

Noise Margin

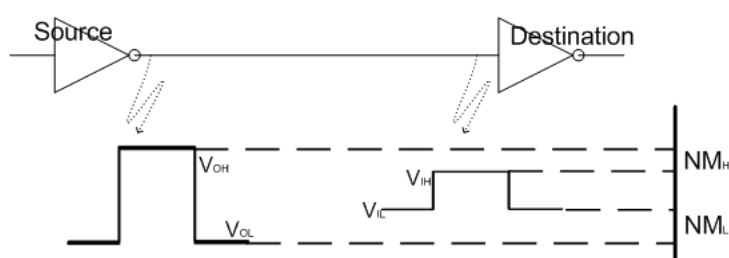
In digital communication the transmitted signal supposed to be one of two values; High value and Low value. But life doesn't go so, i.e a high value may be undergone to fading and distraction so when it arrives receiver side it will be confusing to determine if this signal was high one then decayed or it was low one then superimposed with some noise.

A convention between sender and receiver shall be then stated such that if we have the high value is 5 volt and the low value is 0 volt then they can state together that any signal higher than 2.5 volt will be considered a high one and will be corrected to be 5 volt. Also any signal lower than 2.5 volt will be corrected to be 0 volt.

The problem is not solved yet. Choosing a border between the upper and lower value can't help when the received signal is the border value itself. i.e what if the received value was 2.5 volt? We have then to modify our solution in two steps

1. By considering some values is a forbidden one because the receiver will not be able to determine the signal at these values. For example we can consider the values between 2 and 3 volt are forbidden values. Simply any value ≥ 3 will be considered as 5 volt and any other value ≤ 2 volt will be considered as 0 volt.
2. Define a tolerance for the sender so that the transmitted signal will not violate that tolerance for example if the sender will send a high value (which is supposed to be 5 volt), it can send down to 4 volt and it still be considered as a high value. If the sender will send low value (which is supposed to be 0 volt), it can send up to 1 volt and it still be considered as a low value.

This second step made a difference between the forbidden region at the sender side and the forbidden region at the receiver side. The necessity for this step came up to override the fading problems that may occur to the signal. At the sender side the forbidden region is from 1 to 4 volt. If a signal was sent while it is 3 volt it may be distracted and corrupted at the receiver side. At the receiver side the forbidden region is from 2 to 3 volt. If a signal was received while it is 2.5 volt it will be neglected. The following figure summarizes the convention that may be stated between a sender and a receiver.



So we have a tolerance at the sender side and another tolerance at the receiver side. The difference between both tolerances is called **Noise Margin**.

- The upper noise margin = $V_{oh} - V_{ih}$
- The lower noise margin = $V_{il} - V_{ol}$

The term noise margin tells us the value of noise that may ride on a signal without affecting its logic representation. In our example $V_{oh} = 4$ while $V_{ih} = 3$ means that the upper noise margin = 1. i.e the signal may bear noise up to 1 volt without affecting its logic representation which is the high value (5 volt).