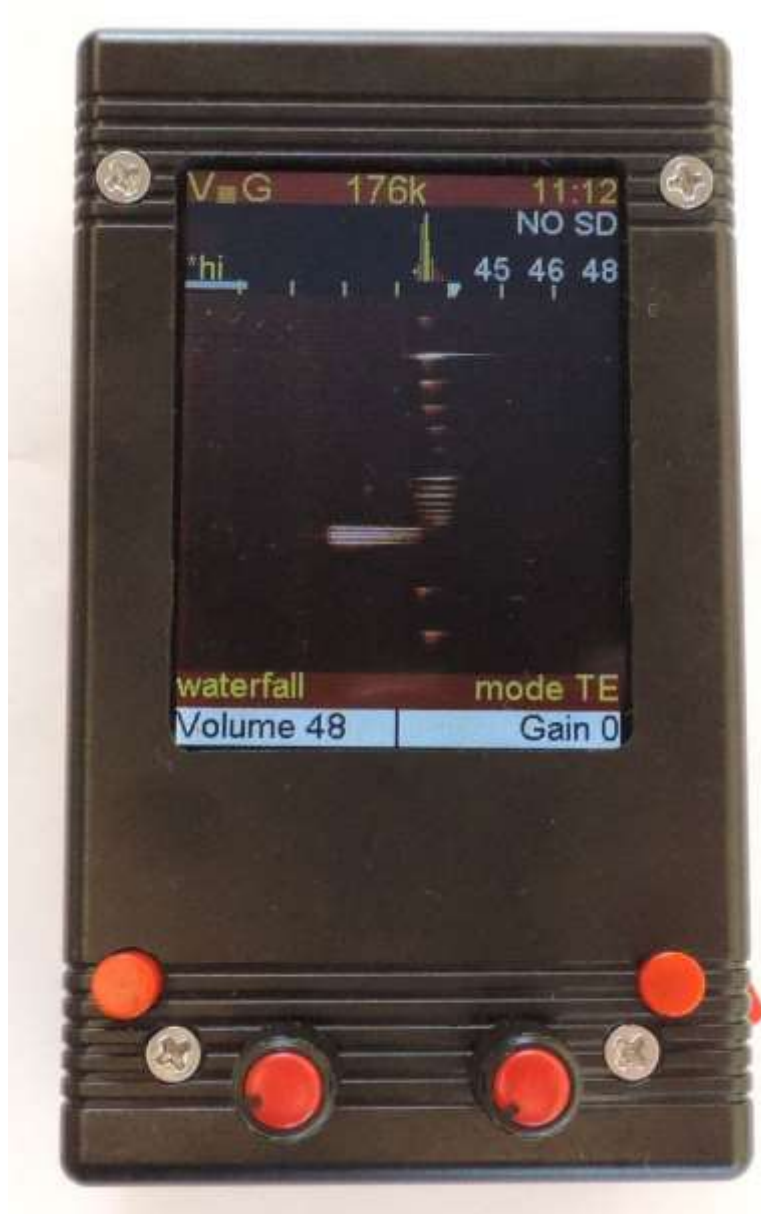


Teensy Batdetector Manual

Software version 1.0



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)

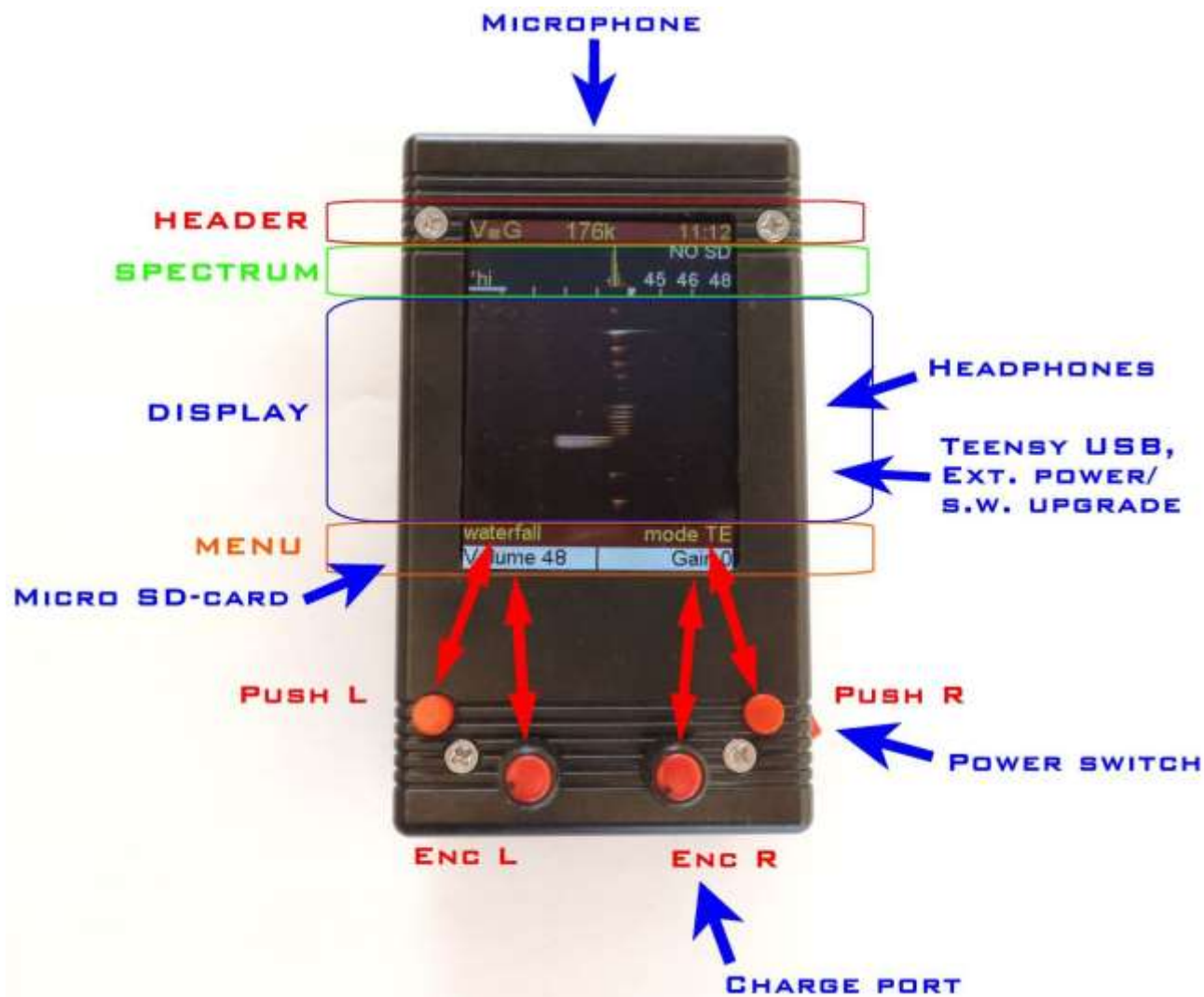
Automatic recording (start at ultrasound detection)

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, 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 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)).

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 (roughly) 140khz.
- **Settings**
3 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 – Time Expansion – earlier recordings (See below)
- **Hipass**
Can be used to set additional filtering to keep out crickets or other low frequency noise.

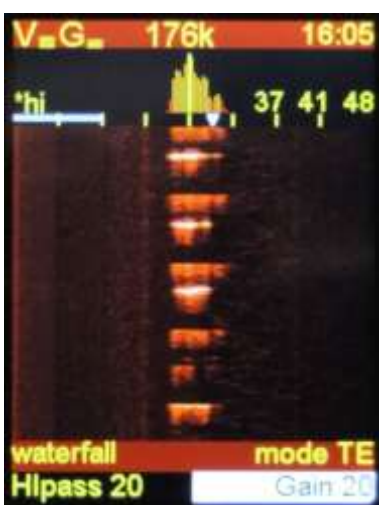
Push Button options

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 :

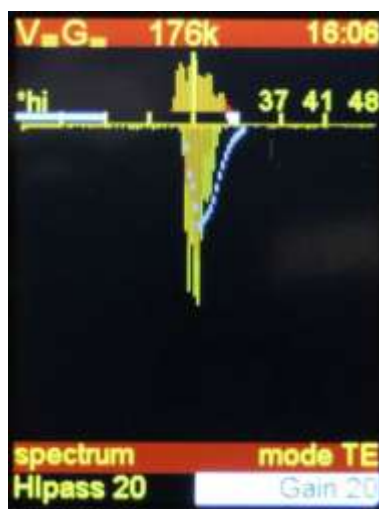
- **HT : manual heterodyne.**
This sets the detector as a normal heterodyne. When selecting this the encoders will (by default) be change to allow control of the volume (left) and the frequency(right). The centre-frequency is set in Khz and the produced audio is based on the difference in frequencies 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. The function of the Push Button can also be set to RECORD or PLAY by using the left-encoder.

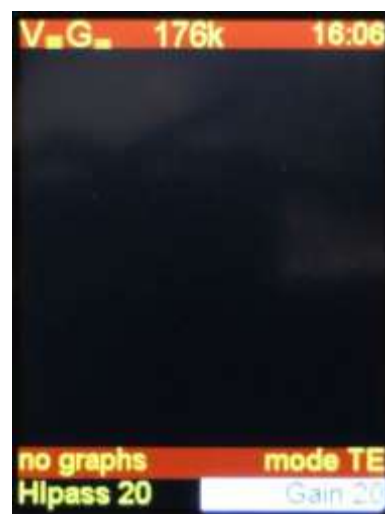
- **DISPLAY** (default function of PushL)



Waterfall



Spectrumgraph

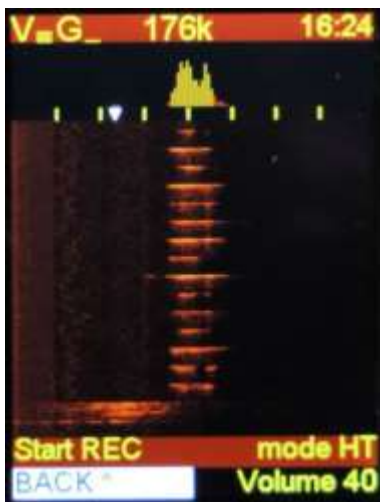


No graph

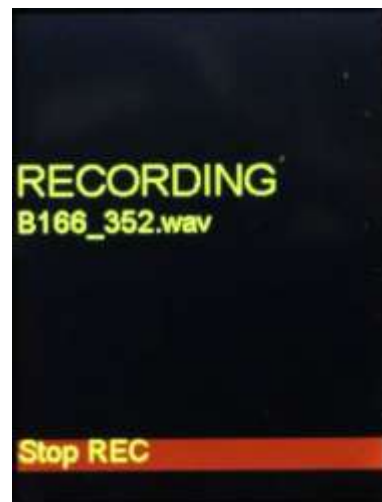
No Graph display setting was used to eliminate digital noises generated by the display, with the latest hardware there is hardly any unwanted noise.

- **RECORD**

When selected the detector is set to record raw 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.



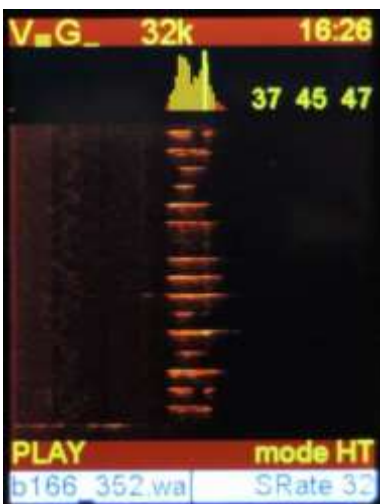
Press PushL and the detector will start recording, the display shows RECORD and filename. Bxx_SRT.wav press PushL again to stop recording

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

The number of files on your memory card can not exceed 999, for this menu to appear you need to have a memory card installed with some free space.

The file name (Bxx_SRT.wav) always starts with B, "xx" is the sequential number "SRT" is the chosen sample rate so you know at what rate to import the raw data in your audio software. (Standard wiles are recorded as .wav file)

- **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 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.

Settings

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



The menu will show the settings used.

Defaults

Rotating EncL will move the active (white) line.

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 3 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
Record Detect	A-Heterodyne/Heterodyne (live listening mode during recording)
HighPass	Off, 12-50Khz filters out low frequencies
TE gap (ms)	80, 15-200 (try lower values for calls with short pauses)
TE low freq.	15-35 (This is used to set the lowest frequency on which time-expansion will be triggered.)
TE speed	1/5-1/30 (This sets the time expansion rate, so it will change the pitch of sounds heard in the headphones)
FD divider	1/4 - 1/16 frequency division rate, changes pitch.
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	8-44 (Default sample rate used at playback)
Fileformat	wav / raw, store recordings as raw or wav file format.

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)
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

Autorecord

Recorder SampleRate	176-384 this is the same value as in the defaults settings page
Max Duration(s)	5-300 Sets the maximum file length (in seconds) during autorecord.
Max Silence(s)	5-60 If during autorecord no stong signals had been detected recording stops after x seconds.
Min Pause	5-300 to set a minimum pause time between recordings.
Low Frequewncy	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.

In the settings menu, pressing EncR will store all the selected values to the eeprom

If you want to test something simply change the values but do not press store, the settings you chose are only valid for this session. If you cycle the power, the settings will be as you stored them before.

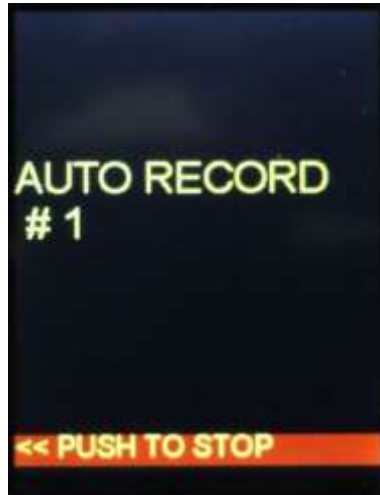
If you mess up your settings you can restore them via the settings menu or you can do a **factory reset** by **holding PushL** and turn the **power on**.

Auto record

To use auto record simply rotate Encl to AutoREC and push Encl



Autorecord is chosen



Autorecord is recording



Autorecord is on pause, before waiting for the next event.

Trouble shooting

I hear no sound.

- Is your stereo headphone connected properly? (do not use 4 conductor connector like smartphone headset).
- Volume to low? (check the volume setting)
- No ultrasound present (rub fingers in form of microphone to test)
- Detection mode is PASS, change to TE, HT, A-HT or FD

Not able to record

- You need to have a micro SD card inserted before power-on
- If a SD card is not detected NO SD will be shown in the top right.
- Maximum number of files is exceeded (999)
- No more free space on the SD-card

The detector is Working slowly

- Lots of files on the SD card will slow down operations like starting the detector or playback. Try to limit the number of files on the SD card by cleaning the card before you go out the next night.

Wrong settings or Impossible colours

- Reset the detector to default settings by holding the PushL button and turn the power on, the display shows "reset to default".