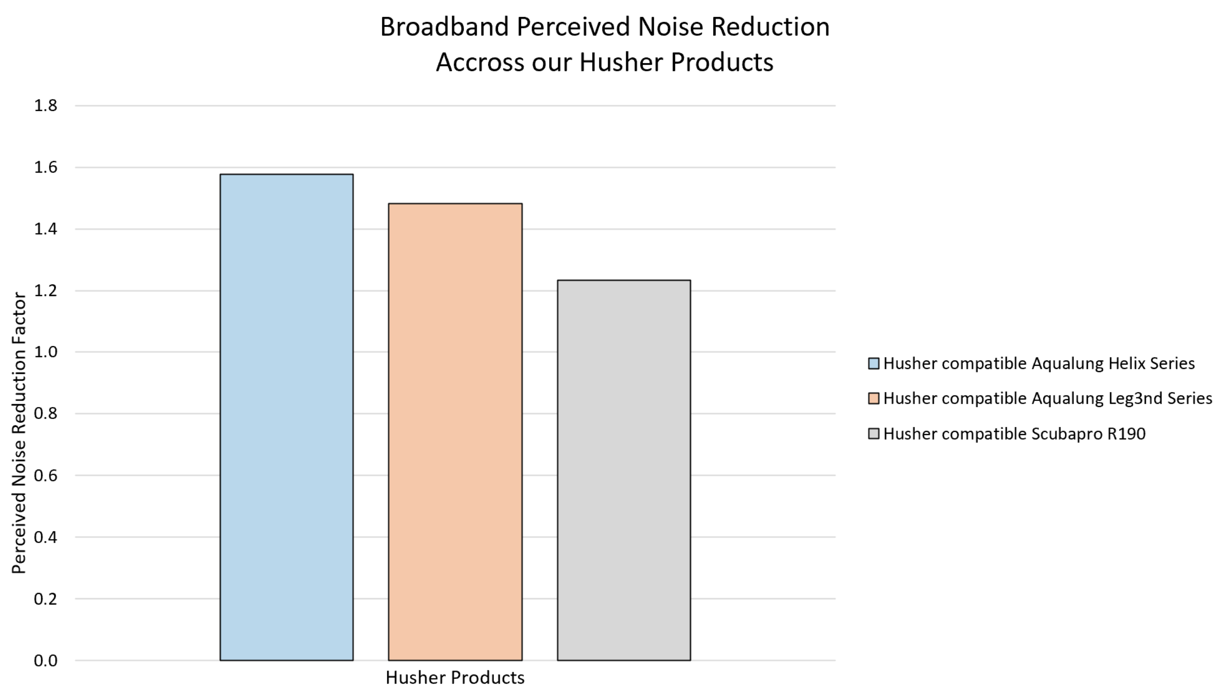
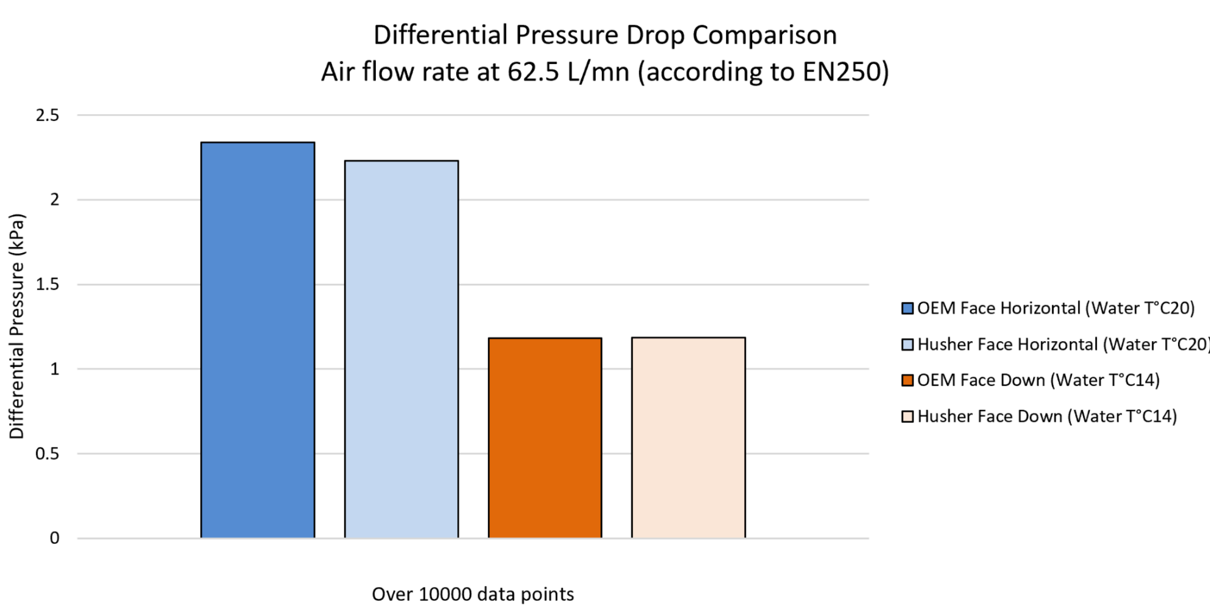
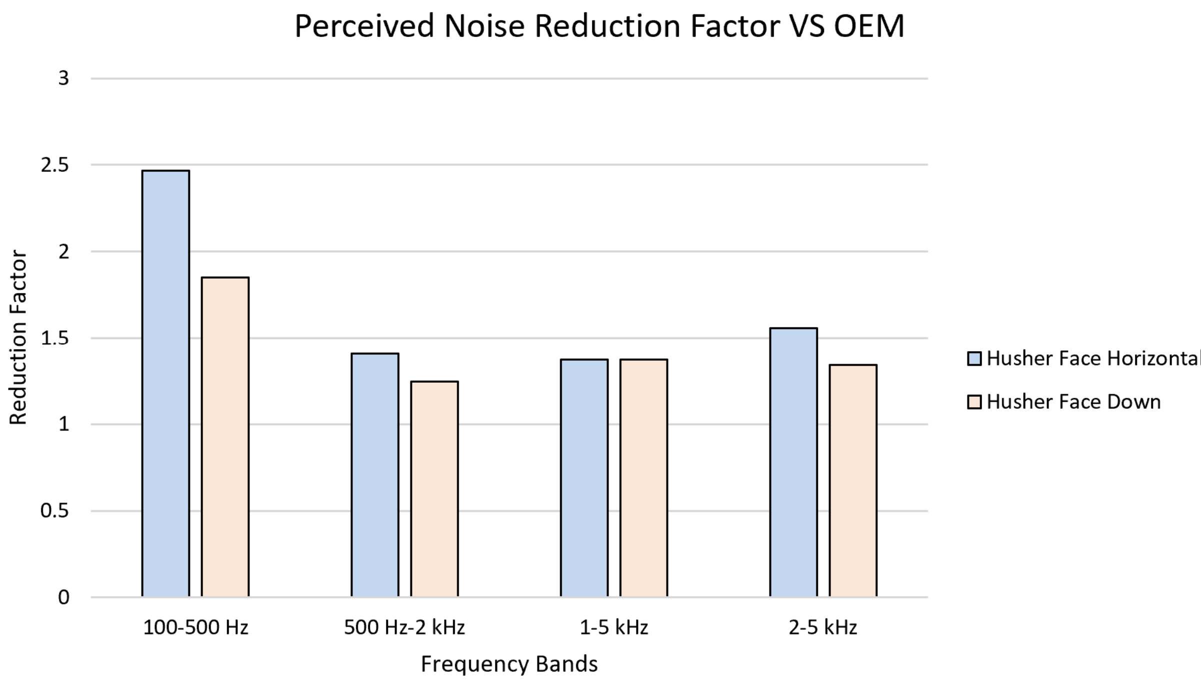
Overall Average Performances across our Products






Perceived Noise Reduction Factor VS OEM
3
2.5
2
1.5
1
0.5
0
Reduction Factor
100-500 Hz
500 Hz-2 kHz
1-5 kHz
2-5 kHz
Frequency Bands
Husher Face Horizontal
Husher Face Down

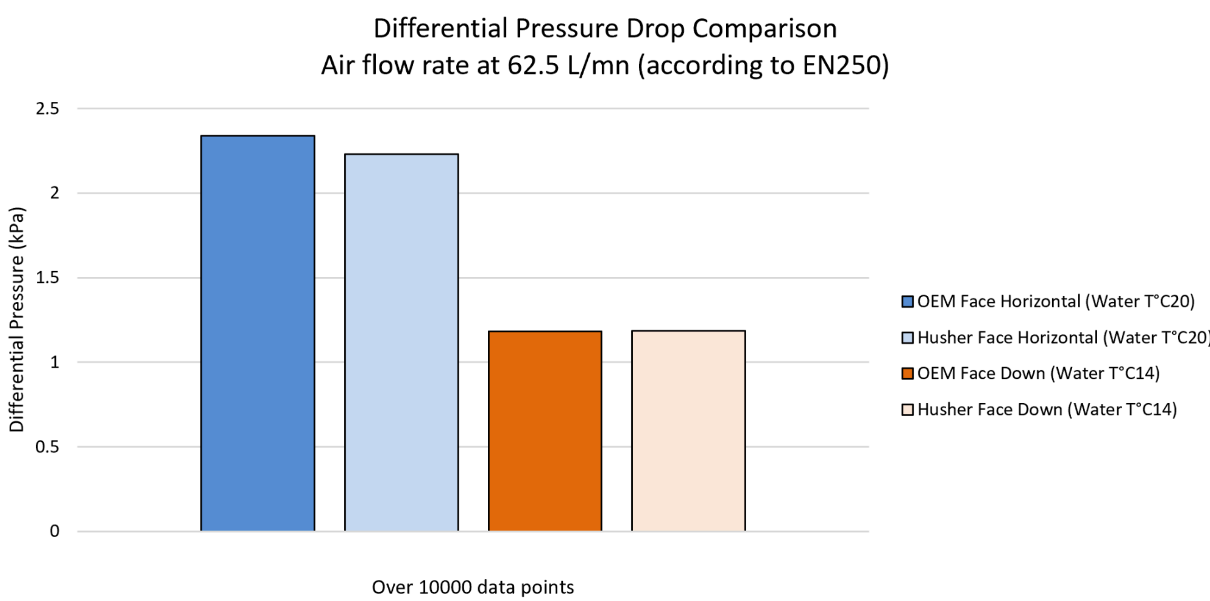
Breathing Performance

A key design objective of the Husher system was preserving natural exhalation behavior while integrating additional acoustic management structures.The internal liquid-balancing pathways were developed to reduce resistance associated with multiphase exhaust flow and water accumulation inside the device.

Pressure-loss testing demonstrated that optimized configurations could maintain exhalation resistance comparable to and in some cases lower than original OEM configurations under controlled test conditions.

Graphic shows typical results during Husher testing and qualification tests according to EN250 standards for diving equipment.

This balance between acoustic attenuation and breathing comfort is a core aspect of the Husher engineering approach.



Acoustic Flow Management

Traditional regulator exhaust systems typically generate coherent and directional gas jets, producing concentrated acoustic peaks and localized turbulence during exhalation.

The Husher system uses a distributed outlet architecture, internal flow perturbation, and phased exhaust geometry to break up coherent flow structures and redistribute exhaust energy more progressively into the surrounding water.

This approach helps smooth the acoustic signature while maintaining efficient exhaust flow behavior.

Graphic shows a typical average perceived noise reduction factor among our Hushers during the validation tests.

Approximation
An approximate psychoacoustic relation was used:
$F \approx 2 - \Delta dB/10$

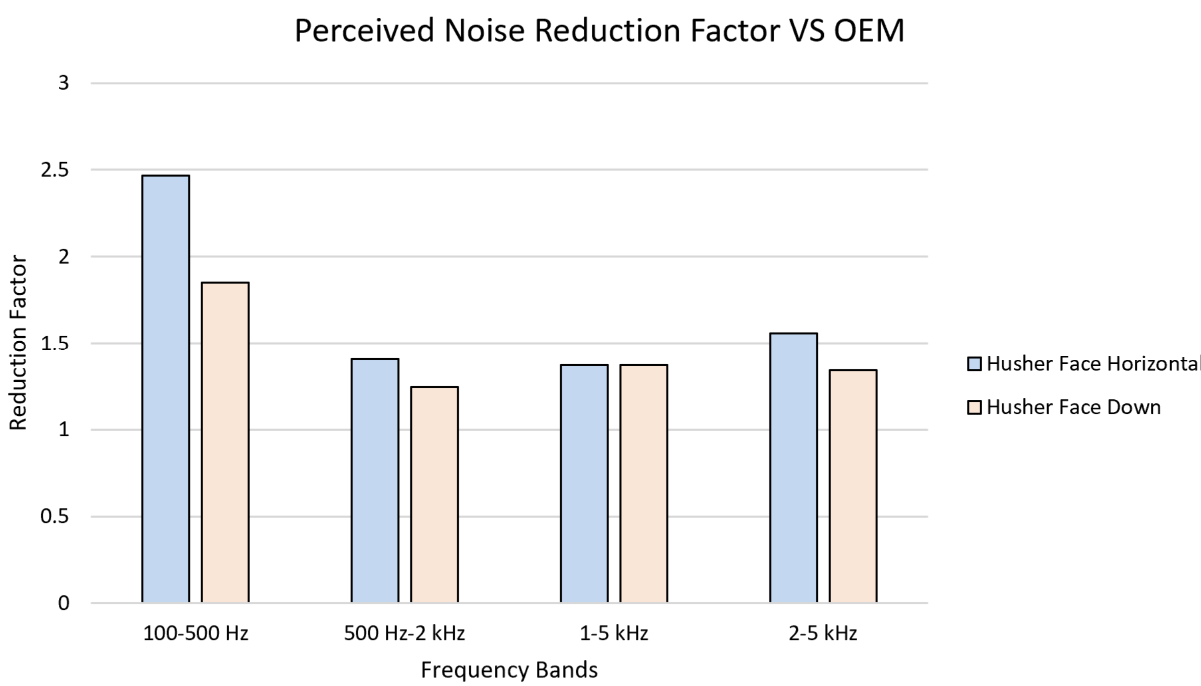
Meaning
This provides a simplified estimate of how changes in acoustic level may relate to perceived loudness differences.
Approximate interpretation:

- −10 dB ≈ perceived as roughly 2× quieter
- −3 dB ≈ noticeable reduction
- −1 dB ≈ slight reduction

Important Note
Perceived loudness underwater depends on many factors including:

- spectral content,
- bubble behavior,
- propagation conditions,
- diver position,
- and human auditory perception.

Therefore, this factor should be interpreted as an approximate comparative indicator rather than an absolute psychoacoustic measurement.



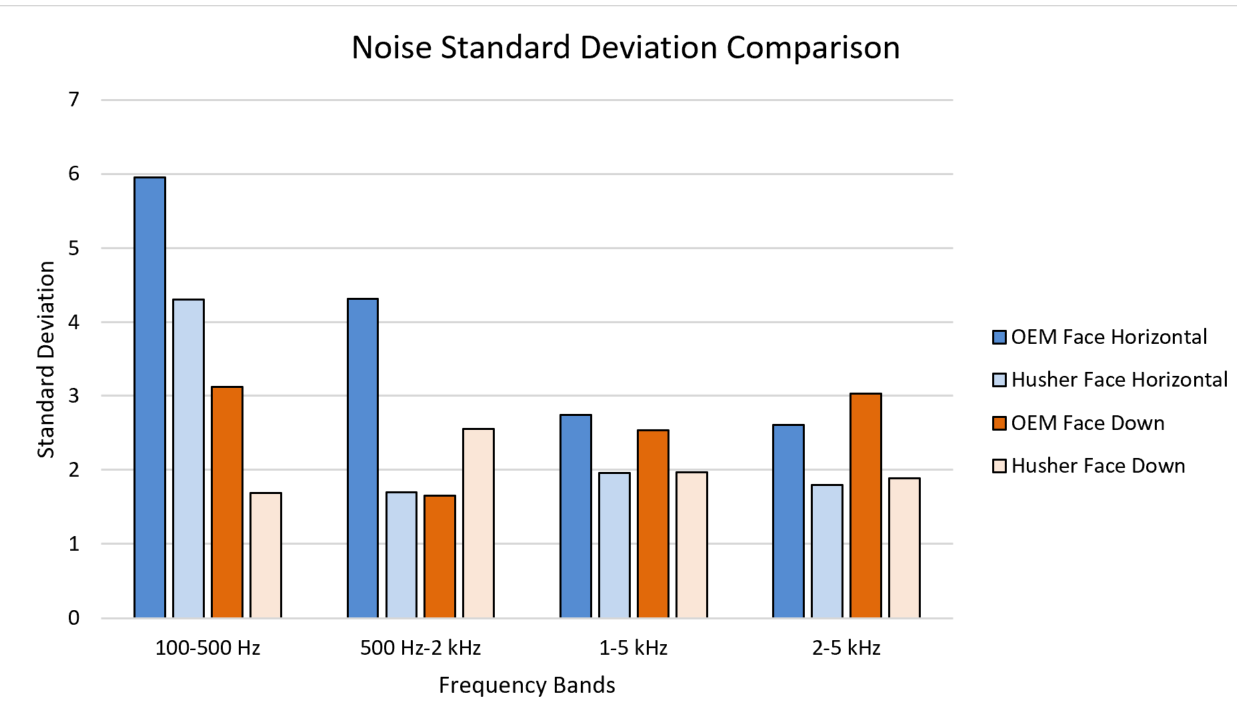
Underwater Acoustic Signature

Rather than focusing solely on global sound reduction, Husher is designed to influence the structure of underwater exhaust noise itself.
Testing showed reductions in tonal peaks and smoother broadband acoustic behavior across multiple frequency ranges relevant to diver perception and underwater acoustic propagation.
The combination of:

- distributed outlet geometries,
- varying perforation diameters,
- angular offset patterns,
- and internal flow conditioning,

helps reduce directional acoustic emission and soften the perceived exhaust signature compared to standard OEM exhaust configurations. **1-5 kHz is the most hearing sensitive window.**

Rolling Standard Deviation (Local Spectral Variability)



$\sigma_{local}(f)=\frac{1}{N}\sum_{i=1}^{N}(S_i-\bar{S})^2$
Where:

- S_i = spectral amplitude samples within a local frequency window
- $\bar{S}$ = local mean spectral level
- N = number of points in the moving window

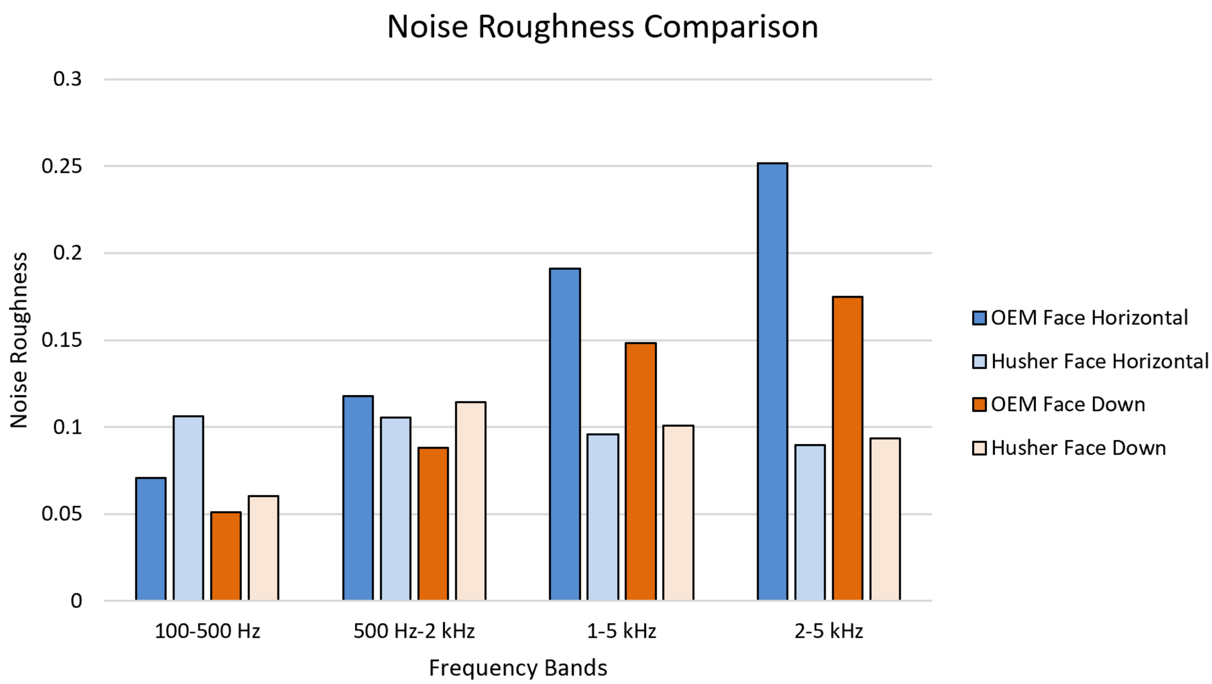
Meaning
Rolling standard deviation measures how strongly the spectrum fluctuates locally across frequencies.
It helps quantify:

- spectral roughness,
- tonal concentration,
- and localized acoustic peaks.

Interpretation
STD value
Interpretation
High STD
Rough / tonal spectrum
Low STD
Smooth / diffuse spectrum
A reduction in local STD generally indicates:

- smoother acoustic behavior,
- fewer harsh peaks,
- and reduced tonal aggressiveness.

Spectral Roughness Index



Equation
$R=N-11\sum i=1N-1|Si+1-Si|$
Where:

- Si = spectral amplitude at frequency bin i

Meaning
The roughness index measures the average local variation between adjacent spectral points.
It evaluates:

- how “jagged” or irregular the spectrum is,
- and how rapidly the acoustic energy changes with frequency.

Interpretation
Roughness Interpretation
<u>High:</u>
Sharp tonal structures
<u>Low:</u>
Smoother broadband distribution
Lower roughness generally corresponds to:

- softer perceived sound,
- reduced tonal sharpness,
- and more diffuse acoustic emission.

Test Methodology

Development and validation testing were performed using iterative acoustic and flow-analysis setups designed to compare OEM and Husher-equipped regulator configurations.
Testing configurations included:

- underwater acoustic measurements,
- spectral frequency analysis,
- differential pressure measurements,
- and comparative orientation testing.

The experimental setups were designed to evaluate both:

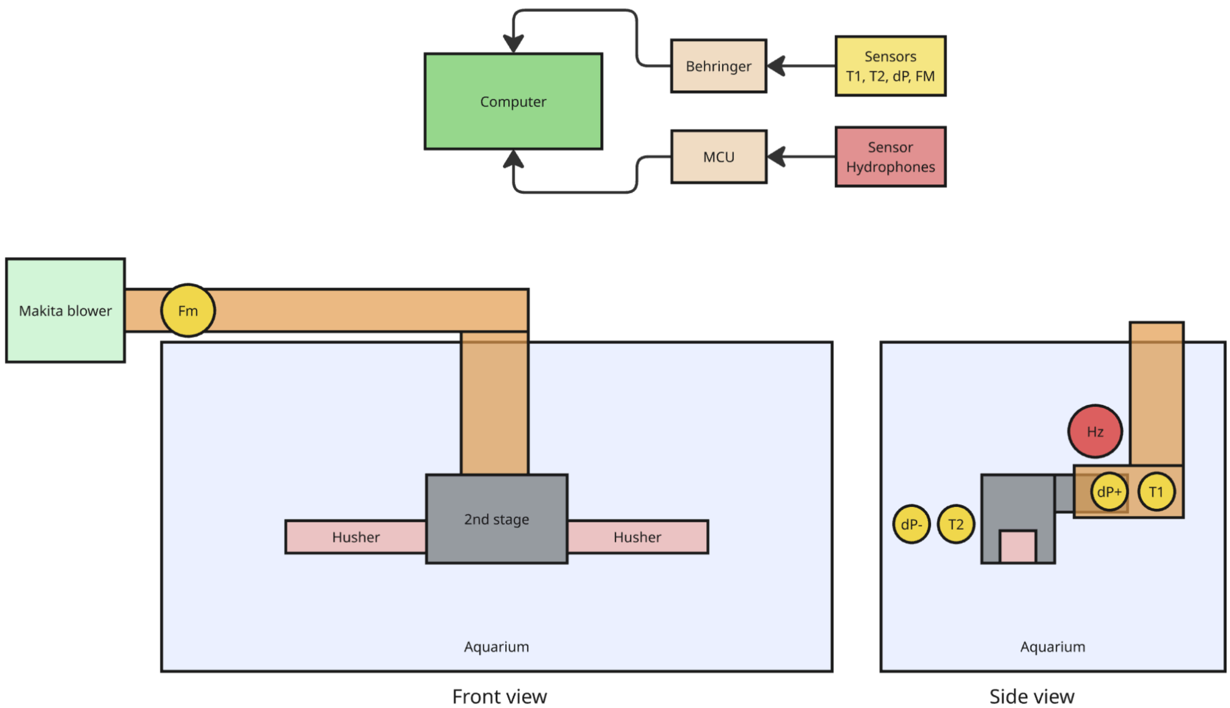
- acoustic behavior,
- and breathing-flow performance,

under repeatable and controlled conditions.

Representative graphs and measurement examples shown on this page illustrate comparative trends observed during development testing and are intended for engineering and informational purposes.

Different acoustic locations were tested ensuring space measurement repeatability.

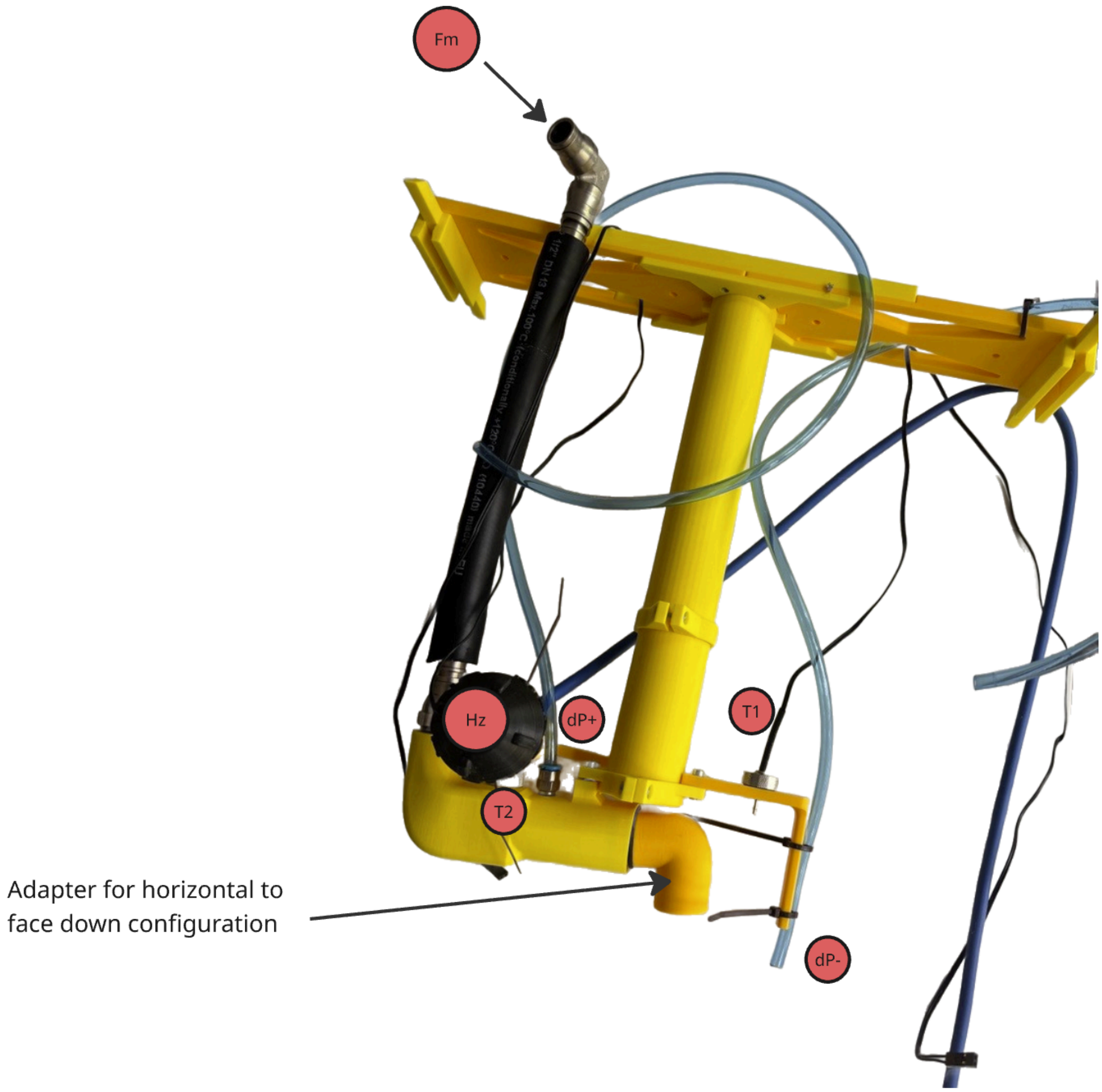
Test bench Schematic



The schematic illustrates the setup used for pressure drop and noise characterization for each of the Hushers developed

1. 1x MCU and 1x computer allowing to collect sensor data
2. 1x Behringer amplificator for the hydrophones
3. 1x Makita blower for supply air flow rate
4. 2x temperature NTC10k for air injected and water
5. 1x DFRobot SEN0360 air flow meter
6. 1x differential pressure sensor MPX2010DP
7. 2x hydrophones Manalive XLR

Instruments column



Here shows the instruments column providing air flow rate into the secondary stage with all the sensor brackets