AMI and HDB1 Line Codes - VHDL Implementation.

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Abstract

Line codings are methods for coding digital data for making them less susceptible to signal losses during transmission. This project implements the AMI — Alternate Mark Inverse — and HDB1 — High Density Bipolar of order 1 codings. This file documents their implementation.

1 Specification.

AMI. This coding takes a binary sequency into a ternary sequency having the signals 0, +1, -1 by the following way:

- Inputs of 1 are coded as +1 or -1 alternately.
- Inputs of 0 are coded always as 0.
- Entradas iguais a zero são codificadas como zero;

Example:

```
Input
 1 0  1 0  1  1 0 0 0  1 0  1  1 0 0  1 0  1 0 0 0  1  1  1
Output
+1 0 -1 0 +1 -1 0 0 0 +1 0 -1 +1 0 0 -1 0 +1 0 0 0 -1 +1 -1
```

HDB1. This coding takes a binary sequency into a ternary sequency having the signals 0, +1, -1 by the following way:

- Inputs of 1 are coded as either +1 or -1.
- Paired inputs of 0 are coded as either +1+1 or -1-1.
- Entradas iguais a zero, isoladas, isto é, seguidas de um e que não foram codificadas em conjunto com outro zero (formando +1+1 ou -1-1), são codificadas como zero;
- Isolated inputs of 0, ie, inputs of 0 not followed by 1 which weren't paired to another 0 (thus forming +1+1 or -1-1) are coded as 0.
- Outputs have always alternate signals. If the last output was -1 and the input is 00, the next output is coded as +1+1, if the last output was -1-1 and the input is 1, the next output is +1.

Example:

```
Input
 1 0  1 0  1  1  0  0 0  1 0  1  1  0  0  1 0  1  0  0  0  0  1  1
Output
+1 0 -1 0 +1 -1 +1 +1 0 -1 0 +1 -1 +1 +1 -1 0 +1 -1 -1 +1 +1 -1 +1
```

2 AMI Encoder.

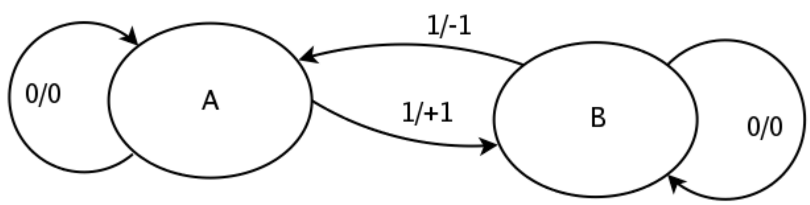

Figure 1: State Map.

Truth Table:

q	e	S_0	S_1	q^+
0	0	0	0	0
0	1	1	0	1
1	0	0	0	1
1	1	0	1	0

Karnaugh Map isn't necessary:

$S_0 = e \cdot q'$
$S_1 = e \cdot q$
$q^+ = e \oplus q$

3 AMI Decoder.

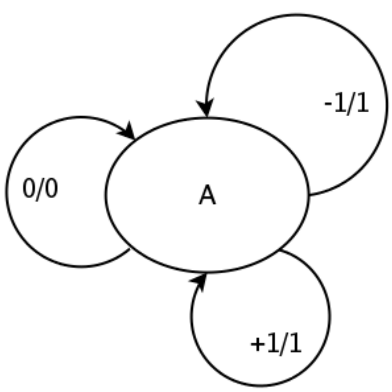

Figure 2: State Map.

Truth Table:

e_0	e_1	S
0	0	0
0	1	1
1	0	1
1	1	X

Karnaugh Map isn't necessary:

$S = e_0 + e_1$

4 HDB1 Encoder.

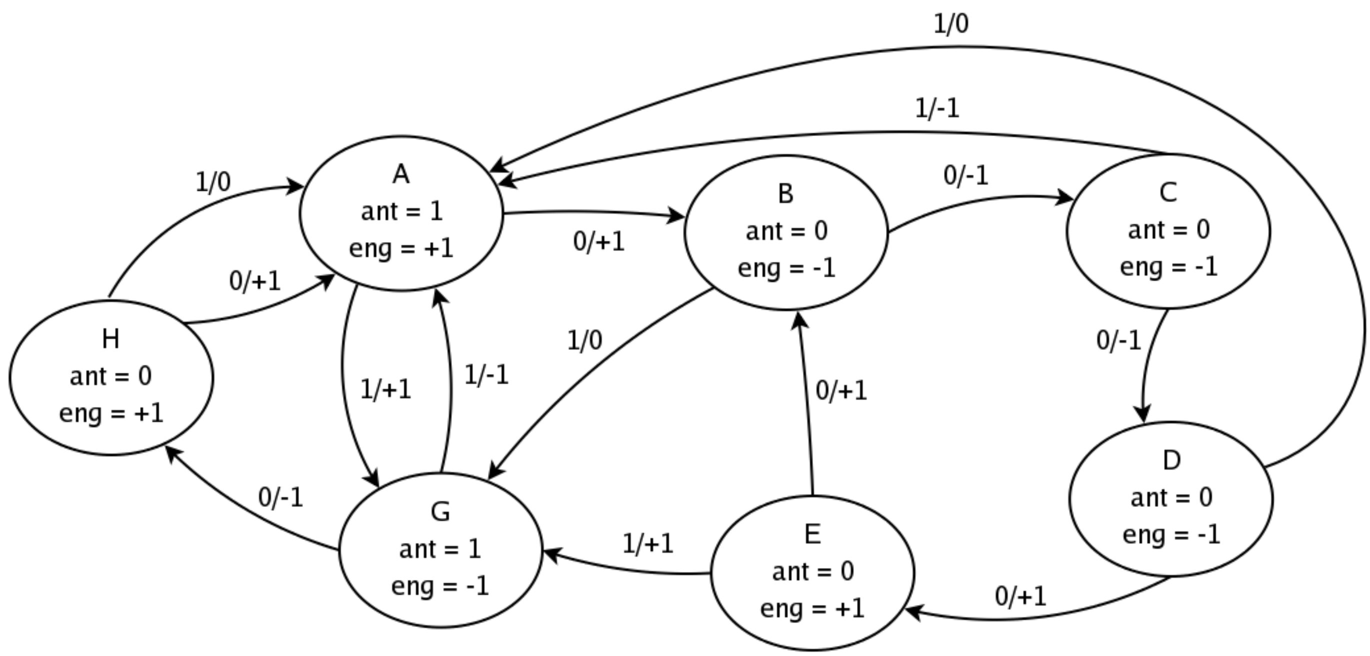

Figure 3: State Map.

Truth Table:

E	q_0	q_1	q_2	q_0^+	q_1^+	q_2^+	S_0	S_1
0	0	0	0	0	0	1	1	0
1	0	0	0	1	1	0	1	0
0	0	0	1	0	1	0	0	1
1	0	0	1	1	1	0	0	0
0	0	1	0	0	1	1	0	1
1	0	1	0	0	0	0	0	1
0	0	1	1	1	0	0	1	0
1	0	1	1	0	0	0	0	0
0	1	0	0	0	0	1	1	0
1	1	0	0	1	1	0	1	0
X	1	0	1	X	X	X	X	X
0	1	1	0	1	1	1	0	1
1	1	1	0	0	0	0	0	1
0	1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	0	1

q_0^+:

q_1q_2 \ Eq_0	00	01	11	10
00			1	1
01		X	X	1
11	1			
10		1		

$$q_0^+ = E.q_1' + E'.q_0'.q_1.q_2 + E'.q_0.q_1.q_2'$$

q_1^+:

q_1q_2 \ Eq_0	00	01	11	10
00			1	1
01	1	X	X	1
11				
10	1	1		

$$q_1^+ = E.q_1' + q_1'.q_2 + E'.q_1.q_2'$$

q_2^+:

q_1q_2 \ Eq_0	00	01	11	10
00	1	1		
01		X	X	
11				
10	1	1		

$q_2^+ = E'.q_2'$

S_0:

q_1q_2 \ Eq_0	00	01	11	10
00	1	1	1	1
01		X	X	
11	1	1		
10				

$S_0 = q_1'.q_2' + E'.q_1.q_2$

S_1:

q_1q_2 \ Eq_0	00	01	11	10
00				
01	1	X	X	
11				
10	1	1	1	1

$S_1 = q_1.q_2' + E'.q_1'.q_2$

5 HDB1 Decoder.

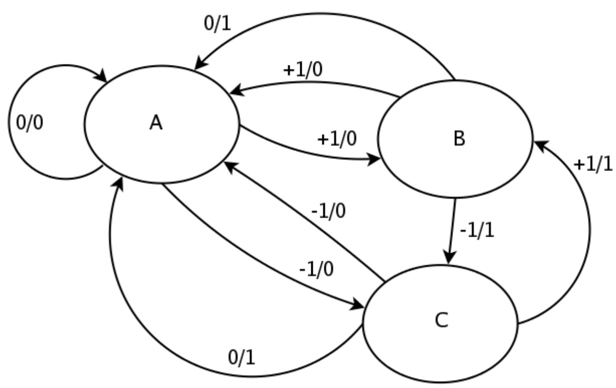

Figure 4: State Map.

Truth Table:

e_1	e_0	q_1	q_0	q_0^+	q_1^+	S
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	X	X	X
0	1	0	0	0	1	0
0	1	0	1	0	0	0
0	1	1	0	0	1	1
0	1	1	1	X	X	X
1	0	0	0	0	1	0
1	0	0	1	1	0	1
1	0	1	0	0	0	0
1	0	1	1	X	X	X
1	1	0	0	X	X	X
1	1	0	1	X	X	X
1	1	1	0	X	X	X
1	1	1	1	X	X	X

$q0$:

e_0e_1 \ q_1q_0	00	01	11	10
00			X	
01			X	
11	X	X	X	X
10		1	X	

$q_0^+ = q_0'.e_0$

$q1$:

e_0e_1 \ q_1q_0	00	01	11	10
00			X	
01	1		X	1
11	X	X	X	X
10	1		X	

$q_1^+ = q_1'.e_1$

S:

		q_1q_0			
		00	01	11	10
e_1e_2	00		1	X	1
	01			X	1
	11	X	X	X	X
	10		1	X	

$S = q_0.e'_0 + q_1.e'_1$