

## ★ The digital abstraction

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So far, we've been studying analog signals like voltage and current, and we focus on how these signals, being transformed by a circuit, will impact the behavior of a certain element in a circuit. The impact manifests itself in terms of analog signals on the element, and we also called it the "response" of the element with respect to the analog signals from a voltage source  $\oplus$  or a current source  $\uparrow$ .

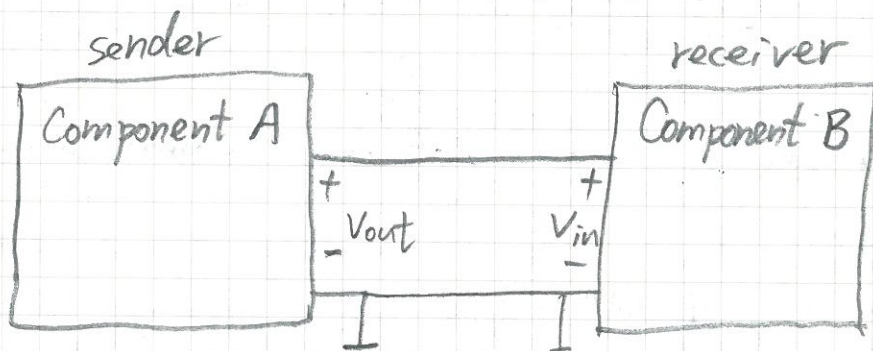
lv

Now, how does an analog signal relates to the "digital world", the world built using some meaningful combinations of 0s and 1s? The digital abstraction serves this purpose. It specifies a transformation that interprets the analog signals into a series of binary digits, the so-called "digital signals."

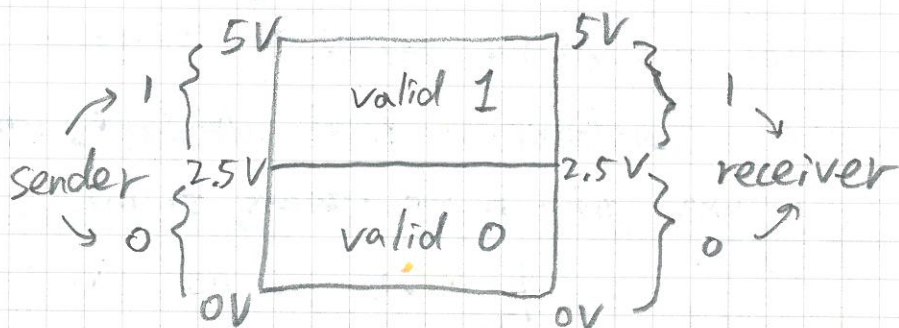
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Review Section 1.8 in the textbook.

- Digital signals are "interpretations" of analog signals, so that they can be understood and be used by a digital system (such as a computer).
- Between physical components in a system, it is still analog signals that are transferred.
- How to transform digital signals into analog ones?



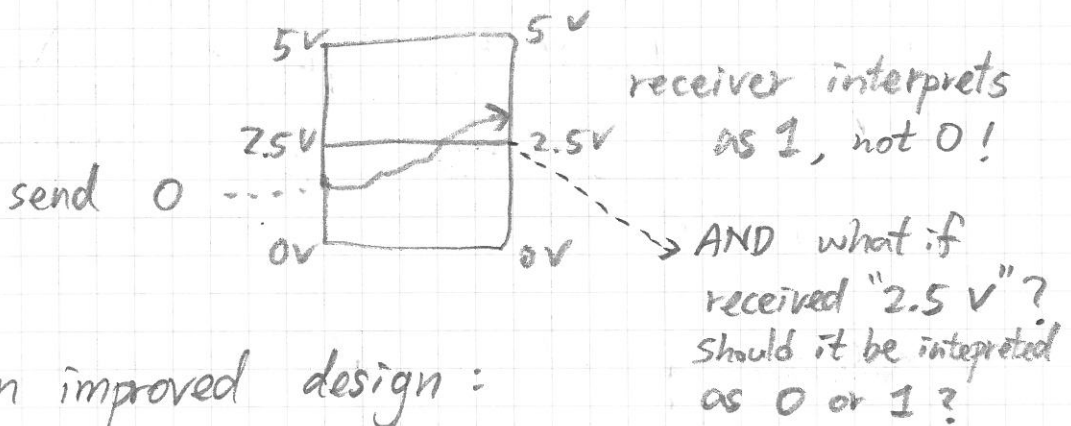
Our first attempt :



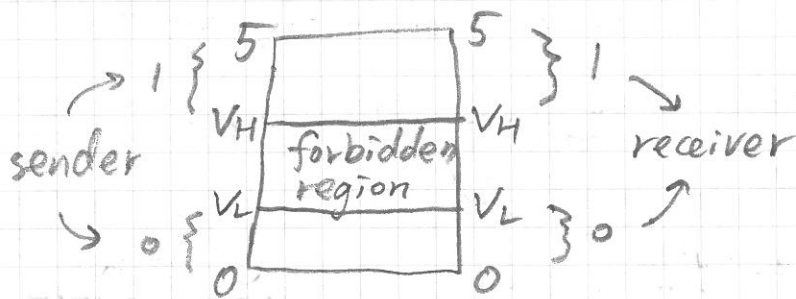
A serious problem :

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there could be noise / interference  
during signal transmissions



An improved design :



A further question :

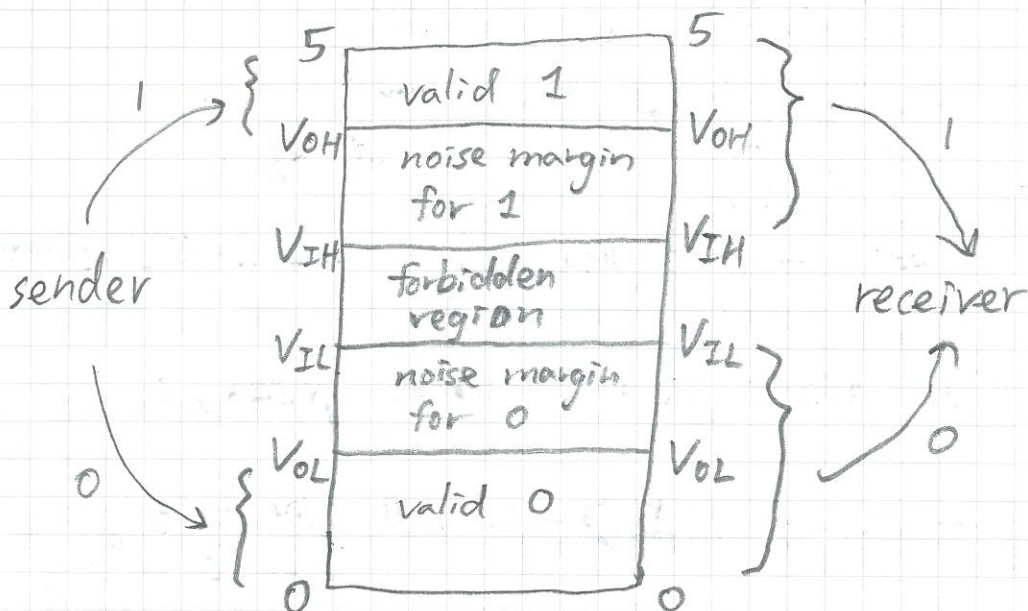
how to quantify the resilience  
to noise ?

and if we can do that, this can serve  
as a contract, and accordingly it would  
ensure device manufacturers to meet consumers'  
need, and components can be connected  
to form a system.



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A better design :



### The static discipline (principle)

A device must interpret correctly voltage inputs falling within the  $V_{IL}$  or  $V_{IH}$  threshold; with a valid input, the device must produce a valid voltage output that falls within the  $V_{OL}$  or  $V_{OH}$  threshold.

↖ A specification of digital devices.

- Figure 5.9 in the textbook is a great illustration for us to remember the relative levels of  $V_{OH}$ ,  $V_{IH}$ ,  $V_{IL}$ , and  $V_{OL}$ .