SRX_400 TELEMETRY RECEIVER USER'S MANUAL Version 4.xx

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TABLE OF CONTENTS

INTRODUCTION

The SRX_400 is a data logging, tracking and telecommunicating receiver designed for a wide range of applications. All of its internal functions are controlled by a dedicated microcomputer with 64k bytes of program memory (EPROM) and 64K bytes of data memory (non-volatile static RAM). Besides its regular housekeeping duties, which are automatic and invisible, the microcomputer provides a number of basic and advanced operations which are accessed through function keys and menus. Specifically, you may:

Control the receiver sensitivity (gain)
Set the operating frequency
Scan through one or more tables of frequencies
Search for signals in designated frequency bands
Obtain graphic and/or numeric signal strength measurements
Measure and display pulse intervals (rates)
Access the real time clock
Apply audio noise blanking (post-1994 models)

Software modules may be selected from a growing applications library to provide special services like pulse width measurements, RS232 serial communications, autodial modem control, temperature monitoring, pulse code discrimination, automatic data logging, etc.. Combined hardware/software options offer selective switching of up to 8 antennas and provide up to 1Mbyte of additional memory for data storage.

This manual describes the basic operating functions of the SRX_400 common to all software versions, as well as a number of "support services" available as options. Some of these services (like serial communications support) cooperate with, or are required by, any of several high level application programs, details of which will normally be supplementary to this manual. For information on which options your version does or does not have, refer to the SRX_400 configuration sheet P/N 577, check the appendices, or try the keys.

The manual is organized in two main sections. The first section describes the receiver hardware and basic key functions. The style is more or less that of a "formal definition"; the information is complete, with little redundancy. In the second section the approach is more tutorial, with numerous practical examples. For self-instruction, various paths are possible; for reference, section 1 is the most concise.

We observe the following typographic conventions:

Example	Type of object	Typestyle
SCAN	Key	SMALL CAPS
SHIFT + SIGNAL	Keystroke sequence	SMALL CAPS
SCAN	Function or environment named by key	**BOLD SMALL CAPS**
Interval	Function (selected from menu)	**Bold**
Interval	Heading of section defining menu item	**Sans-serif Bold**

SRX_400 FUNCTION GUIDE

Power Supply and Accessories

ANT - RF jack for antenna connection (whip antenna, ASP_8 connection)
CHG - Battery charger connection
EAR - Headphones connection
OFF/VOL - On/Off switch, volume control knob

POWER - External DC power cable connection
ASP_8 - ASP_8 antenna switching unit connection - 15 pin
SERIAL I - serial port used for RS232 communications (dumps, terminal control, DSP) - 9 pin
SERIAL II- serial port used for DSP_500 interface in versions supporting both DSP and terminal communications - 9 pin

The SRX_400 receiver will operate continuously for about 12 hours (panel light on) or 16 hours (light off) on a fully charged "C" battery pack. The receiver operates on "C" or "D" type rechargeable nickel cadmium (NiCad) batteries (Panasonic P-240C, Sanyo KR2800CE, or Panasonic P-400D, or equivalent). When the batteries need recharging the shift key ^ character is replaced by a symbol.

SRX_400 receivers produced after April 1994 (look for an "A" in the serial number) are equipped with a new power management system which provides true "fast-charging" of batteries, independence of charge and external power functions and a bicolor charge status indicator. The new supply is designed to charge the receiver's battery at or near the manufacturer's recommended maximum rate until full charge is achieved or until a preset timeout expires, at which time the charge current is reduced to 1/8 of the fast charge rate ("trickle" charge). For a C pack, a charge current of 500mA will provide a full charge in about 4 hours. In cold weather it is also important to **allow the receiver to warm up to at least 10°C before fast charging**. Fast charging will be suppressed if the internal battery voltage falls below 4 volts, so allowing very deep discharge (e.g., leaving the receiver running unattended for long periods) is not recommended. If this condition does occur, the charge controller will switch to trickle charge mode (green light goes on) immediately on connecting the charger. When the battery voltage rises to a safe level, fast charging will commence automatically.

If a charger of lower capacity is used, the fast charge controller will supply current at the charger's maximum rate for 4.5 hours (preset timeout) but will then either have to be manually reset for additional charge cycles, or be allowed to trickle charge up to the rest of the battery capacity. Note also that the chargers supplied with the SRX_400 'A' models will charge older receivers very efficiently (6 hours for a fully discharged "D" pack), but must be manually disconnected to avoid overcharging (overheating) when the cells are full. For safety reasons, therefore, Lotek does not recommend the use of new chargers with older receivers.

Battery service life is specified by the manufacturer to be more than 500 charge-discharge cycles. NiCad batteries will lose their charge over time even if they are not used, and they typically exhibit some form of "memory" effect if operated under repeated partial charge or discharge conditions. If you are going to store the receiver for extended periods (e.g., over winter) it is recommended that you charge the battery once a month to conserve memory backup power (see below) and to avoid possible impairment of the battery's energy capacity and overall life. To minimize memory effects, the best procedure is to run the receiver until the low battery symbol appears (when the SHIFT key is pressed), and then charge until the trickle mode engages (LED switches from red to green). If the receiver is inadvertently stored for an extended period of time without charging, performing a few (1-3) charge-discharge cycles will often restore the main battery to a usable condition, but will not recharge the memory backup battery. All batteries are protected by a resettable fuse. Batteries are replaceable by Lotek Engineering.

The SRX_400 can also operate from an external 11-16V DC power source via a rear panel jack. An external power cable is supplied. In SRX_400 'A' models, application of external power will disable the internal battery as long as the external voltage is above ~10 volts. Internal batteries cannot be charged from the rear panel power jack. **If the SRX is powered via the rear panel jack the applied voltage should not exceed 16V DC.**

In order to satisfy electromagnetic compatibility (EMC) and electromagnetic immunity (EMI) of SRX systems, the wall charger used with the system must comply with corresponding national regulations. Every wall charger supplied by Lotek Engineering Inc. complies with national standards of the country of final destination.

The RF signal input jack labeled 'ANT' on the front panel is a standard BNC type which will accept any appropriate (50 ohm) antenna or mating cable. When using a signal generator be careful that the signal power does not exceed 0dBm. Other front panel connectors include the battery charger jack labeled 'CHG' (see above for charger description) and the headphone jack labeled 'EAR'. Lotek recommends the use of isolating headphones model H10-00 manufactured by David Clark. The knob labeled 'OFF/VOL' is used to turn the receiver on and off as well as for volume control. The front panel speaker is a Projects Unlimited AT-38008M.

A 9-pin (DE-9P) connector on the rear panel is used for RS232 serial communications. The pinout for this connector is given in Appendix A. SRX_400 'A' receivers have a second serial port (PORT 2), to accommodate special applications (e.g., GPS or DSP_500 interfaces). A 15-pin (DE-15P) connector is also provided for antenna switching using Lotek's ASP_8 controller.

See the figures above for locations of front and rear panel connectors.

Maintenance and storage

The SRX_400 should be protected from dust and moisture. If cleaning is required, the housing and front panel can be cleaned using a soft cloth. You may need to use cleaning solution. If so, wipe the housing with a soft, damp cloth using a mild solution of soap and water. Do not allow any liquid inside the housing. When not in use, the unit should be stored in a dry place.

Lightning protection

Any system with SRX_400 and aerial antennas should be protected from a direct lightning strike, as well as from voltage induced in antenna cables due to drainage of a surge to ground. The latter can be achieved through the use of lightning arresters in the antenna lines right at the SRX antenna input. Working frequency is one of the factors to consider when selecting lightning arresters. For protection from a direct lightning strike it is recommended to erect a mast with a lightning rod connected to a grounding pin with a flexible copper cable. The structure will provide a 'protective cone shade' for the antenna. The antenna itself should be connected to the grounding system.

Memory

Operating firmware is contained in permanent read only memory and cannot be overwritten or erased. Variables used by the operating system are likewise indestructible, since they are reinitialized on startup. All other memory, including user-specified parameters like frequency tables and gain settings, and also the time and date, are saved in battery backed-up RAM. Back-up power is supplied by the main batteries, as long as they have sufficient charge, and by an on board lithium battery which will provide memory protection for approximately 6 months if the main batteries are discharged or removed.

The basic SRX_400 receiver provides 64K bytes of data memory, of which roughly half is used by the operating system. In models equipped with the ASP-8-512 memory expansion option, 512K bytes of additional (bank switched) memory are supplied for user application data. SRX_400 'A' models can accommodate 1M byte of extended memory (ASM_8_1M).

Start-up and the Command Environment

The SRX_400 is shipped with the batteries charged and time and date set. 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 audio 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.

PROM initialization

Operating system software is contained in one (SRX_400 'A' models) or two (earlier models) programmable read only memories (PROMs). The SRX_400 can run a variety of different software versions which are specialized for particular applications. Although some options must be factory installed (for extended memory, etc.), some version changes and most regular upgrades may be made in the field. The general procedure for installing and initializing PROMs, using the **New_Prom** routine, is given in Appendix C.

Although it should normally not be required, the **New_Prom** routine can be used as a general low-level software reset in the event of catastrophic misbehaviour. Note that, unlike the hardware reset (pressing SHIFT and ESC keys together), **New_Prom** will typically reset system status variables (like communication port settings) and purge frequency tables and other data. If you do need to use it, please report the circumstances to Lotek's customer support department.

Warning: Changes or modifications not expressly approved by ***Lotek Engineering*** could void the user's authority to operate the equipment.

The Keys and their Functions

All keys except SHIFT have dual markings. The upper markings (above the line) represent SHIFTed functions or commands. The lower markings include some commands but mostly they are reserved for the numeric digits 0 to 9 and the decimal point (**.**). Any key can therefore be referred to by two names, depending on which key function is being selected. This convention is used in the discussion below.

Numeric values are normally entered as a specific number of digits, including leading zeros as necessary.

SHIFT

The SHIFT key selects the functions indicated 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 some routines (**SEARCH** mode and RS232 configuration in **COMM**) and to return from **HELP**.

SET G
↓

The DOWNARROW key is used to decrement the value of a selected variable (normally frequency, gain or scan time) by a selected amount. 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 function. In the **SCAN** mode (see below), the arrow keys may also be used for manual scanning, frequency table editing and control of signal window size. The DOWNARROW also provides a line editing function (backspace) for real number entry (e.g., to calibration tables).

The SET G key activates the set_gain function, which first issues a prompt

```
ENTER GAIN (00-99)
>
```

or, in versions supporting individual antenna or channel gains,

```
MASTER GAIN (XX)
>
```

(where XX is the current value) and then 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 (escape) key causes the function to abort without updating. On exit, the command display (frequency and gain) is restored.

SET F ↑

The UPARROW key is used to increment the value of a selected variable (normally frequency, gain or scan time) by a selected amount. The variable is selected by whichever of the SET G, SET F, or SET SCAN keys were most recently activated. The increment amount is the last value entered using the SET Δ function. The UPARROW is also used to confirm real number entries (e.g., sensor calibration values). See also the discussion of the arrow keys in the **SCAN** mode.

The SET F key activates a function which permits programming 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 (5 digits in 30 - 70 MHz versions) representing the receive frequency in MHz (megahertz). It then sets the receive frequency by programming the frequency synthesizer. If the requested frequency is out of range of the hardware it may, depending on the receiver configuration, be automatically limited to a minimum or maximum value. Pressing the ESC (escape) key causes the function to abort without updating. On exit, the command display (frequency and gain) is restored.

SET SCAN 9

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

```
ENTER SCAN TIME
>
```

and then waits until it receives five numeric inputs (0 to 9) which it automatically formats as X:XX.XX (minutes:seconds.hundredths). 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 (escape) key causes the function to abort without updating. On exit, the command display (frequency and gain) is restored, with the scan time now appearing in the lower left quadrant.

SET Δ
ESC

The ESC key is the general "return" operator. Most commonly it returns you to the main program, restoring the command display on line one. Sometimes it provides a return from a subprogram to the menu from which it was called. Sometimes it is used to terminate data entry (of lists or table values) from the keyboard.

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:

```
ENTER -> GAIN (01-99)
 >
```

```
ENTER -> FREQUENCY
(001-999kHz) >
```

```
ENTER - >TIME (01-99 SEC)
>
```

SEARCH
HELP

The HELP key puts the receiver into its help mode. Once **HELP** has been activated you may then press any key to get information about its function or about appropriate entry formats for data. Note that **HELP** automatically performs a shift operation (help data is naturally provided only for functions). Since help is provided for the SET Δ function (shifted ESC), the SHIFT key, rather than ESC, is used to exit the help mode.

Note that **HELP** services are limited to basic information about key functions only and is not a substitute for the operating manual. In order to conserve program memory, **HELP** is not provided in advanced software versions.

The SEARCH key provides access to several functions. Its menu is:

```
SEARCH: 1)RANGE 2)CONT
3)NEIGHBOURHOOD 4)EXIT
```

The search functions scan through a range of frequencies looking for a signal, using the frequency increment set by the SET Δ operation. If an active signal is found at any frequency the routine continues scanning until it finds a local maximum, at which point it stops and displays the maximum signal intensity and the frequency at which it was found. Pressing the SHIFT key will continue 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. Search functions cycle through their ranges repeatedly until terminated by ESC.

The **Range** function requests a beginning and ending frequency for the search and then scans this range. This function may be used to find the frequency of an unknown transmitter or to check for the presence of any of a known group of signals.

The **Neighbourhood** function searches a range of frequencies from 8KHz below to 8KHz above the current selected frequency. This function may be used, with the frequency increment (ΔF) set to 1 kHz, to find the frequency of best reception for signal data (though not necessarily the best audio response).

The **Cont**inue function continues a search which has been stopped by ESC.

SEARCH is provided in SRX_400 tracking configurations but may be absent from (or have a different function in) some advanced data collection versions.

SIGNAL
7

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

```
1)POWER GRAPH  2)INTERVAL
3)BOUNDARIES   4)CALIBRATE
```

Power Graph uses the bottom line of the LCD display to provide a graphical display of signal strength, with the top line showing the selected frequency and numerical signal strength value between 0 and 255.

```
149.450MHz  +102
min
```

While in this mode, the arrow keys can be used to increment and decrement gain and frequency.

Deleted: , and also to enable/disable audio noise blanking, as discussed below under **Interval** and **Scan** functions.

Interval displays pulse intervals in milliseconds or pulse rate in beats per minute and relative signal strength. In most software versions, received pulses are filtered using a pulse interval window (see **Boundaries**, below). A pulse is considered valid if the time elapsed since the last received pulse is within the window. Valid pulses will trigger a dynamic "strobe" character in the lower right quadrant of the display.

Note that **Interval** 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 the *Optimization* example in section II of this manual).

Interval and **Power Graph** routines pass control to a new environment, in which the following limited set of key functions is available.

SHIFT + SIGNAL assigns the arrow keys to open and close the pulse interval window (**Interval** only). This assignment is indicated by a "**W**" in the delta status position (see Figure 1, below) in the lower right quadrant of the display, and changes in window size are indicated in the upper right display quadrant. Note that if the pulse rate display format has been selected (see below) the window boundaries will be displayed in beats per minute, rather than milliseconds.

SHIFT + TIME toggles the interval display format between time in milliseconds and rate in beats per minute (**Interval** routine only). Both pulse measurements and displayed window values are affected.

SHIFT + CODE selects digital code discrimination in software versions which support coded transmitters (see the Code_Log user's manual that accompanies W17 firmware). When this function is selected a **#** symbol appears in the signal status position of the display. When a transmitted code burst is recognized the code, channel number (user assigned index into the frequency table) and signal strength are displayed.

SHIFT + SET F, SHIFT + SET G assigns the arrow keys to increment/decrement frequency and gain. The delta status position (see Figure 1) shows an "F" or a "G".

F0 (without SHIFT) toggles **audio noise blanking** (a new function available in SRX_400 'A' receivers) which uses the automatic signal detection features of the SRX_400 to enhance audio performance, especially in aircraft or other high-noise environments. The audio noise blanker suppresses the receiver's audio response except when a signal is passed by the internal phase locked loop detector's noise blanking mechanism, which rejects pulses that are too short to be valid signals. (This mechanism is described in more detail in *Example 2* of the **Operations and Exercises** section of this manual).

In a typical tracking application, very weak signals (detected with the noise blanker off to take advantage of the powerful frequency-domain processor in the human auditory cortex) will quickly pass the automatic detection threshold as the aircraft (or other vehicle) is turned to approach the target. Switching the noise blanker on at this point will make further bearing determinations easier (using the numeric or graphic display) and will also greatly reduce auditory saturation and fatigue.

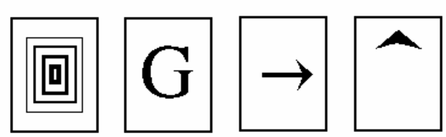
UPARROW/DOWNARROW increments/decrements frequency or gain and opens/closes the pulse interval window in 5 millisecond increments.

ESC exits.

Boundaries allows you to specify a time window in milliseconds for valid pulses. Enter boundary values as 5-digit numbers, including leading zeros, if necessary. If you don't want any time interval filtering, open the window 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 remembered by the receiver until you change them. Note that window values are always entered in milliseconds, even though they may be displayed (using the SHIFT + TIME key sequence in **Interval**) in beats per minute. To specify a window value in beats per minute use the conversion: interval(msec) = 60,000 / rate(bpm).

Calibrate refers to a specialized software feature which is not supported in any current versions. Selecting this option should have no effect.

Figure 1: Display Status Characters (lower right display quadrant, positions 45-48)



SCAN .

The SCAN key calls a function which scans through the frequencies entered in the current active **FTABLE** partition, stops at each frequency for the time set by SET SCAN and cycles continuously through the table. **SCAN** also maintains its own environment, which provides a number of options and control features described below:

Pulse interval and signal strength information may be displayed for any signals detected. This feature may be toggled on and off using the SHIFT + SIGNAL key sequence. Interval measurements, window operations and the dynamic strobe character function exactly as in the

SIGNAL/Interval routine (see above). When the signal measurement option is turned off, the signal strobe character (signal status position) is replaced by a small square. The SHIFT + SIGNAL key sequence also assigns the arrow keys to the job of closing (DOWNARROW) and opening (UPARROW) the pulse interval window, and SHIFT + TIME switches back and forth between pulse interval (in milliseconds) and pulse rate (in beats per minute) display formats.

UPARROW and DOWNARROW keys may also be assigned to their usual (command environment) increment and decrement functions while scanning, using the key sequences SHIFT + SET F, SHIFT + SET G and SHIFT + SET SCAN.

The decimal point (**.**) key stops (or starts) the scan at the current frequency and writes a colon ("**:**") or a direction arrow symbol in the scan status position in the lower right display quadrant.

The SHIFT + SCAN key sequence assigns the arrow keys to control of scan direction (UPARROW = forward, DOWNARROW = backward) and manual scanning. 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 **<=>** symbol or a direction arrow in the delta status position.

Frequencies may be removed from and restored to the active partition while scanning is in progress using the SHIFT + F TABLE key sequence to assign the arrow keys to delete (DOWNARROW) and restore (UPARROW) 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 out first in" basis only to frequencies which have been previously deleted. Frequencies which have been deleted but not restored at the end of a scanning session may be restored *en masse* using the **FTABLE/Copy** function (see below).

The SHIFT + F2 key sequence calls a "scratch pad" routine for manual entry of mercator coordinates, environmental measurements, or any other numeric data. The routine expects two numbers, each up to 9 digits long, with each entry terminated using the UPARROW key and/or edited using the DOWNARROW (= backspace) key. The two numbers are recorded, along with the time and date and the frequency of the transmitter currently being scanned. In version W16, the applications library program **Code_Log** uses the scratch pad memory area for "active code" tables, which are allocated and de-allocated dynamically as the program runs. Memory is shared rather freely, but **Code_Log** has priority in the sense that its initialization sequence also initializes the scratch pad (destroys all scratch pad data) while memory initialization in **SCAN** does not affect the status of **Code_Log**'s tables. For instructions on retrieval of scratchpad data, refer to the *Operations and Exercises* section, or to the documentation supporting **Event_Log** or **Code_Log**, where applicable.

SCAN key functions are summarized in the table below:

Key Sequence	Direct Effect	Arrow Keys	Delta Status	Scan Status
.	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			

SHIFT + CODE	Digital code recognition			
F0	Toggle audio noise blanking			
SHIFT + F2	Scratchpad			

FTABLE 8

The FTABLE key accesses five functions. The menu is:

```
1)ADD  2)DELETE  3)COPY
4)PARTITION  5)SIZE
```

Partition allows you to select one of sixteen separate tables (numbered 00 to 15) as the "active partition".

Size displays a count of all frequencies currently in memory in all tables, including those which have been deleted but not restored during **SCAN**. ESC exits, or, by entering a new value (a positive number or 0) you can remove (and restore) blocks of frequencies on a last in first out basis, or purge all tables at once. In some software versions this "coarse" control is not provided, but the size of the current active partition, as well as the master table, is reported.

Add accepts frequencies (in MHz) from the keyboard and adds them to the "top" of the active partition. Note that some application programs, which assign "channel" numbers to frequencies in the active partition, number the frequencies sequentially, in the order in which they are entered, while others (e.g., W16) request a unique channel number for each frequency entered.

Delete steps through the active partition one frequency at a time and offers the option to delete or continue. In some software versions this item is called **Del/View** and allows scrolling through the frequency table using the arrow keys.

Copy causes all frequencies which have been deleted, but not restored, while scanning to be written back into the active partition. Frequencies deleted by the **FTABLE/Delete** command cannot be recalled in this way, but must be re-entered using **Add**.

Some SRX_400 software versions provide a facility for uploading frequency tables from disk files via the serial port. If your software supports this feature a continuation arrow ("->") will appear on the lower right in the **FTABLE** menu, and the selection **Upload table from Host** will be presented on a second menu page.

In order to use this facility you must first create a text file (ASCII format), containing a list of frequencies and corresponding partitions, using any ASCII editor. Most word processors, and many database and spreadsheet programs, provide ASCII text files as an output option. Program editors, and simple editors like Windows *Notepad* or DOS *Edit*, will produce ASCII files by default. The file should have the attribute **.TXT** with the data arranged in lines, as shown below (comments in italics are not part of the file):

148070	(*Frequency 148.070 MHz; partition defaults to 0.)*
148090 0, 1, 2, 3	(*Frequency 148.090 Mhz in partitions 0,1,2,3.)*
148110 1	(*Frequency 148.110 Mhz in partition 1 only)*

Note that both the space character and the comma are valid separators (as is the TAB).

Because one or more partitions are specified for each frequency, the file is essentially a master list (all frequencies, all partitions). Once it has been sent to the receiver it may be modified by adding or deleting frequencies as described above, but **when a new table is uploaded it will completely replace the existing one**. If a partition is not specified for a particular frequency, partition 0 will be assigned by default.

The complete procedure is summarized in the following table:

SRX or HOST	Action
Host-SRX	Establish/check serial connection between SRX_400 and Host computer.
Text editor	Create a file with frequencies and corresponding partitions.
Text editor	Save it as a text (ASCII) file (extension .TXT) in your **Host** data directory.
SRX	Start SRX_400.
Host	Start Host software.
Host	Use Host software's **Display file** command to view the text file, if desired.
Host	Press **7** for the utility **Upload F Table to SRX**; you will see a list of files in the data directory.
Host	Highlight your file and press <ENTER>.
SRX	Select **Upload table from Host** routine (**SHIFT**, **FTABLE**, **->**).
SRX	Press **1**

On completion of the upload operation, the SRX_400 will notify you by displaying the number of frequencies loaded and/or a diagnostic message.

TIME
6

The TIME key gives a display of date and time and allows you to make changes. The time on the display is actively updated approximately once per second. In the **SCAN** and **SIGNAL** environments the TIME key is used to select pulse interval or pulse rate display formats.

COMM
5

The COMM key accesses various RS232 communications options. The main menu is:

```
1)CONFIGURE   2)DEFAULT
3)TERMINAL 4)AUTO-ANSWER
```

Configure calls the configuration submenu:

```
1)BAUD  2)PARITY/FORMAT
3)FLOW  4)INTERCHAR
```

or, in some firmware versions,

```
1)BAUD  2)PARITY/FORMAT
3)FLOW  4)DELAY  5)MODEM
```

Deleted: ¶

Each of these functions allows you to select values for the named serial communications parameters. These are:

Baud = baud rate from 110 to 19,200
Parity = odd, even, or no parity
Format = number of data bits (7 or 8) and stop bits (1 or 2)
Flow = XON/XOFF or other flow control protocol (version dependent)
Interchar (Delay) = intercharacter delay, to allow interfacing with slow peripheral devices.
Modem = provides some special modem options for cellular telephone links (version specific).

The **Default** selection sets the default values of the configuration parameters. These are:

Baud = 4800
Parity = none
Data bits = 8
Stop bits = 1
Xon/Xoff = enabled
Intercharacter delay = 0

In versions which support remote control of the receiver by a host computer, **Terminal** puts the receiver in its remote mode. Once terminal mode is activated the receiver keypad is locked out; commands will be accepted from the serial port only. Local control can be restored from the host or by a "hard" reset (simultaneous activation of SHIFT and ESC). See the **WILDLIFE HOST User's Manual** that accompanies HOST software for further information on terminal control.

Auto-answer is a modem control function which allows a remote host to establish terminal control by telephone. This feature is available for system service from Lotek, as well as for user applications involving telephone, local radio or satellite links between the receiver and a central processing station.

Deleted: point-to-point

If the receiver is connected to a "Hayes compatible" modem (that is, a modem which supports the basic "AT" command set), selecting auto-answer mode initializes the modem to its power-up defaults and sends the current SRX_400 communication settings. The modem will enable its auto-answer feature (on some modems an LED "AA" indicator will light up) which means it will answer all incoming calls and negotiate a data link with the calling modem. The SRX_400 also asserts its own auto-answer state, which will cause it to enter terminal mode when a call is received, echoing all display information to the serial port and responding to commands from a remote terminal. Auto-answer defaults to OFF on power up, so if the receiver is turned off between sessions auto-answer must be invoked again, even if the modem's auto-answer feature is still enabled. Also, because the auto-answer command sends SRX_400 communication settings to the modem, it must be re-enabled if these settings are changed.

Use of the Auto-answer feature in remote terminal communications is further described in the **WILDLIFE HOST User's Manual** for Lotek's HOST software, and in **Example 3**, at the end of this document.

CODE 4

The CODE key is used in some software versions to enter a five-digit "pass code" which authorizes access to functions which can reformat, reallocate or overwrite memory. There are currently three such functions: **New Prom** initialization (SHIFT + F1), **Memory Test** in the **Event_Log** or **Code_Log** menu, and the memory initialization sequence provided on entry to a number of data logging programs. Once it is entered, a new pass code may be "locked", which means that it will also be required to authorize further changes. Use this feature with caution! In software versions which support coded transmitters, the CODE key also allows code set selection from the command environment and controls the code discrimination option in **SCAN** and **SIGNAL** routines.

Finally, the CODE key is used to set I.D. codes for identification of records from individual receivers in automatic data logging situations

F0-F3
0-3

The top row of keys is reserved for application software and user-specified macros. The F3 key is currently reserved (in all versions) for turning the display luminescence on or off (see below).

The F2 key is used in several versions to set the active antenna outside of the **Event_Log** or **Code_Log** program. This feature requires hardware option ASM_8_512 (antenna switch controller) which provides drive signals for the ASP_8 antenna switch peripheral or, optionally, logic level (5 Volt) outputs for other user equipment. One of eight antennas may be selected, as well as (in W16) a combination of antennas 1-3 (select antenna "0"). Note that in software version W16 the ASP_8 peripheral, antenna 0 will correspond to antenna 8 in the software. F2 is also used for scratchpad data entry in the **SCAN** routine.

The F1 key accesses the system initialization functions. These include the **New Prom** routine, which resets the value of all system variables to their factory default values and, optionally, purges scan tables and data storage. Access to this routine is restricted by the pass code.

The F0 key calls **Event_Log**, **Code_Log, Temp_Monitor** or other application programs, described in the supplementary user's manual that accompanies each program.

F0-F3, like all other “upper” key functions, are normally prefaced by a SHIFT operation. However, since the unshifted keys are used for numeric input only in certain specific situations, the F0-F3 keys, without SHIFT, can also be used for access to “single-keystroke” services. Currently the F0 key (without SHIFT) is used in all environments to toggle the audio noise blanking feature (see the discussion of key functions in the SIGNAL routine, above).

Panel Light Switch

SHIFT + F3 toggles the display luminescent panel on and off. Turning the panel off will conserve battery power and extend the operating life on a charge by about 30%.

Hardware Reset

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 will cause a hardware reset.

SRX_400 OPERATIONS AND EXERCISES

Preface to the Examples

The following exercises are designed to enhance familiarity with SRX_400 functions and operating modes . They are modeled as faithfully as possible on real applications and include a basic radio tracking session, an optimization procedure and an automatic monitoring system installation.

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Example 1: 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

SHIFT FTABLE

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. Note: 2 digits must be entered. After you have entered a two digit number the **FTABLE** menu will once again be displayed.

Press 1 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 **FTABLE** menu. You can now select another table to enter other frequencies, review the frequencies you have just entered (using the delete option), or press

ESC

to leave the menu of **FTABLE**. 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 hundredth of a second intervals over a range of 1 second to 10 minutes.

PROCEDURE: SETTING SCAN TIME

From the command environment, press

SHIFT SET SCAN

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 SRX_400'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 the SHIFT + SET F key sequence, with appropriate five or six digit data entry. Then press

SHIFT SIGNAL

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, 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 UPARROW 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

ESC ESC

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

SHIFT SET G ESC

Arrow keys and SET Δ now control gain. Now press

SHIFT SET Δ

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

SHIFT SCAN

You will see a prompt:

```
AVAILABLE MEMORY 49746
1)INITIALIZE  2)CONTINUE
```

The available memory belongs to the scratchpad, and the reported size will vary depending on the software version and on the current status of memory use by other programs. Initializing the scratchpad will erase current scratchpad data only. If you choose to continue, new scratchpad data will be appended to the existing record.

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

SHIFT SIGNAL

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

SHIFT SET G or SHIFT SET F

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 *Example 2: 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

SHIFT SCAN

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

DOWNARROW

to backup one frequency.

As you get closer to the signal, the receiver will start showing pulse interval 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 animal's location to your satisfaction you may record its position in the scratchpad. Press

SHIFT F2

You will see a prompt:

```
ENTER FIELD COORDINATES
>
```

then enter two numbers, up to nine digits each, terminating each one with the UPARROW key. If you make an error, you can use the DOWNARROW key to delete it.

After entering latitude/longitude values in the scratchpad, 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

SHIFT F TABLE and then DOWNARROW

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

SHIFT F TABLE and then **3)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.

You may store the results of your work by dumping the contents of the scratchpad to a personal computer via the serial communications port. It is good practice to do this regularly, to provide disk file and/or hard copy backup of important data. If this is not practical, data may be held in the scratchpad indefinitely (up to a maximum of about 48K bytes; use the "**Continue**" option on entry to **SCAN**, and keep your batteries charged!).

PROCEDURE: DATA RETRIEVAL USING LOTEK'S HOST SOFTWARE

Lotek's **HOST** Support Software (for MSDOS computers) may be run from the distribution diskette or from your hard disk. The **HOST** Support manual contains details on installation and setup. Connect the SRX_400 to your computer's serial port using a null_modem cable, and make sure that **HOST** knows which port you are using (COM 1 or COM 2). Start the **HOST** program by typing

[Optional pathname] HOST <ENTER>

from your computer keyboard. **HOST** wakes up ready to receive data.
Now from the SRX_400 command environment press

SHIFT F0

Depending on the particular software version you are using you will either see the **Dump** menu immediately or you will be given the option of selecting it. From the **Dump** menu, select the **Pad** option. The scratchpad data will appear in **HOST**'s dump window on your computer screen. When all the data has been transferred, **HOST** will ask you for a file name. Enter a name (up to eight characters plus an optional extension, e.g., DATA_1.DMP).

Example 2: 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).

If the SRX_400 is to be operated on line to a computer or modem it is recommended that you use a filtered RS232 cable. Special cables and connectors are available for this purpose, or a standard cable may be coiled around a ferrite core. Contact Lotek for more information.

Finally, it is a good idea to perform some initial experiments to determine the noise floors and, if possible, the dominant noise types in your study area(s). Although data acquisition programs like **Event_Log** and **Code_Log** are highly adaptive in the presence of noise, some preliminary analysis of real conditions will help you to optimize the gain reduction and noise blanking strategies, and will provide a basis for fault diagnosis, should this ever be required. As a guide, we have included in section II the record of an interactive session (using **Event_Log** version W6) in which **Event_log**'s noise performance was optimized for a particular set of experimental conditions, and an experimental illustration of the function of adaptive gain control in **Event_Log** and **Code_Log**.

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 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 -133dBm. As a general principle, you can hear a signal that is 12dB below the local noise floor but the same signal must be 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 (see below). 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 SRX_400 this is accomplished by delaying the measurement of signal strength long enough for a typical impulse to have decayed completely before the measurement occurs.

Different software (and hardware) versions use different strategies, but all SRX_400 data collection programs employ automatic gain reduction, noise blanking (or delayed power measurements) and time window discrimination in one form or another. In the examples below, we use two versions of the data acquisition program **Event_Log**, which is designed to recognize transmitters coded by pulse rate and by pulse repetition.

The following record illustrates the behaviour of the adaptive gain control (AGC) mechanism currently available in Event_Log version W21 and, with slightly different convergence properties, in Code_Log (W16).

ADAPTIVE GAIN CONTROL
(A Real Example)

This experiment looked at two frequencies, each of which exhibited a different kind of noise problem.

Frequencies	*Signal/Noise Environment*
149.660 MHz	Strong transmitter + computer noise + strong intermittent interference from a voice communication channel.
149.600 MHz	A weak transmitter at or below the level of several coded transmitters (seen as burst noise by Event_Log) + computer noise .

Two groups of switched antennas were used, as follows:

Antenna Groups	*Auxiliaries in Group*	*Programmed Gains*
M0 (=A3)	A1, A2	M=50, A1=50, A2=30
M1 (=A6)	A4, A5	M=30, A4=50, A5=30

With adaptive gain control enabled, a test sequence was run as illustrated in the following table. Each row of the table represents one complete scan cycle (2 frequencies and 2 antenna groups, each with two auxiliary antennas. Table entries represent the values of the receiver gain set by the AGC algorithm, and reported on the display. Event_Log, running in frequency priority mode, only scans the auxiliary antennas when a valid signal is detected on the associated master, so the presence or absence of entries for A1, A2, A4 and A5 signify the success or failure of the program to acquire signals on M0 and M1.

The test sequence consisted of 12 scan cycles with antennas attached followed by 13 cycles (shaded rows) with the antennas disconnected.

149.660 MHz						**149.600 MHz**					
M0	***A1***	***A2***	***M1***	***A4***	***A5***	***M0***	***A1***	***A2***	***M1***	***A4***	***A5***
50	50	30	30	50	30	50			30	50	30
31	32	22	22	31	21	35	50	30	24	35	24
23	37	25	25	37	24	25	35	24	21		
18	36	27	18	36	25	22			19	24	19
15	24	28	21	35	27	15			17	18	14
14	28	29	24	39	28	11	26	22	15		
12	30	29	25	42	20	21			12	18	12
15	28	21	18	27	15	18	23	16	17	17	16
16	29	16	15	19	14	16	17	15	15	15	20
25	35	20	19	28	18	15	14	14	19	14	19
20	23	16	16	21	22	24	23	18	18		
28	30	20	14	16	24	22	19	16	28	23	16
20			13			19			19		
28			18			28			22		
34			21			34			24		
38			24			38			26		
42	21	16	25			42			27		
44	29	20	27			44			28		
46	35	23	28			46			29		
47	39	25	29			47			29		
48	42	27	29			48			30		
49	44	28	30			49			30		
49	46	29	30			49			30		
50	47	29	30			50			30		
50	48	30	30			50			30		

Since the noise at both frequencies was bursty, the gains in the first half of the trial can be seen to fluctuate, while being gradually reduced from their set values. In general, channel 2 (149,600 MHz) exhibited the more “stationary” noise statistics, since coded transmitter noise bursts were usually present during a scan, and indeed the gain reduction series shows a lower variance than for the channel in which the interference was very strong but much more intermittent. Both channels can be seen to recover, in the absence of noise, at more or less the same rate.

This record is from Event_Log version W9, in which a global noise reduction system is used (adaptive AGC started with version W16).

OPTIMIZING NOISE PERFORMANCE IN EVENT_LOG

(A Sample Session)

This is a transcript of a real experiment. Four transmitters were used, having the following characteristics:

Frequency	*Period (rate)*	*Repetition Code Interval*
151.450	936ms (64bpm)	N.A.
151.138	622ms (96bpm)	N.A.
151.149	973ms	2 pulses at 348ms
151.158	1106ms	3 pulses at 339 ms

These frequencies were installed in **FTABLE** partition 0, along with a "dummy" frequency, 151.666. The transmitters were located about 30 metres from the receiver and the receiver was placed on top of the video monitor of a 12MHz 80286 computer (about .5 meters from the computer case) and connected to its serial port by an unfiltered cable. The receiving antenna was a short loaded whip connected directly to the receiver's antenna jack. Under these (just about worst possible) conditions, the **SIGNAL/Interval** routine exhibited self-triggering on noise at a gain of 57. Besides this, there was an interfering 60 bpm signal at 151.158, comparable in power to the test transmitter but slightly off frequency, so that its received pulse was somewhat attenuated in both time and amplitude.

The reporting period was set at one minute with rate group size = 4 and PRC group size = 16, so that all four transmitters could be captured in a single report period almost every time under ideal conditions (high signal to noise ratio), but in the presence of noise the action of the local gain reduction algorithm would slow down acquisition so that this would not generally be possible.

In the first series of runs, the gain was set at 60 (substantial received noise), the global noise threshold was disabled (set to 50) and the noise blank level was adjusted to see whether the interfering signal on 151.158, as well as any impulsive components of the computer noise, could be rejected by the noise blanking algorithm.

The first value tried was the default (=48).

Gain = 60, Noise Blank Level = 48:

```
 10/11/89  14:30:07 151.450*64*126 151.138*96*97
 10/11/89  14:31:05 151.158*3R*114 151.450*64*99
 10/11/89  14:32:15 151.138*96*117 151.149*2R*196 151.158*3R*130
 10/11/89  14:33:17 151.450*64*99 151.138*96*119 151.158*3R*152
 10/11/89  14:34:20 151.450*64*89 151.138*96*135 151.149*2R*187
 10/11/89  14:35:53 151.450*65*98 151.138*96*125 151.149*2R*190
151.158*3R*128
```

Note that while the 3-pulse transmitter was recognized during four of six 1-minute report periods, all four transmitters were reported only once. This is actually quite a good result for the test conditions, as will be seen below.

In the next run, the noise blank level was set at 72.

```
 10/11/89  14:37:08 151.450*64*95
 10/11/89  14:38:07 151.450*64*106 151.138*97*122 151.149*2R*186
 10/11/89  14:39:21 151.450*64*106 151.138*97*127
 10/11/89  14:40:07 151.149*2R*196
 10/11/89  14:41:09 151.450*64*121 151.138*65*100
```

Here the system response is slower, and detectability of repetition coded transmitters (with their obligatory longer group size) is especially poor. What is happening is that so many noise events are being interpreted as impulses (i.e., ignored) that the local gain reduction algorithm has failed to reduce the gain sufficiently to clear away the other (non-impulsive) noise components.

Disabling the noise blanking algorithm altogether had this effect:

```
 10/11/89  14:45:11 151.450*64*78 151.138*96*107
 10/11/89  14:46:03 151.450*64*92 151.138*96*91
 10/11/89  14:47:03 151.149*2R*183
 10/11/89  14:48:34 151.450*63*71 151.138*96*79 151.149*2R*164
```

Again system performance is slow, and the 3 beater at 151.158 is not detected at all, this time because the strong interference could not be sufficiently suppressed by gain reduction methods alone.

With the noise blank level = 64,

```
 10/11/89  14:51:15 151.450*64*90 151.138*97*98 151.149*2R*178
151.158*3R*96
 10/11/89  14:52:07 151.450*64*101
 10/11/89  14:53:05 151.149*2R*173 151.450*64*82 151.138*97*77
 10/11/89  14:54:09 151.149*2R*186
 10/11/89  14:55:14 151.450*64*98 151.138*83*75 151.158*3R*82
```

the 3 beater is back. Trying blank level = 54,

```
 10/11/89  15:01:05 151.149*2R*169 151.158*3R*135 151.450*58*102
151.138*96*87
 10/11/89  15:02:05 151.149*2R*173 151.450*64*95 151.138*96*98
 10/11/89  15:03:03 151.149*2R*164 151.158*3R*132 151.450*64*66
 10/11/89  15:04:25 151.450*64*89 151.138*96*84 151.149*2R*172
151.158*3R*80
 10/11/89  15:05:04 151.450*64*88 151.138*96*92 151.149*2R*175
 10/11/89  15:06:08 151.158*3R*120 151.450*64*79 151.138*96*78
151.149*2R*189
```

This is quite good performance for the conditions.

On the assumption that starting with a lower baseline gain should speed up acquisition we next tried setting the global noise threshold so that the system would settle at a lower gain. In this case the target was 56, the highest gain without noise triggering in **SIGNAL/Interval**. Because the noise blanker is working, we must expect to set the global noise threshold fairly low (since noise rejected by the noise blanker is not logged, and therefore not counted by the gain reduction algorithm).

Trying a value of 4, the gain settled at 58, giving

```
 10/11/89  15:34:06 151.450*66*120
 10/11/89  15:35:10 151.149*2R*172 151.158*3R*127 151.450*64*87
151.138*96*93
 10/11/89  15:36:05 151.149*2R*163 151.158*3R*97
 10/11/89  15:37:11 151.450*64*103 151.138*96*79 151.149*2R*181
 10/11/89  15:38:14 151.450*64*103 151.138*96*85 151.149*2R*172
151.158*3R*123
```

after settling. Using a global noise threshold of 2, the gain settled to the desired value of 56, with the following result:

```
 10/11/89  15:40:08 151.450*64*110 151.138*96*97 151.149*2R*188
151.158*3R*109
 10/11/89  15:41:09 151.450*64*92 151.138*96*91 151.149*2R*194
151.158*3R*140
 10/11/89  15:42:01 151.450*64*90 151.138*96*113 151.149*2R*195
 10/11/89  15:43:02 151.138*94*86 151.149*2R*195
 10/11/89  15:44:20 151.450*64*90 151.138*96*98 151.149*2R*196
151.158*3R*127
 10/11/89  15:45:47 151.450*64*80 151.138*96*80 151.149*2R*202
151.158*3R*116
 10/11/89  15:46:13 151.149*2R*194 151.158*3R*114 151.450*64*100
151.138*96*104
```

There is a subtle improvement. We have now essentially optimized **Event_Log**'s noise filters.

☐

Example 3: Automated Data Collection

You are studying the spawning behaviour of salmon on a major river system. You want to find the most heavily frequented spawning areas and also to assess the effect of several man-made structures, specifically three large hydroelectric dams, along major routes. To identify spawning areas you plan to locate fixed data collection stations at critical branch nodes along the main streams and, after examining the data from these stations, to use aircraft to search for the upstream spawning beds. In the vicinity of the dams, however, you require more spatial resolution, in particular around fish ladders and spillways. Your plan is to analyze relative signal strength data from groups of local antennas placed at various entrances and exits, using two receivers per dam.

One of the most significant tradeoffs you have to make is between overall sample size and temporal resolution. For example, with 200 fish on 200 individual frequencies and with 6 local antennas located around the entrance to a fish ladder the time required to look for each animal once on each antenna is $1200(t + n)$ seconds, where t is the transmitter pulse interval and n is the receiver processing time (typically about 200 msec.). For pulsed carrier transmitters operating once per second this gives a round trip time of 24 minutes, which you judge to be barely acceptable near an entrance but at an exit would translate to a fairly high probability of missed data. Moreover, to meet the range requirements for the experiment, especially around the dams where the water may be deep, your transmitted power limits the transmitter life expectancy to about one month, which effectively disables the spawning study.

To cope with these conflicts you have decided to use coded transmitters. With a set of 25 codes you now only need to scan 8 frequencies and your cycle time becomes $48(t + n)$. With a code interval of 5 seconds this translates to a cycle time of only 4 minutes, and allows the transmitters to last more than 6 months.

Your system specification now includes six receivers for the dams plus another six which will be located at branches in the river. Once the fish have passed the lower dams you may relocate more receivers to other branches further upstream, or use them for tracking by boat or aircraft. You will also need six ASP_8 antenna switching units, appropriate antennas and a quantity of 50-ohm (preferably low-loss) coaxial cable. You will be using Lotek's proprietary coded fish tags and software version W16 (or a relative of it). You still have a logistical problem, however, in that your stations are widely separated. Servicing your receivers, either for data retrieval or for "tuning" of system performance is extremely labour intensive. Consequently you have decided to set up telephone links from the dam sites, where the density of data will be highest, and public phone lines are available. Each receiver will have its own modem and its own dedicated line and will operate in "auto-answer" mode, so that you may call it at any time from your computer and observe real-time performance, modify system parameters or download data.

REMOTE OPERATION BY TELEPHONE

With your receivers running in auto-answer mode, you may access them by phone using Lotek's **HOST** Support Software. The receiver must be connected, via its serial port, to a Hayes compatible 1200 or 2400 baud modem. This connection requires a standard 9 to 25 pin cable, not the "null modem" cable which you use for direct connection to your computer. Before starting the program which you are going leave in unattended operation (e.g., any of several versions of **Event_Log** or **Code_Log**) , press

SHIFT COMM

to access the communications main menu. If you haven't already done so, you must set the receiver's baud rate to match the preference of the modem (1200 or 2400 baud). To do this, select

1)Configure

then, from the configuration submenu,

1)Baud

Finally, use the UPARROW and DOWNARROW keys to select the desired speed, and the SHIFT key to enter (verify) your selection. Now back up (ESC) to the main COMM menu and select

4)Autoanswer

The modem's "AA" light (if there is one) should come on and stay on, and the receiver will report "autoanswer on" if the operation is successful. The receiver will now be in automatic answer mode, no matter which program it is running. To call the receiver from a remote computer, start the **HOST** program and select **Terminal control** from the main menu. Then use the DIAL NUMBER command to call the receiver's modem. (Your host computer must of course be connected to its own modem, which may be either internal or external, and the **HOST** software must be configured for the appropriate baud rate). When the dial sequence is complete the call is initiated and, after one or two rings, the receiver's modem will answer the phone and the receiver will switch into **terminal mode** (see the **WILDLIFE HOST user's manual** that accompanies HOST software). When you are finished working with the receiver you use the **HOST**'s HANG UP command, which terminates the call and causes the remote receiver to return to "local" control, while remaining in autoanswer mode, ready to take another call.

APPENDIX A: RS232 Port Connector and Null Modem Cable

Receiver Back Panel Connector (DE-9P)		Terminal or Computer Serial Port (DB-25P)	
NAME	***PIN***	***PIN***	***NAME***
DCD	1	8	DCD
RXD	2	2	TXD
TXD	3	3	RXD
DTR	4	20	DTR
GND	5	7	GND
DSR	6	6	DSR
RTS	7	4	RTS
CTS	8	5	CTS

APPENDIX B: Antenna Switch Control Port

Pins 1-8 : ASP_8 current switch or 5V active high logic levels

	A7	A6	A5	A4	A0	A1	A2	A3	
(1)	o	o	o	o	o	o	o	o	(8)
(9)	o	o	o	o	o	o	o	(15)	

Pins 9-15 are at logic ground

APPENDIX C: PROM Installation and Initialization

The instructions described below are for reference purposes only and are not intended as a general recommendation or endorsement by the manufacturer for independent firmware installation by the user. To avoid the potential for degrading receiver performance or of inadvertent receiver damage, it is recommended that any firmware installation be performed by the manufacturer

1. Remove the two Phillips screws located at the rear of the receiver which secure the bottom panel then remove the bottom panel.

2. Remove the 14 Phillips screws which secure the cover of the shield box then remove the cover.

3. Carefully remove the PROM from the socket located near the left centre of the shield box (see the figure on page 33). Use a PROM puller if available however two small screwdrivers can be used to gently pry the PROM from the socket.

4. Gently seat the new PROM making sure that the legs are all aligned with the holes in the socket then press the PROM home.

5. Turn the receiver on.

6. If the new PROM is sufficiently different from the old one, the receiver will sense the change and automatically start the 'new PROM' routine. If the receiver does not run the 'new PROM' routine you must initiate it manually by pressing 'SHIFT' then 'F1' on the keypad. A message asking if you want to start the 'new PROM' routine will be displayed. Answer yes then enter the access code (40697).

NOTE: in some software versions step 12 (Set Decode Threshold) will be performed first, followed by step 7

7. The message 'Initialize tables and storage?' will be displayed. Answer yes.
8. The message 'Program frequency range?' will be displayed. Answer yes.
9. When the 'Enter start frequency' message is displayed enter the base frequency of your receiver in MHz. The start frequency may be found on the label located on the battery bracket inside the receiver (see figure page 33). For example, if your receiver is set up to cover the band 148 to 152 MHz the number '148' would be entered. You may include up to 3 significant decimal places after pressing the '.' key. In the event that the frequency entered is incorrect the 'DOWN-ARROW' key may be used as a delete and backspace to correct the entry. When the frequency entered is correct use the 'UP-ARROW' key to confirm the entry.

10. At the 'Enter LO frequency' prompt, the local oscillator frequency of your receiver must be entered. The LO frequency is found on the same label as the start frequency (see figure page 33).

11. Note: before performing this step be prepared to verify the synthesizer count value* with the factory value when it is displayed.
At the 'Enter IF frequency' prompt the IF frequency of your receiver must be entered. The IF frequency and synthesizer count value are found on the same label as the LO frequency (the IF is normally 10.7). After the IF frequency has been entered the following information will briefly appear on the display: programmed frequency range, synthesizer count value and default COM port settings. It is critical that the synthesizer count value displayed matches the

synthesizer count value recorded on the label. If the synthesizer count values do not match then perform the remainder of this procedure up to step 14 then repeat this procedure beginning at step 6. In the event that the values still do not match contact LOTEK Engineering Inc. for assistance.

12. The message 'Set decode threshold?' will be displayed. If the label containing the LO and IF information also contains a 2 digit threshold variable, answer yes, then enter the 2 digit number. Otherwise answer no. (This entry will not affect the sensitivity of the receiver, but allows the optimum gain value for an automatic station, established by the factory, to apply universally to any receiver).

13. The message 'Test extended memory?' does not apply to all versions. If the message appears, there is no need to perform a memory test unless a problem is suspected. Answer yes or no accordingly.

14. When all the above information has been entered the receiver will 'boot' normally and the following information will be displayed: version information, date and time followed by the 'command environment' display of frequency and gain.

15. For receivers equipped with dual bank firmware versions *W30SAT, W31, W32*, it is necessary to do the following:

-Press <SHIFT F0> which is normally used for entering the Code_Log menu.
-The message "NewProm.." will be displayed (the same message, which would show up after hitting <SHIFT> F1, which initiates the New Prom procedure)
-Confirm the first menu dialogue with Yes. It is not necessary to further proceed with the initialization.

For a receiver equipped with dual bank version firmware *W40*, it is necessary to do the following:

-Press <SHIFT> F3 (normally used to toggle between the environments)
-The message NewProm will be displayed (the same message, which would show up after hitting <SHIFT> F1, which initiates the New Prom procedure)
-Confirm the first menu dialogue with Yes. It is not necessary to further proceed with the initialization.

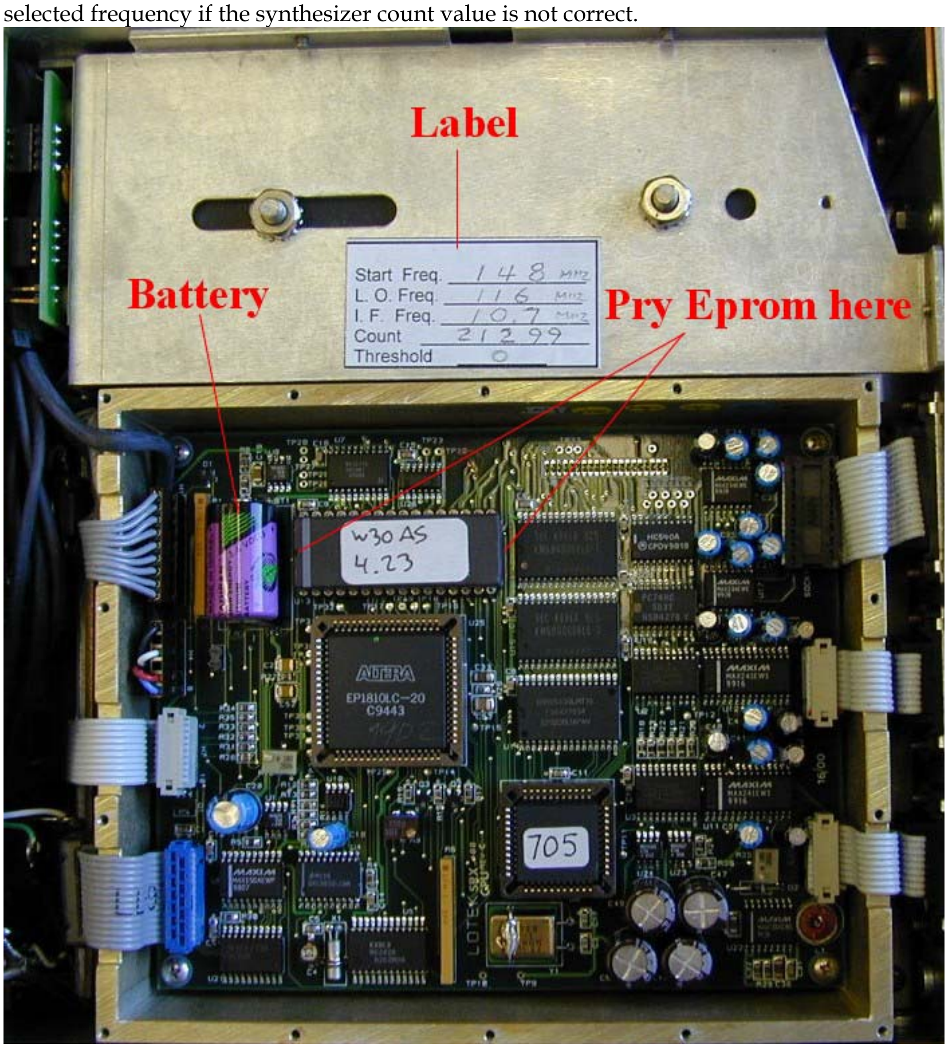
16. If the firmware belongs to the *W16* family, simply start Code_Log with the option "Initialize" and escape from it afterwards. It is not necessary to enter a frequency in the frequency table.

17. Examine the receiver to make sure that no wires and cables are pinched or stressed. Secure the cover of the shield box then secure the bottom cover of the receiver.

18. Verify receiver operation using a new tag. The tag frequency should produce the highest power. This can be verified by shifting the frequency up and down from the tag frequency by 1 KHz using the 'UP-ARROW' and 'DOWN-ARROW' keys. Note that the power decreases and the pitch of the tag signal changes. If there is a large discrepancy repeat this step with a different tag. If the results are the same then contact LOTEK Engineering Inc. for assistance.

[*] The synthesizer count value is a number generated by the processor which represents the timebase the receiver is operating on. If the number displayed does not match the number

recorded on the label there are two possibilities for the discrepancy. The greatest possibility is that the 'new PROM' routine data has not been entered correctly. There is also a small possibility that there is an electrical fault in the receiver. The actual receiver frequency will differ from the selected frequency if the synthesizer count value is not correct.



19. SRX_400A Eprom Replacement

Appendix D: 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.

INDEX