Encoder Renishaw Vionic - Test Bench

Dehaeze Thomas

February 2, 2021

Contents

Note

You can find below the document of:

- Vionic Encoder
- Linear Scale

We would like to characterize the encoder measurement system.

In particular, we would like to measure:

- Power Spectral Density of the measurement noise
- Bandwidth of the sensor
- Linearity of the sensor

Figure 0.1: Picture of the Vionic Encoder

1 Encoder Model

The Encoder is characterized by its dynamics $G_m(s)$ from the “true” displacement y to measured displacement y_m. Ideally, this dynamics is constant over a wide frequency band with very small phase drop.

It is also characterized by its measurement noise n that can be described by its Power Spectral Density (PSD).

The model of the encoder is shown in Figure 1.1.

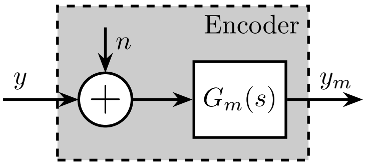

Figure 1.1: Model of the Encoder

We can also use a transfer function $G_n(s)$ to shape a noise $\tilde{n}$ with unity ASD as shown in Figure 1.2.

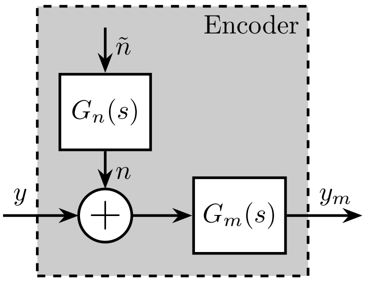

Table 1.1: Characteristics of the Vionic Encoder

Characteristics	**Manual**	**Specifications**
Range	Ruler length	$>$ 200 [um]
Resolution	2.5 [nm]	$<$ 50 [nm rms]
Sub-Divisional Error	$< \pm 15\, nm$	
Bandwidth	To be checked	$>$ 5 [kHz]

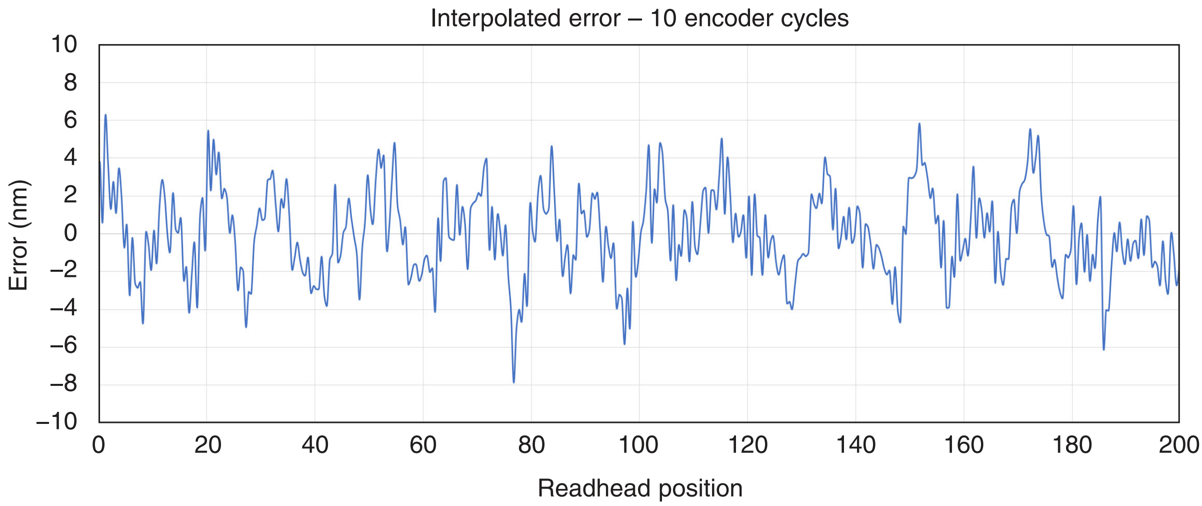

Figure 1.2: Expected interpolation errors for the Vionic Encoder

2 Noise Measurement

2.1 Test Bench

To measure the noise n of the encoder, one can rigidly fix the head and the ruler together such that no motion should be measured. Then, the measured signal y_m corresponds to the noise n.

2.2 Results

First we load the data.

Matlab
```
load('noise_meas_100s_20kHz.mat', 't', 'x');
x = x - mean(x);
```

The time domain data are shown in Figure 2.1. The amplitude spectral density is computed and shown in Figure 2.2.

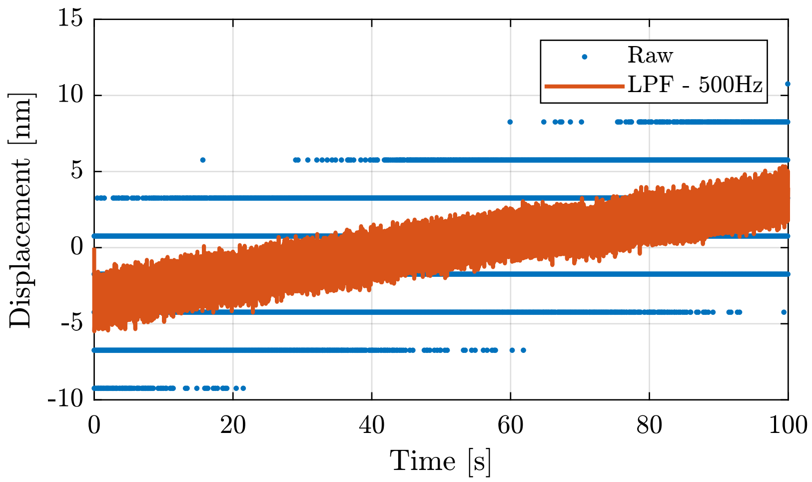

Figure 2.1: Time domain measurement (raw data and low pass filtered data)

Let's create a transfer function that approximate the measured noise of the encoder.

Matlab
```
Gn_e = 1.8e-11/(1 + s/2/pi/5e3);
```

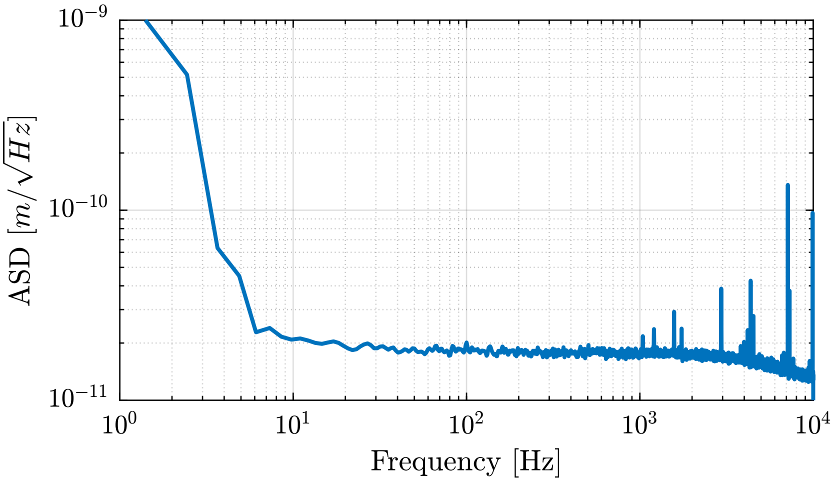

Figure 2.2: Amplitude Spectral Density of the measured signal

The amplitude of the transfer function and the measured ASD are shown in Figure 2.3.

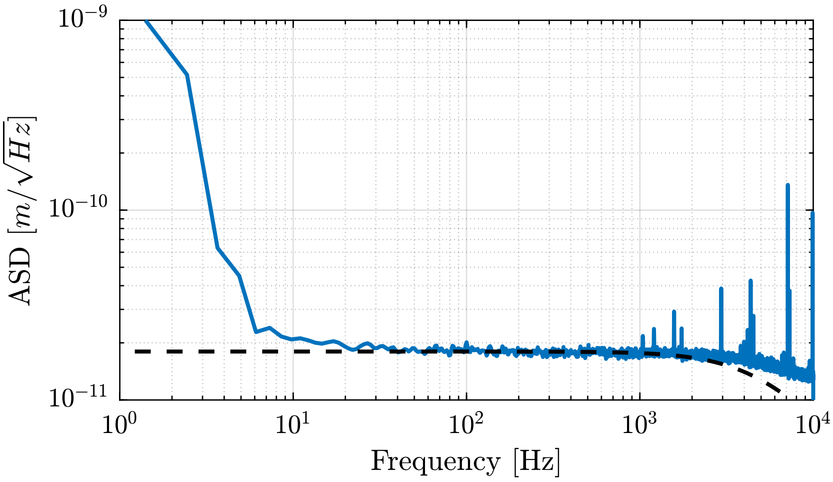

Figure 2.3: Measured ASD of the noise and modelled one

3 Linearity Measurement

3.1 Test Bench

In order to measure the linearity, we have to compare the measured displacement with a reference sensor with a known linearity. An interferometer or capacitive sensor should work fine. An actuator should also be there so impose a displacement.

One idea is to use the test-bench shown in Figure 3.1.

The APA300ML is used to excite the mass in a broad bandwidth. The motion is measured at the same time by the Vionic Encoder and by an interferometer (most likely an Attocube).

As the interferometer has a very large bandwidth, we should be able to estimate the bandwidth of the encoder if it is less than the Nyquist frequency that can be around 10kHz.

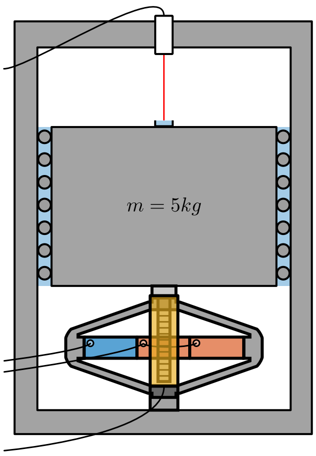

Figure 3.1: Schematic of the test bench

3.2 Results

4 Dynamical Measurement

4.1 Test Bench

4.2 Results