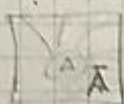


The complementation of the Numbers



- Complementation to $t-1$ (Radix minus one notation)
- Complementation to t (Radix notation)

~~complementation~~

- Complement to $(t-1)$ Radix minus one Notation

$$T = t^n - t^m - N$$

$$N = 12,99 \quad T = 10^2 - 10^{-2} - 12,99 = 87,20$$

$$\begin{array}{r} N \quad 12,99 \\ \underline{17} \quad 87,20 \\ 99,99 \end{array}$$

$$N = 101 \rightarrow T = 010$$

$$(654)_{10} \quad T = (345)_{10}$$

- The Complement to t

$$T_t = t^n - N = T_{t-1} + 1 (\text{LSB})$$

$$N = 1279 = 10^4 - 1279 = 8721$$

$$T_t = T_{t-1} + 1 (\text{LSB}) = 8720 + 1$$

$$N = (101)_2 \rightarrow T_1 = 010$$

$$T_2 = 011$$

NEGATIVE NUMBER

- Sign and Magnitude
- Diminished-Radix Notation (Radix minus one)
- Radix Notation

		2	8	16	10	Number Systems
+	0	0	0	0	0	
-	t-1	1	7	F	9	

	S+M	t-1	t	
+5	0 0101	0 1010	0 1011	if positive nothing after separator
-5	1 0101	1 1010	1 1011	
+9	0 1001	0 1001	0 1001	
-9	1 1001	1 0110	1 0111	

Fixed Point Arithmetic

~~In Base t~~

- Radix Notation (t Base)
- Radix-Minus one (t-1 Base)

case 1 $A > 0$ $B > 0$

case 2 $A > 0$ $B < 0$ (vice versa)

case 3 $A < 0$ $B < 0$

Case A70 B70

(b) wenn $s_3 = 0$: $A+B < t^{n+1}$ (unvergleichbar)
 $s_3 \neq 0$: $A+B > t^{n+1}$ (vergleichbar)

$$\begin{array}{r}
 0000\ 1101 \\
 + 0000\ 1011 \\
 \hline
 0001\ 1000 \\
 1 \\
 \hline
 0
 \end{array}$$

$$\begin{array}{r} -A \\ -B \\ \hline -(A+B) \end{array} \quad \begin{array}{r} (t-1)a_{n-2} \dots a_1 a_0, a_1 \dots a_k \\ (t-1)b_{n-2} \dots b_1 b_0, b_1 \dots b_k \\ \hline (s-1)s_{n-2} \dots s_1 s_0, s_1 \dots s_k \end{array} \quad \begin{array}{r} t^n - A \\ t^n - B \\ \hline 2t^n - (A+B) \end{array}$$

Carry Bit $\rightarrow 1 + \left[t^n \cdot (A+B) \right]$
 \downarrow
 ignore t^n
 Sum $\rightarrow 11011$ $\rightarrow 27$ $\rightarrow 1011$ $\rightarrow 11$ $\rightarrow 1011$ $\rightarrow 11$

$10101 \rightarrow 11010 \rightarrow \frac{(S+M)}{11011}$

$$\begin{array}{r} 10+99 \\ \hline +1 \end{array}$$

050W

$A > 0, B < 0$

$$\begin{array}{r} A \\ -B \\ \hline t^n - B \\ t^n - (B-A) \end{array}$$

$$\begin{array}{r} 15 \\ -6 \\ \hline 9 \end{array} \quad \begin{array}{r} 01111 \\ +1010 \\ \hline 10101 \end{array}$$

$$\begin{array}{r} 01001 \end{array}$$

$$\begin{array}{r} -15 \\ +6 \\ \hline -9 \end{array} \quad \begin{array}{r} 10001 \\ +0110 \\ \hline 10111 \end{array}$$

$$\begin{array}{r} 1000 \\ \downarrow \\ 1001 \end{array}$$

S-M 1001

Diminished - Radix Arithmetic (+1 Base)

• $A > 0, B > 0$

$$\begin{array}{r} +A \\ +B \\ \hline +(A+B) \end{array} \quad \begin{array}{r} 4 \\ +11 \\ \hline +15 \end{array} \quad \begin{array}{r} 00100 \\ +01011 \\ \hline 01111 \end{array}$$

$$\begin{array}{r} +6 \\ +11 \\ \hline 1001 \end{array} \quad \begin{array}{r} 00110 \\ +01011 \\ \hline 10001 \end{array}$$

11 overflow

False

• $A < 0, B < 0$

$$\begin{array}{r} -A \\ -B \\ \hline -(A+B) \end{array} \quad \begin{array}{r} t^n - t^k - A \\ + t^n - t^k - B \\ \hline 2t^n - 2t^k - (A+B) \end{array}$$

$$\begin{array}{r} t^n - t^k \\ + [t^n - t^k - (A+B)] \\ \hline t^n - t^k - (A+B) \end{array}$$

MSB MSB

End-Around Carry

002 /

49

OSOW

$$\begin{array}{r} -3 \\ -11 \\ \hline -14 \end{array}$$

$$\begin{array}{r} 11100 \\ + 10100 \\ \hline \end{array}$$

$$\begin{array}{r} 10000 \\ + 10001 \\ \hline 10001 \end{array}$$

End-Around Carry

11110 S+M → Sign (negative) & positive

• $A > 0, B < 0$

$$\begin{array}{r} A \\ + -B \\ \hline \end{array}$$

$$\begin{array}{r} A \\ + n - B - 1 - k \\ \hline n - 1 - k - (B - A) \end{array}$$

$$\begin{array}{r} -3 \\ + 11 \\ \hline 8 \end{array}$$

$$\begin{array}{r} 11100 \\ + 01011 \\ \hline 100111 \end{array}$$

$$\begin{array}{r} 100111 \\ + 100111 \\ \hline 01000 \end{array}$$

$$\begin{array}{r} -11 \\ + 3 \\ \hline -8 \end{array}$$

$$\begin{array}{r} 10100 \\ + 00011 \\ \hline 10111 \end{array}$$

TYPES of CODES

Numeric codes

- Weighted Binary Codes
- Binary coded Decimal (BCD)
- Self complementing codes
- Reflective
- Unit Distance
- Unit Distance Reflective Codes
- Error Detecting Codes
- Error Detecting and Correcting Codes

Alphanumeric codes

- Octal
- EBCDIC
- ASCII

BCD

→ 10's in 8421 code here 4 bit code for data editing

Decimal	Binary	NBCD
10	1010	0001 0000
141	1001101	0001 0100 0001
375	...	0011 0111 0101

weighted BCD codes

* 8421 = NBCD

$$N = w_3x_3 + w_2x_2 + w_1x_1 + w_0x_0$$

* x53

w_i = weighting factor

* 2421 Alter

5421

7421

86421

	NBCD				
D ₄	8421	XS3	2421	51111	
0	0000	0011	0000	00000	
1	0001	0100	0001	00001	
2	0010	0101	0010	00011	
3	0011	0110	0011	00111	
4	0100	0111	0100	01111	9's
5	0101	1000	1011	10000	
6	0110	1001	1100	11000	
7	0111	1010	1101	11100	
8	1000	1011	1110	11110	
9	1001	1100	1111	11111	

↓
Self
complementing
codes

Self Complementing BCD Codes

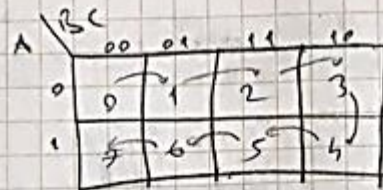
⇒ XS3
6311

⇒ 2421 (Aiken)

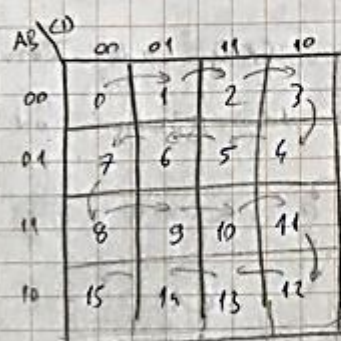
	XS3	2421	Reflected Cod. 1BCD
0	0011	0000	0000
1	0100	0001	0001
2	0101	0010	0010
3	0110	0011	0011
4	0111	0100	0100
5	1000	1011	1100
6	1001	1100	1011
7	1010	1101	1010
8	1011	1110	1001
9	1100	1111	1000

UNIT DISTANCE CODES (UDC)

Dec	UD BCD	4 Bit GRAY	3 Bit GRAY
0	0000	0000	000
1	0001	0001	001
2	0011	0011	011
3	0010	0010	010
4	0110	0110	110
5	1110	0111	111
6	1111	0101	101
7	1101	0100	100
8	1100	1100	
9	0100	1101	
10		1111	
11		1110	
12		1010	
13		1011	
14		1001	
15		1000	



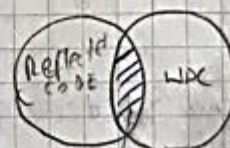
3 Bit GRAY CODE



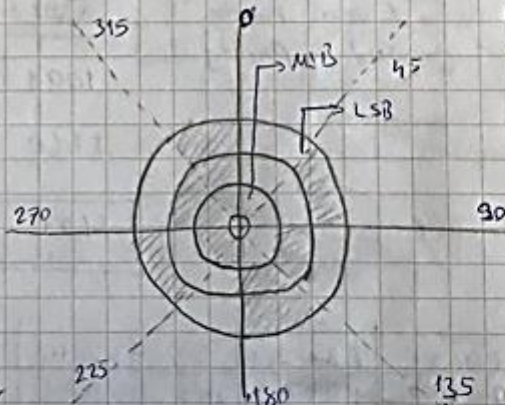
4 Bit GRAY CODE

Angle	Binary Code	GRAY Code
0	000	000
45	001	001
90	010	011
135	011	010
180	100	110
225	101	111
270	110	101
315	111	100

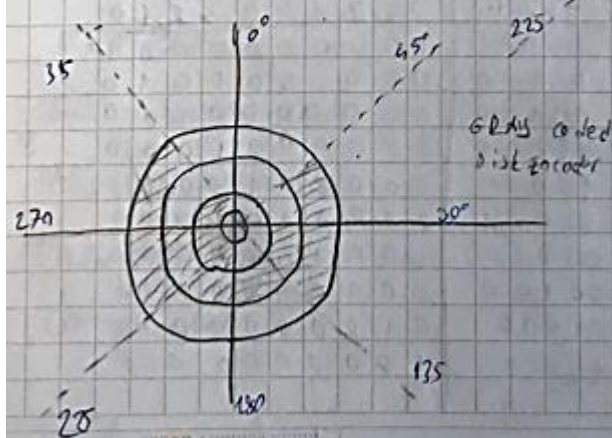
$$\frac{360}{2^n} = \frac{360}{2^3} = \frac{360}{8}$$



GRAY CODE



Binary coded Disk Encoder.



Gray code to Binary code Conversion

Parity bill
air (1) term
1. battle
see

dohil
Susu
depression

Parity dohil
term susu
gift ok
see

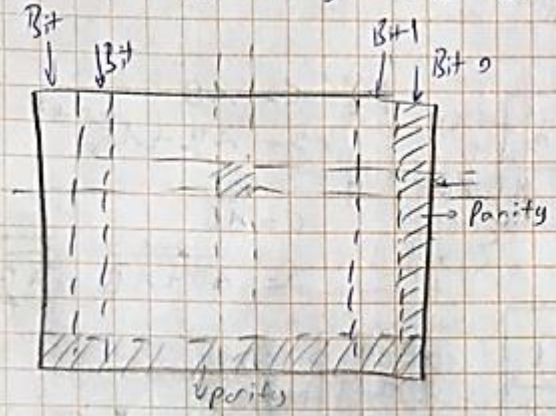
- Even Parity
- Odd Parity

<u>Word</u>	<u>odd parity</u>	<u>Even parity</u>
1001	11001	01001
1110	01110	11110
1101	11101	01101

False

Dec	NBCD	Even P8421	odd P8421	5043210	one hot - Ring Count
0	0000	00000	10000	0100001	00000000001
1	0001	10001	00001	0100010	00000000010
2	0010	10010	00010	0100100	00000000100
3	0011	00011	10011	0101000	00000010000
4	0100	10100	00100	0110000	00000100000
5	0101	00101	10101	1000001	00001000000
6	0110	00110	10110	1000010	00010000000
7	0111	10111	00111	1000100	00100000000
8	1000	11000	01000	1001000	01000000000
9	1001	01001	11001	1010000	10000000000

error detecting and correcting code



bits
code

1	0	0	1	1
1	0	1	1	1
0	1	0	0	0
1	0	0	0	0
1	0	0	1	1

Odd parity code

seven segment code

Dec	a	b	c	d	e	f	g
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	0	0	1	1	1	1	1
7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	0	0	1	1

