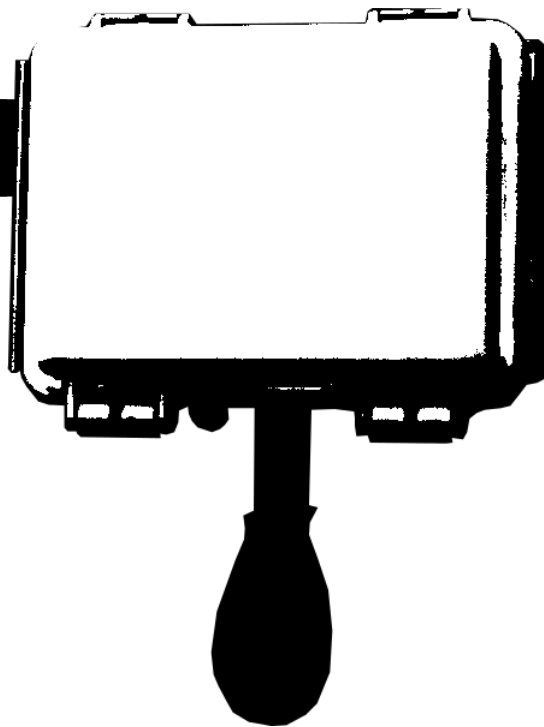


Bioacoustic Audio Recorder



User Guide

Version 1.2

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Features

- Supports multiple sample rates: 8kHz, 16kHz, 22.05kHz, 44.1kHz, 48kHz, 96kHz (with corresponding anti-aliasing filters at their Nyquist frequencies)
- Adjustable gain from 10 to 60dB in 1dB increments
- 16 bit sample resolution
- GPS position and time synchronisation
- Sunrise and sunset based scheduled recordings
- Microphone detection line so you know the microphone is connected
- Standard microphone includes a 20dB class A pre-amp and output driver to drive long cables
- Ultra low noise recordings
- View and edit the schedule on the BAR unit or via Scheduler software on your PC
- Simple user interface
- Detailed diagnostic log files
- Robust, waterproof, lockable enclosure made from a durable UV resistant plastic

A message from Frontier Labs

Thank you for using our Bioacoustic Audio Recorder (BAR).

We designed the BAR with the goal of creating the best possible bioacoustic recorder for scientific field research. To that end we created a recorder that is simple to use and easy to deploy with best in class sound quality so you can hear quiet and distant calls, and we made it strongly built and reliable with the smallest size and weight possible so it's easier to carry in a backpack. We included features like GPS location and time-synchronisation to save you manual work in record keeping, we designed smart microphones with the lowest noise, a built in pre-amp and cable driver that tells the BAR when they're connected and what type of mic it is, and we designed it to use a high-density rechargeable lithium battery instead of bulky and wasteful alkalines.

We designed the BAR to make your field work easier and more reliable. We hope you enjoy using it and if you have any feedback or ideas for improvements we would love to hear from you.

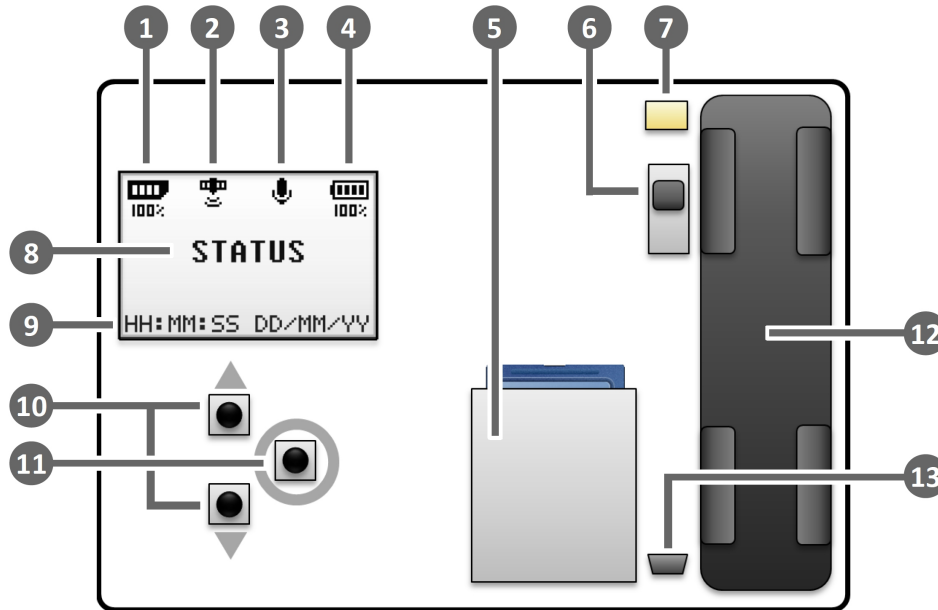


Michael Maggs



Mark Carder







Getting to know your BAR



1 SD Card icon

Shows the SD card free space. When the card is empty this will show 100%

2 GPS status icon

Shows the status of the GPS system;  blinking = getting clock sync;  radio waves blinking = getting position fix;  solid = refining fix;  = fix acquired;  = fix could not be found; when searching, the number of satellites is shown under the icon e.g. 

3 Microphone detect icon

Shows if the microphone is connected.

4 Battery level icon

Check the battery level. If the additional battery pack is installed this is included in the measurement.

5 SD card slot

Insert your Fat32 formatted SD card here. To eject the card, push it down and it will spring back out. Do not eject cards while the BAR is switched on.

6 Power ON/OFF switch

Turn on to begin scheduled recording and take a GPS fix. Turn off to power down the BAR.

7 Battery pack connector

The optional extended battery pack plugs into this connector.

8 Recording status

View the status of current or pending recordings. In Record mode, shows the elapsed time, end time, sample rate and bit-depth of the current recording. In Waiting mode, shows the time and date of the next recording.

9 Current time and date

View the current time and date of the BAR in 24hr HH:MM:SS DD/MM/YY format

10 UP/DOWN buttons

In Menu mode, scroll through menu items; Increment/decrement selections

11 ENTER button

Access the main Menu. In Menu mode, accepts the current selection.

12 Battery socket

Insert only 18650 lithium rechargeable batteries. Positive terminal pointing up.

13 USB port


Used only for firmware upgrades. You can't charge the BAR or copy data through this port.

Recommended operating procedure

In the office:

1. Make sure your SD card is formatted as FAT32 and it's speed is class 6 or faster. SD cards larger than 32GB usually come formatted as exFAT by default, so you'll need to insert them into the BAR and format them through the [SD Card menu](#) before you can use them.
2. Create a recording schedule using the Scheduler program on your computer.
 - When adding new recording events to the schedule it's a good idea to give them a short but meaningful name as this will appear in the filenames of the recorded files. This name is called the *Event name* on the last page of the Recording Wizard when you add a new recording.
 - If there are sunrise or sunset based recordings then it is good practice to set the location and time zone fields in the Scheduler program to roughly where the BAR will be deployed. This will make the recording times shown in the main window more accurate and also provide a backup location value inside the schedule file that the BAR can use to calculate sun based times if it is unable to get a GPS position fix in the field.
3. Save the schedule as ***schedule.flc*** onto your SD card. It must have this name and not be inside any folders for the BAR to use it.
4. Now is a good time to check everything is working as expected before heading out into the field. Follow the deployment steps listed below and check the time of the next scheduled recording is correct. You can then turn it off until you are ready to deploy it.

In the field:

1. Insert the SD card containing ***schedule.flc*** into the SD card slot of the BAR then turn it on with the Power ON/OFF switch.
2. Check the status on the **home screen** or configure the unit by pressing the **ENTER** button.
 - If the unit has been without a battery for a long time, the Setup Wizard will appear and ask you to enter the time zone where the BAR is being deployed (note daylight savings is not taken into account). The home screen will then say "Waiting for GPS time sync" until the clock is automatically updated by the GPS or manually set by the user
 - If there are sunrise or sunset based recordings in the schedule then the home screen will say "Waiting for GPS position for sun based recordings" until a fix has been acquired, otherwise it will display the time of the next scheduled recording.
3. Connect the microphone and check the **microphone detected** status icon appears .
4. It's a good idea to wait until the GPS has acquired a fix before leaving the site in case you need to move to a clearing to get better signal. Under clear skies it should only take a minute or two to get a GPS fix. It only records a GPS fix once after it has been switched on, then disables the GPS to conserve power, so if you move the unit during a deployment and want a new GPS fix, simply turn the unit off and then back on again.



Do not eject the SD card while the unit is switched on as this can result in loss of data and corruption of the file system. Always switch the BAR off before swapping SD cards.

Types of Recording Schedules

The recording scheduler allows you to program recordings to start at a particular time and date with repeating periods throughout the day and over multiple days.

The recording scheduler allows for 3 types of schedule entries:

Record Type	Description
Absolute time based	These recordings are set to begin and end at specified times, e.g. 05:30 (n.b 24 hour clock)
Sunrise based	These recordings are set to begin relative to the sunrise time at the unit's location, e.g. sunrise -30 mins.
Sunset based	These recordings are set to begin relative to the sunset time at the unit's location, e.g. sunset -30 mins.

All schedule entries have a start time and date, a recording duration and configurable recording settings such as sample rate and bit depth.

Each recording can be repeated during the day at regular intervals finishing at a specific time e.g. Start recording at 09:00 on the 01/02/2014 and record for 30mins every 2 hours until 21:00 (which specifies the last recording of the day).

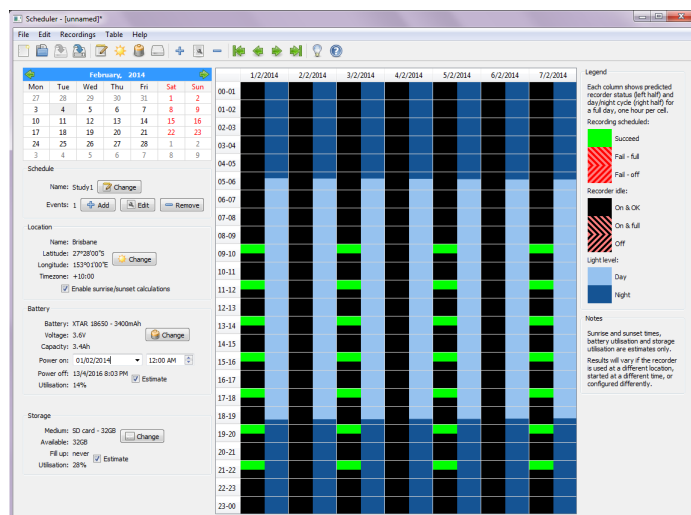
Recordings can also be repeated daily, either every day or every n days (which skips the days in between). e.g. Start recording at 09:00 on the 01/02/2014 and record for 30mins every 2 hours until 21:00 every 2nd day until 07/02/2014 (which specifies the last day on which recordings will take place).

Schedules can be created or edited on a computer or on the BAR unit itself, see the [Schedule](#) item of the **Main Menu**.

In order to create a schedule on your computer you must first install the Scheduler GUI program which can be downloaded from the Frontier Labs website (www.frontierlabs.com.au).

The Scheduler GUI program allows you to create and edit recording schedules and also view the estimated battery life and time when the SD-card will be full.

For more information on creating schedules please see the Scheduler User Manual which is included with the Scheduler software.



Microphones


All our microphones have a built in class A pre-amp with a fixed gain and an output driver to drive cables and maintain the best signal quality. The BAR is able to detect which type of Frontier Labs smart-mic is attached and adjust its internal gain so that the total system gain stays the same even when you change to a microphone with a different pre-amp.

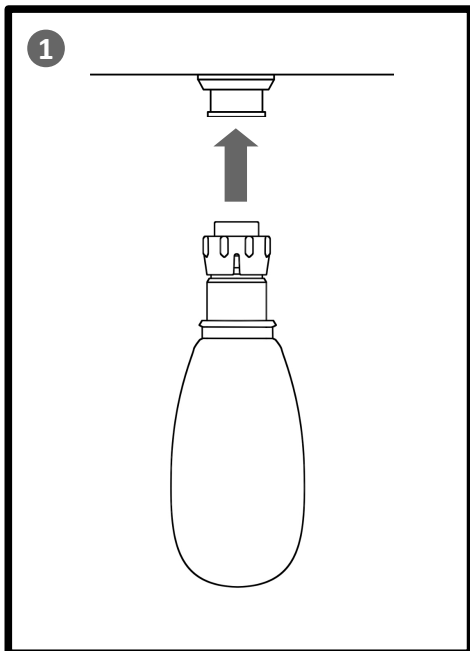
Currently we make 2 different microphones, both of which have a fixed gain of 20dB however this may change in future as needs arise.

The standard black bodied microphone uses a highly sensitive and ultra low noise sensor element with an 80dB S/N ratio and 14dBA self noise. It has a fixed gain pre-amp of 20dB and a flat frequency response (± 2 dB) from 80Hz to 20kHz. It includes an 80Hz high-pass filter to filter out low-frequency wind noise.

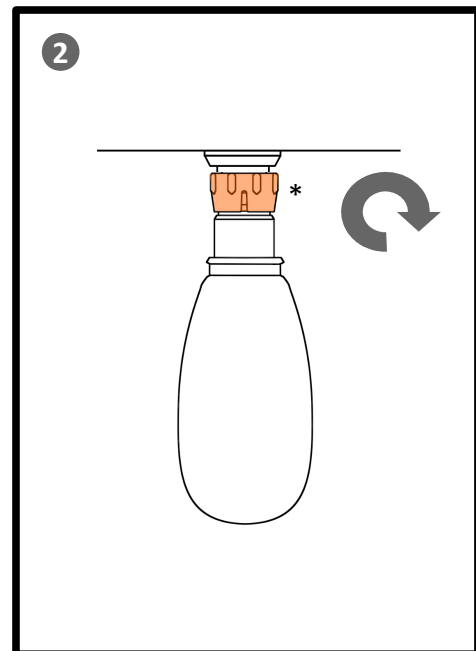
The low-frequency green bodied microphone is exactly the same as the standard microphone but uses a 20Hz high pass filter to allow more low-frequency sounds through.

Attaching a microphone

Follow the steps below to attach a microphone to the BAR. Make sure you see the **microphone detect icon** appear on the **home screen** .



Plug the microphone into the connector on the bottom of the BAR



Push the locking ring in and turn it clockwise until it locks the microphone into place. You should feel it click into place.

Home screen

The home screen is what you see when you turn the BAR on. It shows the status icons along the top, the **Recording Status** in the middle and the current time and date in 24hr HH:MM:SS DD/MM/YY format along the bottom.



The **Recording Status** on the home screen will change depending on whether you are currently in a scheduled recording period or not.

When you are in between scheduled recordings the **Recording Status** area will show the time and date of the next recording, similar to the example shown here:



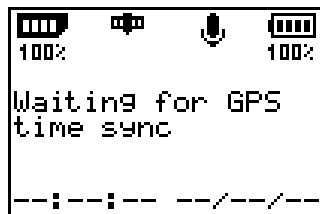
When the BAR is recording the **Recording Status** area will show the **REC** icon with the bit depth and sample rate of the current recording underneath. The large digits on the right show the elapsed time of the recording and the smaller text directly underneath shows the time when the recording will finish. In the example shown below, the BAR is 32 seconds into a 5 minute recording that began at 12:00 and ends at 12:05 and is recording in 16bit 44.1kHz format (CD quality, or 705600 bps).



If there are no more recordings scheduled, because you are after the end of the last recording (or the schedule is empty), the recording status area will say “No Recordings Scheduled” as shown here:



If the internal clock is not set (which can occur after the BAR has been sitting without a battery for a while) then the home screen will say “Waiting for GPS time sync” and the time and date will be displayed as --:--:-- --/--/-- until the clock is automatically updated from the GPS or it is manually set by the user in the [Clock Settings](#) menu. When the GPS updates the clock this area flashes black for a second to show you it's updated.



Menus

Press the **ENTER** button when the home screen is displayed to access the **Main Menu** and use the **UP/DOWN** buttons to select different menu items.

```
- MENU -  
Schedule  
Clock Settings  
Record Settings  
SD Card  
GPS Info  
Device Info  
Back
```

Schedule menu

Select **Schedule** from the **Main Menu** and press the **ENTER** button to bring up the **SCHEDULE** menu.

```
- MENU -  
Schedule  
Clock Settings  
Record Settings  
SD Card  
GPS Info  
Device Info  
Back
```



```
- SCHEDULE -  
+ New entry  
REC  
REC_SUNRISE  
REC_SUNSET  
Back
```

Here you can view and edit the schedule on the SD card. You can also add new entries to the schedule or delete ones you no longer want. See [Types of Recording Schedules](#) for more detailed information about the different types of schedule entries.

Each schedule entry is listed as an item in the **SCHEDULE** menu. The name of each menu item is the name given to the schedule entry when it was programmed on the computer.

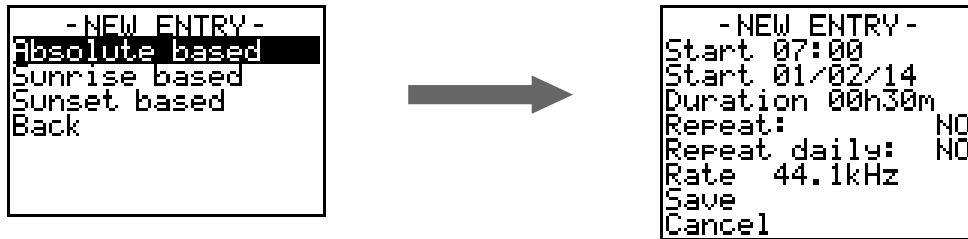
To create a new entry, select **+ New entry** and press the **ENTER** button to open the **NEW ENTRY** menu.

```
- SCHEDULE -  
+ New entry  
REC  
REC_SUNRISE  
REC_SUNSET  
Back
```



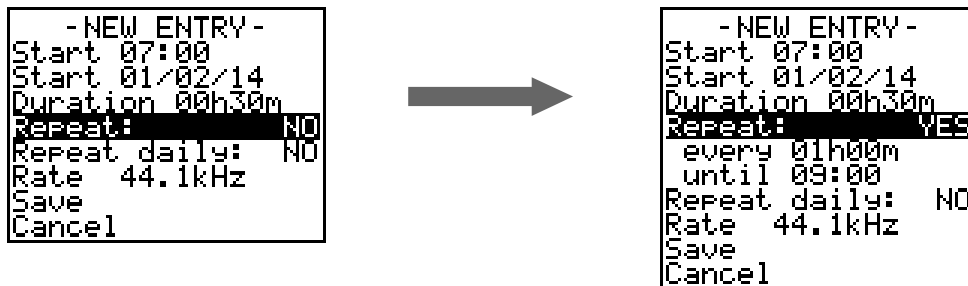
```
- NEW ENTRY -  
Absolute based  
Sunrise based  
Sunset based  
Back
```

Select the type of entry that you want to create and press the **ENTER** button. Note, when creating a new entry on the BAR the name will be automatically set to REC, REC_SUNRISE or REC_SUNSET depending on the type of entry being made.

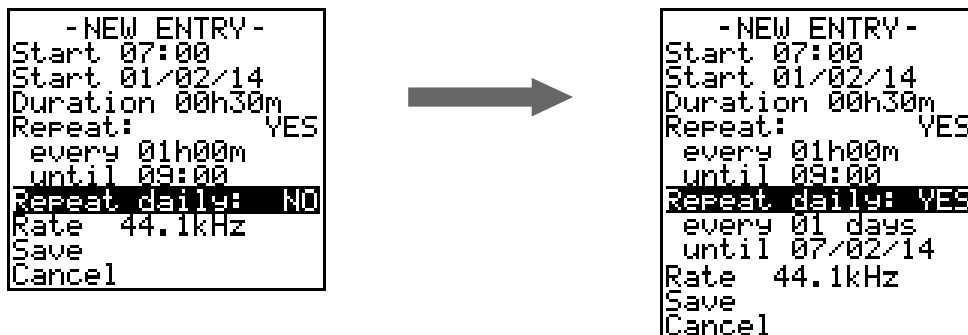


Set the **Start Time**, **Start Date**, **Recording Duration** and the **Sample Rate** of the recording.

To repeat a recording during the day, select the **Repeat** option and press the **ENTER** button to toggle the status to **YES**. Then set the repeat period and the time you want the repeating to stop.

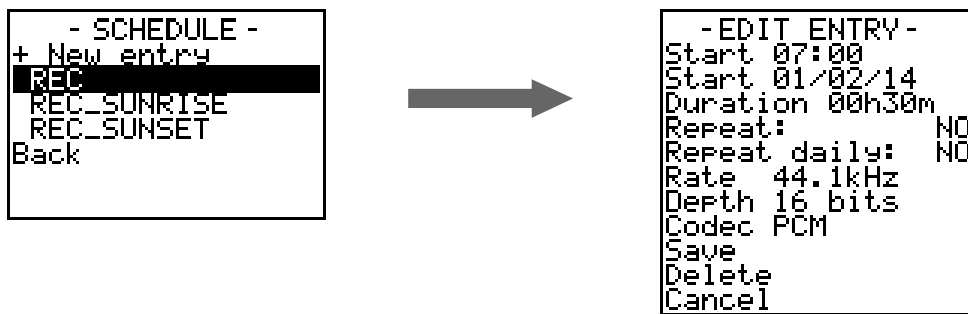


To repeat the recordings daily / every day or every n days (skipping the days in between), select the **Repeat daily** option and press the **ENTER** button. Then set the repeat period in days and then the day you want the repeating to stop. Note this is the last day on which recordings will take place.



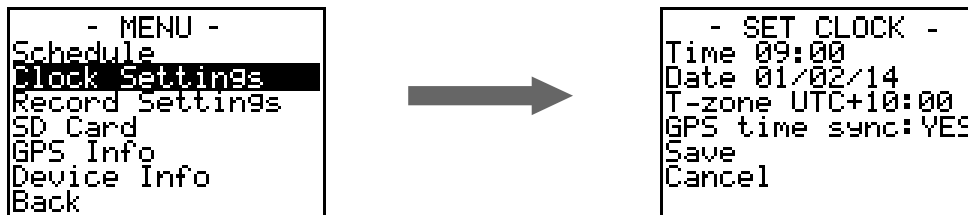
In the example above, the recording is scheduled to start at 7:00am on 1st Feb 2014 and record for 30 minutes every hour until 9:00am every day until 7th Feb 2014.

To edit or delete an existing schedule entry, select the entry from the **SCHEDULE** menu and press the **ENTER** button to open the **EDIT ENTRY** menu.



Clock Settings menu

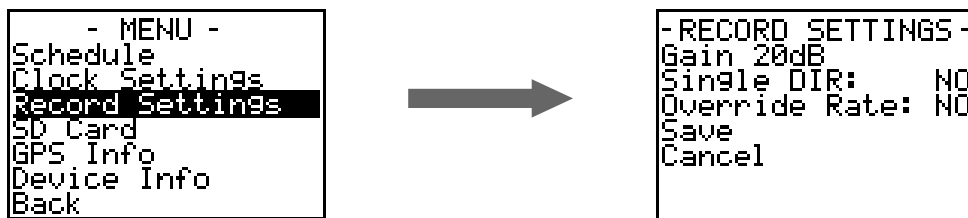
Select **Clock Settings** from the **Main Menu** and press the **ENTER** button to bring up the **SET CLOCK** menu.



This menu allows you to set the current time and date, the time zone that the BAR will be deployed in and enable or disable the GPS time-sync feature (note that daylight savings is not taken into account).

Recording settings menu

Select **Record Settings** from the **Main Menu** and press the **ENTER** button to bring up the **RECORD SETTINGS** menu.



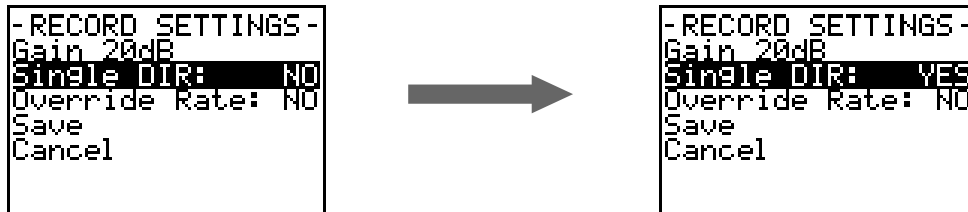
This menu allows you to set the total signal gain of the BAR between 10 and 60dB. Note this figure takes into account the gain of the microphone. You can also choose if all of the recordings get stored

in a single directory on the SD card or in a new directory each day and if desired, you can also override the sample rate settings of all of the scheduled recordings.

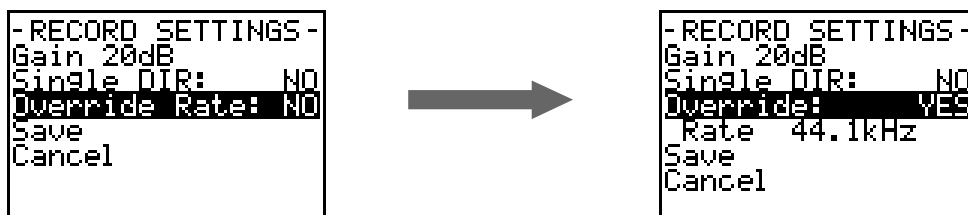


The BAR can detect what model of Frontier Labs microphone is attached and adjust its gain so that the total signal gain will stay the same even if you change to a microphone with a different pre-amp, see [Microphones](#).

To choose whether the BAR puts all of the recordings into a single directory or creates a new directory for each day, selecting the **Single DIR** option and pressing the **ENTER** button.

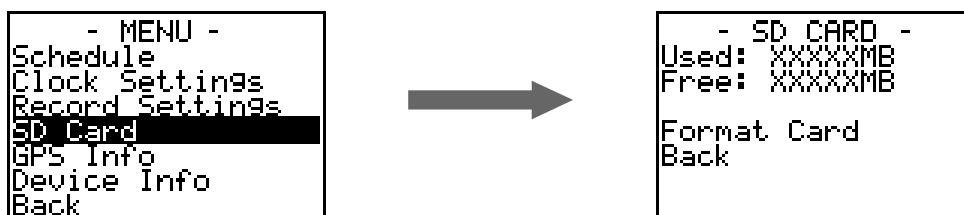


To override the sample rate settings of all of the scheduled recordings, select the **Override Rate** option and press the **ENTER** button, then set the sample rate that you want to use for all recordings.



SD Card menu

Select **SD Card** from the **Main Menu** and press the **ENTER** button to bring up the **SD CARD** menu.

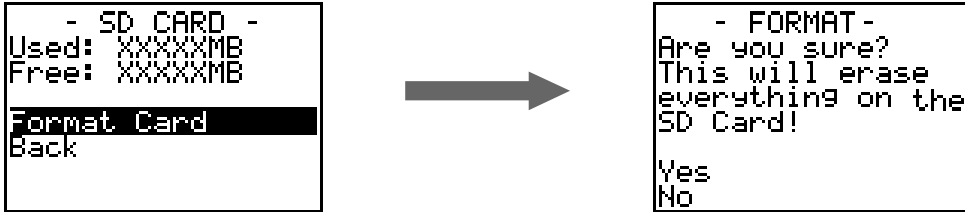


This menu shows the amount of used and free space available on the SD card and allows you to format the SD card.

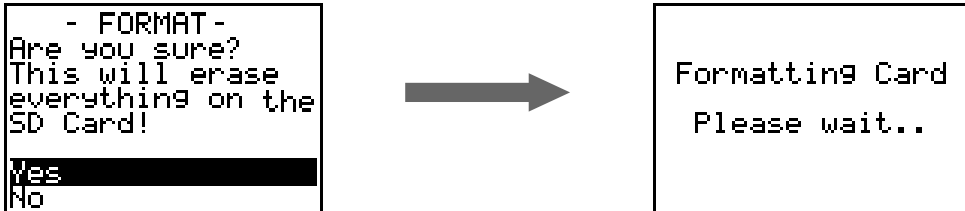


SD cards larger than 32GB usually come formatted as exFat by default. In order to use them in the BAR you will have to format them using this menu option before the BAR will recognise it.

To format the SD card select the **Format Card** option and press the **ENTER** button.



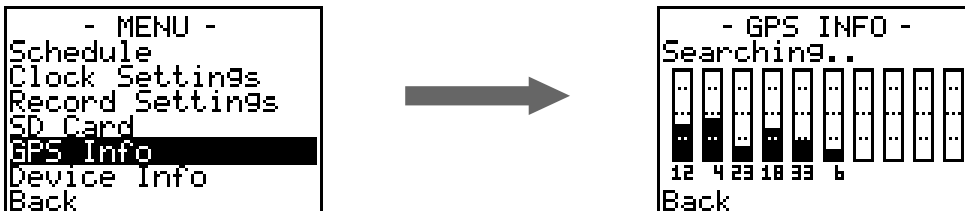
A confirmation message will appear, select **Yes** and press the **ENTER** button to confirm. Formatting the card can take a while, over a minute for large cards, so please be patient.



WARNING: Formatting the SD Card will erase all the data on it!

GPS Info








Select **GPS Info** from the **Main Menu** and press the **ENTER** button to bring up the GPS menu.



This screen shows the status of the GPS as well as the signal strength of up to 10 GPS satellites that are visible to the BAR. The number under each graph shows the satellite ID number and the height represents the signal strength of that satellite as a percentage out of 100%.

It is normal for the number of visible satellites to change over time but the more satellites and higher signal strength then the faster and more accurate the position fix will be. Generally a signal strength above the first dotted line (25%) is good.

The first line of the **GPS INFO** screen shows the status of the GPS which operates in the following sequence:

Stage	Status text	Description	Home screen icon
1	Searching..	Searching for satellites and waiting for time synchronisation.	 Flashing on/off
2	Clock Updated..	Time sync acquired, waiting to get a position fix. Note it's at this point that the clock area on the home screen will flash black for a second to show you it's updated the clock from the GPS.	 ← Flashing → 
3	Refining position	Initial position fix acquired and now refining the position fix to improve its accuracy.	 
4	Position found, GPS disabled.	Position fix has been acquired and the GPS is turned off to conserve power.	
-	Failed: No signal	If a position fix cannot be found within 30 minutes, then an 'X' will appear under the GPS icon. If the schedule contains sunrise or sunset based recordings then the default location that was specified in the schedule file is used to calculate these.	



The GPS works best with a clear unobstructed view of a large area of the sky, if you are unable to get a fix and the number of visible satellites is low and/or the signal strength of each satellite is low then consider moving the recorder into a clearing until it gets a fix which should only take a few minutes.

Device info

Select **Device Info** from the **Main Menu** and press the **ENTER** button to bring up the Device Info menu.

```

- MENU -
Schedule
Clock Settings
Record Settings
SD Card
GPS Info
Device Info
Back
    
```



```

- DEVICE INFO -
Firmware: V1.3

Upgrade Firmware
Back
    
```

This screen shows the current firmware version of the recorder and also allows you to begin the firmware upgrade process. See [Firmware Upgrades](#).

Firmware Upgrades

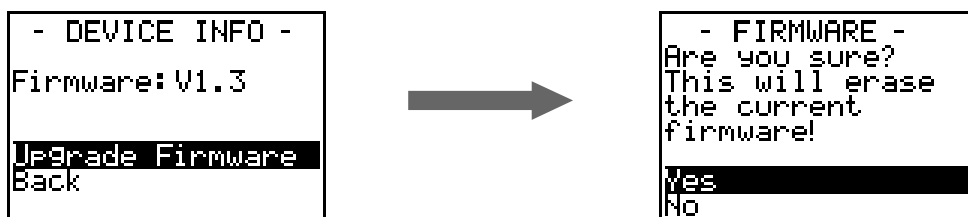
As new features and bug-fixes are released, we encourage you to upgrade the firmware of the BAR to take advantage of these improvements.



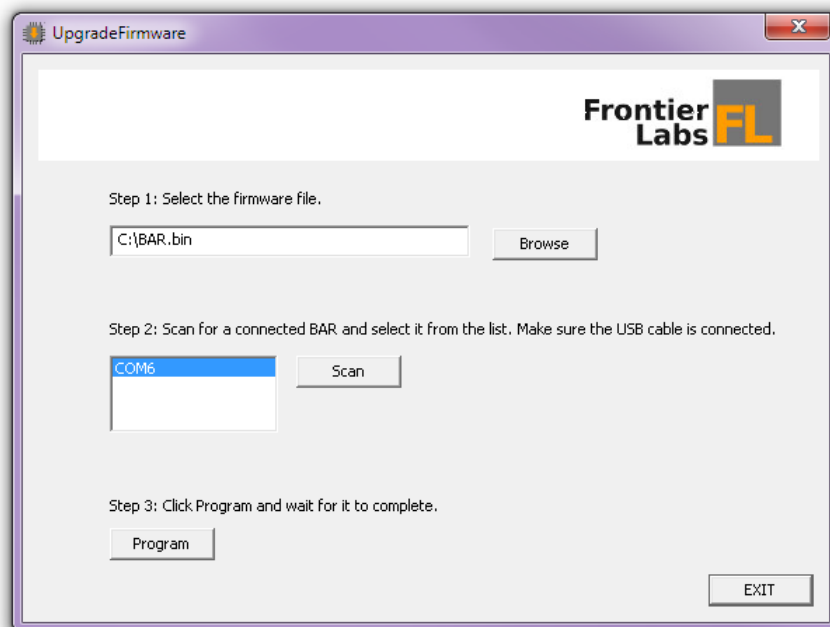
Caution, do not attempt to upgrade the firmware if you do not have a new firmware file.

The firmware upgrade procedure is listed below.

1. Download and install the firmware upgrade utility from the Frontier Labs website.
2. Download the new firmware file and save it onto your computer.
3. Insert a fully charged battery into the BAR and enter the **Main Menu** → **Device Info** menu and select **Upgrade Firmware** and follow the on screen prompts.



4. Connect the USB cable from your computer to the BAR and switch the unit off and then on again. You should see a new device appear in Windows on your computer.
5. Launch the firmware upgrade utility and select the new firmware file you downloaded.



6. Select the connection to the BAR (it should be something like COMx where x is a number), then click the “Program” button.
7. Unplug the USB cable from the BAR and switch it off and then on again.

Tips and Troubleshooting

If you have any questions or issues using the BAR or have ideas for improvements please visit the Frontier Labs support forum at <http://www.frontierlabs.com.au/forum>

Diagnostic Log files

The BAR generates detailed diagnostic log files every time it is used. Each action that is performed is logged with a time and date stamp. Even if there is no SD card present the BAR will log a small amount to internal memory until an SD card is inserted and then dump the internal buffer to the log file. Log files are saved in the folder for that days recording. The log files also contain information about each recording, such as the gain used, the time it started and ended, the battery charge remaining and how much SD card space is left.

If the BAR behaves unexpectedly or you miss a recording that you think should have occurred, check the log files to see why.

Recording time vs Sample Rate

The table below shows the typical recording time vs the sampling rate of the BAR when powered from one 18650 battery with a capacity of 3400mAh. Note that with a higher sampling rate the SD card is written to more often which causes the power consumption to increase. If you have the extended battery pack in the lid which holds up to 3 batteries then simply multiply the recording time by the number of batteries you have installed. For example: with a 22.05kHz sampling rate and 4 batteries installed you should get a little more than 330 hrs of recording time.

Sample Rate in kHz	Typical Hours Recorded with 3400mAh battery
8	89
16	88
22.05	84
44.1	74
96	65

Formatting SD cards larger than 32GB

SD cards larger than 32GB usually come formatted as exFAT by default and Microsoft Windows doesn't let you format them as FAT32, however this is not a limitation of the FAT32 file system which can handle devices up to 2TB. To format your card to FAT32, insert it into the BAR and select the **Format Card** option from the [SD Card menu](#) (see the instructions on page 16).

Disabling Windows cache settings

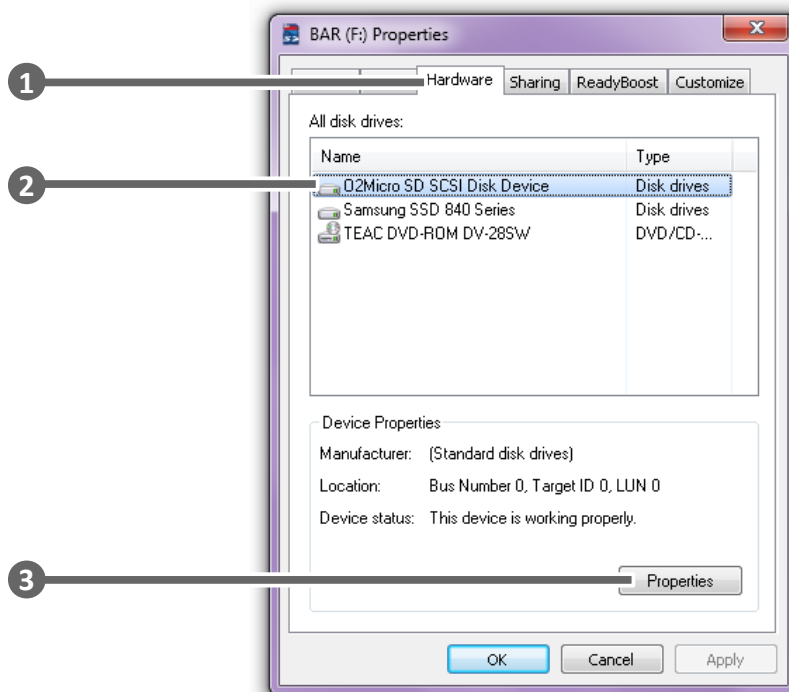
In Microsoft Windows, the default behaviour of removable drives (i.e. SD cards) is to have file caching enabled, which puts off writing data to the card until a later time in order to improve system performance.

This means it is very easy to remove the disk and leave with either the old *schedule.flc* file still on the card or none at all if the card was empty to start with. Even when you re-load the file directly from the card to check it, there is no guarantee that the correct file has been copied onto the disk yet.

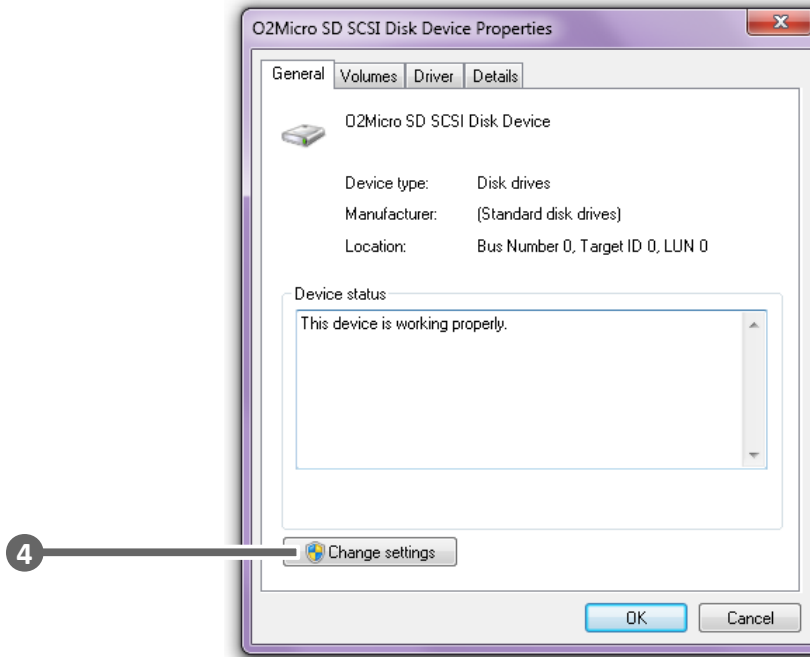
In order to prevent this, you must select **Safely Remove Hardware and Eject Media** from the right hand side of the start bar, or disable the file caching settings for your SD card drive (*recommended*).

To disable file caching, right click on the SD card in **My Computer**, then click **Properties**.

- 1 Click on the **Hardware** tab at the top of the window
- 2 Select the drive of the SD card. (It may have a strange name, look for the letters "SD")
- 3 Double click on the drive in the list or click the **Properties** button

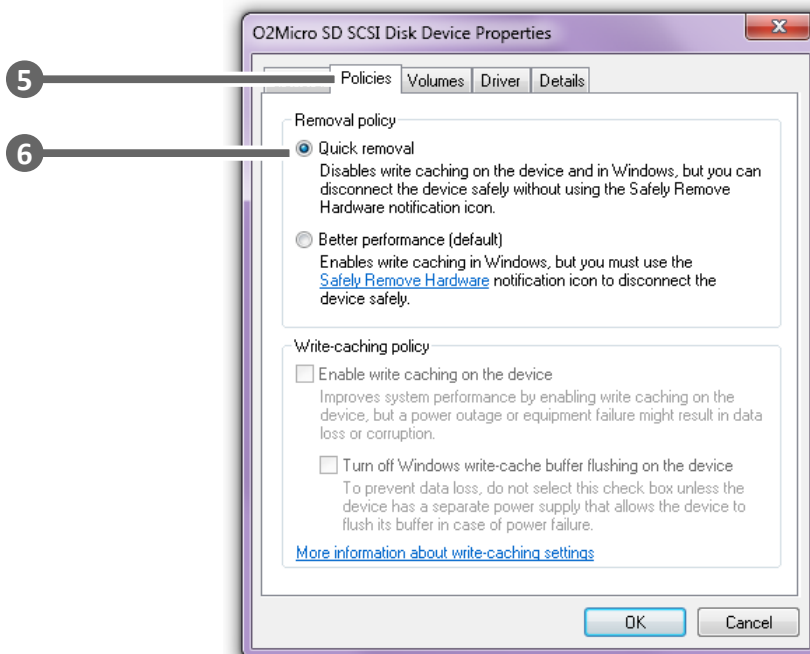


- 4 In the Device Properties window, click **Change Settings**



- 5 Click the **Policies** tab at the top of the window

- 6 Select the **Quick Removal** policy then click **OK**



No GPS lock

If you are unable to get a GPS lock, then consider moving the BAR into a clearing and turning it OFF and then ON to restart the searching process.

The GPS works best with a clear unobstructed view of a large area of the sky and it takes longer under cloudy skies. Deploying the BAR near the bottom of cliffs, in caves or under a dense canopy will likely result in the GPS taking longer to get a fix, or failing to get a fix.

If you are having trouble getting a fix, go to the **Main Menu** → **GPS Info** on the BAR to view the GPS status, the number of satellites the BAR can see and a graph of their signal strength as a percentage out of 100%.

The BAR requires a minimum of 3 GPS satellites in order to get a fix. The more satellites it can see and the higher the signal strength then the faster and more accurate the position fix will be.

If the number of visible satellites is low and/or the signal strength of the satellites is low then consider moving the BAR into a clearing away from walls and tall trees so you can see more of the sky and horizon. Once the BAR has a position fix you can move it back to where you want it deployed.

BAR showing incorrect time

This is most likely caused by an incorrect time zone setting.

By default the BAR will automatically update its' clock from the GPS satellites every time it is switched on (this may take a minute or two, see [GPS Info](#)). If the clock is being updated to an incorrect time then check the **Time-zone** field in the **Clock Settings** menu. You must ensure this is set correctly for the location the unit is being deployed in. It is also important to note that daylight savings time is *not* taken into account by the BAR.

Incorrect Dawn/Dusk times

Dawn and dusk times are calculated on the BAR based on its GPS location when it was last switched on using the ON/OFF switch.

If the BAR is unable to get a GPS position fix, then the position that you set in the Scheduler GUI program when the schedule was created will be used as a backup. If the position specified here is largely different from the real location of the BAR then there will be a discrepancy between the calculated and real dawn/dusk times. For example 0.3 degrees of longitude away (or 30km E/W if you were at the equator) would result in about 1 minute of error.

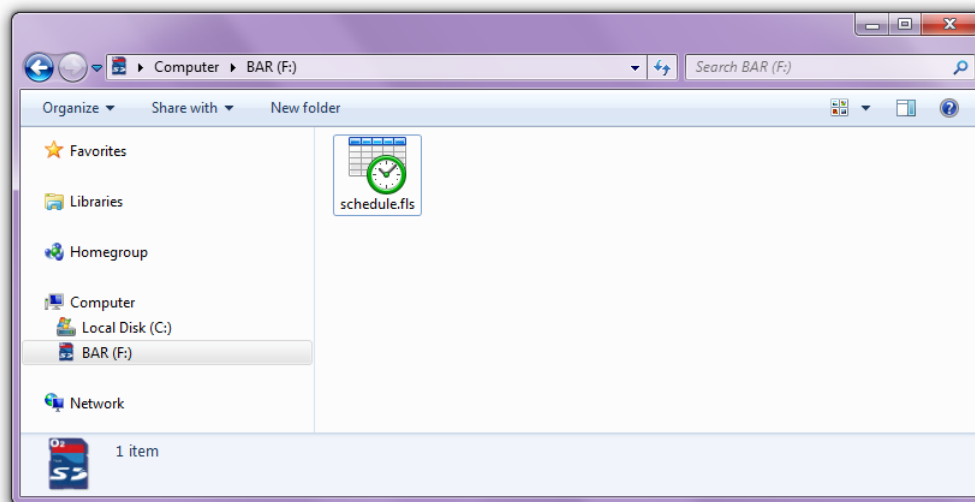
“No Recordings Scheduled” when there should be

When you see the “No Recordings Scheduled” screen (shown below) this means there are no more scheduled recordings left to be done in the future and there is nothing left for the BAR to do.



This can occur for a number of reasons:


- **Past the End Date:** Double check the start and end date of the recordings you were expecting as well as the time and date on the BAR as you may be past the end time and date of the last recording.
- **Incorrect schedule file name:** Check file name and location of the schedule file on the SD card. The schedule must have the file name `schedule.flc` and it must be saved in the root directory of the SD card for the BAR to use it. See below:



- **Incorrectly formatted SD card:** Make sure the SD card is formatted as FAT32. SD cards larger than 32GB come formatted as exFAT when you buy them and you will need to format them to FAT32 before you can use them. See [Formatting SD cards larger than 32GB](#).
- **No GPS position for sun-based recordings:** Sun based recordings require location information to calculate the sun rise and set times. If no GPS position could be found and there was no backup location set in the schedule file then sun-based schedule entries are ignored. (Note this will not occur if you used the Scheduler GUI program on the PC. When you make a new schedule on the BAR directly, you can't set a backup location and you must get a GPS fix when you deploy it.)
- **Schedule file did not properly copy across to SD card:** Windows file caching postpones writing files to the SD-card making it easy to leave with the old schedule file still on there, or no file at all. See [Disabling Windows cache settings](#).

Silent recordings

The most likely cause of this is that the microphone was not properly connected.

Make sure that you see the **microphone detected** symbol  on the top row of the **home screen** to know that the microphone is properly attached. Unplug the microphone then plug it back in again and check that the symbol appears.

Note that after the microphone is pushed on, the locking ring at the base of the connector needs to be turned to lock it into place, see [Attaching a microphone](#).

Calculating Gain

To convert a gain value given in dB into a multiplication factor of the original signal, you can use the following equation:

$$\text{multiplication factor} = 10^{(\text{Gain in dB})/20}$$

For example, 20dB gain is 10 to the power of (20 divided by 20) giving 10^1 which equals a multiplication factor of 10.

Below is a table of common gain values in dB and the corresponding value as a multiplication factor of the original signal.

Gain (dB)	Gain (multiplication factor)
10	3.16 (or $\sqrt{10}$)
20	10
30	31.6
40	100
50	316
60	1000

The table below shows what gain values on the Songmeter SM2 are equivalent to on the BAR.

Songmeter SM2 Gain (dB)	BAR Gain (dB) ver 1.5 firmware or later
36	30
48	42
60	54



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