POLITECNICO DI MILANO

MEASUREMENTS

Asynchronous and synchronous sampling (order tracking)
Time-averaging

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Course website

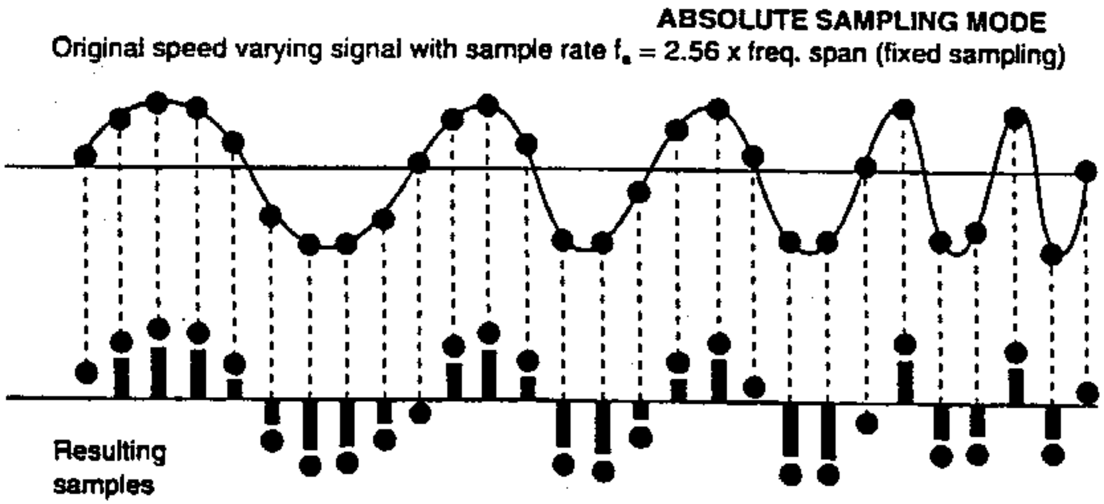
- Measurements on Beep

<u>Asynchronous sampling</u>: the samples are recorded at constant time intervals. If we call Δt the time elapsed between two subsequent samplings, the sampling frequency can be defined as $f_c = \frac{1}{\Delta t}$.

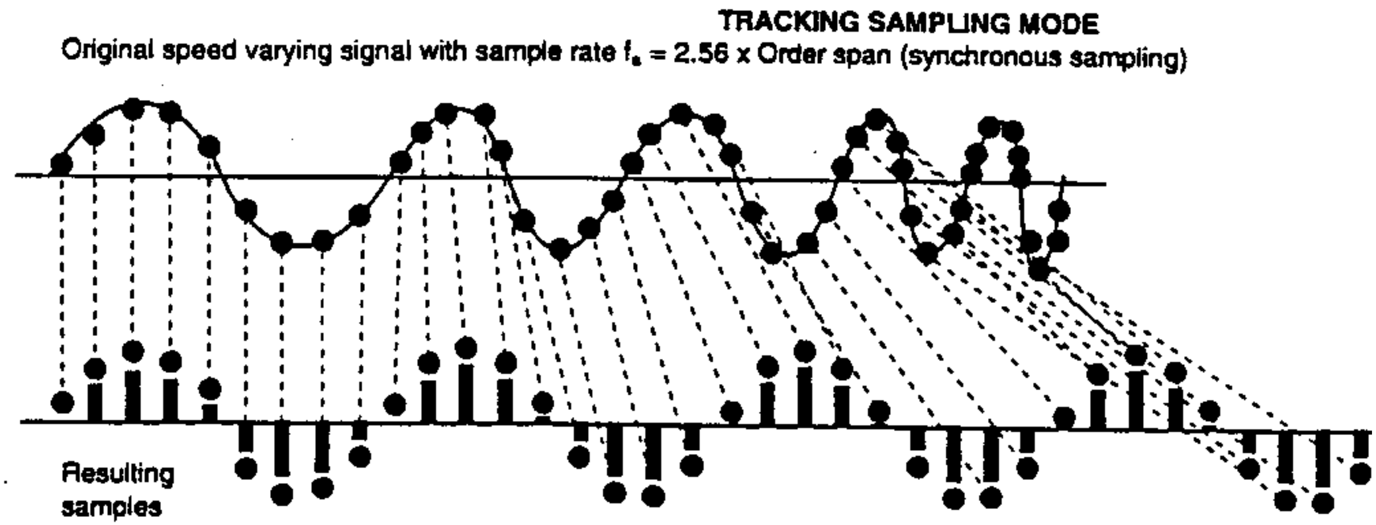
<u>Synchronous sampling (order tracking)</u>: the samples are acquired in a way that is synchronized with a given phenomenon. Generally speaking the synchronous sampling is useful when a periodic phenomenon strictly related to the signal to acquire exists.

Sampling strategies

Asynchronous Sampling



Synchronous Sampling – Order Tracking

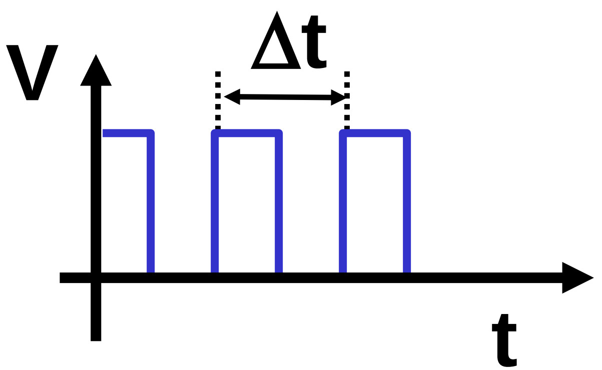


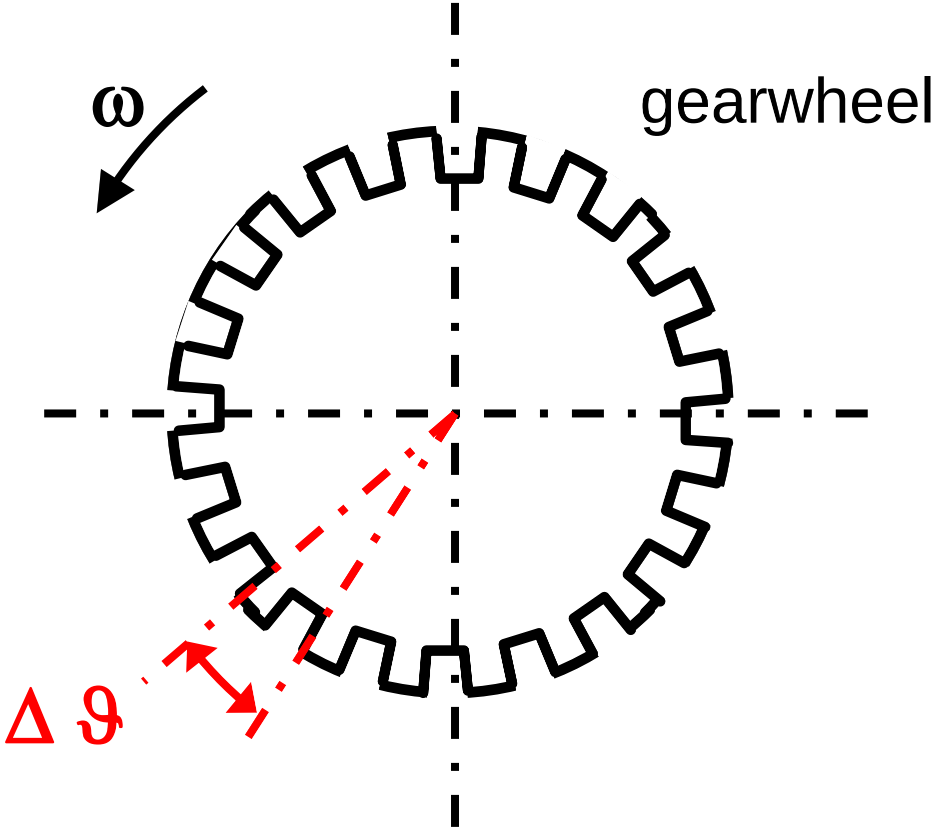
Synchronous Sampling

The time in which each sample of the signal is acquired is determined by the n impulses per revolution given by the encoder.

This results in an acquisition strategy at contstant angle interval $\Delta\vartheta$

In this way even if a change in the angular velocity appears, the number of samples acquired for each revolution remains the same.





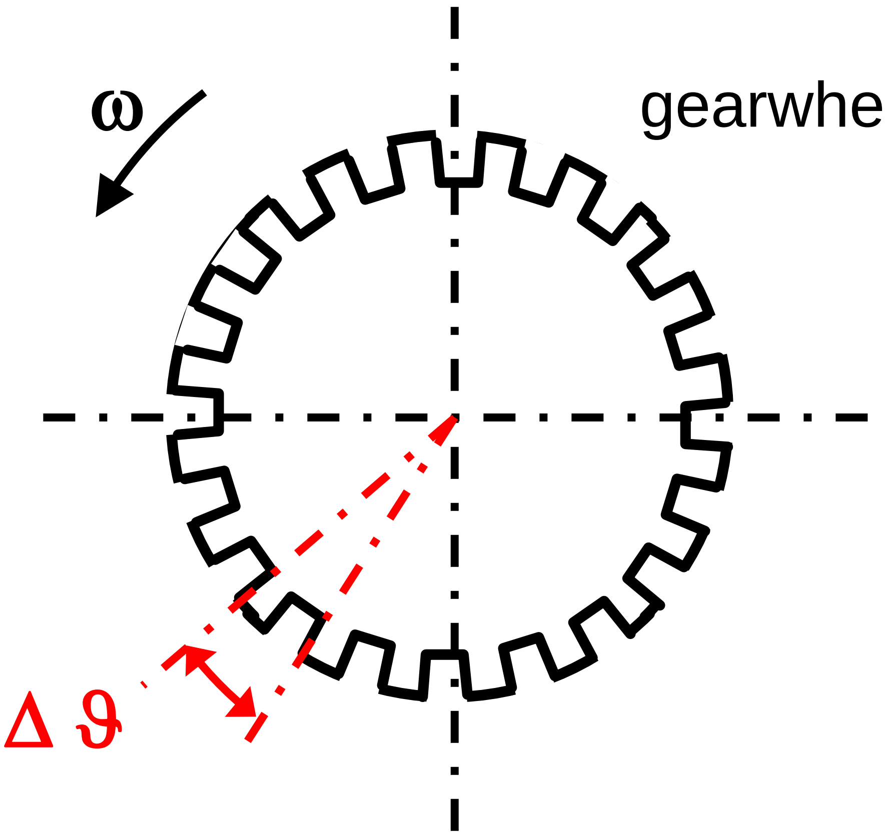
Synchronous Sampling

With this sampling strategy we are able to compensate possible variation of the angular velocity ω

Also with the Synchronous Sampling strategy we face some questions: how many points for each revoution should be recorded in order to sample the signal in a correct way? What should I pay attention at?

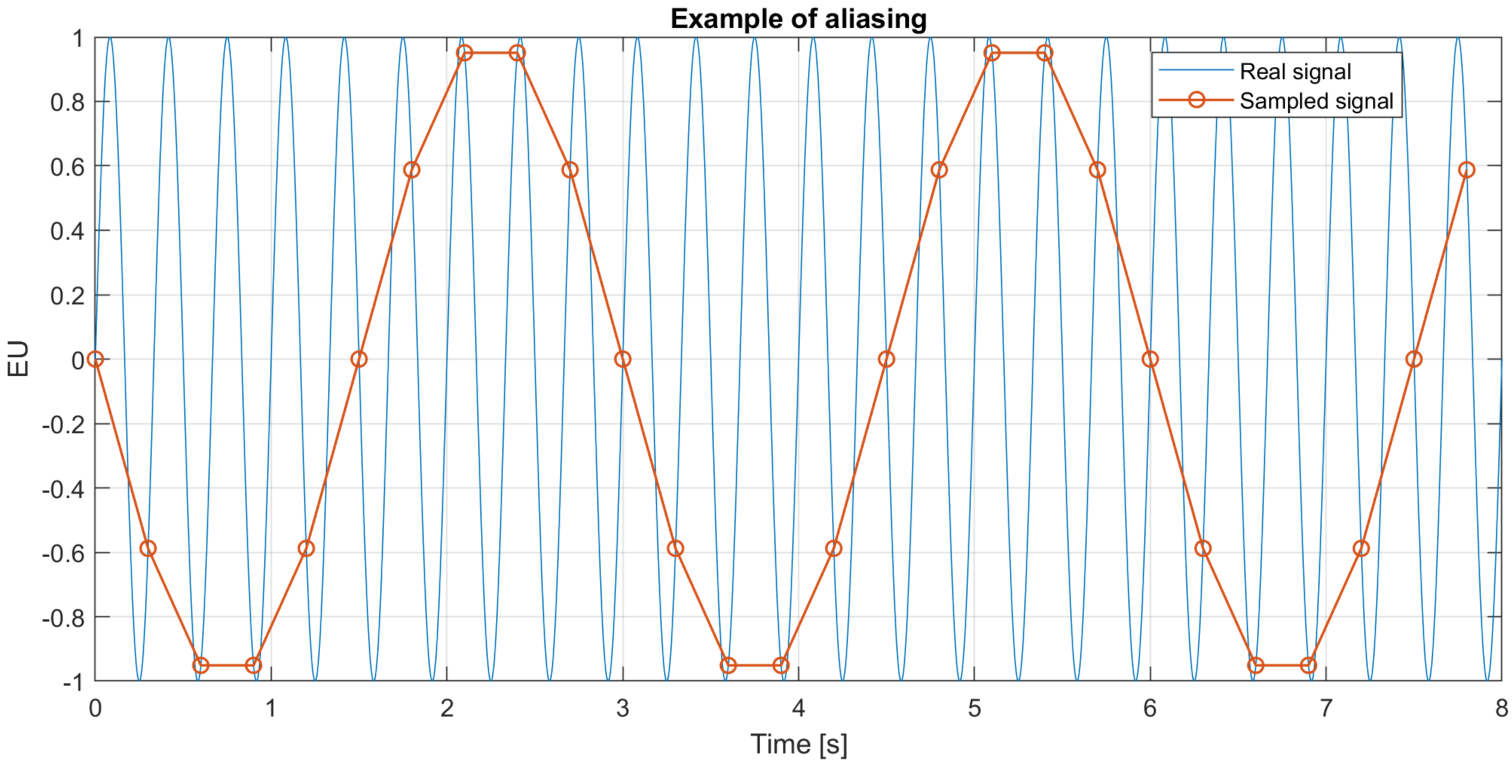
1. Aliasing
2. Leakage

For example…



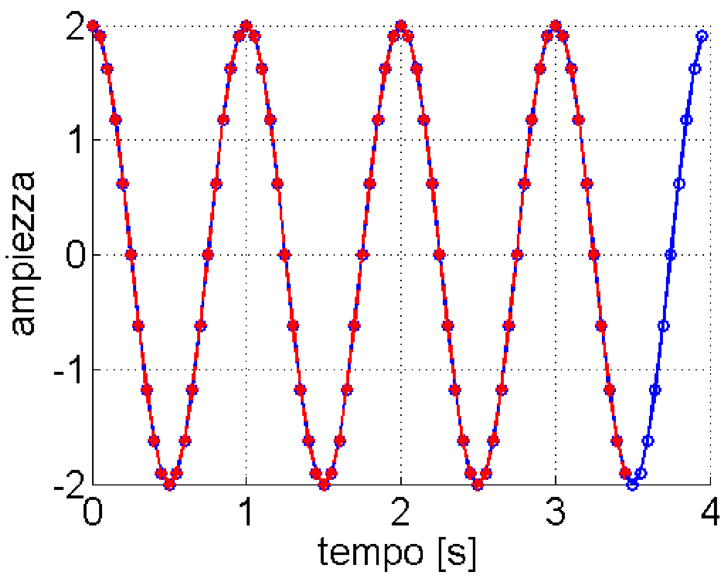
Aliasing

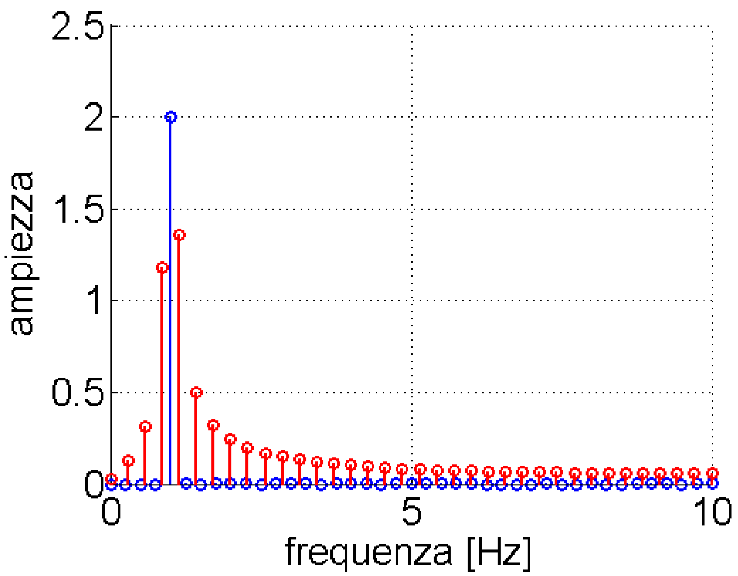
Aliasing: phenomenon that happens when the sampling frequency is lower than twice the highest frequency of the signal (Shannon frequency). The frequency of the signal cannot be detected correctly



Leakage

Leakage: phenomenon that happens when the acquisition time is not an multiple of the signal period.





Charachterization of the behaviour of a single-cylinder engine alternator

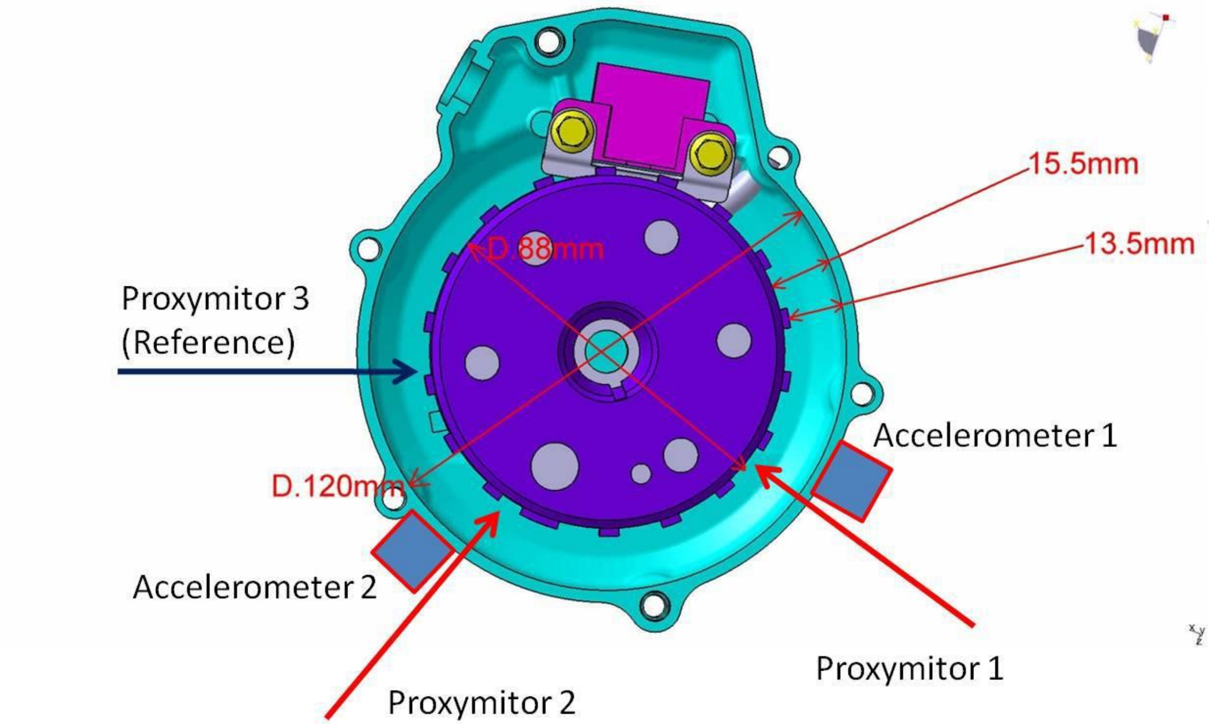
Problem

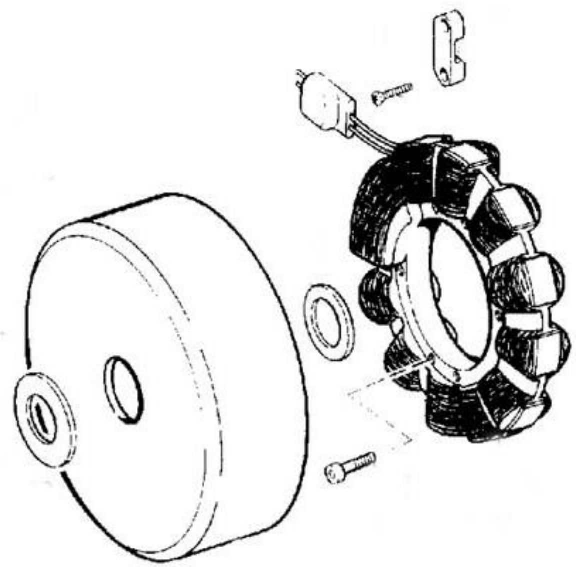
- Damaging of the rotor due to contact with the stator during bench and track tests
- Problem sharpened during the transient

Possible causes:

- Oscillation of the shaft (pitch) for some frequency bands
- Shift of the shaft centre of rotation position

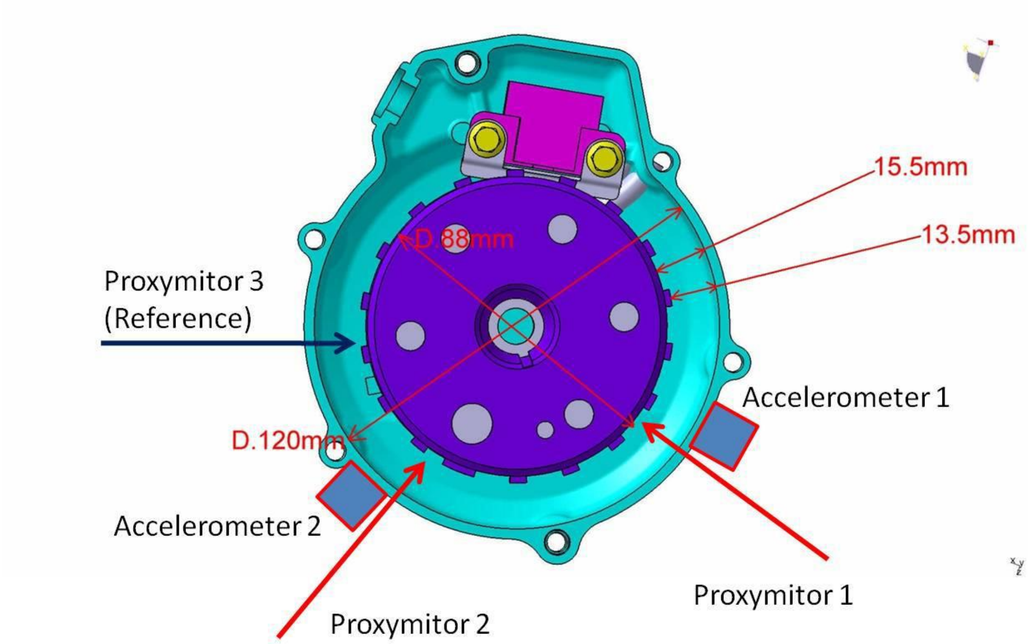
Test set-up





Sensor	Sensitivity	Range
Accelerometers PCB 356A02	10 mV/g	0-500 g
Proxymitor Bently Nevada 330900-50-00	8 V/mm	0-3 mm

Charachterization of the behaviour of a single-cylinder engine alternator



- The test was performed with increasing angular frequency
- Displacement signals were acquired both with synchronous and asynchronous sampling («*data_sync.mat*» and «*data_async.mat*»)
- We would like to <u>decrease the uncorrelated noise level</u> in the acquired signal. How can we do?

Laboratory 03:

1) Load the dataset that you think is the right one to solve the problem: data acquired with synchronous or asynchronous sampling?

2) Calibrate and plot the time histories of the signals.

3) Evaluate the average behaviour during the test (average position of the rotor inside the stator)

4) Apply the ‘time-averaging’ to reduce the uncorrelated noise. What happens?

Variables in *«data_sync.mat»*

- *n_teeth*: number of teeth
- *Note*: measurement unit of the sensitivity
- *proxi_sync*: displacement of the shaft (data acquired with synchronous sampling)
- *sens*: sensitivity

Variables in *«data_async.mat»*

- *fsamp*: sampling frequency
- *Note*: measurement unit of the sensitivity
- *proxi*: displacement of the shaft (data acquired with asynchronous sampling)
- *ref*: displacement in correspondence of the teeth
- *sens*: sensitivity