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BATmode 2S / 2S+

USER MANUAL

May 2023 / Version 3.7.0

GENERAL INFORMATION ON THIS USER MANUAL

This manual belongs to the system BATmode 2S and BATmode 2S+. If instructions belong to both versions, the version naming is omitted hereinafter. Please read these instructions completely and carefully before taking the device into operation, it contains important instructions on commissioning, handling and operation. The safety instructions contained within must be observed!

SYMBOLS

Important notes for the users and operators of the BATmode system are marked with the following signs:

Attention!

Instructions marked with this sign have to be complied. Neglecting any of these instructions may harm persons or cause damage to system parts.

Important!

Advices marked with this sign concerns the correct usage of the system. Neglecting any of these advices may cause malfunction of the system.

WASTE DISPOSAL

European Union:

Do not dispose parts or the whole BATmode system at public of community supplied disposal systems. According to the European WEEE Directive 2002/96/EC on Waste of Electronic and Electrical Equipment we take our devices back for recycling or proper disposal. Send them to bat bioacoustictechnology. This service is free of charge.

Other countries:

We would like to encourage you to send us back defective devices for recycling or proper disposal. This service is free.

SAFETY INSTRUCTIONS

- Only use power supplies authorized or supplied by bat bioacoustictechnology.
- Avoid excessive mechanic strain on the BATmode system, especially on plugs and connectors if cables are connected to the BATmode or the antenna and microphone disc. Strong vibrations, shaking or dropping may damage system parts.
- Ensure a safe and stable mounting of the BATmode and the corresponding discs. Dropping can harm persons, property or the BATmode system.
- Ensure that nobody can stumble on installed and connected wires. Stumbling can harm persons and damage system parts.
- Only use accessories supplied or authorized by bat bioacoustictechnology. The use of unauthorized accessories may damage the device.
- Please contact our support if the BATmode system shows any damage or does not work properly. Do not open system parts and try to repair damage by yourself or through unauthorized personnel. This will cause the loss of warranty.

APPLICATION NOTES

- Microphone capsules of microphone discs and tower microphones are sensitive to mechanical strain. Do not touch the microphone capsules with fingers or objects and never use stickers or any adhesives on its surface.
- Avoid the pollution of the microphone capsules by dust or dirt particles. This can clog the protective grid and/or damage the microphone.
- Try not to expose the running BATmode system to electromagnetic fields. Since the microphone is sensitive to those fields, interferences with the audio signal are possible.
- Ensure a sufficient air circulation around the BATmode. Overheating can cause data loss and/or damage to the BATmode.
- Avoid interrupting power supply while the system is running. This can cause system failure and/or data loss.
- Do not twist or bend wires, since this can damage them.
- Do not use tools (nipper, wrench …) for fixation of cable connections since this can damage the connectors and/or the wires.
- The splash-proof discs protect electronic components against rain. Nevertheless, the microphone has to be exposed to detect incoming sound waves. Indeed, the protective grid is a relatively good protection against rain, but long-lasting exposure to high humidity leads to corrosion and loss of sensitivity. Consequently, avoid exposing the discs to high humidity.
- Do not expose the BATmode to any kind of humidity. Penetration of moisture can cause damage due to corrosion and short-circuiting.
- Avoid fast temperature variations and temperature below 0°C and above 40°C.
- For further questions, contact the support of bat bioacoustictechnology.

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6. GRAPHICS

Icons in parts by Lokas Software (http://www.awicons.com).

7. LAW

This Agreement shall be governed by German laws and regulations and international treaties. Legal venue shall be Winkelhaid, Germany. This license based upon laws of the federal republic of Germany. If any part of this license should be declared antinomian by a court with competent jurisprudence the remaining parts keep their validity anyway.
01/2019, Thomas Scharrer Softwaredevelopment / bat bioacoustictechnology GmbH
http://www.bioacoustictechnology.de

CONTENT

1 SCOPE OF DELIVERY

The scope of delivery of BATmode systems varies depending on the configuration requested by the customer. A system can be used for up to four measuring points simultaneously.

BATmode 2S system:

- BATmode 2S main detector unit
- 1 - 4 UltraSoundGates 116Hnbm/116Hnbm-r or one UltraSoundGate 416Hnbm of Avisoft Bioacoustics (optionally)
- 1 - 4 Microphone discs or tower microphones (optionally)
- 4 port USB hub (optionally)
- Cellular antenna with magnetic base
- Power supply (power connector cable + power supply unit or single power plug)
- 1 - 5 USB cables (optionally)
- Power supply for USB hub (Chinch <-> Clamp 2 pin) (optionally)
- 1 - 4 microphone cables (XLR: 5 pin <–> 5 pin) (optionally)
- Heating cable (Chinch <-> XLR: 2 pin <–> 3 pin) (optionally)
  or
  1 - 4 USB heating cables (USB <-> XLR: 3pin) with USB power plugs (optionally)
- VESA mounting kit
- Transportation case
- Quickstart Guide
- Microphone Calibration Certificates (optionally)

BATmode 2S+ system:

- BATmode 2S+ main detector unit
- 1 - 4 UltraSoundGates 116Hnbm/116Hnbm-r or one UltraSoundGate 416Hnbm of Avisoft Bioacoustics (optionally)
- 1 - 4 Microphone discs or tower microphones (optionally)
- 4 port USB hub (optionally)
- Antenna disc
- Power supply (power connector cable + power supply unit or single power plug)
- 1 - 4 microphone cables (XLR: 5 pin <–> 5 pin) (optionally)
- Heating cable (Chinch <-> XLR: 2 pin <–> 3 pin) (optionally)
  or
  1 - 4 USB heating cables (USB <-> XLR: 3pin) with USB power plugs (optionally)
- 2 antenna cables (RP-SMA <–> RP-SMA)
- Cable for temperature sensor (mini XLR: 3 pin <–> 3 pin)
- VESA mounting kit
- Transportation case
- Quickstart Guide
- Microphone Calibration Certificates (optionally)

2 DEVICE DESCRIPTION

2.1 BATmode 2S/2S+ Main Detector Unit

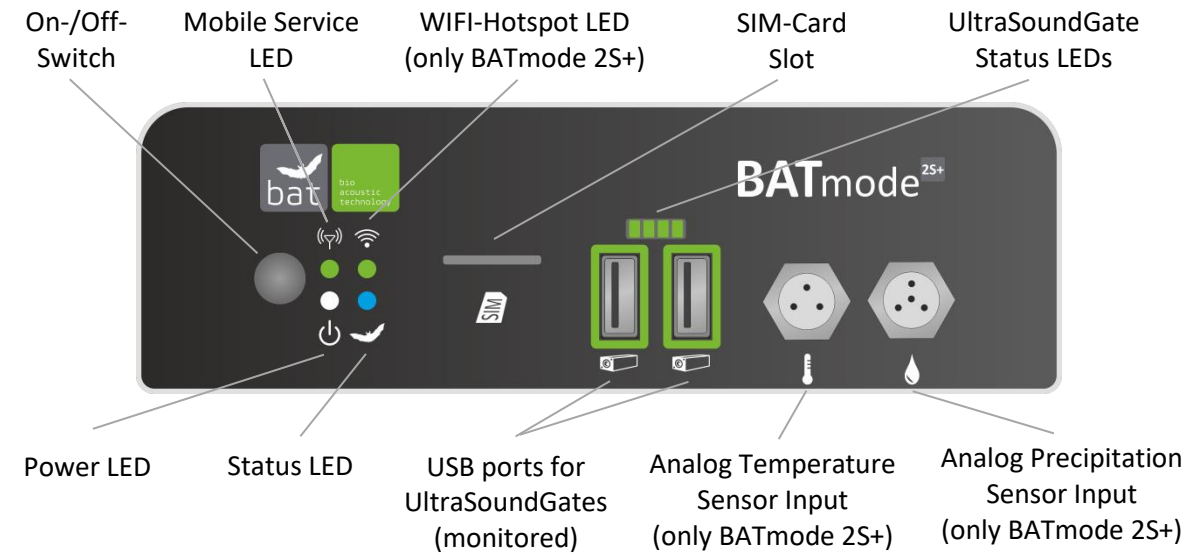


Figure 1: BATmode 2S/2S+ Front Panel

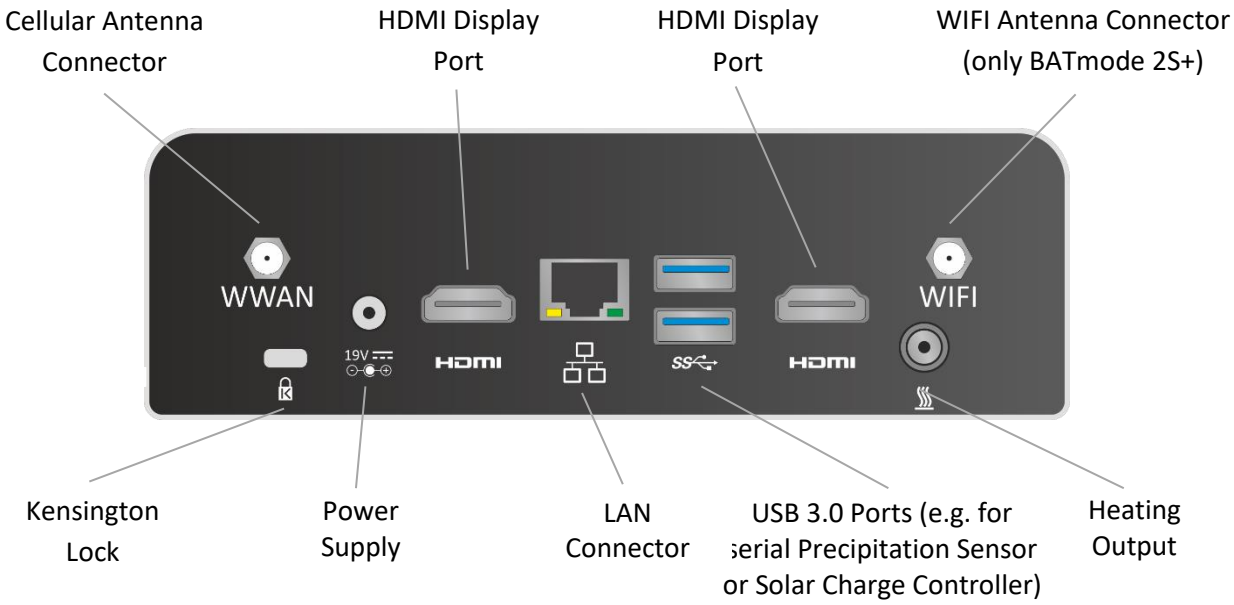


Figure 2: BATmode 2S/2S+ Back Panel

2.1.1 On-/Off-Switch

The On-/Off-Switch allows to switch the system on or off. Table 1 lists all possible system states in dependency of the duration the switch is pressed.

Table 1: System state in dependency of the duration the on-/off-switch is pressed

If the system is in the following state…	… and the On-/Off-switch is pressed for…	…the system changes to the following state
Off	less than four seconds	On
On	less than four seconds	Shutdown
On	more than six seconds	Off

In case of power failure, the BATmode system will restart automatically when power returns.

2.1.2 Power LED

The white Power LED shows the state of the BATmode. Table 2 depicts all possible states of the Power LED.

Table 2: States of the Power LED

LED state	Description
Off	Device off
Continuously on	Device on

2.1.3 Status LED

The blue-red Status LED shows the monitoring state. Table 3 depicts all possible states of the Status LED.

Table 3: States of the Status LED

LED state	Description
Off	BATcontrol software not started
Blue	BATcontrol software started, monitoring off
Blue blinking	BATcontrol software started, monitoring on
Blue-red blinking	Monitoring start not possible – Please check calibration and UltraSoundGates

2.1.4 Mobil Service LED

The green Mobile Service LED shows the state of the mobile connection. Table 4 depicts all possible states of the Mobile Service LED.

Table 4: States of the Mobile Service LED

LED state	Description
Double blinking	No SIM inserted or no mobile service connection
Single blinking	Registered to mobile network
Continuously on	Mobile connection connected

2.1.5 WIFI-Hotspot LED

The green-red WIFI-Hotspot LED shows the state of the WIFI-Hotspot. Table 5 depicts all possible states of the WIFI-Hotspot LED.

Table 5: States of the WIFI-Hotspot LED

LED state	Description
Off	WIFI-Hotspot off
Green	WIFI-Hotspot on
Red	Error - Please check WIFI settings in Windows

2.1.6 UltraSoundGates Status LEDs

The green UltraSoundGate Status LEDs show the number of connected UltraSoundGates and therefore also the number of available microphone channels.

2.1.7 SIM-Card Slot

To establish a cellular data connection and to send and receive SMS a SIM card (Mini-SIM, also often called Classic-SIM or Standard-SIM) with an adequate SMS and data plan is required. The SIM card has to be inserted into the SIM card slot as depicted on the device and in figure 1.

Basically, bat bioacoustictechnology recommends the use of PIN free SIM cards, because only an inactivated PIN allows to unlock the SIM card after a reboot of the system automatically.

2.1.8 Analog Temperature Sensor Connector (exclusively BATmode 2S+)

To acquire temperature data a temperature sensor can be connected to the BATmode 2S+ system via a mini-XLR connector (see Table 6). The BATmode 2S+ is specified for the temperature sensor integrated in the system´s antenna disc. The corresponding pin connection is presented in Table 6.

Table 6: Pin connection of the temperature sensor connector

Pin-Number	Description
1	Ground
2	Sensor output
3	Power supply

Do not use unauthorized temperature sensors und connection wires, since this can cause system failure, damage and the loss of data.

2.1.9 Analog Precipitation Sensor Connector (exclusively BATmode 2S+)

To acquire precipitation data a precipitation sensor can be connected to the BATmode 2S+ - System via a mini-XLR connector (see Table 7). The BATmode 2S+ is specified for the Infrared Precipitation Sensor 5.4103.20.041 manufactured by Adolf Thies GmbH & Co. KG. It can be purchased including a suiting connection cable from bat bioacoustictechnology. The corresponding pin connection is presented in Table 7.

Table 7: Pin connection of the precipitation sensor connector

Pin-Number	Description
1	Ground
2	Sensor output -
3	Not connected
4	Sensor output +

Do not use unauthorized precipitation sensors und connection wires, since this can cause system failure, damage and the loss of data.

2.1.10 Heating Output Connector

The BATmode can supply a microphone heating integrated in the microphone disc of bat bioacoustictechnology. The corresponding pin connection is presented in Table 8.

Table 8: Pin connection of the heating output connector

PIN	Description
Shell	Ground
Inner contact	12 - 19V DC

If the BATmode system is used for a simultaneous data acquisition at several measuring points, the heating output can also be used to supply power to a USB hub. In this case, the heating of the microphone discs is supplied with the USB heating cables.

Please note that microphone discs with a heating connection marked with "5V" have to be operated only via USB heating cables and not via the heating output of the BATmode. Violation may result in the destruction of the microphone heater and equipment failure and damage, as well as data loss.

Do not use the heating output to supply microphone heating units or USB hubs of other manufactures than bat bioacoustictechnology. The use of unauthorized microphone discs, USB hubs and connection wires can cause system failure, damage and the loss of data.

2.1.11 Power Supply Connector

The BATmode can be powered through a 12-19 V DC connector on the back panel (see figure 2). The back panel DC connector is compatible with a 5.5 mm/OD (outer diameter) and 2.5 mm/ID (inner diameter) plug, where the inner contact is +12-19 (±10%) V DC and the shell is GND. The maximum current rating is 10 A.

Use only power supplies of bat bioacoustictechnology to power the BATmode. The use of unauthorized power supplies und connection wires can cause system failure, damage and the loss of data.

2.2 Cellular Antenna with Magnetic Base (exclusively BATmode 2S)

Quadband antenna for cellular network connection of the BATmode 2S.

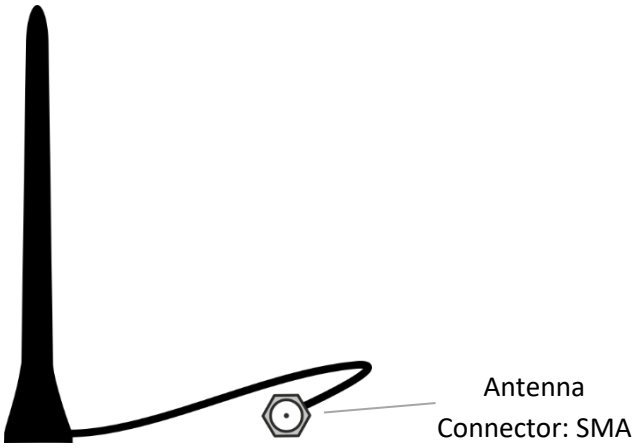


Figure 3: Cellular Antenna with Magnetic Base

2.3 Antenna Disc (exclusively BATmode 2S+)

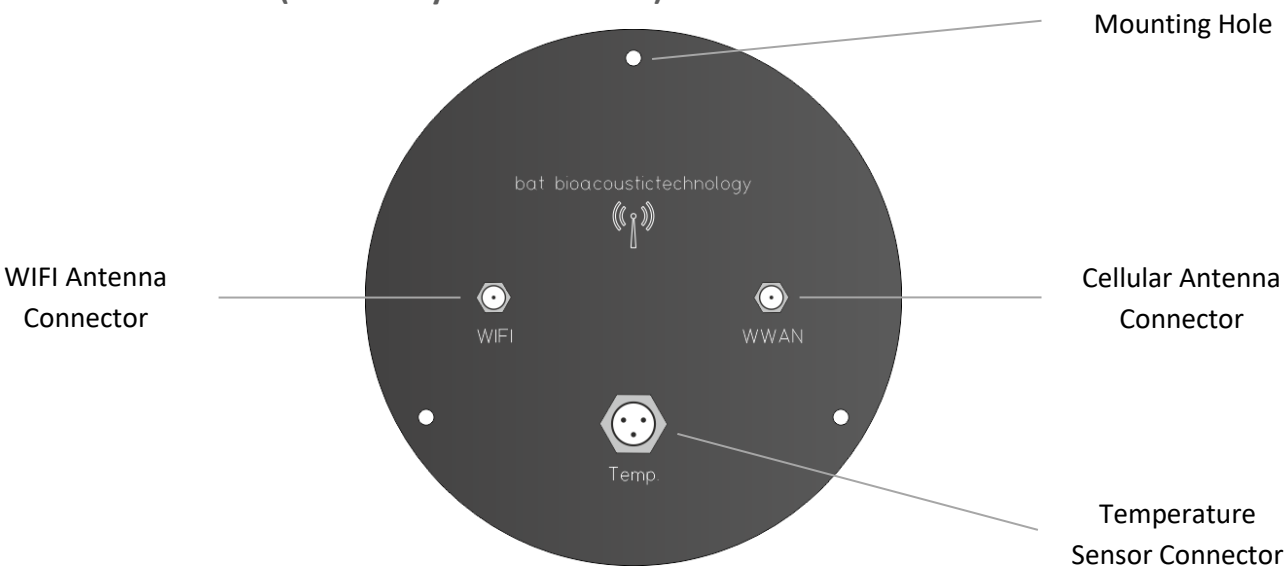


Figure 4: Antenna Disc

The Antenna Disc contains a directional WIFI antenna. Since the direction of the strongest signal is directed into the paper plane, the disc has to be installed with the illustrated connector side turned away from a potential connection partner.

2.4 Microphone Disc GM50 (optionally)

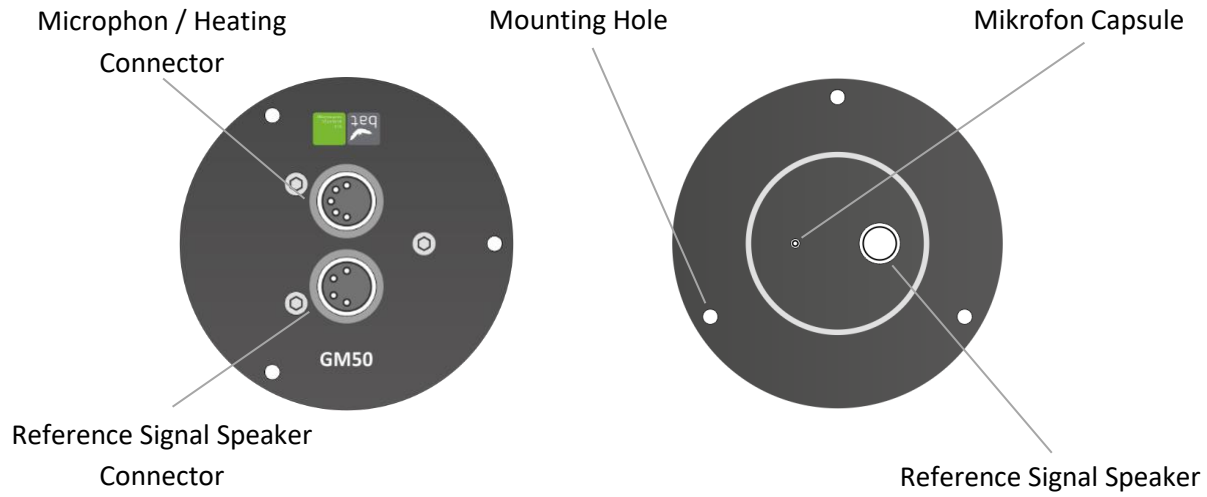


Figure 5: Front and Back View Microphone Disc GM50

The Microphone Disc GM50 can either be used with the enclosed mounting plate or with an optional tripod. Nevertheless, calibration of the GM50 is executed with mounted mounting plate.

To connect the microphone and the reference signal speaker of the GM50 please use the Y-XLR microphone cable.

2.5 Microphone Disc GM90 (optionally)

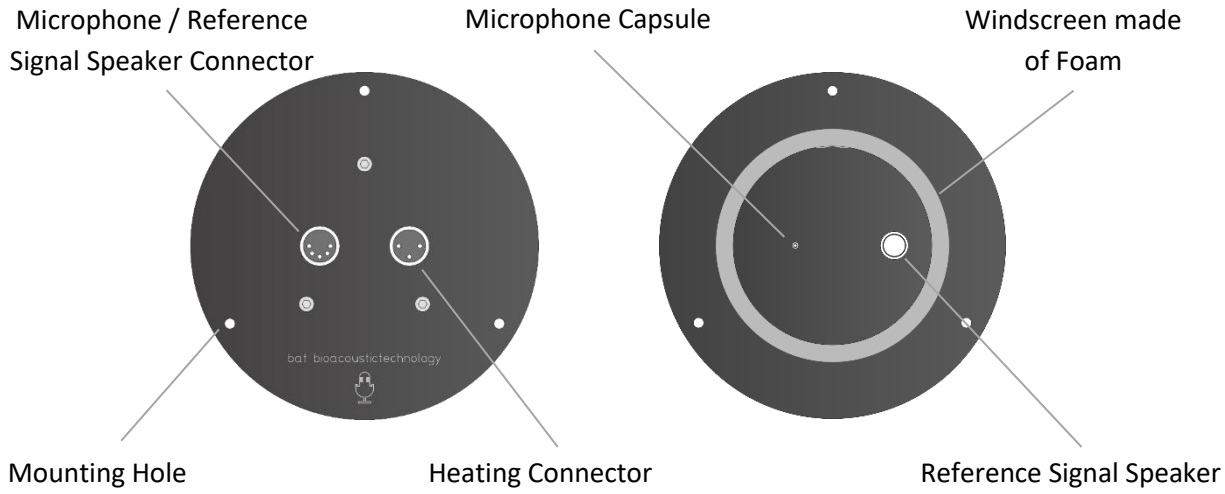


Figure 6: Front and Back View Microphone Disc GM90

Do not remove the windscreen foam, as this has an essential influence on the calibration of your microphone disc.

Please note that microphone discs GM90 with a heating connection marked with "5V" have to be operated only via USB heating cables and not via the heating output of the BATmode. Violation may result in the destruction of the microphone heater and equipment failure and damage, as well as data loss.

2.6 Tower Microphone TM10 without Reference Signal Speaker

The tower microphone TM10 has a diameter of 10mm and a length of 500mm. It can be fixed at any depth from 10 to 450mm with the help of an optional magnetic base that can be moved along the microphone.

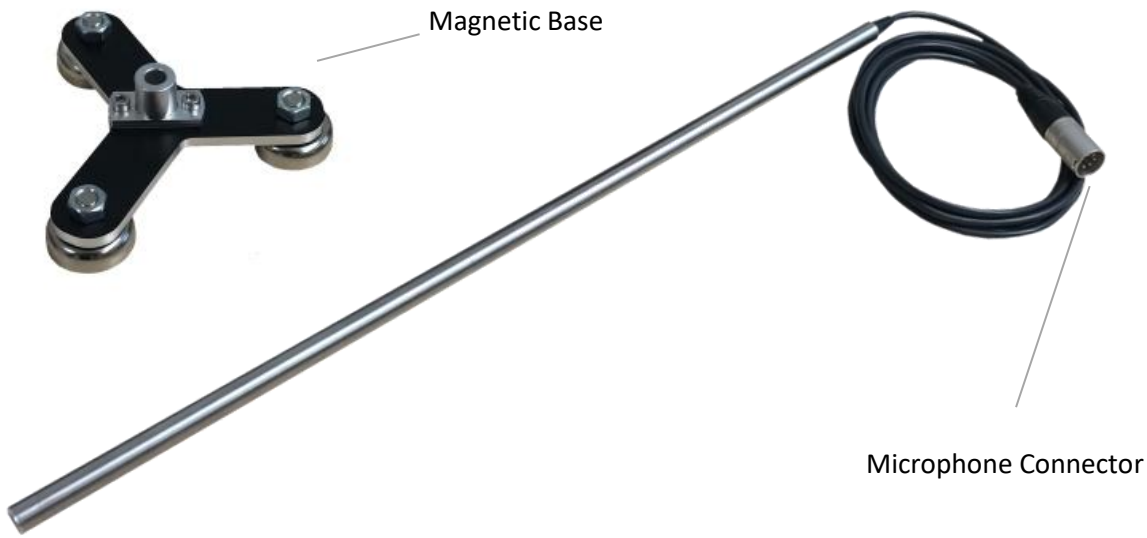


Figure 7: Tower Microphone TM10 with Magnetic Base

2.7 Tower Microphone TM20 with Reference Signal Speaker

The tower microphone TM20 has a diameter of 20mm and a length of 60mm. For mounting, it has on its back a M3 threaded hole. With the help of an optional mounting rod (length 400mm) and a magnetic base, which can be moved along the mounting rod, it can be fixed in any depth from 70 to 450mm.

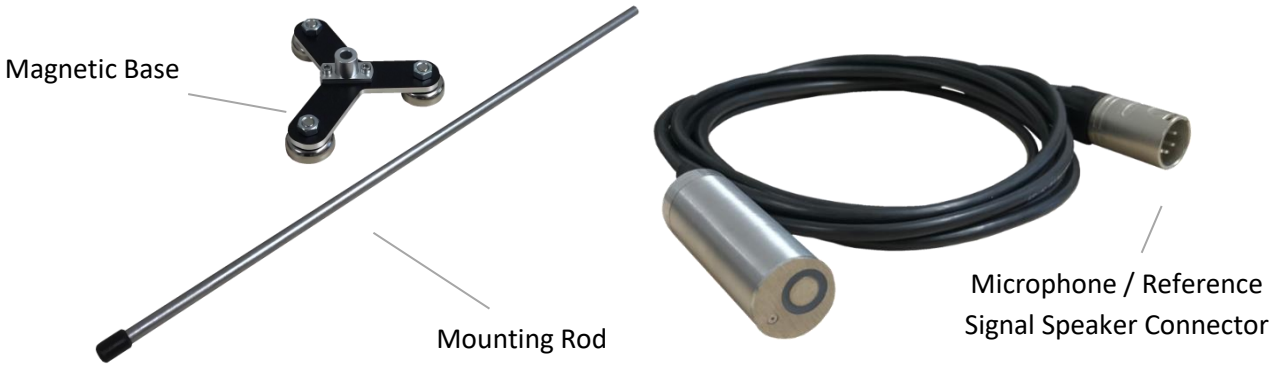


Figure 8: Tower Microphone TM20 with Mounting Rod and Magnetic Base

2.8 UltraSoundGate of Avisoft Bioacoustics (optionally)

The BATmode system can be used with either up to four single-channel UltraSoundGates 116Hnbm, one single-channel UltraSoundGate 116Hnbm and up to three single-channel UltraSoundGates 116Hnbm-r or a four-channel UltraSoundGate 416Hnbm from Avisoft Bioacoustics to record high quality acoustic data from bat calls.

In contrast to the UltraSoundGate 116Hnbm-r, the UltraSoundGates 116Hnbm and 416Hnbm also serve as hardware licensors for Avisoft Bioacoustics' RECORDER software. Since this RECORDER software is essential for the operation of the BATmode system, at least one UltraSoundGate with license must always be connected to the BATmode system.

For more information, please read the instruction manuals of the UltraSoundGates, which can be downloaded from www.avisoft.com.

Figure 9: UltraSoundGate 116Hnbm

Figure 10: UltraSoundGate 116Hnbm-r

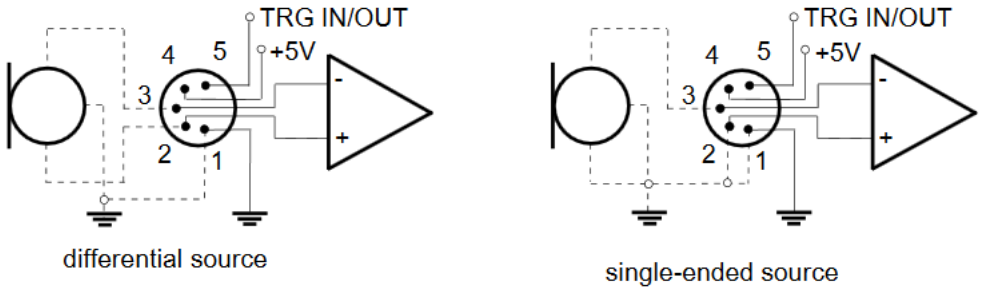
Figure 11: UltraSoundGate 416Hnbm

2.8.1 XLR-Input Connector

The 5-pin XLR-Input connectors represents the analog inputs of the recording devices UltraSoundGate 116Hnbm as well as 416Hnbm and provide power supply voltages for external preamplifiers and microphones. The connector scheme is listed in Table 9.

Table 9: Pin connection of the XLR-input connectors

Pin-Number	Description
1	Ground
2	Positive input
3	Negative input
4	+5 V supply voltage (max. current 20 mA)
5	TRG input/output



2.9 4 Port USB Hub EX-1163HM from Exsys (optionally)

The 4 port USB hub is used to connect several UltraSoundGates 116Hnbm/116Hnbm-r to the BATmode system. This allows to record acoustic data at several measuring points simultaneously. For more information about the USB hub, please refer to the enclosed manual of the device.

Figure 12: 4 Port USB Hub Ex-1163HM

3 START-UP

3.1 Installation

The following chapter explains the installation of the BATmode system in the nacelle of a wind turbine. If you use microphone discs or bat detector dongles not purchased from bat bioacoustictechnology please follow the installation instructions of the manufacturer of your devices.

3.1.1 BATmode 2S and BATmode 2S+ Main Detector Unit

The main detector unit has to be installed protected against splashing water and mechanical strain.

If you want to install the device on a VESA compatible mounting plate, remove the device´s feet and install the provided VESA mounting brackets. Use the VESA mounting screws to fix the device on the mounting plate.

If you install the device on a DIN rail, please use the DIN rail mounting kit, which is available from bat bioacoustictechnology as accessory.

bat bioacoustictechnology recommends the use of the BATbox S, which is especially made for an easy and safe installation of the BATmode 2S and BATmode 2S+ in wind turbines. Since the BATmode is installed in the BATbox S on a DIN rail, the BATmode comes with preinstalled DIN rail mounting kit when you purchase a BATmode system and a BATbox S at the same time.

Be careful not to damage the warranty seals, when removing the device´s feet. A damaged seal will invalidate the warranty agreement.

Ensure a sufficient air circulation around the BATmode 2S and BATmode 2S+ main detector unit. Overheating can cause system failure or damage to the BATmode system.

3.1.2 UltraSoundGate 116Hnbm/116Hnbm-r (optional)

The BATmode can be operated with up to four UltraSoundGates 116Hnbm or one UltraSoundGate 116Hnbm and up to three UltraSpundGates 116Hnbm-r. These has to be installed protected against splashing water and mechanical strain next to the main detector unit.

bat bioacoustictechnology recommends the use of the BATbox S, which is especially made for an easy and safe installation of the UltraSoundGate 116Hnbm/116Hnbm-r in wind turbines. To mount the UltraSoundGate 116Hnbm/116Hnbm-r in the BATbox S use the clamp in the BATbox S.

3.1.3 UltraSoundGate 416Hnbm (optionally)

Alternatively, to the UltraSoundGate 116Hnbm/116Hnbm-r, the BATmode can also be used with an UltraSoundGate 416Hnbm. This has to be mounted protected against splashing water and mechanical strain next to the BATmode.

bat bioacoustictechnology recommends the use of the BATbox S. This is especially designed for an easy and safe installation of the UltraSoundGate 416Hnbm in the nacelle of wind turbines. The UltraSoundGate 416Hnbm is fixed on the inside of the door of the BATbox S with a Velcro strip (not included in delivery scope).

3.1.4 Cellular Antenna with Magnetic Base (exclusively BATmode 2S)

With its magnetic base, the cellular antenna of the BATmode 2S can be easily mounted on most metallic surfaces. Please consider that electromagnetic shielding caused by closed metallic housings (for example the nacelle housing of a wind turbine, which is made of aluminium) may result in poor cellular network reception. In such cases, try to install the antenna outside the electromagnetic shielding producing housing.

3.1.5 Antenna Disc (exclusively BATmode 2S+)

To install the antenna disc, drill a mounting hole with 100 mm diameter in the bottom of the nacelle of the wind turbine. To guarantee for the best possible WIFI reception at the tower base the disc should be installed looking down to the ground as vertically as possible. The disc has to be mounted with three 3.5 mm SPAX-screws. bat bioacoustictechnology recommends to pre-drill the mounting holes for the SPAX-screws.

To avoid damage caused by water do not install the disc in the lowest point of the nacelle. Moisture can cause system failure or damage to the BATmode system.

If the BATmode 2S+ system is installed at sites other than the nacelle of the wind turbines, aim the antenna disc towards a potential receiver and install it using the mounting holes.

Please note that the range of the WIFI signal may be significantly reduced due to objects in the signal propagation path.

Since the temperature sensor of the BATmode 2S+ system is located in the antenna disc, an installation of the antenna disc inside the tower of a wind turbine or other closed rooms can lead to corrupt recorded temperature data.

3.1.6 Microphone Disc GM50/GM90 (optionally)

To install the microphone disc GM50 or GM90 also a mounting hole with 60 or 100 mm diameter, respectively, has to be drilled in the bottom of the nacelle of the wind turbine. In compliance to most legal guidelines, the best place is at the bottom of the nacelle between the tower and the rotor of the wind turbine. To guarantee for optimal acoustical bat monitoring results the disc should be installed looking down to the ground as vertically as possible. The disc has to be mounted with three 3.5 mm SPAX-screws. bat bioacoustictechnology recommends to pre-drill the mounting holes for the SPAX-screws.

To avoid damage caused by water do not install the disc in the lowest point of the nacelle. Moisture can cause system failure or damage to the BATmode system.

Since the GM90 microphone disc is calibrated with the foam ring for weather protection, do not remove it to ensure a correct data acquisition.

3.1.7 Tower Microphones TM10 and TM20 (optionally)

To install the tower microphones in the wall of the tower of the wind turbine, a borehole with at least 22mm (TM20) or 14mm (TM10) diameter is required. If possible, this should be on the side of the tower facing away from the main rain and wind direction. With the help of the optional mounting rod and the magnetic base, the microphones can be fixed in steel towers to the desired depth. For tower made of concrete, please use adhesive pads on the magnetic feet to attach the microphones on the inner wall.

Alternatively, the TM20 Tower Microphone can also be fixed using a M3 threaded hole on the back of the microphone housing.

Make sure that the tip of the tower microphones slightly protrudes on the outside of the tower. If your microphone tip is within the borehole, acoustic reflections on the bore walls may reduce the quality of your recordings.

3.1.8 USB Hub (optionally)

The USB hub has to be mounted protected against splashing water and mechanical strain.

To install the USB hub, use either the mounting holes in the hub housing or the enclosed DIN rail mount.

bat bioacoustictechnology recommends the use of the BATbox S. This is especially designed for an easy and safe installation of the USB hub in the nacelle of wind turbines. The USB hub is fixed and grounded in the BATbox S on a DIN rail.

3.1.9 USB power plug (optionally)

The USB power plugs, which supply the heating units of the microphone discs, have to be plugged into a 230V socket protected against splashing water.

3.2 Connecting

Only use power supplies authorized or supplied by bat bioacoustictechnology, since the use of different devices can cause system failure, damage and loss of data. Do not use tools (nipper, wrench, …) for fixation of cable connections since this can damage the connectors and/or the wires. Always use strain reliefs to avoid unintentional disconnection.

3.2.1 When measuring at one or two measuring points with UltraSoundGates 116Hnbm/116Hnbm-r

1. Connect the USB 2.0 interface connectors of the UltraSoundGates with the green marked UltraSoundGate ports on the front of the BATmode (see Figure 1).
2. If you utilize GM50 microphone discs with two XLR ports, connect the XLR-input connectors of the UltraSoundGates with the single end of the microphone cables. Subsequently, connect both connectors at the other end of the y-wires with the microphone and reference signal speaker connectors of the GM50 microphone discs. Due to different pin numbers, it is not possible to connect the microphone cable incorrectly. If you are using GM90 microphone discs, use the microphone cable to connect the microphone input of the UltraSoundGates to the microphone connector of the GM90 microphone discs.

   When using tower microphones TM10 or TM20, connect the built-in cables to the XLR microphone input of the respective UltraSoundGate.
3. When measuring at one measuring point using a GM90 microphone disc, contact the microphone heater by connecting the heating output connector on the BATmode to the microphone disc with the heating cable.

   When measuring at two measuring points and using two GM90 microphone discs, contact the microphone heaters of the microphone discs by connecting the USB heating cables to the USB power plugs and plug them into a 230V outlet.

Please note that microphone discs GM90 with a heating connection marked with "5V" have to be operated only via USB heating cables and not via the heating output of the BATmode. Violation may result in the destruction of the microphone heater and equipment failure and damage, as well as data loss.

4. **Exclusively BATmode 2S:**
   Connect the cellular antenna to the cellular antenna connector of the BATmode 2S.

   Exclusively BATmode 2S+:
   Connect the antenna wires with the corresponding connectors at the BATmode 2S+ and the antenna disc.

   Ensure not to interchange both wires. This would cause declined signal reception levels of the WIFI and cellular network connection.

5. **Exclusively BATmode 2S+:**

   Use the temperature sensor cable to connect the analog temperature sensor input of the BATmode 2S+ with the corresponding temperature sensor output of the antenna disc.

6. **Exclusively BATmode 2S+:**
   Optionally, precipitation data can be acquired by the BATmode 2S+ via the analog input or USB/RS485 or USB/422 interface. For this purpose, a precipitation sensor has to be connected to BATmode 2S+. For connecting, please refer to the manual of the precipitation sensor.

Only use authorized precipitation sensors und connection wires, since the use of different devices can cause system failure, damage and loss of data.

7. To simplify the parameterization of the BATmode system peripheral pc devices (mouse, keyboard, screens, …) can be connected to the free USB and Minidisplay ports, optionally.
8. If it is intended to use wired LAN connection to remotely access the BATmode system, connect a corresponding Ethernet cable to the LAN port (RJ45, not included in delivery) of the BATmode.
9. Finally, connect the power supply to the BATmode.

3.2.2 When measuring at more than two measuring points with UltraSoundGates 116Hnbm/116Hnbm-r

1. Initially, using a USB cable to connect the upstream port of the USB hub to one of the UltraSoundGate ports on the front panel of the BATmode (see Figure 1).
2. Use the remaining USB cables to connect the UltraSoundGates 116Hnbm to the downstream ports on the USB hub.
3. If you utilize GM50 microphone discs, connect the XLR-input connectors of the UltraSoundGates with the single end of the microphone cables. Subsequently, connect both connectors at the other end of the y-wires with the microphone and reference signal speaker connectors of the GM50 microphone discs. Due to different pin numbers, it is not possible to connect the microphone cable incorrectly. If you are using GM90 microphone discs, use the microphone cables to connect the microphone input of the UltraSoundGates to the microphone connector of the GM90 microphone discs.

   When using tower microphones TM10 or TM20, connect the built-in cables to the XLR microphone input of the respective UltraSoundGate.

4. If you utilize GM90 microphone discs, contact the microphone heaters of the microphone discs by connecting the USB heating cables to the USB power plugs and plug them into a 230V outlet.

Please note that microphone discs GM90 with a heating connection marked with "5V" have to be operated only via USB heating cables and not via the heating output of the BATmode. Violation may result in the destruction of the microphone heater and equipment failure and damage, as well as data loss.

5. **Exclusively BATmode 2S:**
   Connect the cellular antenna to the cellular antenna connector of the BATmode 2S.

   Exclusively BATmode 2S+:
   Connect the antenna wires with the corresponding connectors at the BATmode 2S+ and the antenna disc.
   Ensure not to interchange both wires. This would cause declined signal reception levels of the WIFI and cellular network connection.

6. **Exclusively BATmode 2S+:**

   Use the temperature sensor cable to connect the analog temperature sensor input of the BATmode 2S+ with the corresponding temperature sensor output of the antenna disc.

7. **Exclusively BATmode 2S+:**
   Optionally, precipitation data can be acquired by the BATmode 2S+ via the analog input or USB/RS485 or USB/RS422 interface. For this purpose, a precipitation sensor has to be connected to BATmode 2S+. For connecting, please refer to the manual of the precipitation sensor.

Only use authorized precipitation sensors und connection wires, since the use of different devices can cause system failure, damage and loss of data.

8. To simplify the parameterization of the BATmode system peripheral pc devices (mouse, keyboard, screens…) can be connected to the free USB and Minidisplay ports, optionally.
9. If it is intended to use wired LAN connection to remotely access the BATmode system, connect a corresponding Ethernet cable to the LAN port (RJ45, not included in delivery) of the BATmode.
10. Finally, connect the power supply to the BATmode.

3.2.3 When measuring at multiple measuring points with an UltraSoundGate 416Hnbm

1. Connect the USB 2.0 interface connector of the UltraSoundGate 426Hnbm with one of the green marked UltraSoundGate ports on the front of the BATmode (see Figure 1).
2. If you utilize GM50 microphone discs, connect the XLR-input connectors of the UltraSoundGate with the single end of the microphone cables. Subsequently, connect both connectors at the other end of the y-wires with the microphone and reference signal speaker

connectors of the GM50 microphone discs. Due to different pin numbers, it is not possible to connect the microphone cable incorrectly. If you are using GM90 microphone discs, use the microphone cables to connect the microphone inputs of the UltraSoundGate to the microphone connector of the GM90 microphone discs.

When using tower microphones TM10 or TM20, connect the built-in cables to the XLR microphone inputs of the UltraSoundGate.

3. If you utilize GM90 microphone discs, contact the microphone heaters of the microphone discs by connecting the USB heating cables to the USB power plugs and plug them into a 230V outlet.

Please note that microphone discs GM90 with a heating connection marked with "5V" have to be operated only via USB heating cables and not via the heating output of the BATmode. Violation may result in the destruction of the microphone heater and equipment failure and damage, as well as data loss.

4. **Exclusively BATmode 2S:**
   Connect the cellular antenna to the cellular antenna connector of the BATmode 2S.

   Exclusively BATmode 2S+:
   Connect the antenna wires with the corresponding connectors at the BATmode 2S+ and the antenna disc.
   Ensure not to interchange both wires. This would cause declined signal reception levels of the WIFI and cellular network connection.

5. **Exclusively BATmode 2S+:**

   Use the temperature sensor cable to connect the analog temperature sensor input of the BATmode 2S+ with the corresponding temperature sensor output of the antenna disc.

6. **Exclusively BATmode 2S+:**
7. Optionally, precipitation data can be acquired by the BATmode 2S+ via the analog input or USB/RS485 or USB/RS422 interface. For this purpose, a precipitation sensor has to be connected to BATmode 2S+. For connecting, please refer to the manual of the precipitation sensor.

Only use authorized precipitation sensors und connection wires, since the use of different devices can cause system failure, damage and loss of data.

8. To simplify the parameterization of the BATmode system peripheral pc devices (mouse, keyboard, screens…) can be connected to the free USB and Minidisplay ports, optionally.
9. If it is intended to use wired LAN connection to remotely access the BATmode system, connect a corresponding Ethernet cable to the LAN port (RJ45, not included in delivery) of the BATmode.
10. Finally, connect the power supply to the BATmode.

3.3 First Start-Up

During first start-up of the BATmode system, the following steps should be executed in the named order to individually setup the system and activate all functions.

1. Insert a SIM card in the corresponding slot of the BATmode. The data plan has to include SMS and/or data transmission.

   Basically, bat bioacoustictechnology recommends the use of PIN free SIM cards, because only an inactivated PIN allows to unlock the SIM card after a reboot of the system automatically.

2. For an initial parameterization connect the peripheral pc devices named in chapter 3.2 (mouse, keyboard, screen) to the BATmode.
3. After connecting the BATmode to the power supply start the system by pressing the On-/Off-switch.
4. While starting Windows the BATcontrol software will be opened automatically.
5. For a start, close the BATcontrol software.
6. The first step now should be to change your user password to ensure data integrity. This is a two-step process:
   - To assign a safe new password press <Ctrl-Alt-Del> and click <Change Password> (pre-configured password: “12345“).
   - To allow for an automatic log-on to Windows you have to change the auto-log-on password with the tool “ChangeAutologonPassword”, which can be find under *<Start -> All Programs -> bat bioacoustictechnology -> ChangeAutologonPassword>.*

   Important: Both passwords have to match!
7. If you inserted a SIM card, you have to specify the APN data of your mobile provider to establish a cellular data connection. For this purpose:
   - Navigate to *<Start -> Settings -> Network&Internet -> Cellular>.*
   - Choose the shown cellular network.
   - Click <Advanced options> and *<Add an Internet APN>.*
   - Choose a *<Profile name>*, for instance “telekom”.
   - Type the provided *<APN>*, *<User name>* and *<Password>*.
   - Choose *<Type of sign-in info* > “None”.
   - Choose *<IP type>* “Default”.
   - Enable *<Apply* this profile>.
   - Click *<Save>*.
8. Start BATcontrol.
9. **Exclusively BATmode 2S+:**

   Assign new WIFI hotspot settings on the page *<Connectivity>*. Insert a new WIFI-SSID as well as a new password and start the hotspot.

3.4 Remote access to the BATmode System

Alternatively, you can use peripheral devices named in chapter 3.2 to parameterize the BATmode system and start the acoustical monitoring or you can utilize remote access via WIFI, LAN or cellular network connections.

3.4.1 Remote Access via WIFI Connection

To allow for a remote access via WIFI BATcontrol provides a WIFI hotspot (pre-configured by bat bioacoustictechnology):

- SSID: Your chosen SSID (pre-configured SSID: „BATmode“)
- WIFI password: Your chosen WIFI password (pre-configured password: „12345678“)
- IP of the WLAN adapter: The IP can be found in BATcontrol on the connectivity page or in myBAT. In most cases, the IP is “192.168.137.1”.
- User: BAT
- User password: Your chosen user password (pre-configured user password: „12345“)

The SSID as well as the password of the WIFI hotspot can be changed in BATcontrol.

To change the user password please refer to bullet 6 in chapter 3.3.

Remote access is possible via WIFI-capable PCs (Windows, Linux or Mac OS operating systems), smartphones or tablets (Android, Windows phone, iOS), whereat additional programs or apps might be necessary. bat bioacoustictechnology recommends the following software tools:

- Windows: Additional software is not required; software is integrated in Windows (Remote Desktop Connection)
- Mac OS and iOS: Microsoft Remote Desktop
- Android and Windows Phone: Microsoft Remote Desktop

Example for Windows:

The following steps have to be executed on a Windows running PC to remotely access a BATmode via WIFI:

(a) Connect to the WIFI hotspot of the BATmode system (SSID and password see above).
(b) Open the program Remote Desktop Connection (for instance type "Remote Desktop Connection" in <*Search Windows*>).
(c) Enter in the field <*Computer*> the IP address of the WIFI adapter of the BATmode (see above).

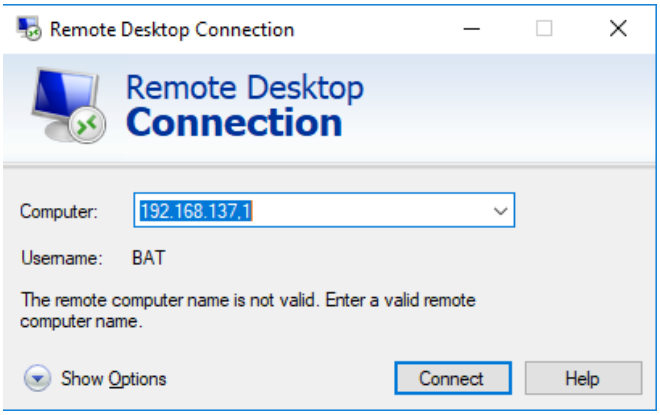


Figure 13: Connecting via Remote Desktop Connection

(d) Press <*Connect*> and sign in with your user password.

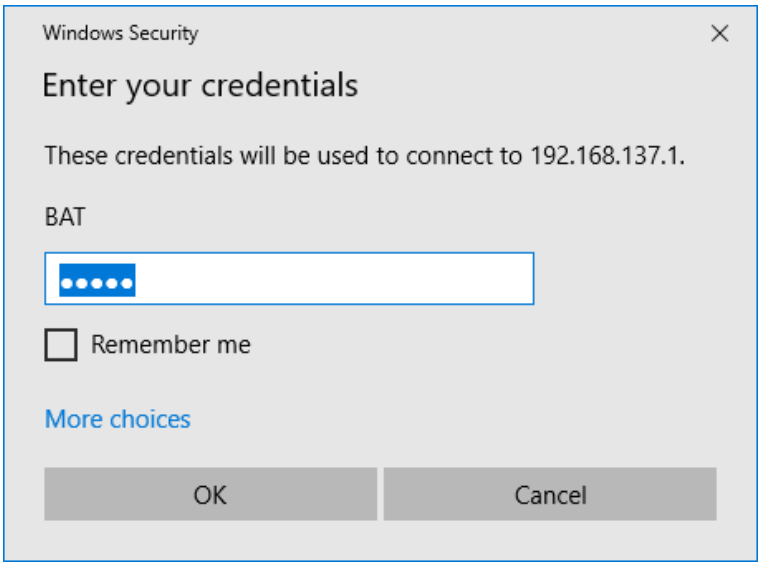


Figure 14: BATmode Login

Example for MAC OS:

The following steps have to be executed on an Apple PC to remotely access a BATmode via WIFI:

(a) Connect to the WIFI hotspot of the BATmode system (SSID and password see above).

(b) Add in the Wi-Fi Network settings a new search domain of your choice in the *<DNS>* tab under *<Advanced...>* (otherwise MAC OS requires an active internet connection to establish the connection to a BATmode)

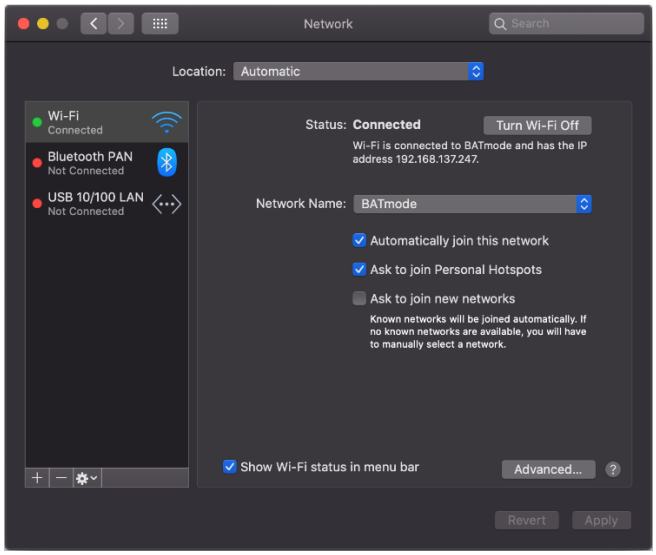


Figure 15: Wi-Fi Network Settings

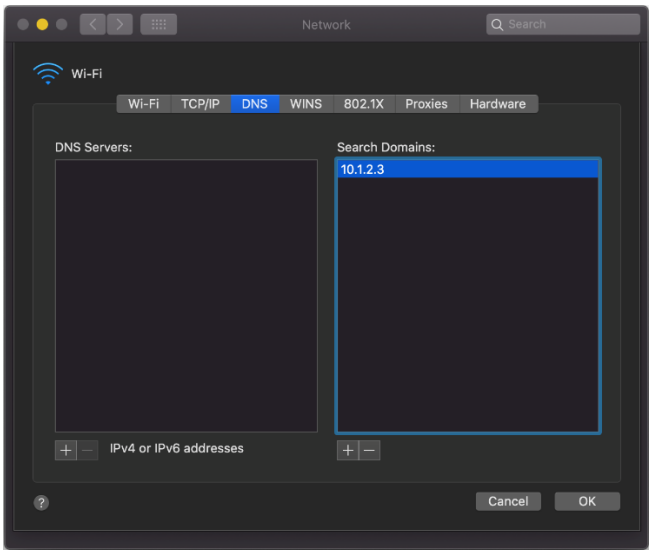


Figure 16: DNS Settings

(c) Open the *<Microsoft Remote Desktop>* application available in the App Store

(d) Enter the IP of the WLAN adapter of the BATmode system under *<PC name>*

(e) Press *<Add>*. You can then establish the connection by double-clicking on the created entry

3.4.2 Remote Access via LAN Connection

To establish a remote connection by LAN the BATmode has to be connected either to the WWW or directly to another PC (for example a Notebook) via the RJ45 port.

- If you connect the BATmode to the WWW please use a static and public IP address of the LAN adapter.
- If you connect the BATmode directly to another PC, use the computer name “BATmode” instead the IP-address to access the BATmode via remote desktop connection.
- User: BAT
- User password: Your chosen user password (pre-configured user password: „12345“)

To change the user password please refer to bullet 6 in chapter 3.3.

Remote access is possible via PCs (Windows, Linux or Mac OS operating systems), smartphones or tablets (Android, Windows phone, iOS), whereat additional programs or apps might be necessary. bat bioacoustictechnology recommends the following software tools:

- Windows: Additional software is not required; software is integrated in Windows (Remote Desktop Connection)
- Mac OS and iOS: Microsoft Remote Desktop
- Android and Windows Phone: Microsoft Remote Desktop

To establish a remote desktop connection via LAN and WWW the IP address of the BATmode have to be public. If your provider uses a NAT server, your IP address is not public. In such cases server based remote services can be used (bat bioacoustictechnology recommends TeamViewer, see Chapter 3.4.4). However, to utilize those services, the corresponding software has to be installed on the BATmode as well as on the accessing PC, smartphone or tablet.

Example for Windows:

The following steps have to be executed on a directly connected Windows running PC to access a BATmode:

(a) Connect the BATmode directly with the other PC via an Ethernet cable.
(b) Open the program Remote Desktop Connection (for instance type “Remote Desktop Connection” in <Search Windows>).
(c) Enter in the field <*Computer*> the computer name “batmode”
(d) Press <*Connect*> and sign in with your user password.

Example for MAC OS:

The following steps have to be executed on a directly connected Apple PC to remotely access a BATmode:

(a) Connect the BATmode directly with the other PC via an Ethernet cable.
(b) Add in the LAN Network settings a new search domain of your choice in the <*DNS*> tab under <*Advanced...*> (see chapter 3.4.1)
(c) Open the <*Microsoft Remote Desktop*> application available in the App Store.
(d) Enter in the field <*PC name*> the computer name "batmode"
(e) Press <*Add*>. You can then establish the connection by double-clicking on the created entry

3.4.3 Remote Access via Cellular Data Connection

The cellular data connection is established via the mobile network. For this purpose, a SIM card has to be inserted in the BATmode and a connection has to be configured (APN settings, see bullet 1 and 7 in chapter 3.3).

Subsequently, if mobile reception level and SIM card balance are sufficient, the BATmode can be accessed remotely. Indeed, due to technical reasons, the SIM card need to feature a public IP address (ask your provider) to establish a connection. Alternatively, server based remote services can be used (bat bioacoustictechnology recommends TeamViewer, see chapter 3.4.4). However, to utilize those services, the corresponding software has to be installed on the BATmode as well as on the accessing PC, smartphone or tablet.

3.4.4 Remote Access and Data Download with TeamViewer

Important Note: To use TeamViewer a license can be required that can be purchased from the company TeamViewer. A free version is available for private use and a first test.

If your BATmode system is connected to the Internet (via LAN, see chapter 3.4.2, or via Cellular Data Connection, see chapter 3.4.3), you can remotely access your BATmode with TeamViewer as if you were sitting in front of it. A non-graphical data download is also possible with TeamViewer. In the following you will find instructions on how to set up the described remote access and what has to be considered.

1. Download the current TeamViewer Client from the TeamViewer homepage (www.teamviewer.cm/en/download/windows/) and install it on your BATmode System.
2. Select *Custom installation – with unattended access support.*

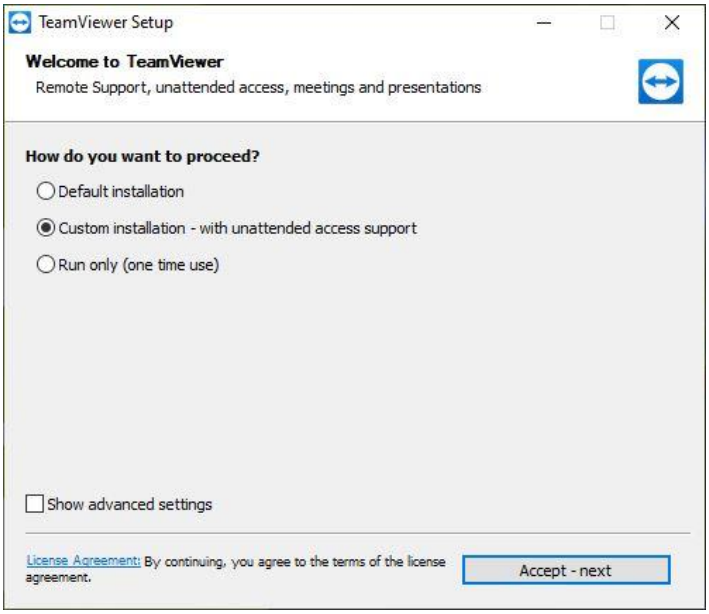


Figure 17: Custom installation - with unattended access support

3. Assign a computer name and password when setting up the *unattended access*.

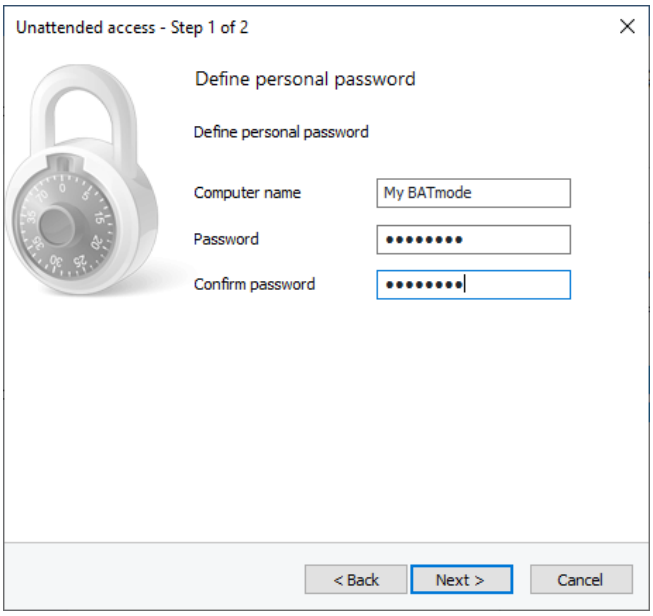


Figure 18: Setup of unattended access

4. In the next step you can create a TeamViewer account in which you can save the access and thus access the BATmode system faster. However, this is not mandatory.
5. In the final step the *TeamViewer ID* is shown. You will need this ID and your self chosen password to access your BATmode system remotely later.

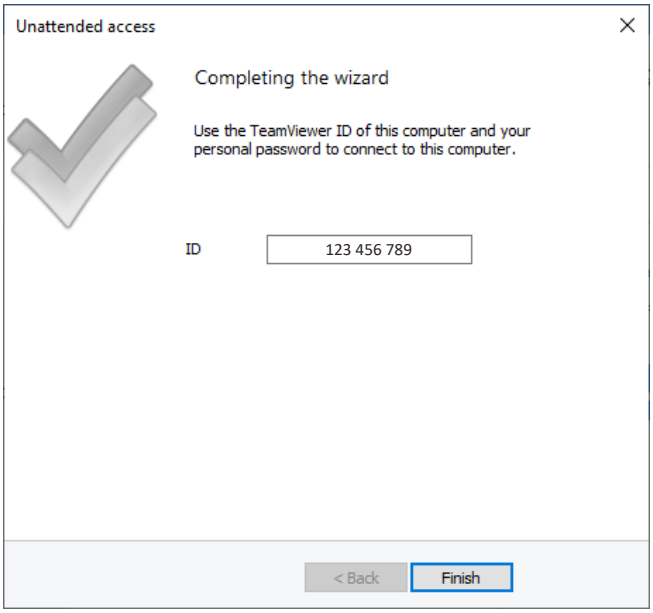


Figure 19: TeamViewer ID

6. Install the TeamViewer Client on your PC/laptop as well (no unattended access is required here). Remote access via tablet or smartphone is also possible, for this you need the corresponding TeamViewer app.

7. After the installation is finished you can log in to your BATmode system from your laptop/PC by entering the ID of the BATmode system under *Partner ID* and clicking *Connect*. You will then be asked for your password.

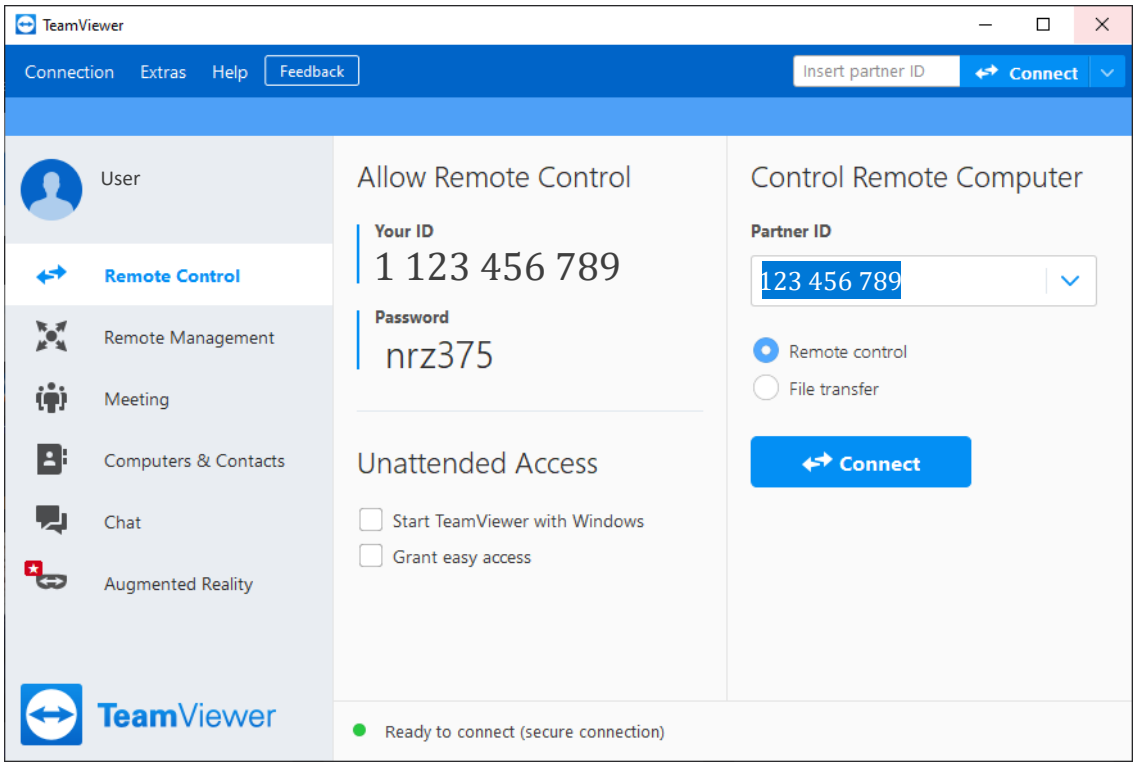


Figure 20: Remote control of your BATmode System

8. You are logged in on your BATmode system and have full remote access. You can now operate, configure, control and even make first evaluations with *BATscreen LITE/PRO* without having to download data.
9. If you want to download data, you can use the *Files & Extras* button in the upper bar of the window to open the *file transfer*. In the window that now opens, you will find the file structure of your PC or laptop on the left side and that of the BATmode system on the right side. You can now transfer files or whole folders between your PC or laptop and the BATmode system by *Drag & Drop* or by using the *Send* and *Receive* buttons.

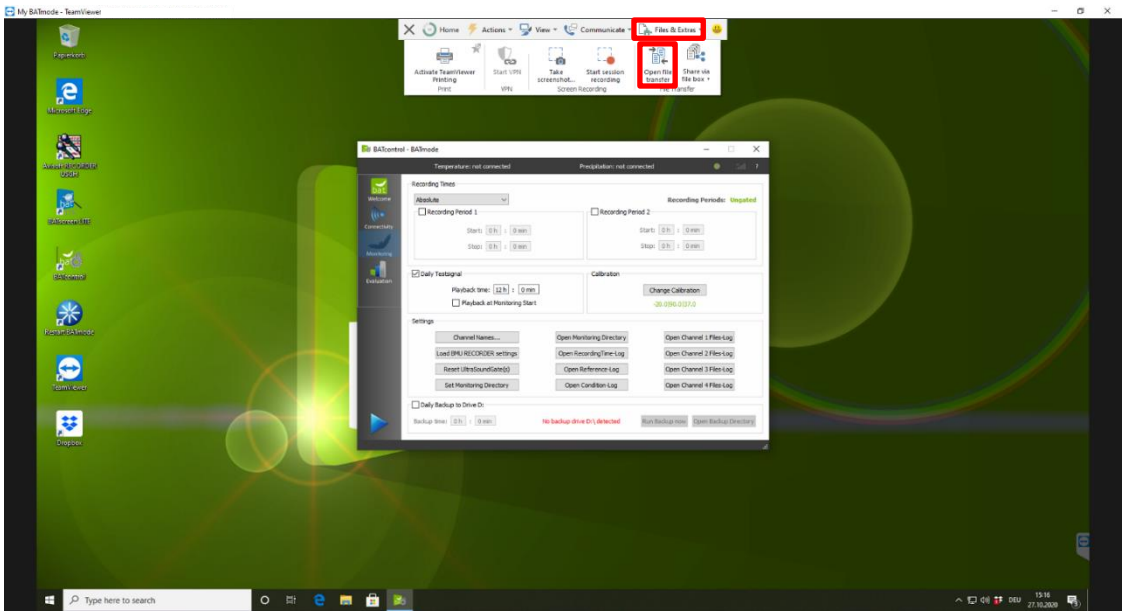


Figure 21: TeamViewer Remote Control Session to your BATmode System

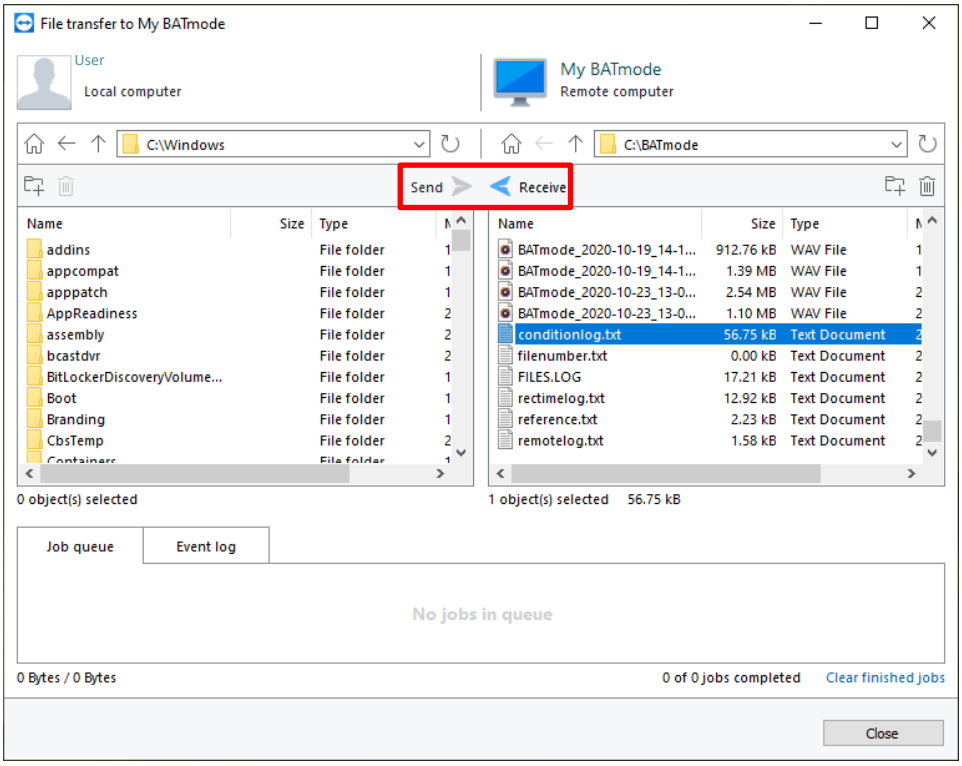


Figure 22: File transfer from your BATmode System

10. You can end the remote session by clicking the *cross* on the left in the upper bar of the window.
11. If you only want to transfer files (e.g. if the Internet connection is too slow for a graphical transfer), you can start the *file transfer* by activating the file transfer below the *Partner ID* in TeamViewer on your PC or laptop and clicking on *Connect*. You will then be asked for the password again (see Step 5) and the file transfer will start (see Figure 22: File transfer from your BATmode System).

3.4.5 Synchronization and Download of BATmode recordings with a Cloud

With the help of a cloud provider, all BATmode recordings and log files can be automatically synchronized and downloaded so that they can be accessed at any time from another computer with Internet access. For example, you can already check or evaluate the recorded data on your office computer during an ongoing bat monitoring session while the BATmode is still installed on the wind turbine and continues to record.

Please note that this requires a sufficient internet connection as well as a corresponding data volume of the internet connection for the BATmode. In the following you will find instructions for the cloud provider Dropbox™, Setup runs analogously for other clouds.

1. Download the latest Dropbox client from the cloud provider's homepage (www.dropbox.com/downloading) and install it on your BATmode.
2. During installation you must register or login with an existing account. You will also be asked how the synchronization should be done. Please select "*Make files local*" here.

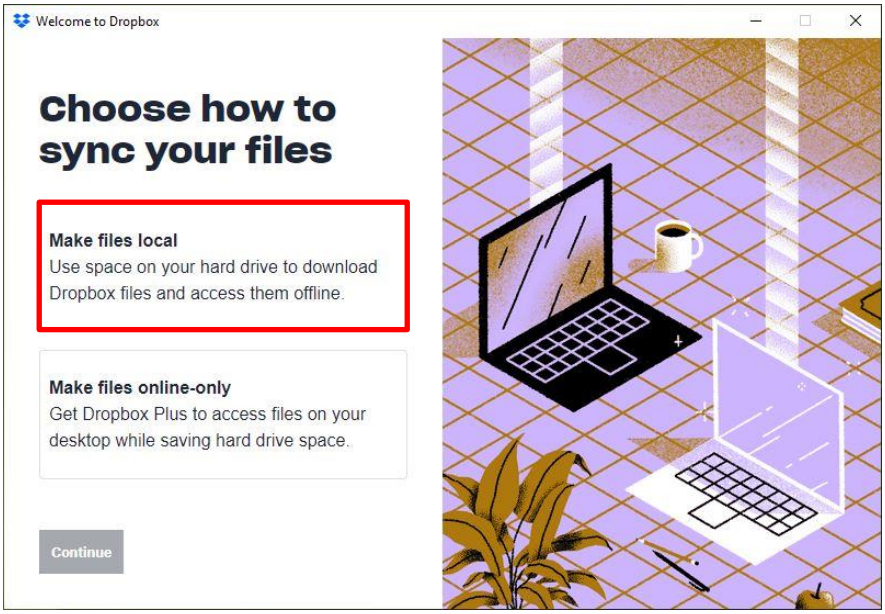


Figure 23: Make files local

3. After successful installation, a Dropbox folder is created (by default under *C:\Users\BAT\Dropbox*) This folder will be synchronized with your cloud storage and other logged-in devices (such as your personal laptop).
4. To synchronize BATmode recordings and log files, it is necessary to link the *Monitoring Directory* to your Dropbox folder. To do this, please go to BATcontrol and press the button "*Set Monitoring Directory*" on the page "*Monitoring*". In the window that now opens, please select the Dropbox folder created by the installation of the Cloud Client (by default under *C:\Users\BAT\Dropbox*) and confirm this with the button "*Select Folder*" (it is also possible to create a subfolder in the Dropbox folder).

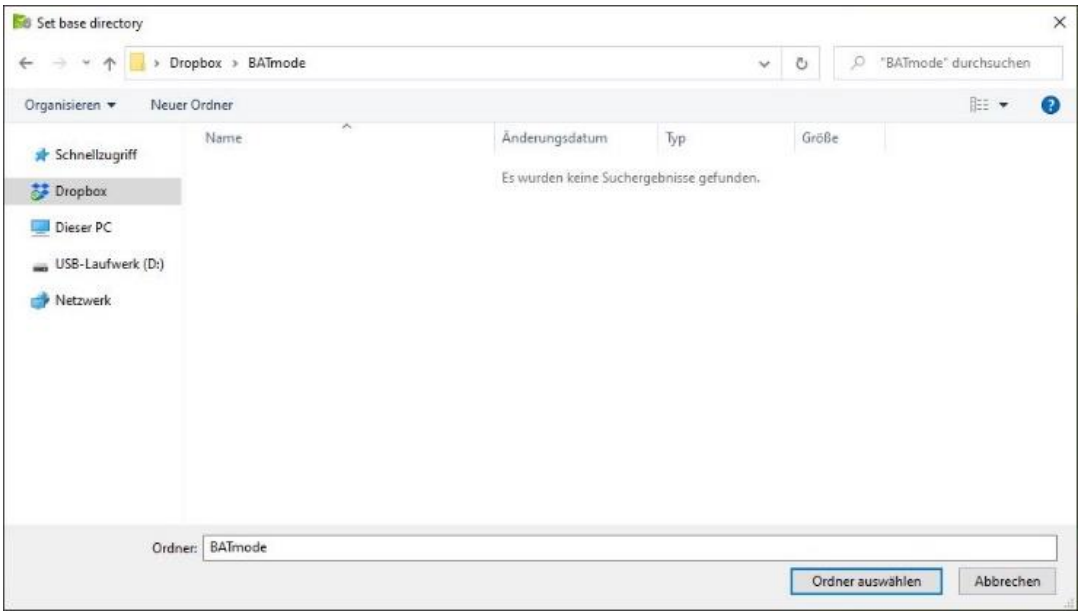


Figure 24: Linking the Monitoring Directory to the Dropbox folder

5. The recordings as well as log files are now stored in the Dropbox folder (or in a created subfolder if desired) and synchronized with the cloud provider. If you also install this client on your private or work computer, the data will be automatically downloaded to this PC.

4 BATCONTROL SOFTWARE

4.1 Structure

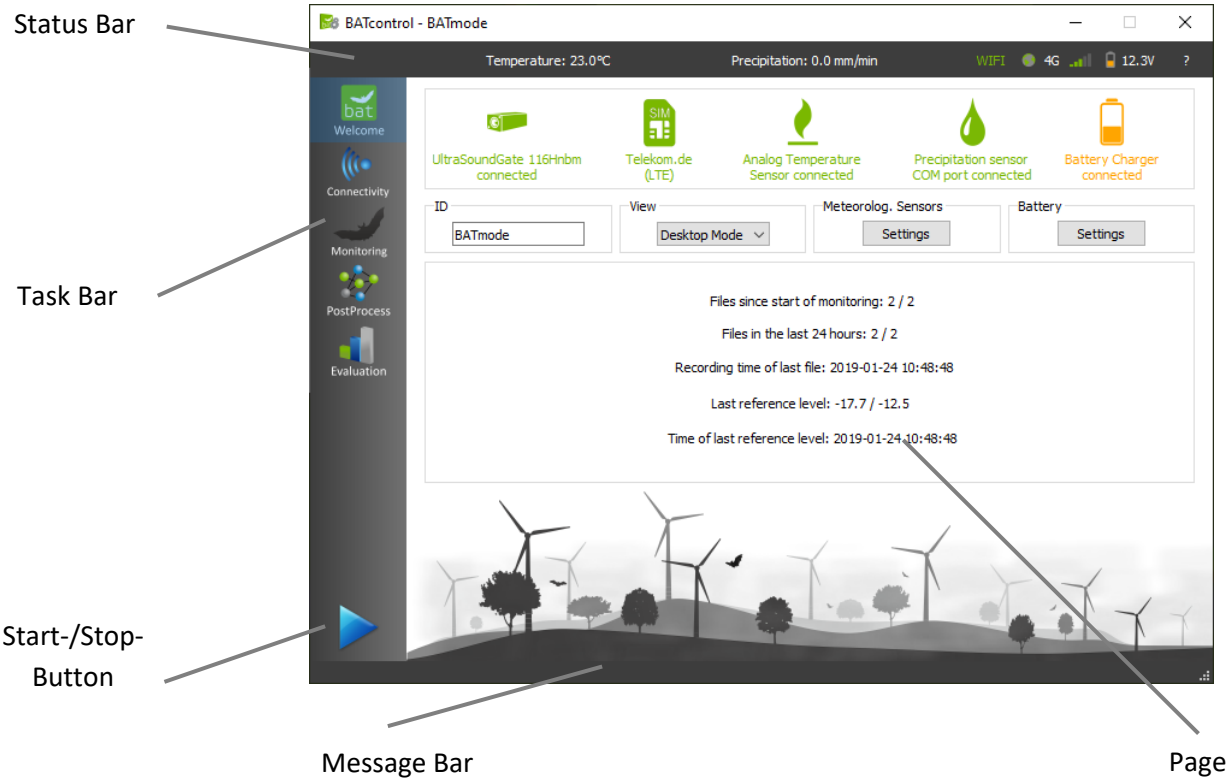


Figure 25: Structure of the BATcontrol software

Fundamental control elements of the BATcontrol software are depicted in Figure 25 and will be described within this chapter in detail.

Words in <…> represents designations used within the BATcontrol software.

4.1.1 Status Bar

The status bar shows current status data of the BATmode system:

- Current measured temperature value
- Current measured precipitation value and, when using the serial precipitation sensor SWS-250 from Biral, also the precipitation type as WMO code.
- WIFI hotspot (If the hotspot is started, a green WIFI symbol is shown.)
- Internet connection (If the BATmode is online a globe token is shown.)
- Type of the mobile broadband connection (G: GPRS, E: Edge, 3G: UMTS, H: HSPA, 4G: LTE)
- Signal level of the mobile broadband connection
- Battery State of Charge (SoC) when using photovoltaic power supply
- Version and License Information by clicking the <?> icon

4.1.1.1 Version and License Information

By clicking the <?> icon in the status bar you open the Version and License Information Window (see Figure 26). Here you get information about the version number of the installed BATcontrol, as well as the corresponding release date. With <*Check for Updates*> you can view all currently available BATcontrol versions and download them directly from the homepage of bat bioacoustictechnology.

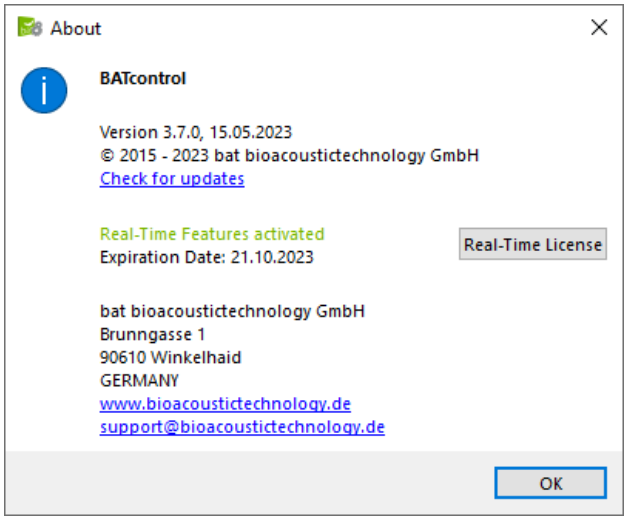


Figure 26: Version and License Information Window

The so-called Real-Time Features of BATcontrol allow to transfer recorded WAV files as well as the results of the post-processing AI Call Detector in real-time via MQTT. In the Version and License Information Window, you can see if the Real-Time features are enabled and when any existing license expires. By clicking <*Real-Time License*> you get further license information and can activate a purchased license. For more information on the Real-Time License, check chapter 4.3.

4.1.2 Task Bar

By using the task bar on the left side, you can switch between the program pages.

4.1.3 Pages

The following pages are available:

- <*Welcome*>: General information, settings for temperature and precipitation sensor and view settings
- <*Connectivity*>: Setting of WIFI hotspot, WWAN connection, status messages, remote control and myBAT
- <*Monitoring*>: Settings of the acoustical monitoring
- <*PostProcess*>: Settings of the Post-Processing of recorded WAV files.
- <*Evaluation*>: Visualization of different parameter over time and “at a glance” evaluation of the recorded acoustical data

In the following chapter 4.2, pages are described in detail.

4.1.4 Start-/Stop-Button

4.1.4.1 Acoustic Monitoring

The Start-/Stop-Button allows for starting and stopping of the acoustical monitoring and, if you using a BATmode 2S+, also the simultaneous recording of temperature and precipitation.

Settings used for the acoustic monitoring can be made on the <*Monitoring*> page.

The number of channels or measurement points to be acquired is selected automatically based on the connected UltraSoundGates. For example, if you want to examine two measurement points in parallel, connect two UltraSoundGates 116Hnbm to the system before starting the monitoring.

4.1.4.2 Recording of meteorological data

Meteorological data are stored in several files depending on the connected sensors:

“conditionlog.txt”:

When starting the monitoring with the start/stop button the recording of temperature and precipitation data starts automatically. An average value of the temperature and precipitation data recorded every 30-seconds is determined every 10 minutes, regardless of the recording times of the acoustic monitoring set on the page <Monitoring>, and is written to the file "conditionlog.txt" in the monitoring directory. The specified time stamp always refers to the beginning of the 10-minute mean interval. If no sensor is connected or if the system BATmode 2S is used, no recording of temperature and precipitation takes place.

“comportlog.txt”:

If you use a serial laser precipitation sensor from ThiesClima (5.4110.X0.XXX) or the SWS-250 from Biral, the telegram data of the sensor are additionally stored with a preceding time stamp in the file "comportlog.txt" in the monitoring directory when monitoring is started. The storage takes place as soon as a telegram arrives. You can configure the telegrams with the <Com Port Console> in the <Temperature and Precipitation Sensor Settings> in the precipitation sensors. Please note the following differences between the sensors from ThiesClima (5.4110.X0.XXX) and the Biral SWS-250 sensor:

- **ThiesClima (5.4110.X0.XXX):** The telegram data also contains the values of the optional additional meteorological sensors connected to the sensor. The telegram type and the time interval in which the Laser Precipitation Sensor transmits can be set with the <Com Port Console> in the <Temperature and Precipitation Sensor Settings>. The telegram type 8/9 and a time interval of one minute are recommended.
- **Biral SWS-250:** This sensor does not offer different telegram types. However, please note that data telegrams must always be sent without a preceding date and time stamp. The date and time setting and the time interval at which the precipitation sensor transmits can be set using the <Com Port Console>. A time interval of one minute is recommended. (Data telegrams without a preceding date and time stamp, as well as a time interval of one minute correspond to the default settings of the SWS-250 sensor).

“wmocodelog.txt”:

When using the precipitation sensor SWS-250 from Biral, additionally the file "wmocodelog.txt" is written in the monitoring directory when monitoring is started. The last WMO code received (WMO Table 4680) and the precipitation value in mm/h averaged in the last 10-minute interval are stored in this file every 10 minutes. The specified time stamp always refers to the beginning of the 10-minute averaging interval.

4.1.5 Message Bar

Latest messages are shown in the message bar.

4.2 Operation

4.2.1 Page: Welcome

The welcome page shows the most essential data of your monitoring and the status of the components of the BATmode system.

Figure 27: Welcome Page

4.2.1.1 Connection Status Box

The Connection Status Box shows the current connection status of BATcontrol:

- Up to four UltraSoundGates 116Hnbm, one UltraSoundGate 116Hnbm and up to three UltraSoundGates 116Hnbm-r or one UltraSoundGate 416Hnbm from Avisoft Bioacoustics can be used to acoustically record bat calls. The type and number of connected UltraSoundGates are displayed below the UltraSoundGate icon.
- Under the symbol of a SIM card the current state of the mobile radio connection is displayed. All possible states are listed in Table 10.

Basically, bat bioacoustictechnology recommends the use of PIN free SIM cards, because only an inactivated PIN allows to unlock the SIM card after a reboot of the system automatically.

- The flame symbol indicates whether a temperature sensor is connected either to the analog temperature sensor input or via USB/RS485 (COM) via a Laser Precipitation Sensor (BATmode 2S+ only).

- The drop icon indicates whether a precipitation sensor is connected either to the analog precipitation sensor input or via USB/RS485 or USB/RS422 (COM) (BATmode 2S+ only).
- The battery symbol depicts the state of charge of the battery when using the photovoltaic power supply. The BATmode is connected to the Victron Energy solar charge controller via a USB/VE.Direct connection.

Table 10: Possible states of cellular connection

SIM state	How to solve problem:
No SIM inserted	Insert SIM
SIM locked	Enter PIN
No cellular network connection	Connect antenna or move device in area with network coverage
Modem not available	Activate Mobile Broadband Adapter in the Windows Device Manager
Modem turned off	Turn on Mobile Broadband Interface in Windows
SIM account not active	Activate SIM card at your provider
Connected provider: … (Data class)	Device is registered to cellular network

4.2.1.2 <ID>-Box

The ID of the BATmode is the individual identifier of the BATmode device. It depicts the beginning of the file name in all recorded WAV files and is sent in all status messages. Please choose an ID, which allows you to assign the files to the respective monitoring, e.g. "BATmode1Windpark1".

4.2.1.3 <View> Box

The drop-down menu can be used to switch between desktop and tablet mode. The tablet mode with full screen view is optimized for mobile devices with touch operation, while the desktop mode is designed for mouse and keyboard operation.

4.2.1.4 <Meteorological Sensors>-Box

To change temperature and precipitation sensor settings, open <*Temperature and Precipitation Sensor Settings*> dialog (see Figure 28) by clicking <*Settings*> (BATmode 2S+ only).

The <*Allow Monitoring without connected Microphones*> check box allows the BATmode to be used as a pure recorder of weather data without UltraSoundGate and microphones. Enable this option only if acoustic recording of bat calls is not desired. Otherwise, the watchdog for the UltraSoundGate connection and the check of the calibration values before starting the monitoring will not be available.

Select <*Weather Sensor Input*> which temperature and precipitation sensor you want to use:

- The analog temperature sensor in the antenna disc and the analog Infrared Precipitation sensor (ThiesClima 5.4103.20.041), both connected via the mini XLR connectors on the front

of the BATmodes 2S+. Select this option even if you only want to use the analog temperature sensor of the antenna disc and no precipitation sensor at all.

- The analog temperature sensor in the antenna disc and a serial Laser Precipitation Sensor (ThiesClima 5.4110.00.XXX). The analog temperature sensor is connected via the mini-XLR connector on the front of the BATmodes 2S+ and the serial precipitation sensor via a USB/RS485 or USB/RS422 converter on the back of the BATmode 2S+.
- The serial expandable Laser Precipitation sensor (ThiesClima 5.4110.10.XXX) with temperature sensor and further optional meteorological sensors. The serial Laser Precipitation Sensor is connected via a USB/RS485 or USB/RS422 converter on the back of the BATmode 2S+.
- The analog temperature sensor in the antenna disc and the serial Precipitation Sensor SWS-250 from Biral. The analog temperature sensor is connected via the mini-XLR connector on the front of the BATmodes 2S+ and the serial precipitation sensor via a USB/RS485 or USB/RS422 converter on the back of the BATmode 2S+.

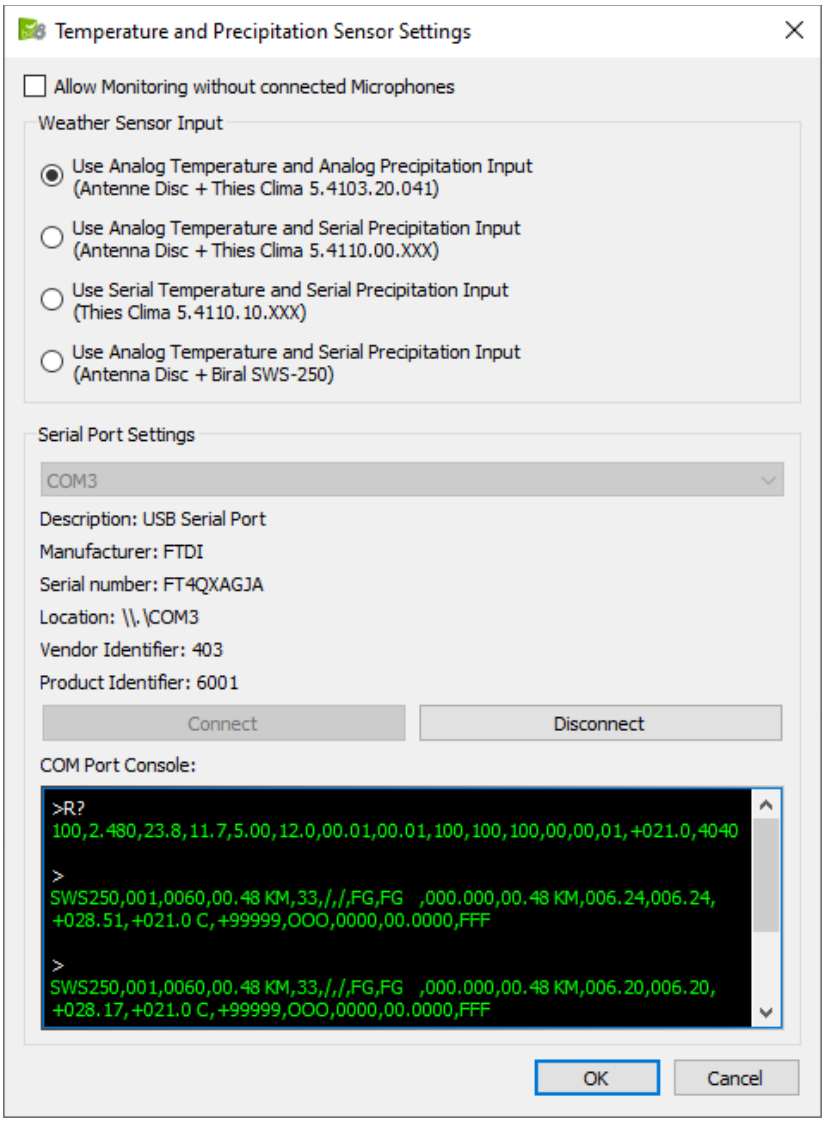


Figure 28: Temperature and Precipitation Sensor Settings

If you use a serial Precipitation Sensor, connect the USB/RS485 or USB/RS422 converter by selecting the corresponding COM port of the converter (see Windows Device Manager) and press <Connect>. In the <COM Port Console> incoming telegram data will be displayed. The <COM Port Console> can also be used to send commands to the Precipitation Sensor and receive responses. The commands are to be composed as shown in the manual of the serial Precipitation Sensor.

For the serial laser precipitation sensors from Thies Clima, this means:

- Data request: <id>BB<CR>
- Change of parameters: <id>BBppppp<CR>

The <id> is the two-digit device address (default value: 00), BB is the command code, ppppp is the five-digit new parameter value and <CR> is a click on the Enter key. Examples:

00DD<CR> or **00TM00004<CR>**

For the serial precipitation sensor SWS-250 from Biral, no <id> must be prefixed to the command. Examples:

R?<CR> or **OSHH1<CR>**

Depending on the connected sensors, the acquired meteorological data are written to several files. For more information, see chapter 4.1.4.2.

4.2.1.5 <Battery>-Box

Click *<Settings>* to open the *<State of Battery Charger>* dialog (see Figure 29). It displays status inforamtion from the solar charge controller of the optionally available photovoltaic power supply. Data is received from the Victron Energy charge controller via a USB/VE.Direct connection, which is automatically established when BATcontrol is started.

The box <Battery> depicts the battery voltage as well as the discharge or charge current of the battery (positive = charging, negative = discharging) and the current charge mode (Bulk - constant current, applied to achieve maximum charging speed, Absorption - constant voltage, applied when the battery is almost full, Float - float voltage, applied when the battery is full). The battery voltage is an indicator of the battery state of charge (SoC). For LiFePO4 batteries which are used in bat bioacoustictechnology's photovoltaic power supply, the maximum voltage is 14.2V. The minimum voltage is 11.0V. It should be noted that the voltage variation is not linear to the SoC of the battery, since in the middle range of the SOC from 10% to 90%, there is only a small change in the voltage during both, charging and discharging.

The box *<Load Output>* displays the information of the load output that is connected to the power supply input of the BATmode. To protect the battery, the load output of the charge controller is switched off as soon as the battery voltage drops below 11.0V. When the battery voltage exceeds 12.0V, the load output is reactivated.

In the box <*Solar*> you find the current information for the connected solar modules.

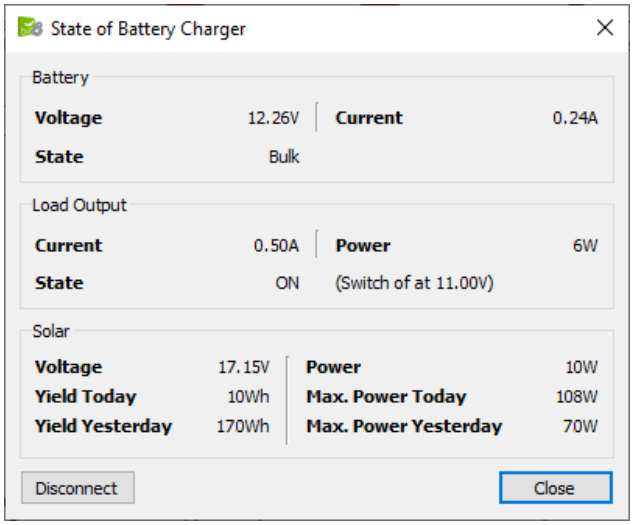


Figure 29: State of Battery Charger

More detailed information of the solar charge controller can be retrieved via Bluetooth with the Victron Connect App (iOS or Android).

In order to also retrieve detailed status data of the solar charge controller via the remote connection of the BATmode, the Victron Connect App for Windows can be installed on the BATmode. However, in contrast to the App for iOS or Android, this app does not access the charge controller under Windows via Bluetooth. Instead, it also utilizes the USB/VE.Direct connection like BATcontrol. Since two connections cannot be establised simultaneously via the USB/VE.Direct connection, it is possible to disconnect BATcontrol from the charge controller using the button *<Disconnect>.* Subsequently, you can connect the charge controller via the Victron Connect App and retrieve detailed information and configure the solar charge controller. Once you have closed the Victron Connect App again, you can use the <*Connect*> button to re-establish a connection between BATcontrol and the charge controller.

4.2.1.6 Monitoring Status Box

The Monitoring Status Box displays latest values of a running acoustic monitoring. In a simultaneous monitoring of several measuring points, the values of the individual channels are separated by a slash symbol ("/").

4.2.2 Page: Connectivity

On page <*Connectivity*>, you can configure all settings, which are relevant to monitor and control the BATmode system remotely.

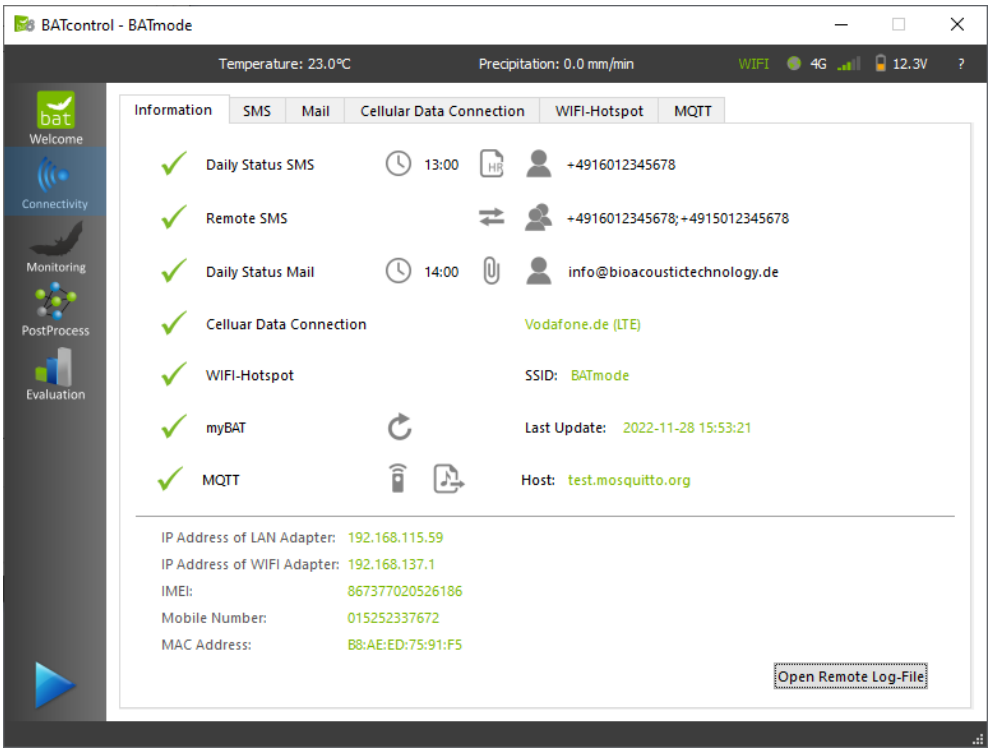


Figure 30: Connectivity Page Information

4.2.2.1 Information

The <*Information*> tab provides a summary overview of all monitoring and remote-control options and their configured settings.

The lower part of the page shows the most important addresses of the BATmode system that are required to connect via remote access:

- <*IP Address of LAN Adapter*>: IP address of the LAN adapter to establish a wired connection via "Remote Desktop Connection". Alternatively, the computer name "BATmode" can be used instead of the IP address.
- <*IP Address of WIFI Adapter*>: IP address of the WIFI adapter to establish a wireless WLAN connection via the "Remote Desktop Connection" to the WIFI hotspot of the BATmode.
- <*IMEI*>: 15-digit IMEI ID of the integrated cellular modem of the BATmode.
- <*Mobile Number*>: The mobile phone number of the inserted SIM card. If no mobile number is displayed, despite a SIM card is inserted and successfully registered in the mobile network (see <*Cellular Data Connection*> tab), this does not affect the functionality of the mobile radio connection.
- <*MAC Address* >: The MAC address is used to uniquely identify the BATmode in myBAT.

All received SMS and myBAT commands are stored in a log file. To open the log file press <*Open Remote Log-File*>.

4.2.2.2 SMS

The <*SMS*> tab shows all settings for sending status SMS and receiving command SMS.

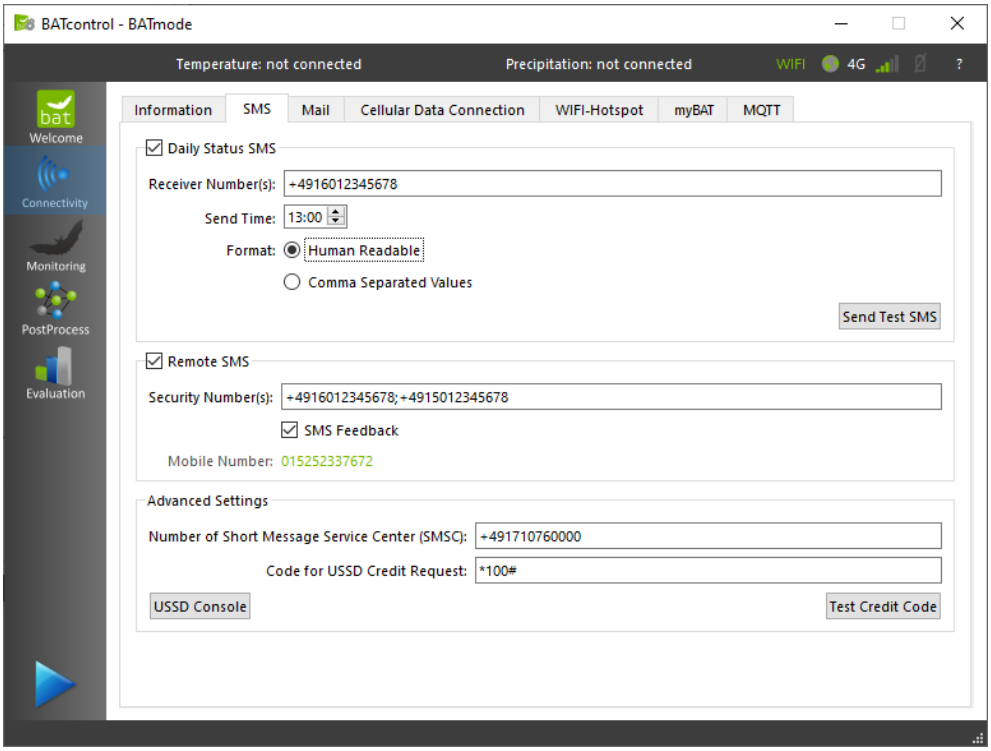


Figure 31: Connectivity Page SMS

DAILY STATUS SMS

The BATmode system can send daily status messages via SMS at a specified time. If you wish to receive the daily messages, check the box <*Daily Status SMS*> and enter the desired receiver's number in international format (for example, +49160123456) at <*Receiver Number(s)*>. If multiple receivers are desired, enter several numbers separated by ";". Transmission time is set via the <*Send time*> input field. Two different SMS formats are available and can be chosen by the radio buttons <*Human Readable*> and <*Comma Separated Values*>. While the human-readable format allows for a manual message evaluation, the CSV (comma-separated values) format is intended to be used with spreadsheet analysis tools or databases. You can send a test message to the specified number(s) by pressing <*Send Test SMS*>. The content of the messages is composed of current status values of the BATmode system. In the human-readable format corresponding acronyms are prefixed to the respective values. Table 11 lists the used acronyms and respective descriptions. By choosing the CSV format values are separated only with semicolons and acronyms are used any longer. A slash character ("/") separates values of different microphone channels or measurement points.

To always comply with the maximum character number of 160 characters per SMS, status SMS may be subdivided into two individual messages, if required.

To send a status SMS a sufficient SIM card balance or adequate mobile tariff is resumed. Furthermore, the system has to be installed in an area with sufficient mobile network coverage.

Table 11: Acronyms used in status SMS

Acronym	Meaning
ID	ID of the system defined with Prefix. The value is also prefixed in the filenames of the record files.
MON	Current status of the monitoring. If monitoring is running, the time periods (e.g., "16: 00-09: 00") or the relative minutes with respect to sunrise and sunset (e.g. "-10/40") are sent. If no time periods are set, the status is set as "ungated".
LRL	Last recorded reference value of the microphone played by the test signal speaker. In brackets deviation from the calibration value.
LRD	Recording date of the last reference value.
LFD	Recording date of the last record.
FL24	Number of records in the last 24 hours.
FT	Total number of records in monitoring directory.
FC	Free disc space on drive C in GB.
FD	Free disc space on drive D in GB.
SL	Current mobile signal level in %. If a connection to the mobile network cannot be established, the following error messages are possible: *MNA*: Modem not available *MTO*: Modem turned off *LOS*: SIM locked *NOS*: No SIM detected *NAS*: SIM account not active
WWW	Status of Internet connection. The following messages are possible: *Off*: System is offline *LAN*: System is online via a LAN connection *E*: System is online via mobile connection; current data type is EDGE *G*: System is online via mobile connection; current data type is GPRS *3G*: System is online via mobile connection; current data type is UMTS *H*: System is online via mobile connection; current data type is HSDPA *4G*: System is online via mobile connection; current data type is LTE
WIFI	Status of WIFI-Hotspot.
CC	Current Prepaid Credit
BV	Current voltage of the battery when using a solar power supply. If the battery voltage drops below 11.0V, the charge controller automatically switches off the power supply of the BATmode. If the battery voltage exceeds 12.0V again, the voltage supply of the BATmode is restored and the device restarts.

REMOTE SMS

Basic remote commands can be transmitted to the BATmode system via SMS. If you want to allow SMS remote, check the box *<Remote SMS>.* To prevent SMS commands execution received from unauthorized persons, telephone numbers from which SMS commands should be accepted must be stored in the *<Security Number(s)>* field. The numbers are to be entered in international format separated by semicolons. Available commands and the corresponding system responses are listed in Table 12. If the check box *<SMS Feedback>* is enabled, the system confirms executed command SMS via response SMS to the sender of the command. *<Mobile Number>* depicts the mobile phone number of the inserted SIM card, to which remote control commands are to be sent. If no mobile phone number is displayed despite an inserted SIM card and successful registration in the mobile phone network (see *<Cellular Data Connection>* tab), this does not affect the function of the mobile phone connection.

To use SMS remote commands an unlocked SIM card has to be inserted in the BATmode. Basically, bat bioacoustictechnology recommends the use of PIN free SIM cards, because only an inactivated PIN allows to unlock the SIM card after a reboot of the system automatically. Furthermore, the system has to be installed in an area with sufficient mobile network coverage.

Table 12: SMS remote commands

SMS text	System response
Reboot!	System reboots.
Shutdown!	System shuts down. *Caution: The system cannot be started again remotely!*
Send status!	Status SMS is sent to predefined number.
Send Mail!	Status mail is sent to predefined E-Mail address. *If no receiver address is defined and/or no Internet connection is available, no action is conducted.*
Send Mail to *max*(at)*moritz.com*!	Status mail is sent to *max@moritz.com*. *If no Internet connection is available, no action is conducted.* *Please note that since BATcontrol 2.1.0 this command must also be terminated with an exclamation mark.*
Start WIFI-Hotspot!	WIFI hotspot is started with the predefined settings.
Stop WIFI-Hotspot!	WIFI-Hotspot stops.
Connect WWAN!	Cellular connection will be established.
Disconnect WWAN!	Cellular connection will be disconnected.
Start monitoring!	Acoustic monitoring will be started ungated. That means acoustic events will be recorded independent of time of day.
Start monitoring: *11:00-14:00*!	Acoustic monitoring will be started gated by recording period one. Consequently, acoustic events will be recorded in this example only in the time period between *11:00* and *14:00* o'clock.

Start monitoring: *11:00-14:00* and *20:00-02:00*!	Acoustic monitoring will be started gated by recording period one and two. Consequently, acoustic events will be recorded in this example in the time period between *11:00* and *14:00* o'clock as well as *20:00* and *02:00* o'clock.
Start monitoring: *-20/10*!	Acoustic monitoring will be started relative to sunrise and sunset. The daily recording of acoustic events takes place in this example between *20* minutes before sunset and *10* minutes after sunrise.
Stop monitoring!	Acoustic monitoring will be stopped.
Kill Recorder!	The acoustic monitoring is stopped by closing the RECORDER software with a kill command. This allows the monitoring to stop when the RECORDER software displays an error message
Reset USG!	Terminates running monitoring and restarts the UltraSoundGate from Avisoft by disconnecting it from the power supply for some seconds.
Send MAC!	The MAC address of the BATmode is send to the sender of the SMS.
Send IMEI!	The IMEI of the BATmode is send to the sender of the SMS.
Send WIFI-IP!	The WIFI IP address of the BATmode is send to the sender of the SMS.
Send LAN-IP!	The LAN IP address of the BATmode is send to the sender of the SMS.
Enable Status-Mail!	Enables the transmission of a daily status mail. Please consider that correct mail settings have to be inserted to use this command.
Disable Status-Mail!	Disables the transmission of a daily status mail.
Enable Status-SMS!	Enables the transmission of a daily status SMS. Please consider that correct SMS settings have to be specified to use this command.
Disable Status-SMS!	Disables the transmission of a daily status SMS.
Send condition!	Current temperature and precipitation values are sent to the SMS sender.
Set calibration 1/0/-20.1/91.2/37.0!	Change the calibration values of a microphone channel. Required parameters are: 1. Channel specification (1,2,3 or 4) 2. Microphone without or with test signal speaker (0 or 1) 3. New "Full Scale Level of Reference Signal" in dBFS 4. New "SPL Level of Reference Signal" in dBSPL (leave blank for microphones without test signal speaker) 5. New "Level of Trigger Threshold" in dBSPL Monitoring must be stopped to execute the command.
Send calibration!	Current calibration values of the microphone are sent to the SMS sender.

Add Security Number: *+491601234567*!	Adds the phone number *+491601234567* to the Security Numbers. Only these numbers are allowed to send SMS commands to the BATmode system.
Set SIM-Card Credit USSD-Code to *100#!	Sets the USSD code for querying the prepaid credit to *100#
Send SIM-Card Credit!	Sends the current amount of the prepaid credit. For the query the "Credit USSD-Code" must be set correctly.
Execute USSD-Code *100#!	Executes the USSD code *100# and sends the response to the SMS sender. This can be used, for example, to query or top up the prepaid credit.
Send Battery Info!	Sends current information of the solar charge controller to the SMS sender.

ADVANCED SETTINGS

To successfully send a SMS, it is necessary to define a Short Message Service Center (SMSC) number. Enter the correct SMSC-number of your SIM provider in the <*Number of Short Message Service Center (SMSC)*> field. In Table 13 you will find the SMSC-numbers of selected SIM providers. Please note that the SMSC-numbers of service providers (e.g., Debitel) may differ from those of network providers. In general, the SMSC-numbers of all SIM providers are published on the internet.

Table 13: SMSC-numbers of selected SIM providers

Provider	**SMSC-Number**
T-Mobile Deutschland	+491710760000
Vodafone Deutschland	+491722270333
O2 Deutschland	+491760000443
1und1 Deutschland	+491722270333
Orange France	+33689004000
Bouygues France	+33660003000

With the mobile modem of your BATmode you can also make queries via so-called USSD-codes. These codes usually consist of digits and start with a * and end with #. They can be used, for example, to query or top up the current prepaid credit. You can execute USSD-codes directly in the <USSD-Console> (see Figure 32). Please note that the USSD-codes for credit enquiries or for topping up the credit may differ from one mobile network provider to another. In Table 14 you will find a list of the USSD-codes of selected SIM providers for credit enquiries. In general, the available USSD-codes of all mobile phone providers are published on the Internet. To integrate the current amount of your prepaid credit into the daily status messages, enter the corresponding USSD-code of your provider in the <*Code for USSD Credit Request*> field. If you do not use a prepaid mobile phone tariff or your SIM provider does not support the credit query via USSD-codes, leave the < *Code for USSD Credit Request* > field empty. To

test the credit query, press <*Test Credit Code*>. The resulting answer is displayed below the Credit Code input window.

Table 14: USSD-Codes of selected SIM providers to check the current prepaid credit

Provider	USSD-Code
T-Mobile Deutschland	*100#
Vodafone Deutschland	*106#
O2 Deutschland	*101#

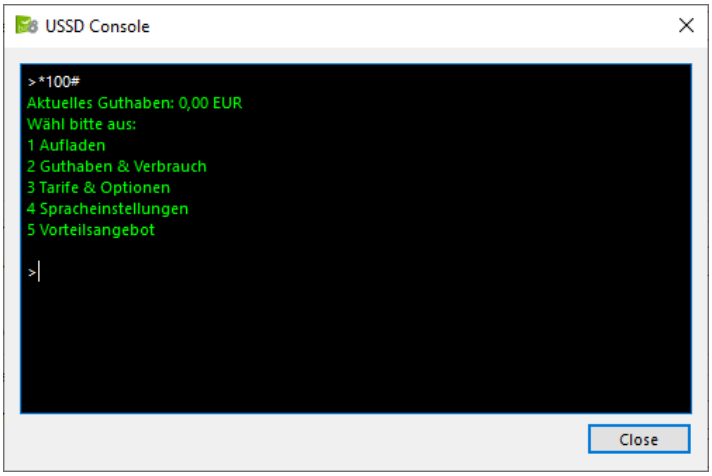


Figure 32: USSD Console

4.2.2.3 Mail

Use the <*Mail*> tab to setup the e-mail configuration.

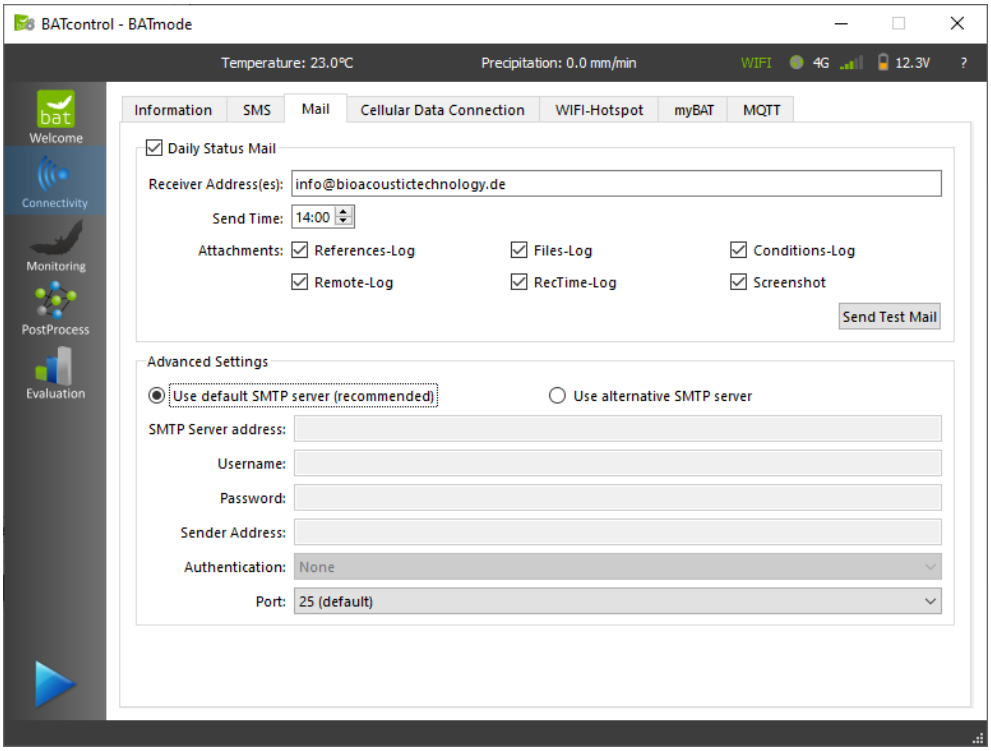


Figure 33: Connectivity Page Mail

DAILY STATUS MAIL

The BATmode system can send daily status mails at a specified time. If you wish to receive the daily mails, check the box <*Daily Status Mail*> and insert the receiver's address in <*Receiver Address(es)*>. Multiple recipient addresses can be entered separated by a ";". Sending time is set in <*Send time*>. By checking the boxes <*Reference-Log*>, <*Files-Log*>, <*Remote-Log*>, <*Conditions-Log*> and/or <*RecTime-Log*> you can determine, which log files are attached to the daily status mail. In addition, with <*Screenshot*> a current screenshot can be attached to the status mail as PNG file. To create the screenshot, the two essential programs, RECORDER and BATcontrol, are brought into the foreground of the screen. A slash character ("/") separates values of different microphone channels or measurement points within the status message.

You can send a test mail to the specified address(es) by pressing <*Send Test Mail*>. If a connection to the specified SMTP server is not possible or an error occurs, this will be displayed in the message bar.

ADVANCED SETTINGS

If you want to send status mails via your own SMTP server or adjust the port of the mail connection, use the *<Advanced Settings>.*

By default, the e-mail is sent via an SMTP server of bat bioacoustictechnology (<*Use default SMTP server*>). The status mail can be sent with this SMTP server via port 25 as well as port 587. Please select the appropriate port in the drop-down menu <*Port*>. If you want to send the status mails via an alternative SMTP server, please select <*Use alternative SMTP server*> and set the SMTP server settings accordingly.

To send a status mail, an active Internet connection is required in which the port selected under <Advanced Settings> must not be blocked.

4.2.2.4 Cellular Data Connection

The *<Cellular Data Connection>* tab displays the most important information of the cellular data connection and allows to connect or disconnect it.

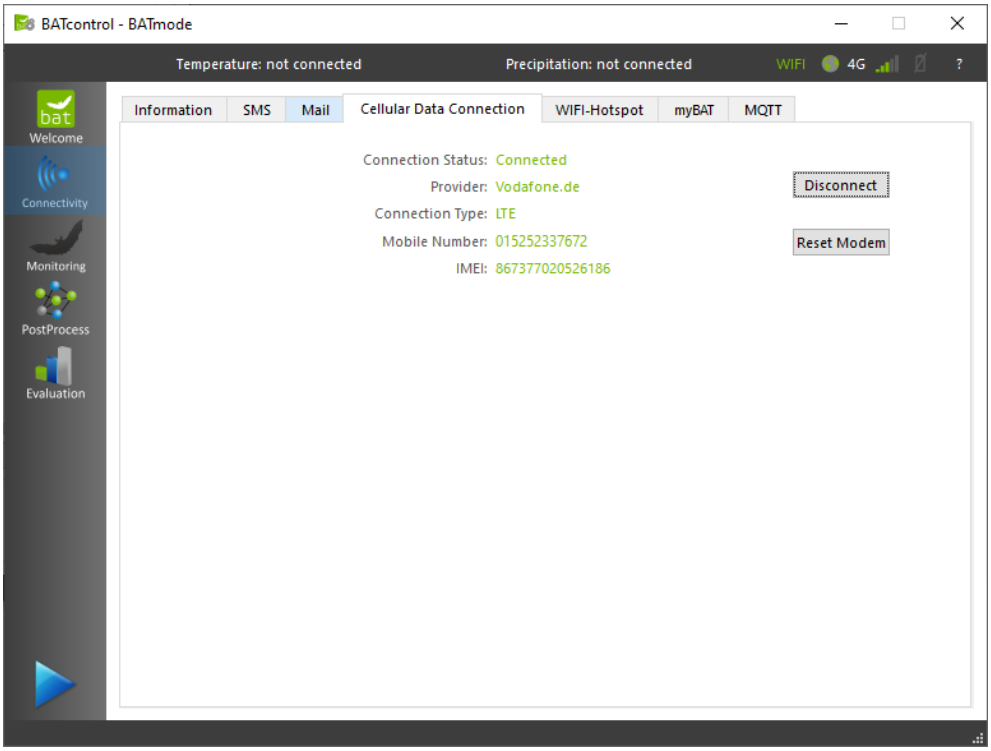


Figure 34: Connectivity Page Cellular Data Connection

Press the *<Connect>* or *<Disconnect>* button, respectively, to either connect or disconnect the pre-configured cellular data connection.

To establish a cellular data connection a SIM card with unlocked PIN has to be inserted in the BATmode and correct APN settings has to be configured. Basically, bat bioacoustictechnology recommends the use of PIN free SIM cards, because only an inactivated PIN allows to unlock the SIM card after a reboot of the system automatically.

With the button *<Reset Modem>*, a hardware reset of the modem can be carried out if a problem with the mobile radio modem occurs or if an inserted SIM card is not recognized. SMS connection as well as a set mobile data connection reconnect automatically after the reset.

4.2.2.5 <WIFI-Hotspot> Box (only relevant for BATmode 2S+)

Use the <*Start*>/<*Stop*> button to deactivate or activate the WIFI hotspot. The SSID as well as the password of the WIFI hotspot can be changed in the respective fields

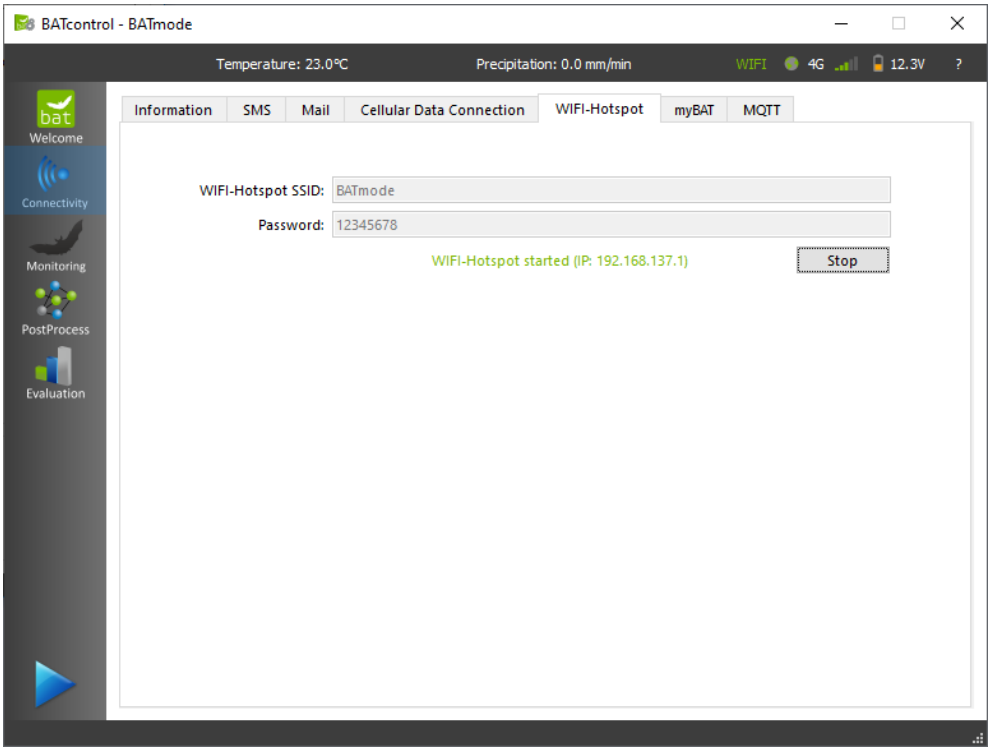


Figure 35: Connectivity Page WIFI

Please note that the WIFI adapter of the BATmode can only manage one connection at a time. This means that if you connect the BATmode via WLAN to your network (the WLAN is provided by a router) it is no longer possible to open a WIFI hotspot through BATcontrol.

4.2.2.6 myBAT

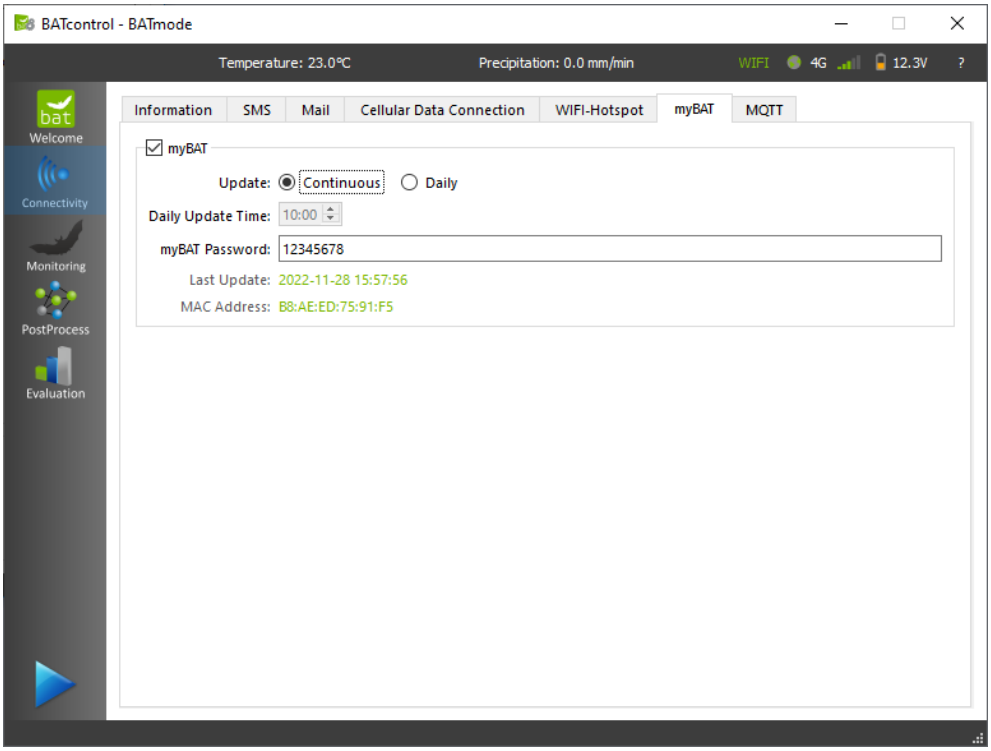


Figure 36: Connectivity Page myBAT

myBAT is a cloud-based monitoring, control and administration tool for your BATmode system. It allows you to view the status of your monitoring system and control it remotely. Furthermore, information about recorded data are imaged and can be exported to external tools. For further information and to signup visit www.mybat.bioacoustictechnology.de.

You activate myBAT for your BATmode system by checking the box <*myBAT*>. You can choose whether you want a continuous data update (<*Continuous*>) or whether this should only take place daily and after a restart (<*Daily*>). The daily update time can be defined in the <*Daily UpdateTime*> input field. Please note that the remote functionality, i.e., the remote control of the BATmode system via myBAT, is only available with <*Continuous myBAT*>. Define a password in the field <*myBAT Password*>. You will need this password to assign your BATmode system in myBAT to your account. The last time BATcontrol updated the system status on myBAT is shown under <*Last myBAT Update*>.

At <*MAC Address*> you find the MAC address of your BATmode system, which is needed to assign the BATmode device to your myBAT account.

myBAT requires an active Internet connection in which port 3306 may not be blocked. By using myBAT increased charges of your Internet service provider may occur. Use the option <Daily myBAT> to reduce the amount of data to be transferred.

4.2.2.7 MQTT

MQTT is an open network protocol for M2M (machine-to-machine) communication in an IoT environment. It is perfectly suited for use with low-bandwidth connections and time-limited connection interruptions.

MQTT connections are based on the publish and subscribe principle between multiple clients and a host, often also called a broker or server. Based on this principle, clients can send messages to a host (publish) and subscribe to the host to receive messages. The messages are assigned to a hierarchical topic (e.g.,"floor/temperature" or "floor/light/status").

With the MQTT feature the BATmode acts as MQTT client and can send status information as well as receive commands. At the same time, it is possible to forward acoustic recordings as WAV files to the host in real time.

Thus, BATmode systems can be integrated into the operational management of wind turbines and can be monitored and controlled from a central location. Due to the real-time transmission of the acoustic recordings, it is also potentially possible to influence the turbine operation based on the currently present bat activity and to realize real-time curtailments.

A Real-Time License is required to use the real-time transmission of WAV files and to publish AI Call Detector results via MQTT. More information about the Real-Time License can be found in chapter 4.3.

Details about the MQTT protocol of the BATmode can be found in the document "**MQTT Protocol of the BATmode System - Messages and Commands**", which can be downloaded from the download area on our website www.bioacoustictechnology.de.

The tab *<MQTT>* allows the configuration of the MQTT interface of the BATmode.

By checking *<MQTT>* the MQTT feature of the BATmode system is activated. You can use *<MQTT Remote>* to specify whether your BATmode only sends messages or also accepts control commands via MQTT. With *<Publish new WAVs>* enabled, newly recorded WAV files are transmitted to the MQTT host.

If <MQTT Remote> is activated, check the configuration of your MQTT host (server) as well as the MQTT connection to ensure that only authorized devices can send control commands to the BATmode. bat bioaocustictechnology cannot accept any liability for damage or data loss resulting from an incorrect or insecure configuration of the host or the MQTT connection.

To use WAV file transfer with <Publish new WAVs>, make sure that your host accepts appropriately sized messages. The WAV files can be up to 40MB in size.

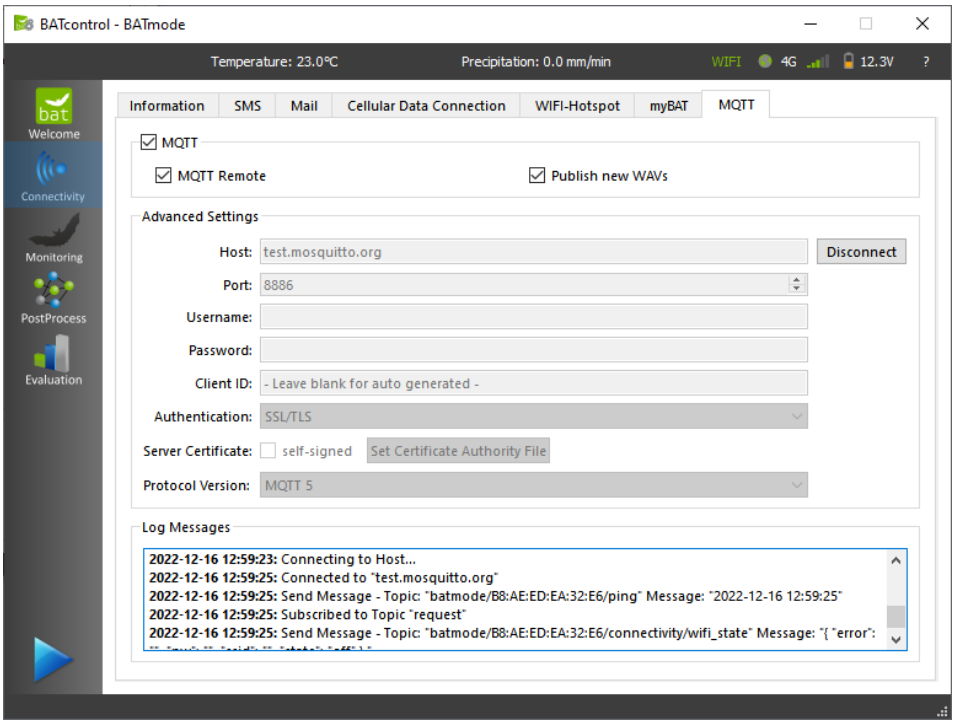


Figure 37: Connectivity Page MQTT

The settings for the MQTT connection to the host are defined in the *<Advanced Settings>* box. The address of the MQTT host - often also called broker or server - is to be defined under *<Host>*. *<Port>* defines the corresponding MQTT port of the server. For unencrypted connections port 1883 is usually used, for encrypted connections port 8883. *<Username>* and *<Password>* are optional and like the *<Client ID>* depend on your host configuration. With *<Authentication>* you define whether data should be transmitted encrypted via SSL/TLS. If your host uses a so-called "self-signed" certificate, check the corresponding box and specify the location of the certificate file on the BATmode with *<Set Certificate Authority File>.*

The box *<Log Messages>* displays the last 500 MQTT messages and connection events.

4.2.3 Page: Monitoring

On page <*Monitoring*>, the setup for the acoustical monitoring is configured.

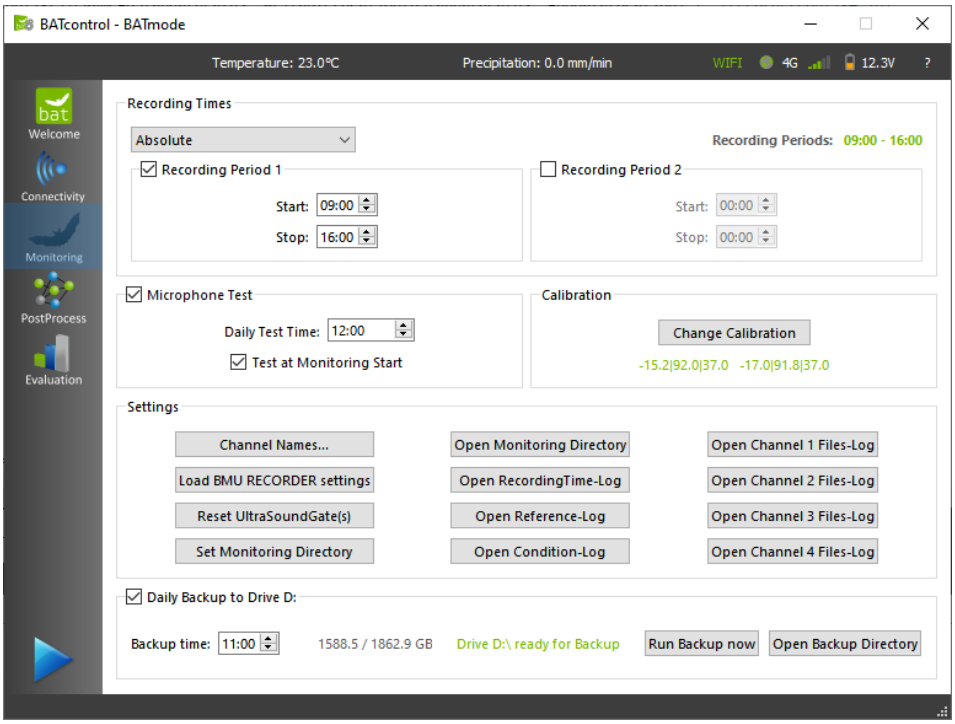


Figure 38: Monitoring Page

4.2.3.1 Recording Times of Acoustical Monitoring (<Recording Times> - Box)

The recording times of the acoustic monitoring, that means the daily time intervals within which bat calls will be recorded, can be defined as absolute time intervals or relative to sunrise and sunset.

In case of absolute recording, the daily periods of time within which the recording of bat calls is active are defined by the two fields <*Recording Period 1*>and <*Recording Period 2*> (see Figure 38). If neither of both periods is checked, the acoustical monitoring is activated continuously over the whole day.

If bat call recording periods are to be relative to the sun's course, the geographic position of the data acquisition location has to be entered for the calculation of sunrise and sunset times in the fields <*Latitude*> and <*Longitude*> (see Figure 39). These coordinates can be determined, for example, on the Internet using map services such as Google Maps. To specify the number of minutes the bat call recording is to be started relative to sunrise and sunset, use the two fields <*Delay to Sunset for Start*> and <*Delay to Sunrise for Stop*>. Hereby, negative values represent the number of minutes before and positive values the number after sunrise or sunset, respectively.

The resulting daily recording periods are displayed as <*Recording Periods*> for the current day in the upper right corner (see Figure 38 and Figure 39).

These settings do not affect the recording of the temperature and precipitation values, which is automatically started with the monitoring and always stores in a 10-minute interval the mean values of the data determined every 30 seconds (exclusively BATmode 2S+).

Figure 39: Relative Monitoring periods

4.2.3.2 Test of Microphone Sensitivity (<Microphone Test> - Box)

To ensure a correct acoustic bat monitoring, which records all bat calls of a maximum pressure level greater than the previously in the calibration (see section 4.2.3.4) defined trigger level ("Level of Trigger Threshold"), an ultrasound signal generator is integrated in the microphone disc. It generates a defined ultrasound signal with known sound pressure level, which allows the monitoring of the microphone sensitivity. By this, the validity of the acoustic monitoring can be verified.

In order to determine microphone sensitivity, the ultrasonic signal generator is activated by the RECORDER software for one minute and generates a temporally varying narrow-band ultrasound signal between 30 and 50 kHz. By this, temperature-dependent influences on the resonance frequency of the ultrasound signal generator are compensated. With the automatically opened "Trigger Level Calibration" dialogue, the software RECORDER measures the maximum signal level relative to the maximum output value of the microphone in dBFS (dB Full Scale), continuously (see Figure 40). Finally, the maximum measured value is stored in the file "reference.txt" in the monitoring directory.

A fictitiously assumed value of -13.6 dBFS means that the maximum sound pressure level of the test signal generator determined during the measurement is -13.6 dB below the maximum output value of the microphone. If the value is within a range of ± 6 dB around the "Full Scale Level of Reference Signal" specified in the calibration certificate, bat monitoring will provide correct data.

If smaller negative values are determined (for example -10 dBFS) than specified in the calibration certificate, the test signal generated by the ultrasonic signal generator is recorded "too loud" by the microphone. This indicates that there are sound reflecting objects in front of the microphone. If, on the contrary, larger negative values are determined (for example -25 dBFS), the test signal is recorded as "too quiet". This is mostly due to dirt, aging or a defect of the microphone.

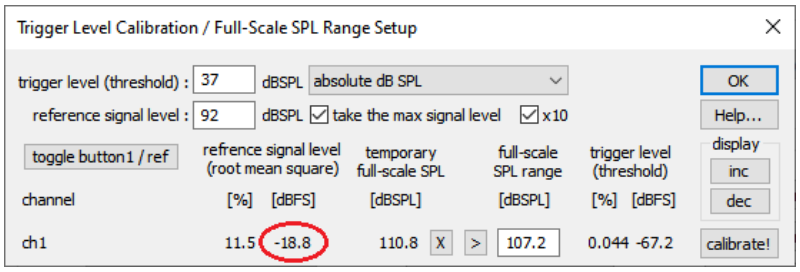


Figure 40: Trigger Level Calibration Dialog of the RECORDER Software

To daily check the sensitivity of the microphone by measuring the reference signal level, enable the box <*Microphone Test*>. The playback time of the reference signal can be determined with the time spin box. This is independent of the determined recording periods. Nevertheless, to avoid masking of bat calls, it should not be within the recording periods.

If you want to execute the microphone sensitivity test at monitoring start, check the box <*Test at Monitoring Start*>.

In addition to the measured microphone sensitivity values stored in the file "reference.txt", legal authorities often also demand to record the WAV files of the respective test signals. If you have selected absolute recording periods in the <Recording Times> - Box (see section Settings 4.2.3.1), these WAV files are automatically saved no matter what time you have selected for the daily test signal. However, if relative recording periods are selected, the WAV files will only be saved if the time of the daily test signal is within the selected recording periods. Consequently, if the recording of test signal WAV files is desired in the relative recording periods case, select a time for the test signal that is safely within the relative recording periods throughout the whole year (for example, 01:00).

4.2.3.3 Calibration

To make bat call recordings comparable and compatible to German BMU guidelines and the tool ProBat, a calibration of the used trigger level threshold is necessary. For this purpose, open the calibration dialogue by pressing the button <Change *Calibration*> (see Figure 41). To perform a calibration, first select whether the microphone used on this channel has a built-in reference signal speaker. The GM50 and GM90 microphone discs as well as the TM20 tower microphone are equipped with reference signal speaker. In contrast, the tower microphone TM10 has no integrated reference signal speaker. Subsequently, enter the desired trigger level threshold (default value: 37 dBSPL) and the calibration data supplied with each microphone. Then press the <Calibrate now!> Button. For further information on BATmode microphone calibration visit http://www.bioacoustictechnology.de/calibration-of-the-batmode-system/?lang=en.

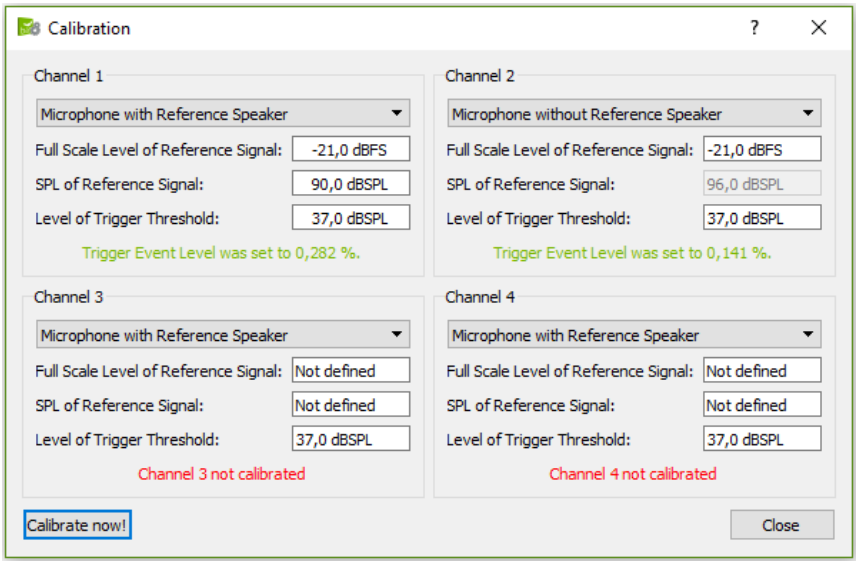


Figure 41: Calibration Dialogue

bat bioacoustictechnology recommends to recalibrate microphones after each year of monitoring. This is necessary to consider sensitivity alternations of the microphone and/or changes of the sound pressure level of the test signal speaker, which can be caused by ageing, dirt particles or influences of weather. If you wish to recalibrate your microphone and test signal speaker, contact the support of bat bioacoustictechnology and send the microphones.

To make recorded acoustic data compatible with the evaluation software ProBat, a trigger level threshold of 37 dBSPL or 50 dBSPL must be selected. bat bioacoustictechnology recommends to set the trigger level threshold to 37 dBSPL and only use 50 dBSPL for wind turbines with a very high noise level. Please, consider the enclosed documents of the PROBAT software.

Depending on the currently connected UltraSoundGates, the values set during the last calibration are given in the following format under the button *<Change Calibration>:*

Full Scale Level of Reference Signal in dBFS | SPL of Reference Signal in dBSPL | Level of Trigger Threshold in dBSPL

4.2.3.4 Settings

Use the <Channel Names ...> dialog to specify channel names if multiple measurement channels are utilized. These names determine the storage location of the recorded WAV files (selected monitoring directory + "\ Channel Name \"), as well as the identification of the respective channels in the evaluation plots. If the BATmode system is only used for a single measurement point, the definition of a channel name is not necessary and the files are stored directly in the selected monitoring

directory. For both, single-channel and multi-channel data acquisition, the filenames of the recorded data are always composed as follows:

[ID of BATmode][date and time of acquisition][autoincremented number].WAV

If you use multiple UltraSoundGates 116Hnbm/116Hnbm-r, please note that the channel-to-UltraSoundGate assignment will not change unless the UltraSoundGates are disconnected from the BATmode system. If you have disconnected the UltraSoundGates from the system, make sure that after reconnection a certain channel also represents the corresponding measurement point.

By using the button <L*oad default RECORDER settings*> you can load default BMU-configuration for RECORDER software. These default BMU-configuration conforms to the settings recommended by bat bioacoustictechnology. On loading default values current settings will be discarded.

Please consider that all settings, which are employed within the RECORDER software, are saved on closing the software.

Also running the RECORDER software externally, that means, it is not started by BATcontrol, may affect settings, if one of the configuration files (depends on the selected number of measurement channels)

- *"C:\Users\BAT\AppData\Roaming\BATcontrol\recorderconfig.ini",*
- *"C:\Users\BAT\AppData\Roaming\BATcontrol\recorderconfig1.ini",*
- *"C:\Users\BAT\AppData\Roaming\BATcontrol\recorderconfig2.ini",*
- *"C:\Users\BAT\AppData\Roaming\BATcontrol\recorderconfig3.ini" or*
- *"C:\Users\BAT\AppData\Roaming\BATcontrol\recorderconfig4.ini"*

is loaded.

To change settings of the RECORDER-Software, which are not covered by BATcontrol, we recommend the following approach:

1) *Start monitoring in BATcontrol*
2) *When the RECORDER-Software is opened, stop the recording by pressing the Stop-Button in the RECORDER-Software*
3) *Change settings in the RECORDER-Software*
4) *Close the RECORDER-Software*
5) *Restart monitoring with BATcontrol*

Please note that the settings made outside of BATcontrol are only saved for the current number of measurement channels.

The button <*Reset UltraSoundGate(s)*> restarts connected UltraSoundGates of Avisoft Bioacoustics if an error occurs in the software RECORDER, when the monitoring is started. For this purpose, the voltage supply of the green marked USB UltraSoundGate ports is interrupted for a short time. This triggers a reinitalization of the UltraSoundGates.

By using <S*et monitoring directory*> you can determine the location the recorded bat call files are stored to. Default location is: “C:\BATmode\“.

By using <*Open Monitoring Directory*> you can open the location the recorded bat call files as well as environmental data are stored. The default location is: „C:\BATmode\“.

With <Open RecordingTime-Log> you can open the file "rectimelog.txt" in the monitoring directory. It contains the start and stop times of the monitoring as well as of the recording periods. In addition, the respective calibration values and monitoring settings are saved. Furthermore, played test signals and their validity are logged. In order to determine when a monitoring was interrupted by a power failure, for example (in this case it is no longer possible to generate a normal stop monitoring entry), it is written in the one-minute interval whether the monitoring is active. When restarting after a monitoring abort, this value is used to determine the abort time and save it under "Monitoring aborted". The "rectimelog.txt" file is therefore suitable for the automatic determination of valid monitoring times and can be imported into PROBAT. As of BATcontrol 3.2.14 the time stamps in the "rectimelog.txt" file are in accordance with ISO8601 (e.g. 2020-01-01T12:00:00+01:00).

By using <*Open Reference Log*> you can open the file “reference.txt” in the monitoring directory. All microphone sensitivity tests with the test signal speaker are logged in this file. Consequently, this file can thus be used as proof of a correct monitoring.

Clicking <*Open Condition Log*> opens the file "conditionlog.txt" in the monitoring directory. This file contains temperature and precipitation data, which is automatically recorded in a BATmode S+ system, when the acoustic monitoring is started. The time stamp of the values always refers to the beginning of a 10-minute mean interval.

In a single point measurement, clicking <O*pen Channel 1 Files Log*> opens the file "FILES.LOG" in the monitoring directory. For multi-channel measurements, the file "*Channel Name 1*.LOG" is opened in the location of the first channel. All monitoring start/stop events and times of acoustic recordings are logged in this file.

By clicking on the other <*Open Channel x Files Log*> buttons the respective files "*Channel Name x.*LOG" in the location of the x-th channel is opened.

4.2.3.5 Daily Backup

To perform a daily backup of the recorded files to a connected USB device with drive address “D:/” enable the box <*Daily Backup to drive D:*>. The time the daily backup is executed can be chosen with the corresponding time spin box.

To trigger the backup manually use the <Run Backup now> button.

To open backup directory, press <Open Backup Directory>.

Ensure that enough memory is available and that the user has the permission to write on the device. If there is not enough space available or writing is not permitted, backup won´t be executed.

Ensure that Windows assigns the drive letter "D" to your backup device. If another drive letter is assigned to your backup drive, backup won´t be executed. To assign a different drive letter to your device:

- *Right click on the Start menu .*
- *Select Disk <Management>.*
- *Right-click on the drive letter you want to change and click <Change Drive Letter and Paths>.*
- *Click <Change>.*
- *Use the drop down to the right of <Assign the following drive letter> to select the new drive letter D:.*
- *Click <OK>.*

Make sure that the backup device file system is exFAT. Other file systems sometimes do not allow to store such large number of files that are generated during a continuous bat monitoring.

You can use the backup function to export recorded data from the BATmode system without login on the system. To do this, enable the daily data backup before starting the monitoring and connect a sufficiently large USB stick to the system (bat bioacoustictechnology recommends at least 128 GB). If you want to export the data during the ongoing monitoring, simply remove the stick, which contains all recorded data, and connect a new empty USB stick to the same USB port of the BATmode system. Data recorded and stored on the BATmode system as well as future records will be automatically copied again on the new stick.

4.2.4 Page: PostProcess

The <*PostProcess*> page lets you adjust the settings for post-processing WAV files after they have been recorded by the Avisoft RECORDER software.

4.2.4.1 AI Call Detector

The AI Call Detector is a neural network based bat call detector from bat bioacoustictechnology. It is known from the analysis software BATscreen PRO, in which it is used for the analysis of bat call files at the end of a monitoring season. It allows to detect bat calls and to identify them on species level. In addition to the aforementioned neural network-based models, also a maximum likelihood ratio test is used to improve accuracy. More information about the AI Call Detector can be found in the manual of BATscreen PRO, which can be downloaded from the download area of the homepage www.bioacoustictechnology.de.

While the AI Call Detector in BATscreen PRO is applied on large data sets, it is used in BATcontrol for real-time post-processing of WAV files directly after their recording by the Avisoft RECORDER software. The files are analyzed and the results are written directly into the header of the WAV files.

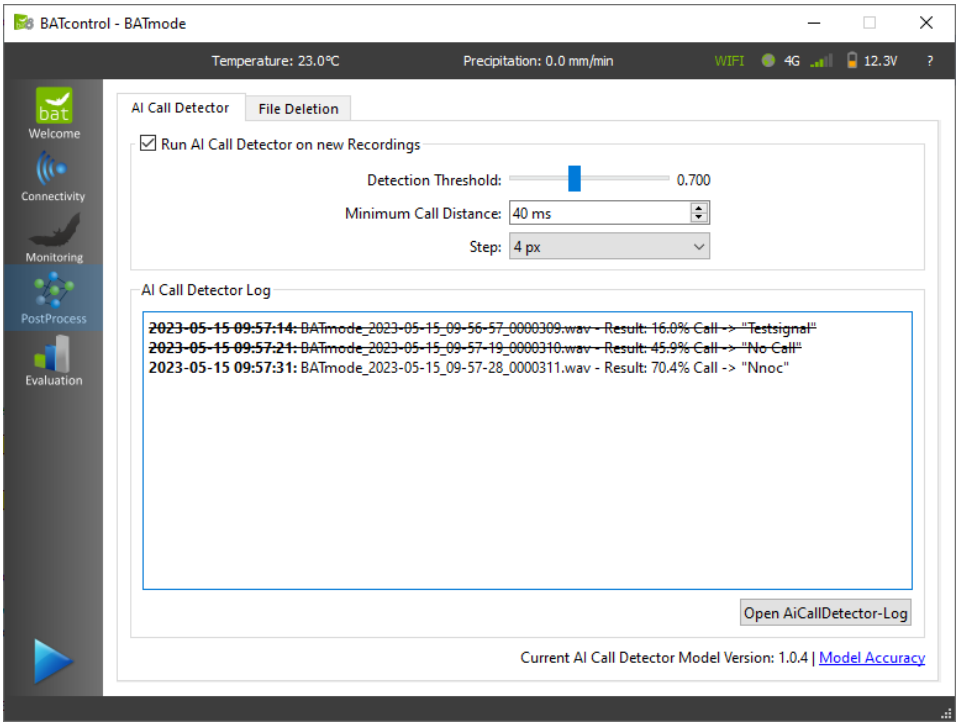


Figure 42: PostProcess Page – AI Call Detector

To enable AI Call Detector post-processing, check <*Run AI Call Detector on new Recordings*> in the tab <*AI Call Detector*> on the page <*PostProcess*> (see Figure 42). Also specify which <*Detection Threshold*>, <*Minimum Call Distance*> and <*Step*> to use in the analysis. The <*Detection Threshold*> defines the probability threshold for which a call is detected as a bat call. This value must be determined individually for the respective monitoring site in advance. The evaluation method <*AI Call*

Detector Performance Evaluation> of BATscreen PRO can be used for this purpose. The value <*Minimum Call Distance*>, as the name implies, specifies the minimum temporal distance between two bat calls. <*Step*> represents the step size with which the analysis window is moved over the spectrogram.

The <*AI Call Detector Log*> shows a live log of the last 500 results of the AI Call Detector analysis. For each analyzed file, the analysis time, the file name and the analysis result are displayed. For example, the following log entry means:

2023-05-15 09:57:31: BATmode2023-05-15_09-57-28_0000311.wav Result: 70.4% Call -> „Nnoc"

- **2023-05-15 09:57:31:** End time of the AI Call Detector analysis.
- **BATmode2023-05-15_09-57-28_0000311.wav**: Filename of the analyzed file.
- **Result: 70.4% Call:** Probability that the file contains a bat call.
- **„Nnoc":** Identified bat species, „No Call" or „Testsignal".

If an entry is crossed out, the file was deleted after the analysis due to the setting in the <*File Deletion*> tab on the <*PostProcess*> page.

With the button <*Open AiCallDetector-Log*> the file "aicalldetectorlog.txt" in the monitoring directory can be opened. This contains a detailed log of the AI Call Detector results.

If a real-time license was activated in BATcontrol for a BATmode system, the result of the AI Call Detector is sent via MQTT message in real-time after the analysis. Thus, a real-time curtailment of wind power plants can be performed based on the prevailing bat activity. More information about the Real-Time License can be found in chapter 4.3.

The model version of the AI Call Detector currently installed on your BATmode can be found at the bottom right of the window. Click on the <*Model Accuracy*> link to open a document that describes the accuracy of the installed model version for a specified test data set. In principle, it is also possible to train models with site-specific data sets to increase the accuracy of call detection. If you are interested in this, please contact bat bioacoustictechnology.

4.2.4.2 File Deletion

The <*File Deletion*> tab on the <*PostProcess*> page (see Figure 43) specifies whether recorded WAV files should be deleted directly after post-processing. It can be specified whether None, All or only WAV files identified by the AI Call Detector as "Call" or "No Call/Test Signal" should be deleted.

Please note that the WAV files will be deleted permanently. It is not possible to restore the files.

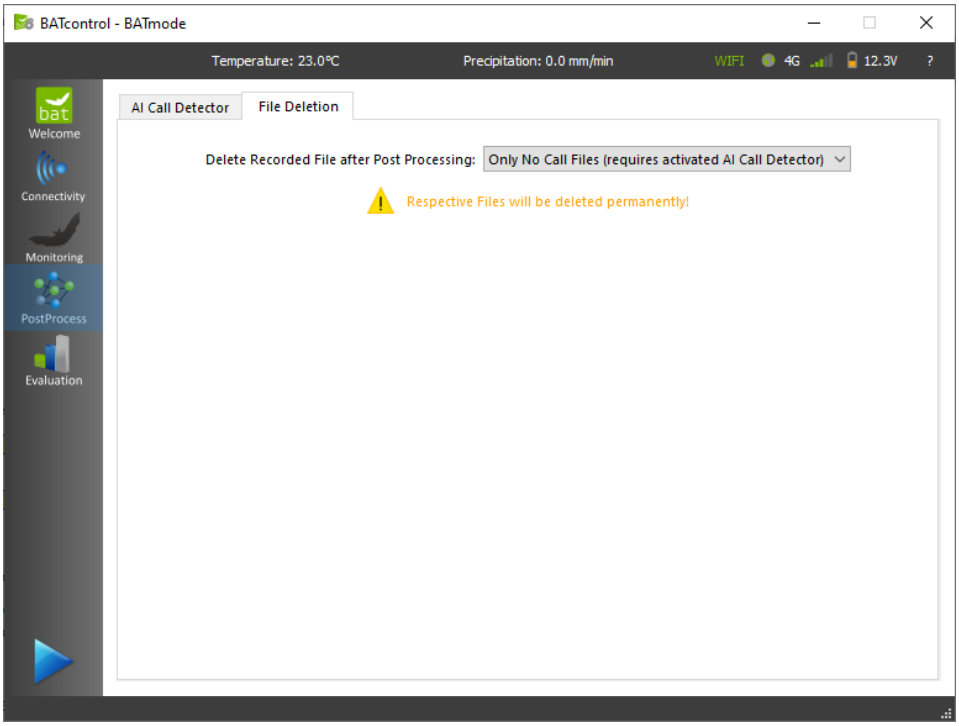


Figure 43: PostProcess Page – File Deletion

4.2.5 Page: Evaluation

The page <*Evaluation*> visualizes important parameters of the acoustical monitoring as well as of the environmental condition logging. By applying this graphical evaluation tools you can easily assess the quality of your recorded data and intervene, if data quality is below your expectations.

To regenerate the plots, use the button <*Refresh*>.

If you want to export a plot as pixel or vector graphic, use the button <*Export*>.

The following plots are available:

4.2.5.1 Reference Level

This plot (see Figure 44) visualizes the sound pressure level of the daily reference signal in reference to the maximum sound pressure level (SPL) of the microphone in dB (see section 4.2.3.2). The horizontal grey lines mark a ±6 dB discrepancy of the recorded SPL from the SPL determined in the calibration. Variations of the daily test signal level either indicate an altered microphone sensitivity (microphone sensitivity can alter due to ageing, weather induced effects or deposed dirt particles on the microphone´s protective grid) or a changed SPL of the test signal speaker. If the daily test signal level is also after a restart of the system constantly beyond the ±6 dB lines, the microphone or the reference signal speaker may be defective. Please contact the support of bat bioacoustictechnology.

To toggle between the reference levels of different microphone channels, use the arrow buttons "<" and ">" next to the plot.

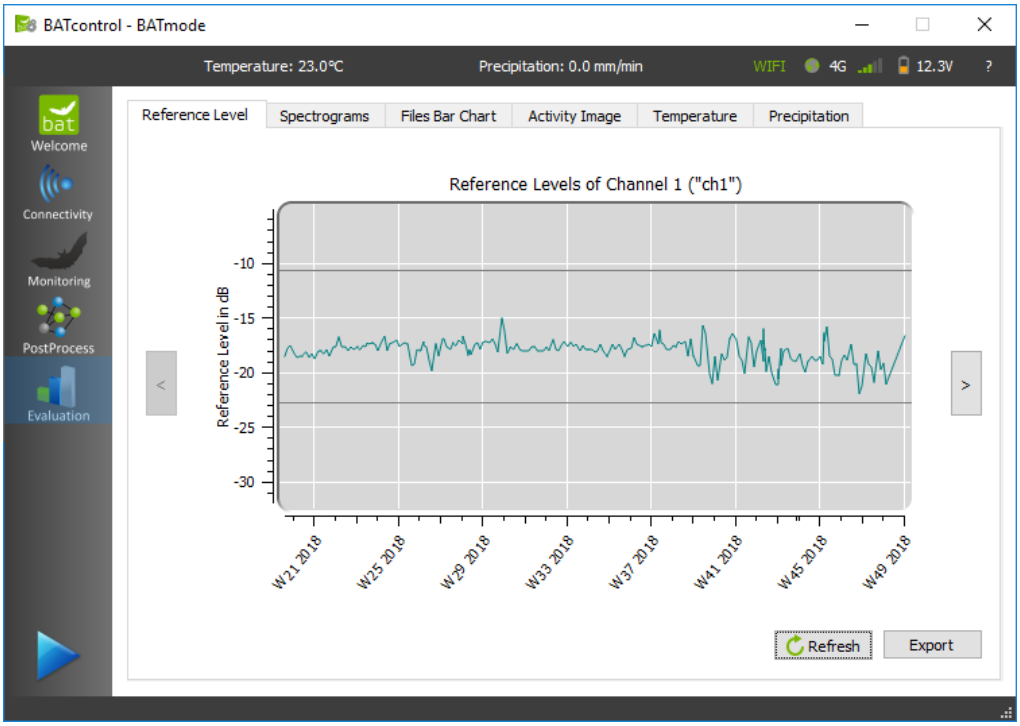


Figure 44: Evaluation Page - Reference Level

Since the file “reference.txt“ at the specified monitoring directory is evaluated to create the plot, not only data from the current acoustical monitoring are incorporated in the figure. In addition, data from past monitorings may be shown in the plot, if data was not deleted.

4.2.5.2 Spectrograms

This representation (see Figure 45) allows you to calculate the spectrograms of the recorded files. In the lower half of the screen, the recorded files are listed separately by measuring channel. Double-click on the respective list entry to display the file as a spectrogram in the upper half of the screen. The following parameters are used to calculate the spectrograms:

- Window width: 512 samples
- Window function: Hamming
- Overlap: 50%

Use the arrow keys on the keyboard to navigate through the file lists. Press the left or right arrow key to calculate the spectrogram of the previous or next file.

To zoom, use the left mouse button to stretch a frame over the image area to be enlarged. By pressing the right mouse button, you return to the overall representation of the file.

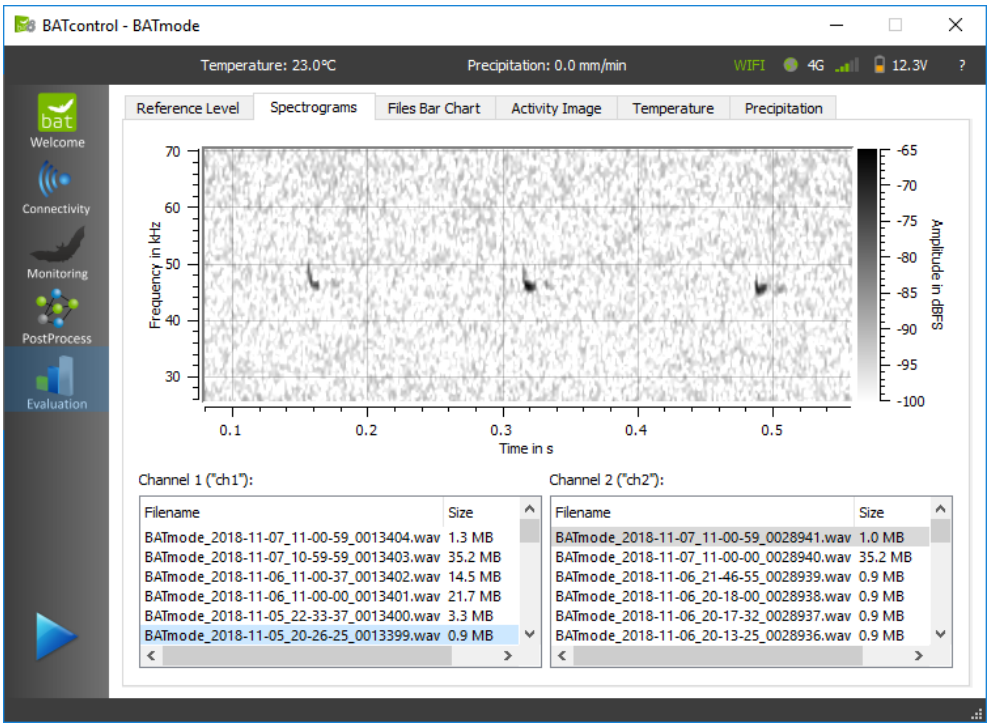


Figure 45: Evaluation Page – Spectrograms

4.2.5.3 Files Bar Chart

In this bar chart, the numbers of recorded files are plotted per day. Microphone channels are distinguished by differently colored bars. By clicking on the respective entries in the figure legend under the graph, individual microphone channels can be hidden.

Since all WAV files in the monitoring directory are evaluated to create the plot, not only data from the current acoustical monitoring are incorporated in the figure. In addition, data from past monitorings may be shown in the plot, if data was not deleted.

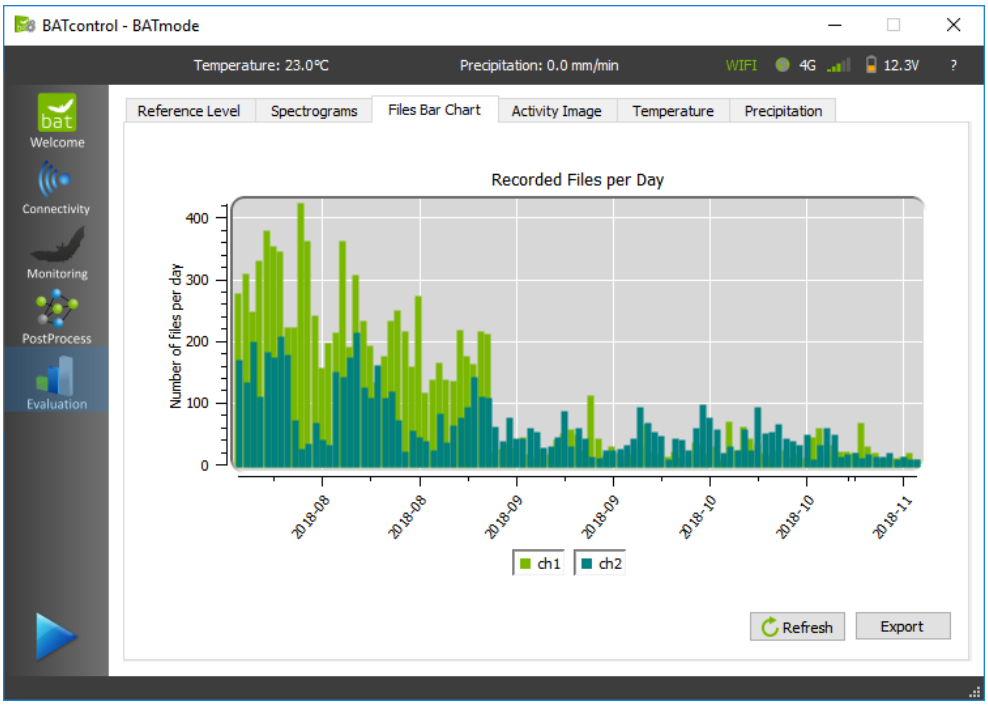


Figure 46: Evaluation Page – Recorded Files per Day

4.2.5.4 Activity Image

This image visualizes the number of recorded WAV files per 10-minute interval as colored circles with different opacity. The opacity increases by 10% for each file. Consequently, the opacity is 100% for 10 or more files of the respective measurement channel within the respective 10-minute interval. Thereby, the x-axis represents the date and the y-axis depicts the respective daytime when files were recorded. By clicking on the respective entries in the figure legend under the graph, individual microphone channels can be hidden.

By applying this graphical evaluation tool, you can easily assess the quality of your recorded data. Recorded noise will be distributed equally over the whole day, for instance. In contrast, bat calls will be recorded mainly in times of twilight.

By specifying the geographical <*latitude*> and <*longitude*> of the recording location, the daily time of sunrise and sunset is determined and inserted into the graph.

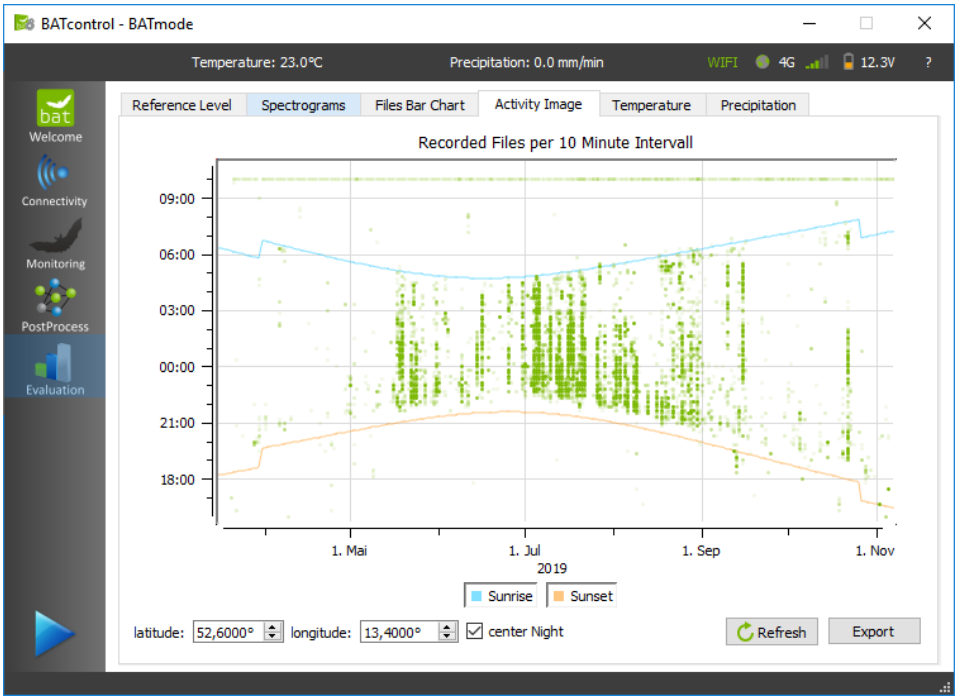


Figure 47: Evaluation Page - Activity Image

Use the check box <center Night> to center the graph to night or day times.

Since all WAV files in the monitoring directory are evaluated to create the plot, not only data from the current acoustical monitoring are incorporated in the figure. In addition, data from past monitorings may be shown in the plot, if data was not deleted.

If there are WAV files in the monitoring directory that have been recorded in different years, you can switch between the years by using the arrow buttons "<" and ">" next to the graph.

4.2.5.5 Temperature Values over Time (only relevant for BATmode 2S+)

This figure shows the logged temperature values over time.

Since the file “conditionlog.txt“ in the monitoring directory is evaluated to create the plot, not only data from the current monitoring are incorporated in the figure. In addition, data from past monitorings may be shown in the plot, if data was not deleted.

4.2.5.6 Precipitation Values over Time (only relevant for BATmode 2S+)

This figure shows the logged precipitation values over time.

Since the file “conditionlog.txt“ in the monitoring directory is evaluated to create the plot, not only data from the current monitoring are incorporated in the figure. In addition, data from past monitorings may be shown in the plot, if data was not deleted.

4.3 Real-Time License

With a Real-Time License for BATcontrol you can activate the so-called Real-Time Features in BATcontrol. These allow a real time curtailment of wind turbines triggered by bat activity.

4.3.1 Real-time transmission of recorded WAV files via MQTT

With activated license and activated <*Publish new WAVs*> (see chapter 4.2.2.7) newly recorded WAV files are transferred to a MQTT server. It can evaluate the files according to your needs and sends signals to a turbine control system if necessary.

4.3.2 Real-time transmission of AI Call Detector results via MQTT

The neural network-based AI Call Detector from bat bioacoustictechnology can be applied directly in a post-processing step on newly recorded WAV files (see chapter 4.2.4.1). If the real-time license is activated, the results of the detector, which include bat call identifications on species level, are transmitted via MQTT message to a server, which in turn can send signals to a turbine control system. More information about the MQTT protocol can be found in the document "**MQTT Protocol of the BATmode System - Messages and Commands**" in the download section of the homepage www.bioacoustictechnology.de.

4.3.3 Activating a Real-Time License

To activate your Real-Time License, open the License dialog (see Figure 48) by pressing the <*?*> icon in the status bar and then clicking the <*Real-Time License*> button.

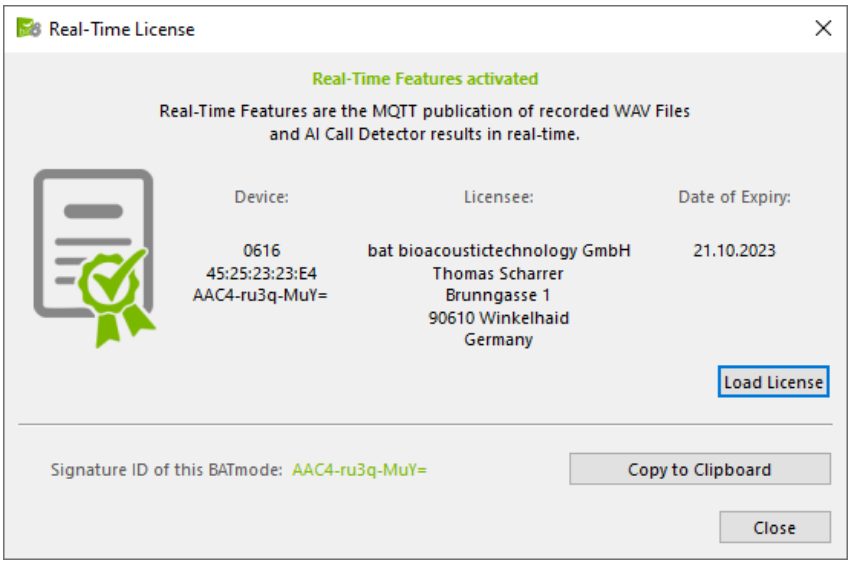


Figure 48: License Dialog

Here you can see whether a real-time license is currently activated and, if so, the licensee, the licensed device and the expiration date. Real-Time Licenses are always bound to a BATmode system, which is identified by the so-called Signature-ID. This consists of three hyphen-separated blocks of 4 characters each. To purchase or extend a license, you will need this signature ID. It can be copied to the Windows clipboard by clicking <*Copy to Clipboard*>. To activate a license, click <*Load License*> and select a corresponding license file with the extension ".lic".

5 TECHNICAL DATA

5.1 BATmode 2S/2S+

5.1.1 Power supply

- 12-19 V DC (± 10 %), Connector: 5.5 mm/2.5 mm, max. current rating: 10 A

5.1.2 Heating output

- 19 V DC / 500 mA

5.1.3 SIM card slot

- Mini-SIM, often also called Classic-SIM or Standard-SIM (15 mm x 25 mm)

5.1.4 Temperature sensor input (exclusively BATmode 2S+)

- Sampling rate: 128 Hz
- Resolution: 12 bits
- Input impedance: 8 MOhm

5.1.5 Precipitation sensor input (exclusively BATmode 2S+)

- Shunt: 200 Ohm
- Sampling rate: 128 Hz
- Resolution: 12 bits
- Input impedance: 8 MOhm

5.1.6 Operation temperature:

- 0 – 40 °C

5.2 Cellular antenna with magnetic base (exclusively BATmode 2S)

- Frequency range: 850/900/1800/1900 MHz
- Gain: 2 dBi
- Cable length: 3 m
- Diameter of magnetic base: 32 mm
- Operation temperature: -10 – 55 °C

5.3 Antenna disc (exclusively BATmode 2S+)

- Operation temperature: -10 – 55 °C

5.3.1 WIFI antenna

- WLAN 802.11 a/b/g/n
- Gain: 5 – 7 dBi directional

5.3.2 Cellular antenna

- Frequency range: 791 – 960 MHz, 1710 – 2170 MHz, 2500 – 2700 MHz
- Gain: 2 – 3,5 dBi

5.3.3 Temperature Sensor

- Accuracy: ±0.3 °C typical
- Local Sensor Accuracy (Max): : ±2.7 °C

5.4 UltraSoundGate 116Hnbm, 116Hnbm-r or 416Hnbm Avisoft Bioacoustics (optionally)

- Sampling rate [kHz]: 50, 62.5, 75, 100, 125, 150, 166.6, 187.5, 214, 250, 300
- Resolution: 16 bits
- Type of converter: Delta-sigma-architecture with integrated adaptive anti-aliasing-filter
- Frequency response (-3dB): 20Hz – 135 kHz
- Input sensitivity: -9 dBV = -7 dBu = 0.35 Vrms
- Input impedance: 50 kOhm

5.5 Microphone disc GM50 (optionally)

- Operation temperature: -10 – 55 °C

5.5.1 Microphone

- Knowles Electronics FG-23629-P16
- Impedance: 4.4 kOhm
- Sensitivity: -53 dBA

5.5.2 Testsignal Speaker

- Sens Comp K Series 40KT08
- Center Frequency: 40 kHz ± 3.0 kHz
- Bandwidth (-6dB): 1,5 kHz
- Total Beam Angle (-6 dB): 125° typical

5.6 Microphone disc GM90 (optionally)

- Operation temperature: -10 – 55 °C

5.6.1 Heating unit

- Input: 19V DC, max supply current: 130 mA
- Heating power: 2,5 W

5.6.2 Microphone

- Knowles Electronics FG-23629-P16
- Impedance: 4.4 kOhm
- Sensitivity: -53 dBA

5.6.3 Testsignal Speaker

- Sens Comp K Series 40KT08
- Center Frequency: 40 kHz ± 3.0 kHz
- Bandwidth (-6dB): 1,5 kHz
- Total Beam Angle (-6 dB): 125° typical

5.7 Tower Microphone TM10 (optionally)

- Operation temperature: -10 – 55 °C
- Knowles Electronics FG-23629-P16
- Impedance: 4.4 kOhm
- Sensitivity: -53 dBA

5.8 Tower Microphone TM20 (optionally)

- Operation temperature: -10 – 55 °C

5.8.1 Microphone

- Knowles Electronics FG-23629-P16
- Impedance: 4.4 kOhm
- Sensitivity: -53 dBA

5.8.2 Testsignal Speaker

- Sens Comp K Series 40KT08
- Center Frequency: 40 kHz ± 3.0 kHz
- Bandwidth (-6dB): 1,5 kHz
- Total Beam Angle (-6 dB): 125° typical

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BATcontrol is based in part on the work
of the Qwt project (http://qwt.sf.net)

Product illustrations similar.
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