BIOTRACKER RADIO RECEIVER

User's Manual

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Quick Start Guide

Before first use, we recommend you put the Biotracker on charge. The battery is fully-charged when the receiver is manufactured, but rechargeable batteries self-discharge slowly over time and after any period of storage will not be at full capacity.

Description of receiver operation

The receiver has three modes: *Frequency*, *Channel* and *Scan.*

Frequency Mode: Frequency is set directly via the numeric keypad or arrow keys.

Channel Mode: Channels holding stored frequencies are selected via the numeric keypad or arrow keys. There are 256 channels.

Scan Mode: The receiver steps in numerical sequence through all channels or selected channels only.

Basic Functions

- To turn the receiver on and off hold **[ON/OFF]** down for at least a second.
- To toggle between *Frequency* and *Channel Mode* (shown by 'F' or 'C' in bottom right corner of display) press **[F/C]**.
- **[X]** cancels the current operation.
- **[✓]** enters the current number (channel, frequency etc) or completes the current operation.
- **[DEL]** deletes the character at current cursor position. To delete the contents of a channel in *Channel Mode* hold the button down for more than a second.
- The key with the light bulb symbol toggles the display back-light on and off. The light switches off automatically after about 4 minutes.
- To adjust receiver gain, use the keys with loudspeaker symbols. The gain level (00 to 99) is displayed next to the mode indicator on the bottom row of the LCD. Gain can also be adjusted (up to the limit shown in the display) using the gain knob. The knob does not change the gain level displayed on the LCD.
- Signal strength is displayed on the top line of the LCD as a horizontal bar graph, and the peak signal value is displayed on the top right. The peak value is held on the display for 1 second or updated if another signal is received sooner.

Frequency Mode

- In *Frequency Mode* 'F' is displayed in the bottom right corner of the display.
- Typing a number enters the kHz frequency units (numbers after the decimal point). Press **[✓]** to set the frequency or **[X]** to cancel and revert back to the previous frequency.
- To change the MHz frequency (numbers before the decimal point) press **[MHz]**. Enter the MHz frequency and press **[✓]** to set or **[X]** to cancel.
- The up/down arrows tune the frequency one step at a time, at the current tuning resolution (1 kHz or 0.1 kHz).
- The tuning resolution is toggled between 1 kHz and 0.1 kHz by the key marked **[.000 / .0000]**.

Channel Mode

- In *Channel Mode* 'C' is displayed in bottom right corner of display.
- The up/down arrows step through stored channels in the receiver's memory.
- Channels can also be recalled by entering a channel number. Press **[✓]** to set or **[X]** to cancel.
- To delete the contents of a channel, press **[DEL]** for a second or more.

Storing Frequencies in Channels

- Start in *Frequency mode* and tune to the frequency to be stored
- Press **[Store]** to display the last used channel on the top line of the display
- Choose a channel using the up/down arrow keys, or enter a channel number followed by **[✓]**.
- Press **[Store]** to save the frequency to the channel displayed on the top line. The receiver will then be in *Channel Mode* on the chosen channel.

Scanning Mode

- Press **[SCAN]** to enter *Scanning Mode*. Two opposing curved arrows are shown on the bottom right of the display. The top line shows the scan interval in seconds.
- Choose a scan interval by using the arrow keys or typing a number (up to 999). Press **[✓]** to accept.
- Press **[✓]** again to display channels on top line of the display. Channels that are selected for scanning show 'SC' in the top right of display.
- Toggle channel selection status ('SC') on/off by pressing **[✓]**. Scroll through channels using the arrow keys or type a channel number followed by **[✓]** to see other channels.
- To select all channels for scanning, press **[DEL]**. Pressing **[DEL]** again deselects all channels without affecting individual channel selection status ('SC'). When all channels are selected for scanning, 'AC' is displayed.
- To start scanning press **[SCAN]**.
- To stop scanning and return to the mode and frequency settings prior to scanning press **[X]**.
- To stop scanning and return to *Channel Mode* with last channel scanned press **[SCAN]**.

Top Panel Controls

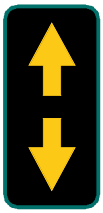
This section explains in detail the function of individual keys.

Power

Hold this key down for one second or more to switch the receiver on or off. When the receiver is switched on it returns to the state it was in when it was last switched off. It remembers mode, digital gain level, step size and frequency or channel. All memory contents are also retained.

LCD Backlight

This key switches the LCD back-light on and off. The back-light increases receiver power consumption (and reduces battery life) by around 50%. To conserve power if the light is accidentally switched on, the light switches off automatically after about 4 minutes.



Up/Down Arrows

These keys are used to change frequency or channel, depending on which mode the receiver is in.

When in *Frequency Mode* ('F' displayed in bottom right of LCD), the frequency displayed on the bottom row of the LCD is changed in either 0.1 kHz or 1kHz steps. Pressing the key marked **[.000/.0000]** toggles between the step sizes (tuning resolution).

In *Channel Mode* ('C' displayed in bottom right of LCD), the arrow keys step through occupied channels displayed on the bottom row of the LCD. Empty channels are not displayed. After pressing **[STORE]**, the up/down keys step through all channels displayed in the top row of the LCD, including empty ones.

In *Scan Mode* (two opposing curved arrows displayed in bottom right of LCD), and when scan interval is displayed in the top row of the LCD, the up/down keys change the scan interval. After setting the scan interval, the up/down keys step through occupied channels. Empty channels are not displayed.

Mode Selection

This toggles between *Frequency Mode* and *Channel Mode*. When returning from *Channel Mode* to *Frequency Mode* the frequency displayed is that of the last channel selected. The default tuning resolution (step size) is set to 0.1 kHz.

Tuning Resolution

This key toggles between displaying the frequency to the nearest 0.1 kHz (four decimal places) or to the nearest 1 kHz (three decimal places). It operates only in *Frequency Mode*.

Digital Gain/Volume Control Keys

The keys with loudspeaker symbols control the radio frequency (RF) gain and audio gain (volume) of the receiver. The upper key increases gain and the lower one reduces it. The gain level is indicated by the number between 0 and 99 in the bottom right of the LCD, immediately before the mode symbol.

These are known as 'digital gain keys' because they set gain in discrete steps. Gain can also be controlled using a knob on the front of the receiver. The knob controls gain in an analogue fashion within the limits set by digital keys gain (i.e. up to the level shown on the LCD). **It does not change the number displayed in the LCD.** Setting the gain to 99 (maximum) using the digital keys enables the knob to cover the entire gain range.

generally the digital keys are used for setting gain to a particular, repeatable level (displayed on the LCD). For normal tracking situations, where it is not necessary to know the exact gain level, the knob allows both faster and finer control of gain.

Scanning

This key puts the receiver into *Scan Mode*. The top row of the LCD displays 'INTERVAL' and a number between 001 and 999. This is the period in seconds the receiver dwells on each selected channel when scanning. The number can be entered directly via the numeric key pad, or increased/decreased using the arrow keys. When the desired interval is displayed, press **[✓]** to set it.

Once the scan interval has been set, the LCD top row displays occupied channels and indicates whether they are selected for scanning. The information displayed is frequency, channel number and, for channels that are selected, the letters 'SC' or 'AC'. These indicate whether selected channels (SC) or all channels (AC) are to be scanned. If a channel is not selected for scanning, only the frequency and channel number are displayed. When scanning starts, these channels will be excluded. To select or deselect a channel, press **[✓]** which toggles channel selection. Do not press **[✖]** to deselect a channel, as this cancels Scan Mode. To toggle the selection/deselection of **all channels** (AC) press **[DEL]**. Use the arrow keys to step through channels for selection.

When the channels to be scanned have been chosen, pressing **[SCAN]** starts the receiver scanning. The bottom row of the LCD displays the frequency and number of the channel currently being scanned, the gain level and the symbol for scan mode (curved opposing arrows). The top line of the LCD displays signal strength and 'AC' or 'SC', depending on whether all channels (AC) or selected channels only (SC) are being scanned.

To cancel Scan Mode during scanning, press **[SCAN]**, which returns to *Channel Mode* with last channel scanned, or **[✖]**, which returns to the mode and frequency settings prior scanning.

Store in Memory

When pressed in *Frequency Mode* or *Channel Mode* this key displays the last used channel on the top row of the LCD. The channel number can be set either with the arrow keys, or by entering a number directly from the numeric keypad. If entered from the keypad, **[✓]** must be pressed to set the channel. Pressing **[STORE]** a second time puts the currently displayed frequency on the bottom row into the channel displayed on the top row. The receiver is then returned to *Channel Mode* with the new channel displayed in the bottom row.

The main use for **[STORE]** is to add new channels or change frequencies in existing channels. Some typical sequences are shown below to illustrate this.

To add a new frequency to a new channel:

1. In *Frequency Mode*, tune to the frequency you wish to store in a channel.
2. Press **[STORE]** to display a channel on the top row of the LCD.
3. Select the channel in which you want the frequency to the stored (either using the arrow keys or by direct entry via the numeric keypad followed by **[✓]**).
4. Press **[STORE]** again to set the frequency in the chosen channel and automatically switch to *Channel Mode* with the new channel displayed.

To change the frequency of an existing channel:

1. In *Channel Mode* select the channel to be changed.
2. Press **[F/C]** to change to *Frequency Mode*.

3. Change the frequency (either using the arrow keys or by direct entry via the numeric keypad followed by **[✓]**)
5. Press **[STORE]** to display the channel on the top row of the LCD.
6. Press **[STORE]** again to set the new frequency in the channel and automatically switch back to *Channel Mode* with the new frequency displayed.

Change MHz

This key allows the MHz frequency to be changed in *Frequency Mode*. After pressing **[MHz]** the first placeholder of the MHz frequency will flash and a new 3-digit number can be inserted from the numeric keypad. After inserting 3 digits the cursor moves to the first decimal place and the kHz frequencies can also be changed if required. Pressing **[✓]** at any time selects the new frequency. Pressing **[✖]** cancels any changes and returns to the previous state.

If a number below than the lower frequency limit or above the upper frequency limit is entered, an 'OUT OF RANGE' message is displayed on the top row of the LCD. Enter a valid frequency or press **[✖]** to return to the previous one.

Delete

The delete key has three separate functions.

The main function, in *Channel Mode*, is to delete the contents of a channel. To do this, display the channel to be deleted, then hold the **[DEL]** key down for 1 second. Alternatively, press **[STORE]** to display a channel on the top row of the LCD. Display the channel you want to delete and press **[DEL]** to delete it and return to *Channel Mode.*

The second function of the delete key is to delete characters under the cursor during frequency or channel editing via the numeric keypad.

The third, and least intuitive, function of **[DEL]** is to toggle the selection/deselection of **all channels** for scanning in scan mode (AC). When selecting channels for scanning, **[✓]** toggles selection of **individual** channels (displaying either SC or blank after frequency and channel number in the top row of the LCD), whereas **[DEL]** toggles between AC and SC or blank. When AC is shown, all channels are selected for scanning. Pressing **[DEL]** returns all the channels to their previous state (SC or blank).

Numeric Keys

The numeric keypad is used to enter channels or frequencies.

When entering channel numbers, new digits are inserted in the right-hand place-holder and shifted left if further characters are added. This is to eliminate the need to enter leading zeros.

When entering frequencies, the cursor starts under the left-hand placeholder and moves right as new number are added.

Accept

This key is equivalent to **[ENTER]** on a computer keyboard. It is used to accept any changes being made via the numeric keypad.

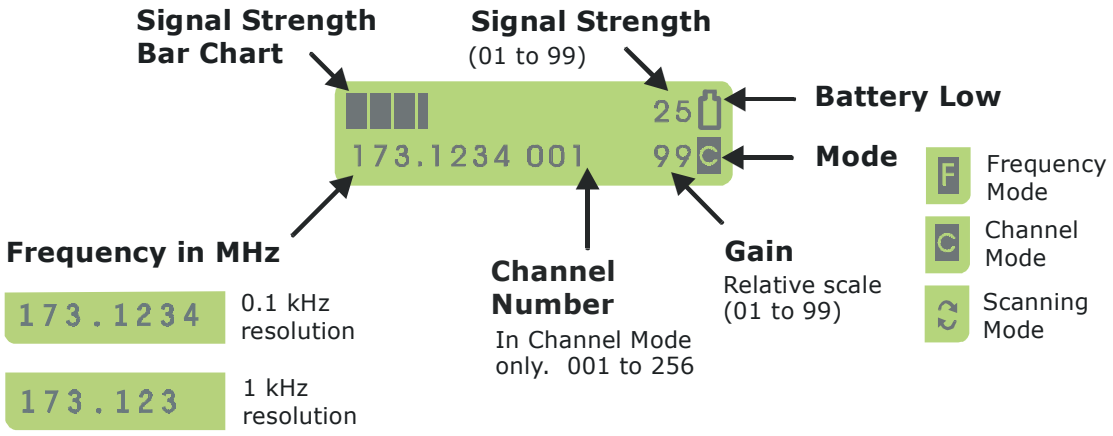
Cancel

This is the 'Cancel' Key. Pressing it during any editing operation returns the receiver to the state it was in before the editing operation began. Pressing **[✖]** in *Scan Mode* cancels scanning and returns the receiver to its previous mode.

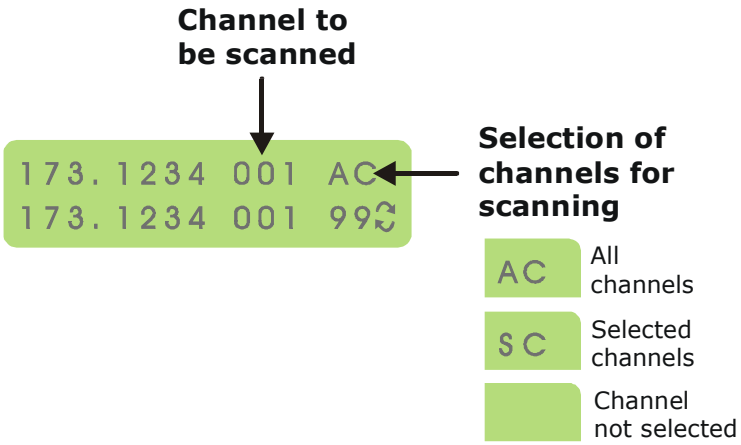
Liquid Crystal Display (LCD)

The LCD has two rows with 16 character places per row. The diagrams below show the position of information displayed in different modes.

LCD Functions in *Frequency Mode* or *Channel Mode*



LCD Functions in *Scanning Mode*



Signal Strength Display

The Lotek Biotracker Receiver displays signal strength in two ways: using a bar graph and a number. Both indicators are displayed on the top line of the LCD. The system responds to pulses over 10 ms long and above a threshold, so under normal circumstances noise is ignored. The display is held for 1 second after triggering (otherwise pulses would be too short to see). If the display is constantly being triggered by noise, the pulses are likely to be missed.

The display can be changed by adjusting the gain. If there is too much noise and it is triggering the display, turn the gain down. Similarly, reduce gain if the signal is causing the bar graph to swing full scale (and the number displayed is 99).

Battery State Indicator

The empty battery symbol in the top right of the LCD indicates when the battery needs to be recharged. When the battery is OK this symbol is NOT shown; it only appears when the battery has about 10% of its capacity remaining. There is no 'full battery' symbol.

Front Panel Connectors and Controls

Gain Control Knob

Receiver gain is controlled by two keys (marked with loudspeaker symbols) on the keypad and by a knob on the front of the box. The keypad controls are digital and set gain to a level shown in the LCD as a whole number between 0 and 99. The knob also controls gain, but on a continuum between zero and the value shown in the LCD. The knob does not change the gain level number displayed on the LCD.

Setting gain to 99 using the keypad allows the full gain range to be controlled by the knob. Setting digital gain to a lower level prevents higher gains being accessible via the knob, and gives finer control over the available gain range. The main benefit of using the knob to control receiver gain is that it is quicker to move through the gain range.

The potentiometer under the gain control knob is hermetically sealed, as is its hole in the receiver box. Unlike analogue controls on most electronic equipment, it is completely waterproof.

Battery Charger and External Power Socket

Charging must be done in an ambient temperature between 5 and 35°C. This is because there is a thermal cut-out in the charging circuit to prevent over-charging of the battery cells (over-charging cells can damage them). The thermal cut-out threshold is set to 50°C, but the heat generated by the charging process can cause this threshold to be reached in ambient temperatures above 35°C.

The charging state is shown by an LED next to the charging socket. It flashes red during battery charging and steady green when charging is complete.

The receiver will not be harmed if the external power supply is left attached after charging is complete, but still it is good practice not to leave the power supply connected for longer than necessary.

Only the special NiMH 4A battery pack supplied with the receiver can be charged inside the receiver. The receiver prevents any other form of battery being connected to the internal charging circuit. This is mainly to safeguard against charging non-rechargeable (i.e. primary) cells, because if charged they may explode!

If other rechargeable cells are used (i.e. with the AA battery holder supplied), they need to be charged independently with a separate AA-size battery charger.

Charging LED

This LED flashes red during battery charging and steady green when charging is complete.

Antenna input

The connector is a standard BNC 'bayonet' socket with an impedance of 50 ohms.

Headphones Socket

This is a 3.5mm stereo jack socket designed for a matching stereo jack plug. The headphones supplied with the receiver have 32 ohm speakers. These are standard personal stereo headphones. Headphones with 8 ohms speakers can also be used, though they increase the power consumption. A mono jack plug can be used, but the sound will be quieter.

The internal speaker cuts out when headphones are used. However, we can supply a special adapter lead, if you would prefer the speaker to continue to sound.

The battery will last longer when headphones are used instead of the internal speaker, and weaker signals can be heard using headphones. Therefore we recommend the use of headphones whenever possible.

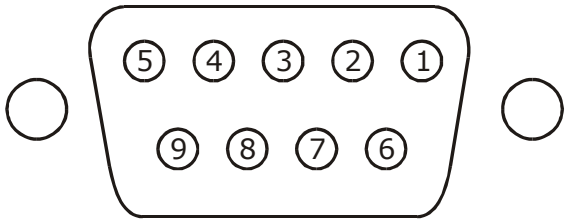
If required, a special lead with an 'in-line' volume control can be supplied to enable volume to be controlled independently of receiver gain. This is mainly to enable signal loudness to be adjusted without affecting the signal strength indicator. It is not necessary to use this lead to get the best performance from the receiver. However, for tracking very powerful tags at close range it may be useful to further reduce signal level.

Please note that it is not necessary for the gain to be on maximum to get the best receiver sensitivity (i.e. to hear the weakest signals). When using headphones, set the gain to a level which is comfortable, not on maximum. Receiver sensitivity starts to reduce below a gain level of about 60; above this there is no advantage other than to overcome extraneous noise (e.g. when not using headphones).

Serial Port (RS232)

The serial port enables receiver gain, frequency and channel to be controlled by a computer via a serial connection. The receiver is wired for a straight-through cable to the PC (no cross-over of Tx and Rx lines). The use of the serial link is explained later in this manual. USB adaptors are available for computers with no serial port.

The wiring is shown below (9-way 'D' connector, viewed from outside the box)



Pin No.	Function
1	Not used
2	Tx
3	Rx
4	Not used
5	Ground
6 – 9	Not used

The serial data protocol is as follows:

1200 baud
1 start bit
8 data bits
1 stop bit
no parity checking
no handshaking

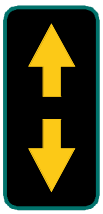
Step-by-step instructions

This section of the manual explains step-by-step how to use the main functions of the receiver. The functions covered are:

- Changing frequency
- Storing frequencies to memory channels
- Deleting channels
- Scanning

Changing frequency

Normally when entering a new frequency in *Frequency Mode* the three places to the left of the decimal place (the MHz value) do not need to be changed.

Therefore you need only to use the up-down arrow keys 

OR…

Enter the frequency from the numeric keypad 

then 

If you wish to change the entire frequency, then press 

before entering the MHz frequency from the numeric keypad.

Press  when the desired frequency is displayed.

Using the arrow keys the frequency will change in steps of either 1 kHz or 0.1kHz (.001 / .0001 MHz).

The step size (tuning resolution) is toggled by pressing 

Storing frequencies to memory (channels)

The receiver has 256 memory channels to which you can save frequencies.

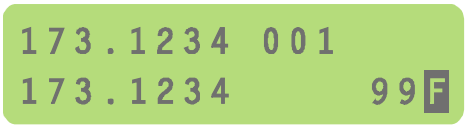
Initial Conditions

The receiver needs to be in *Frequency Mode*, and set to the frequency you wish to store.

Step 1

Press 

to display the last used channel on the top row.



Step 2

Use 
to select the channel in which you want to store the frequency.

OR…

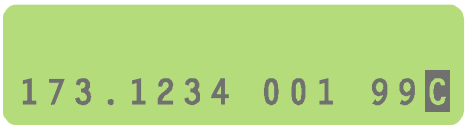
Enter the channel number from the numeric keypad 

then 

Step 3

Press to save the frequency in the chosen channel.

The receiver will revert to *Channel Mode* with the stored channel selected.



Software to enable channel frequencies to be uploaded via a serial or USB port from a PC is available.

Deleting Channels

Initial Conditions

The receiver needs to be in *Channel Mode.*

Step 1

Use the arrow keys  to select the channel which you want to delete.

OR…

Enter the channel number from the numeric keypad  then 

Step 2

Press and hold  for 1 second or more to delete the contents of the channel.

This will set the channel frequency to '000.0000', but the channel will still be displayed. When another channel is selected (e.g. via the arrow keys) the empty channel will be removed.

Scanning

The receiver has a *Scanning Mode* in which selected channels are automatically stepped through in sequence at a user-definable time interval. There is no facility to automatically detect signals in this mode (unlike an amateur radio 'scanner').

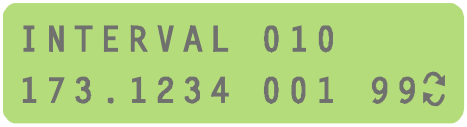
Initial Conditions

The receiver can be in either *Frequency Mode* or *Channel Mode*.
The frequencies to be scanned should already be stored in memory.

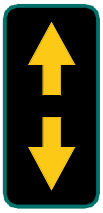
Step 1

Press 

to display the scanning interval (in seconds) on the top line of the display.



Step 2

Use  to select the interval (in seconds, 1 - 999).

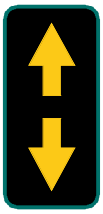
OR…

Enter the interval from the numeric keypad 

then 

Step 3

Press  to display channels on the top line of the display.

Step through the channels using the arrows 

Select or deselect individual channels using 

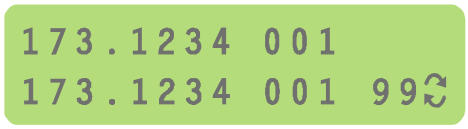
This toggles the channel selection and shows the selection state in the top right of the display (SC = channel selected for scanning, or blank = channel not selected).

Use 

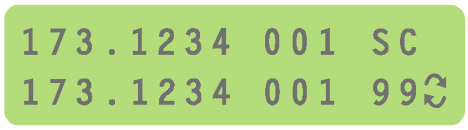
to select or deselect all channels at once. The individual selection status of each channel is not affected by 'all channel' deselection.

The following LCD diagrams show the characters displayed for the different selection states:

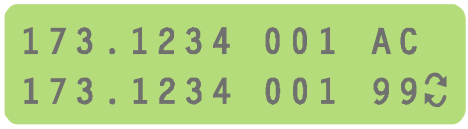
Individual channel not selected



Individual channel selected



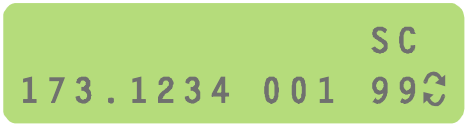
All channels selected



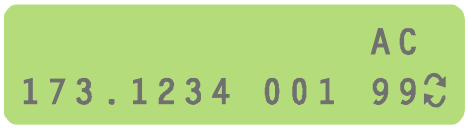
Step 4

When the channels to be scanned have been selected, press SCAN to start the scanning process.

When only selected channels are being scanned the top line of the display shows 'SC'.



When all channels are being scanned the top line of the display shows 'AC'.



Step 5

Press SCAN to stop scanning and enter *Channel Mode* with the receiver set to the last channel scanned.

Alternatively, to stop scanning and enter *Channel Mode* with the receiver set to the channel used when the receiver was last in *Channel Mode*, press 

Receiver Use

Tracking in wet weather

You do not need to protect this receiver from the rain. The membrane keypad on the top panel is completely waterproof, as is the battery compartment lid. All front panel controls and connectors are sealed on the inside of the receiver box so that water can not reach the receiver electronics. When they are not in use, the open sockets (headphones, serial port and charger) should have covers fitted to prevent water entering them. Spare covers are included with the receiver, and more can be supplied on request.

If any of the open sockets get wet, please dry them out in air (or with a hair dryer) as soon as possible.

Batteries

The empty battery symbol in the top right of the LCD indicates when the battery needs to be recharged. When the battery is OK this symbol is NOT shown. It only appears when the battery has about 10% of its capacity remaining. There is no 'full battery' symbol.

The receiver has a variety of power supply options to suit the needs of any radio-tracking project. Apart from the external power supply, there is an internal battery which can take a number of forms. As supplied, the receiver is fitted with a battery pack that can be recharged from any 12V 500mA DC supply via the external power socket. This battery pack contains four 'A'-size Nickel Metal-Hydride (NiMH) cells built in a single block with a re-settable 'poly-switch' and temperature-sensing thermistor to prevent short-circuit damage and over-charging. It will run the receiver for about 28 hours on a single charge, and it takes about 10 hours to charge from a completely discharged state.

When facilities for recharging are not available, the 4A battery pack can be replaced by a holder for four AA cells. The cells used in this holder can be either primary (non-rechargeable) or rechargeable NiCads or NiMH cells. If rechargeable AA cells are used, they have to be taken out of the receiver for charging. As a safety feature – to prevent accidental charging of primary cells which may explode – only the 4A battery pack supplied with the receiver can be recharged *in situ*. During battery pack charging the ambient temperature must be between 5 and 35°C. The battery pack may not charge fully outside these temperatures.

If you are using the receiver for many hours each day, and have access to a charging power supply (e.g. mains electricity or a car battery) we recommend that you use the rechargeable 4A battery pack. If you do not have access to a charging supply, then you have the choice of primary cells, or rechargeable cells that have to removed from the receiver for replacement or recharging. The main factors to consider when deciding whether to use primary or rechargeable cells are: 1) rechargeable cells do not last as long as primary cells, and 2) rechargeable cells self-discharge at a high rate and thereby lose their capacity even if not used. If the receiver is used infrequently or for only a short period (e.g. for a few hours per week) it is better to fit primary cells. Using rechargeable cells reduces waste.

Remove the battery if the receiver is to be stored for more than 3 months, because the circuitry draws a very small amount of current even when switched off, and it is good practice because of the risk of leakage from exhausted primary cells. Rechargeable batteries that have been stored for 3 months or more should be recharged before use. This applies even if the battery was fully charged after it was last used, because rechargeable batteries have a high self-discharge rate.

The receiver memory is retained indefinitely even when the receiver has no battery.

Trouble-shooting

Charging Problems

There are some special cases where charging may be problematic. The battery in a new receiver has been charged only once or twice and may not yet have reached its full capacity. As a result, for the first few charge-discharge cycles, the receiver may not run for quite as long as expected. Similar problems may occur if the receiver has been stored for a long time and the battery is deeply discharged. This may also result in the battery apparently not charging properly (i.e. the green light comes on too soon, wrongly indicating that the battery is fully charged).

To overcome these charging problems, charge the receiver repeatedly (three or four times), with an interval of about 30 minutes between charges. There is no need to discharge the battery between each charging session. Simply unplug the charger when the green light comes on, wait half an hour, then plug it in again.

Battery cover bolts

A few users have reported loosening of the bolts retaining the battery compartment lid. We believe this may be caused by the heads of the bolts rubbing on clothing. We provide spare bolts with each new receiver and we will supply a limited number of further replacements free of charge.

To prevent the loss of bolts we recommend they are checked periodically to ensure they remain tight. We are trying to find a long-term solution to this problem, but in the meantime, if the bolts on your receiver continue to become loose, we suggest covering them with insulating tape.

Please do not over-tighten the bolts, nor use thread-locking compounds to keep the bolts in place.

Using the serial port

The receiver should be connected to a PC via its serial port (RS232, or 'COMM' Port) then switched on and set to *Frequency or Channel Mode.* The PC sends messages to it via this serial link, and the receiver replies. If the message is a command, the receiver replies with "OK" (as an ASCII code), whereas if the message is a query, the receiver sends data corresponding to the query type (i.e. frequency, channel number or gain). The command and query formats are detailed below. Serial to USB converters are available (with their own installation software) for computers with no serial port.

Commands

sf###.####x **Set Frequency**
Sets the receiver to *Frequency Mode* and to the frequency '###.####', which must be a number in the range 138.0000 to 173.9999. The data are in ASCII format and are usually sent as a string. For example, if the frequency to be set is 150.1234 MHz, the string "sf150.1234x" would be sent to the PC serial port. The receiver will respond by returning ASCII "OK" to the host PC.

sc##x **Set Channel**
Sets the receiver to *Channel Mode* and to channel '##', which must be a two byte hex number corresponding to the wanted channel in the range 0000h (0) to 0100h (256). The left byte (sent first) is the least significant byte (LSB) and the right byte is the most significant byte (MSB). Usually the data are sent as the ASCII characters represented by the numbers. For example, if the desired channel is 256, the two byte number will be 0100h (the hex equivalent of decimal 256). The LSB (00h), should be sent first, and the MSB (01h) second. Using a BASIC programming language, such as MS Visual Basic, the message sent to the serial port would be "sc" & CHR(0) & CHR(1) & "x". The receiver will respond by returning ASCII "OK" to the host PC.

sg#x **Set Gain**
Sets the gain level of the receiver, where # is a 1 byte number corresponding to the gain level setting and can be in the range 00h (0) to 63h (99). As explained above for channel setting, the data byte is usually sent as the ASCII character represented by it. The receiver will respond by returning ASCII "OK" to the host PC.

Queries

qfx **Query Frequency**
The receiver transmits its current frequency setting via the serial link to the host PC in the format ###.#### where # are ASCII numeric characters representing the frequency e.g. "150.1234"

qcx **Query Channel**
The receiver transmits its current channel setting via the serial link to the host PC in the format ## ,where ## is a 2 byte number corresponding to the channel and can be in the range 0000h (0) to 0100h (256). The byte sent first is the LSB followed by the MSB. e.g. 01h 00h is channel 1.

qgx **Query Gain**
The receiver transmits its current gain level via the serial link to the host PC in the format # ,where # is a 1 byte number corresponding to the gain level setting and can be in the range 00h (0) to 63h (99).

Glossary

Analogue
Variable on a continuous scale (cf. *Digital*).

Back-light
The light that illuminates the display for tracking at night.

Bar graph
Shown on the top line of the display.

Battery
A power supply comprising a number of *cells*, usually connected in series. To get greater voltage cells are wired together in series to make the battery.

Cell
The individual units comprising a battery. Can also be used alone (i.e. not as part of a battery), if their voltage is adequate for the equipment being powered. Cells have a fixed output voltage depending on their chemistry (e.g. Nickel Cadmium – NiCad – cells develop 1.2V). In common parlance a cell is often called a battery. See also *battery.*

Channel
A location in memory holding a frequency and other information about the frequency (e.g. whether it is selected for scanning). Channels in Biotracker are numbered from 1 to 256.

dBm
A measurement unit of power. In this document it refers to radio-frequency conducted or radiated signals. It is a ratio measurement on a logarithmic scale indicating the strength of a signal relative to 1 milliWatt (1 mW):

dBm = 10 log(P) where P is signal power in mW

Some typical measurements:

10 dBm = 10 mW	Only the largest radio tags are as powerful as this.
0 dBm = 1 mW	Reference power level for dBm.
-40 to 0 dBm = 0.1 uW to 1 mW	Range of power levels that includes most small tags.

Digital
In discrete steps (cf. *Analogue*).

Dwell time
The period of time that the receiver spends on each channel while scanning, sometimes called the 'scan interval'.

Gain
The amount of amplification within the receiver. In some receivers the overall system gain is split between radio frequency (RF) gain (or just 'gain') and volume. In the Biotracker, the gain control changes both RF and volume in parallel.

LCD
Liquid Crystal Display (referred to here as 'the display')

MHz, kHz, Hz
Units of measurement of frequency. The full frequency display on the Biotracker (e.g. 150.1234) is in MHz. During tracking you rarely need to change the 'MHz frequency' (the numbers to the left of the decimal point) so the Biotracker allows you to change the 'kHz frequency' separately (those to the right of the decimal).

Minimum Discernible Signal (MDS)
This is the weakest signal that can be heard on a receiver. It is usually measured in bench tests using a calibrated signal generator. The generator output is reduced until the signal can only just be heard, and the level of the signal is recorded. The best tracking receivers achieve an MDS of –150 dBm. Although MDS is more comprehensible than other measurements of sensitivity such as Signal-to-Noise Ratio or Noise Figure, it is not as objective because it requires a judgement about when a signal can be heard and when it can not be heard.

Radio Frequency (RF)
Those frequencies typically used for radio-communications. Nearly all frequencies used for animal radio-tracking are within the Very High Frequency (VHF) Band of 30-300 MHz, and most are within 138-174 MHz.

Resolution
The smallest unit of adjustment. In the Biotracker this usually refers to frequency and the resolution is selectable between 1kHz or 0.1 kHz.

Scan interval
The period of time that the receiver spends on each channel while scanning, sometimes called the 'dwell time'.

Scanning
In the context of radio-tracking this means stepping from one frequency to another and dwelling on each one for a pre-set time (the dwell time or scan interval). In normal communications parlance, scanning has a different meaning: that of a receiver stepping quickly though a band of frequencies and stopping if a received signal exceeds a threshold signal strength.

Signal strength
The strength (loudness) of a received signal. Displayed on a bar chart and as a number on the Biotracker display.

Toggle
Alternate between one state and another on the press of a button.

Biotracker Specifications

The **Summary Specifications Table** below gives at-a-glance features that make the Biotracker receiver so different from the crowd.
The **Full Specifications Table** overleaf lists specifications, their values and explains what they mean and why they are important in practical terms for animal radio-tracking. Sentences in ***bold italics*** are the key ways in which you should judge receiver performance.

Summary Specifications Table

Frequency Band	▪ The receiver covers a 4, 8 or 30 MHz band on frequencies between 138.000 and 174 MHz ▪ Fine tuning in 1kHz or 0.1kHz steps
Functions and Controls	▪ Direct frequency entry from the membrane keypad (no need to enter MHz part of frequency each time a frequency is set) ▪ 256 user-programmable channels ▪ Scanning of all or selected channels (scan interval 1 to 999 s, settable to 1 s resolution) ▪ Internal speaker ▪ Headphones socket (switches out internal speaker) ▪ LCD Back-light (automatic switch-off after 4 minutes) ▪ Dual gain control (keypad buttons and knob) ▪ Control of frequency, channel & gain from a PC serial port (RS232) ▪ Bar chart and numerical display of signal strength
Environmental Specification	▪ *Fully water-proof* (to IP65) ▪ *Operating temperature range:* –20 to +50°C (battery charging temperature range: 5 to 35°C) ▪ *Temperature stability:* +/- 1 kHz over –20 to + 50°C
Electrical & Mechanical Specification	▪ *Minimum Discernible Signal:* -150 dBm over entire frequency band ▪ *Gain Control Range:* 90 dB ▪ *Power supply:* internal battery pack, external power supply (DC, 10.5-15V, >500 mA) or four internal rechargeable or primary (non-rechargeable) AA cells. ▪ *Battery Life:* 28 hours on internal NiMH battery pack ▪ *Weight:* 800g including strap and battery ▪ *Size:* 150 x 85 x 55 mm (6 x 3.25 x 2 inches)

Full Specifications Table

Specification	Value	Explanation
Frequency Bands	4, 8 or 30 MHz bands between 138- and 174 MHz.	Most tracking receivers cover a 1-2 MHz band only. Biotracker can cover up to 30 MHz! If such a wide band is not required there are versions with 4 or 8 MHz bands (these cost less). Receivers with narrower bands can be upgraded. The main benefits of the 30 MHz band version are: ▪ ***Biotracker can be used almost anywhere*** ▪ ***Biotracker is 'future-proof' against changes in frequency allocation***
Sensitivity MDS	-150 dBm	***The more sensitive a receiver, the better the chances of you hearing very weak signals***. MDS means 'Minimum Discernible Signal' and is the weakest signal that can be heard on the receiver. ***The more negative the MDS, the better the sensitivity (e.g. –150 is better than –145)***.
Selectivity 6 dB 60 dB	± 2 kHz ± 4 kHz	***The more selective the receiver, the less chance you will hear 'interference' from adjacent frequencies*** (including radio tags and signals from other radio users). However, beware selectivity that is too narrow (e.g. < ±1 kHz at 6dB). This will make tuning more critical and increases the risk of missing a transmitter that has shifted frequency slightly (*e.g.* due to a change in temperature).
Gain Control Range Receiver gain	90 dB	When tracking powerful tags at close range you have to be able to reduce the gain to very low levels, otherwise the signal will no longer appear to be directional. ***The greater the Gain Control Range, the less likely you are to encounter problems with close range tracking***. Receivers with inadequate gain control range need attenuator switches.
Channels Number of channels (user programmable)	256	***Having channels makes the receiver easier to use in the field and enables memory scanning for lost animals.*** Two-digit numbers (up to 99 animals) are easier to remember than 3, 4 or 5 digit frequencies. Also, if you routinely track animals in a particular sequence, you can arrange the channel order to match this. One press of the channel 'up' key then selects the frequency of the next animal.

Full Specifications Table (continued)

Specification	Value	Explanation
Scanning Minimum scan interval Maximum scan interval	 1 second 999 secs (16 mins and 39 seconds)	The Scanning function steps through the channels on your receiver and stops on each one for a predefined interval. You can set the scan interval and select which channels are to be included in the scan. ***Scanning automates the process of frequency changing when searching for a number of tags at once.*** It is especially useful during searches from vehicles (including aircraft).
Weight	800g	***The lighter the receiver the easier it will be to carry in the field***. However, bear in mind that the battery contributes extra weight but that heavier batteries last longer. There is inevitably some compromise here. Also, receivers in lighter, plastic cases may not be as robust as those in metal cases.
Size	150 x 85 x 55 mm 6 x 3.25 x 2 inches	***The smaller the receiver the easier it will be to carry in the field.*** However, consider carefully how the receiver is to be used. Will you need to use it with gloves on ? Small receivers usually have small controls that may be difficult to use, especially with gloves, or the controls may not be in the optimum position for operation with one hand while holding a Yagi with the other. Biotracker was designed with these factors in mind.
Waterproofing Method Rating	 Neoprene and silicone seals. IP65	The waterproof rating code 'IP65' is from a standard dust and water resistance scale. It means the device is dust-tight and impenetrable to water spray from all directions. Biotracker has a waterproof seal on box lid and battery compartment. The speaker is fully covered by the membrane keypad and the gain control is hermetically sealed. All connectors are sealed on inside of box and external covers are supplied for connectors when not in use. ***Water-proofing to IP65 is an essential feature of any modern radio-tracking receiver.***
Frequency Stability Over –20 to +50 C Over time	 < 2.5 kHz < 1 kHz in first year (slower change thereafter)	If a receiver frequency changes with temperature there is a chance that you will miss tags because the receiver is no longer tuned to the best frequency on which to hear them. This is more likely to be problematic if your study area is prone to large swings in temperature, or if you are tracking in a very cold climate and have tuned into your tags indoors in the warm. In practice, a change of +/- 1 kHz does not cause much of a problem, provided you are aware of it. Remember that tags too are likely to change frequency with temperature. ***The more stable the frequency of the receiver over temperature and time, the less the risk you will miss a tag because of frequency shift.***

Full Specifications Table (continued)

Specification	Value	Explanation
Tuning	N/A	The receiver can be tuned in 100 Hz (0.1 kHz) or 1 kHz steps. The fine tune (0.1 kHz) is good for selecting the sound (pitch) you find most comfortable to listen to. The 1 kHz tuning resolution allows faster frequency stepping using the arrow keys.
Battery life Rechargeable NiMH battery pack (4 x 'A' NiMH cells) Primary alkaline 'AA' cells NiMH 'AA' Rechargeable cells NiCad 'AA' Rechargeable cells (not recommended)	 28 hours 26 hours 20 hours 10 hours	***Long battery life reduces both running costs and the risk that the receiver will stop working in the middle of fieldwork.*** A receiver designer's choice of battery involves a compromise between size (weight) and battery life. Batteries that last longer will also be heavier. Primary cells are 'ordinary' non-rechargeable batteries (we recommend high grade alkaline cells). We suggest using primary cells only if you have no local facility for recharging. Rechargeable cells are more expensive to buy, but more cost-effective in the long run. We strongly recommend the Nickel Metal-Hydride battery pack supplied with each receiver because it contains higher capacity 'A'-size cells, and will not suffer from the over-charging/memory effects of NiCads.
External power supplies	10.5 – 15 V	The receiver can be powered from an external battery (e.g. car cigarette lighter). The internal battery is recharged via the same socket. ***Powering a receiver from an external power supply saves internal battery life and allows the receiver to run from a vehicle or for long periods with a data logger.***
Back-light on LCD On-time	256 secs (4.3 mins)	***This is for using the receiver at night.*** It can be switched on and off using a single key, and it switches off automatically after about 4 minutes.

Regulatory Compliance

FCC ID: FW9BIOTRACKER
Model: Biotracker
Telemetry Receiver

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Location of Inputs, Outputs and Controls

Liquid Crystal Display (LCD)
Top row: signal strength and low battery symbol
Bottom row: frequency - channel - gain - mode

Enters Scan Mode

Sets MHz frequency

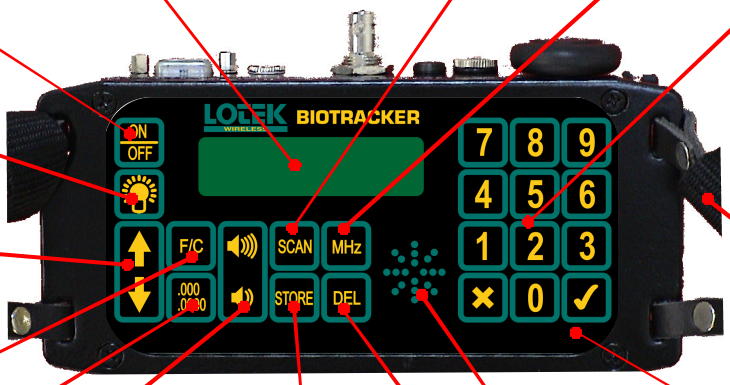
Numeric Key Pad
Tick and cross keys are accept (enter) and reject (cancel)

On/off Switch

LCD Back-light
Timed auto switch off

Frequency/Channel up/down keys

Frequency/Channel mode switch
Current mode is shown in bottom right of LCD (after gain level)



Shoulder Strap
Leather stirrups and adjustable nylon strap

Membrane Keypad
Completely waterproof. Keys are domed and click when pressed

Tuning Step
Switches between 0.1 and 1 kHz

Digital Gain up/down keys
Gain level is displayed on bottom right of LCD

Stores a frequency in memory
(channels)

Delete Key

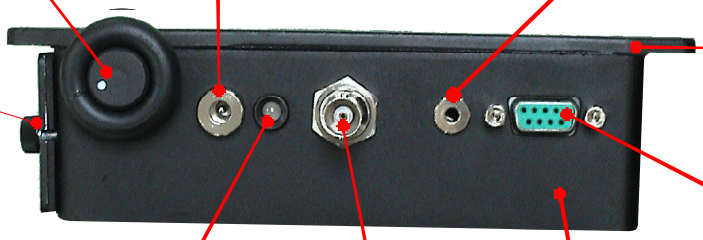
Loudspeaker
Fully protected under membrane keypad

Gain Knob
Analogue control sets gain from zero to an upper limit set by the digital gain keys

Battery Charger and External Power Socket
The receiver comes with a mains power supply, but can be charged from any 12V source (e.g. car battery, lead supplied).

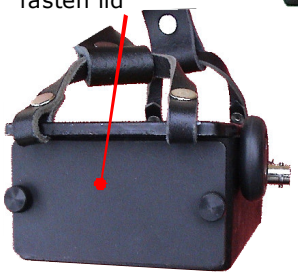
Headphones Socket
Internal speaker is silenced when headphones are inserted.

Battery Compartment
Neoprene water proofing seal. Knurled nuts to fasten lid



Silicone seal on lid
For complete water proofing

Serial Port (RS232)
For computer control of receiver functions



Charging LED
Flashes red during charging and steady green when fully-charged

Antenna Connector
(standard BNC)

Diecast Aluminium Case
Lightweight and very robust

End View
Shows battery cover and shoulder strap

APPENDIX A: ADDITIONAL INFORMATION

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determine by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

WARNING

Changes or modifications not expressly approved by Lotek Wireless could void the user's authority to operate the equipment.