\overline{\overline{w y} + \overline{w x} + \overline{w y} + x \overline{y}}$

$$= \overline{\overline{w y} + \overline{w x} + \overline{w y} + x \overline{y}}$$

$$= \overline{(\overline{w y}) (\overline{w x}) (\overline{w y}) (\overline{x y})}$$

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

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

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

g:  $\overline{\overline{w} + \overline{y} + \overline{x}}$

$$= \overline{\overline{\overline{w} + \overline{y} + \overline{x}}}$$

$$= \overline{\overline{\overline{w}} \overline{\overline{y}} \overline{\overline{x}}}$$

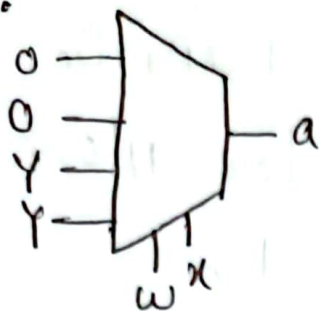
$$= \overline{w y x}$$

$$= \overline{w + y + x}$$



# Multiplexer format Equations

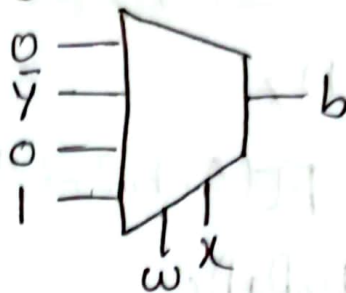
a:



$$a = yw\bar{x} + ywx$$

$$= w\bar{x}y + wx y$$

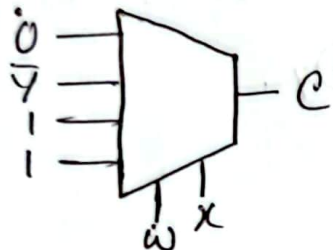
b:



$$b = \bar{y}\bar{w}x + 1 \cdot wx$$

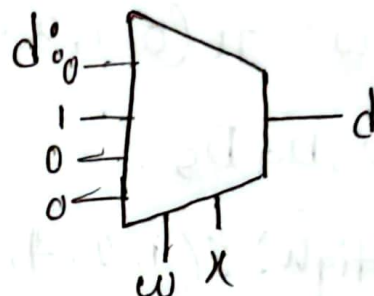
$$= \bar{w}x\bar{y} + wx$$

c:



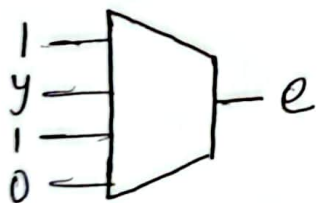
$$c = y\bar{w}x + \bar{y}\bar{w}x + 1 \cdot wx + 1 \cdot wx$$

$$= \bar{w}x y + \bar{w}x \bar{y} + wx + wx$$

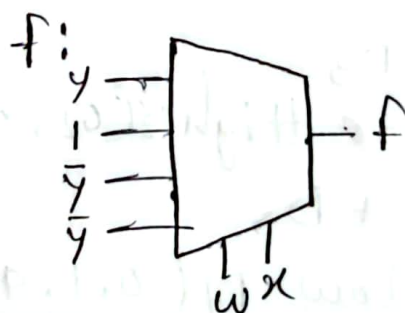


$$d = 1 \cdot \bar{w}x = \bar{w}x$$

e:

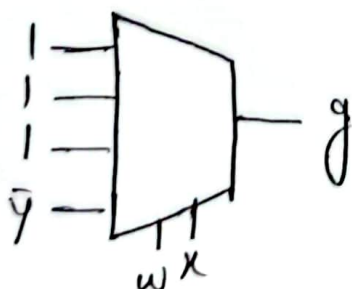


$$e = \bar{w}xy + \bar{x}$$



$$f = \bar{w}x y + \bar{w}x + wx\bar{y} + wx\bar{y}$$

g:



$$g = \bar{w}\bar{x} + \bar{w}x + w\bar{x} + \bar{y}wx$$

## Decoder Format Equation

a:

Active High:  $\Sigma(5, 7)$

$$D_5 + D_7$$

Active Low:  $\prod(0, 1, 2, 3, 4, 6)$

$$D_0 D_1 D_2 D_3 D_4 D_6$$

b: Active High:  $\Sigma(2, 6, 7)$

$$D_2 + D_6 + D_7$$

Active Low:  $\prod(0, 1, 3, 4, 5)$

$$D_0 D_1 D_3 D_4 D_5$$

c: Active High:  $\Sigma(1, 2, 4, 5, 6, 7)$

$$D_1 + D_2 + D_4 + D_5 + D_6 + D_7$$

Active Low:  $\prod(0, 3)$

$$D_0 D_3$$

d: Active High:  $\Sigma(2, 3)$

$$D_2 + D_3$$

Active Low:  $\prod(0, 1, 4, 5, 6, 7)$

$$D_0 D_1 D_4 D_5 D_6 D_7$$

e: Active High:  $\Sigma(0, 1, 3, 4, 5)$

$$D_0 + D_1 + D_3 + D_4 + D_5$$

Active Low:  $\prod(2, 6, 7)$

$$D_2 D_6 D_7$$

f: Active High:  $\Sigma(1, 2, 3, 4, 6)$

$$D_1 + D_2 + D_3 + D_4 + D_6$$

Active Low:  $\prod(0, 5, 7)$

$$D_0 D_5 D_7$$

g: Active High:  $\Sigma(0, 1, 2, 3, 4, 5, 6)$

$$D_0 + D_1 + D_2 + D_3 + D_4 + D_5 + D_6$$

Active Low:  $\prod(7)$

$$D_7$$

# Cost Analysis

## Number of Different Gates Needed

For SOM:

(7411) 3 Input AND gate : 30

(7432) 2 Input OR gate : 7

(4075) 3 Input OR gate : 8

(7404) Hex Converter (NOT) : 3

Number of ICs :

3 Input AND IC : 10

$$\text{Cost} = (10 \times 35) = 350 \text{ tk}$$

2 Input OR IC : 2

$$\text{Cost} = (2 \times 30) = 60 \text{ tk}$$

3 Input OR IC : 3

$$\text{Cost} = (3 \times 41) = 123 \text{ tk}$$

Hex Converter : 1

$$\text{Cost} = (1 \times 30) = 30 \text{ tk}$$

Total Cost : 563 tk.



For POM:

3 Input OR Gates : 26

3 Input AND Gates : 7

2 Input AND Gates : 5

NOT Gates : 3

Number of ICs

3 Input OR IC : 9

Cost =  $(9 \times 39) = 351 \text{ tk}$

3 Input AND Gates : 3

Cost =  $(3 \times 35) = 105 \text{ tk}$

2 Input AND Gates : 2

Cost  $(2 \times 30) = 60 \text{ tk}$

Hex converter : 1

Cost  $(1 \times 30) = 30 \text{ tk}$

Total Cost : 564 tk

For SOP:

2 Input AND gates: 6

2 Input OR gates: 7

2 Input XOR gates: 2

NOT gates: 3

Number of IC:

2 Input AND IC: 2 cost =  $(2 \times 30) = 60 \text{ tk}$

2 Input OR IC: 2 cost =  $(2 \times 30) = 60 \text{ tk}$

2 Input XOR IC: 1 cost =  $(1 \times 25) = 25 \text{ tk}$

Hex converter: 1 cost =  $(1 \times 30) = 30 \text{ tk}$

Total cost = 175 tk.

For POS

3 Input OR gates: 4

2 Input OR gates: 11

2 Input AND gates: 9

NOT gates: 3

Number of IC:

3 Input OR IC: 2 cost  $(2 \times 41) = 82 \text{ tk}$

2 Input OR IC: 3 cost  $(3 \times 30) = 90 \text{ tk}$

2 Input AND IC: 3 cost  $(3 \times 30) = 90 \text{ tk}$

Hex Inverter: 1 cost  $(1 \times 30) = 30 \text{ tk}$

Total cost: 292 tk

## For NAND gate

2 Input NAND : 25

3 Input NAND : 1

Number of ICs:

2 Input NAND IC : 6 cost  $(6 \times 25) = 150 + k$

3 Input NAND IC : 1 cost  $(1 \times 31) = 31 + k$

Total cost =  $181 + k$

## For NOR gate

2 Input NOR gate : 30

3 Input NOR gate : 1

Number of ICs

2 Input NOR IC : 10 cost  $(10 \times 25) = 250 + k$

3 Input NOR IC : 1 cost  $(1 \times 35) = 35 + k$

Total Cost  $(250 + 35) = 285 + k$



For Multiplexer

$$74153 \rightarrow 4$$

$$\text{Cost} \rightarrow (4 \times 32) = 128 + k$$

$$\text{Total Cost } 128 + k$$

for Decoder (3 to 8)

$$74139 \text{ (3 to 8 decoder)} \rightarrow 1$$

$$\text{Cost } (1 \times 35) = 35 + k$$

$$2 \text{ Input AND gate: } 17$$

$$2 \text{ Input AND ICs: } 5$$

$$\text{Cost } (5 \times 30) = 150 + k$$

$$\text{Total Cost } 185 + k.$$