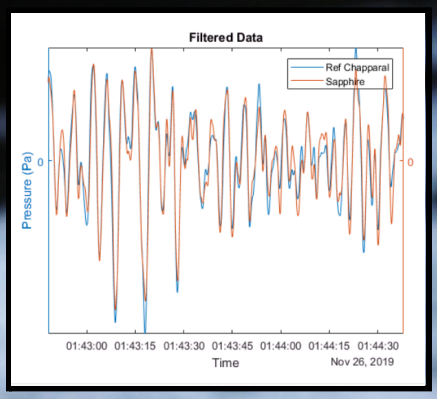
Sapphire Mini

The Inexpensive Infrasound Node

A small self-contained infrasound recorder

The Sapphire Mini is a small low power infrasound recorder designed for weeks-long campaigns in urban and rural settings. The recorders are simple enough to mail to hosts and merely need to be switched on to begin recording.

Small enough to deploy nearly anywhere, the Sapphire Mini is also inexpensive enough to deploy in quantity.



0.1-0.5 Hz Chaparral to Sapphire Mini comparison ambient noise in Dallas

Small

The ½ pound node will fit a coat pocket. A MHT connector provides a connection to passive wind noise reducers, although in many cases the small size allows the node to be deployed in dense shrubs that eliminate the need for an external wind filter.

Simple recording format

All data are recorded in the industry standard miniSEED format. Users have an option to record as simple floats in physical units that include all sensor calibrations or in a slightly lower power integer format that may be post processed into physical units.

Accurate timing

GPS timing is used to accurately time tag the sampled data. In addition, the sampling clock may be synchronized to GPS time such that adjacent recorders may be used in an array.

Easily customized

Internal connectors provide access compatible sensors and extension boards, such as a higher sample rate analog sensor, a second digital infrasound sensor, or meteorological sensors.

Easy data recovery and firmware upgrades

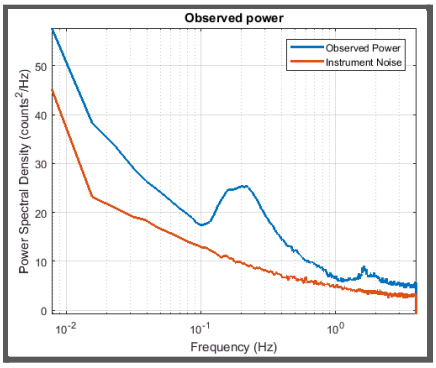
Data is recovered and firmware may be upgraded by swapping a micro SD card eliminating the need to ever have a computer in the field.

Simple

Incorporate a Sapphire Mini in your research as citizen science and collect scientifically relevant data.

Wide range

Use the simultaneously sampled microbarometer to record signals near explosive sources and correct pressure signals with the built-in accelerometer.



Ambient noise spectra (blue) during low wind in Dallas compared to instrument noise.

TECHNICAL SPECIFICATIONS

Sensors

Pressure:
- All Sensors DLHR 18-bit differential
  - ±125 Pa full scale
- BMP388 absolute pressure
  - Up to 0.03 Pa resolution
  - 300-1250 hPa range

Temperature
- Recorded from DLHR or BMP sensor

Acceleration (optional)
- Simple MEMs accelerometer

Analog A2D (optional)
- One channel with signal conditioning
- Adjustable gain
- Low pass antialias filter
- Three raw channels
- 16-bit standard

Power

High efficiency power supply

Internal
- 4 AA batteries
- recommend Eveready L91's
- Estimated life
  - Depends upon recording mode
  - Up to 20 days

USB powered
- Automatic switch to internal when USB removed
- Peak power 250mA (estimated)
- Nominal power 30mA (estimated)
- Low Power mode 8mA (estimated)

External Power
- 4-15 Volt accepted

Physical

Weight:
- With batteries: 238 gm
- Without batteries: 174gm
- Without case and batteries: 30gm

Dimensions:
- 60 x 66 x 115 cm

Connector:
- US male garden hose connector

Weather Protection:
- Fine mesh insect screen
- Withstands water up to ½ cm above base with no water incursion
- Withstands water up to 2 cm above base with no water into electronics

Labeling
- QR code identifier on exterior

Temperature Range
- 0-70℃ (typical SD card limit)
- -40-85 ℃ (untested)

Mounting Options
- Up to 4 spikes to secure on slopes
- Up to 4 screws for tree or building

Acquisition

Sample Rates:
- 1,2,4,8,16,32,64,128 Samples/sec

Number of Simultaneous Channels:
- 5 channels at 128 samples/second

Format:
- MiniSEED floating, int32, int24, int16 in block multiplexed format
- Log data saved as 6th miniSEED Channel
- Configuration saved as JSON text file

Memory:
- 64K NVRAM for configuration
- SD cards up to 64G (27 days/G for float format, 1 channel, 128 samples/sec)

State-of-Health Log

Power
- Battery voltage
- Bus voltage
- Bus current
- Bus Power

GNSS
- Time
- Number of fixes
- Latitude
- Longitude
- Height
- Clock skew
- Clock slew rate
- Number of seconds on

Misc
- Sample Count
- Thread CPU utilization
- Diagnostic messages

Accessories

Micro SD Card:
- MicroSD card reader
- Weather-proof storage case
- Low power micro SDcard

USB cables
- USB micro to USB-C
- USB rechargeable supply

Batteries
- Eveready L91 primary lithium
- Rechargeable LiMH
- Tiny lightweight Li-poly for UAV
- Adapter cable for external 12V

Spike kit

Carrying Case
- Carry-on luggage size
- Rugged waterproof
- Inserts for 24 Sapphire Mini's
- Space for 24 sets of spare batteries
- Space for spare SD cards and adapters

Signals recorded from McAlester, Ok explosive ordnance disposal

Timing

Internal TCXO:
- ±2ppm

GNSS receiver:
- Configurable for GPS, GLONASS, BeiDou, Galileo

GNSS power:
- One shot, cycled, continuous

Timing Accuracy:
- During GNSS lock: <1mS
- During GNSS unlock: <2ppm

Configuration Parameters

Sample Rate:
- 1,2,4,8,16,32,64,128

Channels to record
- DLHR pressure
- DLHR temperature
- BMP pressure
- BMP temperature
- Acceleration (Z direction)

GNSS
- Mode: single, cycle continuous
- Time between fixes
- Seconds required for fix
- Maximum search period
- Required lock time

Timing
- GNSS sync: true or false
- Jamset Threshold
- Trim Threshold
- Required Trim
- Crystal aging offset
- Micro offset
- Latency

Recording
- File Sync time
- Length of recording file

State of Health Status
- Sample Period
- Serial Number
- Watchdog Timeout
- Battery Cutoff voltage

USB Monitor
- Maximum time to monitor system