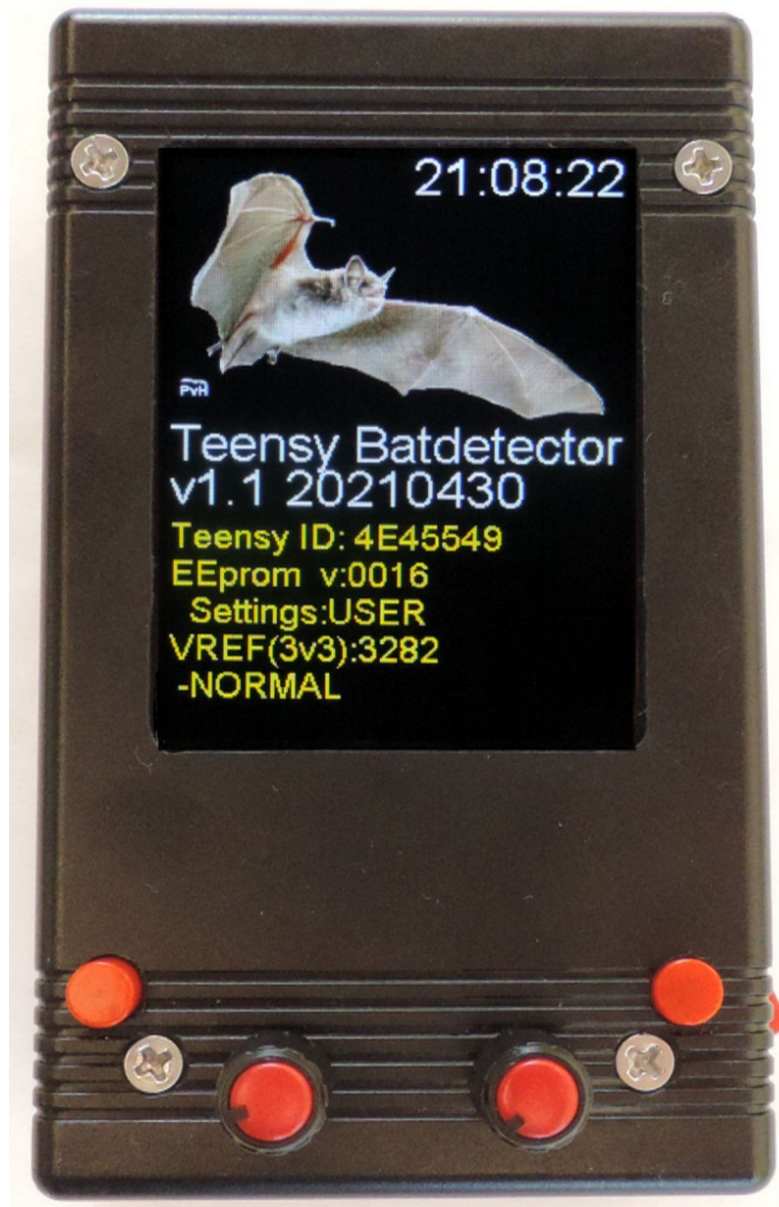


Teensy Batdetector Manual

Software version 1.1dev



Picture in bootscreen by Paul van Hoof www.paulvanhoof.nl

The Teensy bat detector is a detector that you can build yourself. It uses a Teensy 3.6 “development board”, Teensy Audioboard, 2.8” color TFT display.

Small size, 116x68x36mm (4.7x2.7x1.5in)

Heterodyne, Auto Heterodyne, Frequency Division and Time Expansion detection modes

High speed recording (up to 384kHz sample rate)

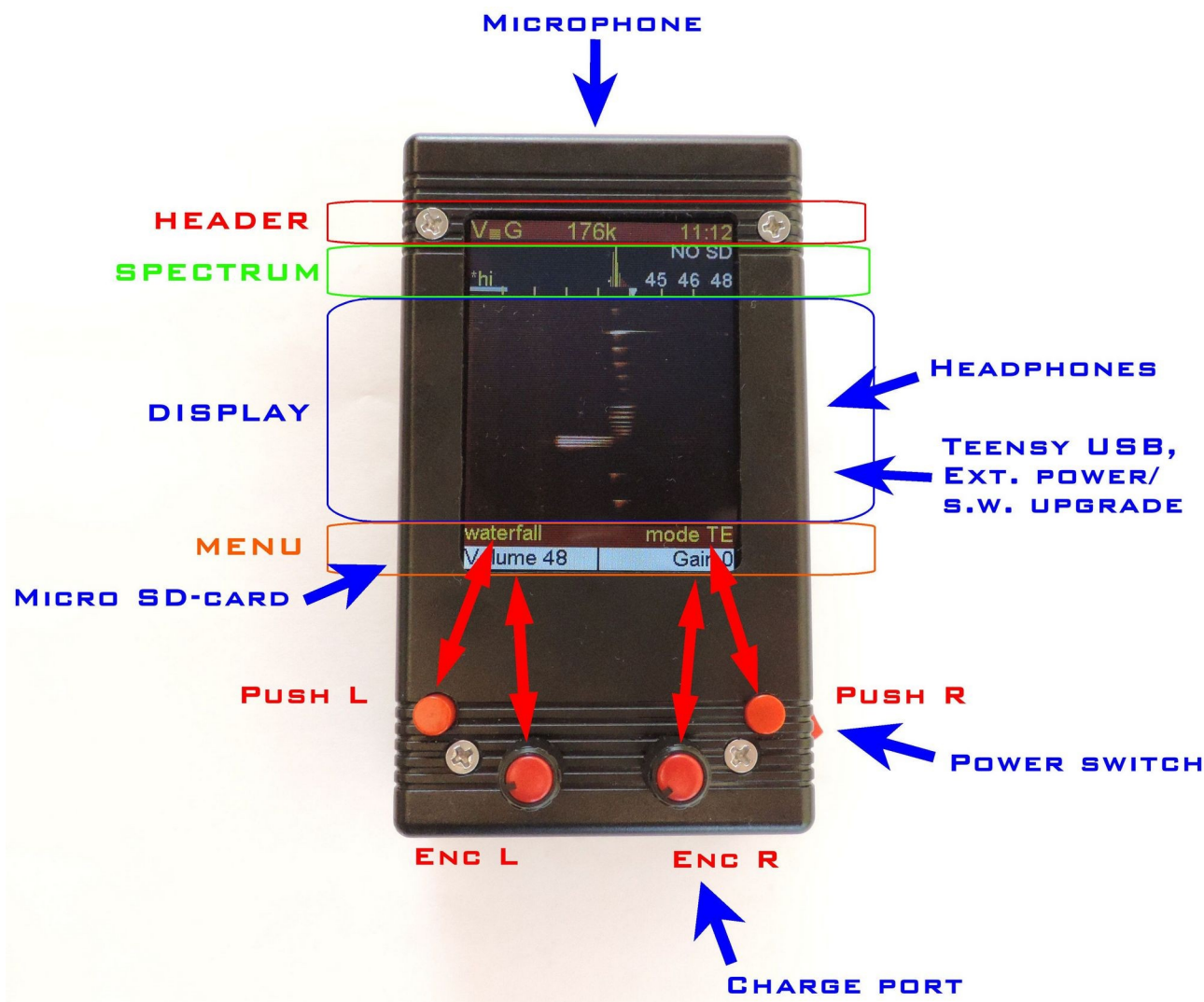
Automatic recording (start at ultrasound detection)

Two visualisation modes (Audio spectrum display or Waterfall display)

Display of received frequencies (Low/Hi/Peak)

Sensitive microphone that picks up sounds that are over 100kHz

Can run over 20 hours on an internal battery, or be powered externally



Hardware,

The microphone is mounted on the front, on the right side you will find a headphone jack and a micro USB for external power or upgrading software and a power switch.

On the back there is another micro USB jack for charging the power bank, and LEDs that will show the state of charge. On the left side there is a small slot to insert a Micro SD-Card.

Power switch, power bank and microphone positions are up to the builder, this (picture above) is how I like to build my detectors.

Controls

The bat detector has 4 controls, 2 pushbuttons (PushL and PushR) and 2 encoders (EncL and EncR). The encoders also have a pushbutton function.

Pushbuttons (PushL PushR)

The pushbuttons are used to switch between options based on the setting that is visible on the bottom line of the MENU section. In the image above the bottom line of the MENU states DISPLAY for PushL and DETECT for PushR. If the user presses PushL the display-mode will change, and if the user presses PushR the detector-mode will change. The pushbuttons step through all possible options in a cyclic manner.

Rotary Encoders with push button (EncL EncR)

The encoders are used to step through the menu (see below) and allow selecting a specific menu-item and then changing the setting for that item.

To do this the user rotates the encoder until it shows the menu-item on screen (in yellow) that needs changing. Then the user presses the Encoder and the colour of the menu-item changes from yellow to white. The encoder can now be used to control the setting of this menu-item by rotating (up is clockwise) the encoder. After setting the menu-item the encoder needs to be pressed again to confirm the setting and the colour of the menu will change from white to yellow again.

The left-encoder has the full menu available but the right encoder only can be used to set a few (the most used) options.

Screensections

The screen is divided in 4 sections, a header, a small spectrum, a dynamic display and a menu.

The header shows for several parameters (gain(g), frequency(f), volume(v) and sample rate(s). Also temperature and GPS status is shown (optional) and time is on the far-right.

The spectrum section shows a compact spectrum of the latest processed sounds, every 10Khz of the spectrum is shown with a yellow divider on the bottom and the white marker shows the current frequency for heterodyne detecting, On the top right 3 figures appear that will show the low-peak-high frequency (in Khz) of the latest detection.

The display section is used to show the incoming signals, it can be set to 3 modes (waterfall (as shown above), spectrum, no display). The spectrum shows a live spectrum graph, the waterfall shows the spectrum over time and will scroll upwards every time a new signal is detected that has a peak above a set frequency (user set with menu TE_low).

The 1st line of the menu section shows the menu item that can be changed by the encoders. The left encoder has access to all menu items but the right encoder is limited to a smaller set of the same menu. The 2nd line of the menu shows the setting for a specific item that is controlled by the pushbuttons. In the example above for instance pushing PushL will step the display through its modes and pushing PushR will change the detector-mode.

The current options for the menu (version 0.90) are :

- **Volume** (0..90)
This set the volume of the headphones.
- **Gain** (0..63) This sets the amplification (gain) of the microphone signal (Try to keep this relatively low when recording, to keep harmonics out)
- **Frequency**
Used in Heterodyne detection, is used to choose the mixing-frequency
- **SampleRate** (8,11,16,22,32,44,48,88,96,176,192,234,281,352,384)
The sample rate determines the maximum frequency that can be detected. Default this is set at 281k which translates to a maximum detection frequency of about 140khz.
- **Settings**
Several settings pages for storing your personal sttings. (see below)
- **Record**
This menu option changes the left button function from DISPLAY to RECORD.
One can only see this menu item when a micro SD-card with free space is inserted.

- **Play**
Can be used to replay recordings on a lower speed.(See below)
- **Hipass**
Can be used to set additional filtering to keep out crickets or other low frequency noise.

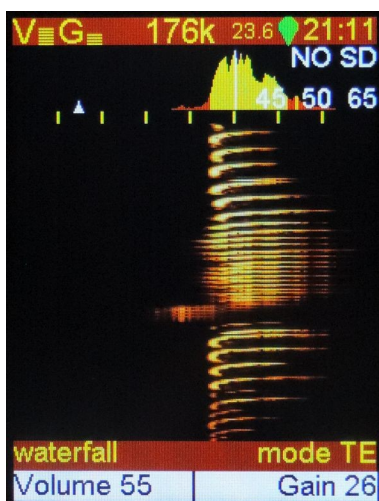
Push Button options

The right pushbutton (PushR) is used to set the detector mode or step through d/m/y and hh/mm in the settings menu. The detector can be set to the following modes :

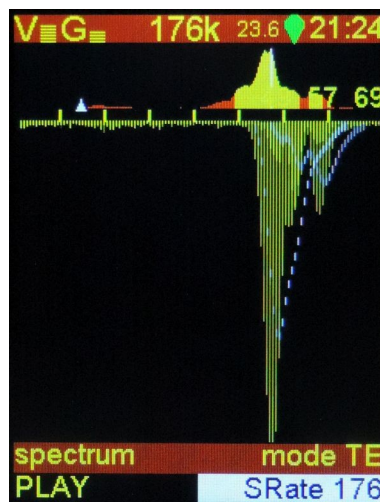
- **HT : manual heterodyne.**
This sets the detector as a normal heterodyne. When selecting this the encoders will (by default) be change to allow control of the volume (left) and the frequency(right). The centre-frequency is set in Khz and the produced audio is based on the difference in frequencies between the incoming signal and the centre-frequency.
- **Auto HT : automatic heterodyne**
This is the same as the HT mode but the centre-frequency is automatically controlled and will track the peak.
- **Auto_TE : automatic TimeExpansion**
In this mode the detector will wait for an incoming ultrasound and then directly replay that signal but at a slowed down speed. During this time (currently) no new signals can be detected and therefore in this mode you can also miss clicks of bats but it sounds way much better than other detection modes.
- **FD : Frequency Divider**
All incoming signals are divided by X to change them from ultrasonic to audible.
- **PASS**
The detector does not process the signal and just allows you to listen to the audible part.

The left Push Button (PushL) is by default set to control the DISPLAY mode. The display can be set to spectrum, waterfall and no display (see screensection). The function of the Push Button can also change to RECORD PLAY or STOP during record/playback mode.

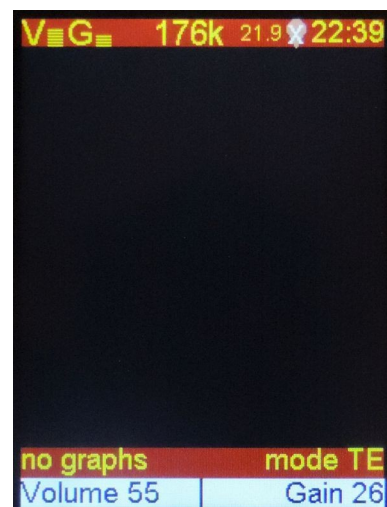
- **DISPLAY** (default function of PushL)



Waterfall



Spectrumgraph

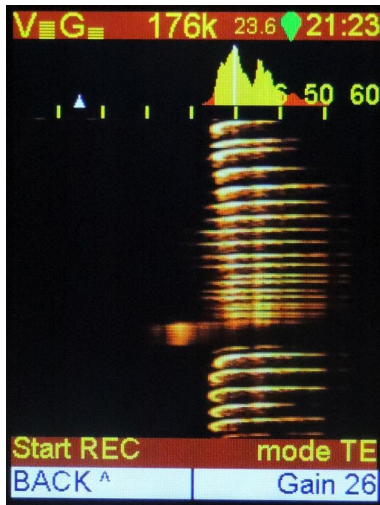


No graph

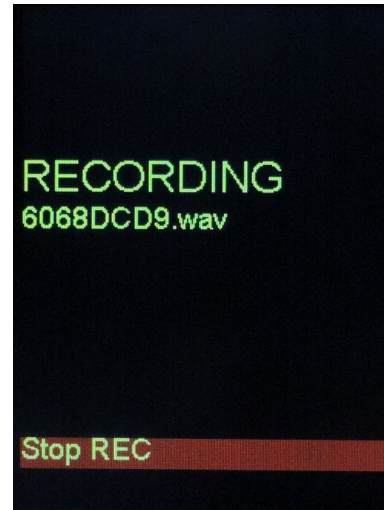
No Graph display setting was used to eliminate digital noises generated by the display, with the latest hardware there is hardly any unwanted noise.

- **RECORD**

When selected the detector is set to record WAV data at the press of a button. When the left pushbutton is pressed a recording will start (the filename will be shown) and when the left pushbutton is pressed again the recording will stop.



Turn EncL to select record and push EncL, REC OFF will appear.



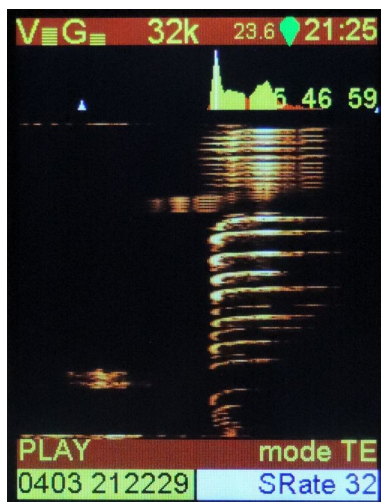
Press PushL and the detector will start recording, the display shows RECORD and filename. HEXFILENAME.wav press PushL again to stop recording

When you have stopped recording, simply press EncL again to exit record mode.

Before we had filenames Bxx_SRT.wav We had to keep track of the last file created, with the new hex-filenames we can save memory space.

You can also record in RAW file, but wav is better. The data is exactly same but wav stores samplerate and other metadata. Gps data is also stored in the metadata using guano standard.

- **PLAY**



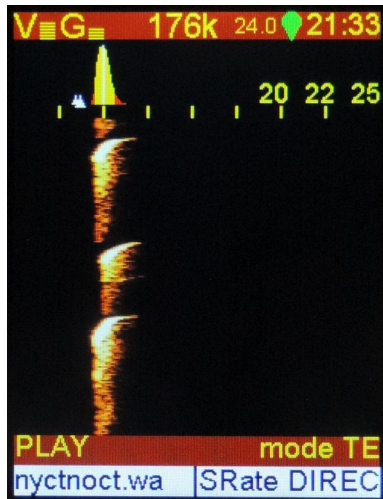
By turning EncL, one can select Play, after pressing EncL, the following display appears. PushL now gets the play function and rotating EncL will allow you to select the file.

The hex filemanes are recoded so you will see the creation date and time.

The file selection is now the only function or EncL, the default function of EncR is to change the playback sample rate. This changes the playback speed and will also change the pitch of the audio heard in the headphones.

EncR can also still be used to change the volume. (also Frequency and Gain are shown in the menu but have no function during playback).

Apart from the low samplerates that allow you to playback ultrasound on a lower speed we can also use DirectPlay

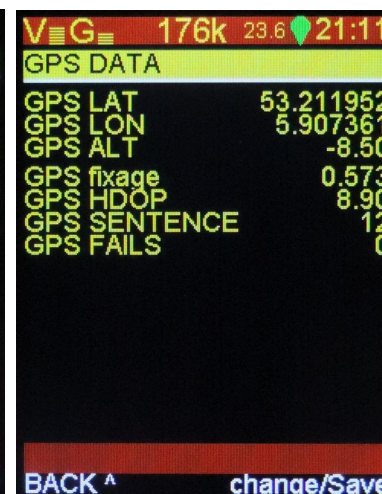
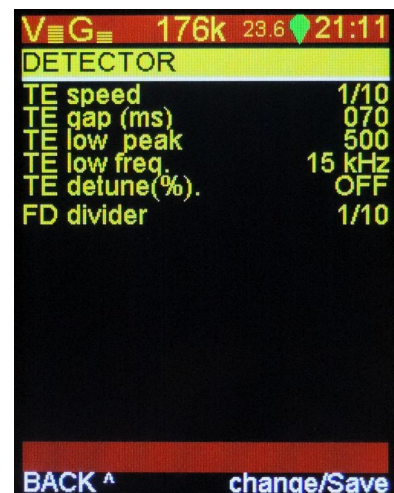
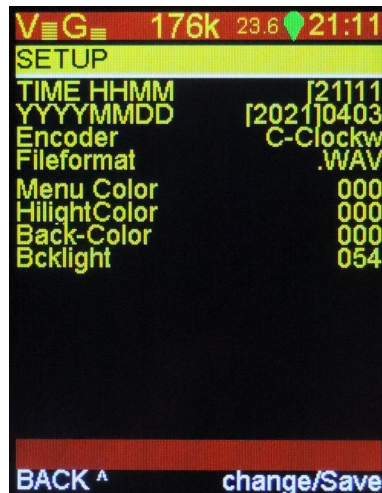
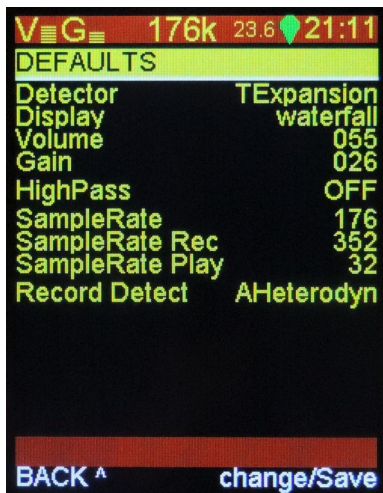


Using SRate DIRECT you can play 192Khz training files. These are played back and heard in the display and seen on the screen as if they were picked-up on the wild.

This function allows you to teach yourself yow different animals can sound, we have a bunch of sounds from open sources or own recordings that you can play using SRate but you can also use other files as long as the samplerate is 192KHz

Settings

From software version 1.0 we do have a few settings pages. Simply rotate EncL to select Settings and push EncL to open the settings menu.



When EncL is not used yet and the menu name is yellow, EncR can select the different menu pages. Depending on GPS availability (and software) you can see four or five pages with settings.

Defaults

Rotating EncL will move the active (white) line. (yellow on menu selection)
Rotating EncR will change the value for that line. (or change menu page)
Pressing EncL will exit the settings menu (altered values are chosen for this session only, so not stored)
Pressing EncR will store all the settings of all pages, it will also store settings for volume, gain and frequency as you used then the last time.

Detector	T Expansion/Freq. Divider/Passive/Heterodyne/A-Heterodyne
Display	waterfall/spectrum/no graph/settings
Volume	Numeric value of the volume usually around 50
Gain	Numeric value for gain. normally about 36 or lower.
HighPass	Off, 12-50Khz filters out (dampens) low frequencies
SampleRate	8-384 (sample rate used in "live listening/display" in kHz)
SampleRate rec	44-384 (sample rate used for recording in kHz)
SampleRate play	8-48 (Default sample rate used at playback)
Record Detect	A-Heterodyne/Heterodyne (live listening mode during recording)

Setup

Time	If you need to do any time correction.... Press PushR to switch between HH and MM (for file creation time)
YYYYMMDD	Year, month, day. Press PushR to switch between YY MM and DD (file creation date)
Encoder	Clockw/C-Clockwise (change the direction of your encoders)
Fileformat	wav / raw, store recordings as raw or wav file format. (use wav)
Use EEprom	Eeprom/Default (use stored settings or choose default. If you really messed up select Default, save turn off and back on)
Menu Color	000-127 change colors, just try an you will see.
HighlightColor	000-127
Back-Color	000-127
Bcklight	Backlight intensity setting, useful values are around 50-110

Detector

TE speed	10, 1/5-1/30 (This sets the time expansion rate, so it will change the pitch and duration of sounds heard in the headphones)
TE gap (ms)	80, 15-200 (try lower values for calls with short pauses)

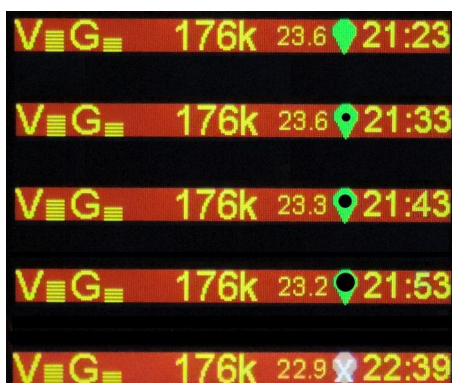
TE low-peak	500, 100-5000 sets threshold of TE trigger and waterfall updating. (low gain can use low setting, standard value is fine)
TE low frq.	15, 15-35 (This is used to set the lowest frequency on which time-expansion will be triggered.
TE detune	This allows you to lower frequencies in time expansion. The speed will be the same, but you can lower the tones. It is a heterodyne mixer after time-expansion. (usually off but functional for higher frequencies if you don't want a large expansion factor)
FD divider	1/4 - 1/16 frequency division rate, changes pitch.

Autorecord

Recorder SampleRate	176-384 this is the same value as in the defaults settings page
Low Frequency	10-80 (frequency in Khz, only if a detected signal is above this setting and loud enough, recording will start)
Low signal strength	1-20 (this allows us to only start recording a strong enough ultrasound signal. Set to 1 it will still pickup weak signals, set to 20 we need quite a strong signal to trigger auto record.
Max Duration(s) or rec	5-300 Sets the maximum file length (in seconds) during autorecord.
Max Silence(s) in rec	5-60 If during autorecord no strong signals had been detected recording stops after x seconds.
Pause (s) between rec	0-300 to set a minimum pause time between recordings.
Display during rec	ON/OFF switches display during autorecord

GPS DATA

These values are actually not setting but it displays the last GPS received data. The GPS receiver consumes a lot of battery power, switch it off when you don't need to have new GPS information.



The GPS indicator droplet can tell you how old the last received data is. A dot will grow in the center of the droplet, every 10 minutes GPS data was not updated the the dot will be a step bigger. Eventually the droplet will be red with a white X indicating the data is old.

If you had GPS reception before, the old data is stored in the metadata. If you only see the red droplet/X after powering up, no GPS data is stored. Lat/lon will be 0/0.

Auto record function.

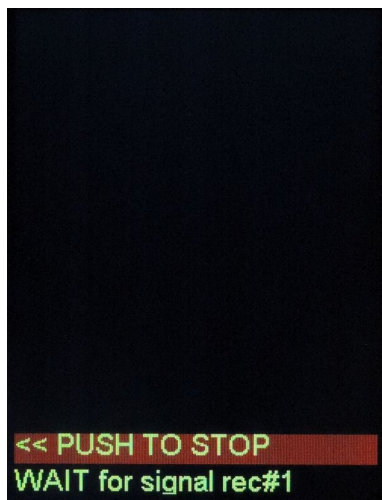
To enter auto record, simply turn the left encoder until auto record is shown and press the encoder. This instantly activates the auto record mode.

Now the detector is waiting for an ultrasound signal if the parameters for frequency and volume are met (Low Frequency and Low signal strength) a recording session starts until x seconds after the sound is lost or the max duration timer is met.

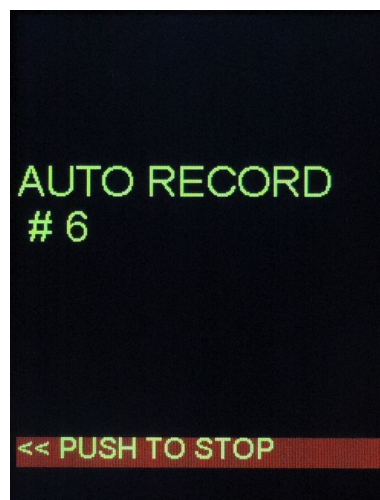
A press on PushL will stop the auto record feature, you need to press EncL again to be able to change to back to the menu.

Be aware that the display can be set to off in the auto record settings menu, to save battery power. If you chose display off, a message will be shown for a few seconds that the display will be turned off. A press in PushL will activate the display again and stop the auto record session.

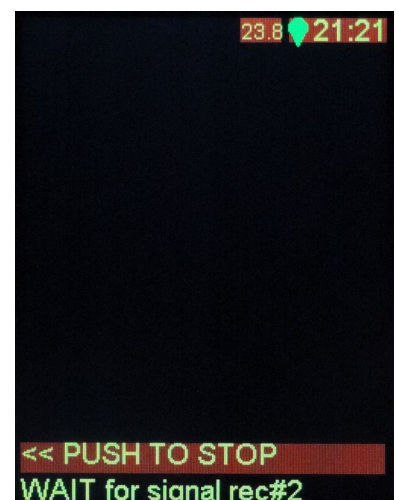
(Display off needs a PWM display backlight modification)



Autorecord is chosen



Autorecord is recording



Autorecord is waiting for the next event.

Trouble shooting :

“Factory reset”

If for any reason the detector is not behaving properly due to a strange setting or something you can reset to default values. Hold PushL and power on the TeensyBat and release PushL when Resetting to defaults is shown you can release PushL

Encoders are working in reverse. After a reset or software update the encoder knobs can work in the opposite direction. You can change the direction of the encoders in the settings menu chang C.Clockw / Clockw.

Live listening sound is softer or different during recording. During recording we can not simultaneously use live Time Expansion. The detector will switch back to (Auto)Heterodyne. In settings/defaults you can choose for heterodyne/auto heterodyne.

Play or Record not possible. If TeensyBat does not detect a micro-SD card this will show in the display as NO-SD. The menus with record and play functions will not appear. Use SDHC cards (NO SDXC) up to a maximum of 32GB. With a speed of class 10 or faster. I used genuine Kingston and Sandisk of 8 and 16GB. Cheap Chinese cards usually don't meet the speed markings. Be aware of counterfeit materials.

Batthey does not charge. The USB connector next to the headphone jack can not be used to charge the battery. (depending of the way of construction) You can use this micro SD connector to power the detector using you smartphone charger, or power bank. To charge the internal battery you need to use an other port, I usually build these on the short end that is facing toward you when handling the detector.

I hear no sound from the headphone jack. Use headphones or earphones (stereo/3 contacts jack-plug) and not a headset with four contacts. Check the volume setting and detection mode (“Pass” will not produce bat sounds)



Display is scrolling but I hear no sound.

Keep in mind that if you are using TE, we need ten times the recording time to play the sounds we receive.

If you set gain very high, or TE low-peak on a low setting the waterfall can start scrolling. This means sound is detected continuously and there is no time to play it properly. Lower gain or raise the TE low-peak so TE is not activated all the time.