

Communication Theory - 2026

Chapter 2. Signals and Signal Space

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Definitions: Signals and Systems

Signals

A signal is a set of information or data.

Examples: Audio signals, video signals, sensor data, etc.

In all these examples, the signals are mostly functions of the independent variable **time t** .

Systems

Signals may be processed further by systems, which may modify them or extract additional information from them.

For example, an anti-aircraft radar system processes the received signals (inputs) to determine the position and velocity of an aircraft (outputs).

Thus, a system is an entity that processes signals (**inputs**) to yield another set of signals (**outputs**).

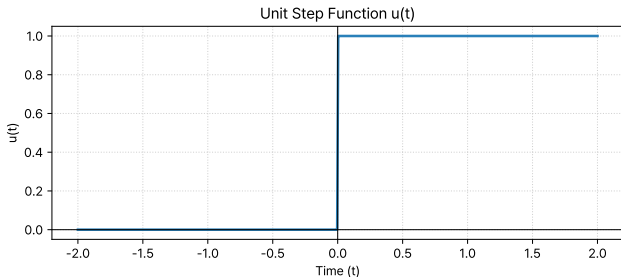
More examples: Amplifiers, filters, modulators, demodulators, etc.

2.1 Size of A Signal

- 신호의 크기(Size of a Signal)란 무엇인가?
- 에너지 신호(Energy Signal)와 전력 신호(Power Signal)
- 신호의 에너지(Energy)와 전력(Power) 계산 방법

- **Basic Signals:** 단위 계단 함수 $u(t)$ 와 델타 함수 $\delta(t)$
- **Signal Operations:** 시간 이동 (Shifting)과 스케일링 (Scaling)
- **Correlation:** 신호의 유사도 (Similarity) 측정

1. Basic Signals: Unit Step Function



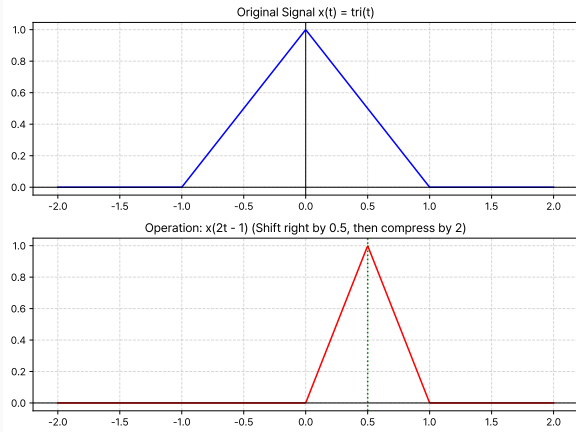
Definition

$$u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

Key Property:

시스템의 스위칭 동작(Switching)을 수학적으로 모델링할 때 사용됨.

2. Signal Operations: $x(at - b)$



해석 순서 (Order of Operations):

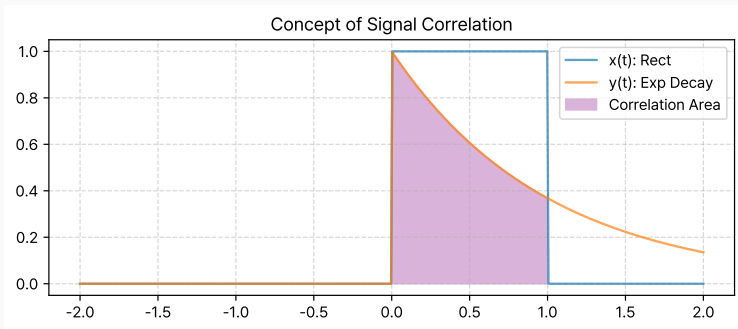
1. **Shifting:** $t \rightarrow t - t_0$
(Right if $t_0 > 0$)
2. **Scaling:** $t \rightarrow at$
(Compression if $a > 1$)

Caution

$x(2t - 1)$ 은 $x(t)$ 를 1만큼 이동 후 2배 압축하는 것이 아님!

→ $x(2(t - 0.5))$ 로 생각해야 함.

3. Signal Correlation



Correlation Coefficient (C_n)

두 신호가 얼마나 닮았는가? (Measure of Similarity)

$$\rho = \frac{\int x(t)y^*(t)dt}{\sqrt{E_x E_y}}$$

- **Unit Step** $u(t)$: 인과성(Causality) 표현의 핵심
- **Operations**: $x(at - b)$ 꼴의 변환을 자유자재로 다뤄야 함
- **Correlation**: 통신 시스템에서 수신 신호를 검출(Detection)하는 기본 원리