TeensyBat USER MANUAL

Open source advanced DIY bat detector
Software Version 1.71, March, 2024

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	01 April 24	First attempt by Edwin Houwertjes
Rev. 1		
Rev. 2		

Note from the writer.

Since this is an open source project and many users find smart new enhancements the software keeps developing.
With new features most older features stay as they were. If the version number advances you can still use the earlier manual for most functions.

Feel free to ask for the original file if you want to add information, correct mistakes or write a translation.

OPERATIONS MANUAL

TABLE OF CONTENTS

1.0   GENERAL INFORMATION

1.1   System Overview

This bat detector/recorder is a versatile and advanced bat detector one can build by themselves.
It basically is a software defined ultrasound detection and visualization device for listening and looking at short sounds emitted by bats, grasshoppers, small rodents and other animals or even machinery. The heart of this device is a Teensy 4.1 development board by PJRC. Cor Berrevoets has been improving the initial code written by Frank DD4WH, and Edwin Houwertjes joined in to improve the hardware and develop a printed circuit board that helps building this somewhat complex device the easy way. The synergy between Cor and Edwin resulted in a device that is capable of doing tasks one only finds in the more expensive bat detectors. Since there are a lot of hobbyists and enthusiasts that can not afford an expensive detector this could be a solution. The TeensyBat detector is not intended to be used by the professionals like ecology research bureau's. The device will not be sold as complete functional device and it will be kept as an open source project. TeensyBat is not a PJRC product, it only uses the Teensy 4.1 development board by PJRC.
The software is written in "C" using the help of readily available libraries of the Arduino/Teensy device family. All used libraries can be found in the software source that is found on Github.

1.2   Main features

- Display detected sounds as waterfall and power-spectrum on 2.8" color display.

- 4 listening modes

    - Heterodyne (mixer)
    - Auto heterodyne
    - Frequency division
    - Granular stretch (stretch function of granular synthesis synthesizer technique)

- Sample rates up to 384kHz

- Recording started and stopped by a single button press.

- Automated unattended recording activated by ultrasound trigger

- Memory buffer that allows to store sounds that you just heard a few seconds ago.

- Files stored per day in a separate folder on a micro SD card.

- Files can hold GPS data and other information using GUANO standard

- Media transfer protocol via USB cable, or simply place the micro-SD card in a computer

- Two rotary controls and two push buttons to control functions

- Several menu pages to change settings or view database

- Playback with slowed down speed or as if you are receiving live sounds

Temperature
sensor (option)

External mic conn. (optional)

Knowles MEMS mic.

GPS
power
switch

(optional)

Micro
SD-card

socket

Head-
phone
conn.

Micro
USB
conn.

Power
switch

V G 281k   15.8 15:10
              45 48 58
48

Start REC   GranularS
Volume 50   Gain 21.0
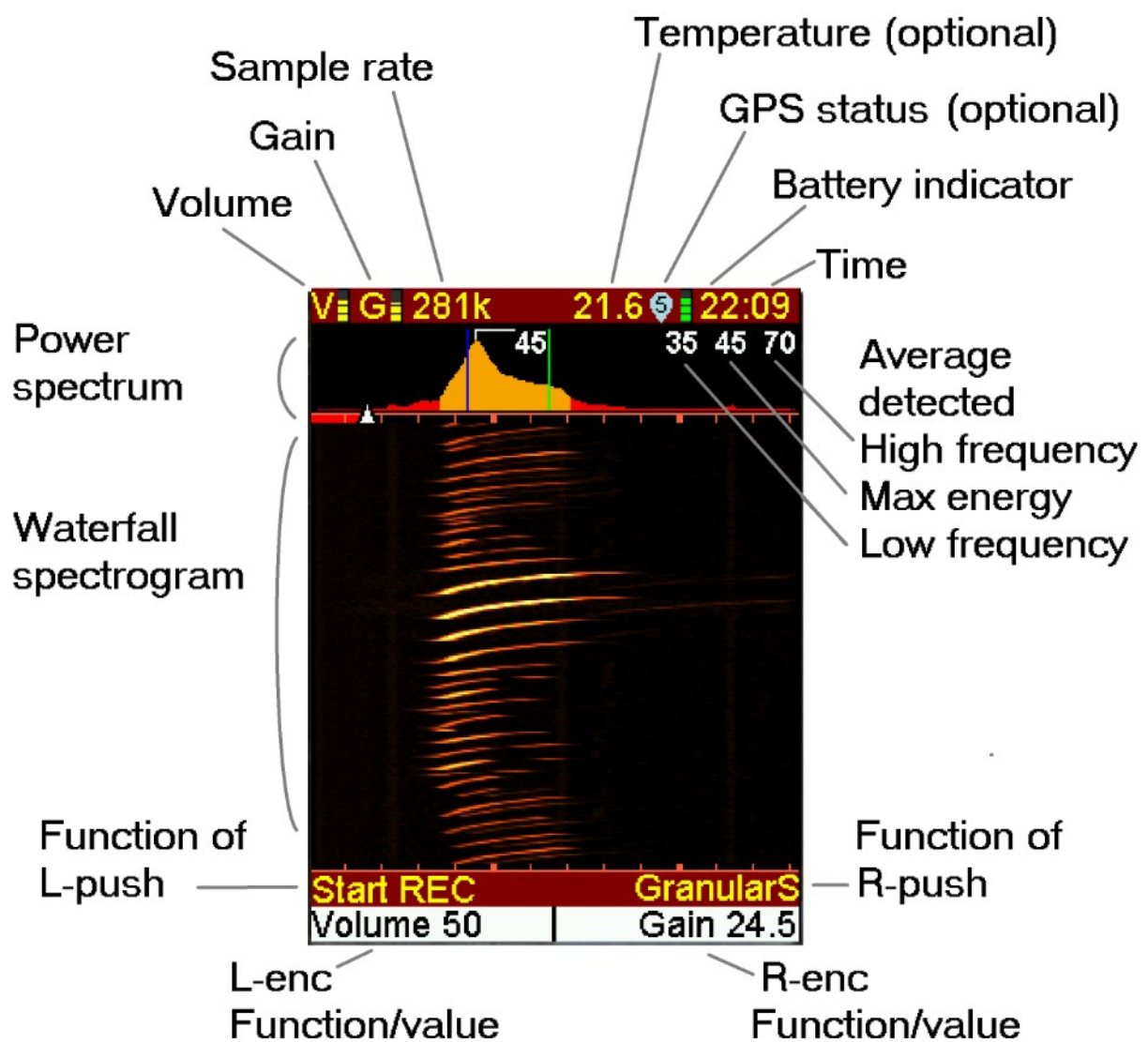
USB-C charging
socket 5V 1Amp

Charging
indicator LEDs

2.0   SYSTEM FUNCTIONS

2.1   Display overview

The display gives us a lot of information, this is the default view after starting up.

GPS and Temperature sensor are optional, the detector will discover the sensors at startup. Temperature is not shown by default.
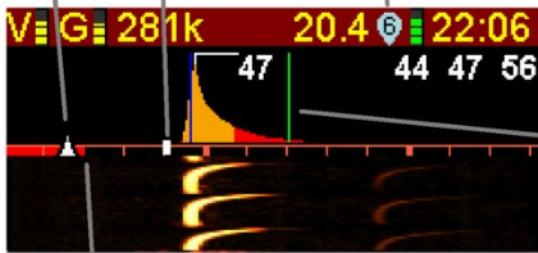
The display shows the frequency spectrum with 0kHz on the left and highest frequency on the right, on every 10kHz there is an indicator, every 50kHz there is a wider indicator.

Trigger frequency for waterfall / GS (15kHz)

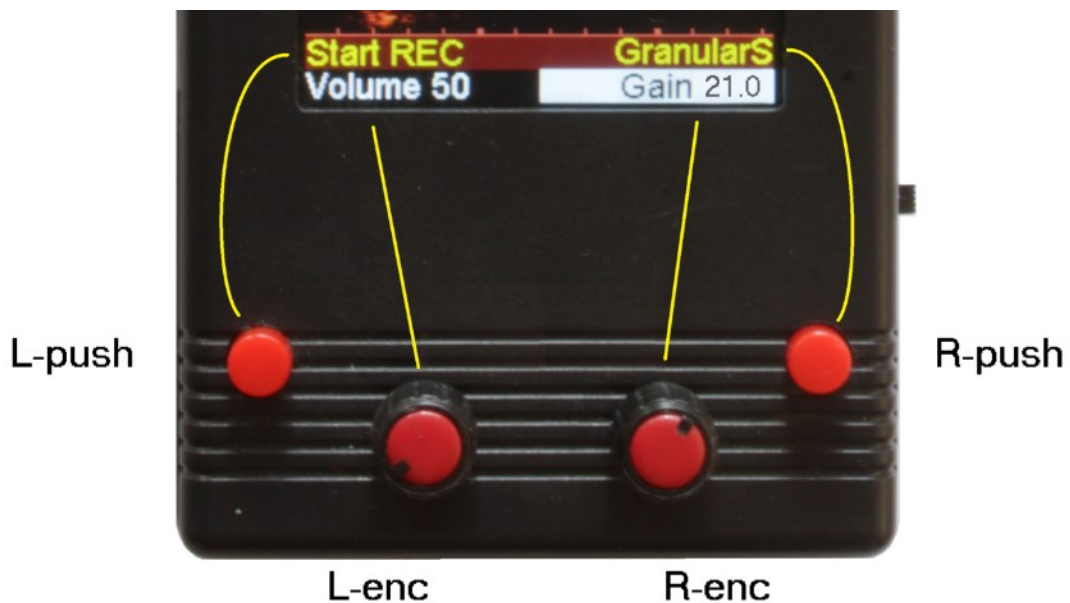Heterodyne frequency indicator (40kHz)

Number of sattelites in view

Blue and green lines show average frequency of maximum energy and average highest frequency

High pass filter setting (20kHz, red bar)

2.2   Buttons overview

The detector has four controls, two push buttons L-push and R-push and two rotary encoders L-enc and R-enc. The functions of these controls can change depending on the displayed information or chosen function. The display will show you which function each button has.

2.3   General use

Live use, detecting and changing encoder functions.

When one heads out into the great wide open at night, all one needs to do is plug in the headphones and power on the unit. Slightly adjust the Gain setting so that the display does not start scrolling when there is no sound.

The setting for gain usually appears on the right encoder and the left encoder changes volume.

To change the function of the encoder, one can press the encoder (background changes color) and rotating can alter the function. Press the encoder again to select that function. The right encoder has a limited set of functions. The left encoder has more functions.

This example sets the gain. (Standard R-enc usually already is set to gain except for heterodyne mode.)
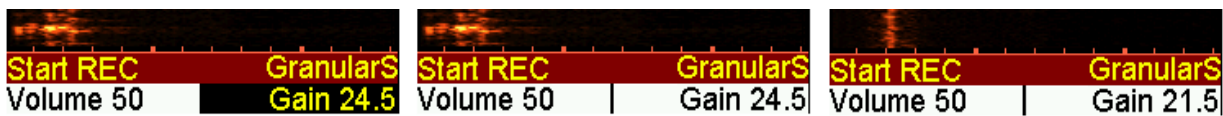
Rotate **R-enc** to select gain   Press **R-enc** (notice color change)   Rotate **R-enc** to change value.

When one wants to change the function of the encoder, simply press the encoder again, the background turns black and turning the encoder now switches between functions.

The **L-push** button is mainly uses for recording, L-push can start recording and a second push will stop the recording. (When no SD-card is present L-push will switch the detection mode)

R-push button is to change the detection method. Standard is **granular stretch** as this simply gives the most detailed sounds. **Frequency division** is a quit crude way of lowering frequencies and **Heterodyne** is a quite commonly used technique for bat detectors. A part of the ultrasound spectrum is lowered to a frequency that can be heard. It works like a radio receiver so you have to tune fr the right frequency, upon selecting heterodyne, R-enc will change to "frequency" . **Auto heterodyne** is a similar function but the mixing frequency is chosen automatically based on the received sounds. A fifth mode "passive" will simply output the same sound as what the microphone receives.

To observe the received sounds it is important that gain is not too high, keep the display from scrolling when there is no sound. Also the granular stretch function is dependent on the ultrasound trigger that makes the display scroll. When the waterfall keeps scrolling granular stretch will not work properly.

The scrolling of the display and playing of granular stretch is dependent on the gain setting but also on the menu items "Signal peak above" and "Signal strength above" in the granular stretch menu.

L-enc can be used to change: Volume, Gain, Sample rate, Filter freq., display, select: PLAY, AutoREC or settings.
R-enc can only be used to set Volume, Gain and Sample rate.

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2.3.1 Encoder settings and push button functions

Volume,
this setting changes the volume on the headphone output.

Gain,
this setting controls the gain on the input stage, turning op the gain will let you detect bats that are far away, but also other sounds are easily picked up. Set the gain on a level where the display does not start scrolling when there is no sound.

Sample rate,
The detector supports multiple sample rates, usually 281kHz should be enough to capture most species, a lower sample rate usually makes better use of the with of the display, where for extremely high frequencies one would probably rather use 384kHz. At 384kHz there is more noise in the recording so we chose 281kHz as standard to get the best of both worlds.

Filter,
The high-pass filtering function has several setting, in this menu item you can olny change the frequency and see the number of filter stages (1). Other filter function can be found in the settings menu.

Display, waterfall disp/spectrum disp/no graph disp/horizontal disp
The display shows the **waterfall spectrogram** by default. The view visualizes the sounds that are heard, brighter colors are stronger signals. Low frequencies are on the left high on the right. Scales with 10KHz indicators are on the top and bottom of the screen.
There also is a **spectrum display** which shows the sound spectrum in a live manner, it is a larger and faster version of the average power spectrum.
No graph disp was made to eliminate display update noise, the hardware however has evolved and this option to make the best recording is not used anymore.
The fourth option is **horizontal disp**, this the waterfall display in a horizontal manner, most pople are used the this view on their computer. Unfortunately the display does not support a scroll function like this, the display view is recalculated very quickly, this takes time and processing power, the standard waterfall works more fluently.

Selecting **PLAY** function, please refer to "playback" in chapter 5

Selecting **Autorecord** function, please refer to automated and unattended recording 2.4.2-2.4.4

Select **SETTINGS**, please refer the chapter with settigs. 3.1-3.6

Push button functions

Left push does start recording a long push activates auto record

Right push changes the detection mode, a long push saves a screenshot

Encoders push function change the function assigned to the knob, however there are also long push functions.

Left encoder long push is a shortcut to Settings menus.

Right encoder long push plays back the last stored wav file. (see play functions)
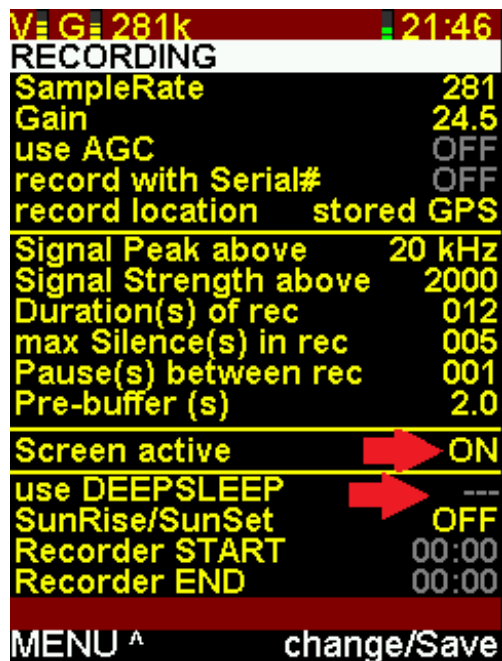
2.4   Recording

2.4.1   Manual recording

Recording is quite easy. Just make sure a micro-SD card is installed (SDHC class 10) and press **L-enc** during your bat survey. The detector will show that you are recording. Press L-enc again to stop the recording. REC will be shown in the lower part of the display, on the top the filename is shown.

If the memory chips are installed (optional) part of this memory is used as an audio buffer. This buffer holds several seconds of audio. When pressing record, this buffer will be stored as well, so you are also saving sounds that you heard just a few seconds ago. The length of this portion depends on the sample rate, on 384kHz sample rate it is about 3 seconds, lower sample rates save a longer portion.

2.4.2   Automatic recording

Auto-record can be used in several ways. The way it acts depends on settings. We will be describing **automatic recording during a bat survey**.

Two settings on the RECORDING settings page are important.

Screen active needs to be ON. And use DEEPSLEEP should be OFF. (Use DEEPSLEEP will be set to off on every power cycle)

Screen active will enable you to view all the data you normally see on your display during a bat survey.
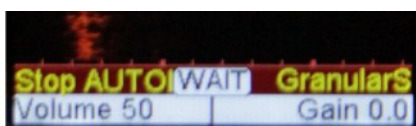
The only difference is that after selecting auto record you will see "WAIT" or "AREC" on the display.

Every ultrasound that has a component higher than "signal peak above" and "signal strength above" will trigger a recording.
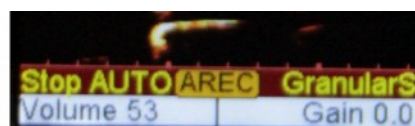
Auto record can be started from the **menu** under **L-enc** or by a long-press on **L-push**
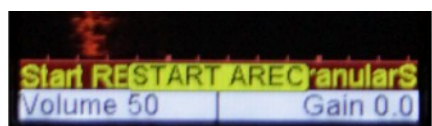
Activated AREC
ultrasound

Waiting on ultrasound

Recording detected

Pressing **L-push** will **stop** the auto record function

2.4.3 Automatic Unattended recording

If you want to record a (portion of) the night and not stick around you can choose to turn off the display.
Change the setting "screen active" to off.

When auto record is activated via the L-enc menu (AutoREC) or using a long-press on L-push the display will show a message that the display will be turned off.
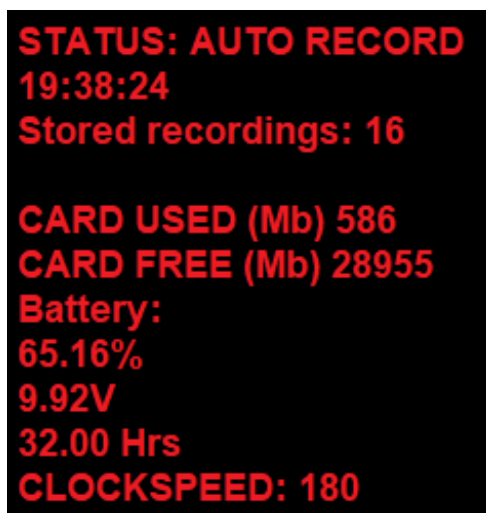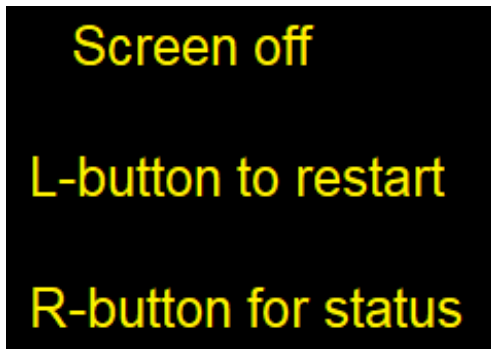
On the right you see an example of what the status screen looks like after pressing R-push

Pressing L-push will take you out of auto record.

The HRS remaining is an estimated value, this will only work after a number of minutes. The estimation of time is something experimental. It will calculate the remaining tine depending on different battery measurements. Remaining time si dependent on display brightness, GPS use, type of battery and charge state.

2.4.4 Automatic, multiple nights, unattended recording

The last and most complex way of unattended recording is deepsleep recording. The recording depends on a time scheme. Time can be calculated automatically by using the sunrise/sunset bu this requires to have GPS locations to be set or acquired. The setting "use DEEPSLEEP" can only be used when valid times are entered.
"use DEEPSLEEP" is a value that does not get stored. If the detector is turned of and on again you need to set "use DEEPSLEEP" again if you want to use it. "use DEEPSLEEP" will overrule the setting "Screen active"

When the detector is in sleep mode, it wakes up every 15 seconds, this serves two reasons.
If the detector is powered by a powerbank via the micro-USB connector the very short current draws help to keep the powerbank active.
The other reason is to scan if L-push or R-push is pressed.
During recording L-push and R-push will work without delay, when the detector is in sleep mode it can take up to 15 seconds so it sometimes takes a very long press to get the status or exit deepsleep-autorecord. As soon as the logo appears, release the button as otherwise auto record will be activated again by the long push.

2.5   Playback

2.5.1   Standard Playback

The playback function can be chosen from the **L-enc** menu.

Once PLAY is activated the display will show a folder name [YYYYMMDD], file length in milliseconds sample rate and the filename.
If there is enough information in the filename an accumulated power-spectrum is also shown. This can give some indication about the species.

L-enc is used to **select** the **file**.
L-push will start **playback**, pressing L-push again will **stop** playback.
R-enc can be used to set the playback speed, apart from different **speed** rates **1/20** to **1/5** there is also an option **Direct**, Direct plays full-speed and **R-push** can be used to select detection modes: Granular stretch, heterodyne, auto heterodyne of frequency division. This allows you to listen to recording as if it is a live bat. This function can also be used to train you to recognize bat species.

Pressing **L-enc** will brigs you back to the root folder. Rotating **L-enc** is used to select the folder, the filename and number of files in the folder is shown.

L-push selects the chosen **folder**, Pushing **L-enc** gets you back to the menu and **exit** the playback function.

2.5.1   Quick playback (D-PLAY)

Sometimes it is nice to quickly listen back to the file you just recorded. You can uses this function as if you were using a time expansion detector.
This will only work after you just recorded a file, so when you switch on the detector no file can be played this way.

Press and hold R-enc until you see REPLAY, release R-enc and the **D-PLAY** function will start playing the last file.

The way the file is played depends on the settings you used for the normal play function. Keep in mind that the file also has the recorded buffer so it is several second longer and it can start with silence. The right buttons have no function **L-enc** is for **volume**, **L-push** is to **exit** the D-play function.
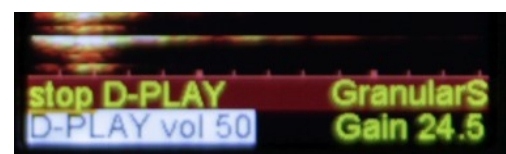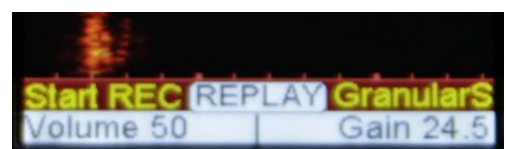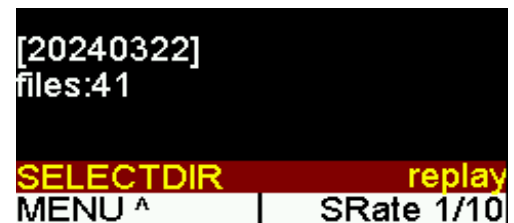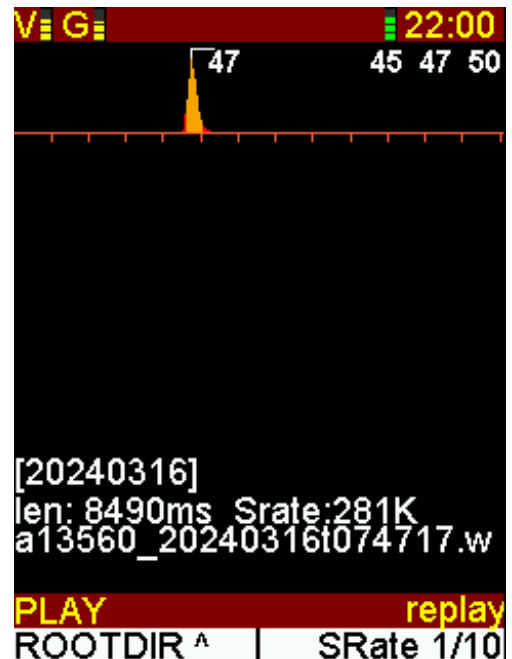
2.6   File operations

When you have a **micro-SD** card installed (SDHC at least class 10) you can use the recording functions. To use the recordings on a computer one can **pull the card from the detector and put it in a card reader on in the computer**.

An other option is to used the **Media Transfer Protocol**, do not turn on the detector. **Connect** the detector using a **micro-USB** cable to the **computer**, now the detector will power up and start in "media transfer mode"

Media transfer mode will create a "drive" named Teensy, this looks like a regular disk drive but you will probably not be able to open files directly in you bat-call software.

The media transfer protocol is made to transfer the media from the device to the computer. The display shows the name, version number serial number and the time the software was created. The size of the micro-SD card and the Size that was used. (yes your 32GB cars shows up as less than 32GB this is normal)
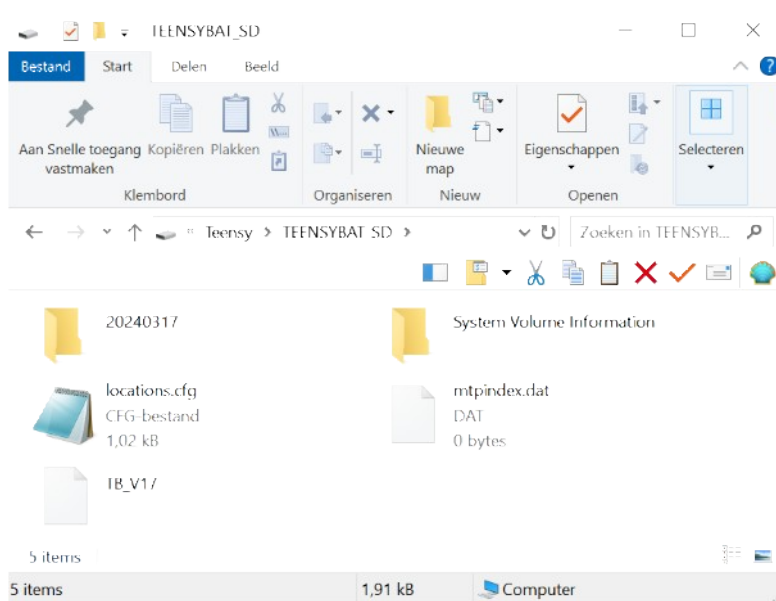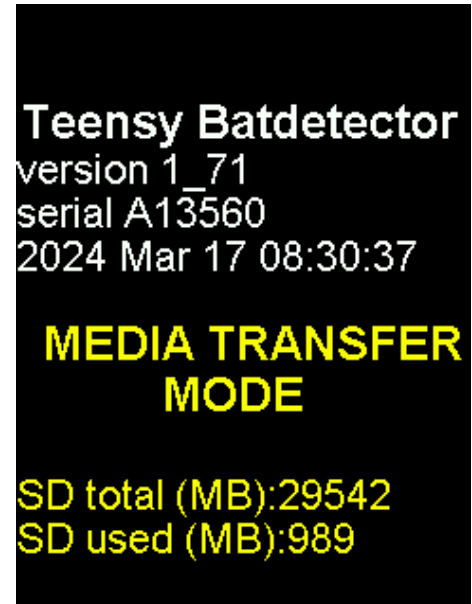
This is what the file explorer looks like in windows once you have selected the "Teensy" drive.

There are folders for each day that you have recorded sounds, you can easily copy this data to you computer in order to work with these files in your preferred programs.
The file TB-V17 has saved settings, locations.cfg will be discussed in GPS settings. mtpindex.dat and System volume information are system files.

2.7   About the device

The TeensyBat detector can be built wilt several options, the first ones had Teensy 3.6 micro controller and different firmware's depending on the installed hardware.

Today we have 3 firmware versions one for Teensy 3.6 and two for Teensy 4.1 depending on installed PSRAM memory.

Upon booting we seen a nice photo by Paul van Hoof, in the right top corner the current time, below the photoe we see the Name Teensy Batdetector, version number, processor speed and processor serial number, Time and date the firmware was compiled.

If installed it shows the size of PSRAM that is discovered and when a GPS module is built in it will connect to the module and try to find satellites. As satellite positions change often you will probably need to get a fix via the satellite settings page.

If you had a recent fix you will get a fix again during the satellite search count-down.
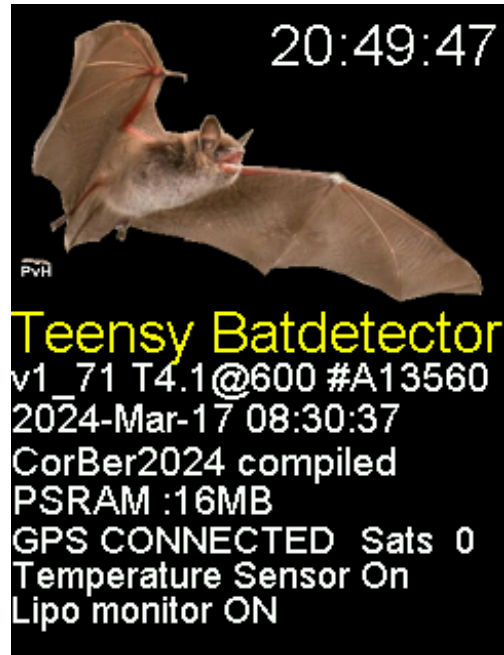
3.0   SETTINGS MENU

There are a lot of settings in this detector. These are arranged over a number of pages.

To access settings, we **rotate L-enc** to select SETTINGS, once we **press L-enc** we enter the settings pages.

A **quick** way to enter SETTINGS is a **long press** on **L-enc**, the display will show SETTINGS and upon releasing **L-enc** on changes to the SETTINGS menu.

NAVIGATING in settings

Rotating L-enc will change the **position** op the **active line** (white background), **Press L-enc** to **exit** settings.

Rotating R-enc will change the **value** of the active line, on the top line you will change between menu pages. **Press R-enc** to **save** the menu settings. Settings are saved in the detector but there is also a copy on the micro SD-card (if installed)

KEEP IN MIND, CHANGING A VALUE IS INSTANT, IF YOU EXIT THE SETTING THE DETECTOR REMEMBERS THE SETTING, BUT ON A POWER CYCLE THAT SETTING IS LOST. YOU NEED TO SAVE THE SETTING IF YOU WANT TO KEEP IT, OR OF IF YOU ONLY WANT TO TEST THE SETTING, JUST CHOOSE NOT TO STORE IT AND EXIT THE MENU. IF YOU DO NOT LIKE IT, POWER OFF AND ON AGAIN AND YOU HAVE THE PREVIOUSLY STORED SETTINGS.

3.1 Startup Defaults menu

Most of these setting will look quite familiar of you already read the top part of this manual.

Detector mode can switch between Heterodyne, Auto heterodyne, frequency division and Granular stretch. Granular stretch is default because the sound are most detailed, these "synthesizer techniques" around for several decades, pleas look up granular synthesis on the internet for more information.

**Display** can be set to waterfall, horizontal (waterfall), no graph or spectrum display.

Volume and **Gain** should be quite clear I guess, as is **RampleRate**.

SampleRate play is the playback rate, 1/20 up to 1/5 can be chosen but also Direct which plays full-speed and the detector mode is used to listen.

AGC is automatic gain control, if you have a lot of strong signals in between weak signals it can be nice to lower the gain of the amplifier to prevent over steering in the received audio. The increase and decrease times determine how quickly the amplification is lowered or raised. If AGC is on there can be less perception of distance to the bat.

HighPass is a software defined filter, the frequency determines the cut-off frequency. In this example High pass is only set to 8kHz but this has a special reason, as stages and Q are also not set to a standard value. There also is some small high pass filtering in the hardware of the detector (which can be turned of by jumper or switch)

The filter **stage** determines how steep the filter is, for example, the filter on 20kHz and stage one still has quite a but of signal on 10kHz but on stage 3 or 4 there is much more suppression on 10kHz
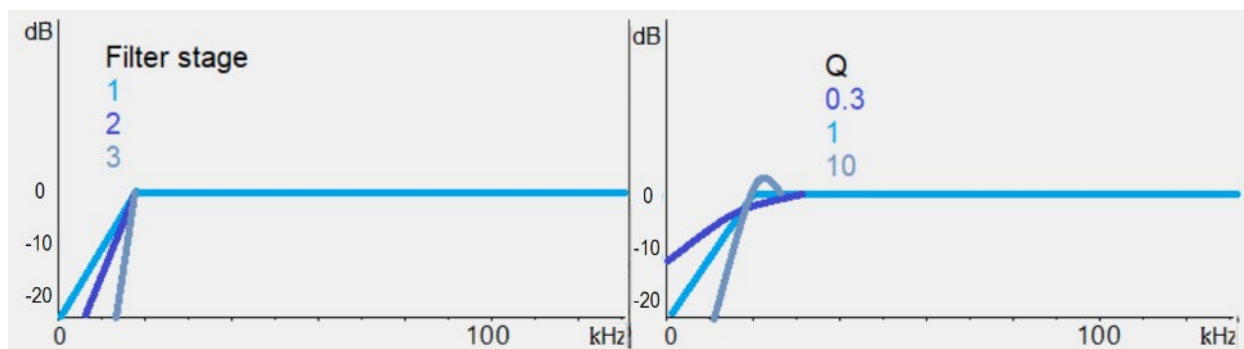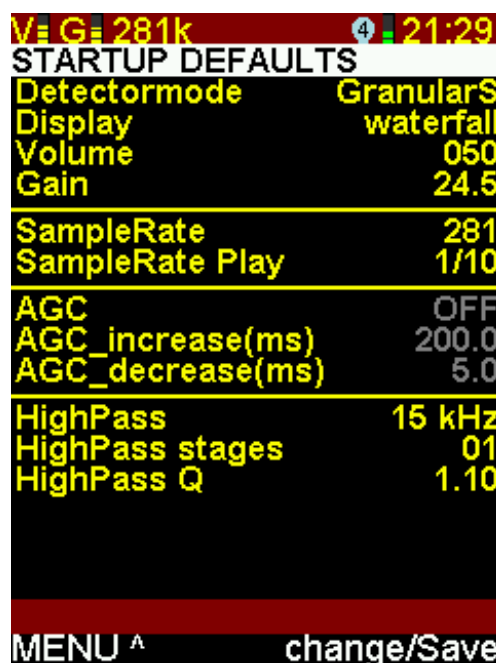
The value for **Q** is a bit more difficult to explain, it is more about the width of the filter Q1 is a "normal" value, 10 creates a bump and Q0.3 makes a shallow band, even effecting the 20kHz that is set, in the example 0dB is more around 30kHz. Be careful messing around with very high or low values. Don't use Q below 0.4 or high values, also be aware that higher high-pass frequencies can alter the bat call sounds.

Since the microphone is most sensitive around 23kHz I experimented with values to "equalize" the microphones sensitivity, 8kHz, stages 3 and Q0.4 compensate for the high sensitivity of the microphone around 23kHz.

3.2   Setup menu

The setup menu also shows some battery information in the title bar, the number of hours is calculated and takes some time to display a proper value.

CLOCKSPEED is an experimental value, a lower value should save energy, in deep sleep we switch to low seed automatically.

TIME HHMM can be set using **R-enc** and **R-push** to switch between hours and minutes. If a GPS module is installed time is updated when GPS data is received.

YYYYMMDD can be altered the same way as time by turning **R-enc** and pressing **R-push** to switch between year, month and day. The date is also updated via GPS is GPS data is present.

Location is can be one of 10 stored positions or live GPS position, this is described in the Location settings page.

GPS hardware is actually switched by a mechanical switch, if that was on at power-up it should be detected already, if that failed you can try to reactivate it by turning on this setting.

Show temperature will only work if a temperature sensor is installed. It can show and hide the data on the main display, whether this is on (yellow) or off (gray) the data will always be stored in the Guano data in the wav file.

Backlight controls the brightness of the display, values below 50 will be to dark, even for nigh time, during the daytime a higher value will be more pleasant, above 140 the display dies not get any brighter.

Encoder direction, sometimes seem to operate in the opposite direction, clockwise of counter-clockwise can be set here. Upon building be sure to mount two that act same.

ColourScheme This is a value that only works when the menu, hilight and back colors are not default.

Menu color, highlight color and also back color accept values between 000 and 127, 000 are the default colors. If one sets a color and changes the color scheme one can see a huge number of different colors can be created.

Using these color settings is quite complex and not easy to describe, you are on your own here. Fortunately you have a rest to default to restore all setting if you really mess up.

Waterfall scheme is a color scheme that is used to display the sounds on the spectrogram. There a bunch of fancy manes but as soon as you turn **R-enc** also a preview of the color scheme is shown on the bottom of the display.
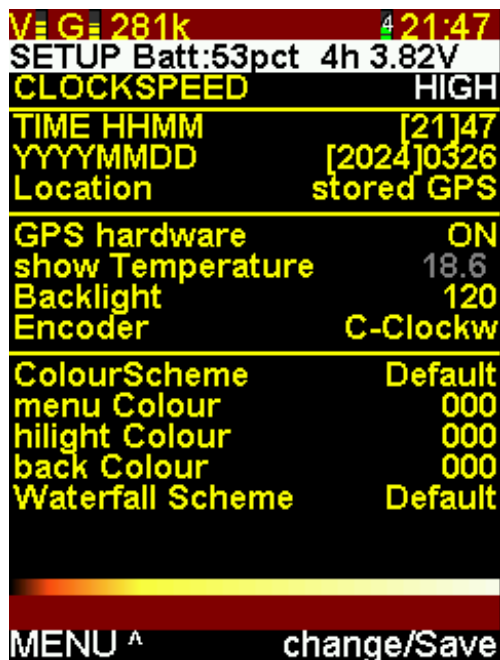
3.3 Granular stretch

For more information about Granular Synthesis I guess you can find a lot on the internet. The stretch function used here needs some setting. There will probably not be a reason to make major changes but it is important to know these settings are here.

Stretching the sounds out in time is something we can only do for short portions of time. Usually the stretching is set to a factor 10, this makes the sounds last 10 times longer and the frequency is lowered by a factor of 10.

Replay speed, this is the stretching factor, to make the frequencies lower one can change to a larger factor like 1/20 however this also makes the replay time twice as long and there is a good chance not all calls will be heard.

Max signal duration if a signal is longer than the value used here that part will not be played.
Signal peak above this value in kHz is one of two vales that have to be met before the stretching process starts.
Signal strength above is a value for the amplitude that has to be met in order to trigger the stretching function.

If in this case a signal over 500 with a frequency over 15kHz is received the sound gets stored in the memory and at the same time playback of this stored sound is started.

FD divider is the division factor of the "frequency division" detector mode.

3.4 Recording (automated recording)

SampleRate this setting is also found on an other page it determines the maximum recording frequency there is also some info in 2.3.1

Gain in this menu is a gain setting that belongs to the auto record function. In active uses gain is changed quite often, so for auto record we have a fixed value.

Use AGC this tells to use automatic gain control.

Record with serial adds the serial number of the Teensy to the filename. When this function is on the serial number is shown, otherwise OFF is displayed (gray)

Record location can be set to off of you do not want to store location data in the wav file.

Signal peak above is used in a similar way as the granular stretch setting, the frequency received needs to get over this value to start an automated recording together with.

Signal strength above only when this amplitude level is met together with the minimum frequency recording is started.

Duration of recording, this is the maximum length or a recording in seconds (even is ultrasound is present for longer time) Standard is set to 12 seconds which is rather short.

Max silence in rec, this value determines how long (seconds) the sound is allowed to be below the max peak above and max strength above levels. If the sound is too weak for longer that this time the recording is stopped.

Pause between records if one dos not a lot of "connecting recordings" this value can be set up to 15 minutes (900 seconds)

Pre Buffer, this value sets the length of the buffer that will be stored, when auto record gets triggered by an approaching bat, it probably can be heard already a second or two before the trigger values are met.

Screen active, determines whether the screen will be of or on during recording, for unattended recording it is better to have the display set to off so the detector does not attract attention and battery power is saved.

To uses automated recording during a bat survey this value needs to be set to on. Do remember that automated recording sets the microphone gain so when starting a survey you might want to change gain right after activating auto record to get the required gain level for active use.

Use deep sleep is used for unattended recording over multiple nights or when one wants to set recording during the daytime for the coming night.

Use deep sleep overrides the screen active setting and one can only set use deep sleep to on when useful times are entered for start and end times.

SunRise/SunSet can be switched on or used with an offset of 15 or 30 minutes +/- to calculate sunset and sunrise times based on the GPS position.

Recorder START and **Recorder END** are the times the detector wakes-up and goes to sleep when using deep sleep mode for automatic recording.

3.5 LOCATION [#xx]

Location is a new function introduced in version 1.7
The idea is that one can add location information to
the wav file without having a GPS reception, because
there is no GPS signal, you want to conserve energy
and keep the GPS off, or when there simply is no GPS
built in.

There are 10 GPS locations, where location number 0
is reserved for the live GPS data.

Location will show the chosen GPS location in the
tile bar a number [#00] is shown. Active GPS can be
seen when there is recent GPS data, Stored GPS wille
be shown is the reception is lost. Locations [#01] to
[#09] standard have manes home1 – home9 but these
can be altered on a computer.
UTC-OFFSET is the offset that belongs to the chosen
locations
DST-ZONE is the daylight savings tome region that belongs to this location
Latitude can be stored for each location, using R-push on can select to chance D degrees, dd
decimals or mm milli's.
Longitude works in a similar fashion,.   Locations can also be stored from the GPS menu
page.
All white lines are not settings but simply information.

The location data is stored in a file on the micro-SD card, using a text editor one can also change the
values, but do not alter the loc0 lines.

3.6 GPS

This menu is only shown when you have the GPS power switch on at the moment you switch on the detector. If you turned on GPS afterwards you can set GPS hardware to ON in the setup menu. Or switch off/on the power after switching on GPS.

Acquiring GPS reception seems to take some time, you can speed it up by accessing the GPS settings page. Be sure you have a clear view to a large portion of sky and you should get a GPS fix in about 50 seconds. If the GPS menu page is open, the detector data is retrieved more often.

The menu name does show GPS CONNECTED when there is a serial data connection to the GPS mode if the module is off, "not CONNECTED" is displayed.

When GPS is off or we have no active or recent Fix, the vlaues are stores values and shown in Gray. "Fix 0d(0)"

Location is the location that was set on the contractions settings page, fir live data "active GPS" Is shown, if the connection is lost "stored GPS" is shown.

Overwrite location is used if you want to store the active position on the chosen location number.

UTC shows the current UTC time when there is a satellite fix.

Latitude and Longitude are displayed in both degrees and decimals but also degrees minutes and seconds.

Altitude is also determined, it can be used is indicator how correct the measurements are when you know your altitude.

H-accuracy should give an indication on accuracy on the horizontal measurement.

Fix(SIV) shows if one has proper fix, when only 2d accuracy is acquired, values are still gray, when 3d is displayed the data will be updated in yellow indicating a proper fix, the SIV values is for the number of satellites in view. The more satellites the higher the accuracy.

head speed shows the direction (heading) in degrees and speed that one travels in m/s, the value for speed can also be a good indication if you have found enough satellites to find the right position.

3.7 Reset to default values

If you did mess up your settings, or maybe performed a firmware update it can be wise to do a reset to default values.

This can be done by holding the L-push button and turning on the detector, A message "RESET TO DEFAULTS" is shown and L-push can be released.

The all the values will be restored to the standard values.
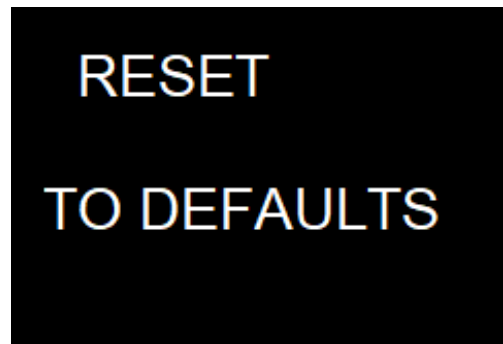
Reset to stored values from the micro-SD card

The setting one stores, are stored in some memory in the Teensy development board, but they are also stored on the micro SD-Card.
A file TB_V17 or similar will created in the root of the SD-card. If you do have some settings you love to work with it is wise to make a backup of the TB_V17 file as this will be overwritten every time you store settings.

If you messed up your settings, or do want to share settings with a friend copy the right TB_V17 file to the root of the SD-card, put the card back in the detector and hold R-push button while turing on the detector.

4.0   GOOD OWNERSHIP

Please be careful with moisture, the microphone and the other parts of the detector are not rainproof.

Take care of the battery, store the detector with a fully charged battery, turn the detector off when not in use. There is low battery protection built in, but after longer period of time even this will not save your battery.

Remove and place the micro SD card when the detector is off, there is a smaller chance of damaging the card and the card contents are read at startup, so do not place a card when the detector is on.

When using an external microphone it is safer to connect and disconnect it with the power off. Also in this circuit is some protection but it is better to be safe than sorry.

Do not put headphones in the external mic socket, or place any other external mic in the socket The Elecon FG-black should work as well as a SPU0410LR5H-QB with 3.3V(trip), mic(ring), GND(sleeve)

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5.0   FIRMWARE UPDATE

Instructions are based on a windows computer.

To update the firmware we first need to know that the version of the detector is. We have:
Teensy 3.6 based
Teensy 4.1 based without memory
Teensy 4.1 based with PS-RAM memory.

The Boot logo shows us what version we have (See 2.7 about the device)

Now we need to download two sets of files.
One containing the **update tools** which can be found here.
www.Teensybat.com/software

The other is the actual **firmware hex file** which can be found here.
https://github.com/CorBer/teensy_batdetector

Unzip the files, in Windows 10 or 11 simply connect the computer to the micro USB connector and windows will tin stall the drivers which are already built in.
If you are using windows 7 or earlier serial_install needs to be run first.

Next Run Teensy.exe

Select File and choose the right "teensybat".hex file

now run reboot.exe (if you can reach the small switch on the teensy you can press that instead)

The Teensy reboots and loads the new software.

On Linux you might need to install all Arduino, Teensyduino and the program source.
https://www.arduino.cc/
https://www.pjrc.com/teensy/teensyduino.html

If you managed to install Teensy 3.6 on a Teensy 41 or vice versa, you can load the right hex file and in stead of running reboot.exe you need to press the button on the Teensy. Open the unit and remove the display to access the Teensy. Connect the micro USB cable, have teensy.exe running with the right file loaded and press the small button on the Teensy.

6.0 TROUBLESHOOTING

Not turning on (black display)

Check if it will power on using a power bank charger or computer when connected to the micro SD-connector on the side. If that works, the battery might be empty, charge via the USB-C connector. Charge indicator should light red when charging, green when full.

Microphone not working

If you have an external microphone socket, chances are the switch in the socket is the culprit. Place a jack-plug and remove it to break and make the switch. (you can uses the headphone connector, but best is to turn off the detector first).
If you are in the building process, check that solder jumpers SJ1and SJ2 are closed of the external mick socket is in place.
Furthermore the microphone has no moisture protection so keep it dry!

Battery not charging

The battery can not be charged via the micro USB connector on the right side of the detector, (next to the headphone connector) that port can power the detector and is used for software updates/debugging but not for charging.
Use the port located on the short side facing the operator it is a USB-C style socket, a charger should be capable of at least 5V, 1Amp.
(charging a drained 8000mAh battery can take over 8 hours)

Headphones not working (on older versions)

When you have a detector with a separate audio board, be sure to use a stereo headphone (3 conductor TRS) and no 4-conductor (TRRS) jackplug headset with microphone. (Teensy4.1 with PCB v0.7 and later can be used with TRRS connector)

Messed up settings

If you accidentally changed a setting and do not know how to restore it, restore to default settings by holding the left push button (L-push) and power-on the detector.

GPS not working

GPS is a bit tricky, the reception is less than on a dedicated navigation device, it is recommend to first acquire a satellite fix by using the GPS settings page. You should get a fix in 50 seconds or less. If you have GPS reception but no location is in the wav file, check the RECORDING settings for the option "record location" when it is off, no location is stored.

PSRAM NOT FOUND !! STOPPED !! / ! WARNING AUDIOMEM LOW !

If this message is displayed you could have some problems with the PSRAM chips. If you have no PSRAM installed you might have loaded the wrong firmware. I encourage everyone to use the memory chips because it gives a great audio buffer. On Cor's github site you can find software that works without the audio buffer, try the NOPSRAM version.

Missing Menu "GPS"

The GPS menu is only visible if a GPS module is discovered.
The detection process of the GPS module is at the moment you switch on the detector, so be sure to have the GPS switch sett ot ON at the moment you turn on the detector. (The GPS power switch is in series (behind) the main power switch)

Missing menu "Locations".

The Locations menu is dependent on the mico-SD card. If no card is found when the detector is powered up, the loactions menu will be hidden

No recording functions.

For recoding we need to have a micro-SD card inserted at the moment the detector is powered up. If there is no SD card found the display will show "no SD" . If a card is present but not detected, clean the card contacts or try an other card. Switch on the detector after placing the card!

Missing metadata, broken files, distorted audio.

When files tend to be distorted, there is a good chance it simply is in the SD-card you are using. The SD-card has to be class 10 or faster. Be sure to have a good trusted brand from a trusted source. Also do not use SD-cards that were used in raspberry PI or cards that are nearly full. You can test card speed on your computer wilt tools like "SpeedOUT"

Continuous tone in recordings

One of the reasons here cloud be that the you are recording near some electronics device. Specially switched power supplies like phone and computer chargers but also LED lighting work on high frequencies. There is a good chance this is picked up by the microphone.

A second reason could be a bad seal of the microphone. It is very important that there is a good seal between the microphone and the enclosure.

7.0   CONNECTIONS

CONNECTIONS

Optional, external microphone
(disconnetcs internal microphone)
Tip = 3.3V (500r current limiter)
Ring = micr. signal
Sleeve = GND

Exteral microphone
connector is 3.5mm
TRS connector, use
well shielded cable.
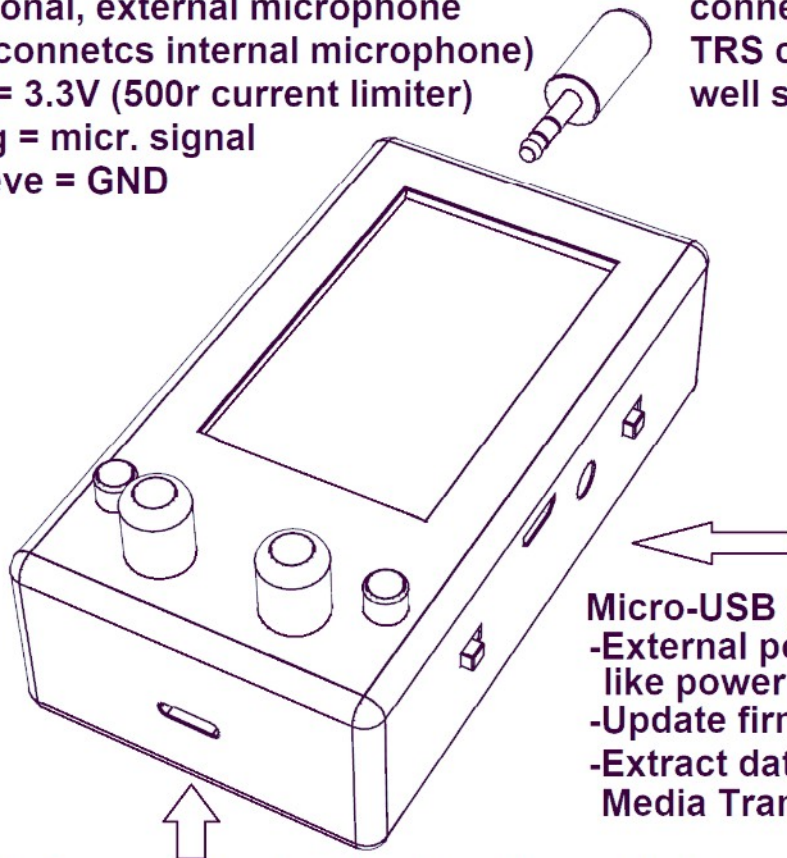
Micro-USB (Teensy)
-External power (5V)
 like power bank
-Update firmware
-Extract data (wav files) via
 Media Transfer Protocol

USB-C connector for charging internal battery.
Uses any USB-C charger (phone/tablet) Current is limited
to 1Amp. This connector is not used for data.

There is a 500ohm resistor on the microphone power supply-line. A microphone typically uses very little power and will work without problems. To protect the detector or any accidentally placed other devices the resistor prevents large currents. The microphone connections are similar to the FG-black or FG-Green microphone. You can use an external microphone on an extension cable to keep the detector indoor and just the microphone outdoor.

I like to uses a thin cable by Tasker C202 the Tasker C286 should perform better but is not as easy to find, Tasker C280 also looks fine. There are several other good cables, usually the better ones are at music stores. At Thomann I found these pro_snake_21000_nf_cable and sommer_cicada_sod14_sw unfortunately many companies doe not describe capacity (lower is better for high frequency) or attenuation.

8.0   SPECIFICATIONS

Since this is a DIY product you can build in your own extras and options.

Field of application	Active (mobile) monitoring as well as unattended logging
Acoustic signal processing	Real time 16bit-full spectrum
Type of microphone	Knowles SiSonic MEMS SPU0410LR5h-QB
Number of microphones	One (there are options for a 2nd but the software is up to you)
Sample rate	Up to 384Khz
Recording frequency range	10–192kHz (High-pass filter can be disabled)
Live monitoring	Granular stretch/(Auto)Heterodyne and Frequency division
Recording functions	Manual or automatic (by adjustable trigger)
Recording schedulers	Manually set times or automatically calculated sunset/sunrise
Audio out	3.5mm stereo plug, standard no speaker
Storage	Micro SD-card SDHC, class 10 32GB recommended.
Display	2.8 inch 240x320 color TFT display (max. 3.2" possible)
Interface	Rotary encoders with push function and push-buttons
GPS	Optional
Other sensors	Option: Temperature
Housing size	W-66 L-115 D-36 mm (excluding knobs)
Weight	310g (with full options and largest battery)
Protection class	IP20
Power	5V 1000mA (charger)
Power supply	Internal rechargeable li-ion battery or 5V via Micro USB
Operating time	Up to 96h per battery charge (Four summer nights using large battery, deep sleep auto-record, no GPS)
File format	WAV, 16bit. Location and temperature stored in GUANO metadata. Screenshots are saved as BMP

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