Design IV

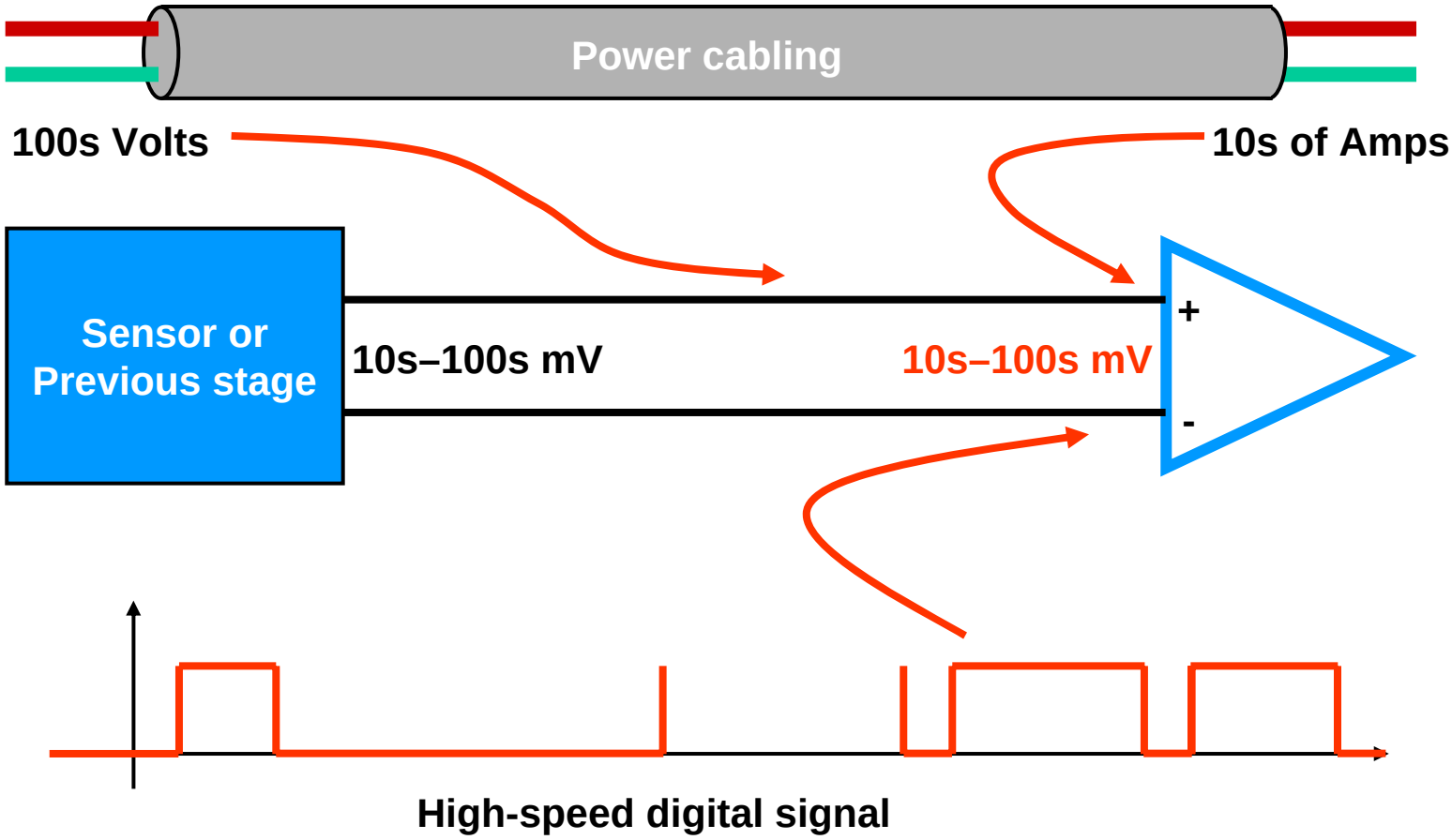
E232 Spring 07

Class 7

Bruce McNair
bmcnair@stevens.edu

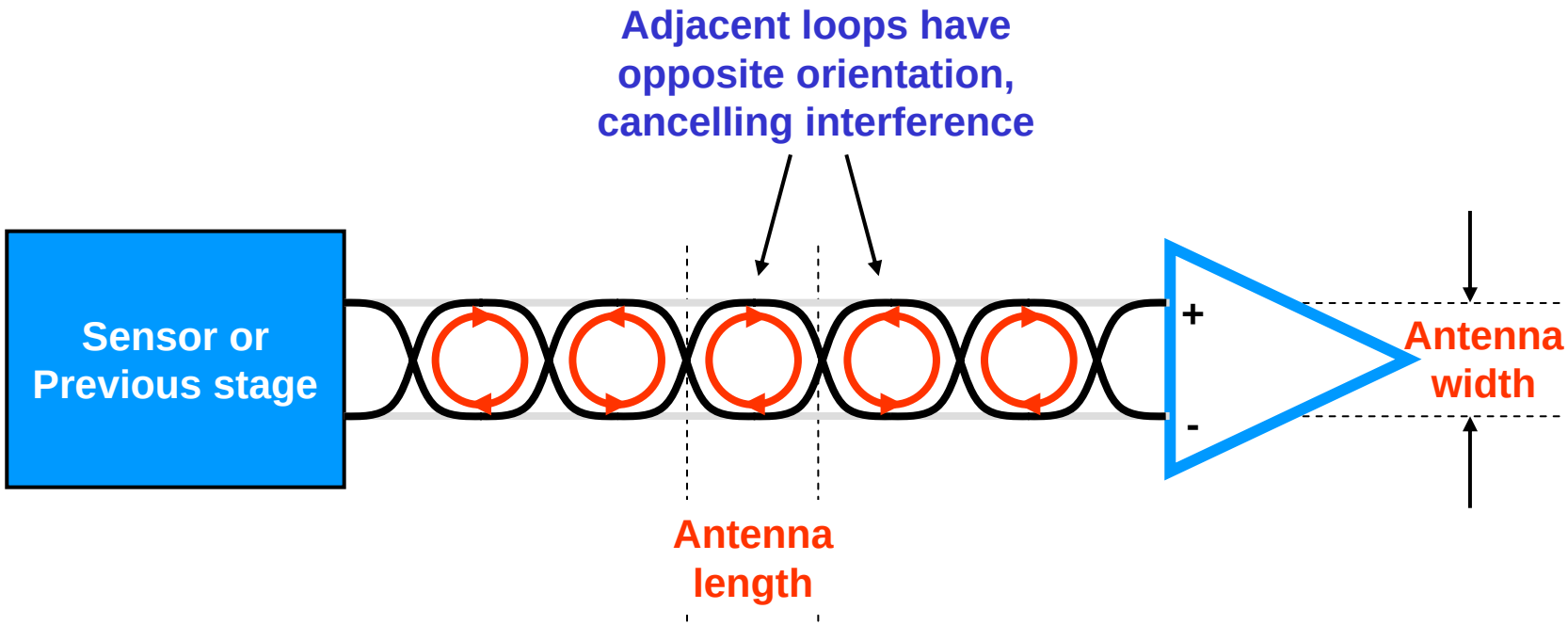
Transmission Systems

- Signal level considerations



Transmission Systems

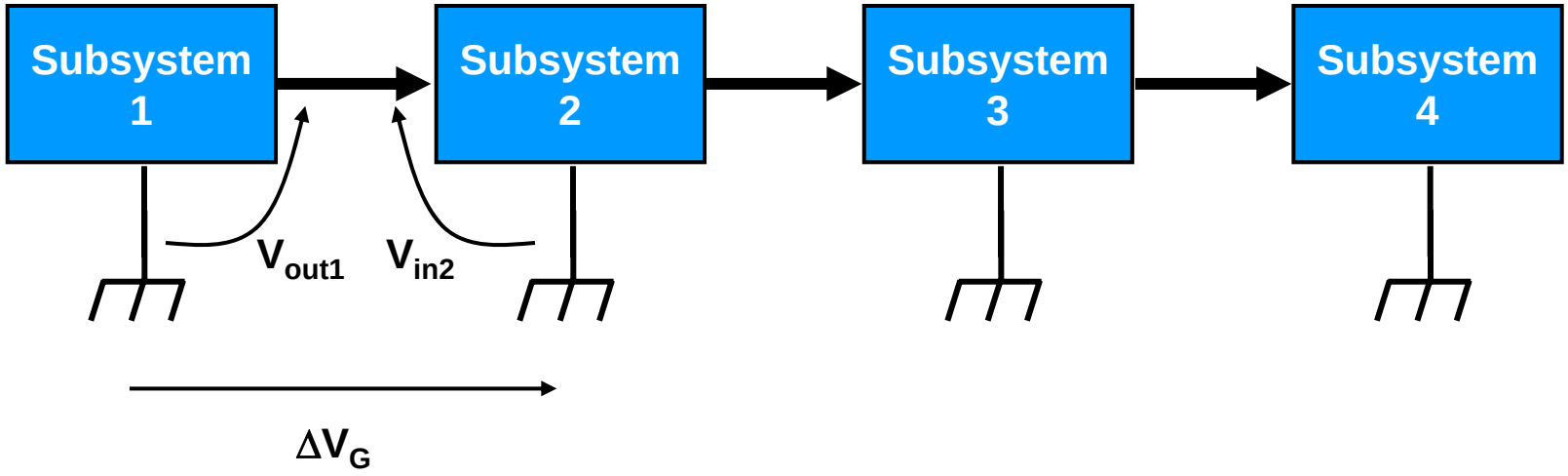
- Controlling interference with twisted pair cabling



Interference pickup $\propto$ antenna area

Transmission Systems

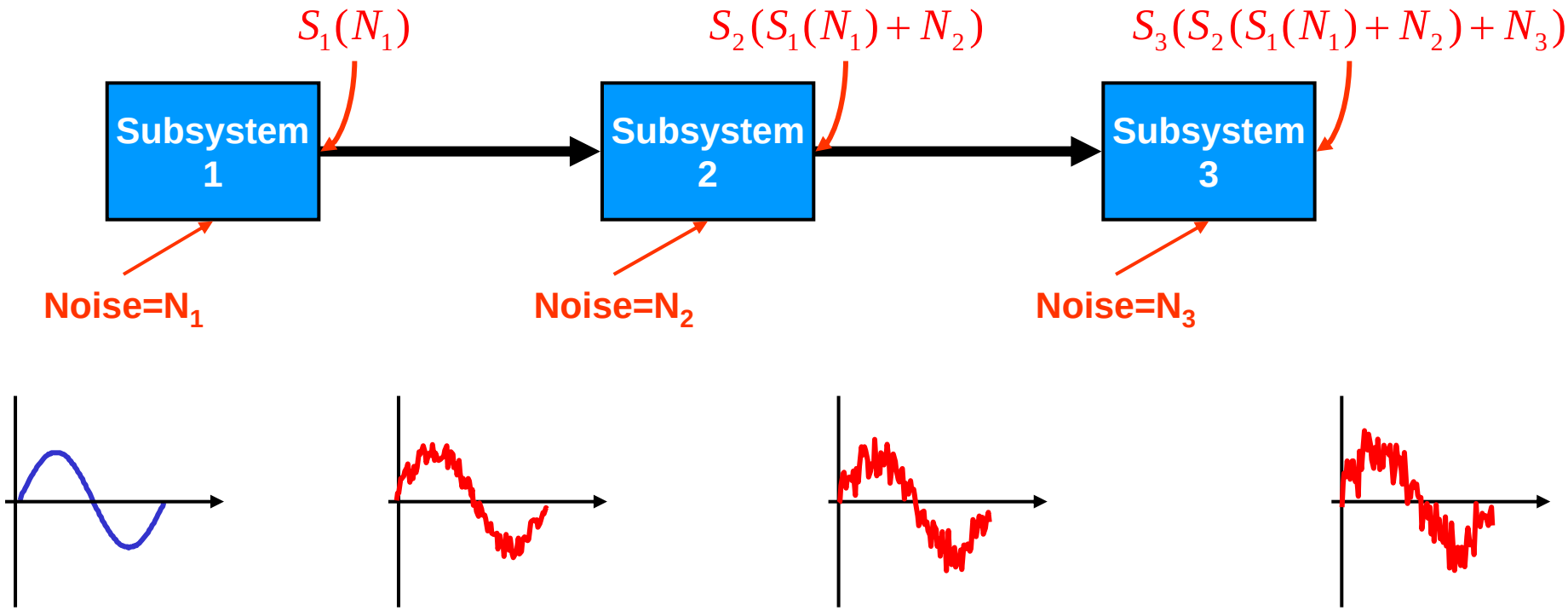
- Ground loops



Why might V_{out1} and V_{in2} differ?
Difference in ground voltage shows up as input noise.

Transmission Systems

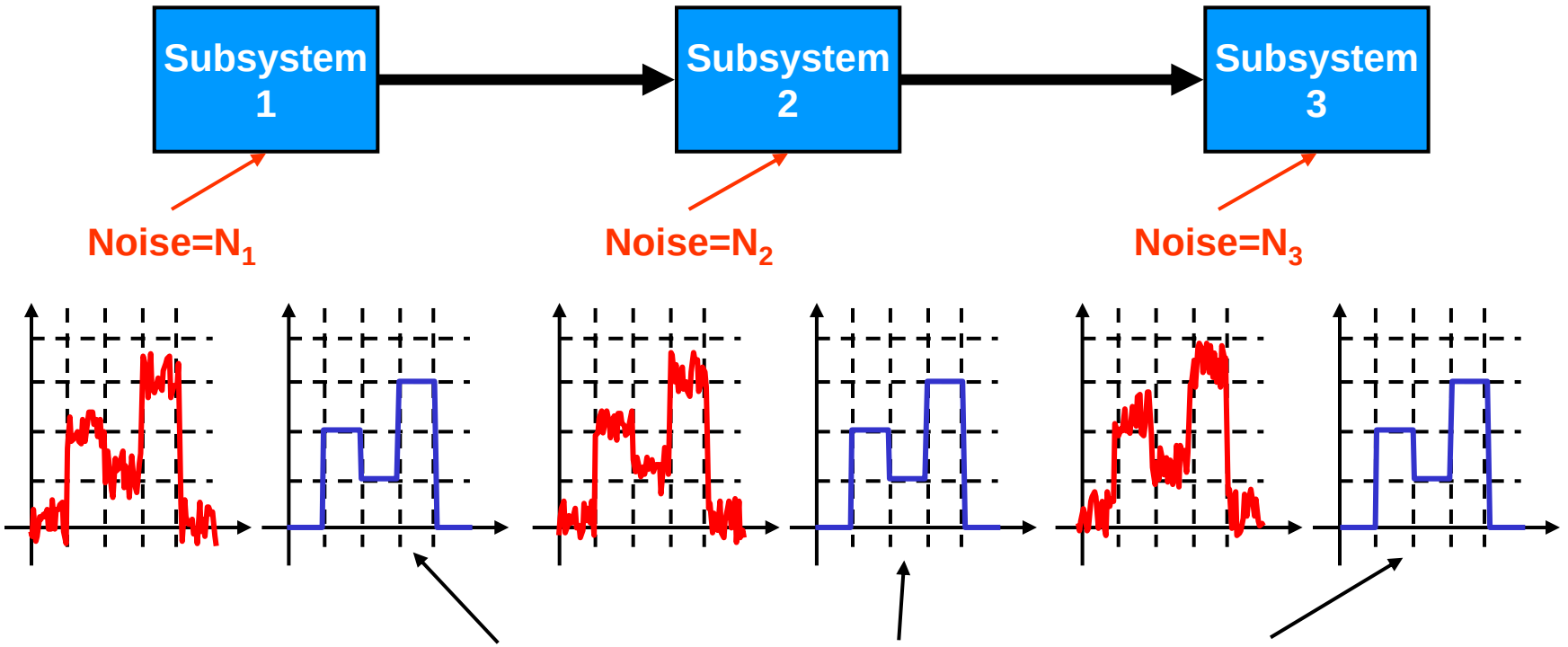
- Analog signal transmission



Noise from each stage combines with input noise and cannot be removed

Transmission Systems

- Digital signal transmission



Output at each stage is regenerated, allowing transmission to start with clean, unimpaired signals.

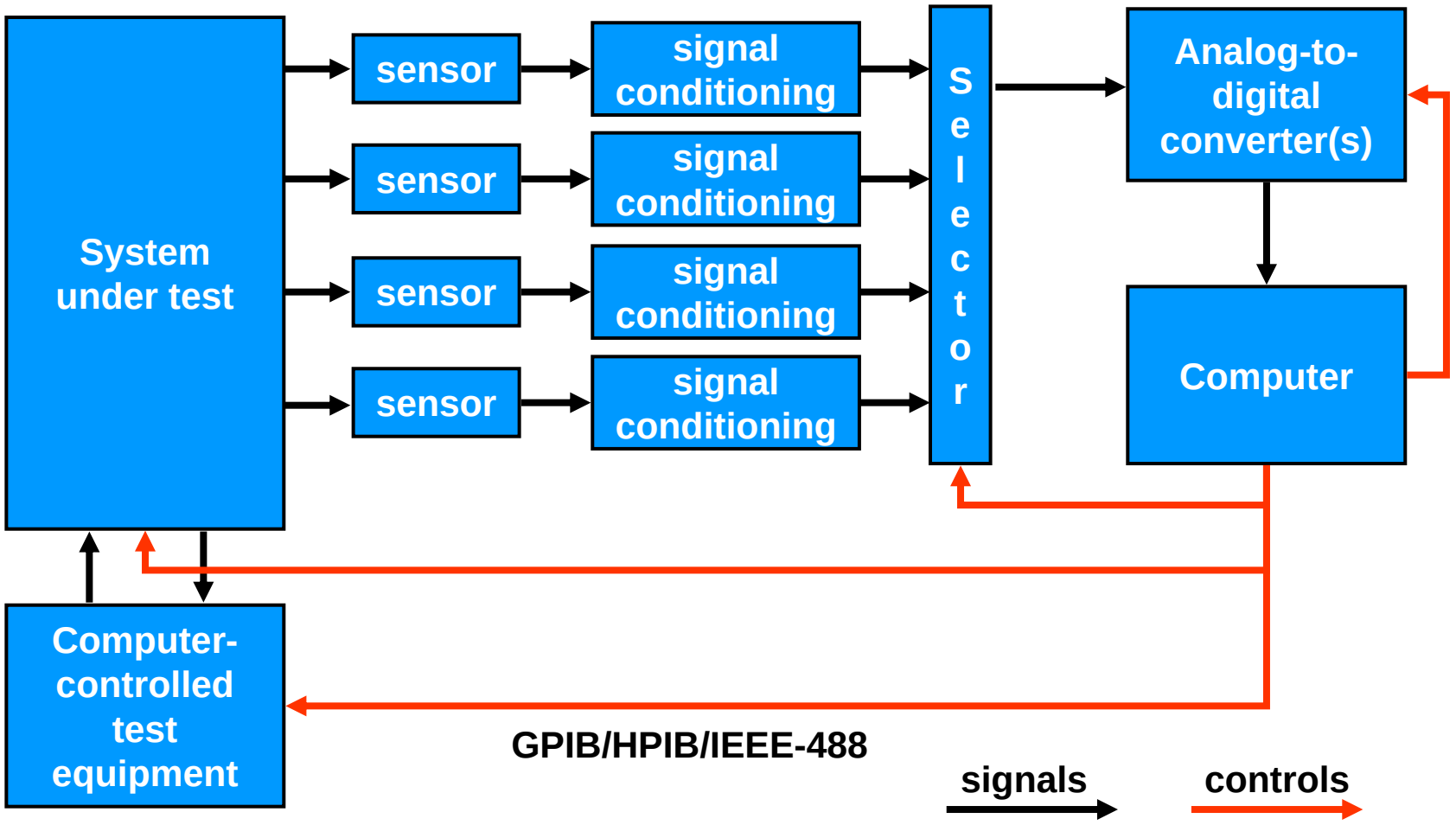
Signals change at established points in time, with specific allowed levels

Today's topics

- Computerized Data Acquisition
  - Architecture
  - Components
  - Signal representation
  - A/D conversion

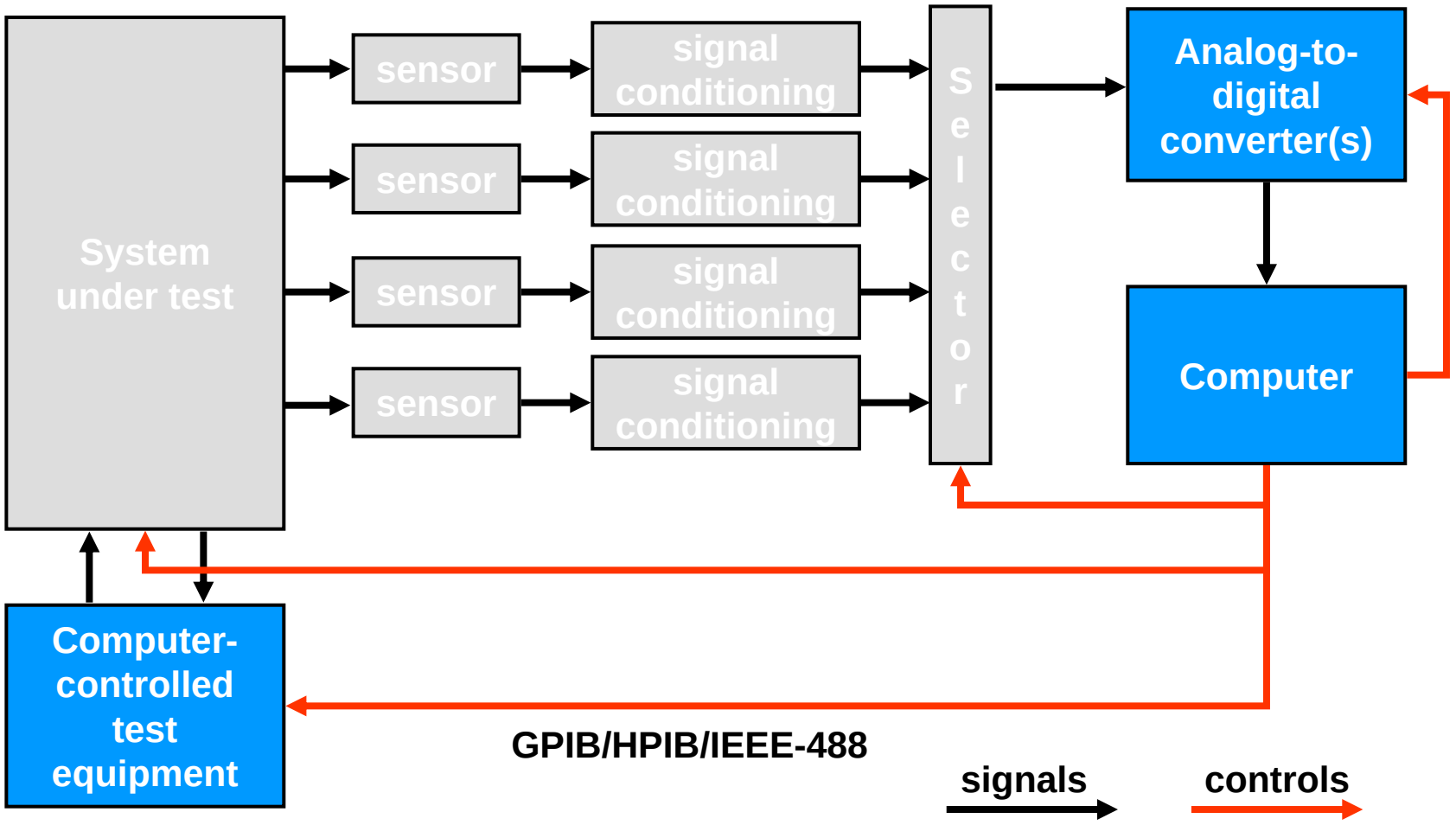
Computerized Data Acquisition

- Measurement system architecture



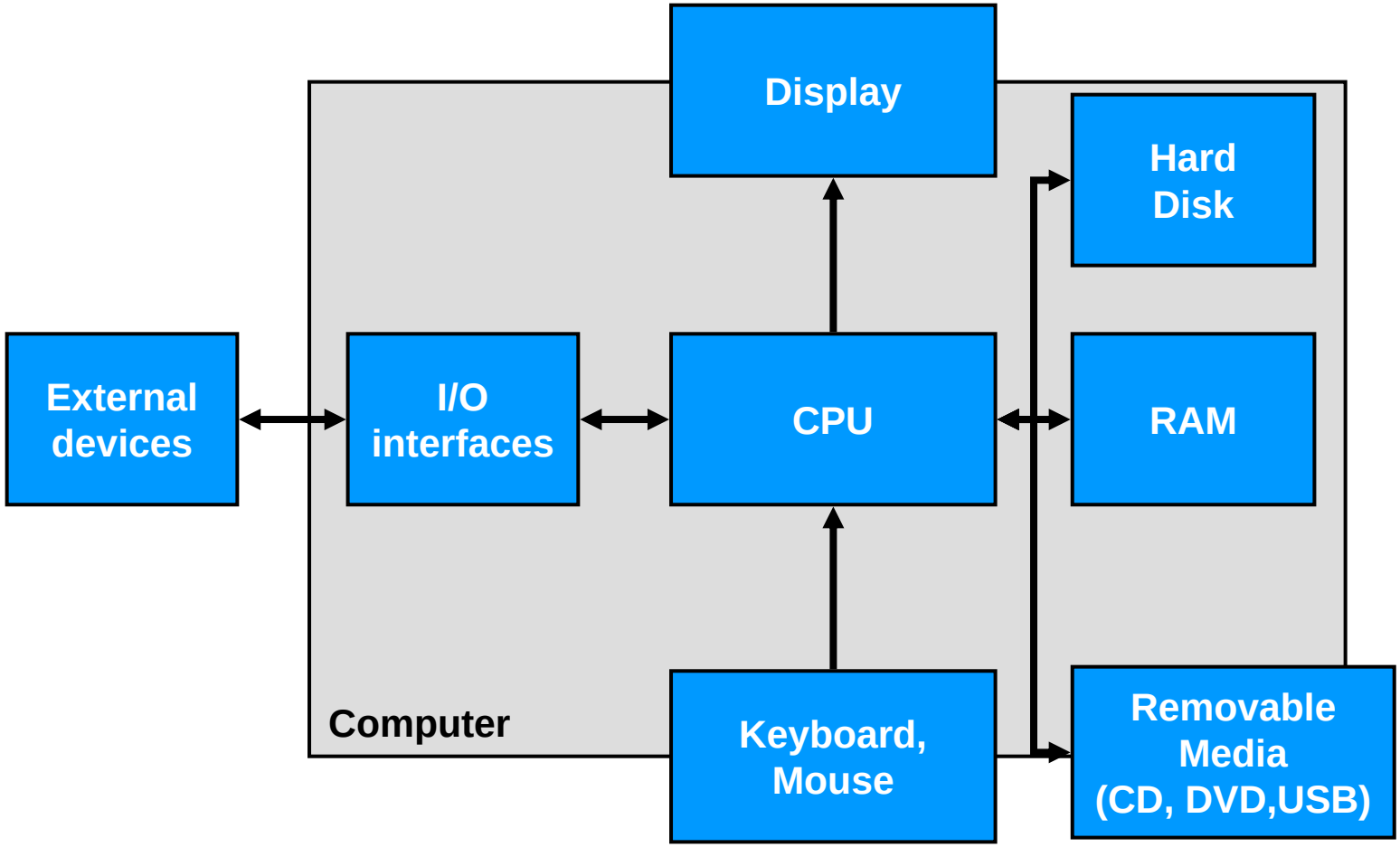
Computerized Data Acquisition

- Measurement system architecture



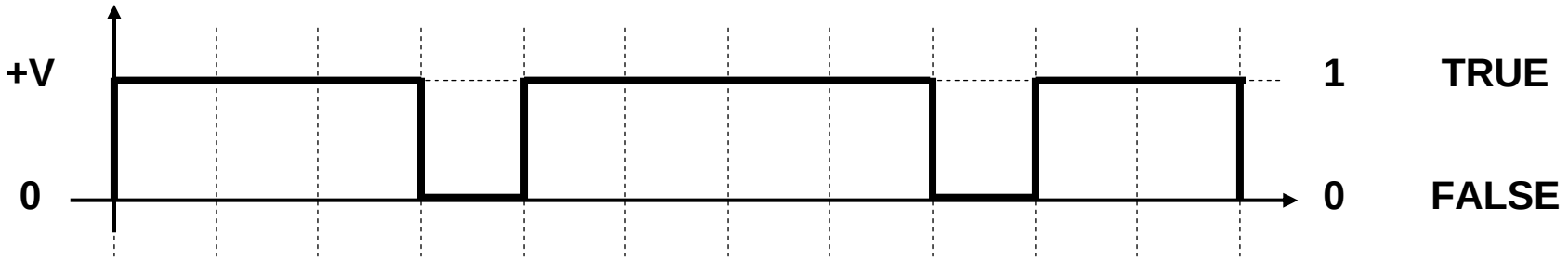
Computerized Data Acquisition

- Components



Computerized Data Acquisition

- Signal representation



All information is represented by a series of 1's and 0's using Base-2 arithmetic

Computerized Data Acquisition

- Signal representation

In Base-10 arithmetic:

$$849_{10} = (8 \times 10^2) + (4 \times 10^1) + (9 \times 10^0)$$

Computerized Data Acquisition

- Signal representation

In Base-10 arithmetic:

$$849_{10} = (8 \times 10^2) + (4 \times 10^1) + (9 \times 10^0)$$

In Base-2 arithmetic:

$$849_{10} = 1101010001_2 =$$
$$(1 \times 2^9) + (1 \times 2^8) + (0 \times 2^7) + (1 \times 2^6) + (0 \times 2^5) +$$
$$(1 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) =$$
$$512 + 256 + 64 + 16 + 1$$

Computerized Data Acquisition

- Converting Base-10 to Base-2:

  – First, recognize powers of 2:

1
2
4
8
16
32
64
128
256
512
1024
2048
4096
8192
16384
32768
65536
131072
262144
524288
1048576
2097152

$2^{10} \sim 1000$

$2^{20} \sim 1{,}000{,}000$

$2^{30} \sim 1{,}000{,}000{,}000$

Computerized Data Acquisition

- Converting Base-10 to Base-2:
  - Successive integer division by 2, noting remainder

Remainder:

2)849
2)424 -> 1
2)212 -> 0
2)106 -> 0
2)53 -> 0
2)26 -> 1
2)13 -> 0
2)6 -> 1
2)3 -> 0
2)1 -> 1
0 -> 1 -> 1101010001

Computerized Data Acquisition

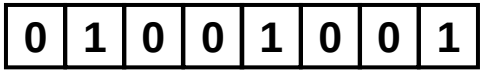
- Converting Base-2 to Base-10:
  - Successive doubling with addition of bits

$$1001001_2 =$$
$$2^6 + 2^3 + 2^0 =$$
$$(((1 \times 2) + 0) \times 2) + 0) \times 2) + 1) \times 2) + 0) \times 2) + 0) \times 2) + 1 = 73_{10}$$

Computerized Data Acquisition

- Representing binary numbers

73_{10}:

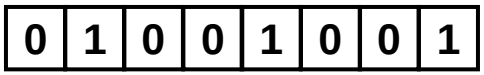


MSB **LSB**

Computerized Data Acquisition

- Representing binary numbers

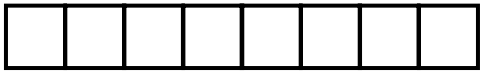
73_{10}:



MSB **LSB**

- Representing negative numbers – 2's complement:

-73_{10}:

Sign 

MSB **LSB**

Computerized Data Acquisition

- Representing binary numbers

73_{10}:

0	1	0	0	1	0	0	1

MSB **LSB**

- Representing negative numbers – 2's complement:

-73_{10}:

	01001001
Invert bits	**10110110**
Add 1	**00000001**
	10110111

Sign

1	0	1	1	0	1	1	1

MSB **LSB**

Computerized Data Acquisition

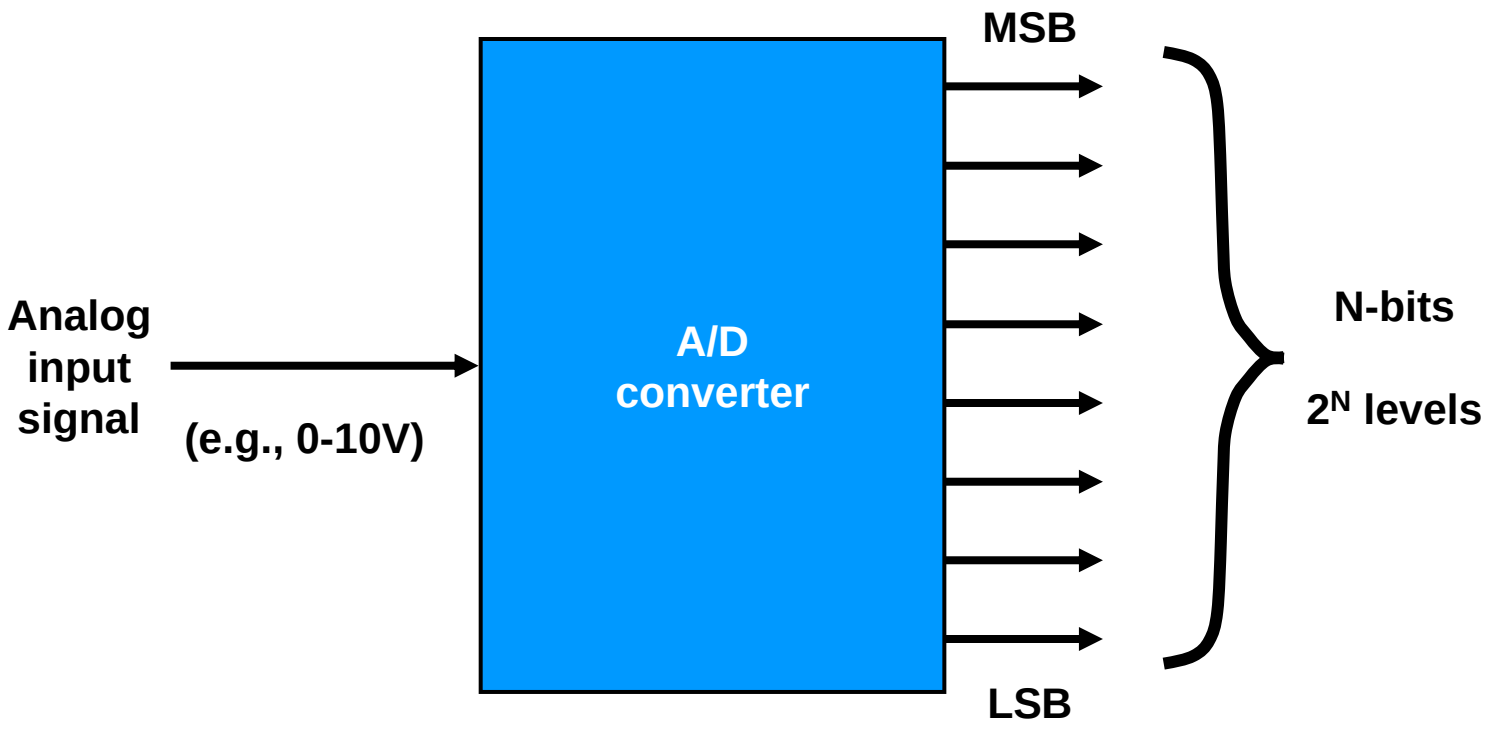
- Arithmetic with 2's complement

10_{10}	00001010
$+23_{10}$	00010111
--------	--------
33_{10}	00100001
-17_{10}	11101111
--------	--------
16_{10}	X00010000

2's complement numbers can be added (subtraction by adding negative numbers) continually, as long as final result can fit in word size.

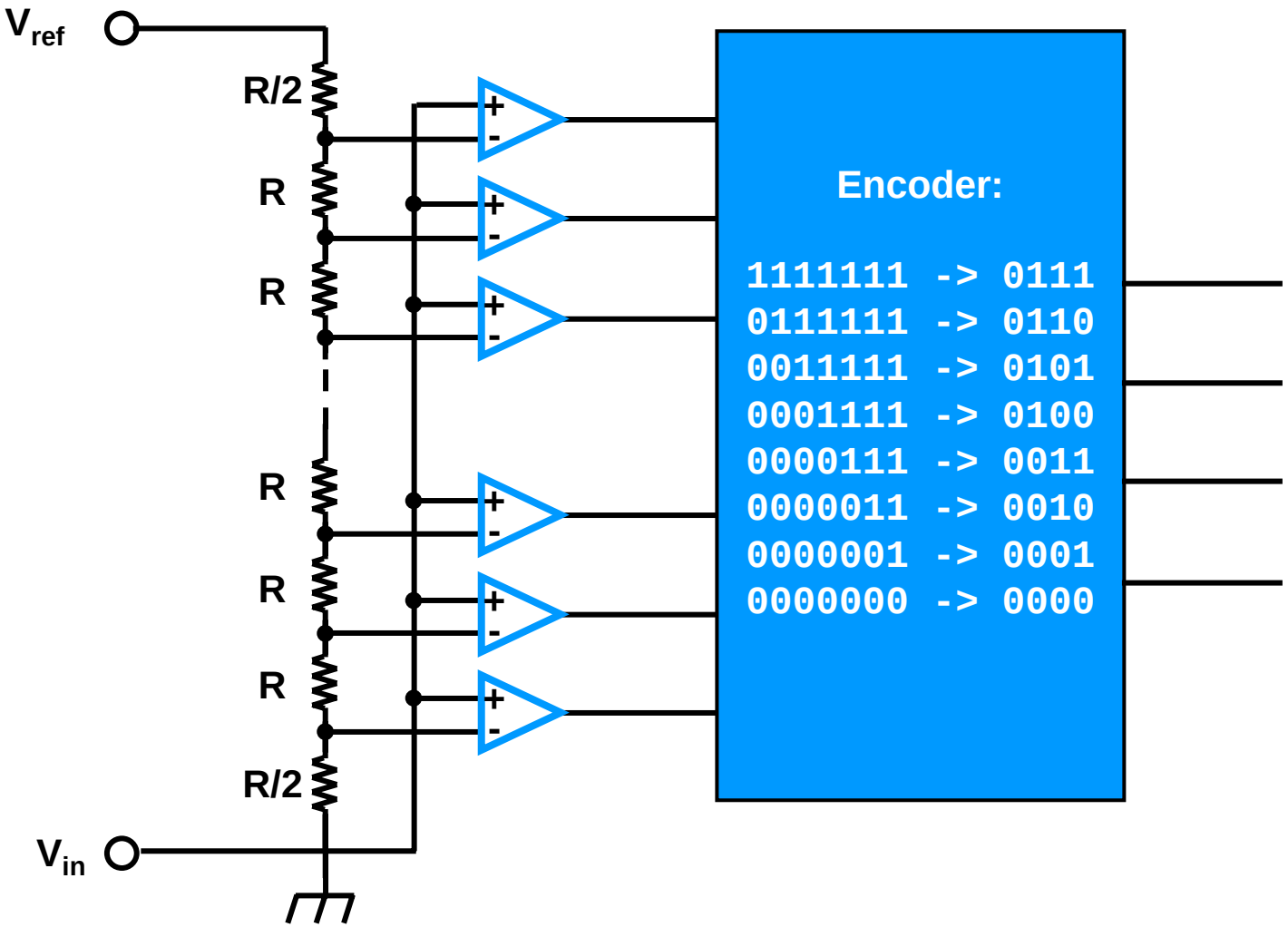
Computerized Data Acquisition

- Analog-to-digital converters



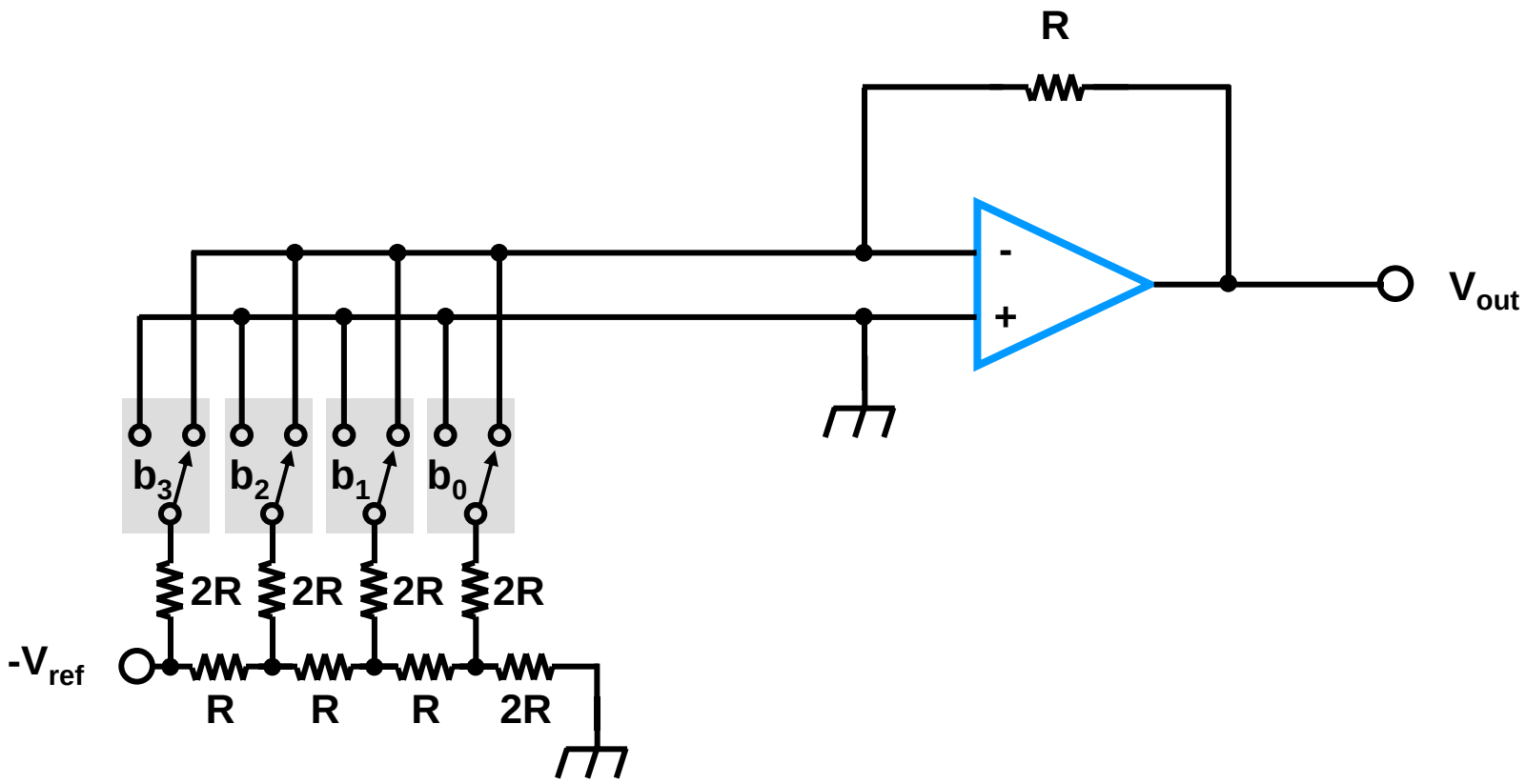
Computerized Data Acquisition

- Analog-to-digital converters – Parallel/Flash A/D



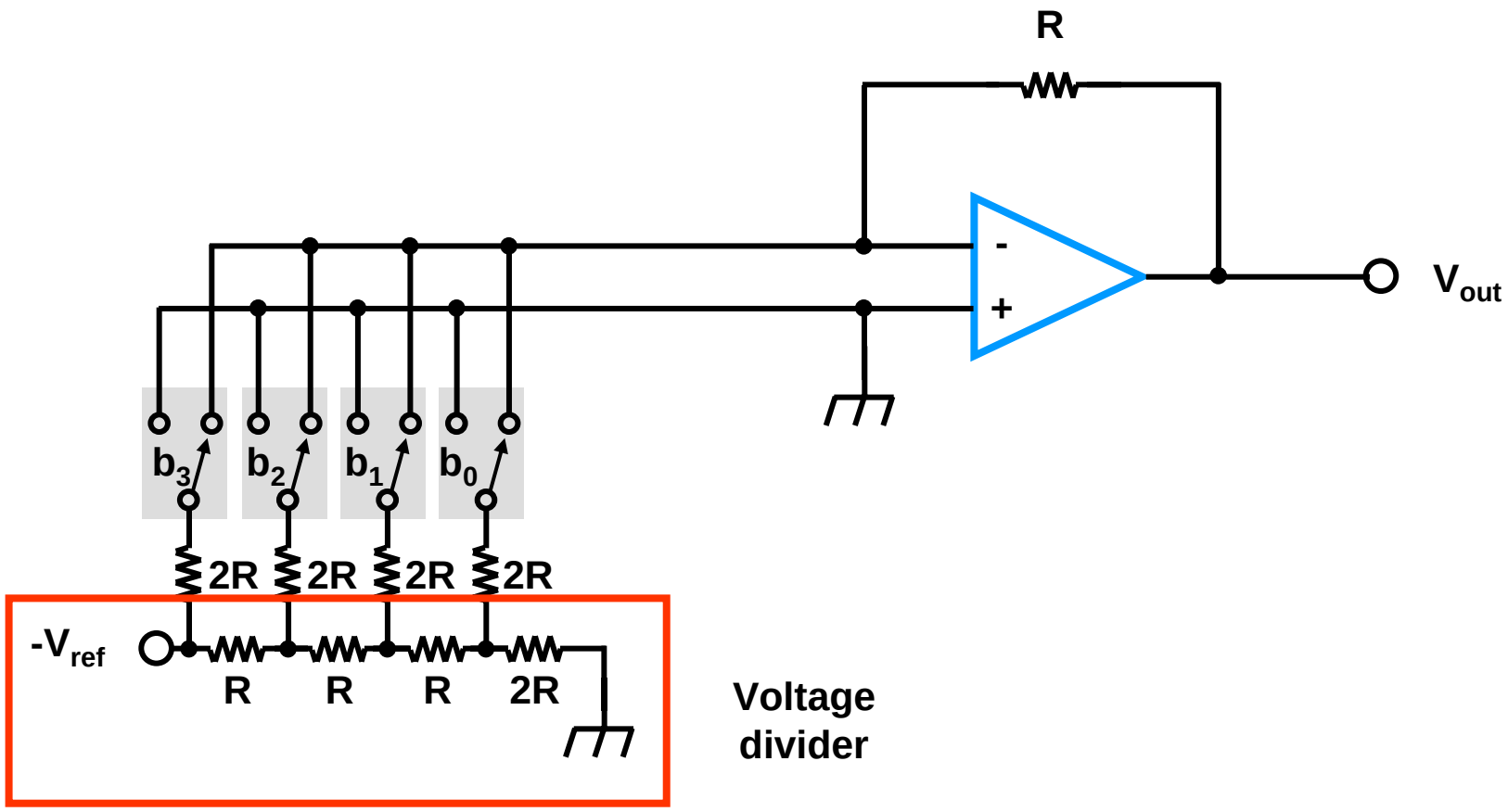
Computerized Data Acquisition

- Digital-to-analog converters



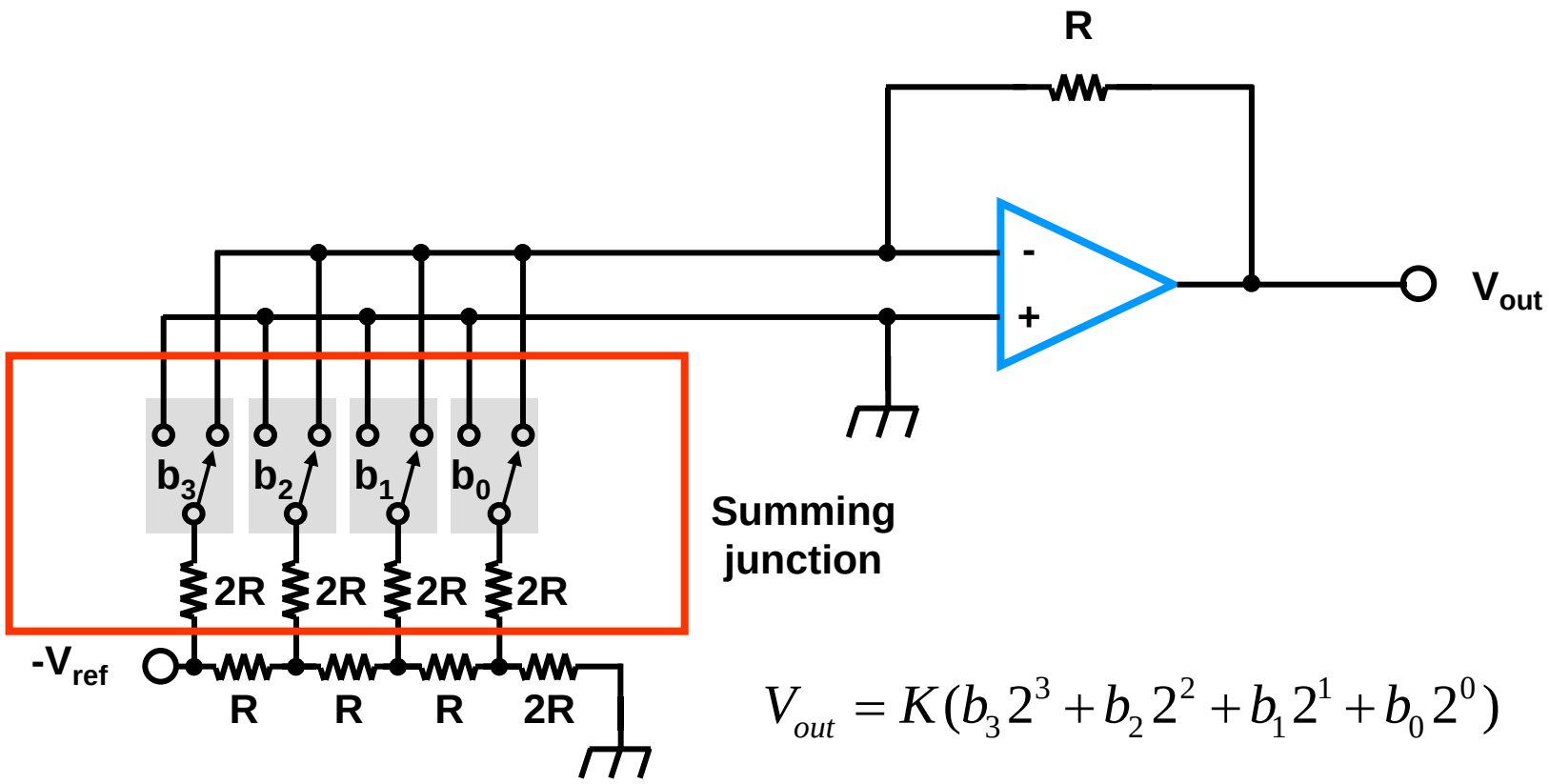
Computerized Data Acquisition

- Digital-to-analog converters



Computerized Data Acquisition

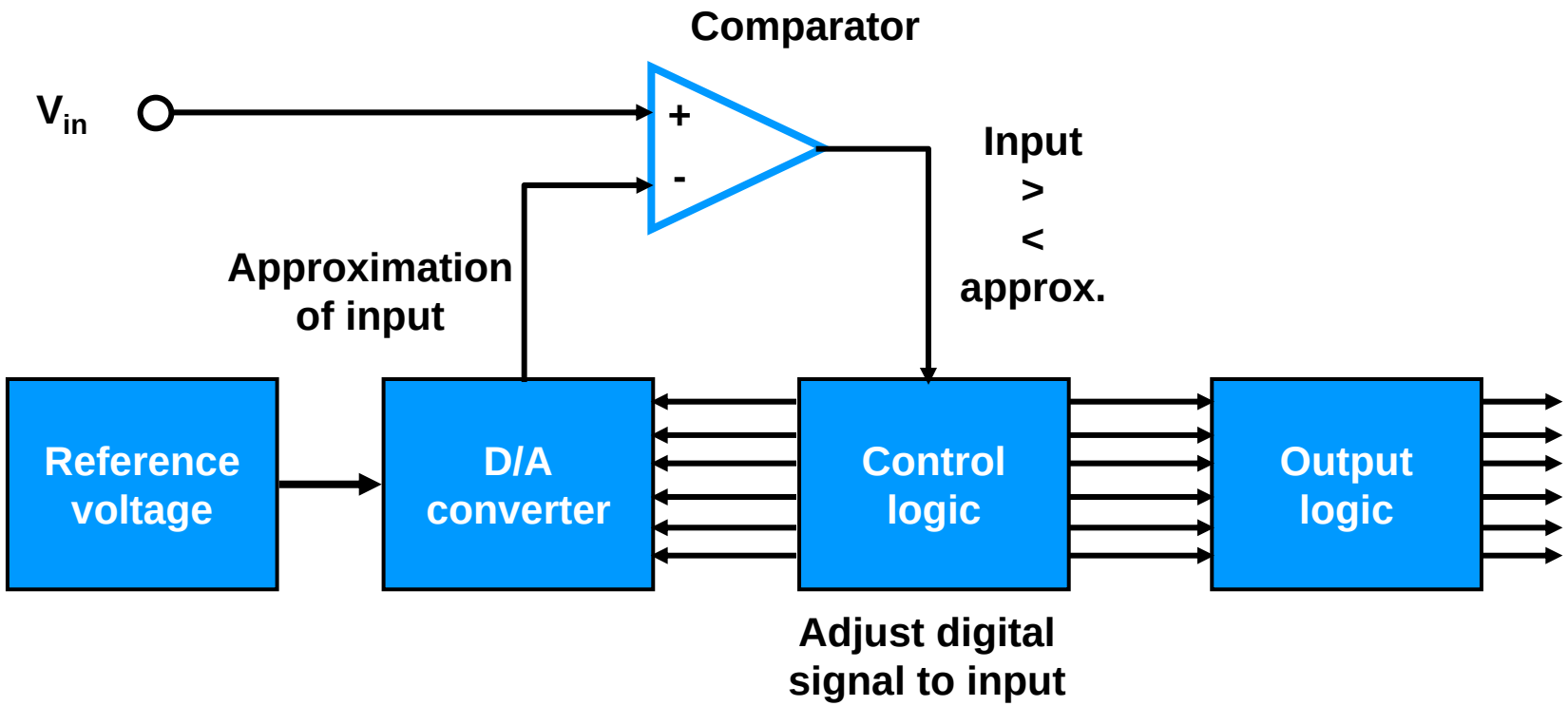
- Digital-to-analog converters



$$V_{out} = K(b_3 2^3 + b_2 2^2 + b_1 2^1 + b_0 2^0)$$

Computerized Data Acquisition

- Successive approximation A/D converter



Next topics

- Computerized Data Acquisition
  - Sampling
  - Quantization effects
  - Fourier Transform and frequency domain analysis