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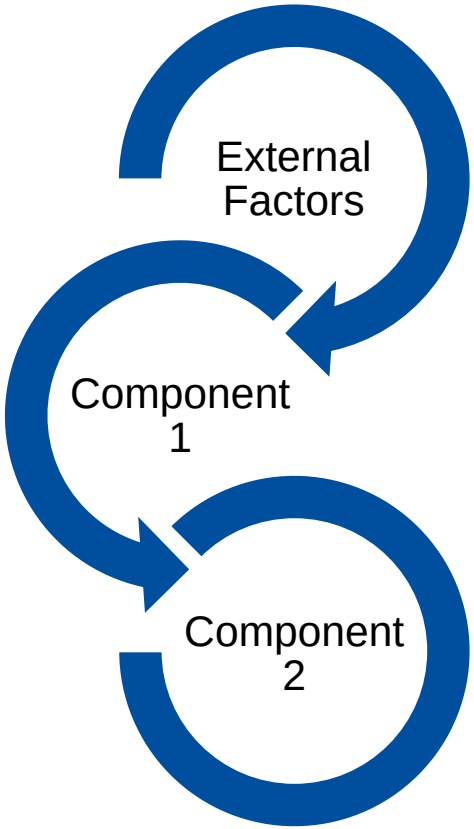
Oldenburg

Simulation of Renewable Energy Systems

Understanding Data Loggers and their configurations

26.09.2024
Dr. Tanja Behrendt

Motivation



Physical quantities varying

- with time
- depending on other physical quantities
- depending on interconnection

…

Description by Simulation and Modelling techniques

Renewable Energy System

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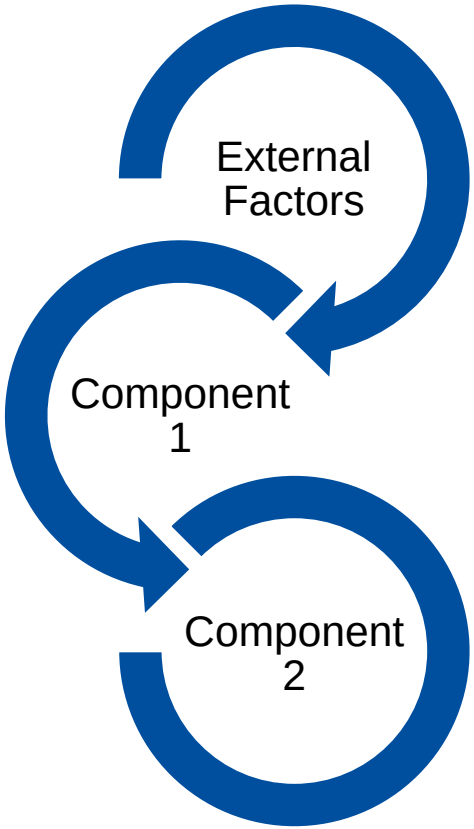
Motivation



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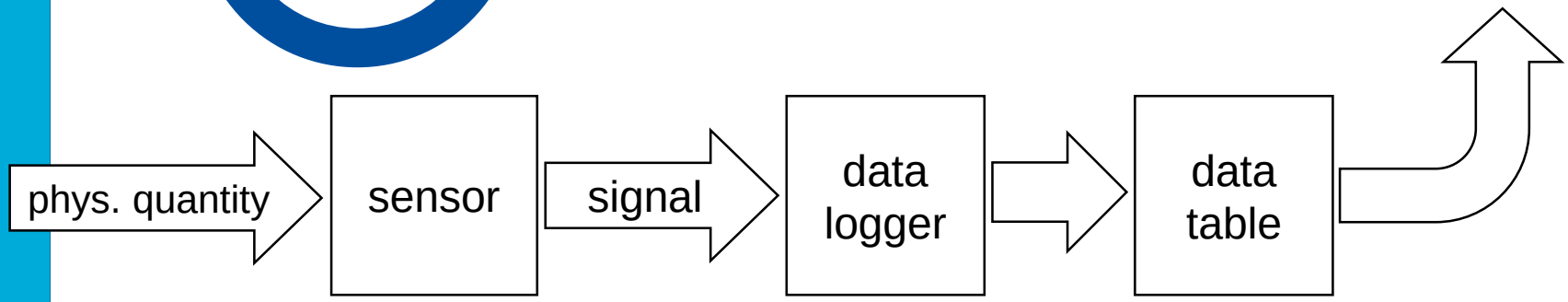
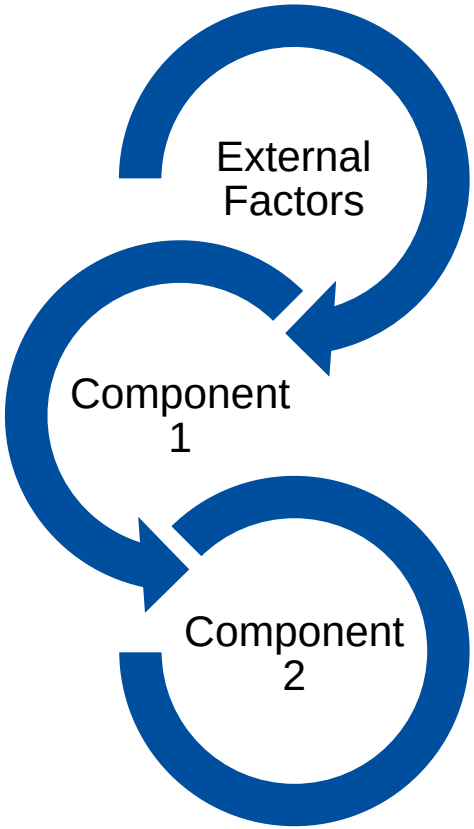
Description by Simulation and Modelling techniques



Motivation

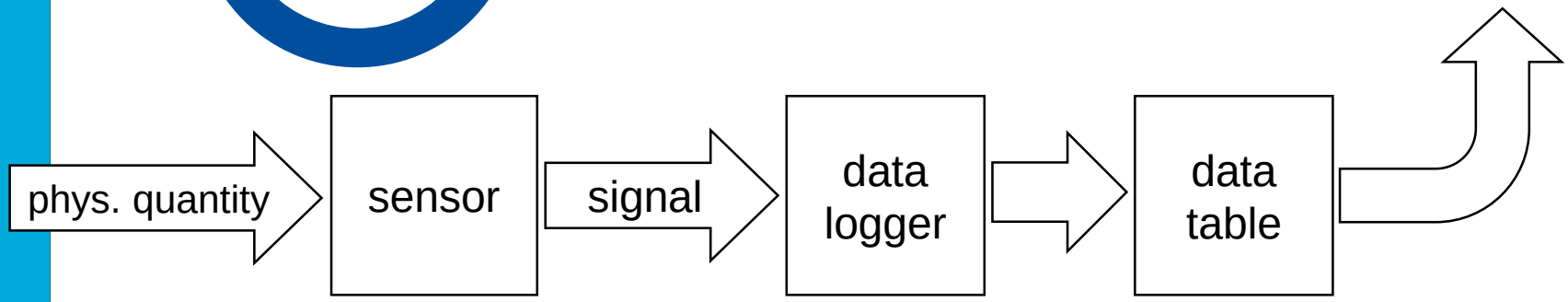


Physical quantities varying

- with time
- depending on other physical quantities
- depending on interconnection
- …

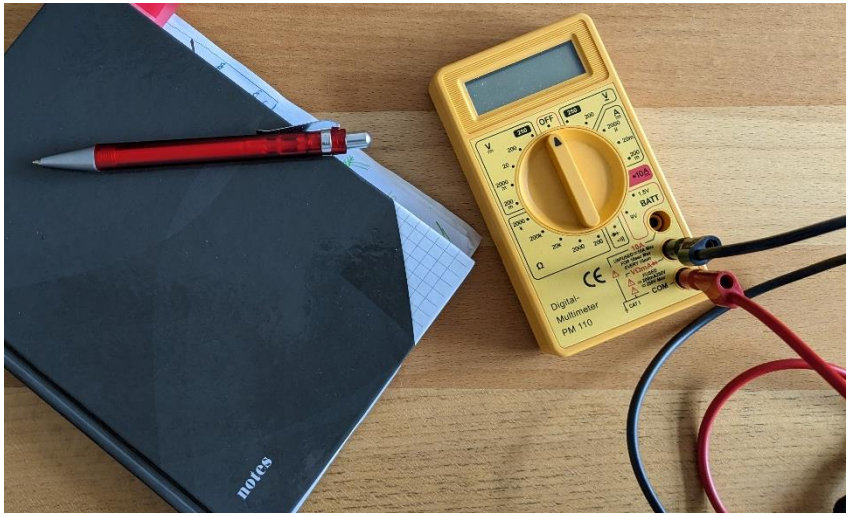
Description by Simulation and Modelling techniques

Define the „truth“



Measuring Time Signals

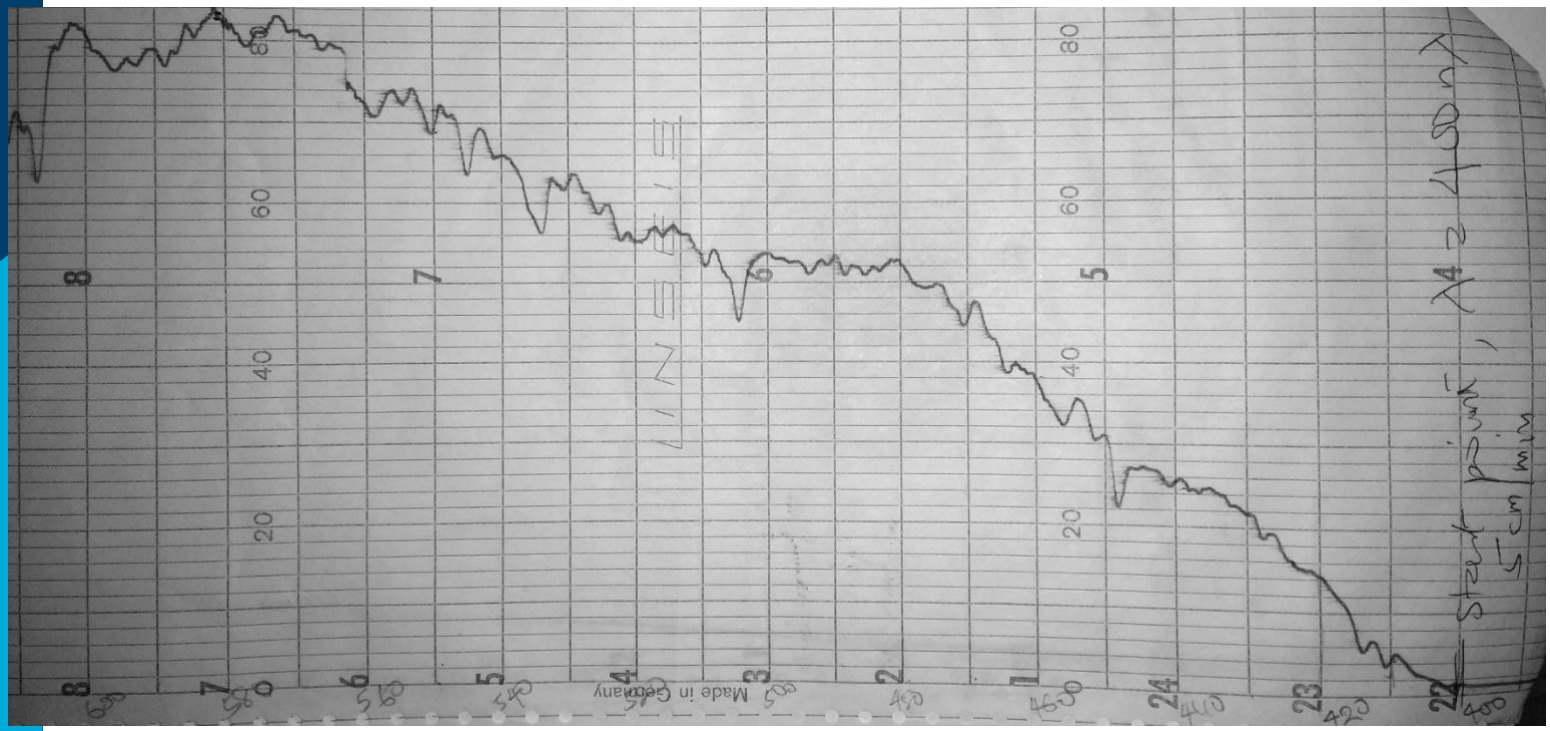
- Multimeters



Measuring Time Signals

- Multimeters
- (historical): xt-writer

Measuring Time Signals



Solar spectrum measured during WinterLab
(Agbeve, Maharjan, Dec.7th 2005)

Measuring Time Signals

Settings for the xt-writer

Solar spectrum measured during WinterLab
(Agbeve, Maharjan, Dec.7th 2005)

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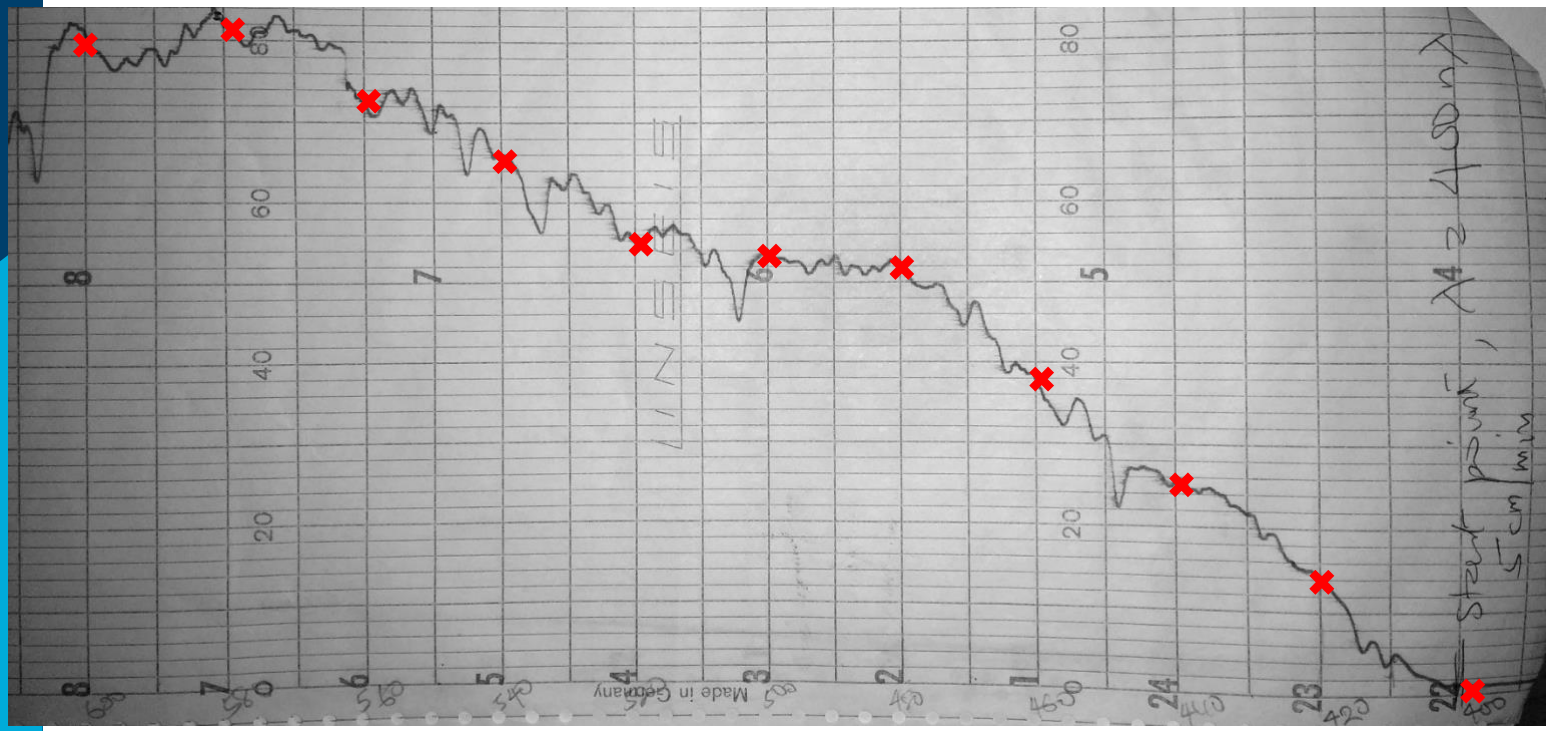
Digitization

Analog signal!

Good accuracy but we want to have it in the computer

Solar spectrum measured during WinterLab
(Agbeve, Maharjan, Dec.7th 2005)

Digitization - „AD-conversion“



Solar spectrum measured during WinterLab
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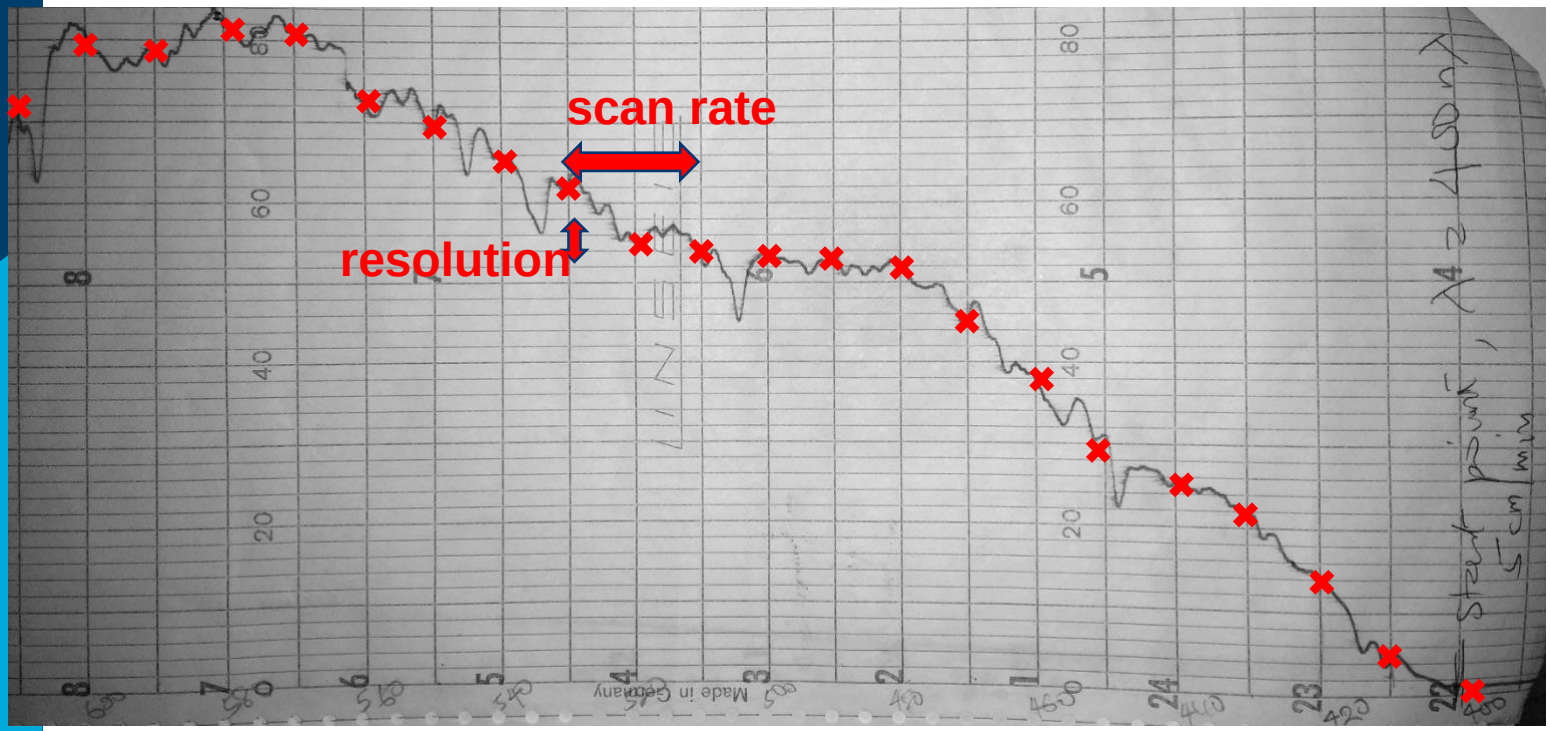
Digitization – best settings

Discretisation in Time & Space

→ loss of information

→ choose an appropriate AD converter (Arduino 12bit)



Solar spectrum measured during WinterLab
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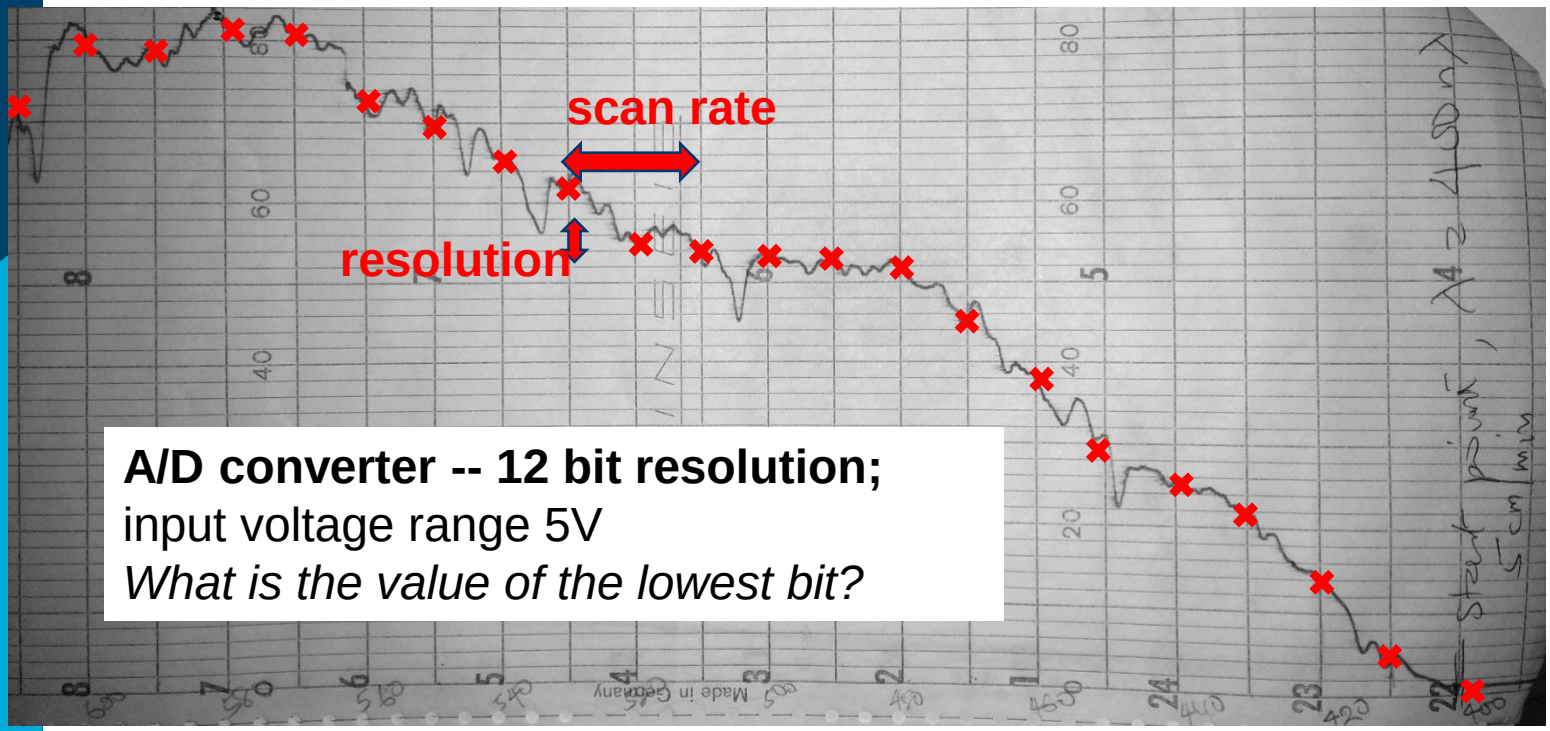
Digitization – best settings

Discretisation in Time & Space

→ loss of information

→ choose AD converter properly (Arduino 12bit enhancement)



Solar spectrum measured during WinterLab
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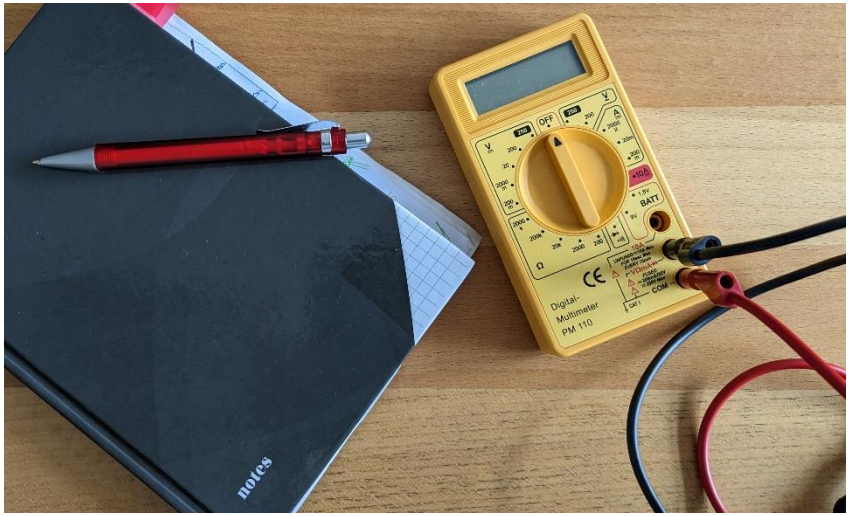
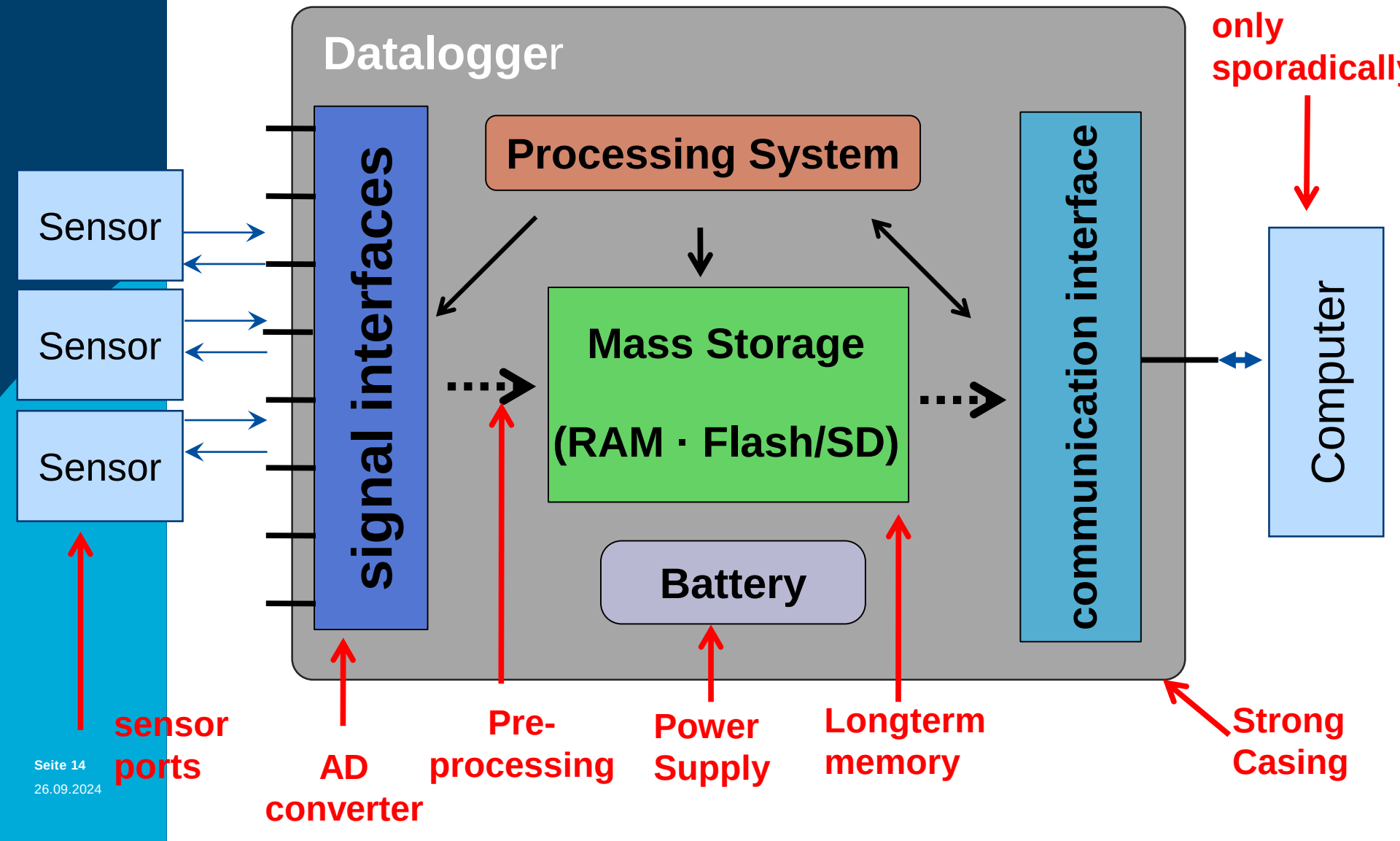
Measuring Time Signals

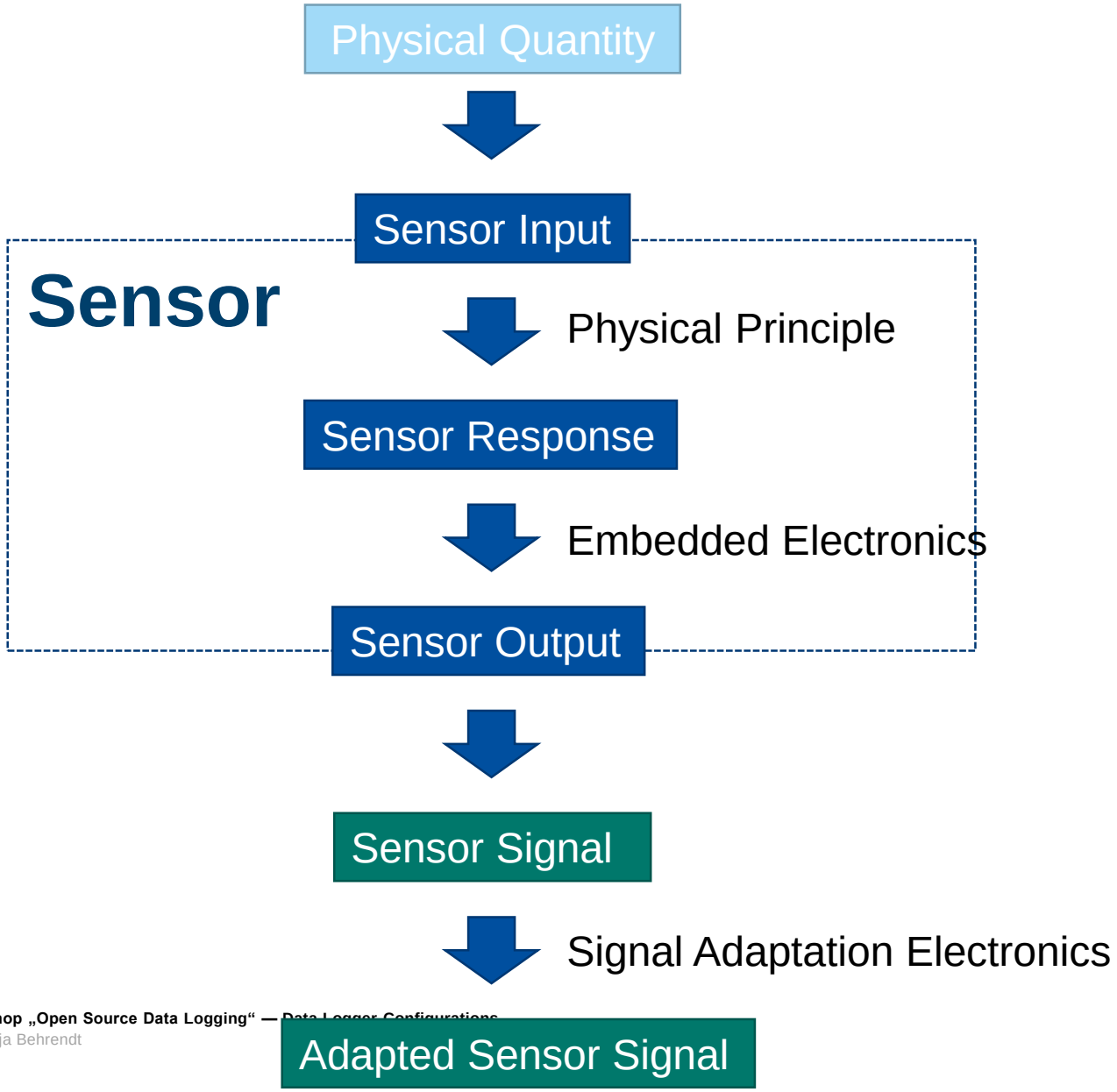
- Multimeters
- (historical): xt-writer
- Data Logger

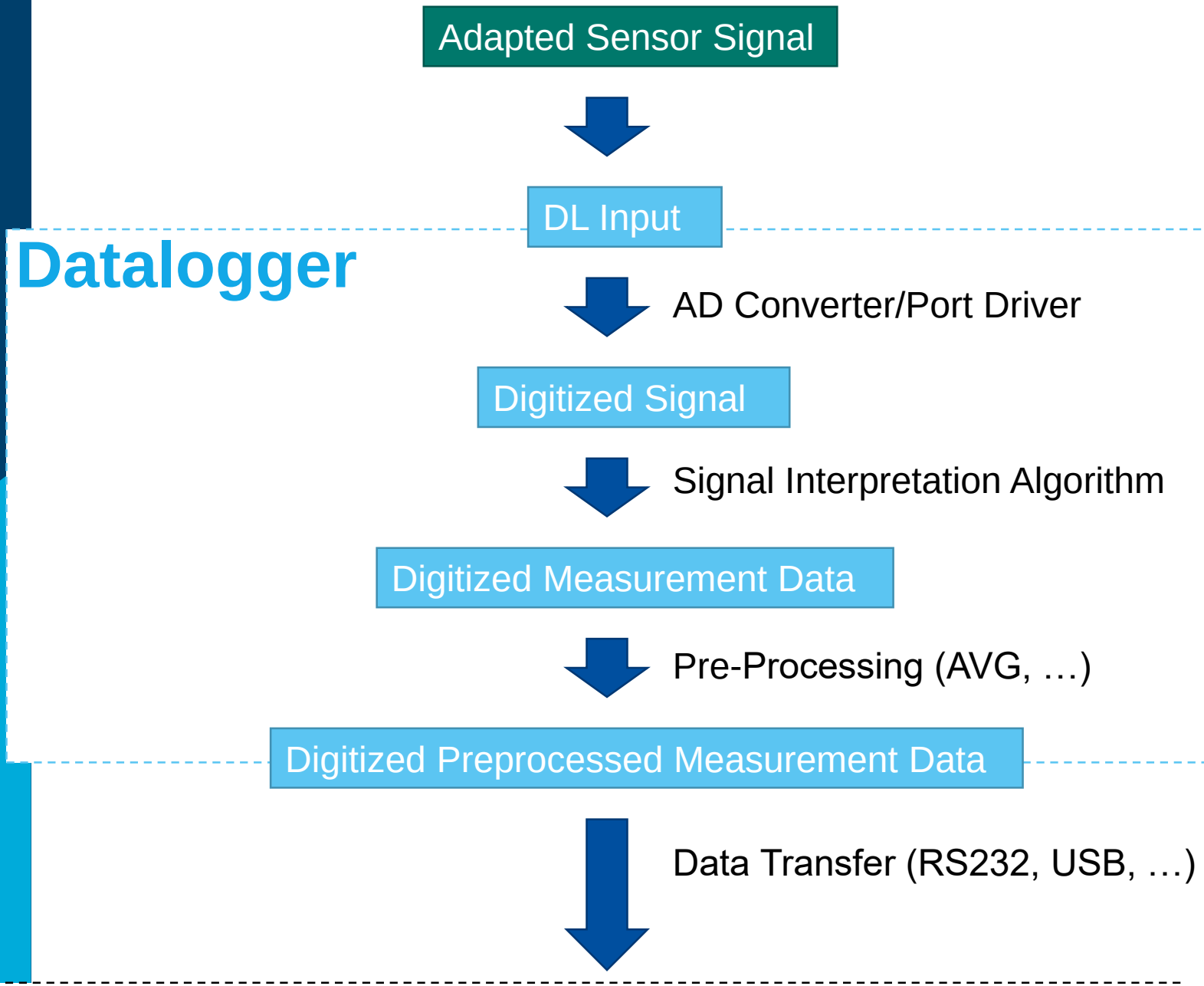


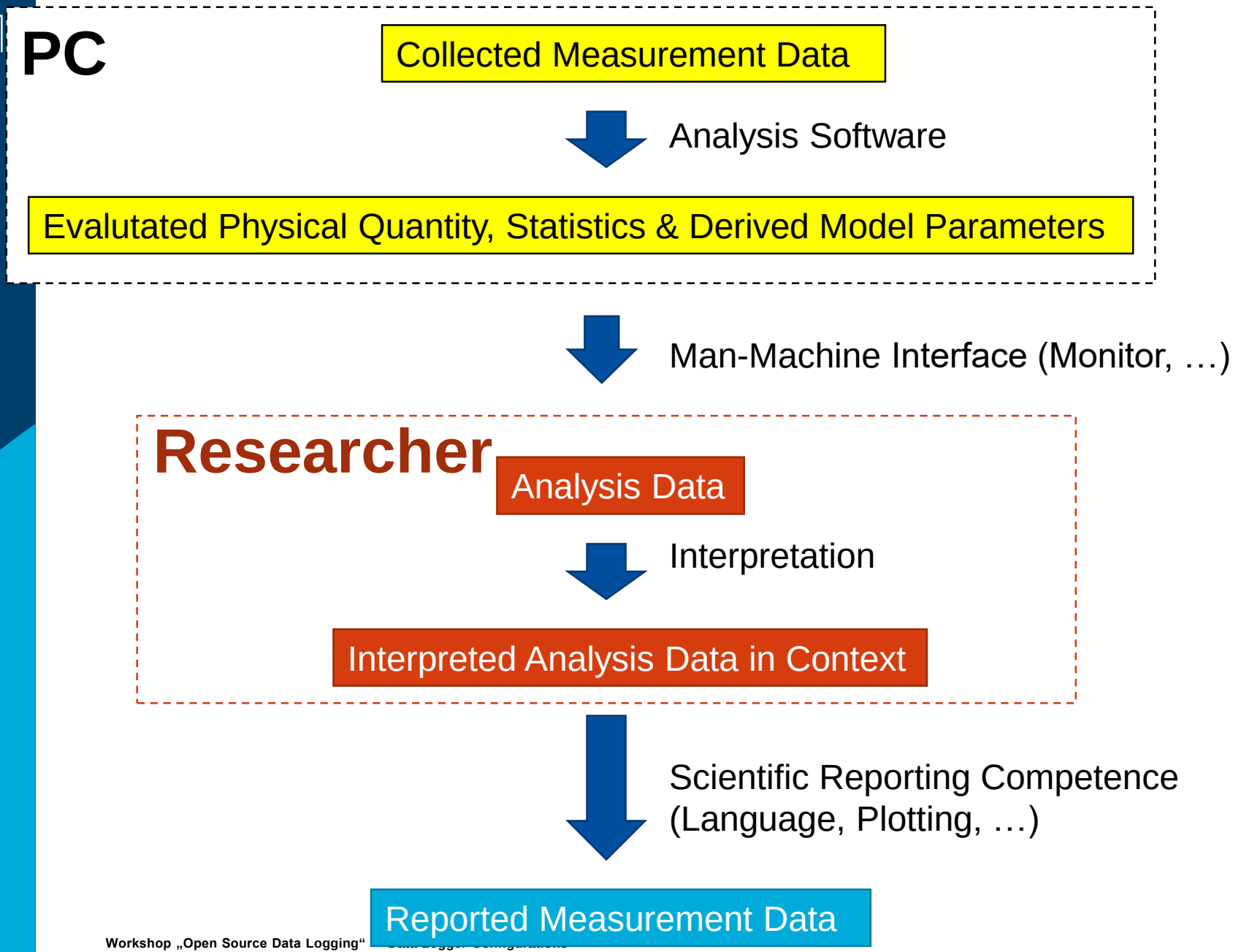
Our definition of a Data Logger



Where things could go wrong




Adapted Sensor Signal
DL Input
Datalogger
AD Converter/Port Driver
Digitized Signal
Signal Interpretation Algorithm
Digitized Measurement Data
Pre-Processing (AVG, …)
Digitized Preprocessed Measurement Data
Data Transfer (RS232, USB, …)
PC
Collected Measurement Data


PC
Collected Measurement Data
Analysis Software
Evalutated Physical Quantity, Statistics & Derived Model Parameters
Man-Machine Interface (Monitor, …)
Researcher
Analysis Data
Interpretation
Interpreted Analysis Data in Context
Scientific Reporting Competence
(Language, Plotting, …)
Reported Measurement Data

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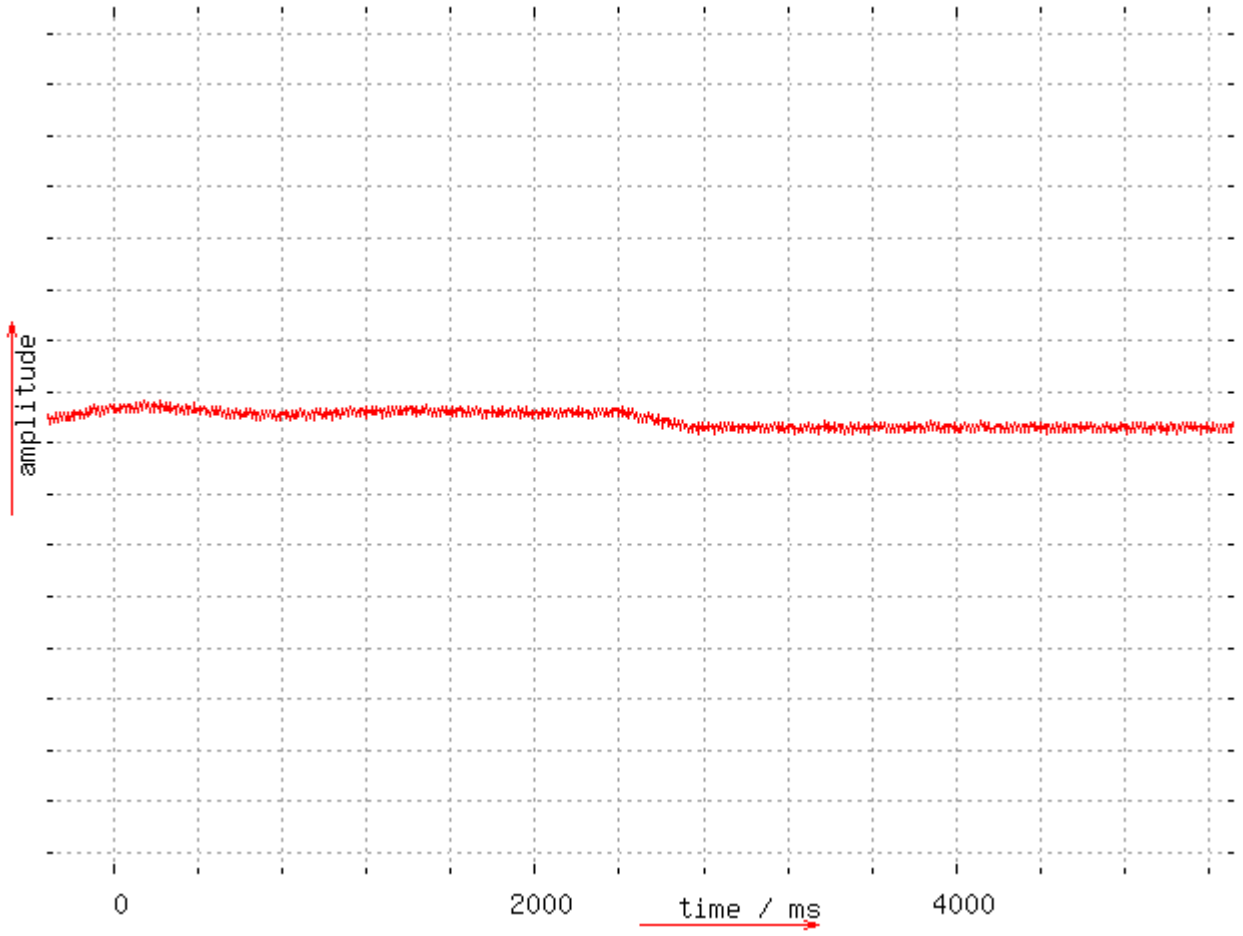
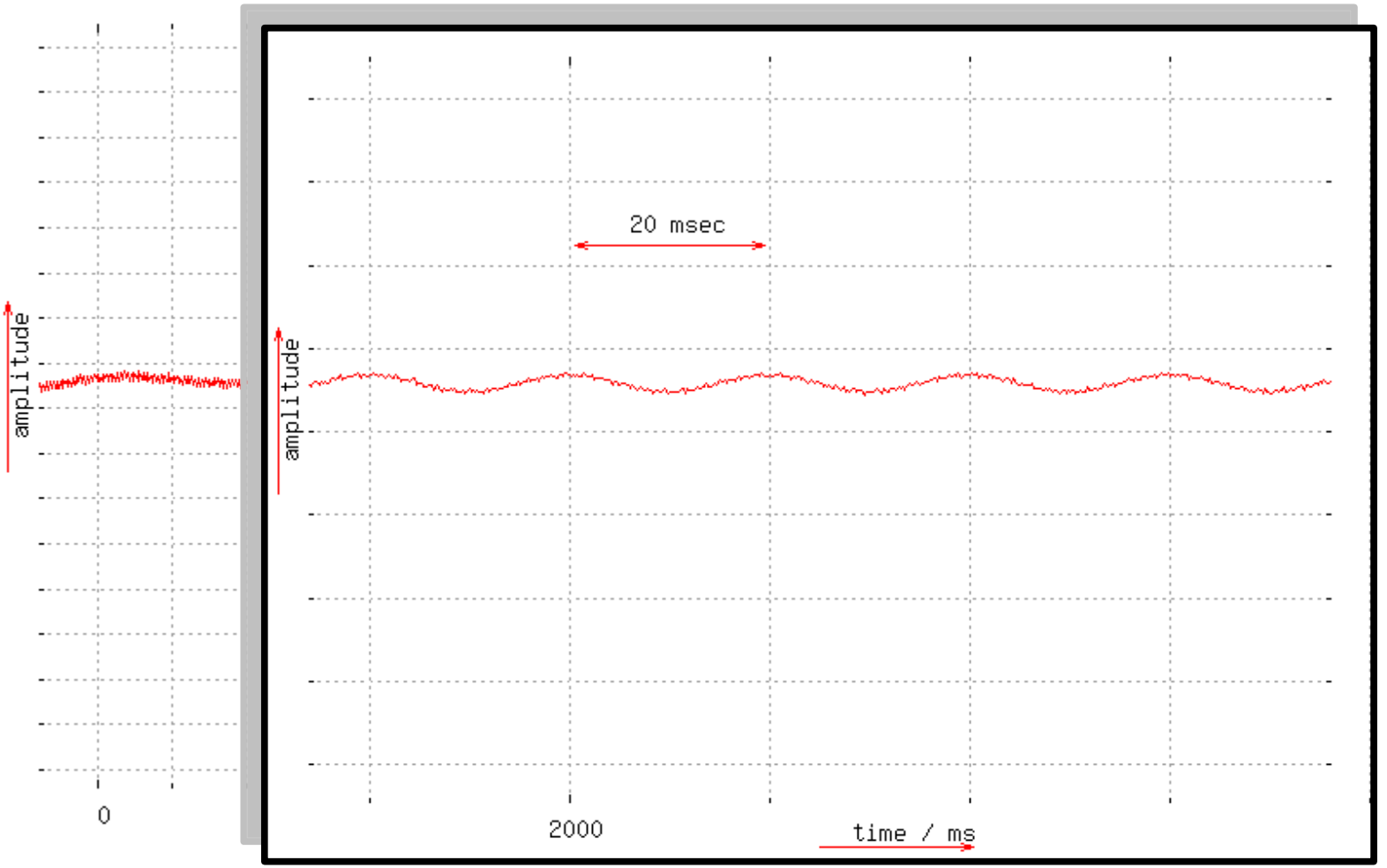
Measuring time signals



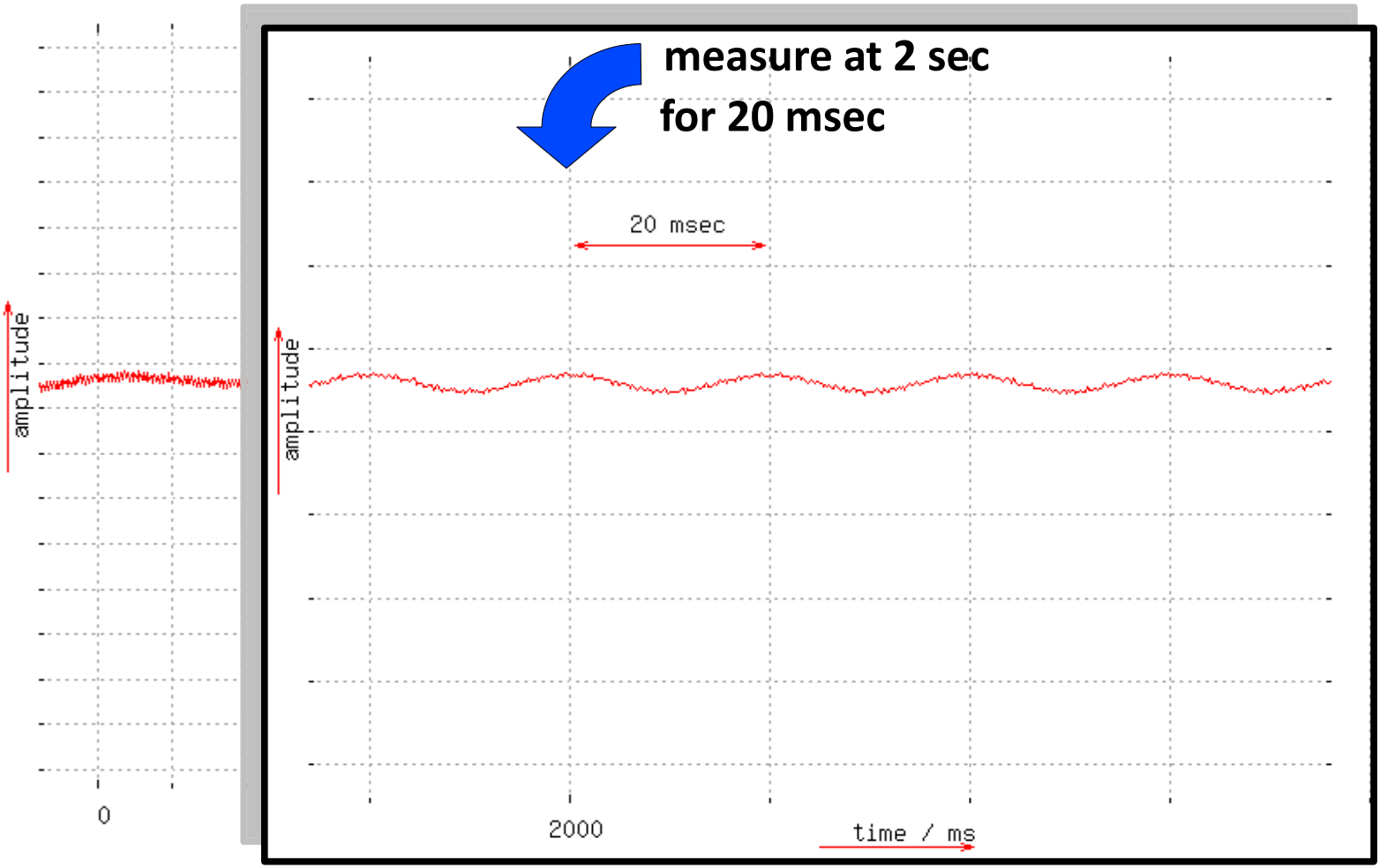
- time signal: 'constant' – noise
- not possible: to measure at a point

Measuring time signals



- ripple period: 20 ms = . . Hz
- “integration time” = length of signal measurement

Measuring time signals



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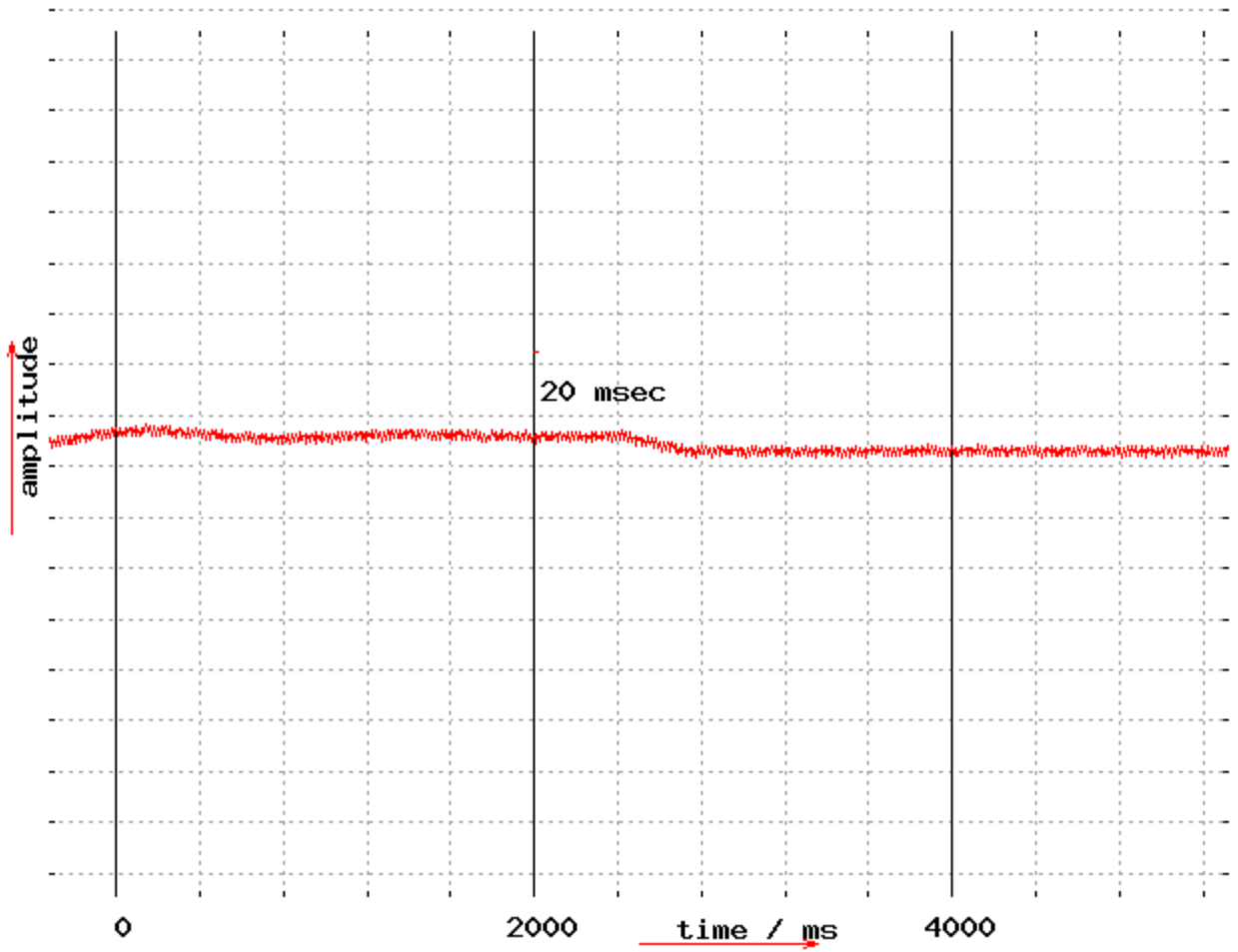
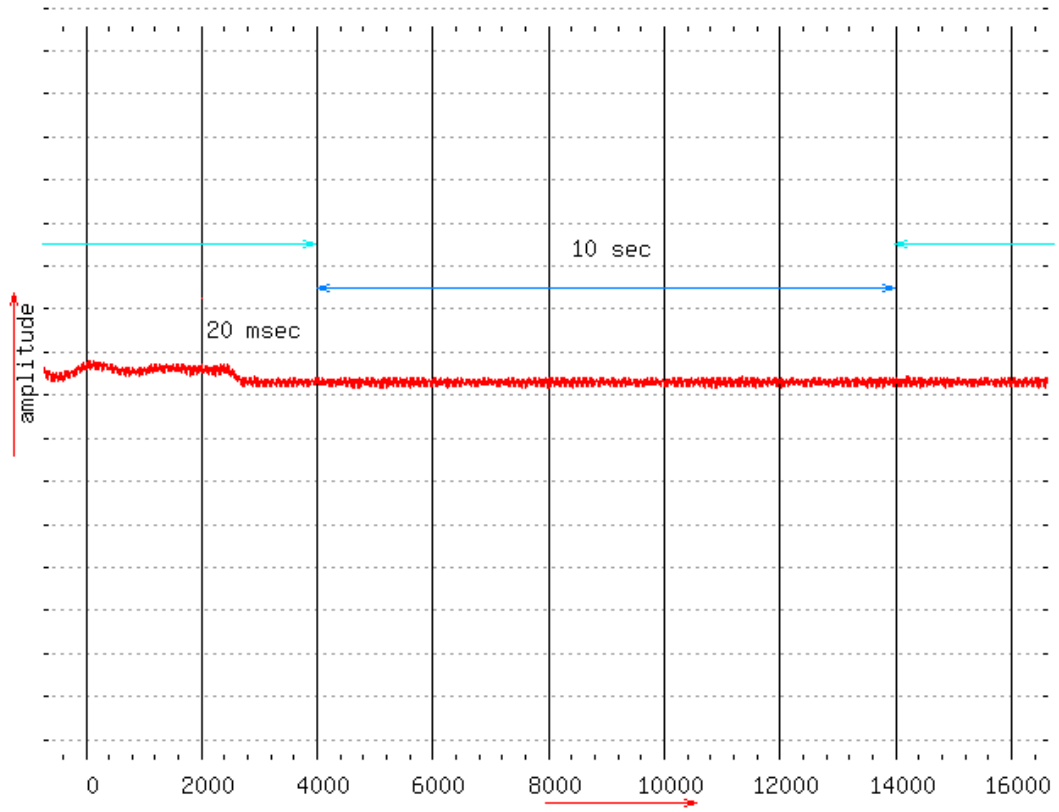


- 'slow' change -> measure every 2 seconds
- scan rate, sampling rate = how often to take a sample

Measuring time signals



- statistical fluctuations -> mean of a set of measurements: 10 sec . . 10 min . . . .
- “averaging interval” (storage of value)

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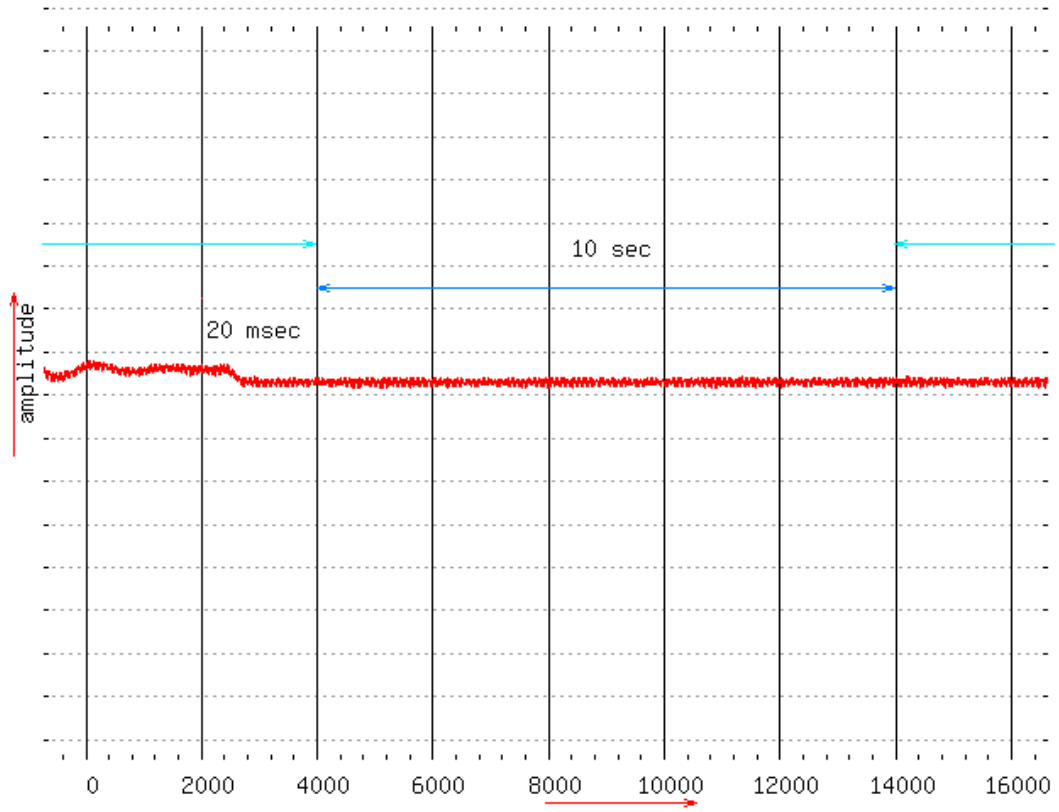
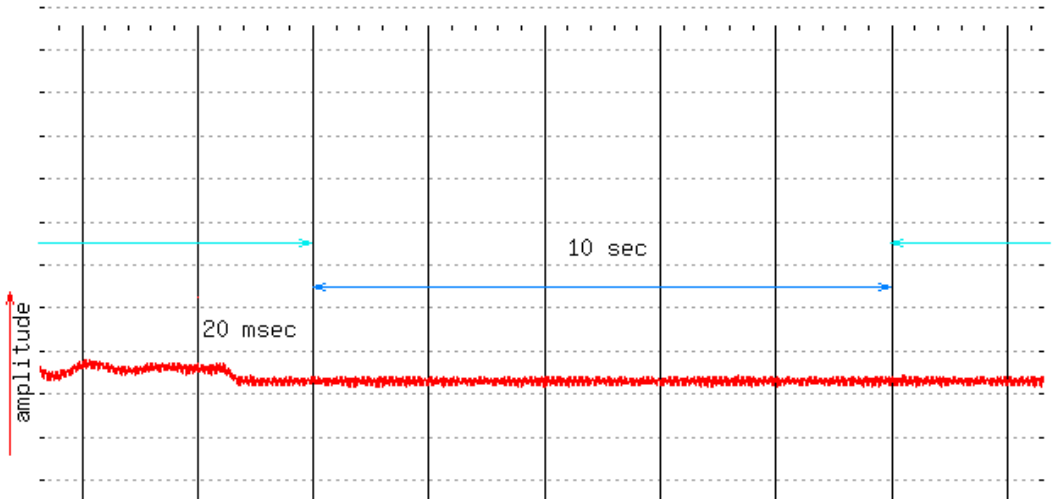
Measuring time signals



integration time: length of signal measurement (to reduce noise)
scan rate: how often to take a sample
averaging interval: length of signal measurement (to reduce data)

Measuring time signals



to monitor a time signal,
set

- integration time
- scan rate
- averaging interval

according to

← ambient noise
← needed samples
← purpose

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What is a data logger able to read?

signal type	DL detector
▪ analogue signals	→ A/D converter
▪ pulses	→ counter
▪ flags	→ comparator
▪ frequencies	→ counter / fixed time interval

Voltage measurements

Voltage $U = \phi_2 - \phi_1$
Potential Difference

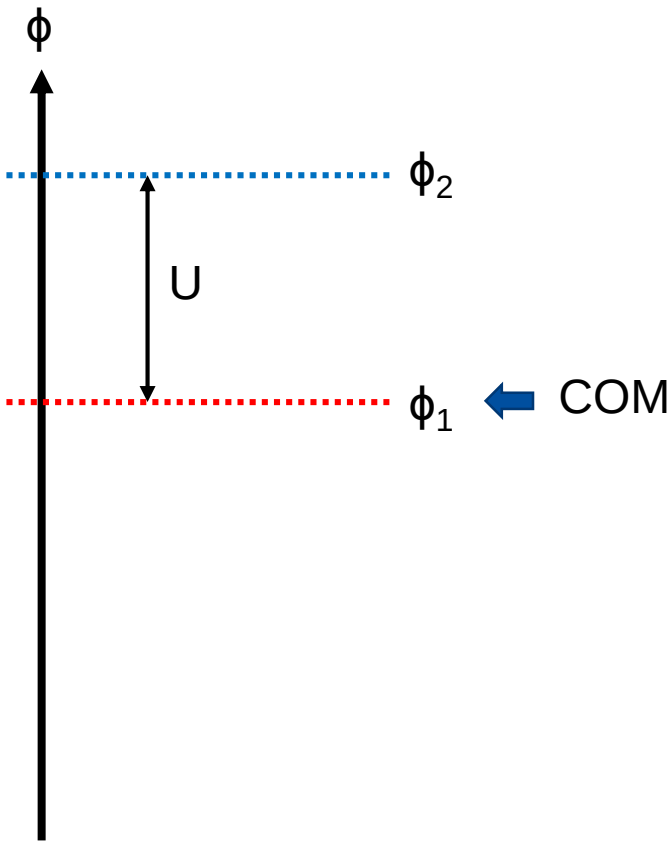
Voltage measurements

Voltage $U = \phi_2 - \phi_1$
Potential Difference

with Multimeter:
It did not matter where the potentials were

One terminal was simply declared the **COMmon**

→ Voltages are always measured against a reference or common



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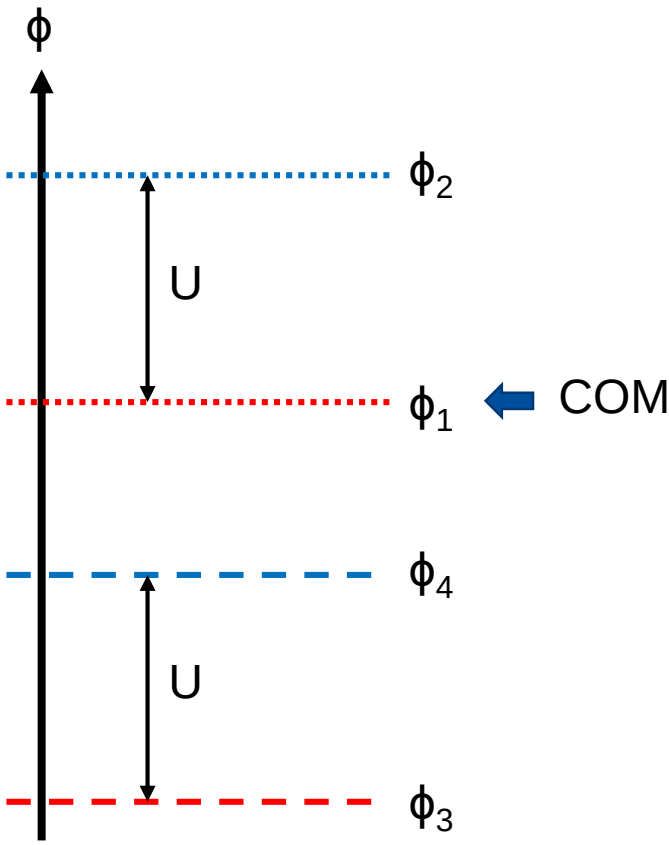

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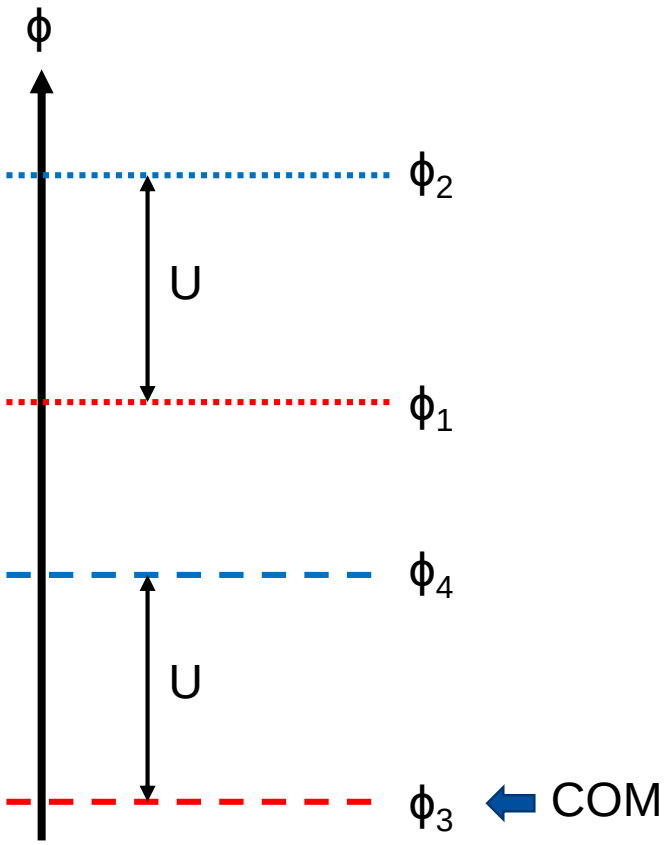
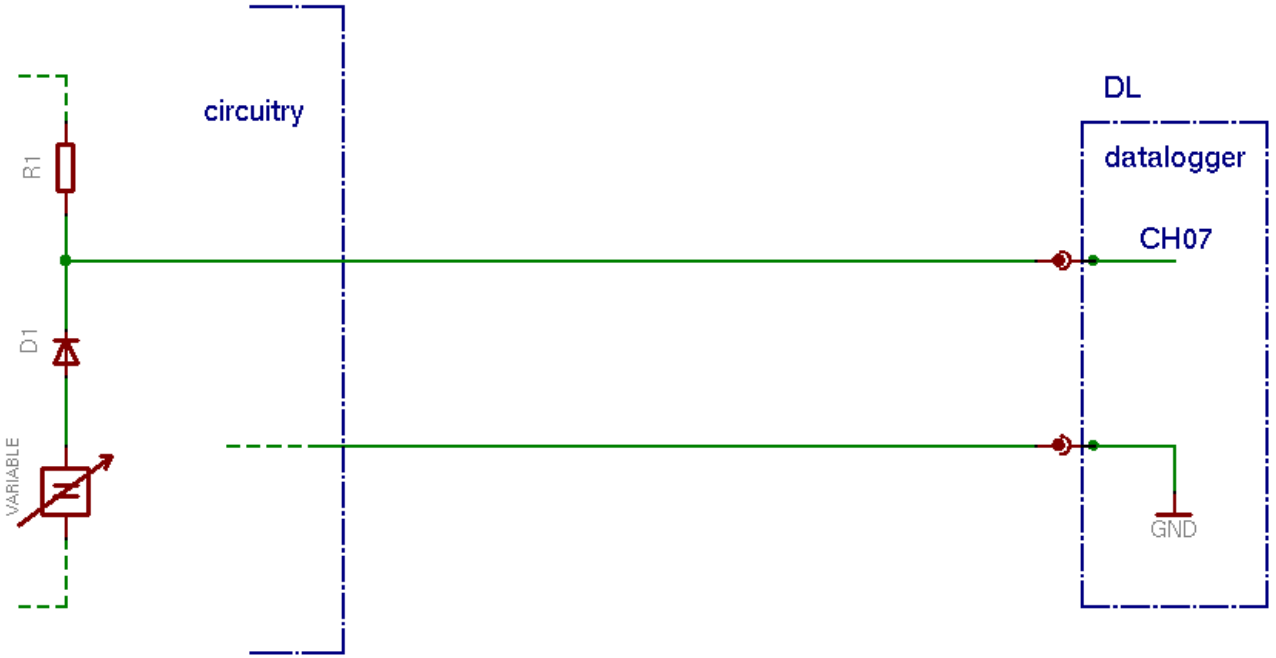


Voltage measurements – detection modes

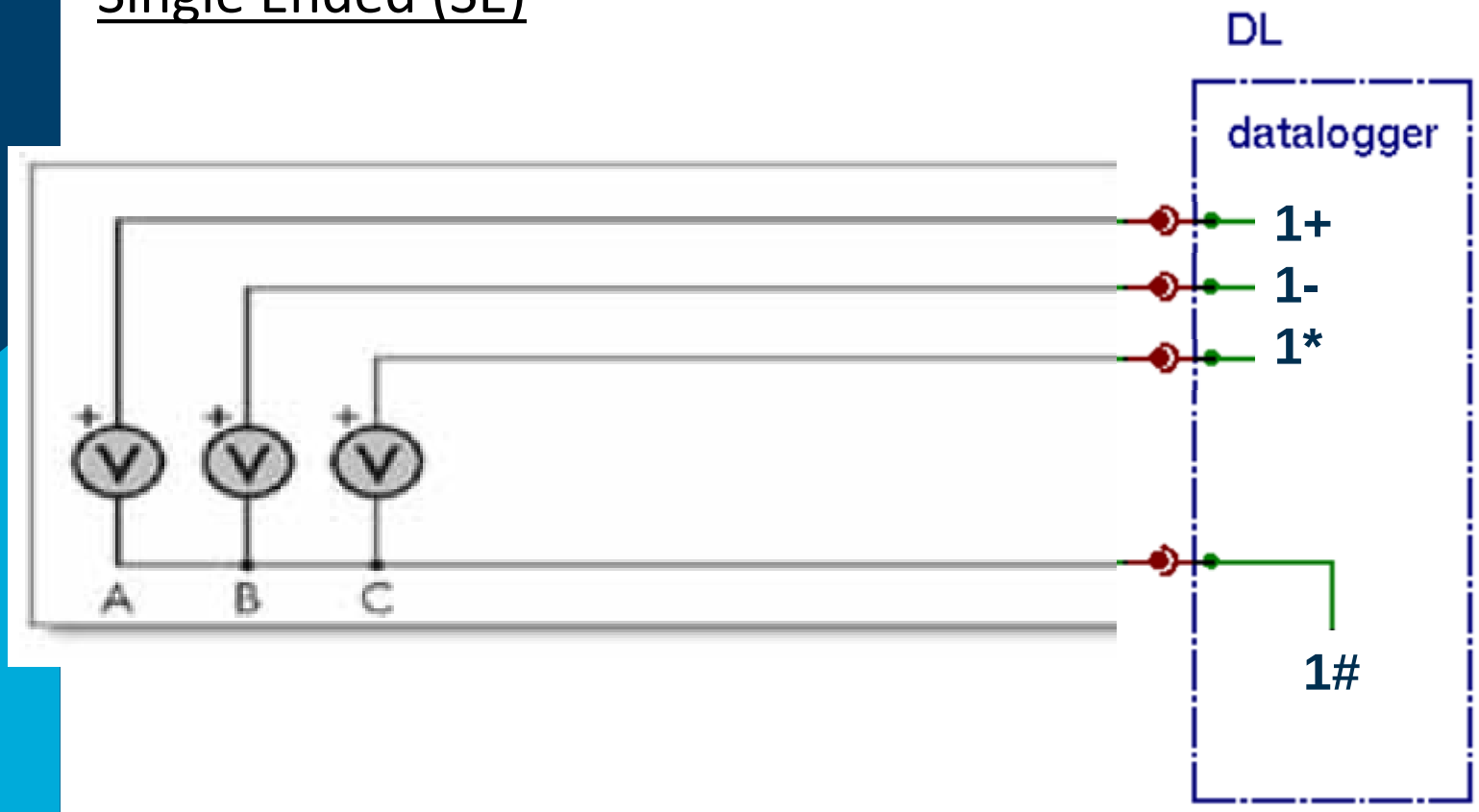
Single Ended (SE)



Only one cable/probe needed for detection

Voltage measurements – detection modes

Single Ended (SE)

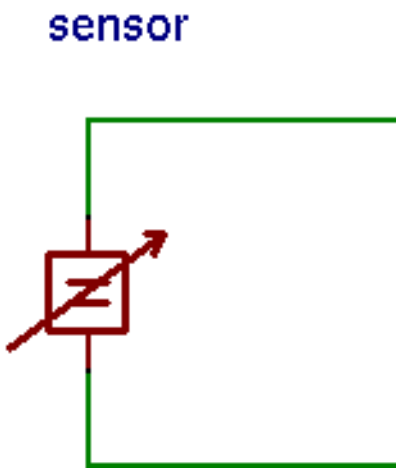


typical situation: circuitry should share 'common‘ with the DL
'voltage at some point’, can be shared by multiple probes

Source: DT 80 range user‘s manual

Voltage measurements – detection modes

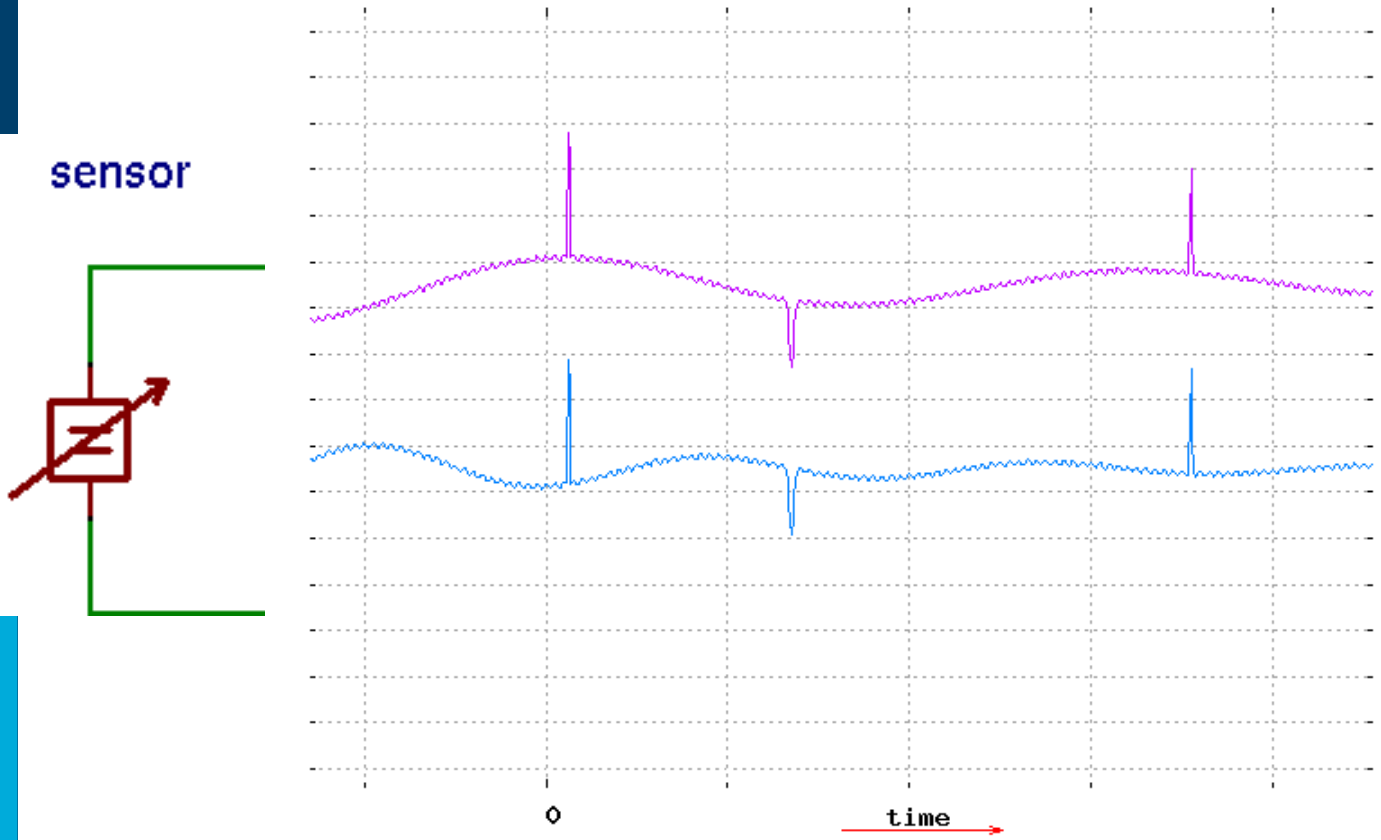
Issues with SE measurements



- small amplitude of signal, twisted pair cable

Voltage measurements – detection modes

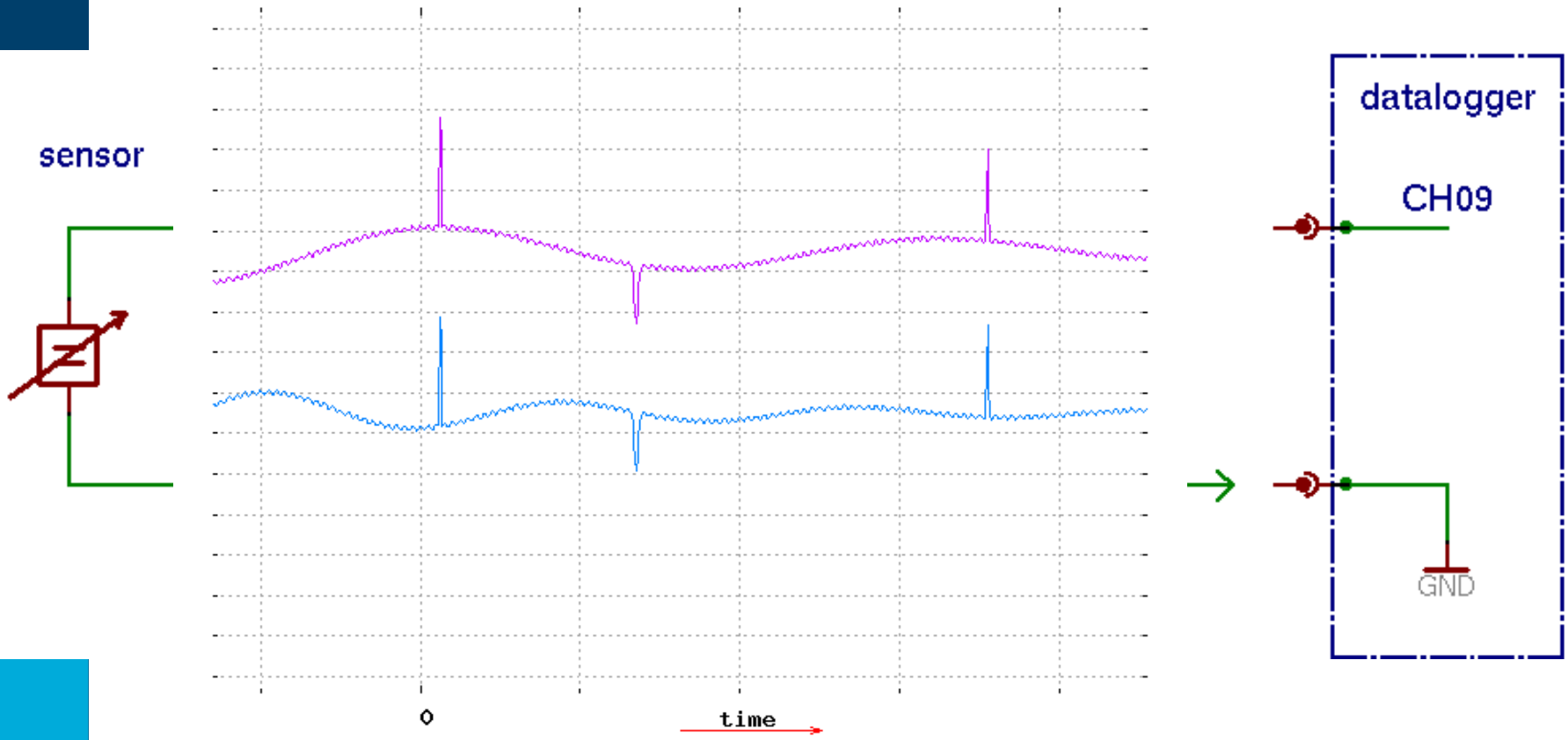
Issues with SE measurements



- small amplitude of signal, twisted pair cable
- disturbance on both wires

Voltage measurements – detection modes

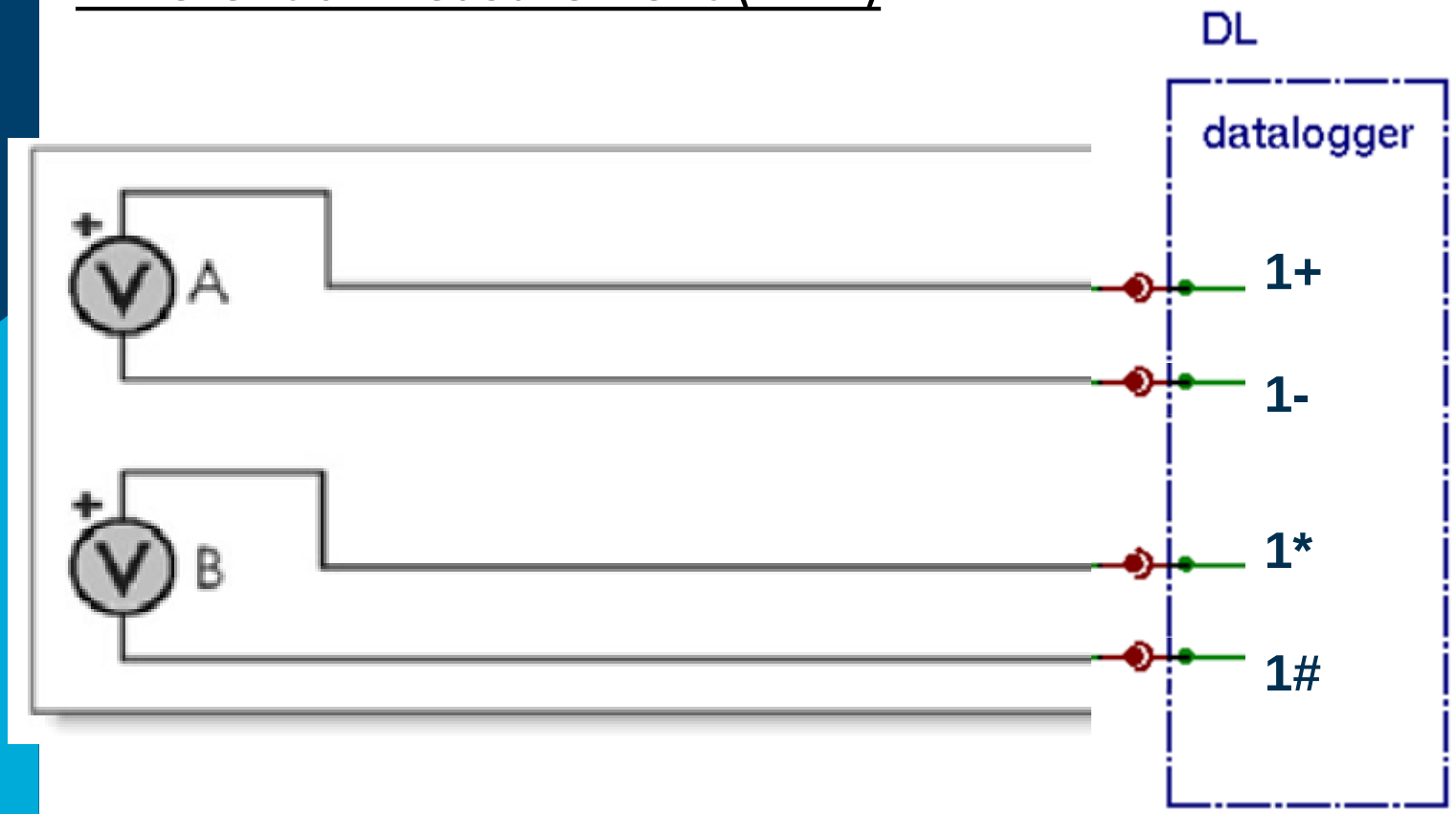
Issues with SE measurements



- disturbance on both wires
- connect ONE to common ➔ wrong measurement!

Voltage measurements – detection modes

Differential measurement (DIFF)



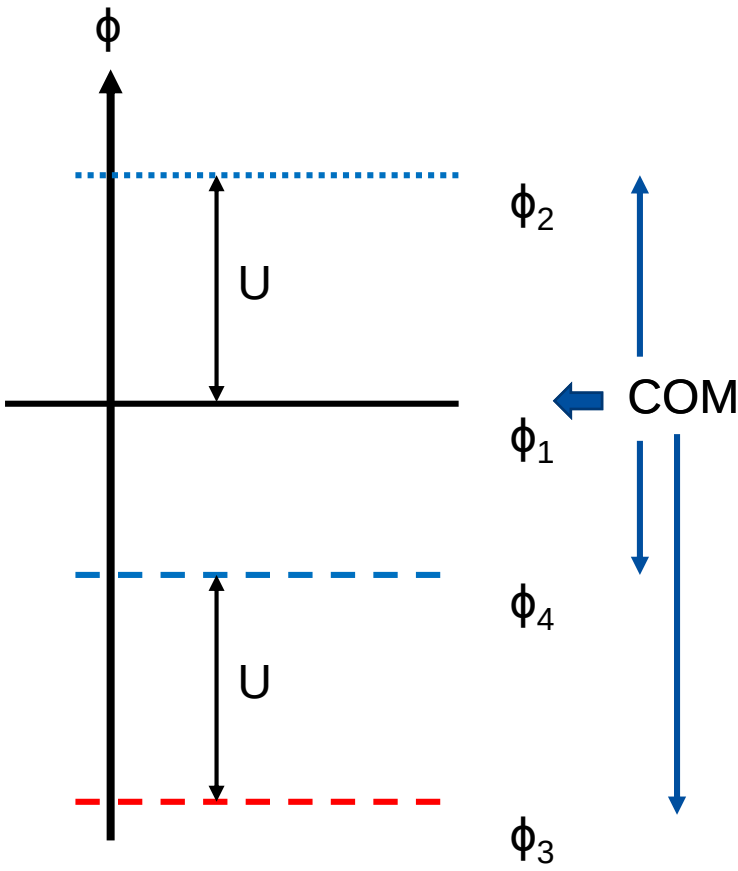
- solution: differential input (= 2 connections)
- connect reference point somewhere in sensor

Voltage measurements

With Dataloggers

ALL terminals are measured against the same COMMON

→ Voltages are always measured against a reference or common



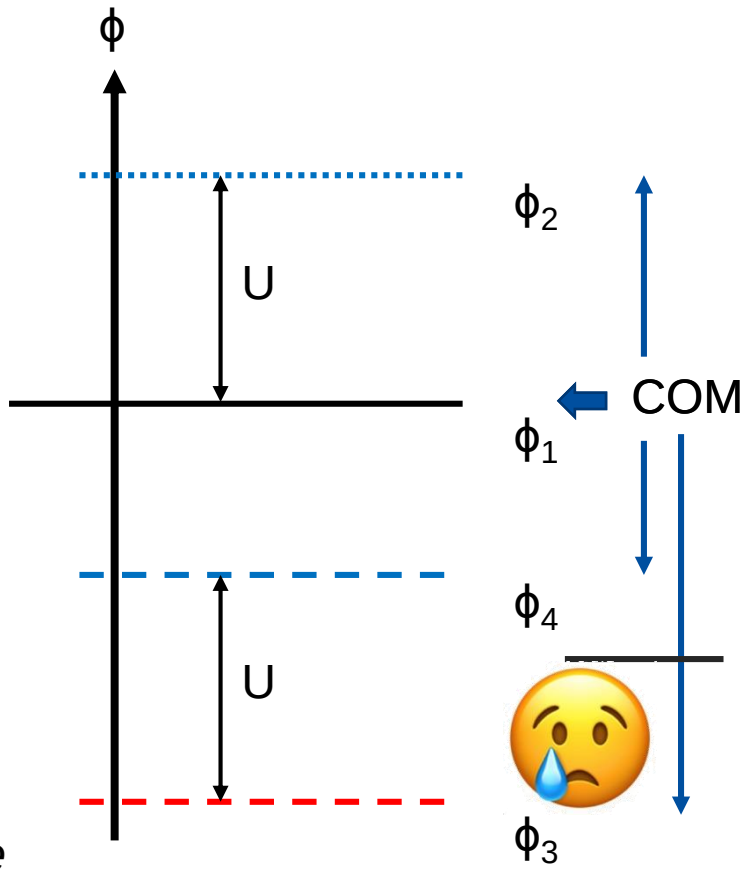
Voltage measurements

With Dataloggers

ALL terminals are measured against the same COMMON

→ Voltages are always measured against a reference or common

BUT it was also possible to be *out of range*

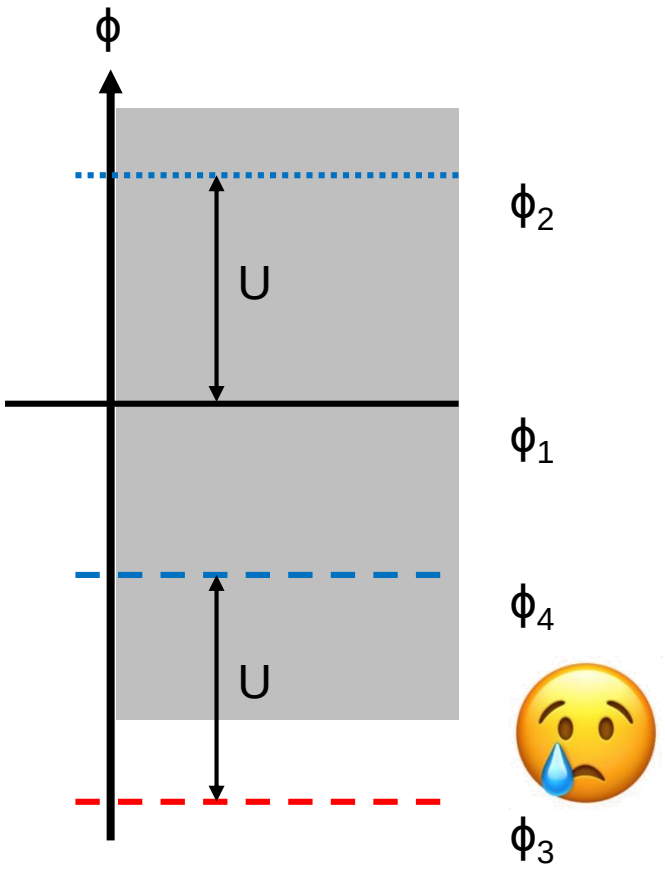


Voltage measurements

With Dataloggers you have to pay attention to this

ALL terminals are measured against the same COMMON

→ Voltages are always measured against a reference or common
→ All must lie within the <u>COMMON mode range</u>
i.e. a particular range around the COMMON

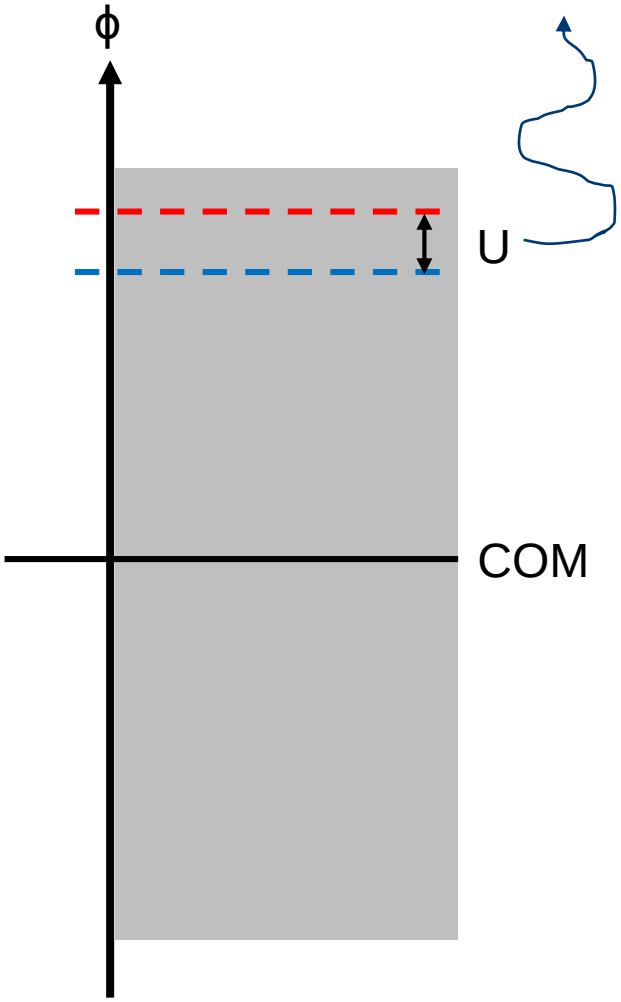


Voltage measurements

Can lead to weird effects:

This voltage of 1V can be detected with a range 2V setting

BUT if there is no connection to the datalogger COM the voltage may be floating



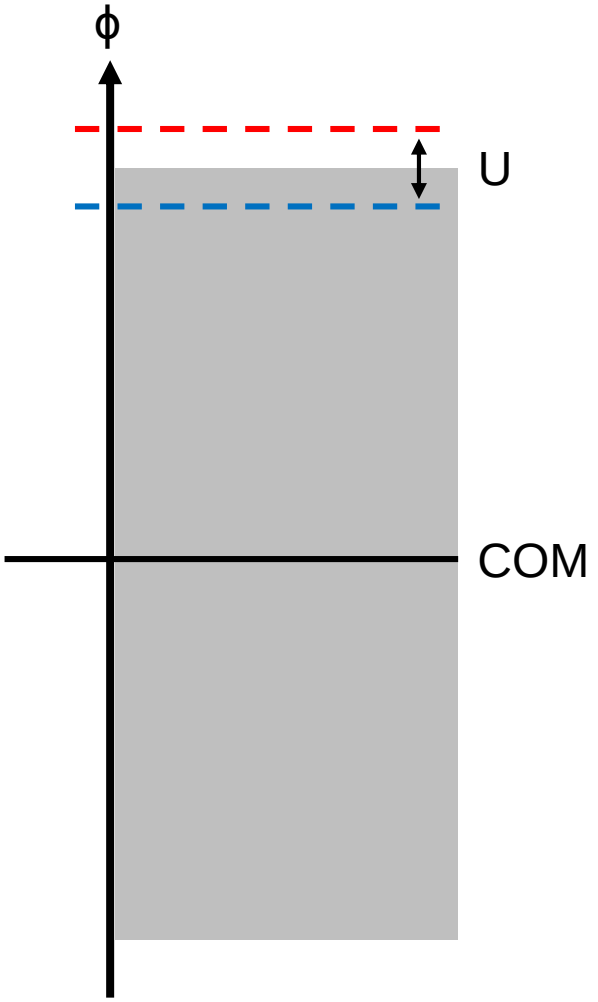
Voltage measurements

Can lead to weird effects:

This voltage of 1V can be detected with a range 2V setting

BUT if there is no connection to the datalogger COM the voltage may be floating

This voltage of 1V can no longer be measured
as one terminal is out of the common mode range even
though the voltage is small enough
→ Leads often to confusion



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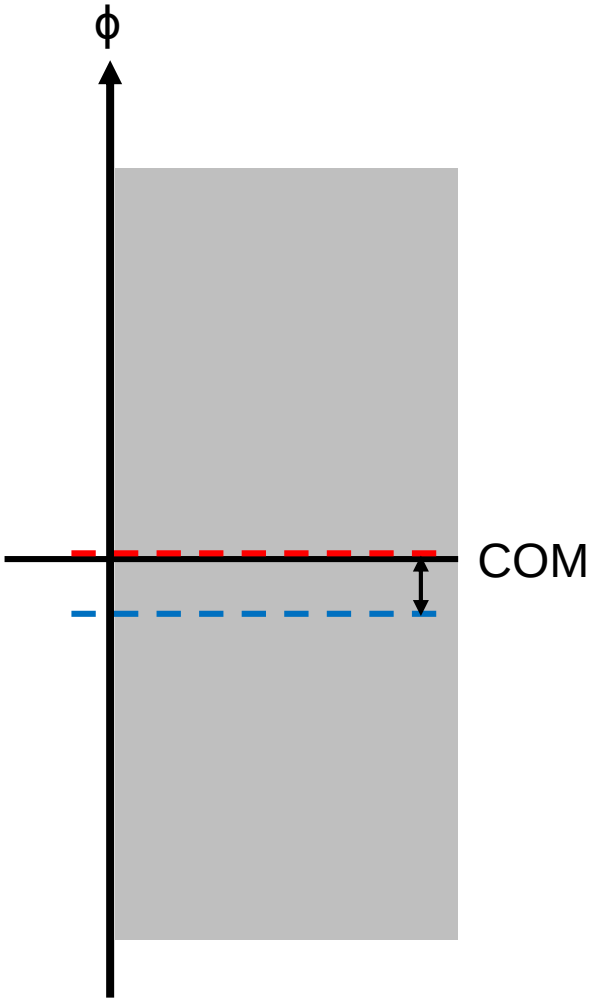


Recommendation:
In each independent circuit connect one point to the datalogger COM
→ Fixes voltage

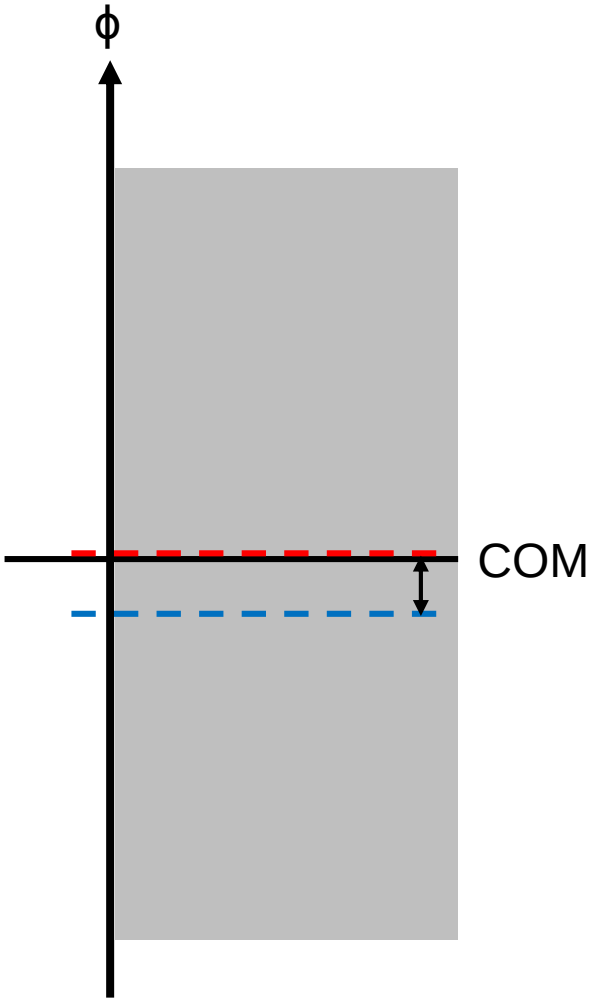
Voltage measurements

But be careful!

Only one point in each independent circuit may be connected

Otherwise you shortcircuit two points in a circuit via the COMMON → ground loop

DANGEROUS especially with batteries



Summary / Repetition

consider and decide on:

- integration / sample / storage
- SE or differential, number and location

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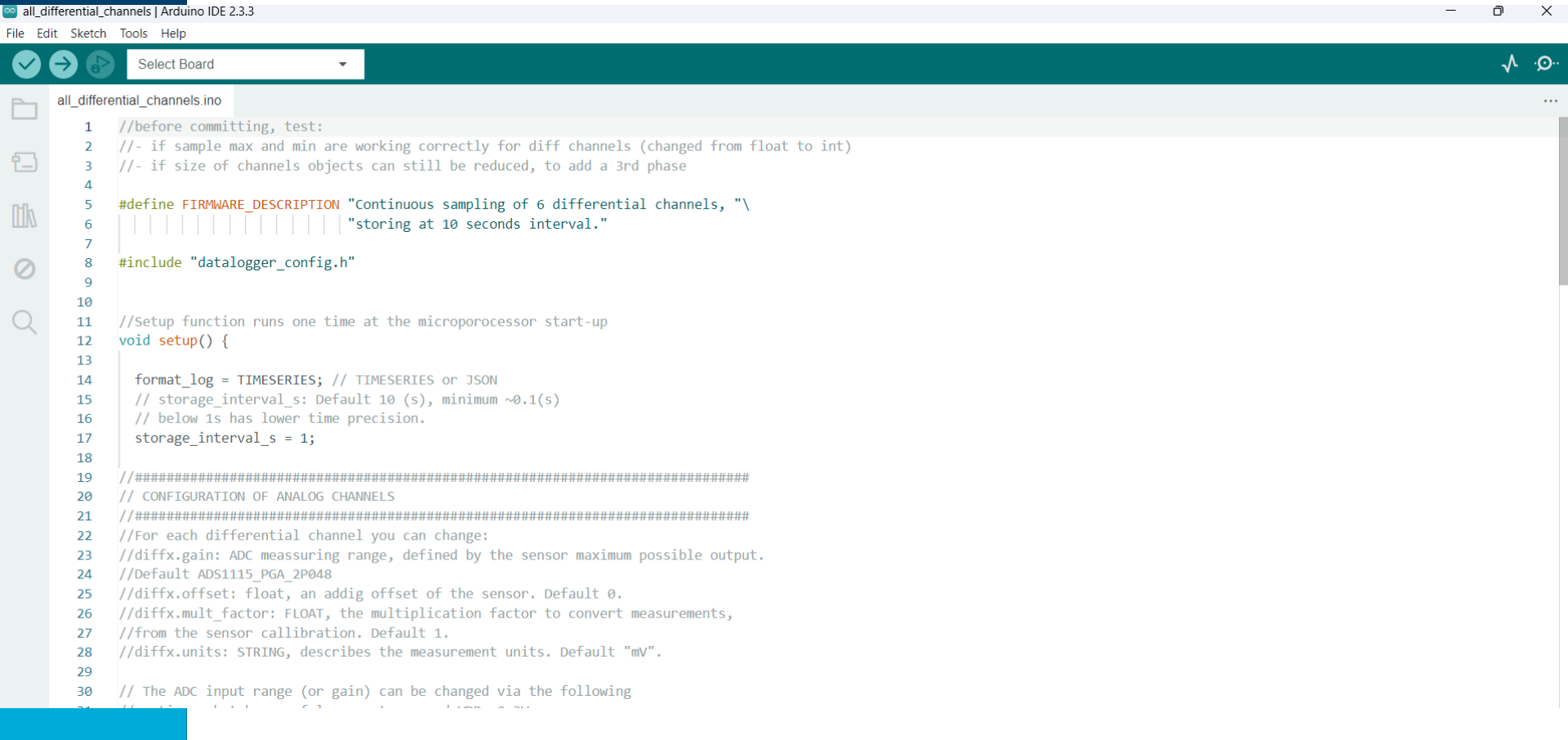
Summary / Repetition

consider and decide on:

- integration / sample / storage
- SE or differential



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Questions?