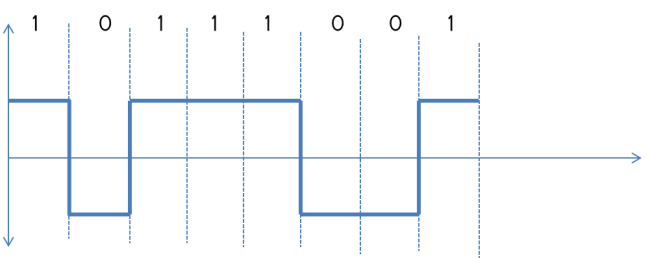
**NRZ-L Line Coding With MatLAB Code For Encoding and Decoding**

**Basic**

Non Return To Zero (NRZ) line code is a binary code in which ones are represented by one significant condition, usually a positive voltage, while zeros are represented by some other significant condition, usually a negative voltage, with no other neutral or rest condition.

Non Return To Zero Level (NRZ-L) is a type of NRZ line coding. In NRZ-L usually binary 1 maps to logic level high, and binary 0 maps to logic level low. Although binary 0 maps to logic level high, and binary 1 maps to logic level low is also NRZ-L. We will use the first way that is binary 1 maps to logic level high and binary 0 maps to logic level low.

Here is an example of NRZ-L line coding for bits 10111001.



Conversion from bitstream to signal is called encoding.

Conversion from signal to bitstream is called decoding.

**Coding With MatLab**

For encoding we need the bitstream first. In MatLAB that can be defined as array or we can take input from user. Both ways are given below:

|  |  |
| --- | --- |
| 1 | bits = [1 0 1 1 1 0 0 1]; |

or,

|  |  |
| --- | --- |
| 1 | bits = input('prompt'); |

With bitstream we need bit rate that means how much bit(s) will appear in each second. This can be also defined as a variable or can be taken as input. Normally bit rate is considered as 1 bit per second. So we will define it to 1.

|  |  |
| --- | --- |
| 2 | bitrate = 1; |

We need a sampling for each bit. So that MatLAB needs to know how much sample point will be appeared for each bit. Low sampling can loss data or cannot define bits accurately. Very high sampling can cause slow your program. Here we will define it as 1000.

|  |  |
| --- | --- |
| 3 | n = 1000; |

MatLAB needs to know the total time needed for the bitstream. Sometimes total time T may be given or said to take as input. If not then we need to find it by dividing length of bitstream with bitrate.

|  |  |
| --- | --- |
| 4 | T = length(bits)/bitrate; |

We have a sampling for each bit we have declared previously. Now we need to find total sample point needed for whole bitstream. We can find it by multiplying sample point of each bit with the number of bits as below.

|  |  |
| --- | --- |
| 5 | N = n\*length(bits); |

Now, we need to found time for each sample point. For this we divide the whole time (T) with number of total sample points (N).

|  |  |
| --- | --- |
| 6 | dt = T/N; |

We are near to the main process. Now we will define the time domain. That is the all values of X-axis. For this we need to declare an array from time 0 to time T by partitioning with dt. That is an array like this.

|  |  |
| --- | --- |
| 7 | t = 0:dt:T; |

For better performance we need to set all values of the result (amplitue domain) to 0. We can do this task with a build in function zeros().

|  |  |
| --- | --- |
| 8 | x = zeros(1,length(t)); |

Now for each bit if that bit is one than a range of the amplitude domain is redefined with value 1. If not defined anything else. Here we will continue a loop from 1 to length of bitstream. Inside the loop we will check whether the bit is 1 or 0. If the bit is 0 then we will fill a range from x((i-1)\*n+1) to x(i\*n) with negative voltage (i.e. -1). But if the bit is 1 the we will fill range from x((i-1)\**n+1*) to x(i\*n) with positive voltage (i.e. 1). That is if i=1 then we will fill from 1 to n’th (sample points per bit) position of the array with 1 if bit is 1 or with -1 if bit is 0. If i=2 then we will fill from (n+1) to 2\*n’th position. Here is the loop required.

|  |  |
| --- | --- |
| 9  10  11  12  13  14 | for i=1:length(bits)    if bits(i)==1      x((i-1)\*n+1:i\*n) = 1;    else x((i-1)\*n+1:i\*n) = -1;    end  end |

Everything required for encoding is done. We will now plot the result (amplitude domain) on respect to time domain. Here is the plot. Here ‘Linewidth’, 3 means the signal line will be bold three times than original signal.

|  |  |
| --- | --- |
| 15 | plot(t, x, 'Linewidth', 3); |

**Code For Encoding**

|  |  |
| --- | --- |
| 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15 | bits = input('prompt');  bitrate = 1;  n = 1000;  T = length(bits)/bitrate;  N = n\*length(bits);  dt = T/N;  t = 0:dt:T;  x = zeros(1,length(t));  for i=1:length(bits)    if bits(i)==1      x((i-1)\*n+1:i\*n) = 1;    else x((i-1)\*n+1:i\*n) = -1;    end  end  plot(t, x, 'Linewidth', 3); |

For decoding we need a counter that will count how much bit has been decoded. We will define the initial value of the counter to 0.

|  |  |
| --- | --- |
| 16 | counter = 0; |

Now we need a loop again to decode the signal. The loop will run from 1 to length of t. That is same times of total sample point. In the loop we will test whether t(i) is greater than the counter than we will increase the value of counter. And will assign the value of x(i) to result(counter) array if x(i) is positive or we will assign 0 to result(counter array. In this way we will assign or test the second sample value of each bit to the result bitstream. And for other samples the if condition will be false. For example, At first the value of t(1)=0 and that is not greater than counter so nothing occured. Then t(2)=0.001 and that is greater than 0. So counter increased to 1 and the bit is set to the value of x(2) or 0 (depending on voltage level). Next values of t(i) will be skipped (if condition will be false) as long as it is not 1.001. For each bit same things will be held. The loop looks like below.

|  |  |
| --- | --- |
| 17  18  19  20  21  22  23  24  25 | for i = 1:length(t)    if t(i)>counter      counter = counter + 1;      if x(i)>0        result(counter) = x(i);      else result(counter) = 0;      end    end  end |

After this decoding is also done. We need to display it. We can display that by just writing the variable without semi-colon. Or this can shown with disp() function.

|  |  |
| --- | --- |
| 26  27 | disp('NRZ-L Decoding:');  disp(result); |

**Full Code (Encoding and decoding)**

|  |  |
| --- | --- |
| 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25  26  27 | bits = input('prompt');  bitrate = 1;  n = 1000;  T = length(bits)/bitrate;  N = n\*length(bits);  dt = T/N;  t = 0:dt:T;  x = zeros(1,length(t));  for i=1:length(bits)    if bits(i)==1      x((i-1)\*n+1:i\*n) = 1;    else x((i-1)\*n+1:i\*n) = -1;    end  end  plot(t, x, 'Linewidth', 3);  counter = 0;  for i = 1:length(t)    if t(i)>counter      counter = counter + 1;      if x(i)>0        result(counter) = x(i);      else result(counter) = 0;      end    end  end  disp('NRZ-L Decoding:');  disp(result); |

I think, your experience with this tutorial is quite good. You can notify me anything related to this tutorial via comment or contact form.