Suretrack STR1000-W1
User's Manual

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8629, rev A

LOTEK Wireless Inc. **Newmarket, Ontario, Canada**

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INTRODUCTION

Thank you very much for choosing the LOTEK Suretrack STR1000-W1. To take full advantage of the features available in this product, please study this manual thoroughly prior to operation.

The Suretrack STR1000-W1 is a light-weight non-datalogging receiver for manual tracking of pulse carrier transmitters commonly used in wildlife and fisheries telemetry studies. The Suretrack contains an extremely sensitive front end capable of receiving signals as weak as -150 dBm making it ideal for squeezing every last mile out of transmitters which, by necessity, characteristically exhibit very low power outputs and low duty cycles. In addition, an internal microcontroller gives the Suretrack the intelligence to perform tasks more complex than traditional tracking receivers providing the operator with many useful and timesaving features. The "W1" enhancements introduced in Fall, 2002, provide features and functions previously only available in Lotek SRX-400 receivers.

This manual has four major sections. The first section is an overview of the Suretrack features. Following this is a more detailed section with specifications. Thirdly, the Controls and Connections section explains all the control and key functions plus connector uses providing a useful reference. Finally, a Set-up and Operation section gives a step by step description of how to use the receiver for various applications.

FEATURES

Basic Features

- **On/Off audio volume control**

  A single on/off volume control allows easy powerup and adjustment of volume in one convenient movement thus limiting the volume of the powerup noise burst in the headphones.

- **Control of the receiver sensitivity (RF gain)**

  The user can exert full control over the receiver sensitivity by selecting different values of RF gain. Higher values increase the receiver sensitivity to permit detection of very weak signals. Lower values decrease the receiver sensitivity to optimize performance in high signal strength environments as when making a final approach toward a transmitter.

- **Separate audio gain control (volume)**

  A separate audio gain control allows the user to adjust the volume of the signal for comfortable listening without affecting the receiver sensitivity.

- **1 kHz tuning over 4 MHz**

  The ability to tune the receiver in 1 kHz steps permits fine adjustment to accommodate for transmitter drift or varying receiver tone preferences.

- **Internal Speaker**

  An internal speaker is provided so that headphones are not required to operate the receiver.

- **Headphone jack**

  A headphone jack is provided to allow isolated listening to the receiver audio allowing the user to concentrate and operate effectively even within a noisy environment.

- **Internal rechargeable battery**

  An internal rechargeable battery allows the receiver to be used independently of external power sources for an extended period of time. Overnight recharging makes the receiver available continuously for daily portable tracking.

- **External power/battery charge jack**

  The front panel charge jack permits recharging of the receiver while in the carrying case. The same jack can be used to provide external power for added operation time.

- **6 kHz IF bandwidth (Selectivity)**

  A 6 kHz IF bandwidth means that the receiver can resolve any two transmitters that are more than 6 kHz apart and of equal signal strength. Narrow IF bandwidths increase the ability of the receiver to resolve transmitters close in frequency. They also improve receiver sensitivity. However, too narrow a bandwidth can make it difficult to locate transmitters as they drift due to environmental and tolerance changes. 6 kHz is a good compromise for today's transmitter technology.

- **-150 dBm sensitivity**

  -150 dBm sensitivity is very close to the theoretical limit. Therefore, until the laws of physics change, the STR1000-W1 is one of the most sensitive receivers available.

- **Nearly 40 dB dynamic range**

  A 40 dB dynamic range means, in line of sight reception, no adjustment of RF gain is required between 10 and 1000 meter range between signal strength measurement saturation to fringe detection.

- **Graphic and/or numeric display of signal strength**

  The signal strength can be displayed either graphically, using a peak hold bar meter or digitally with three digits of resolution. Therefore, direction finding is made easy regardless of user display preference.

- **Scanning of user programmable frequency tables**

  A set of any frequencies within the receiver operating range can be programmed into a frequency table for easy scanning of user defined channels.

- **16 separate frequency tables**

  The Suretrack STR1000-W1 has 16 separate frequency tables that can be stored in memory. Each frequency table has an assigned partition which is selected depending on the table desired at any given time or location. As a result, it is not necessary to re-program the receiver each time a separate field site with a different set of transmitter frequencies is visited.

- **Frequency Scanning Delete/Add Feature**

  While scanning the frequency table, individual channels can be sequentially deleted and restored from the sequence. This is useful for reducing cycle time. As transmitters are located it is no longer necessary to listen to their frequency.

- **Built in real-time clock**

  A built in real-time clock keeps the time of day close at hand for reference when making entries into written logs.

- **Memory**

  The receiver is controlled by firmware (software contained in permanent read only memory) and cannot be overwritten or erased. All other memory, including user-specified parameters like frequency tables, gain settings, time and date, are saved in battery backed-up RAM. Back-up power is supplied initially by the main batteries. If the main batteries are discharged or disconnected, an on board lithium battery will provide memory protection for approximately 6 months.

- **Low Battery indication** — A low battery symbol is displayed in place of the shift character when the voltage is getting dangerously low. A bar graph below the low battery symbol increases in length as discharge continues. When the bar is at full length, the receiver has less than 5 minutes operating time left.

- **Battery charger** — A battery charger which plugs into 115 VAC (230 VAC European) is provided with the receiver.

- **Flexible omni-directional antenna** — A flexible "rubber duck" antenna is included with the receiver. This is often useful for verifying the operation of transmitters.

- **Padded Nylon Carrying Case** — An attractive padded nylon carrying case with a notepad pocket is also included to protect the receiver in the field from impact and moisture.

- **Warranty** — A standard two year warranty comes with every receiver.

- **Pulse interval and rate (BPM) display** — The addition of a pulse interval/rate display makes determination of transmitter characteristics easy. If the pulse rate is being used to encode sensor data or simply for identification, this feature is a necessity.

- **Copy Command** — The copy command is a convenient feature which allows all channels deleted during the scan operation to be restored at once.

SPECIFICATIONS

General

Dimensions (LxWXH)	7.15 in x 8 in x 3.5 in
Weight	2.2 kg
Battery Operating Life	Backlight on: 9 Hrs Backlight off: 12 Hrs.
Operating Temperature	-20 to +50 °C
External Operating Voltage	12-18 VDC
External Charging Voltage	14-18 VDC
External Power/Charge Connector	Barrel
Audio Output Impedance	4-16 Ω
Audio Output Connector	1/4 inch jack
Antenna Input Impedance	50 Ω
Antenna Input Connector	BNC female

RF

Frequency Coverage	Any tunable bandwidth in the 148 - 158 MHz range or in the 170 - 174 MHz range. (Others available on special request)
Tunable Bandwidth	4 MHz
IF Bandwidth (Selectivity)	6 kHz
Sensitivity	Audio: -150 dBm Digital: -135 dBm
Maximum Input Power	0 dBm

Digital

Liquid Crystal Display	2 lines of 24 characters

Key Pad Size	16 keys
Frequency Display	6 digits
Frequency Control	Direct selection of any frequency in the tunable bandwidth with a resolution of 1 kHz
Frequency Steps (ΔF)	Adjustable 1 to 999 kHz
Number of Frequency Table Partitions	16
Maximum Frequency Table Size	512
Signal Strength Display	3 digits or bar graph
Signal Strength Range	40 to 230 relative signal strength units (approximately 40 dB)
RF Gain Display	2 digits
RF Gain Control	Direct selection of gain between 0 and 99 units (approximately 60 dB) at a resolution of 1 unit
Gain Steps (ΔG)	1 to 99 units
Scan Rate Display	5 digits
Scan Rate Control	1 s to 9 m 59.99 s at 0.01 s resolution
Scan Time Steps (ΔT)	1 to 99 seconds
Pulse Rate/Interval Units	Beats per Minute (BPM) or Milliseconds (ms)
Time Interval Window	0 - 34463 ms

CONTROLS AND CONNECTIONS

ANT Connector

This standard BNC jack is the antenna connector. Using a 50 Ω coaxial cable such as Belden 9311, this jack can be connected to any matched antenna. The choice of antenna, i.e. yagi, vertical, corner reflector, etc., depends on the study environment and objectives.

CHG Connector

This charge connector is a barrel jack which accepts the lead from the AC-DC wall adapter provided. When power is supplied form the adapter or another 14 to 18 VDC power source the receiver batteries will charge. External power between 12 and 14 VDC may be supplied to extend the operating time, however, charging will not occur.

OFF/VOL Control

This control doubles as an on-off switch and volume control. When turned fully counterclockwise, the receiver is turned off. Clockwise rotation initially powers up the receiver and then increases the volume.

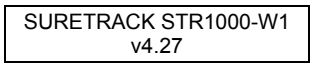
EAR Connector

This 1/4 inch jack is for a standard headphone plug. Any mono headphones with an impedance between 4 and 16 ohms may be used.

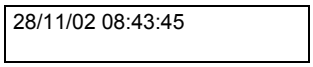
Display

The backlit liquid crystal display has two lines of 24 characters. Various numbers and messages are shown depending on the mode of operation and keyboard selection.

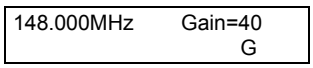
When the receiver is initially turned on, a title display showing the firmware option and version number is shown resembling the following:



A few seconds later, the date and time is briefly displayed to allow verification of the internal clock.



Finally, the power-on default display appears as follows:



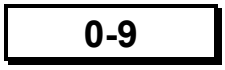
The receiver is now in manual or command mode with the current tuner frequency and gain displayed along with a letter which indicates which value the upward and downward arrows will increment. G indicates gain, F indicates frequency and T indicates scan time.

After this, the contents of the display varies only according to the keys pressed.

Keypad

Most of the 16 keys have two functions, **primary** and **shifted**. The primary functions are indicated by the characters on the lower half of the key. The shifted functions are indicated by the characters on the upper half of the key. To access the primary functions simply press only the desired key. **To access shifted functions**, begin by pressing the **SHIFT** key and then press the function key. For example, to access the F2 function, press in sequence:

In the following key descriptions, reference will be made only to the function itself. **IT WILL BE UNDERSTOOD that shifted functions are preceded by the SHIFT key**.



The numeric keys from 0 to 9 are used to enter numeric data such as frequencies, gain levels, partition numbers etc. They are also used to select menu options by pressing the number that corresponds to the menu selection shown.

The decimal key is used for entry of a decimal point when real numbers are required during data entry. As an example, this is required when entering the local oscillator frequency during EPROM initialization (see **F1** key). Occasionally, it is also used for control purposes.

The upward arrow key is used for various functions requiring incrementing of values or control of processes. Occasionally, it is also used as an enter key. At the power-on default display, this key increments the value of frequency, gain or scan time by an amount defined with the **SET Δ** key. The value changed depends on which **SET** key was most recently pressed (**SET G**, **SET F**, or **SET SCAN**).

The downward arrow key is used to decrement values or control processes. At the power-on default display, this key decrements the value of frequency, gain, or scan time by an amount defined with the **SET Δ** key. The value changed depends on which **SET** key was most recently pressed (**SET G**, **SET F**, or **SET SCAN**). The variable is selected by whichever of the **SET G**, **SET F**, or SET **SCAN** keys were most recently activated. The decrement amount is the last value entered using the **SET Δ** key.

The **CODE** key is not used in the Suretrack receiver.

ESC

The **ESC** key is the general "return" operator. Most commonly it returns you to the previous menu or to the default receiver frequency and gain display. Alternatively, during data entry, it is used to select the current default value. If pressed simultaneously with the **SHIFT** key, a hardware reset will occur and the receiver will return to its power-on state.

F TABLE

The **F TABLE** key is used to program the frequency table used for scanning. The corresponding menu has five options. That menu appears in the display as follows:

```
1)Add  2)Del/View  3)Copy
4)Partition 5)Size
```

Press the numeric key corresponding to the option you wish. Pressing **ESC** will return you to the power-on default display.

1) Add

This option allows you to add frequencies to the frequency table in the current partition. When selected the following appears on the display:

```
Add >
ESC exits
```

Using the numeric keys, enter the desired frequency. After the first three digits are entered, a "." appears forcing the display to read in MHz. After entering three more digits (for an accuracy of 1 kHz) the frequency is accepted. If the frequency is out of the receiver tuning range, a "Value out of range" message appears and the prompt reappears. When the frequency has been accepted, the prompt immediately reappears and entry can continue. Press the **ESC** key when finished.

2) Del/View

When this option is selected, a display similar to the following appears:

```
148.000MHz
1)Delete < = = > SCROLL
```

The frequency displayed is the first one in the table of the current partition. If you wish to delete this frequency, press **1**. If you wish to view the next frequency in the table, press **2**. The next frequency will be displayed with the same options. After the final frequency in the table, the display returns to the **F TABLE** menu.

3) Copy

Selecting this option copies all frequencies, which have been temporarily deleted in **SCAN** mode, back into the active partition. Frequencies deleted using the previous option cannot be restored in this way and must be re-entered using the Add option. Copy is available only in configuration 2 and 3 Suretrack receivers.

4) Partition

This menu option allows you to select from up to eight (dependant on the Suretrack Configuration number) separate frequency table partitions, numbered 0 to 7. When selected, the following display appears:

```
Active Partition (0-15)
(0)>
```

The current or "active" partition is shown before the prompt and it is the default value assumed if **ESC** or an invalid digit is pressed. Entry of a valid partition number redefines the active partition to be used in **SCAN** mode.

5) Size

This menu option displays a count of all frequencies currently in memory in all tables (Master Table Size), including those which have been temporarily deleted but not restored while in **SCAN** mode, and a count of all frquencies currently in the designated partition (Partition Size) :

```
Master table Size = X
Partition Y Size = Z
```

F0

In the Suretrack receiver, this key has no assigned function.

F1

The **F1** key is used to initialize the receiver when new firmware is installed or reinitialize the receiver to the factory default settings at anytime. When pressed, the following message appears:

```
NEW PROM Initializes
system variables...
```

Shortly afterwards, the display changes to a prompt:

```
NEW PROM Initializes
OK to proceed? 1)Y 2)N
```

If **2** or **ESC** is selected, the display returns to the power-on default. If **1** is selected, the receiver prompts for an access code:

```
NEW PROM Initializes
Enter access code:
```

This access code can be obtained from your LOTEK account representative or one of our systems engineers if this function is required.

Again, **ESC** can be pressed to return to the power-on default display or the access code can be entered. As the access code is entered, random characters appear on the display. When the correct code has been accepted, the receiver will display the following:

```
NEW PROM: Purge tables
and storage?  1)Y 2)N
```

At this point, the ESC abort option is still supported, however, if **1** is pressed, all frequency tables will be purged. It will be necessary to reprogram the frequency tables before scanning can resume. If **2** is pressed, the frequency tables will remain intact. In either case, the following display appears:

```
Program frequency range?
1)Yes 2)No
```

If **2** is pressed, the receiver will retain the current values for the receiver base frequency, local oscillator frequency and IF frequency and continue to the port configuration display shown below. Otherwise, if **1** is pressed the following appears:

```
Enter start frequency
>
```

At this point, you will have to remove the bottom cover of the Suretrack receiver to see the calibration information recorded on a sticker. The start frequency should be entered as shown, this time using the "." key before the last three digits. If the last three digits are 0, they, or the decimal are not needed. If you make a mistake, the downward arrow can be used to erase the last digit. After the start frequency is keyed in, press the upward arrow key to enter it. If **ESC** is pressed, the old value will be retained. After this, the following display appears:

```
Enter LO frequency
>
```

Now, enter the IF frequency shown on the sticker in the same manner as the start frequency. Next, the following display appears:

```
Enter IF frequency
>
```

Enter the LO frequency shown on the label. After this is entered, the display shows briefly:

```
148-152MHz
Synth count = 21297
```

Then the following is briefly displayed:

```
Port configured:
4800,N,8,1
```

Finally, the receiver reverts back to the power-on default display.

F2

In the Suretrack receiver, this key has no assigned function.

F3

This key toggles the display backlight on and off. Turning the backlight off will conserve battery power and extend the operating life before recharge by about 30%.

HELP

This key is used to obtain abbreviated descriptions of **shifted key functions**. Once **HELP** has been activated you may then press any key to get information about its shifted function and appropriate entry formats for data. Since help is provided for the **SET Δ** function (shifted **ESC**), the **SHIFT** key, rather than **ESC**, is used to exit the help mode.

SCAN

This key is used to scan through the frequencies entered in the **F TABLE** of the currently active partition. When pressed, a display similar to the following appears:

```
Scanning partition 0
```

This indicates that the receiver is entering the scan mode using the frequency table partition number 0. Shortly, the display changes to:

```
148.500MHz
                    G→
```

The frequency shown is the channel currently being monitored. The "□" is the position of the signal strobe that will be discussed shortly. The "G", like in manual mode, indicates that the gain can be incrementally changed up and down using the arrow keys. The "→" indicates the scanning direction through the frequency table. To the right of the arrow, a "^" character appears after the shift key is pressed and before the shifted function key is pressed to indicate whether the primary or shifted function will be accessed when the next key is pressed. These four characters are referred to as display status characters. The strobe position is the signal status, the "G" is the delta status, the "→" is the scan status and the "^" is the shift status.

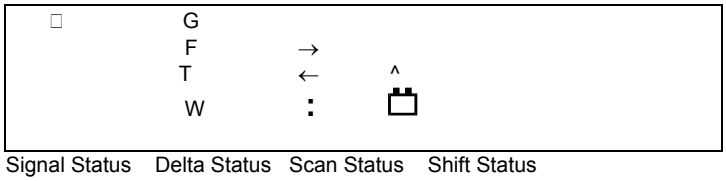


Figure 1: Display Status Characters

After a period of time, the receiver automatically changes to the next frequency in the table. The dwell time on each frequency is governed by the value specified using the **SET SCAN** key. Scanning continues indefinitely in a cyclical pattern, returning to the first frequency after the last one is scanned.

Pulse interval and signal strength information can be displayed while in scan mode by using the key sequence:

SHIFT **SIGNAL**

This acts as an on/off toggle. When on, interval measurements in milliseconds(ms) or rate measurements in beats per minute(bpm), are displayed after each transmitter pulse in the lower left corner. To the right of the interval measurement appears the relative signal strength. This value can be as low as 40 for weak signals and as high as 230 for very strong signals. In the signal strobe position, the square place holder, mentioned above, is replaced by a strobe in synchronous with the transmitter pulse. The delta status changes from G to W to indicate that the detection window will be adjusted by the arrow keys. The current window limits are also shown at the top right of the display. As an example, the display might look like this:

```
149.423MHz [30:5000]
982ms                □W→
```

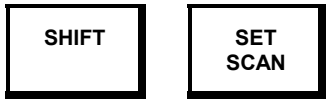
The detection window is a range of pulse intervals or rates that will be recognized by the receiver. Outside of this range, signals will be ignored.

The units of measurement, ms or bpm, can be toggled using the key sequence:

SHIFT **TIME**

Whether in scan mode or not, the parameter that is incrementally adjusted using the arrow keys can be selected by using one of the following key sequences:

SHIFT **SET F**



SET F is for frequency adjustment, **SET G** is for gain adjustment and **SET SCAN** is for scan time adjustment. The currently active parameter is displayed by the delta status position character. All adjustments remain in effect except the frequency adjustment which will be reset when the receiver steps to the next channel. When **SET SCAN** is selected, the scan time is displayed in the lower left corner of the display. If interval/rate measurement is on, the scan time will not be displayed until an arrow key is pressed. The displayed scan time will be replaced by the interval or rate at the next pulse.

The decimal point (**.**) key pauses and continues the scan. When paused, a colon ("**:**") is displayed the scan status position.

When scanning has been paused, you can manually step through the frequencies in the table by pressing the key sequence:

This key sequence assigns the arrow keys control of the scan direction (upward arrow is forward, downward arrow is backward). This allows you to step quickly through the scan table in either direction to find a particular frequency. Arrow key assignment is indicated by a double or single arrow in the delta status position (arrow to right is forward, arrow to left is backward). If the arrow keys are pressed while scanning is not paused, they will control the direction of automatic scanning.

Frequencies may be removed from and restored to the active partition while scanning is in progress using the key sequence:

This sequence assigns the arrow keys to delete (downward arrow) and restore (upward arrow) functions. The assignment is indicated by a "+" character in the delta status position, which changes on activation of either arrow key to a "+" or a "-" to indicate the last operation performed. Restoration is applied on a "last deleted first replaced" basis. Frequencies which have been deleted but not restored at the end of a scanning session may be restored collectively using the **F TABLE** Copy option (see above).

SCAN key functions are summarized in the following table:

Key Sequence	Direct Effect	Arrow Keys	Delta Status	Scan Status
1	Stop/Start			: - > or <-
SHIFT + SCAN		Scan up/ Scan down	<=> - > or < -	

SHIFT + SET F		Inc/Dec Frequency	F	
SHIFT + SET G		Inc/Dec Gain	G	
SHIFT + SET SCAN		Inc/Dec Scan Time	T	
SHIFT + SIGNAL	Signal Measurements	Open/Close Window	W	
SHIFT + F TABLE		Remove/Restore Frequency	± + or -	
SHIFT + TIME	Pulse Interval/ Rate			

Table 1: Control Key Sequences for SCAN mode

SEARCH

This key is used to search through a range of frequencies for a signal. It is especially useful if the exact frequency of a transmitter is unknown. The following menu is displayed:

```
1)Range  2)Cont
3)Neighbourhood 4)Exit
```

Range

This menu option is used to specify the frequencies to scan between. When selected the following prompt appears:

```
Enter start frequency
>
```

Enter the frequency, to the accuracy of 1 kHz, at which you wish the search to start. It is not necessary to enter the "." before the last three digits, as it will appear automatically. When the last digit is entered, the display will change to:

```
Enter end frequency
>
```

In the same fashion, enter the frequency you wish the search to stop at. When complete, the following display will appear:

```
148.999MHz >> Searching
ESC exits
```

With the dwell time specified using the **SET SCAN** key, and a step interval specified using the **SET Δ** key on frequency, the receiver will step through the range specified. If a signal is found, the receiver will find the frequency of maximum signal strength and generate a display like this:

```
149.419MHz     +100
SHIFT=continue  ESC=exit
```

The receiver will remain on the frequency until the signal disappears or either **SHIFT** or **ESC** are pressed. **SHIFT** will continue the search, **ESC** will exit the search.

Because of the pass band characteristics of the receiver's ultra-stable IF filters there may be more than one local maximum for a given signal, and if the signal is subject to dynamic fading (due to relative motion of transmitter, receiver or interfering objects) the maximum signal point(s) may move slightly or change in relative intensity. The search algorithm is designed to discriminate multiple peaks of equal or increasing magnitude, and locks on to each one individually until you press **SHIFT**. The search over the specified range repeats continuously until terminated by **ESC**.

Neighbourhood

This option initiates a search over a range of frequencies from 8KHz below to 8KHz above the current manual tuner frequency.

Cont

The continue option simply continues a search which has been stopped by **ESC** from the same point it left off.

EXIT

The option returns you to the power-on default display or manual mode. **ESC** accomplishes the same.

SET F

The **SET F** key permits manual tuning of the receiver operating frequency. **SET F** first issues a prompt:

```
Enter frequency
>
```

and then waits until it receives input from the keypad in the form of a 6-digit decimal number representing the receive frequency in MHz. If the requested frequency is out of range of the hardware, a "Value out of range!" message will be displayed and the receiver will wait for another input. Pressing the **ESC** key causes the function to abort without updating. On exit, the power-on default display is restored with the current frequency displayed.

SET G

The **SET G** key allows the user to directly enter a gain setting. It issues the prompt:

```
Enter gain (00-99)
(50)>
```

The range of acceptable values is shown in on the top line and the current default value is shown on the bottom line. The receiver waits until it receives two numeric inputs from the keypad. Shifted or non-numeric keys (except **ESC**) are ignored. The system gain is then set according to the received two-digit value. Pressing the **ESC** key causes the function to abort without updating. On exit, the power-on default display (frequency and gain) is restored.

SET SCAN

The **SET SCAN** key sets the dwell time for the **SCAN** and **SEARCH** functions. It issues a prompt:

```
Scan time (m:ss.ss)
(0:05.00)>
```

The format for the numerical input is shown on the top line meaning minutes, seconds, and hundredths of seconds. The current default value is shown at the bottom left. The receiver then waits until it receives five numeric inputs which it automatically formats with the colon and decimal. Shifted or non-numeric keys (except **ESC**) are ignored. The scan time is then set according to the received five-digit value. Pressing the **ESC** key causes the function to abort without updating. On exit, the power-on default display (frequency and gain) is restored, with the scan time now appearing in the lower left corner as follows:

```
149.220MHz          Gain=70
0:05.00T
```

SET Δ

The **SET Δ** ("set delta") key is used to set incremental values of frequency, gain or time for use by the increment and decrement functions (arrow keys). Which variable is set depends on which of the three other "set" keys (**SET F**, **SET G**, or **SET SCAN**) were activated last. The three prompts are:

```
Delta G (01-99)
(01)>
```

```
Delta F in kHz (001-999)
(001)>
```

```
Delta T in secs (01-99)
(01)>
```

The top line shows the range of values accepted and the number of digits that must be entered. The current default value is shown in the bottom left corner.

SHIFT

The **SHIFT** key selects the functions on the upper half of the keys. When **SHIFT** is activated the **^** symbol appears in the lower right corner of the display. When the batteries are low, the **^** symbol is replaced by a small picture of a battery. The **SHIFT** key is also used as a "continue" or "confirm" operator in **SEARCH** mode and to return from **HELP**.

If **SHIFT** and **ESC** are pressed simultaneously, a hardware reset will occur. This is exactly the same as turning the receiver off and on again. If you should experience a lockout (receiver won't respond to keys) or find yourself in a place from which you can't escape, pressing **ESC** and **SHIFT** simultaneously is your last resort.

SIGNAL

The **SIGNAL** key is used to select signal measurement and display options. Its standard menu is:

```
1)Power Graph   2)Interval
3)Boundaries
```

1) Power Graph

Selecting this option will make the receiver display a bar graph and a dimensionless relative signal strength number between 0 and 255 upon reception of an impulse signal. The signal strength value is not compensated by the RF gain setting, therefore a change in RF gain will cause a change in signal strength reading. The power graph display provides you with a visual representation of signal strength that simplifies relative measurements. The display looks similar to the following:

```
149.450MHz +102
min■■■■■■■■ |
```

While in this mode, the arrow keys can be used to increment and decrement gain and frequency as discussed earlier. The gain appears in the display only when it is adjusted. **ESC** is used to return to the **SIGNAL** menu

2) Interval

This option filters the received pulses using a pulse interval window. A pulse is considered valid if the time elapsed since the last received pulse is within the time interval defined by window (see boundaries below). Valid pulses will trigger a dynamic "strobe" character in the lower right quadrant of the display. The interval display looks like the following:

```
151.445MHz
943ms   214              □G
```

The receiver does not exercise any automatic control of receiver gain. In a noisy environment (e.g., in an aircraft or in the vicinity of computer equipment) it is possible to set the gain high enough so that the receiver is saturated with noise and cannot detect even a reasonably strong signal. Simply reducing the gain will normally correct this situation. (See also ***Optimization***).

In this mode, the arrow keys can be used to increment and decrement the gain, frequency and window size as discussed earlier. The gain and window only appear when they are being adjusted. **ESC** is used to return to the **SIGNAL** menu.

3) Boundaries

This option allows you to specify a time window in milliseconds for valid pulses. The following prompt appears:

```
Time interval upperbound
(04950)>
```

The time shown at the lower left is the current default upper boundary for the window in ms. Enter the new boundary value as a 5-digit number, including leading zeros, if necessary. After entering all 5 numbers the following prompt appears:

```
Time interval lowerbound
(00080)>
```

Enter the lower boundary for the window in the same manner.

If you don't want any time interval filtering, open the window wide by setting the boundary values far apart (e.g., upper bound = 10000 and lower bound = 00001). Whatever values you set for the window will be retained by the receiver until you change them or re-initialize the receiver with **F1** or **NEW PROM**. Note that window values are always entered in milliseconds, even though they may be displayed (using the **SHIFT** + **TIME** key sequence in **Interval** mode) in beats per minute. To specify a window value in beats per minute use the conversion: interval(msec) = 60,000 / rate(bpm).

TIME

This key displays the date and time as follows:

```
28/11/02   23:42:25
1)Update  2)Quit
```

If you wish to return to the power-on default display without updating the clock, press **2**. If you wish to update the clock, press **1** and the following prompt appears:

```
Enter date (dd/mm/yy)
>
```

Enter the day, month and year in the suggested format or press ESC to retain the current date. After this, the display will switch to the following:

```
Enter 24h time (hh:mm)
>
```

Enter the hour in 24h format (i.e. 10:00 PM is 22:00) and enter the minutes past the hour. As soon as the last minute is entered, the clock will start at that time. The receiver will display the running time for a few seconds then return to the power-on default display.

COMM

This key has no function in the Suretrack W1 receiver.

SET-UP AND OPERATION

Battery Operation

The Suretrack receiver will operate continuously for about 9 hours on a fully charged "Sub C" battery pack and up to 12 hours with the display backlight turned off. When the batteries need recharging the shift key ^ character is replaced by a ⊏ symbol. A fully discharged pack takes about 12 to 14 hours to recharge. NiCad batteries will lose their charge over time even if they are not used. If you are going to store the receiver for extended periods (e.g., over winter) it is a good idea to charge the batteries at least once a month to conserve memory backup power (see below).

The Suretrack can also operate from an external 12-18 VDC power source. Note however that a source supplying less than 14 volts DC will not charge the internal batteries.

Antenna

The only connection necessary to prepare the Suretrack for use in the field is the antenna. The Suretrack will work well with any 50 Ω antenna connected with 50 Ω coaxial cable and a BNC connector. Antennas come in many shapes and sizes. Typically, three element hand-held yagis are used in the field since they are light and reasonably small, therefore, easy to carry. In a fixed station, the Suretrack could be hooked up to a 9 element beam or an omnidirectional antenna on a tower. Corner reflectors are also periodically used to null out interference from behind the antenna. Please consult us about the application you have in mind and we will recommend or even engineer the most suitable antenna system for you.

Start-up and the Command Environment

The Suretrack receiver is shipped with the batteries charged and time and date set to Eastern Time. To operate the receiver, attach the antenna to the front panel RF jack and turn the OFF/VOL switch on (clockwise). The receiver will display the software version information, followed by the date and time, followed by the current frequency and gain. The receiver is now ready to accept commands.

From the main command environment (display shows frequency on the left and gain on the right) all key functions are accessible and the receiver is in its manual mode. By judicious use of gain and audio volume controls, signal bearings may be obtained using a directional antenna and isolating headphones. Some keypad commands return you to this environment after adjusting some receiver parameter (frequency, gain, scan time, etc.). Others transfer control to a new environment (e.g., frequency scan or signal measurement) in which keys may be reassigned and functions redefined. Navigation is guided by interactive menus and the ESCape key.

Preface to the Examples

The following exercises are designed to enhance familiarity with Suretrack receiver functions and operating modes. They are modeled as faithfully as possible on real applications and include a basic radio tracking session.

Tracking

You are studying caribou populations on a group of islands off the Labrador coast. There is some physiognomic evidence that these populations have experienced some degree of isolation, but a quantitative measure of their independence, and in particular the impact on their genetic viability of a proposed mainland development, cannot be assessed without some behavioural data. You have 200 animals instrumented with radio collars, 50 on each of four islands. The transmitters are at individual frequencies spaced 10KHz apart. Your method is to overfly the islands twice a week (weather permitting) and try to locate as many of these animals as possible.

One strategy that occurs to you is to install your frequency list in four separate partitions of the scan table, one for each island. This will keep your initial search list small, your "round trip" scan time short, and your probability of missing an animal while your receiver is scanning through a largely inactive list as low as possible. You recognize, however, that in order not to bias your experiment, you will need an efficient procedure for finding animals which have "jumped" islands, so you have reserved a partition also for the complete list, one for a combination of the lists from islands 1 and 2 (which are close together), and one for a combination of the lists from islands 3 and 4 (which are closest to the mainland, though distant from each other). This gives a total of 7 tables.

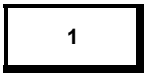
PROCEDURE: SELECT TABLES AND ENTER FREQUENCIES

From the command environment, press

The display will prompt you to make a selection using one of the numbered keys. To select the table you want to be active, press 4. The display will prompt you to make a selection of a table where you wish to store the frequencies, and will make this the active table.

Press the desired number between 00 and 15. After you have entered a two digit number the **F TABLE** menu will once again be displayed.

Press



to "add" frequencies.

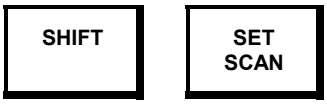
Enter the frequencies you wish as six digit numbers, or five digit numbers if you have a 30 or 50MHz receiver. The decimal point is supplied by the program but nothing bad happens if you enter your own. You may keep entering frequencies one after another; when you have entered all the frequencies you want, press ESC. This takes you back to the **F TABLE** menu. You can now select another table to enter other frequencies, review the frequencies you have just entered (using the delete option), or press

to leave the menu of **F TABLE**. If you run into trouble, press the ESC key repeatedly until you are back to the main menu (frequency and gain display), and then start over.

When you have created your frequency tables you will set the scan (or dwell) time. This is the amount of time the receiver will stay at each frequency in the scan table before proceeding to the next frequency. You can choose this time in a hundredth of a second intervals over a range of 1 second to 10 minutes.

PROCEDURE: SETTING SCAN TIME

From the command environment, press



The screen will prompt you to enter a 5 digit number (minutes:seconds. hundredths); the colon and decimal point are automatically supplied. Normally you will select a scan time that is (at least 100 msec.) longer than the longest pulse interval of your transmitters to ensure that no signals are missed. For example,

- Enter 0:10.50 for 10.5 seconds
- Enter 1:23.00 for 1 minute, 23 seconds, etc.

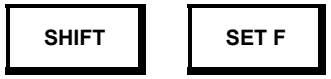
NOTE: All digits must be entered. After the last digit is entered, the receiver will automatically return to the command environment display (frequency and gain) with the addition of scan time in the lower left quadrant. The arrow keys will now adjust the scan time using the time increment selected by the **SET Δ** function.

Since you will be flying, you will be concerned about the levels of noise generated by the aircraft engine and how this will affect your receiver sensitivity. Your first flight is in fact dedicated to setting up your antennas and establishing a "noise floor", using one or more reference transmitters in a known location on the ground. While flying, you will use the **SIGNAL/Interval** routine to assess the level of noise.

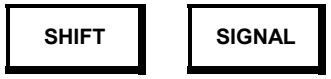
PROCEDURE: NOISE AND SIGNAL MEASUREMENTS

The SIGNAL key controls the Suretrack's pulse interval and signal strength measurement functions. All of these functions except **Power Graph** are also available in the **SCAN** environment. This example illustrates the use of **SIGNAL** functions for a single frequency.

First, from the command environment, set a frequency using



with appropriate five or six digit data entry. Then press



and, at the menu, press 2 to select the **Interval** routine.

If a signal is present, the bottom line of the display will show the pulse interval (repetition period) in milliseconds (in configurations two and three), relative signal strength and two status characters. These are an expanding "strobe" which follows the signal pulses and a letter (**G** or **F**) which gives the status of the arrow keys (control of gain or frequency). You may use the arrow keys to increment/decrement gain or frequency while the **Interval** routine is running.

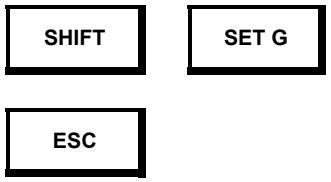
To determine the noise floor for your environment, start with a low gain (try 50) and watch the strobe while slowly increasing the gain using the upward arrow key. For this measurement it is easier if their are no transmitters running, and it is usually advantageous to have your gain increment set to 1. If you haven't done this, observe the following.

PROCEDURE: SETTING THE GAIN INCREMENT

If you are not in the command environment you must first return there. From the **SIGNAL/Interval** routine, for example, press

to leave **Interval** and **SIGNAL** respectively.

If you were adjusting gain in the **SIGNAL** environment you are ready to set the gain increment. If not, you must perform a SET G operation. You may do this without specifying any new value of gain. Press



Arrow keys and SET Δ now control gain. Now press

and enter the two-digit gain increment value (e.g., 01).

Returning to the **SIGNAL/Interval** routine, you continue to increase the gain until you begin to see random triggering of the signal strobe character (lower right display quadrant). For automatic signal recognition by the receiver you should set the gain just below this value. In many applications this will also be the optimum gain for audio tracking as well. For a further discussion of these issues, see the ***Optimization*** section, below.

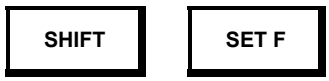
On tracking flights, you will be using the **SCAN** routine to search for animals and record their locations. You want to minimize the probability of missing animals, either because they are not where you expect them to be or because they are in a radio shadow (e.g., in a steep ravine) and their detection window is very short. In the interest of economy you also want to minimize the flight time. As the study evolves, you develop a plan for which tables to check in which locations, and in all cases you use the remove and copy utility to facilitate the aims listed above.

PROCEDURE: USING THE SCAN TABLE

To start the **SCAN** routine, press

The program will begin scanning the current active partition (active table). On entry, the signal measurement strobe will be inactive. To activate it, press

The upper right quadrant of the display will show the lower and upper boundaries of the time interval window and the arrow keys will control the window size. For tracking, you will normally want to have access to gain or frequency control, so you may use

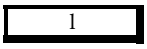


or

to restore arrow key control of gain or frequency respectively, while leaving the signal strobe active.

If you are using a set of isolating headphones, you will be able to hear very weak transmitters before the receiver does (see ***Optimization*** below). You may wish to turn the aircraft in the

direction of the strongest signal to obtain a more accurate position estimate, in which case you can stop the scan by pressing the decimal point key



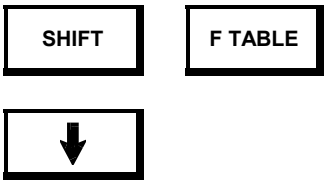
If the program has already scanned to the next frequency before you are able to stop the scan, press

to assign the arrow keys to manual scan functions. Then press

to backup one frequency.

As you get closer to the signal, the receiver will start showing pulse interval (or pulse rate) and relative signal strength on the bottom line of the display. You may use the signal strength indication to guide the airplane, and to provide an indication of the point where you have passed over the animal. When you have fixed the animals location to your satisfaction, note its position.

After locating an animal, you are no longer interested in the transmitter you have identified, and you would rather do without the overhead of continuing to look for it. Press



to remove the frequency from the table. Then use the decimal point key again to restart the scan.

As you successfully locate more and more animals, your scan tables become sparser and your search for the remaining animals intensifies. You may find that using one or two large tables is actually more efficient than having many small ones, especially if your populations turn out to be less isolated than anticipated.

Before starting a flight, you will normally want to restore the frequency tables to their original condition. You may do this easily using the **FTABLE/Copy** utility.

PROCEDURE: RESTORING THE FREQUENCY TABLE

To restore a table to its "original" condition after removing frequencies during a **SCAN** session, from the command environment press

and then

for **Copy**

All frequencies which have been removed during SCAN will be restored, and the program will report the number of frequencies copied. If you are using more than one partition (table) you will have to repeat this operation for each one individually. To change the partition (from the **F TABLE** menu) select item 4 (**Partition**) and enter a two digit number.

Optimization

Achieving optimum performance from a radio data acquisition system entails individual consideration of all system components and links. If you are not using Lotek transmitters, it will be necessary to verify the optimum reception frequency of each transmitter by running the **Power Graph** or **Interval** routines (in **SIGNAL**) and varying the receiver frequency in 1 KHz steps around the nominal value (the one supplied by the manufacturer or previously established using another receiver). Keep transmitters and receiver reasonably well separated (at least 10 meters) and keep the gain down to avoid saturation.

The receiving antenna is a critical system element. For maximum range and signal/noise ratio your antenna should be tuned to your reception band, should be matched to 50 ohms (low VSWR) and provide as much gain as possible consistent with physical size constraints. The antenna should be mounted as high off the ground (water surface) as possible, and should be polarized to give maximum reception for the transmitters you are using, under the actual conditions in which you are using them (e.g., in water).

Whether you are trying to locate or analyze signals, your greatest single source of problems is likely to be noise, or more properly, the ratio of signal power to noise power in your particular environment. Under ideal conditions (on the tundra perhaps, or inside a shielded chamber) you will be able to detect, by ear, pulsed signals whose received power is less than -145dBm, and the receiver will be able to acquire and measure signals on the order of -135dBm. As a general principle, you can hear a signal that is 12dB below the local noise floor but the same signal must be 6dB above the noise for reliable electronic recognition. This is the same for all receivers and as a consequence, in non-ideal environments, minimum discernible signal levels will rise with the noise floor.

Even if the signal to noise ratio (SNR) is adequate, noise effects may still need to be compensated. High absolute levels of noise can saturate the receiver, reducing the effective SNR, and can prevent signal acquisition by overburdening the processor. Interestingly, the ear is subject to similar constraints! Thus the first line of defense against noise is to reduce the receiver gain.

Some forms of noise are naturally "bursty", like mobile voiceband messages or satellite transmissions. Here the best remedy is for the receiver to attempt to reject signals with inappropriate time "signatures". This is the function of the pulse interval window. Setting the

window boundaries tightly around the expected pulse interval of the transmitter will help prevent bursts of noise from being reported as signals. It will also help relieve congestion in the processor, since invalid events take less time to process than legitimate ones.

Both gain reduction and time interval filtering have limited usefulness if the dominant noise source is "impulsive". Engine noise of all kinds falls into this category. Impulsive noise is characterized by repetitive, but typically very narrow pulses, each with sufficient peak power to be recognized by the receiver even though the average noise power may be well below the level of the desired signal. In such cases the time interval window must be opened (to include intervals on the order of the noise period) and signals and noise distinguished on the basis of pulse duration. In the Suretrack receiver this is accomplished by delaying the measurement of signal strength long enough for a typical impulse to have decayed completely before the measurement occurs.

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 determined 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 Engineering could void the user's authority to operate the equipment.