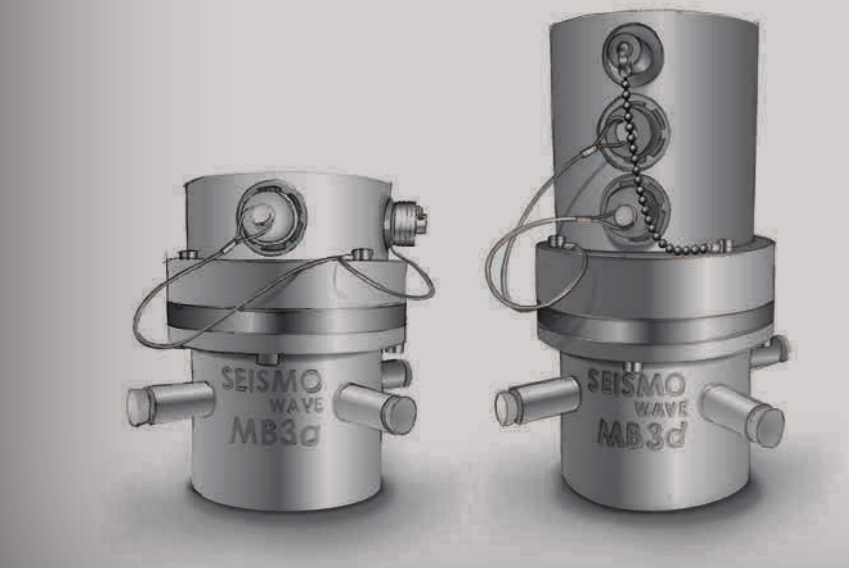
SEISMO WAVE



INFRASOUND TECHNOLOGY

- SENSORS
- METROLOGY
- WIND NOISE REDUCTION SYSTEMS
- ACCESSORIES

SEISMO WAVE

THE COMPANY SEISMO WAVE SPECIALIZES IN INFRASOUND SENSORS FOR THE RESEARCH COMMUNITY AND FOR CIVIL AND MILITARY SECURITY.

A long-term partner of the Military Applications Division (DAM), the Environmental Assessment and Monitoring Department (DASE) of the French Alternative Energies and Atomic Energy Commission (CEA), Seismo Wave manufactures and markets high-precision infrasound sensors, also known as micro-barometers.

In partnership with

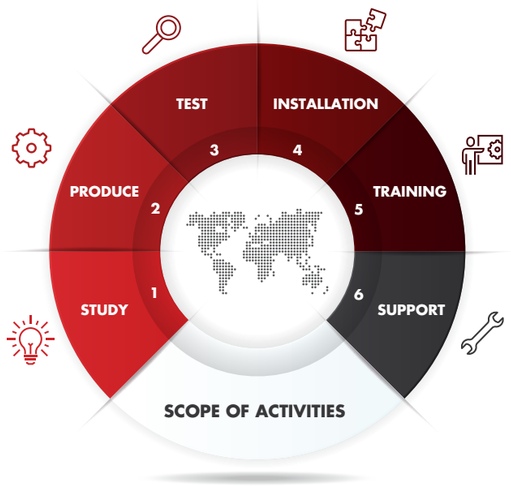
enviroearth

cea

Designed by the CEA, the MB3a (analog) and MB3d (digital) sensors enable the detection of extreme atmospheric events with frequencies included between **0.01Hz and 28Hz**. Both models are characterized by their low self-noise (**approx.10db under the low-noise model at 1Hz**) and their remote calibration capability. Known as reliable and robust, the MB3 sensors are all in-lab calibrated on the Seismo Wave premises.

Installed worldwide, Seismo Wave micro-barometers serve in many scientific observation and prevention applications:

- Meteorology: study of atmospheric pressure, gravity waves, sudden stratospheric warnings, lighting...
- Volcanology: to track eruptive activity, to understand eruption dynamics, to analyze volcanic ashes (early warning systems for the aviation)
- Nuclear explosions, quarry blasts
- Earthquakes
- Tsunamis
- Tornadoes
- Meteors
- Landslides, avalanches
- Wind farm emissions



Seismo Wave assists its customers throughout their project, from the design of specific accessories to station maintenance.

Located in France, Seismo Wave has its own laboratory of metrology, with an infrasound calibrator designed by CEA/DASE, to qualify sensors on the frequency bandwidth from 0.01 Hz to 10Hz. In the R&D department, engineers work on the improvement of infrasound technologies and on the development of new products and accessories (cables, interconnection boxes, packaging, etc.).

Seismo Wave and Enviroearth, its partner for the installation of stations, operate worldwide for private and public organizations.

With over 10 years' expertise in installing infrasound stations, Enviroearth designs customized infrasound stations that are adapted to your constraints, and supplies all the required equipment: vaults, power, data transmission, Wind Noise Reduction Systems (WNRS).

PROPERTIES OF INFRASONIC WAVES

INFRASOUND SOURCE OR TYPE	FREQUENCY RANGE (HZ)	MAX. OBSERVED AMPLITUDE (PA)	ESTIMATED MAX. DETECTION RANGE (KM)
Atmospheric nuclear explosions	0.002-20	> 20	> 20 000
Underground nuclear explosions	1-20	1	1 000
Mining explosions	00.5-20	5	> 5 000
Bridges and other structures	0.5-20	0.5	< 100
Launching of rockets and spacecraft	0.01-20	5	3 000
Satellite and spacecraft re-entry	0.1-10	1	> 2 000
Subsonic aircraft	0.3-20	2	< 100
Supersonic aircraft	0.3-20	10	5 000
Meteors	0.01-20	> 10	> 20 000
Calving of icebergs and glaciers	0.5-8	1	200
Volcanic eruptions	0.002-20	> 20	> 20 000
Convective storms	0.01-0.1	0.5	> 1 500
Earthquakes	0.005-10	4	> 10 000
Landslides, avalanches	0.1-20	1	1 000
Mountain associated waves	0.007-0.1	5	10 000
Lightning	0.5-20	2	50
Tornadoes	0.5-20	0.5	300
Tsunamis	0.5-2	0.1	1 000

Source : *Infrasound monitoring for atmospheric studies, A. Le Pichon, E. Blanc, A. Hauchecorne (Springer)*

SENSORS

**MB3a & MB3d,
INFRASOUND SENSORS
WITH REMOTE
CALIBRATION CAPABILITY.**

The MB3 sensor is a new generation of micro-barometer, which takes after the market leader MB 2005. The sensor core is an aneroid capsule (vacuum-sealed bellow) coupled with a magnet and a coil transducer. Remote calibration capability is provided by a secondary coil wrapped around the main coil.

USE

Detection of infrasonic waves up to 20 Hz caused by natural or artificial phenomena.

INTEREST

Volcanology, meteorology, civil and military security.

ADVANTAGES

- Wide frequency bandwidth
- Low self-noise
- Lab calibrated (Verification Certificate)
- Remote calibration (sine, pulse or MLS)
- Easily set in pressure output or pressure derivative output mode
- Outside temperature and absolute pressure sensors included
- On site easily adjustable according to the altitude

TECHNICAL SPECIFICATIONS

TRANSDUCER BLOCK

Bandwitdth (f -3 db)	Pressure output: 0,01 - 28 Hz Pressure derived output: DC - 28 Hz
BLDR (Band Limited Dynamic Range) [0,02 ; 4 Hz]	111 dB @ f < 106 Hz 109 dB @ f = 4 Hz
Self-noise	0,13 mPa/√Hz @ 1 Hz < 10 dB under LNM (Low Noise Model)
Resolution [0,02 ; 4 Hz]	1,75 mPaRMS
Nominal sensitivity (adjustable gain)	• Pressure output: 20 mV/Pa • Pressure derived output: 2 mV/Pa.s-1 • Calibration output: 6 Pa/V
Auxiliary outputs Temperature sensor Atmospheric pressure Sensor	 • [-40 ; +110]°C, 10 mV/°C, ±0,2°C • [150 ; 1150] hPa, 1 mV/Pa • Offset stability: 0,25% full scale / uncertainty: 1,5% full scalr

ENVIRONMENTAL SPECIFICATIONS

Operating temperature	-20°C to +50°C
Storage temperature	-30°C to +70°C
Seismic sensitivity	< 30 Pa/m.s-2
Sealing	CEI 60529-IP67 (with sealed acoustic inlets)
Shock / Drop	NF EN 60721-3-1, 2M1 (free fall, impact, shock)
Transport	NF EN 60721-3-2, 2M3 (vibration)
EMC	NF EN 55024 classes A & B (immunity) NF EN 55022 class B (emission)

MB3a

ANALOG SENSOR

ANALOG HOOD

Output range	24 V pp
Output type	Differential (symmetric)
Output impedance	2 x 50 Ω
Dynamic range	Output P (Pa): ± min (12 000 [Pa/s] / 2.π.f[Hz] ; 1200 [Pa]) Output dP: ± 12 000 (Pa/s)
Power requirements	12 V DC (7-20 V) - 120 wW

Product sold under licence of

MB3d

DIGITAL SENSOR

DIONISOS SOFTWARE

The DIONISOS software is a specifically designed application to control the MB3d micro-barometer.

The DIONISOS application responds to three fundamental and complementary requirements:

- Graphic data displayed from different sources (files, data servers, digitizers), both in **real time** and in deferred time
- Configuration and display of the **health condition** of these sources
- Checking that the measurement station is **operating correctly**, in geophysical terms

DIGITAL HOOD

Clipping level & output range	Pressure: ± min (12 000 [Pa/s] / 2.π.f[Hz] ; 1000 [Pa]) Pressure derived: ± 10 000 (Pa/s)
Sampling rate	20, 50, 100 Hz
Nominal sensitivity	1,178 10-4 Pa/lsb or 1,178 10-3 Pa/lsb @ gain = 1
Built-in gain	1, 2, 4, 8 (Digitizer gain)
Data storage	1 GB / miniSEED
Power requirements	12 V DC (7-20 V) - 840 wW

Product sold under licence of

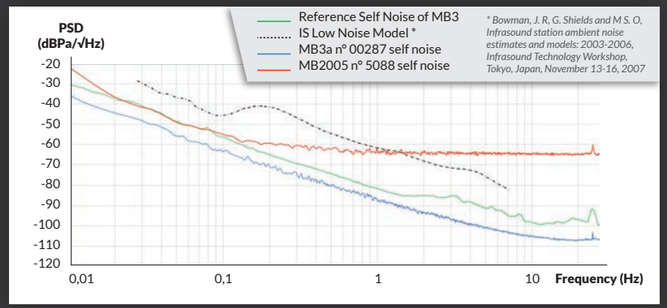
METROLOGY

THE METROLOGICAL PROCESS CONSISTS IN A NORMALIZED METROLOGY SYSTEM WHICH COMPARES A REFERENCE SENSOR WITH THE SENSOR TO CALIBRATE.

Acoustic calibration : a known signal generated by the IS Calibrator is injected into the two sensors (one reference sensor and the sensor to be tested) and then output signal are compared. The bench is periodically monitored and verified.

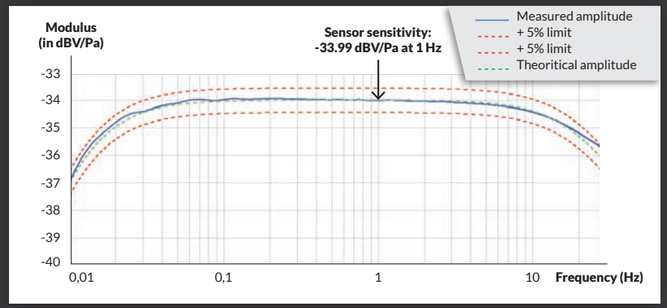
SENSOR SELF-NOISE MEASUREMENT

Electronic noise plots showing the sensor pressure outputs obtained with the sealed air inlets in the 0, 01-28 Hz bandwidth.



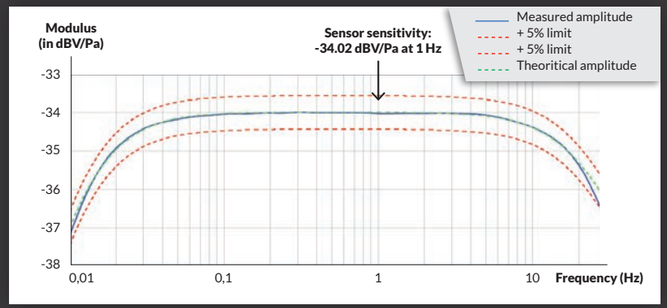
RESPONSE OBTAINED BY THE 0.01 TO 28-HZ ELECTRIC CALIBRATION

Full frequency response obtained by the electrical sensor self-calibration capability for the pressure output amplitude and phase as recorded data points, accompanied by corresponding plots in the 0.01-28 Hz bandwidth.



RESPONSE OBTAINED BY THE 0.1 TO-28-HZ ACOUSTIC CALIBRATION

Full frequency plots obtained by dynamic pressure output amplitude and phase calibration using a sine signal in the 0.1-28 Hz bandwidth.



WIND-NOISE REDUCTION SYSTEMS

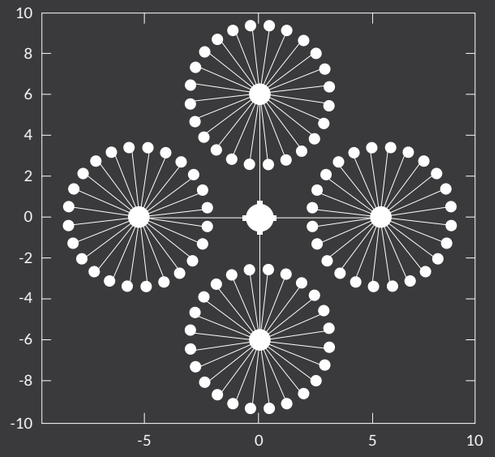
In partnership with

enviroearth

THE WIND-NOISE REDUCTION SYSTEM (WNRS) IS AN ARRAY OF AIR INLETS CONNECTED WITH PIPES TO REDUCE WIND-NOISE AND IMPROVE SIGNAL QUALITY.

It is a very sensitive part of any infrasound station. The main challenge is to keep it perfectly airtight over the years. For this purpose, Enviroearth adds valves onto its filters to enable pressure tests, thus facilitating leak detection.

Over the years, Enviroearth in collaboration with International organizations and geophysical institutes, has refined its model to come up with a standard and well diffused 18-m span Rosette configuration. The acoustic response using this configuration is fully satisfactory and the WNRS can then be customized to be adapted to specific constraints or use. Enviroearth provides two ranges of WNRS with options: the full Stainless-steel pipe range and the flexible hose range



WNRS WITH FLEXIBLE HOSES 96 AIR-INLET

- 18m span – rosette configuration
- Designed for difficult access to places with uneven ground
- Easily installed and to transported
- High quality hose with abrasion and long-life standards
- Possibility of performing out pressure tests

WNRS WITH STAINLESS STEEL TUBES 96 AIR-INLET

- 18m span - rosette configuration
- Designed for harsh surrounding conditions
- Every single part of the system is made of stainless-steel
- Very little maintenance
- Possibility of performing pressure tests

OPTIONS

- Without valve
- Smallest design => 10m span
  Design for temporary installations
  or for confined spaces
- Pipe supports
- Valve extension for gravel
- Sealed fully customizable sensor housing
- Orientation of the Air inlet
  (horizontal or vertical)

INSTALLATION

Enviroearth is a state of the art designer and supplier of turnkey infrasound monitoring station with references worldwide. Their scope includes installation of all sensors and equipment displayed in this catalogue but also the Civil Works for site preparation, power supply equipment and data transmission systems.

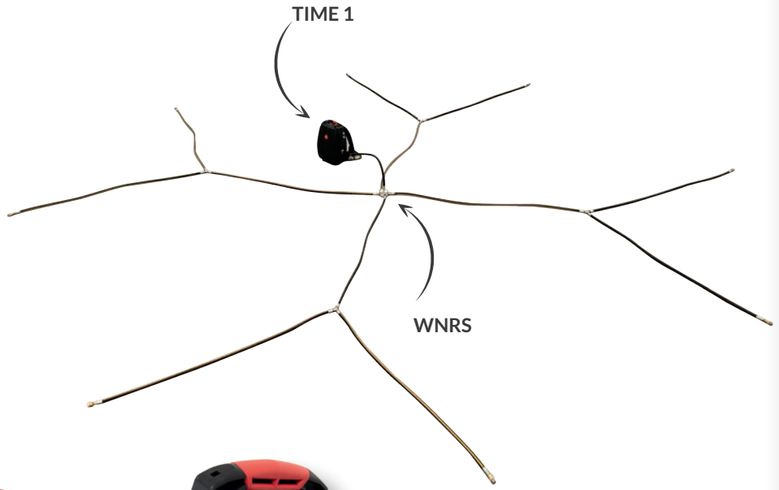
MAINTENANCE

Our team is highly experienced in operating stations, particularly in remote areas with special accesses. We can provide a permanent presence or carry out regular preventive and corrective maintenance visits to maintain the stations in perfect working order. Enviroearth is available to perform maintenance actions in many places worldwide.

TRAINING

An adapted training plan is designed for each project, taking the trainees' knowledge and skills into account.

ACCESSORIES



TIME 1 (TEMPORARY INFRASOUND MONITORING EQUIPMENT)

The TIME 1 portable station has been designed for short-term measuring campaigns on different types of sites (volcano surroundings, wind farms...) and to proceed to site survey to help find the best location for a permanent station.

Equipped with a MB3d, a battery and a solar panel, a GPS antenna and a small WRNS, the portable station is packed inside a water-proof backpack. The 1GB MB3d memory allows up to 4-week autonomous measurements.

Thanks to DIONISOS and the USB cable, you can easily set up the sensor parameters, and have access to the data.

ADVANTAGES

- Light
- Transportable by plane
- Water-proof
- Powered with a solar panel
- 2-days autonomy without sun

WNRS (OPTIONAL)

A 6-meter diameter with 8 air inlets:

- Y connectors
- Stainless steel strainers
- Flexible hoses
- Light weight: 23 Kg (including the transport case)
- Easy assembly and diassembly
- Easy to carry thanks to its wheeled case

PACKAGING WITH ADAPTED FOAMS

- Srewpack (1 sensor)
- Carton boxes (1 sensor)
- Pelicase 1430 (1-2 sensors)
- Pelicase 1650 (6 sensors)

CABLES AND TOOLS

- MB3a/MB3d power cable
- Signal cable
- MB200x power cable
- MB3d serial cable
- Ground cable
- GPS cable
- GPS antenna
- PC/USB cable
- Magnet wrench
- Magnet adjustment cable
- Etc...

CUSTOM-MADE CABLES AND ACCESSORIES UPON REQUEST

SEISMO WAVE

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