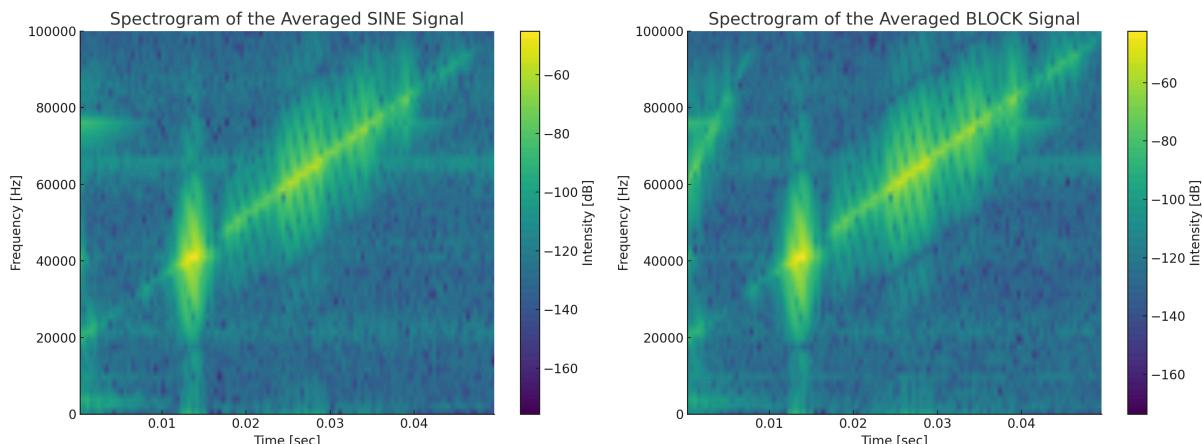


Comparing Sine sweep versus Block Wave

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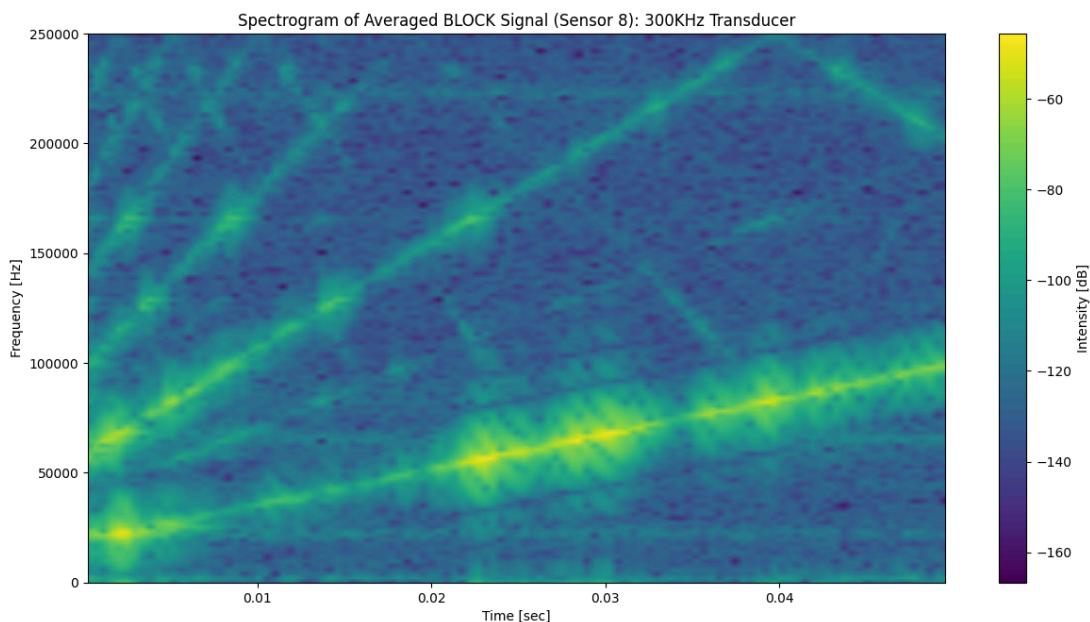
To compare the sine versus block wave, it would be easier to see what effect each have on certain features. However, at the time of writing there are no features yet selected. To do a simple analysis however, I have performed a few simple analyses.

When starting by analyzing some of the air measurements, you can see that throughout the sweep the intensity remains fairly constant



The major difference between both responses is the visibility of the higher harmonics (odd) in the BLOCK signal. A line leaving from 60000kHz moving up is visible.

However, when we move to measurements on the plants, these seem to appear as well:



in both the sine and block response these components are visible.

The transferred power of a blockwave versus a sinewave is about a factor 1.25 bigger. This is not very much, but regarding the possible low amount of higher harmonics, this should be in line. Overall power of the block is thus higher.

ChatGPT:

Let's consider if the power difference is logical:

Harmonic Content:

A block wave contains a fundamental frequency and its odd harmonics, meaning that it spreads its power across multiple frequencies. This inherently increases the total power compared to a sine wave, which only has power at one frequency.

Theoretically, the power of a block wave compared to a sine wave with the same peak amplitude can be significantly higher due to the additional energy in the harmonics.

Power Ratio:

If we compare the total power, the BLOCK signal has about 1.25 times the power of the SINE signal ($5.88 \times 10^{-6} / 4.69 \times 10^{-6} \approx 1.25$).

This ratio is relatively modest, which makes sense if the sine wave was of a similar amplitude and the block wave didn't have very high harmonics.

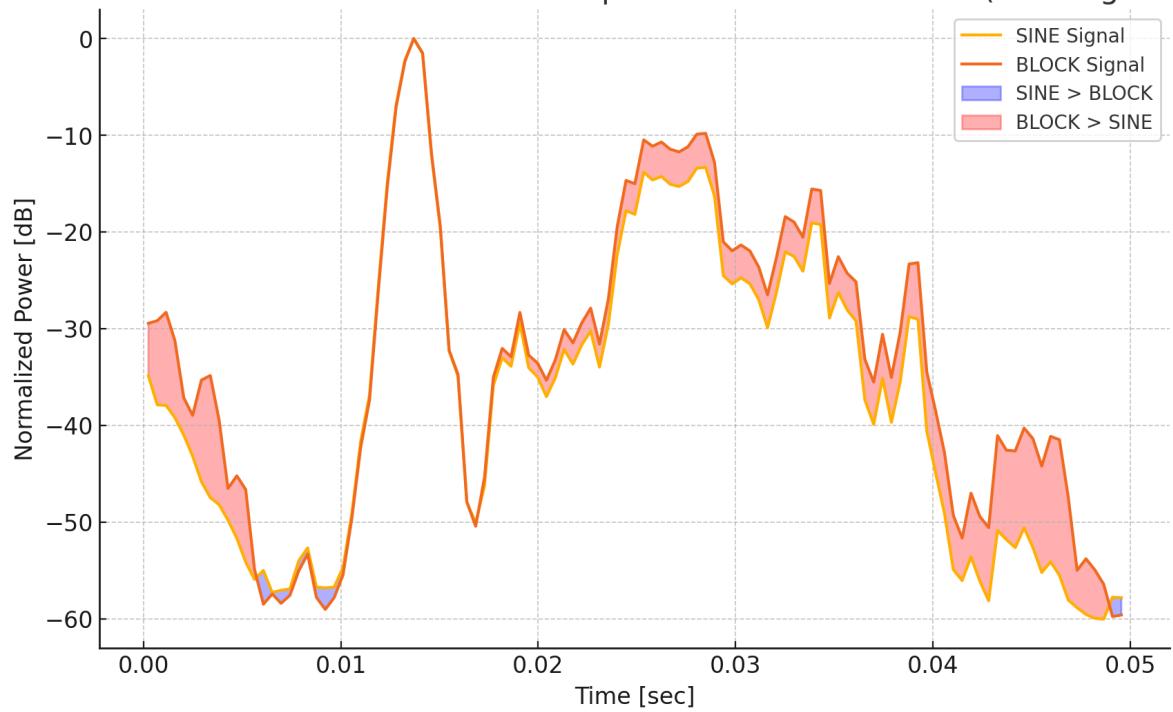
Factors Affecting Power:

The actual power difference would depend on the amplitude of the signals, the bandwidth of the analysis, and the presence of higher harmonics. If the harmonics of the BLOCK signal are within the measured frequency range, they contribute to the total power.

I can also compare the signal power over time directly:

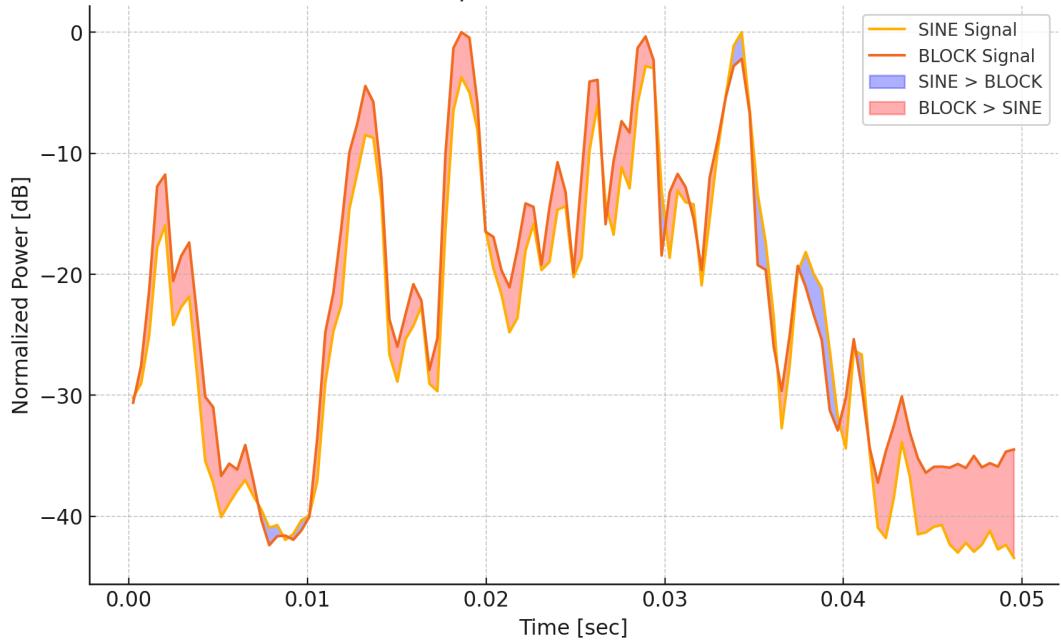
First AIR measurements:

Normalized Power Over Time Comparison - SINE vs BLOCK (New Signals)



And then a measurement on plant

Normalized Power Over Time Comparison - SINE vs BLOCK (New IRRIGATION Signals)



Overall in a first glance, the differences are not very noticeable, but this is also because the features to be extracted are not known. Overall the block wave

transmits more power it seems, which might be an argument for the sine wave, but a block wave is built from much simpler circuitry.

Evaluation on a 300KHz transducer

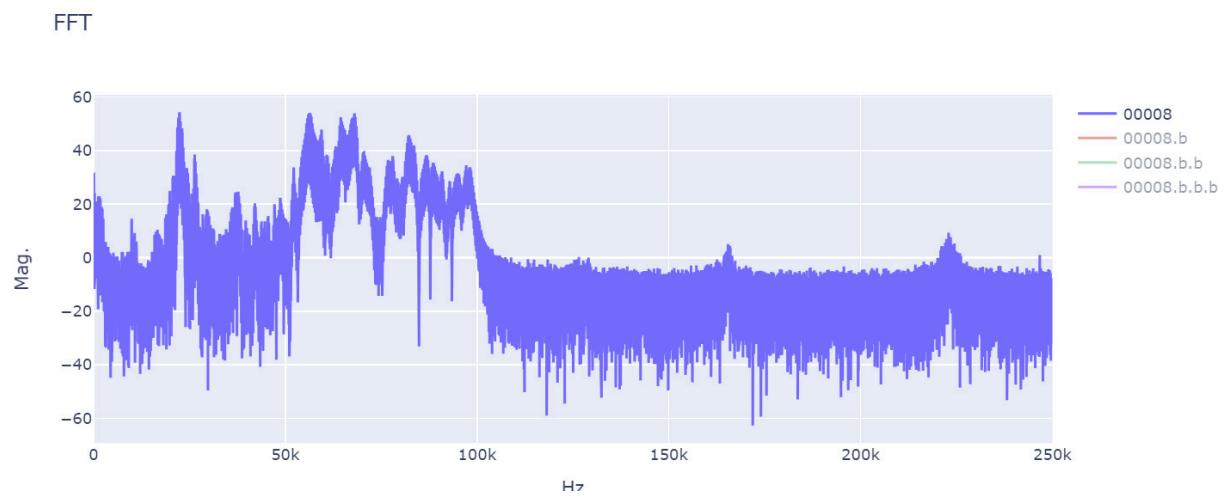
Since our current 40KHz transducer is in resonance during our sweep. An experiment is performed, where the 40K Transucer is replaced with a transducer with a 300KHz resonance peak. This transducer has a much more flat response within our sweep band and this might be valuable for actually measuring the plant response variations. The primary goal of this experiment is to get a more flat input of our sensingsystem.

The potential of the 300KHz is important to evaluate, as there are still ideas to move towards a direct-contact-solution, where a 300KHz might be more optimal in terms of power.

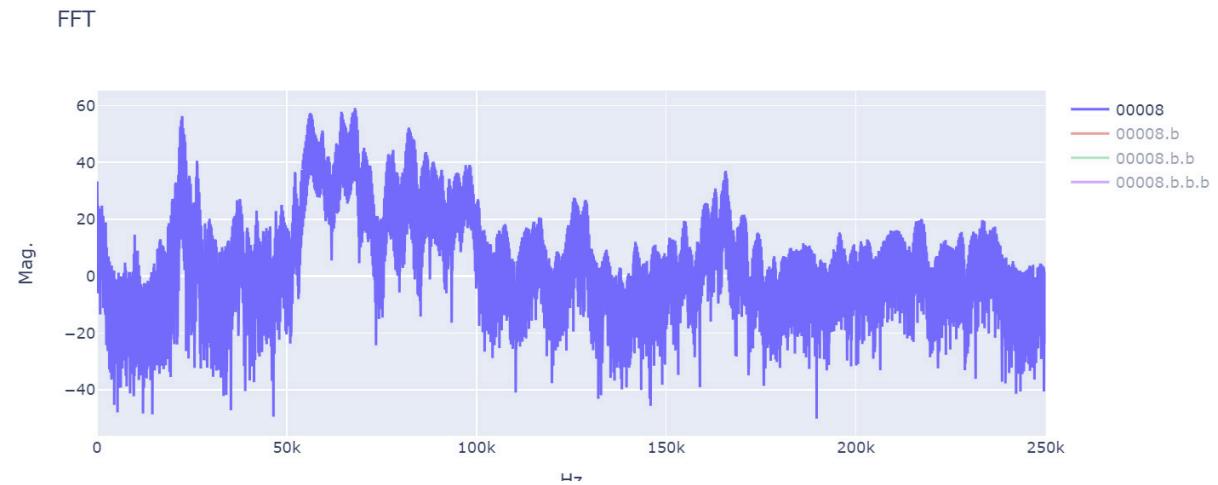
Flat response

The flat response is nice in terms that it produces more information regarding the plant, and less from the sensors characteristics. The power is then more equally spread across the spectrum.

When on the 300KHz a sine wave is propagated, through a chrysanthemum, the power spectrum shows the following when sweeped across from 20-100KHz:

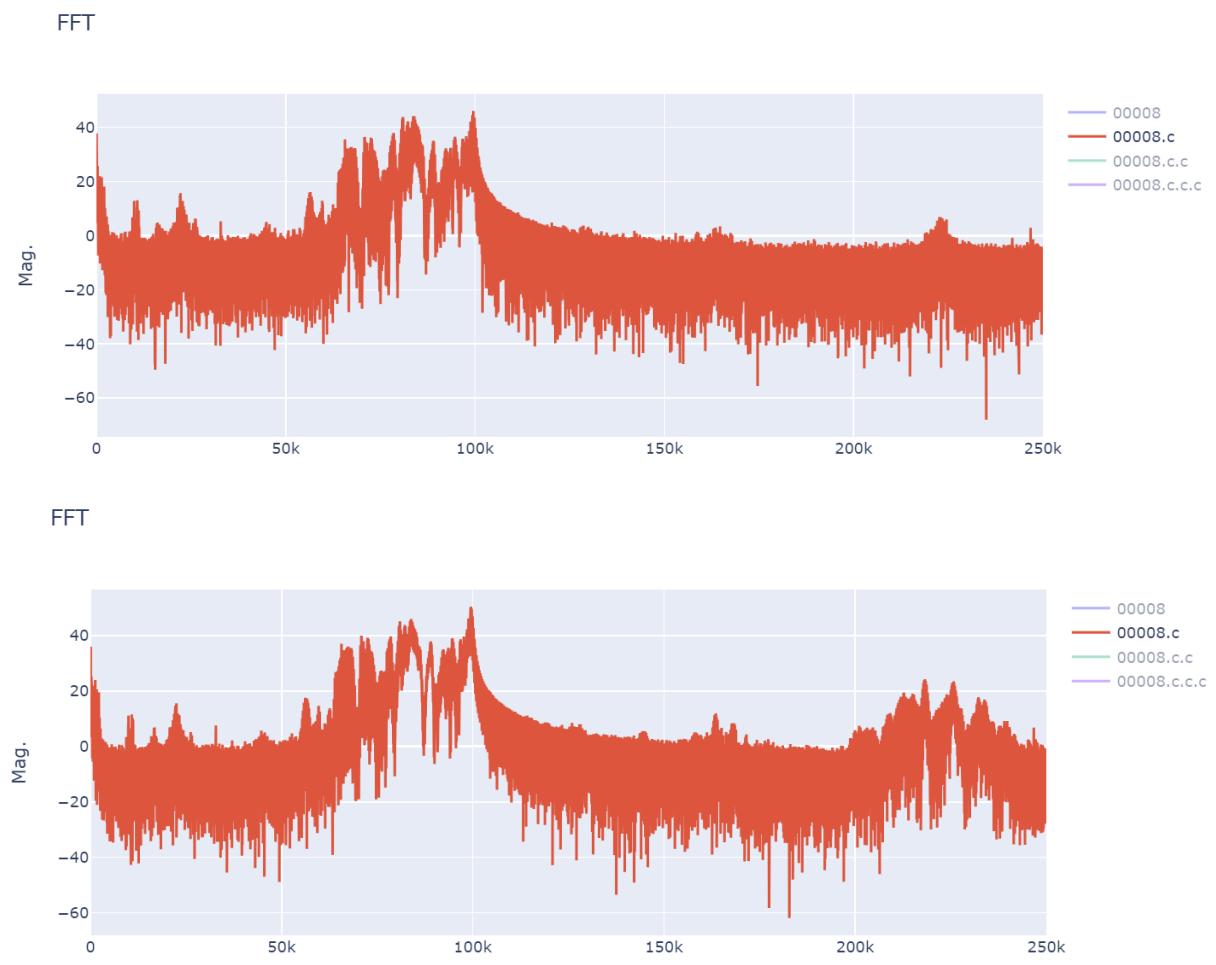


Comparing this with the BLOCK(square wave) input:



In here the higher order components are clearly visible.

For a sweep from 70K to 100k, this gives the following:



In here the higher order components are already a lot less visible. Since the higher orders only start from 210KHz (3*70K)

Transducer effects

As opposed to the current working 40K setup, the gain of a 300Khz transducer increases as the input frequency nears its resonance of 300KHz. These are frequency which are currently present in the square wave signal.

Higher frequencies will hardly be transduced by our current setup, while they are well transduced in the 300K setup.

Below the spectrogram of both sine and square wave sweeps of 20-100K and 70-100K

