

* Chosen Characters

Rhythm 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)

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

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

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

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

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

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

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

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

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

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

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

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

$$g \rightarrow \Sigma(1, 2, 3, 4, 5, 6 \cancel{, 6})$$

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

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

$$a = \omega y$$

b:

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

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

c:

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

$$\begin{aligned} c &= \omega + x\bar{y} + \bar{x}y \\ &= \omega + x \oplus y \end{aligned}$$

d:

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

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

ℓ :

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

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

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

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

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

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

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

$wx \setminus$	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:

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

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

c:

$wx \setminus$	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:

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

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

$f:$

wx	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	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

$$a: \underline{w y} \\ = \underline{\underline{w y}}$$

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

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

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

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

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

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

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

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

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

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

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

NOR gate formal equation

$$a: \overline{w}y$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

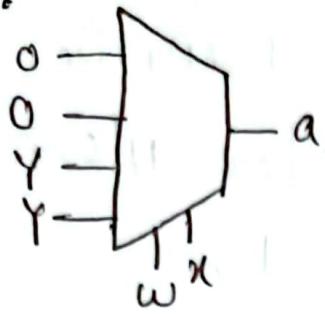
$$= \overline{\overline{w}\overline{y}\overline{x}}$$

$$= \overline{wyx}$$

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

Multiplexer Format Equations

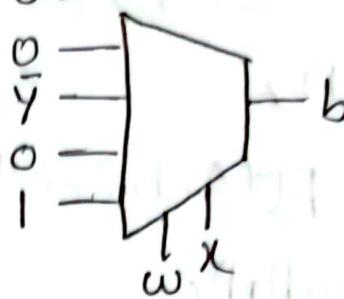
a:



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

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

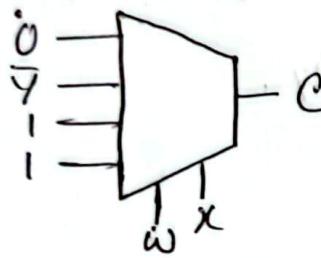
b:



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

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

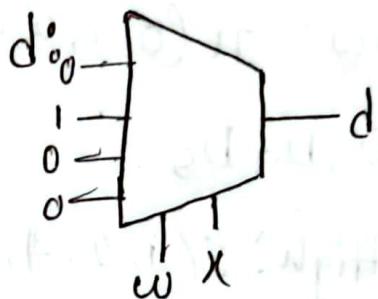
c:



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

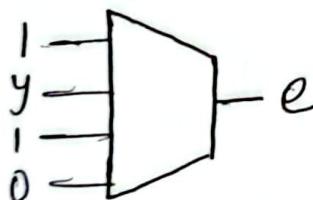
$$= \bar{w}\bar{x}y + \bar{w}x\bar{y} + w\bar{x} + wx$$

d:



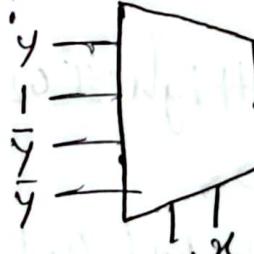
$$d = 1.\bar{w}x = \bar{w}x$$

e:



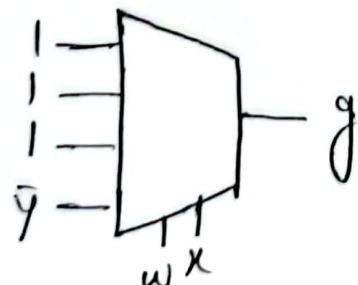
$$e = \bar{w}xy + \bar{x}$$

f:



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

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: $\Sigma(0, 2, 3)$

$$D_2 + D_3$$

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 : 37

(9075) 3 Input OR gate : 8

(7409) 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 = $(9 \times 39) = \cancel{345} + 369 \text{ tk}$

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 : 569 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 = $(2 \times 30) = 60$ tk

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

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

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

Total cost = 175 tk.

For POS

3 Input OR gates: 9

2 Input OR gates: 11

2 Input AND gates: 9

NOT gates: 3

Number of IC:

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

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

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

Hex Inverters: 1 cost $(1 \times 30) = 30$ 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 $(6 \times 25) = 150$ tk

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

Total cost = 181 tk

For NOR gate

2 Input NOR gate : 30

3 Input NOR gate : 1

Number of ICs

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

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

Total Cost $(250 + 35) = 285$ tk.

For Multiplexer

74153 \rightarrow 4

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

Total Cost $128 + k$

for Decoder (3 to 8)

74139 (3 to 8 Decoder) \rightarrow 1

Cost $(1 \times 35) = 35 + k$

2 Input AND gate: 17

2 Input AND ICs: 5

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

Total Cost $185 + k.$