CPE 100

Computer Logic Design I

Lecture 3

1/27/2021

9 → 09

9.000

```
  11
+  7
----
  18
```

```
 1111
 01011
+00111
------
 10010
```

16 2

18

```
 1 +1
 1 +1
-----
10 +2
```

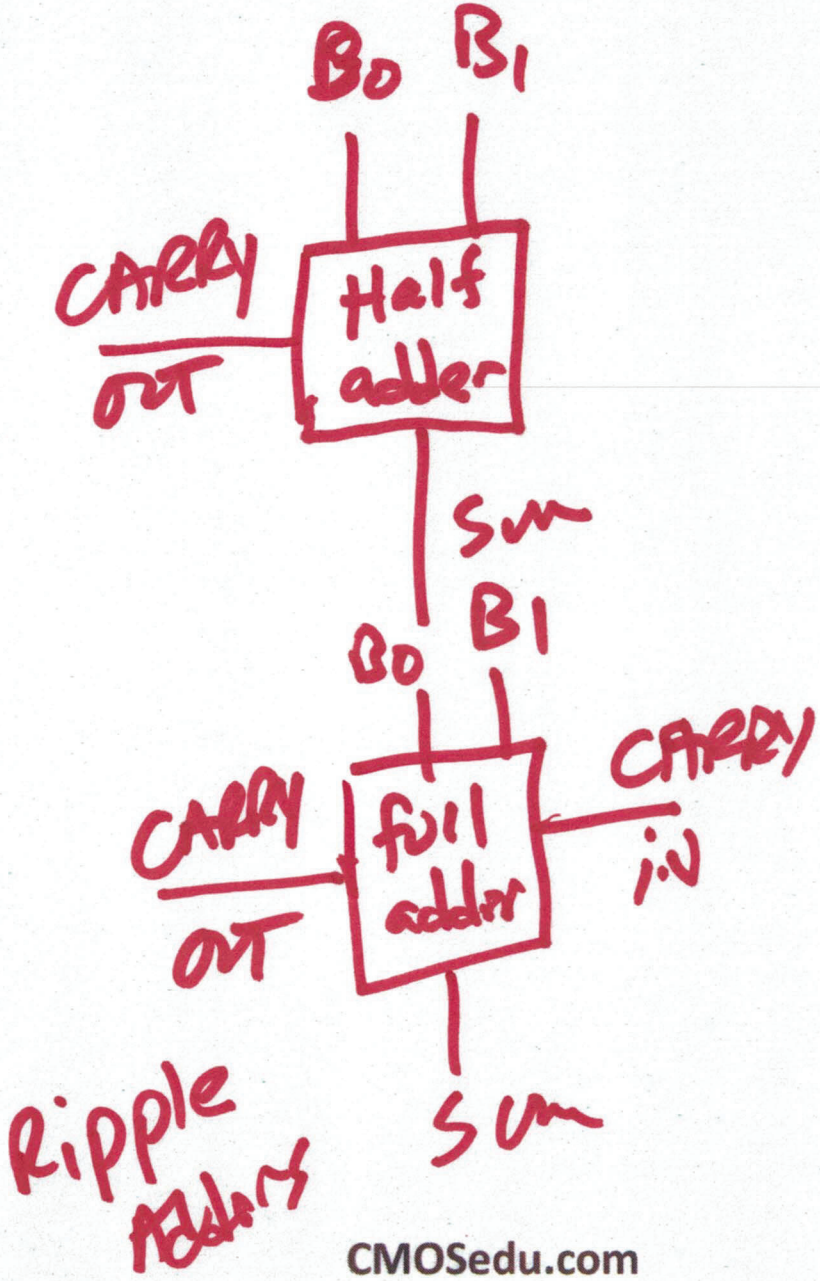
```
  1  +1
  1  +1
  1  +1
-------
 11   3
```

1 0
0 0 1 1 3
1 0 1 0 10
---
1 1 0 1 13
8 4 1

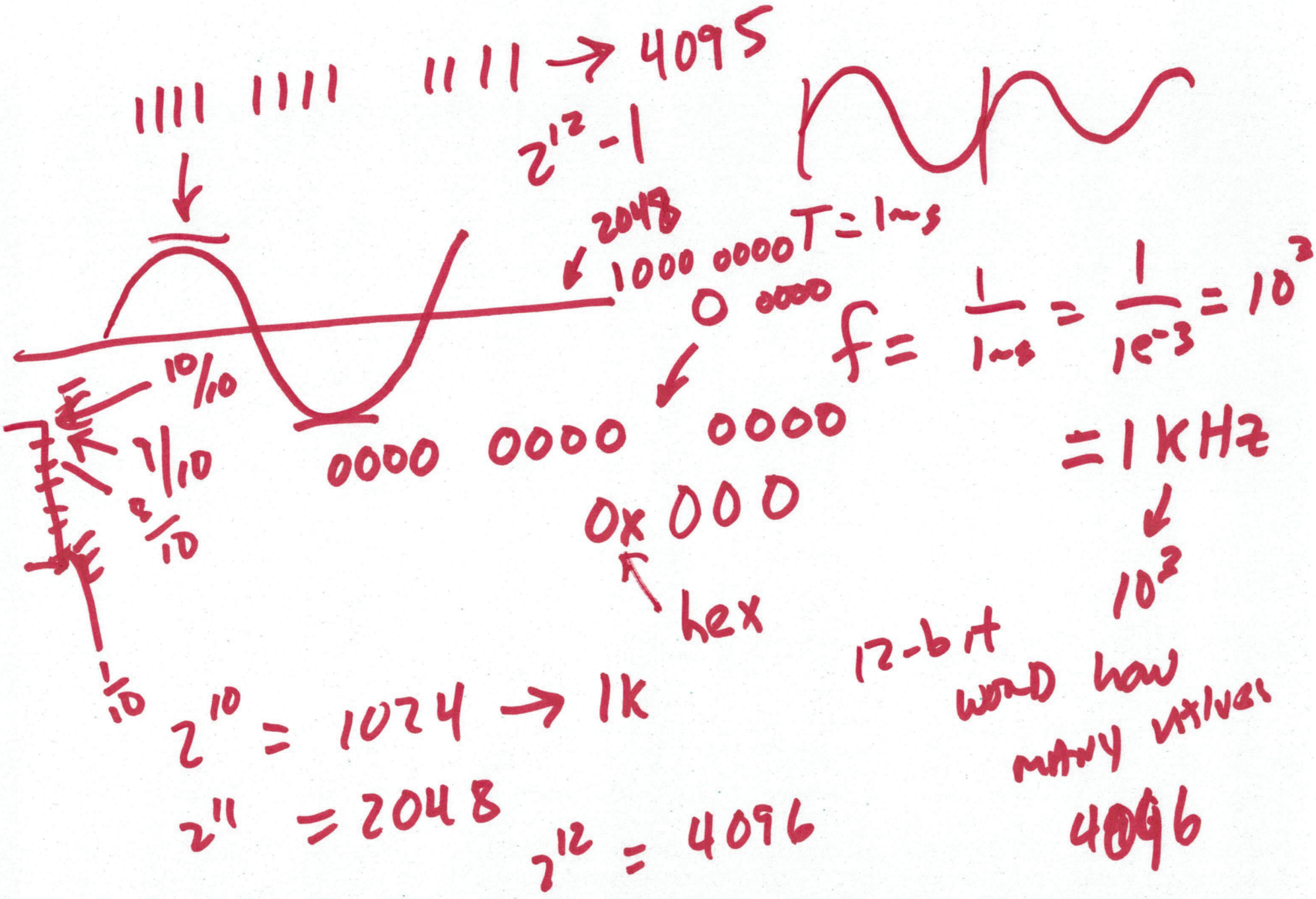
13

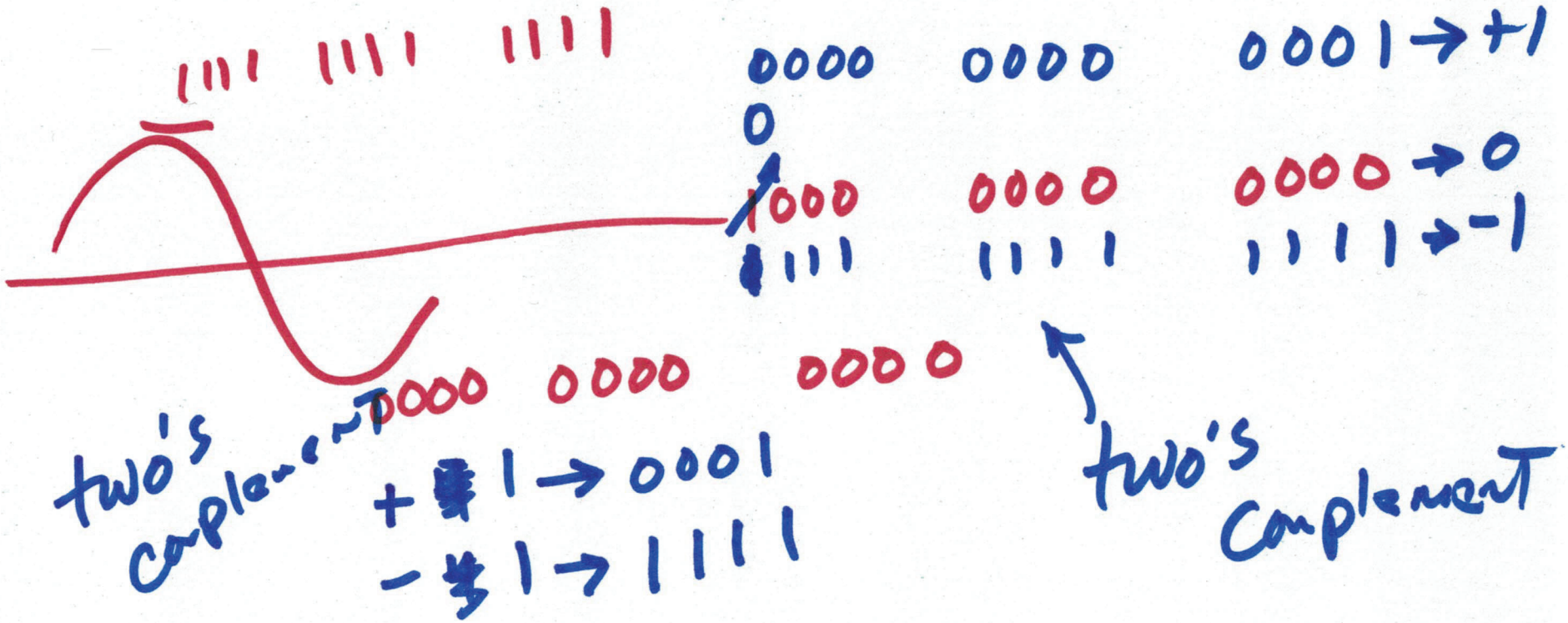
1 1
1 1 0 1 13
0 1 0 0 4
---
1 0 0 0 1 17
16 1

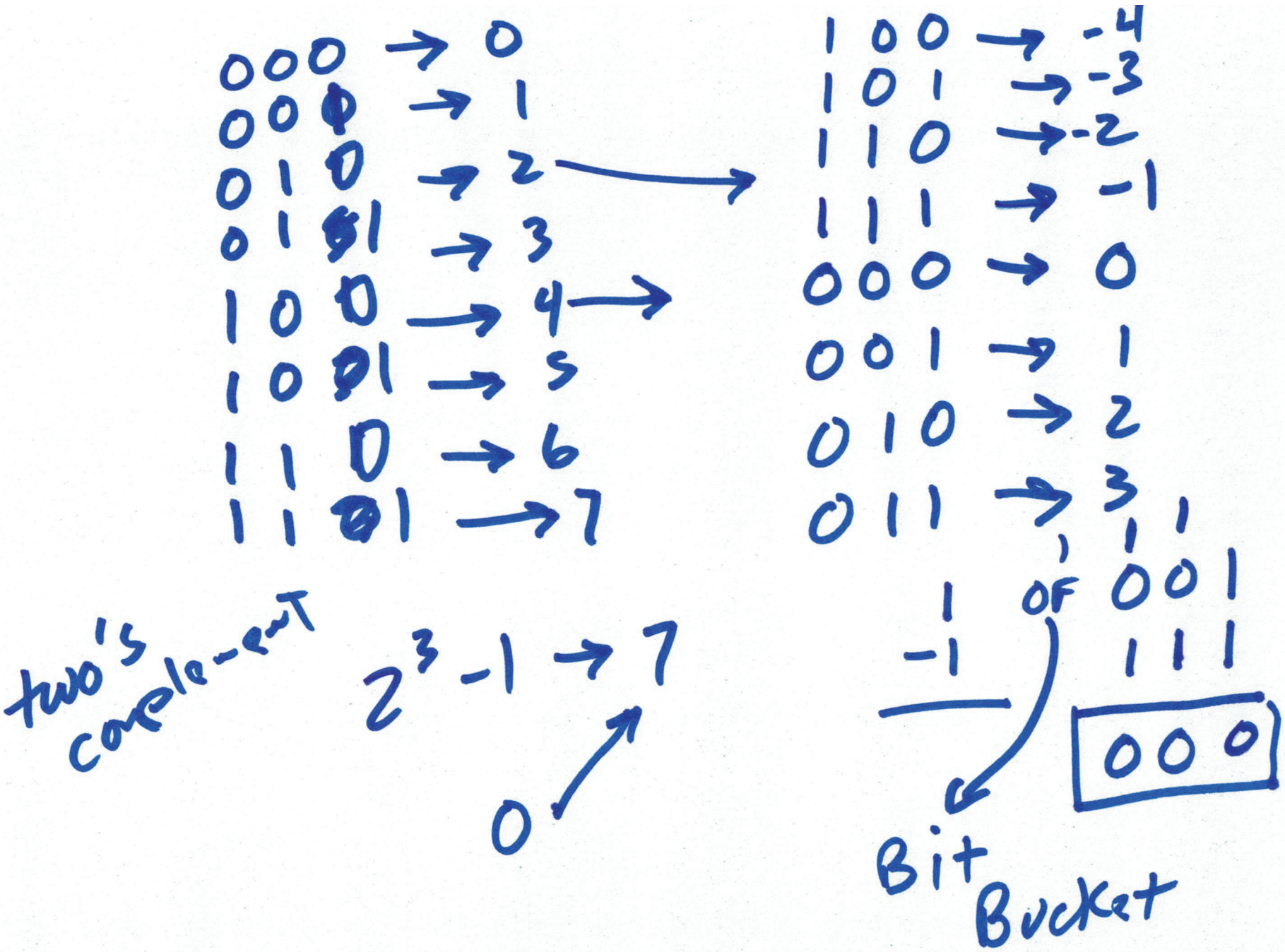
17



Ripple Adders


1111 1111
1111 → 4095
$2^{12}-1$
2048
1000 0000
0 0000
T = 1ms
10/10
1/10
2/10
-1/10
0000 0000 0000
0x000
hex
$f = \frac{1}{1ms} = \frac{1}{1e^{-3}} = 10^3$
= 1 KHz
10^3
12-bit word how many values
4096
$2^{10} = 1024 \rightarrow 1k$
$2^{11} = 2048$
$2^{12} = 4096$


1111 1111 1111
0000 0000 0001 → +1
0
1000 0000 0000 → 0
1111 1111 1111 → -1
0000 0000 0000
two's complement
+1 → 0001
-1 → 1111
two's Complement


000 → 0
001 → 1
010 → 2
011 → 3
100 → 4
101 → 5
110 → 6
111 → 7
two's complement
$2^3 - 1 \rightarrow 7$
0
100 → -4
101 → -3
110 → -2
111 → -1
000 → 0
001 → 1
010 → 2
011 → 3
1
001
-1
111
000
OF
Bit Bucket

$2^5 - 1$

Binary

$$\begin{array}{r} (13) \\ +(-15) \\ \hline -2 \end{array} \rightarrow$$

$$\begin{array}{r} 01101 \\ 10001 \\ \hline 11010 \end{array}$$

two's complement

two's complement

-2

11111	31	01101 → +13
⋮	⋮	
10000	16	00000 → 0
01111	15	11111 → -1
⋮	⋮	11110 → -2
00010	2	
00001	1	10001 → -15
00000	0	10000 → -16

1

11010 29

$$\begin{array}{r} 5 \\ -4 \\ \hline 1 \end{array}$$

0000 →	+3	0001 +5
111		
110	+2	1100 → −4
101	+1	
1100 →	0 →	(1) carry: Bit
011 →	−1	
010 →	−2	
001 →	−3	
000 →	−4	

$$\begin{array}{r} 4 \\ -4 \\ \hline 000 \end{array}$$

$$\begin{array}{rr} 0101 & +5 \\ 1100 & -4 \\ \hline 0001 & +1 \end{array}$$

1111 → −1
1110 → −2
1101 → −3
1100 → −4

$$\begin{array}{rr} -4 & 1100 \\ +5 & 0101 \\ \hline & \end{array}$$

77 − 17

= 60 ✓ two's comp

↑ 77
0
↓ −77

two's compl.

0100 1101 +77

0000 0000 → 0

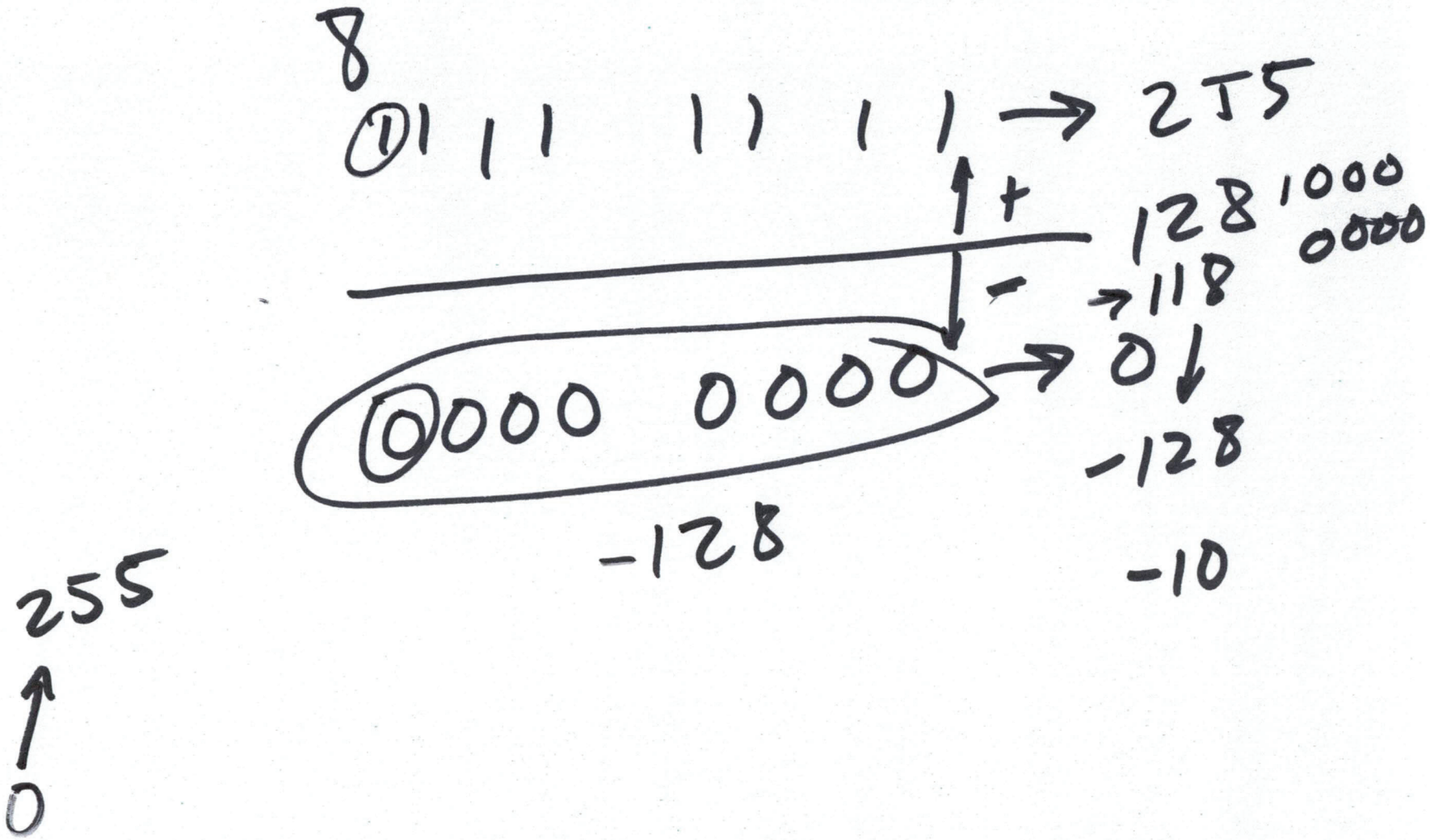
64
xxx xxxx
32 16 8 4 2 1

0000	0000	→ 0
1111	1111	→ −1
1111	1110	→ −2
1111	1101	→ −3
1111	0000	→ −16
1110	1111	→ −17

$$
\begin{array}{r}
0100\ 1101 \rightarrow +77 \\
1110\ 1111 \rightarrow -17 \\
\hline
0011\ 1100
\end{array}
$$

32 16 8 4 = 60

$$
\begin{array}{r}
77 \\
-64 \\
\hline
13
\end{array}
$$


8
01111111 → 255
+
128 1000 0000
-
→ 118
0000 0000 → 0
-128
-128
-10
255
0