

Motor Cogging Analysis — Legacy Data

This folder contains analysis results for cogging torque and voltage oscillations from the **085_2U** and **Syntec** motors.

All data were parsed and analyzed by **Phill Phillipou (2025)** using the `cogging.py` script. Angular position was derived using the **arctangent method** applied to sine and cosine encoder signals - the graphs were generated by **Tasin Sayed (2025)** through a modified version of the `cogging.py`.

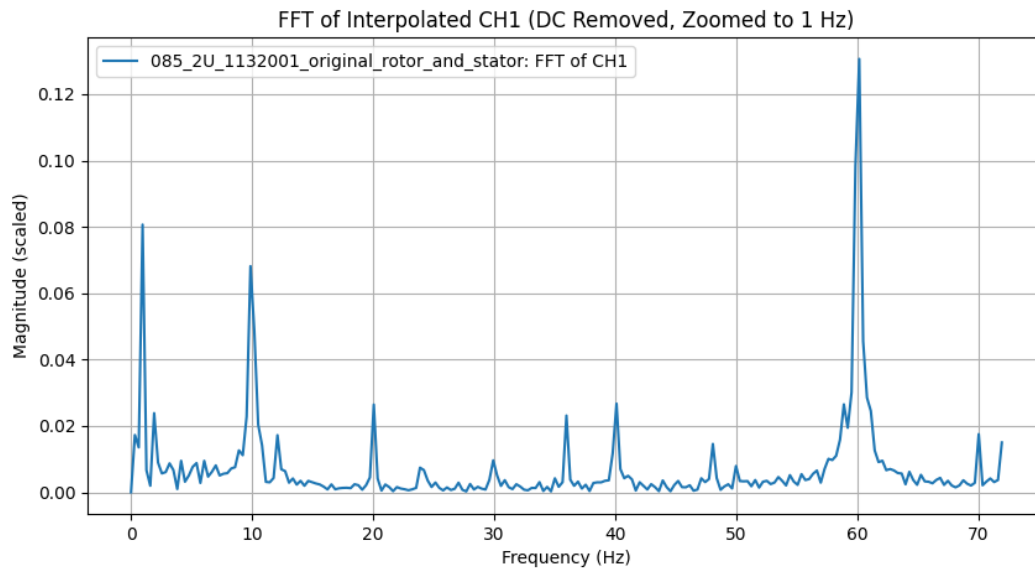
File Overview

The nomenclature of the file names indicate which motor and what data is being looked at. It is the prefix which defines the motor, and suffix which defines the type of plot.

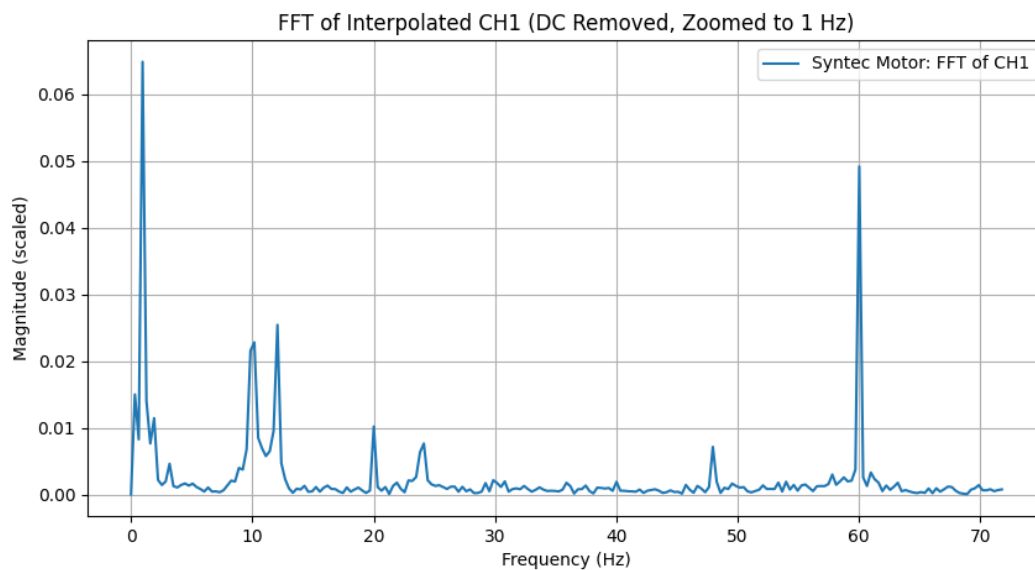
- `*_oscillation_plot` — Voltage signal oscillations versus angular position (degrees).
 - `*_oscillation_plot_polar` — Same data displayed in polar form, corresponding to the motor's rotational plane.
 - `*_spatial_FFT` — Frequency-domain analysis of spatial oscillations, highlighting harmonic content.
 - `Overlay_*` — Overlays comparing the **Syntec** and **085_2U** motor data for direct visual comparison.
 - **Excel files (.xlsx)** — Contain the raw and processed measurement data used for plotting.
 - `cogging.py` — Python script used to parse and analyze data.
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Frequency Domain (FFT) Analysis

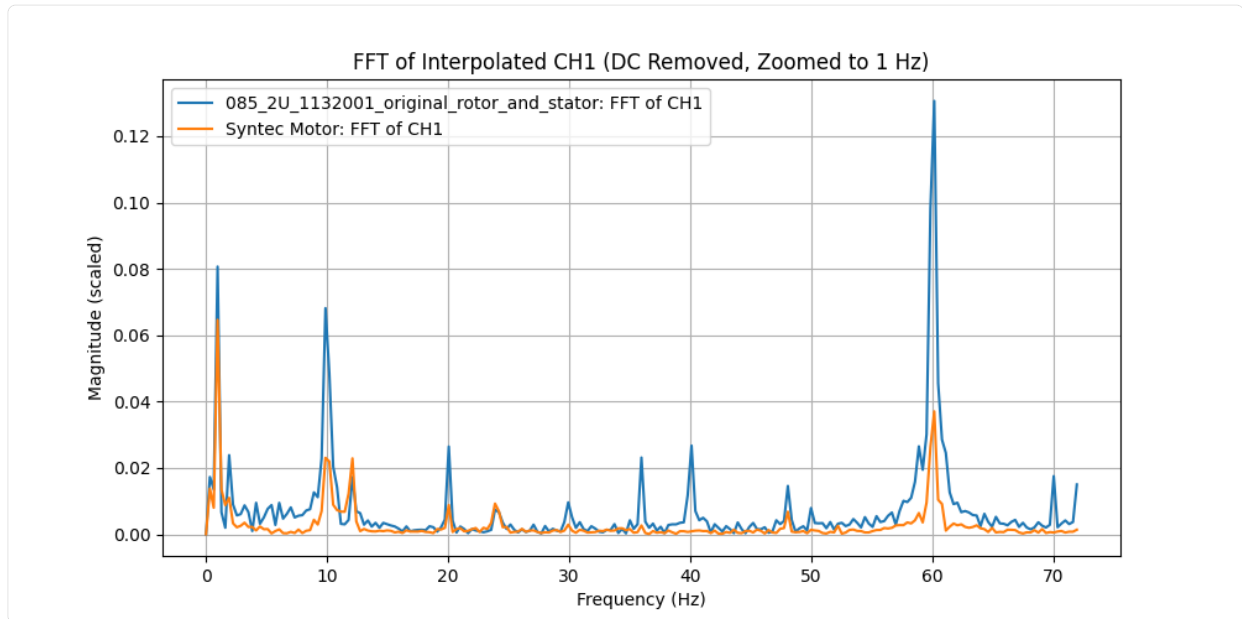
085_2U Motor — FFT



Syntec Motor — FFT



Overlay of FFTs (Comparison)



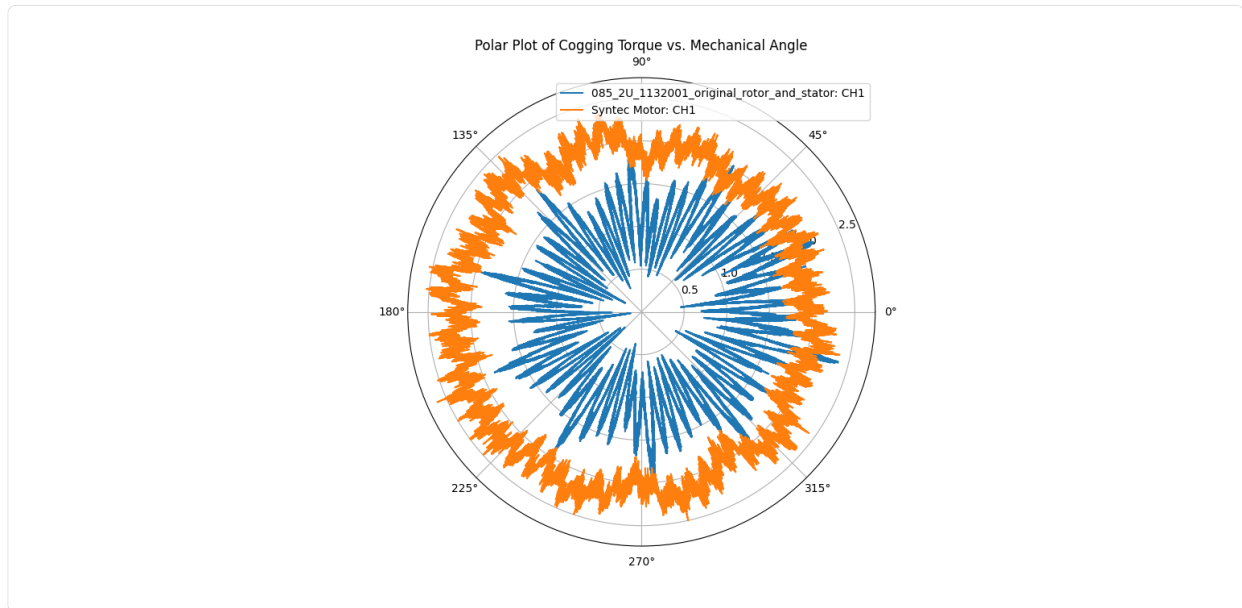
Frequency Observations

Both motors exhibit characteristic peaks in the frequency domain corresponding to cogging-related harmonics.

- **~60 Hz** — This dominant component is consistent across both motors and corresponds to one electrical revolution of a **10-pole (5 pole-pair)** or **12-pole (6 pole-pair)** configuration under a consistent rotational speed.

- **Low-frequency peaks (below 10 Hz)** — These are linked to slower oscillations and mechanical imperfections such as bearing or alignment variations. However the precise cause of these are not necessarily known, and may even arise from very low frequency rig oscillations.
- **Harmonic peaks (10–30 Hz)** — Represent periodic torque ripple and spatial harmonics induced by slotting effects and non-ideal magnet distribution.
- The **Syntec** motor displays relatively **lower harmonic magnitudes** in comparison, suggesting smoother torque and reduced cogging compared to the **085_2U** motor. To verify this, a larger dataset should be collected.

Polar Comparison of Cogging Torque



The polar plot illustrates cogging torque as a function of mechanical angle. The **085_2U** motor shows more pronounced asymmetry and higher amplitude ripple compared to the **Syntec**, indicating higher cogging torque variation. The higher relative magnitudes in the lower frequency end also suggests this, however the FFT is performed over a single cycle, with sub-sampling rate corresponding to the sampling rate of the oscilloscope itself (hence, NOT sub-sampled at a lower frequency to remove any high frequency noise/ mechanical effects).

However given how relatively 'clean' the FFT is, the data is considered sufficiently reliable for a simple comparison.

Summary

This dataset and accompanying visualizations provide a comparative study of cogging and torque ripple characteristics between the **085_2U** and **Syntec** motors.

The combined FFT and polar analyses highlight the harmonic content and angular distribution of voltage oscillations associated with cogging torque.
