Batbox **Duet**
bat detector : user guide

The **Bat**box **Duet** is a dual-functioning bat detector, with both heterodyne and frequency division, which has been designed for single-handed operation.
The large LCD back-lit display is extremely accurate and easy to read at all light levels. A reference button has been incorporated for adding voice commentary, whilst recording. The unit is very easy to use and comes supplied with a soft carrying case.

IMPORTANT
Please read these instructions before using your Batbox **Duet bat detector**

BATTERY CONNECTION

When fitting the battery, make sure that the unit is switched off and that you fit it correctly. Connecting it the wrong way round may cause damage to the detector.

DISPLAY INITIALISATION

When the Duet power is turned on, the display will show all used segments (188) for one second, followed by the software version (e.g. 2) for one second, after which the heterodyne frequency setting will be displayed. Whilst the display is initialising, the audio output can still be heard.

PEAK-FREQUENCY DETECTION

The resonant frequency of bat sonar varies according to the species. This resonance is often called the *peak-frequency*. When listening on the heterodyne system, this is the frequency setting called the *null-point*; the point at which the output of the detector is strongest and lowest in pitch. Bats focus most of the energy in their calls at a particular frequency. This resonance or peak-frequency will be determined by the size of the bat and its echolocation requirements.

A good example of the importance of peak–frequency is the difference in the calls of British pipistrelles, *Pipistrellus pipistrellus* (44 - 48kHz), *Pipistrellus pygmaeus* (52 – 56 kHz) and the rarer *Pipistrellus nathusii* (39 – 40 kHz)*. Although it is possible to find these frequencies using the heterodyne section of the **Bat**box **Duet**, a certain amount of subjectivity is involved. When the bat is moving at speed and might only make one pass, there may not be time to tune-in to the peak-frequency. By recording from the frequency division output, no bat can be missed, regardless of the frequency set on the digital counter. The Duet listens to the entire ultrasonic range between 17kHz and 120kHz. This means that if you are monitoring a noctule and a pipistrelle at 55kHz flies overhead, even though you may not hear it in the heterodyne, it will be recorded, as well as the noctule, for later analysis.
* Individuals from each species may fluctuate by a few kHz above or below these frequencies.

Recording ultrasound, without a bat detector, can be tricky. Firstly, microphones need to be specially designed and very sensitive. Also, the specialist tape recorders and other instruments able to cope with such high frequencies are extremely expensive. Most domestic tape recorders will only record frequencies up to 15-20kHz. **Heterodyne** and *frequency-division* techniques make it possible for us to hear bat echolocation calls.

FREQUENCY-DIVISION

The **Bat**box **Duet** divides the incoming sonar frequency by 10, bringing the ultrasonic calls into human hearing range (25kHz would become

2.5kHz), and also into the range of an audio recorder (MP3, minidisc, tape etc.).

The **Bat**box **Duet** also measures the amplitude of the sonar before dividing by 10 and then reinstates it at the output. This creates an identical waveform to the original signal but reduces the pitch to an audible frequency. Having analysed the recorded calls on a computer, our peak frequency of 2.5kHz, would be exactly 1/10th of the original bat sonar (25kHz). To ascertain the original peak-frequency, simply multiply the analysed result by 10.

HETERODYNE

Heterodyning involves the mixing of two signals, one being the bat call from the ultrasonic microphone and the other produced by a local-oscillator in the detector. These signals are mixed and filtered in such a way as to produce a difference between them at the output of the detector. The difference is low enough in frequency to hear. For example, if the detector oscillator (frequency control) is set to 42kHz and a frequency of 40kHz supplied to the microphone, a difference of 2kHz will be heard at the output.

The digital frequency-counter of the Duet gives the exact frequency of the local-oscillator to the nearest 1kHz. When the detector is tuned to the peak frequency of a bat call there is, in theory, zero frequency output.

In practice, because the bat is in motion the calls will always be heard, but the lower the pitch of the output, the closer the local-oscillator frequency is to that of the bat's peak-frequency.

CONNECTION TO RECORDING DEVICE (MP3/minidisc/tape, etc.)

Batbox **Duet** will record both frequency division and heterodyne, at the same time, so that when doing the computer analysis, it is possible to listen simultaneously to the heterodyne calls whilst looking at the frequency divided calls. This will be useful to those with some experience of identifying bats with a heterodyne bat detector, like the **Bat**box III. A stereo recorder will record F/D in the left channel and heterodyne in the right. Connection to a mono recorder will result in F/D only, i.e. without heterodyne.

The recording device should have a line level input. If not, and your recorder has only a microphone input, a special attenuation lead may be required, in order to reduce the signal level from the detector.

HEADPHONES

Although it is possible to listen through the built in monitor speaker, listening with headphones provides greater sensitivity and clearer reception, for hearing bats. Both channels on the **Bat**box **Duet** headphone socket are the heterodyne function.

Do not turn the volume up too high, with headphones, as you may not be able to hear people and things around you. In some circumstances this may put your personal safety at risk, especially near roads, at night.

Before inserting headphones into the headphone socket, ***make sure that the volume is turned down***. When the volume control is set high, the headphone level may be too great for comfort.

Higher levels should only be used for listening to distant bats.

VOICE COMMENTARY

By pressing the '**Ref**' button, during recording voice commentary can be added to recordings e.g. Date, time, place, conditions etc. Voice recording is routed to the left channel of the tape socket, in place of the frequency division. When the button is released, the Duet will return to normal, dual channel recording. The heterodyne output is unaffected by the '**Ref**' button.

The unit should be held between 10 and 25 centimetres from your mouth and better quality voice recording will be obtained by talking across the microphone, rather than into it. This will allow undistorted commentary and ensure that no moisture enters the microphone.

BACKLIGHT

The backlight behind the LCD display will not be apparent in daylight but as light levels go down, sufficient light to read the display will be apparent, without being so bright as to spoil night-vision.

BATTERY LOW INDICATOR

When the battery voltage drops below 7 volts a 'BAT' legend will appear in the top left hand corner of the display. The Duet will continue functioning normally for a few more minutes.

When turning on the unit, if the battery output is below 7 volts, as well as the BAT indicator, the display will flash '**LobA**' for 5 seconds, and then display 0 kHz. At this point, the audio output of the Duet may still be heard, even though the display reads 0 kHz. However, you should renew the battery at this point, in order to maintain proper functioning of the detector.

MICROPHONE CARE

The ultrasonic microphone, situated at the front of the **Duet** is a very sensitive device and should be treated with the same respect as a camera lens. Do not allow any ingress of moisture or excessive dust.

Do not use the Duet in rain, unless under cover.

ADVANTAGES AND LIMITATIONS OF ANALYSIS

It is possible to glean a lot of information from recorded bat calls :

- **Peak-frequency**
- **Pulse length**
- **Repetition rate**
- **Social calls**

Even with the heterodyne function alone, all of these factors can be assimilated, by experienced bat workers in the field, in real time, to produce accurate species identification. However, if the detector is tuned to a 55kHz bat and a noctule, which is echolocating at 20kHz flies past, the calls may be missed on the heterodyne. Frequency division, though, will pick up both frequencies and render the calls as 5.5kHz and 2kHz, respectively, so that later computer analysis would reveal the noctule pass.

An important thing to remember is that some species will remain very difficult to identify, even with good recordings containing all of the above features. This is because some bats will produce the same echolocation calls in similar environments, in order to glean the same SONAR picture for their navigating and feeding requirements. The best way to identify these bats is by looking at their commuting calls.

QUALITY OF RECORDINGS

You will need a recorder with an input level control. This can sometimes be in the form of an AGC (Automatic Gain Control) in the cheaper recorders, but far better, is to use one with a manual level control, which does not interfere with the recorded pulses and produces less background noise.

Poor recordings, i.e. record levels too low or high, will not give much useful information, so a single pass by a distant bat will, almost certainly, remain unidentifiable. It is, therefore, important to make sure that your recorder is set up correctly. The loudest pulses should not go above 0dB (preferably –3dB) to allow for very close bat passes. Recordings that go into 'clipping' (over-recorded) will add unwanted harmonics to the signal, so do not automatically choose the strongest pulses from your recordings for analysis. Tape recorders (cassette) are kinder to levels that are too high than digital recorders (MP3, minidisc or DAT). However, digital recorders have a much greater dynamic range and less inherent noise, so that you can afford to record at slightly lower levels.

Although recording levels can be easily brought up to 0dB level (normalised) with computer software, it is important to get onto the recording the strongest signal possible without distortion so as to create the biggest difference between the wanted signal and any background noise.

WINDOWS^{TM} SETTINGS FOR LINE INPUT

You will need to make sure that the computer is ready to accept your recordings into the line input socket on the sound card.

Double–click on the loudspeaker icon on the toolbar. This should bring up the WINDOWS^{TM} mixer. Click **Options** then **Properties**, select the **Recording** button and look in the **Show the following volume controls window**. Make sure there is a check in the LINE box, if not, click in the box and then click OK. Your computer will now record line level input, usually via a 3.5mm stereo jack socket and on lap-top computers, this is often the same socket as the microphone input.

CREATING .WAV FILES

Transfer the bat recording to a format that the computer can recognise e.g. .WAV file. This just requires an audio connecting lead between the tape recorder and the computer sound card.

If you do not have an audio recording program, the WINDOWS^{TM} recorder will record adequately, but make sure that you use the 44.1kHz sampling rate, for best results. This can be accessed in WINDOWS^{TM} from **Start-Programs-Accessories-Entertainment**. To change the sample-rate, go to: **File-Properties-Choose from**: select **Recording formats** from the drop-down menu, then click **Convert Now**. Choose **44100 16 Bit Stereo** and click **OK**.

You will need to go to the **OPTIONS** tab and select the line input for record, as described earlier. Remember to label the recording with a cryptic file name related to the place, date or species recorded. You should always have a 'new folder' for more than one clip, from a particular place. This means that you can use the same file-name for two different places e.g. '45pip'.

The software that you use for analysis should have a **Normalise** function. Normalising brings the signal to the maximum level possible (0dB) without distorting it. You should normalise the recording to get the optimum results from analysis software.

Use 44.1kHz sampling rate on digital recordings, including the recording to **.wav** files into the computer. This sample rate, currently, is the format most easily transferred to CD writer, for the copying of files from one computer to another or for archiving.

ANALYSIS USING BATSCAN

Analysis of the recordings can be quickly and easily achieved, using **Bat**Scan

The **Bat**Scan computer program is designed for examination of the time and frequency characteristics of the **Bat**box **Duet** frequency division

signal. Its basic display format is a spectrogram plot of signal level versus frequency versus time in which the signal at frequencies from 17kHz to 120 kHz, over a 10 second time period, is plotted using a variable color scale to represent spectral intensity.

BatScan can be used for recording, either direct from the **Duet** or from any 'line' source e.g. MP3, MiniDisc, tape etc. Files can be monitored and saved. With the mouse or 'hot keys', files can be opened as a spectrogram and calls analysed for shape, frequency range and interval. A 'zoom' function is incorporated for closer scrutiny of calls.

Furthermore, by clicking the mouse button, over a single call, a readout of time (milliseconds), frequency (Hz) and sound pressure level (dB) at the position of the mouse pointer (cursor) is displayed, at the bottom of the screen. A coordinate grid can also be added or removed by clicking the "GRID" button at the bottom right of the display.

If you have made recordings in a compressed format (MP3 etc.) you will need to convert them to .WAV files before they can be analysed. MP3 players usually come with appropriate software for this. Sonagrams can be saved, imported into reports or printed.

THE NEED FOR PRACTICE

It is very important that you get used to using the bat detector and recorder, before expecting perfect results and definitive recordings. Just as you would have to get used to using any other sophisticated tool, you will need to practise. Firstly, get used to plugging in your recorder, headphones etc. in daylight, as you will find it very difficult to set up your system and adjust recording levels, whilst holding a torch, in the dark. Once the **Duet** has been connected to your recorder and the record level set, no further adjustment will be needed. Just use the pause button on your recorder, in between recording episodes.

Because the *F/D – het* output is at a fixed level, turning the frequency tuning control of the **Duet**, whilst recording, will not affect the recording level. However, only bat calls whose frequency is within the set frequency band of the heterodyne will be recorded (on the right channel), but all bat calls will be recorded on the left channel as frequency-divided calls. Moving the volume control will only affect the monitor speaker output and not the recording.

Batbox **Duet** is guaranteed for 12 months from the date of purchase against faulty manufacture. However you can expect many years of excellent service, if the unit is treated with care.

Make sure that the detector is switched off before replacing it in the case provided. Remove the battery when storing the bat detector for more than two weeks.

SPECIFICATIONS:

MODE 1 Heterodyne	
Tunable range:	(heterodyne) 17kHz – 125 kHz
Bandwidth:	>16kHz
Tape out (3.5 mm socket):	line level to right channel only
Headphone out (3.5 mm socket):	to both channels (8 -16 ohm)
Display:	12.5 mm digital LCD with back-light
Counter accuracy:	less than 100Hz
Display Accuracy:	1 digit
MODE 2 Frequency division	
Divide by 10	
Dynamic input waveform tracking circuit	
Tape out:	line level to left channel only
Microphone:	electret condenser
Range :	17kHz –125kHz
Ref :	Momentary voice commentary button to left channel
GENERAL	
Suitable recording formats:	MP3, DAT, MiniDisc, compact cassette
Speaker:	weatherproof 35mm
Amplifier:	350mW (max)
Power supply:	1 x 9v PP3
Quiescent current:	22mA
Wrist strap:	high-strength polyester woven cord
Case:	fitted soft nylon micro-weave with zip and belt loop
Dimensions:	125 x 69 x 32 (mm)
Weight:	147gm (without battery)

Due to continuing improvements, specifications may change without notice.
(Windows is a trademark of the Microsoft Corporation)

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