

Data Sheet of Testing Field Measurements

Two parted experimental structure for studies on the effects of environmental and operational conditions (EOC) affect vibration-based output-only SHM

File Management

The two folded nature of the experimental testing field results in two main datasets. The datasets are recorded from the laboratory setup, and from the field setup. While the laboratory setup provides measurements under constant conditions, the field setup is under the influence of changing excitation and conditions. Similar and comparable mass perturbation studies were conducted for both structures.

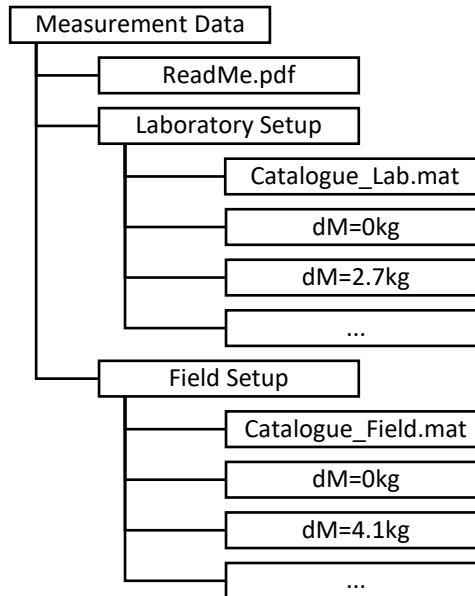


Figure 1: File Organization Structure.

All data is saved in hierarchical data format (HDF5) and chronological sorted in a folder structure. The File is named by ‘YYYY-MM-DD_Messung_dM_hhmm.h5’ for laboratory measurements and ‘YYYY-MM-DD_Live_Monitoring_hhmm.h5’ for measurements from the field setup.

Structure of Data

Each file contains the Group ‘/’, with the dataset ‘RecBuff’. This contains the Attributes of the measurement and the data, consisting of timestamp, the acceleration measurement data, and the control values *BitStates* stored.

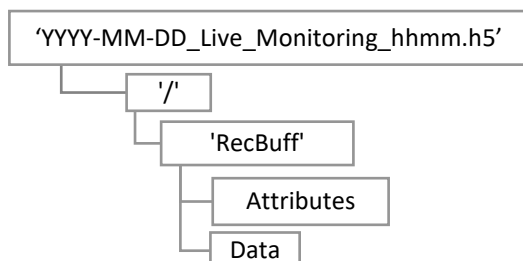


Figure 2: Data organization in file structure.

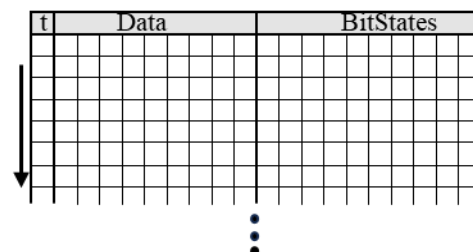


Figure 3: Organization of Dataset.

Timestamp

The timestamp is stored in the first column of the data and in microseconds $[\mu\text{s}]$. The sample frequency of the measurements is 10 kHz (one sample was recorded for every 100 μs).

Data

The presented acceleration data is in [m/s²], all quantification factors and sensitivities are already factored in. The channels are sorted by columns, the first channel (Ch1) is in the second column (after the timestamp) and the last channel (Ch24) is stored in column 25 (see Figure 3). The used EtherCAT Terminal (ELM3602 by Beckhoff) are equipped with an inbuild low-pass filter, to prevent aliasing, and an parameterizable FIR high-pass filter, to filter the influences of IEPE Bias Currents (AcCoupling). The combined transfer function is shown in Figure 4

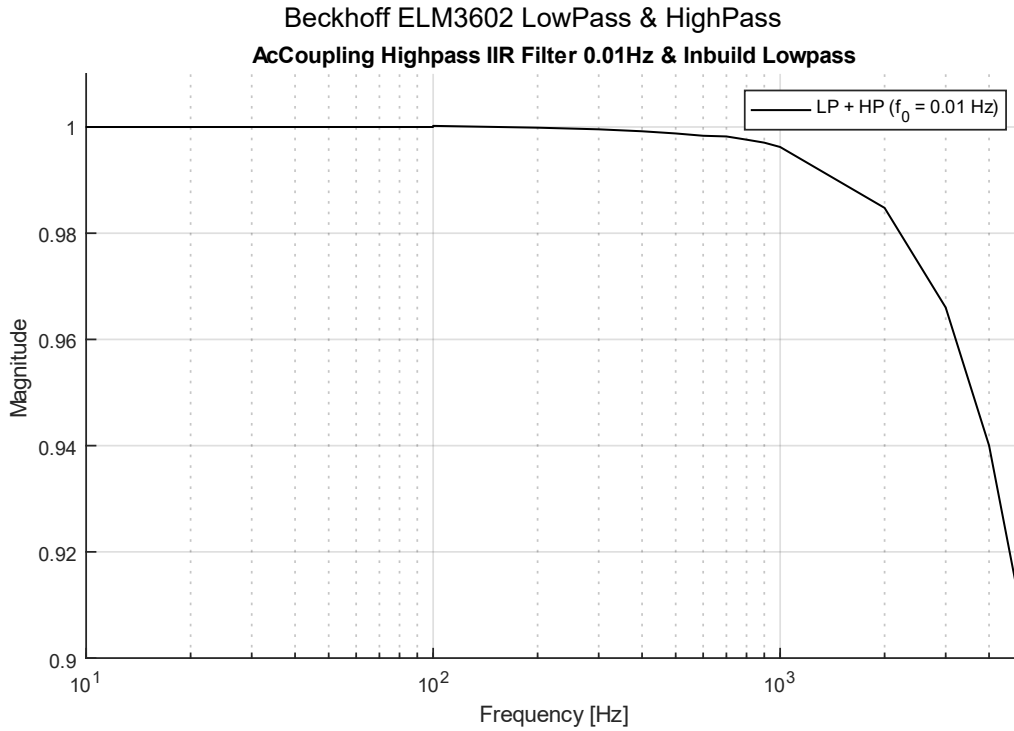


Figure 4: Transfer function of the ELM3602 Terminal.

For the field setup the meteorological data is also stored in additional channels. The channel numbers and the associated meteorological data is shown in Table 1.

Table 1: Meteorological Channels

Channel	Value	Unit
25	Surface Temperature*	° Celsius
26	Wind direction**	° Degree (Angle)
27	Wind speed	m/s
28	Rel. Air Humidity	%
29	Rain (Precipitations)	True (=1) or False (=0)

***Sensor is attached on the eastern side, 20 cm above ground.**

****Note to Wind direction: Magnetic north is at 190 °!**

BitStates

The BitStates store information for every sample of every channel recorded. The format is in 8Bit, where the first four bits contain information about possible errors of the measurement system at that moment the sample has been recorded, and the last four bits state the quantification range of the channel. All measurements provided are free of any errors, and the quantification range is already calculated into the acceleration data. Therefore, this information is about channel sensitivity and for further analysis of the influence of quantification noise.

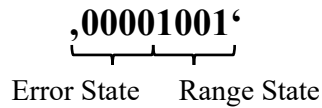
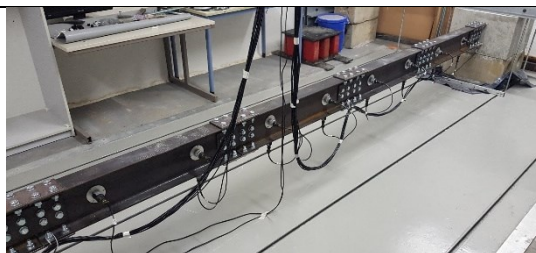


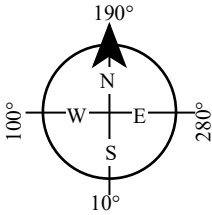

Table 2: BitStates Values

BitState	Error
10000001	Range Error
01000001	Channel Error
00100001	Communication Error
00010001	Invalid CoE channel configuration + Jitter
BitState	Quantification Range
00000000	Invalid
00000001	10 V
00000010	5 V
00000011	2.5 V
00000100	1.25 V
00000101	0.64 V
00000110	0.32 V
00000111	0.16 V
00001000	0.08 V
00001001	0.04 V
00001010	0.02 V

Dataset 1: Laboratory Setup (IPE200, ~6 m)

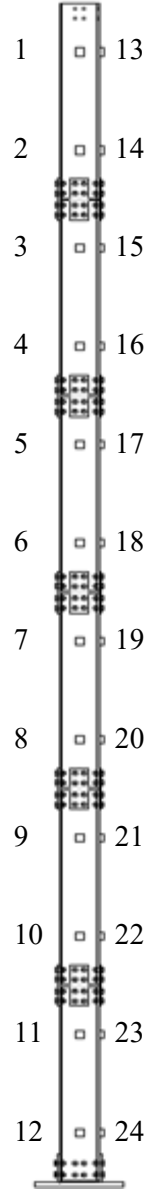


Channels		Weak Axis																							
		12	11	10	9	8	7	6	5	4	3	2	1	Strong Axis											
		24	23	22	21	20	19	18	17	16	15	14	13												
Location:		Laboratory for Structural Dynamics of the Institute for Statics, Structural Dynamics, System Identification, and Simulation (I4S) at the University of Applied Sciences Leipzig																							
Excitation:		Wind machines																							
Acceleration Sensors:		PCB393A03																							
Number of Measurements:		324						Size of Dataset:			340 GB														
Time period:		17. Apr. – 10. June 2023						Duration per Measurement			600 s														
Sample Frequency:		10 kHz						Channels:			24														
Ensembles:		14 Mass Perturbations						1 Reference																	
Position of Mass	ΔM [kg]	Number of Meas.						Time period																	
1 – 2	2,62	15						14. May 2023																	
	4,24	15						17. Apr. 2023																	
	7,14	15						18. Apr. 2023																	
	5,68	15						19. Apr. 2023																	
	8,75	15						19. Apr. 2023																	
	11,32	15						21. Apr. 2023																	
	19,92	15						12. May 2023																	
5 – 6	2,62	15						15. May – 16. May 2023																	
	4,21	15						06. May – 07. May 2023																	
	7,14	15						04. May – 05. May 2023																	
	5,68	15						05. May – 06. May 2023																	
	8,75	15						25. Apr. 2023																	
	11,32	15						07. May – 08. May 2023																	
	19,92	15						10. May – 11. May 2023																	
Reference Measurement	0	18						12. May – 13. May 2023																	

Dataset 2: Field Setup (IPE200, ~6 m)			
			
Location:		Roof of Nieper-Building at the University of Applied Sciences Leipzig	
Excitation:		Ambient Excitation	
Acceleration Sensors:		PCB393A03	
Number of Meas.:		3728	
Size of Dataset:		~ 4,4 TB	
Time period:		05. Apr. – 21. Sep. 2023	
Duration per Meas.:		600 s	
Sample Frequency:		10 kHz	
Channels:		24 Acceleration + 5 Meteorological	
Ensembles:		6 Mass Perturbation	1 Reference
Position of Mass	ΔM [kg]	Number of Meas.	Time period
5 – 6	13,4	577	05. Apr. – 01. May 2023
5 – 6	8,0	766	02. May – 30. May 2023
5 – 6	4,2	236	30. May – 13. June 2023
1 – 2	8,1	1027	12. July – 10. Aug. 2023
1 – 2	12,4	208	12. Aug. – 14. Sep. 2023
1 – 2	4,4	214	15. Sep. – 21. Sep. 2023
Reference Measurement	0	700	13. June – 12. July 2023

Weak Axis

Channels



Strong Axis