HTR
User Guide

Wildlife Computers
Innovative Tags for Innovative Research

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WILDLIFE COMPUTERS MICROPROCESSOR-CONTROLLED HEART-RATE / STOMACH-TEMPERATURE RECORDER INSTRUCTION MANUAL

Overview of the manual

This manual contains three chapters and several appendices.

- Chapter 1 contains a general description of the heart-rate / stomach-temperature recorder (HTR) and simplified set-up instructions. It is *strongly* recommended that you read this chapter in its entirety before attempting to use our HTRs for the first time.
- Chapter 2 provides detailed descriptions of all the available functions.
- Chapter 3 describes the format of the output files for those who wish to write their own graphing and analysis software, although such software is provided by Wildlife Computers.
- The appendices provide more technical descriptions of the functioning and operation of the HTR, tips on how to best use the instrument, and a section on troubleshooting -or what to do when things don't seem to be going right. The troubleshooting concentrates on communications between the heart-rate / stomach-temperature recorder and a host computer; other sorts of problems would probably require the return of the HTR to Wildlife Computers.

We recommend that you read or at least browse through the entire manual so that you are familiar with what information is available and where it is located. For most simple applications, however, the information contained in Chapter 1 will be sufficient.

Notation Conventions

The following notation conventions are used:

KEY	Press the key(s) in this typeface. For example, **ENTER** means press the "enter" (or "return") key.
`text`	Enter the text in this typeface exactly as shown. For example, **`d`** means press the letter "d".
`text`	Replace the text in this typeface with the appropriate values, and enter. For example, **`d`** *`dd/mm/yy`* means to type the letter "d" and the day, month, and year as "d 31/01/06" (for January 31, 2006).

CHAPTER 1 - An Overview

How your heart-rate / stomach-temperature recorder works:

It is helpful for the user to have some idea of how Wildlife Computers HTRs work to better appreciate some of the restrictions that will be detailed later.

The HTR is used in conjunction with one of two possible accessories, a stomach-temperature transmitter or a heart-rate transmitter.

The stomach-temperature transmitter is cast into a pill, which the study animal is persuaded to swallow. It transmits a 10 ms duration electromagnetic pulse, modulated at 5 kHz, at intervals that vary linearly with temperature.

The heart-rate transmitter consists of an epoxy block, from which 2 wires extend for attachment to EKG electrodes (not supplied). It transmits a 10 ms duration electromagnetic pulse, modulated at 5 kHz, every time the study animal's heart beats.

The HTR receives pulses from either transmitter and measures the time between successive pulses. The HTR has 2 modes of storing this information: The inter-pulse time can either be stored each time a pulse is received, or the last inter-pulse time measured can be stored at fixed time intervals. The data are stored in a 2 MByte non-volatile memory, *i.e.* memory which will retain the stored data even if the battery goes completely flat.

The HTR spends most of its time in a low-power sleep mode which is powered by a single 3.5 Volt battery. It wakes up whenever a pulse is received or when the clock chip determines that it is time to store a new reading.

When a wake-up occurs, the HTR becomes fully active and this causes the light-emitting diode (LED), located on the top of the unit near the communications connector, to turn on. The active period is very short (2-15 ms), so the flash that you observe from the LED during normal data sampling represents the entire time that the HTR is fully active and drawing significant power from the battery.

The single internal 3.5 Volt battery has sufficient power to run the HTR only in the pulse mode detailed above. When communicating with a personal computer (to setup the HTR or to dump collected data) the internal battery is woefully inadequate to power the HTR. This is why an external battery pack is used to power the HTR during communication sessions. The external battery pack is connected to the communications interface box, and its power is fed to the HTR through the communications (ribbon) cable. It is a matter of considerable concern if the LED remains illuminated for more than a few seconds when the external battery pack is not connected: The longevity of the internal battery is quickly reduced under these circumstances.

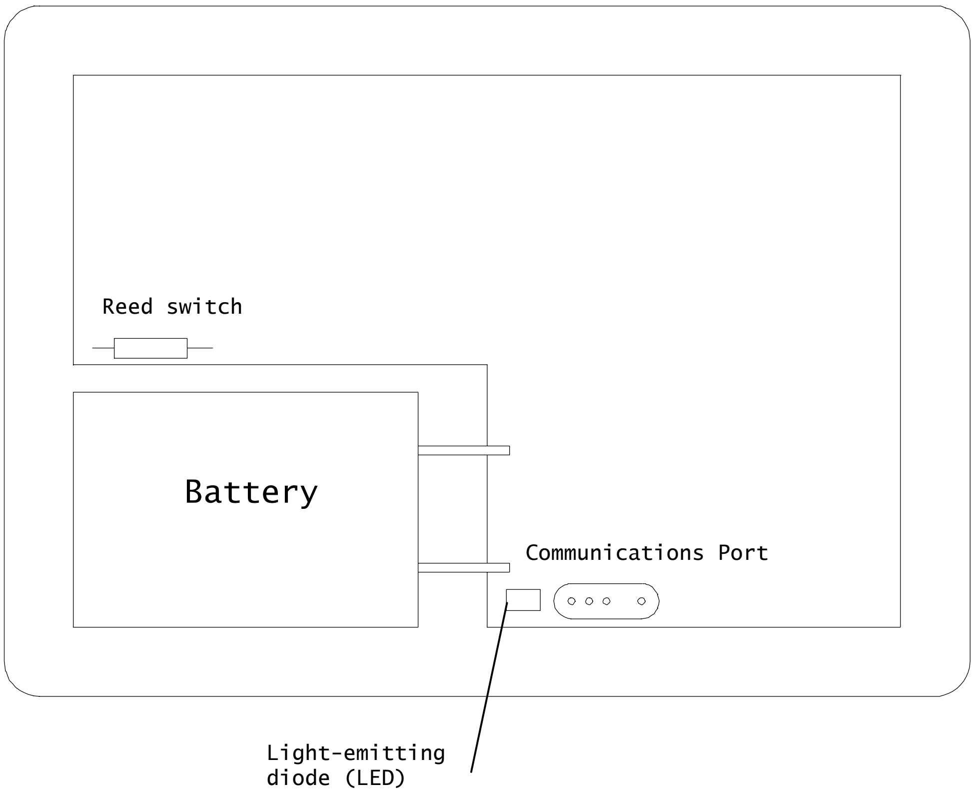

Figure 1: The Wildlife Computers heart-rate / stomach-temperature recorder (top view). The components are cast in an epoxy block measuring approximately 5 x 7 x 1.4 cm.

Getting Started:

You should have received the following items in your shipment:

1. Heart-rate / stomach-temperature recorders or HTRs (epoxy-cast blocks). See diagram on page 5.
2. Stomach-Temperature Transmitters ("Pills") and/or Heart-rate transmitters.
3. A CD-Rom of appropriate software and documentation.
4. This instruction manual.

In addition to the items listed above you will need the following in order to successfully use your HTRs:

1. A PC (almost any computer running MS-DOS or PC-DOS version 2.0 or later will do).
2. A serial (RS-232) interface (this is a male 25-pin or 9-pin outlet on the back of your PC sometimes referred to as an asynchronous communications interface).
3. A communications interface with voltmeter (so your personal computer can talk to the HTRs). It consists of a blue plastic box with attached cables and an 8-pack plastic holder for AA (external) batteries. These items are purchased separately from your recorders.
4. One or two complete sets (8 to a set) of AA alkaline batteries (e.g. Duracell MN1500)
5. You may wish to purchase a Simulator which generates pulses simulating either heart-rate or stomach-temperature transmitters.
6. You may also wish to purchase a Polar brand heart-rate receiver. This looks like a watch, but reports the heart-rate (in beats/min) from the heart-rate or stomach-temperature transmitters. This is a useful diagnostic tool, particularly when experimenting with electrode placement, or verifying the transmissions of the stomach-temperature pill from within a study animal.

Step 1: Establish Communications

Establishing communications between with your PC and the HTR is similar to using your PC to log onto a mainframe, only in this case the HTR will act as the "host" computer.

1) Turn on your PC. Connect the communications cable to the RS-232 port of your PC. Load HyperTerminal. If you decide to use some other communications software, it should be set up as follows:

   a) to communicate with 8 data bits, no parity bits and 1 stop bit,
   b) to enable XOFF/XON (ctrl-S/ctrl-Q) software handshaking,
   c) to disable any hardware handshaking,

d) to display all received characters verbatim using the full 8-bit IBM character set (all "filtering" disabled)

e) to communicate at one of the following baud rates: 300, 600, 900, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14400, or 28800 baud. Generally a baud rate of 9600 is recommended, however, see the Selecting maximum baud rate appendix on page 39 for tips on selecting the maximum baud rate that your software can reliably handle.

2) Connect a power supply (pack of AA cells or a battery eliminator) to the communications interface box. The idea is to have the HTR draw its power from the interface box during communications, thus saving the internal batteries for sampling and storing data. In order for this to happen, the communication power supply's voltage must be between 6 and 15 Volts.

3) One set of batteries should last for a complete season, but it is a good idea to always have an extra set along.

4) Without connecting a HTR, turn the communications "on" using the switch to the right of the voltmeter on the communications interface box.

5) Check that the voltage on the interface box reads between 6 and 15 Volts. If this voltage is below 6 Volts, replace the AA batteries because communications may become erratic. If this voltage is high, above 15 Volts, (in the case of an inappropriate battery eliminator), *do not continue*, your HTR will be damaged.

6) Check the connecting cable assembly by typing several characters on your PC keyboard; they should echo to the screen (although sometimes not reliably at baud rates above 9600). If characters do not echo at baud rates of 9600 or less, your communications program is directing output to the wrong serial port. Computers may have 1 - 4 serial ports, called COM1 through COM4. If your PC does not have an internal modem, the serial port you are using is usually COM1. If it does, then it may be COM2. You may need to test all the possibilities to determine which COM port you are using.

7) Turn the communications "off" at the communications interface box.

8) Verify that characters typed do not echo now. If they do, you are probably using the wrong COM port. See step 6) above.

9) Insert the communications connector into the HTR communication port, orienting the “missing pin” on the HTR with the blocked socket on the connector. There is only one possible orientation. *If you force the connector in any other orientation, you will destroy the recorder*.

10) Turn the communications "on" at the communications interface box.

11) The LED should illuminate and stay on until you turn off the blue box as described below. If the LED does not come on, your voltage on the AA-cells may be too low. Otherwise, you may have a bad HTR or cable. See the Troubleshooting appendix on page 36. On rare occasions you may need to pass a magnet over the reset reed switch (see Figure1, page 5 with the blue box turned on to get the LED to illuminate.

12) Press the **SPACE** bar of your PC once or twice and the HTR identification and copyright notices should appear on your PC's screen. If you get no response, pass a magnet over the reset switch location. If the screen looks garbled, you are probably trying to communicate faster than your communications program can manage: Try reducing the baud rate. If the copyright notice is not surrounded by a box, check that your communications program is set for 8 data bits, and/or disable any character filtering.

13) Press a **RETURN** to accept the limit of liability displayed.

14) You will now get a brief listing of the default settings of the HTR followed by the HTR> prompt. Instructions to the HTR are all given at this HTR> prompt.

Communications with the HTR:

NOTE: All commands described below must be followed by **RETURN** or **ENTER**; Case (lower or upper) is immaterial. While using HyperTerminal:

- Press **CTRL-C** or **ESC** to stop listings type
- Press **CTRL-S** to pause a listing
- Press **CTRL-Q** to resume a paused listing
- Press the **BACKSPACE** key to delete the last character typed
- Press **CTRL-U** or **CTRL-X** to delete the last line typed
- When presented with a question, type **Y RETURN** for "yes", all other input is interpreted as "no".
- If a response is prompted in rectangular brackets [ ], pressing **RETURN** will use that response.

Note: On-line HELP

Type **H** at the HTR> prompt; there are many simple commands listed on the help menu. Further help can be obtained on any command by typing **h** *x*, where *x* is the key letter of the command of interest. Only a few of these commands are necessary to set up the HTR for sampling, and are described in the following sections. A full description of all the commands appears in Chapter 2.

Step 2: Date and Time

Type **D** at the HTR> prompt; the current date will appear on the screen (or what the HTR thinks is the current date). To set the date, type **D** *dd/mm/yy* (note that the date is coded day first followed by month then year; e.g., Feb 4th 1987 would be entered *4/2/87*). You can check the date at any time by just typing **D**; it is a good idea to do so upon retrieving a HTR to ensure that the calendar is still functioning correctly. The date will be displayed in an unambiguous form.

To set the time type **T** *hh:mm:ss* (seconds are optional); press **ENTER** at the moment the time matches what you have just typed. The HTR uses a 24-hour clock so 9:05 am should be entered 9:05, 9:05 pm should be entered 21:05. The time can be checked by just typing **T**; again, this is a good idea upon retrieving a HTR to ensure the clock is still functioning correctly. If you are instrumenting your animal with more than one recorder, it is essential that you set the time as accurately as possible. The best technique is to set it using a time standard; otherwise, set it using your watch, and then determine your watch's error by comparison to a time standard and make a note of it. The error in the HTR's and the other recorder's time should be noted upon retrieval of the instruments.

Step 3: Setting the Sampling Regime

Command **S** is used to set the sampling regime. There are 4 modes of operation:

0 = Store stomach-temperature at set time intervals
1 = Store stomach-temperature on every pulse of the transmitter
2 = Store heart-rate at set time intervals
3 = Store heart-rate on every pulse of the transmitter

In regimes 0 and 2, you will additionally be prompted for the time interval.

The advantage of storing data on every pulse of the transmitter is that it gives the most detailed data: You will know the time of every pulse. In the heart-rate mode, this will give you every R-R interval (accurate to 0.01 seconds), so that R-R variability can be studied, and you can determine exactly when hear-rates change. In the stomach-temperature mode, you will be able to track temperature changes as quickly as possible.

The disadvantage of storing data on every pulse of the transmitter is that it uses memory faster: You can only store 11 days of heart-rate with average rate of 60 beats/min, or 22 days of stomach temperatures of 40°C. The data is also more difficult to analyze because the time between data samples is not fixed, thus your time-base is variable.

The advantage of storing data at fixed time intervals is that the data are easy to analyze and to align with data recorded on another recorder when an animal is dual-instrumented. The memory is also used very frugally, there is room for 2,000,000 readings (or 115 days when data are stored every 5 seconds). However, the chances of an animal holding a stomach-temperature pill or heart-rate transmitter for 115 days are negligible.

The disadvantage of storing data at fixed time intervals is that it increases the time for a change in sensor output to be noted: If you are saving heart-rate every 10 seconds, the heart-rate saved will be that calculated from the time between the last 2 beats, rounded to the nearest beat/minute. If the heart-rate is changing rapidly, the change may have occurred as much as 10 seconds earlier.

Step 4: Checking the Transmitter and Receiver

The operation of the Transmitter (either stomach-temperature or heart-rate) and HTR receiver circuits should be checked before deployment using the **A** command.

If you are using a stomach-temperature pill, remove the magnet. This will turn it on.

If you are using a heart-rate transmitter, you will need to connect it to an EKG source, either a person or the study animal. There is no on/off switch on the heart-rate transmitters, they automatically turn on when there is an electrical connection (*i.e.* a body) between the electrodes. They also automatically turn off when the electrical connection is broken.

Run the **A** command (for more details, see page 16). Provided all your electronics are working, and you selected an appropriate sampling regime in Step 2, above, you should get one line of output per pulse of your transmitter indicating the time since the previous pulse and the equivalent heart-rate or temperature.

If you are not receiving the pulses, you have either a bad transmitter, bad HTR or both. To diagnose such problems, you will need additional transmitters and/or HTRs and figure out which unit is bad by a process of elimination. Two accessories are available to help diagnose problems: A pulse simulator, which provides a reliable pulse with variable rate and a light that blinks on each pulse; and a heart-rate monitor, which resembles a wrist watch, and provides an indication of heart-rate on a display. Both of these accessories are made by Polar Instruments, and may be available at your local fitness center as well as from Wildlife Computers. We have no accessory that gives a direct indication of temperature, however the Polar brand heart-rate monitor will display an output (beats/min, not temperature) when used with a stomach-temperature pill.

Step 5: Disconnecting the HTR

1) Having verified the time and date, selected your sampling regime and tested the heart-rate or stomach-temperature transmitters, you are ready to exit communications and disconnect the HTR from the communications interface.

2) Exit communications by pressing **E** (see Command **E**, for exit, on page 19). Follow the prompts carefully!

3) You are finally told to disconnect the communications cable. Disconnect and deploy as follows:

    a) Turn "off" the communications on the interface box. Make sure this is done before you remove the communications connector from the HTR.

b) Remove the communications connector from the HTR.

c) Observe the small red light on the top of the HTR next to the communications connector. It should flash whenever a heart-rate or stomach-temperature transmitter pulses, and at the sampling interval if you selected a sampling mode of operation in command **S**, above. If the LED does not flash, re-connect the communications connector and verify that the light works, and re-exit as before. If the light stays on constantly at any time after the communications connector is removed, you may need to reset the unit (see item 3 of Troubleshooting on page 37). A flashing light is your indication that the HTR is working correctly.

4) Disconnect the battery pack from the interface box after you have set up all your recorders. Even when the box is "off", there is a current drain which will flatten the batteries over time.

Step 6: Deploying the HTR

1) Protect the communications socket from seawater damage by putting a spot of grease on the end of the teflon plug supplied with your recorder, and inserting the plug into the socket. Note that the plug has unevenly spaced holes that align with the pins of the communications socket; do not try to force it in backwards. If your animal might dislodge the plug during the deployment, you may want to cover the plug with a bit of 5-minute epoxy.

If you lose all your plugs, our current recommendation is to fill the socket with grease to keep the water out, cover the grease-filled socket with a small piece of paper, and then cover the paper with some fast-setting epoxy, which should be bonded to the surrounding encapsulation. Note that the communication socket is sealed and electrically isolated during deployment; the grease is to protect the gold plating from corrosion, not to prevent leakage into the HTR.

2) The HTR is now ready for deployment.

3) Mount the heart-rate transmitter, or induce the study animal to swallow the stomach-temperature pill. This is the hardest step, and may take several hours or days to perfect.

- If you are measuring heart-rate, you will need to find good locations for your EKG electrodes. The heart-rate monitor accessory described in Step 4 can be very useful at this time. Otherwise the set-up HTR can be used as it will blink on every received heart beat.[1] The last option is to use an HTR running the **A** command, if you can risk having your PC sitting next to a writhing animal...

- If you are measuring stomach temperature, you may find that the pill is too small, and is passed through the animal, in this case you will need to make the pill larger by adding additional epoxy. Make sure that you leave most of the titanium sleeve exposed, as this senses the temperature. Additional epoxy should be of a 24-hour curing variety (as distinct from 5-minute) because the cured epoxy is much harder and will be less likely to come adrift in the stomach. Custom pill shapes and sizes are available from Wildlife Computers.

4) The HTR should be placed on the back of the study animal as close as possible to the stomach (for stomach-temperature experiments) or adjacent to the heart-rate transmitter (for heart-rate experiments). Verify that the LED is blinking at an appropriate rate.

Recovery of the HTR and your data

After recovering your HTR:

1) Clear the communications socket.

If the socket was sealed with epoxy, chip the epoxy off with a pen-knife. Remove the Teflon plug. If there is excessive grease present, remove it with a spray can of contact cleaner. The socket does not have to be immaculately clean, just 90% or better. Take care of the four connector pins - *try not to bend them*! If you do happen to bend them, straighten them out before inserting the communications connector.

2) Establish communications as described in **Step 1: Establish Communications** on page 6, to get to the HTR> prompt.

3) If the time and date are correct, and the number of collected data points is reasonable, then the batteries probably did not go flat during the preceeding deployment. If time and date are incorrect, or the number of collected data points is shown as something unreasonable (like 0 or more that the size of the data memory), then the data pointers need restoring. Use command **F** (see page 21) to find the collected data in memory. This may take quite a long time, particularly after a long deployment, as it steps through every memory location looking for the end of the collected data. Apart from being a bit slow, there is no disadvantage to running command **F** and it can be used even if the batteries did not go flat if you are at all unsure that all the collected data are being reported.

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[1] Note that if the HTR is set up to record every heart beat, the blink of the LED will be longer and brighter that in the sampled mode, where the bright blinks are the timed wakeups when data are stored.

4) Set the communications program on your PC to save or capture the incoming data to disk.

5) List the data using one of the L commands, and HyperTerminal will store the listing to the disk file. You can either use the L0 listing for a verbose, but readable decimal format, or use L2 for a compact, but cryptic hexadecimal format. If you intend to use Wildlife Computers graphing or analysis packages, you *must* use the **L2** listing command. You can also repeat this exercise using **L0** if you want a readable listing too.

If you get corrupted lines of data on the screen when saving data to disk your baud rate is probably too high, reduce it and try again as described in the Selecting maximum baud rate appendix on page 39. Also double-check the communications parameters (especially verify the XON/XOFF flow-control is enabled). Note that all lines following the **<data>** header in command **L2** should be the same length.

6) When the listing is finished and the HTR> prompt is displayed, turn off the save or capture setting of your communications program.

It is recommended that you list and save the data twice in case your data get damaged or corrupted.

NOTE: Be aware that the size of the file that gets stored onto your disk may be quite large. If you use the Hexadecimal format listing, the size is approximately 2.13 times the number of bytes of data collected. Things get worse in the Decimal format, the expansion factor is between 3 and 6! Make sure you have enough room for the data file on your disk before you start to save it.

7) You are now ready to re-deploy or disable the instrument. Use Command **K** "Shut Down" (see page 24) if you wish to disable it. In this state the current data will be maintained, and the batteries should last about ten years.

A final not for those who intend to read no further:

> At no time should you disconnect an HTR from the communications interface without either Exiting or Shutting Down the instrument.

CHAPTER 2 - The HTR's Commands in Detail

Once you have established communications between your PC and the HTR you can invoke any of the following commands in almost any order; each is described in some detail below. The only restriction is that command **E** or **K** must be the last command invoked before disconnecting the communications cable.

A	show current heart-rate / temperature
B	Browse the HTR settings
D	set or enquire Date
E	Exit and start data sampling
F	Find collected data in memory
H	this Help message
H *x*	further Help on topic *x*
I	re-Initialize the HTR
K	Shut Down the HTR - disable all sampling
L	List sampled data
M	perform Memory test
P	Program user-defined name
S	set Sampling regime
T	set or inquire Time
Z	Erase (Zap) the non-volatile memory

NOTE: When a command prompts you for a **Y** or **N** response, pressing **Y** **ENTER** means yes; all other input is interpreted as **N**.

Command A - show current heart-rate / temperature

Description: Command **A** allows you to check that the HTR is correctly receiving beats from a heart-rate or stomach-temperature transmitter. You need to have an active transmitter close to the HTR for this command to do anything. The format of the output will depend on the regime selected in command **S** (page 28). For more details on testing the transmitters and receivers see page 10 in Chapter 1.

Format: Type **A** to invoke this command.

Examples of output:

(an HTR in heart-rate mode)

```
Pulse interval = 0.86 sec, this converts to 69 bpm
```

(an HTR in stomach-temperature mode)

```
Pulse interval = 2.76 sec, this converts to 24.8 C
```

To terminate conversions, press the **SPACE** bar.

Command B - Browse the HTR settings

Description: Command **B** provides the user with a brief listing of the following useful information:

Unit number of this HTR. Each HTR has an unique unit number.
Your identifier for this HTR (see Command **P**, page 27)
Time (see Command **T**, page 29)
Date (see Command **D**, page 18)
Current sampling regime (see Command **S**, page 28)
The total memory size of this HTR in bytes or data points
The number of bytes of memory filled with data

Format: Type **B** to get the browse listing.

Command D - Report/set HTR's date

Description: Command **D** is used to report or set the date of the HTR's clock. The date should be set when the HTR is first switched on and subsequently checked when data are retrieved after deployment.

Format: To set the date, a string of numbers representing the date must be included in the command line. The format is **D** *dd/mm/yy* where *dd* represents the day, *mm* represents the month and *yy* represents the year. If no numbers follow the **D** command, the current date will be reported in an unambiguous form.

> **NOTE**: The order for date entry is day, month, year - *not* month, day, year. Years less than 50 are interpreted as in the 21st century (*e.g.*, 15/03/40 = March 15, 2040).

Command E - Exit communications and deploy HTR

Description: Command **E** is used to exit the communications commands and start recording data. It checks to see if any data still exist in memory and allows you to erase them, this will take a couple of minutes.

Format: Type **E** to invoke this command.

If you currently have any sampled data in memory, you will be asked if you want to discard them. A response of:

- **Y** will overwrite the old data with the new data
- **N** will append the new data to the end of the old

You will then be prompted with:

The time	- see Command **T**, page 29
The date	- see Command **D**, page 18
The sampling regime	- see Command **S**, page 28

and asked to verify that these are correct. A response of:

- **N** returns you to the HTR> prompt
- **Y** invokes a message to disconnect the communications cable and go for it... If you selected that data should be stored at fixed time intervals in Command **S**, then sampling begins (and the LED flashes) immediately upon disconnection, but data are only stored when the HTR clock reaches a whole minute (so your sampled data begin on a whole minute).
- **I** is the same as **Y**, except that data storage begins (and the LED flashes) immediately (not on the first whole minute). This response can speed up testing the HTR in sampled data mode, but should not be used when exiting for a real deployment. In sampling regimes that store data on every received pulse, responses **I** and **Y** are completely equivalent; data storage starts immediately

You should always verify that the LED flashes before deploying the HTR by placing an active transmitter nearby.

If the light stays on constantly after the communications connector is removed, reconnect the HTR to the communications interface box, turn the interface box on, and pass a magnet over the reset reed switch (see Figure 1, page 5), and re-establish communications. Repeat the **E**xit command, turn off the interface box, and disconnect the connector.

If the light either stays on or never flashes, you have a bad HTR which needs factory servicing. *A regularly flashing light is your indication that the HTR is working correctly*.

See Disconnecting and deploying the HTR, page 11, for details of the disconnection and deployment sequence.

Command F - Find Collected data in Memory

Description: Command **F** will be useful if you have recovered an HTR whose battery is completely flat. Such a recorder may indicate that it has either no data collected, or more data than is physically possible, or have data and time that make no sense. Command **F** will cause the HTR to scan through all of the memory space and re-locate the collected data, which can then be listed with command **L**.

Format: Type **F** to invoke this command. You will be asked to confirm this choice. Running this command cannot do any damage provided it is allowed to run to completion; if you abort this command you may not be able to access your data and you will have to run this command again.

Command H - "On-line" help

Description: Command **H** is used to access the help screens which are built into your recorder. There are two levels of help: If you just type **H**, you will get an overview of all the commands available. If you type **H** *x* where *x* is another command letter, you will get additional help on that command.

Format: Type **H** to get the command overview, or **H** *x* to get help on command *x*. For example **H T** will tell you how to set the recorder's time.

Command I - Re-Initialize HTR

Description: Command **`I`** is used to reset the HTR to its default, power-up settings:

This function is generally used by the manufacturer to initialize the HTR after connecting the battery. The user should not need to use this command.

Time is set to 00:00:00
Date is set to 1st January 1996 (or year of manufacture)
Number of collected data points is set to zero
Sampling protocols are set to default protocols

Format: Type **`I`** to invoke the re-initialization, you will be asked to confirm this command selection.

This function does not change any sampled data, although **`L1`** or **`L3`** will have to be used to access them.

Command K – Shut Down HTR

Description: Command **K** is used to disable the HTR from all further sampling. This command should be used when the HTR is to be stored. Command **K** minimizes the battery drain while maintaining the contents of memory, the time, and the date.

Format: Type **K** to invoke the disabling of the HTR. You will be asked to confirm this function. If you do confirm this function, you will be prompted to disconnect the HTR.

The HTR will now do nothing other than maintain the contents of memory and the correct time and date until communications are re-established. See Disconnecting and deploying the HTR on page 11, for details of the disconnection sequence - it is the same as for command **E**.

HTR's are "resurrected" by re-establishing communications following the same connection procedure as used when communicating with a HTR which has been collecting data - see To Establish Communications, page 6.

Command L - List sampled data

Description: Command **L** is used to list collected data, usually while capturing to disk. 4 possible listing formats are available:

- 0 list sampled data in decimal
- 1 list entire memory in decimal
- 2 list sampled data in hexadecimal
- 3 list entire memory in hexadecimal

Listing formats 0 and 2 list only the data that the recorder considers to be new (*i.e.* collected since the HTR was turned on or since data were discarded in the **E** command), the other formats list all of the contents of memory regardless.

Format: Type **L***n* to invoke this command where *n* corresponds to one of the listing formats above. If *n* is absent, you will be prompted with the above alternatives and asked to chose one.
L0 is recommended for browsing through small amounts of data; it is verbose, but readily readable.
L2 is recommended for downloading data as it is faster and can be handled by all communications packages, however you will need some additional software to decipher this hexadecimal file (provided by Wildlife Computers).

NOTE: Listings can be paused by typing **CTRL-S**, resumed by typing **CTRL-Q**, or aborted by typing **CTRL-C** or **ESC**.

Command M - Memory Test

Description: Command **M** is used to test the memory of the recorder. Testing is performed by writing a standard test pattern to all of memory and then checking that the test pattern reads back correctly.

Program memory is also tested for integrity.

Format: Type **M** to invoke the memory test which includes the writing phase. You will be warned that this test will overwrite any collected data. Data are then written to all addresses and read back to check that they are the same. If a discrepancy occurs, the bad data address, original data and bad data are reported. This test takes several minutes to complete.

Generally, a failed memory test indicates that the memory chip may be bad; if so, the HTR may have to be discarded. Contact Wildlife Computers for further assistance.

Command P - Program User-Defined Name

Description: This command allows you to set the user-defined name of the HTR. This name will appear in Command **B**, and in all data listings (Command **L**).

Format: Type **P** to invoke this command. You will be prompted for a name. Your name can contain up to 23 characters, both upper and lower case.

Command S - Set Sampling Regime

Description: Command **S** is used to set the sampling regime for collection of data. See the section Setting the Sampling Regime on page 10 for details of the merits of each sampling regime.

Format: Type **S** to invoke this command. You will then be prompted with the available sampling regimes:

```
0 = Store stomach-temperature at set time intervals
1 = Store stomach-temperature on every pulse of the transmitter
2 = Store heart-rate at set time intervals
3 = Store heart-rate on every pulse of the transmitter
```

If you select regimes 0 or 2, you will be additionally prompted for the sampling interval.

Command T - Report/set HTR's Time

Description: Command **T** is used to report or set the time of the HTR's clock. The time should be set when the HTR is first switched on and subsequently checked when data are retrieved after deployment.

Format: Type **T** *hh:mm:ss* to set the time, where *hh* represents the hour, *mm* represents the minutes and *ss* represents the seconds. Press **ENTER** when the time you just set is equal to the current time (*i.e.*, enter a time 5-10 s ahead of the current time and wait until they coincide to press **ENTER**). Remember that the HTR uses a 24-hour clock. If no numbers follow the **T** command, the current time will be reported.

NOTE: If you are using the HTR in combination with another recorder, it is vitally important to set both clocks accurately (that is, bother recorders should have their clocks set to the same time), and to note any time discrepancies between recorders upon recovery. This will enable you to synchronize the data sets during analysis.

Command Z - Erase (Zap) the Data Memory

Description: This command is used to erase all data from the memory chip. It is invoked automatically by command **E** if you choose not to retain collected data. You might want to use this command to erase collected data for security reasons when lending an HTR to a colleague.

Format: Type **Z** to invoke this command. You will be asked to confirm this selection. Once data are erased, they can never be recovered.

CHAPTER 3 - Output File Formats

Command **L** allows you to list collected data from the HTR in 2 basic formats: decimal and hexadecimal. The decimal format is in plain English, with deployment information fully detailed and sampled data converted to beats/minute, °C or seconds, as appropriate. It is the most verbose, and is not recommended for large data listings; it may, however, be useful for short listings or for testing purposes. The hexadecimal format is more compact and reflects how the data are stored internally in the HTR, but requires additional deciphering. All Wildlife Computers analysis software require your data to be listed in hexadecimal format.

Certain header information is common to all listing formats, an example follows:

```
Wildlife Computers Heart-rate / Stomach-temperature recorder v1.00
Recorder number 96-129.  Your identifier = .....
Time is 14:05:32.01
Date is 1st May 1996
Unit will record stomach temperature on every pulse from the
temperature transmitter

Total memory available for data collection = 2080768 bytes
Memory filled with data = 30610 bytes
1 deployment has been recorded
<Manufacturer>
Wildlife Computers
<Recorder type>
HTR HW:1.00 SW:1.00
<Recorder number>
96-129
<Owner>
Dr Michael Hammill
Peches et Oceans, Canada
850 Rue de la Mer, CP 1000
Mont Joli, Quebec, G5H 3Z4
<Your identifier>
.....
<Password>
C74F5A60A671E6D604
<Bytes collected>
30610
<Data>
```

The first part of the listing is simply the output from a **B** command; following this are self-explanatory introducers (in angle brackets < >), followed by the related data. The collected data are listed following the `<Data>` introducer as follows:

Decimal Listings

Listings in this format write one sample or other event per line. Each event is reported in one of the following formats (*italicized* text represents variables):

Stomach-temperature measured at set time intervals

1. `Deployment measured stomach temperature every` *n* `seconds`
2. `Deployment number` *n* `started on` *mm/dd* `at` *hh*:*mm*:*ss*
3. `Sampling starts on` *mm/dd* `at` *hh*:*mm*:*ss*
4. `error #241`
5. `error #242`
6. *xx.x*
7. `Hour` *n*

Stomach-temperature measured on every pulse of the transmitter

8. `Deployment measured the interval between temperature pings`
9. `Deployment number` *n* `started on` *mm/dd* `at` *hh*:*mm*:*ss.ss*
10. `Beat:` *mm/dd* `at` *hh*:*mm*:*ss.ss*
11. *xxx.xx*

Heart-rate measured at set time intervals

12. `Deployment measured heart-rate every` *n* `seconds`
13. `Deployment number` *n* `started on` *mm/dd* `at` *hh*:*mm*:*ss*
14. `Sampling starts on` *mm/dd* `at` *hh*:*mm*:*ss*
15. `xx`
16. `Hour` *n*

Heart-rate measured on every pulse of the transmitter

17. `Deployment measured the interval between heart-beats`
18. `Deployment number` *n* `started on` *mm/dd* `at` *hh*:*mm*:*ss.ss*
19. `Beat:` *mm/dd* `at` *hh*:*mm*:*ss.ss*
20. *xxx.xx*

Formats 1, 8, 12 and 17 occur whenever you perform an **E** command to exit. It defines the type of deployment that follows.

Formats 2, 9, 13 and 18 also occur when you exit with an **E** command. It gives the time that you exited, as distinct from when the first data were collected.

n	is the number of the deployment: 1 for 1st in memory, 2 for 2nd, etc.
mm/dd	is the date of deployment (month/day)

hh:mm:ss.ss is the time of deployment (hours:minutes:seconds). The seconds are reported to 1/100th second accuracy when using a mode that measures every pulse.

Formats 3 and 14 occur when the first measurement is made at a fixed time interval. This is generally on the minute following the time reported in Formats 2 and 13.

Format 4 is reported if stomach-temperature beats were too far apart to be converted to a temperature.

Format 5 is reported if stomach-temperature beats were too close together to be converted to a temperature.

Format 6 is the scaled temperature data in °C.

Format 17 is the scaled heart-rate in beats/minute.

Formats 7 and 16 are hour markers.

Formats 10 and 19 occur when measuring every pulse and this is:
The first pulse of the deployment
The first pulse following an hour change
The time to the preceding pulse is greater than 327.67 seconds

Formats 11 and 20 is the inter-pulse interval in seconds, you will need to convert this to a temperature or a heart-rate:

Converting inter-pulse intervals to temperature:

$$\text{Temperature (°C)} = 20 \times (4 - \text{interpulse interval}).$$

This works for interpulse intervals from 2 to 4 seconds. Longer periods indicate missed pulses, shorter periods indicate stray pickup.

Converting inter-pulse intervals to Heart-rate:

$$\text{Heart-rate (beats/min)} = 6000 \div \text{interpulse interval}.$$

Hexadecimal Listings - Data sampled at regular time intervals.

The following lines contain the sampled data and informational markers (*e.g.*, hour change, new deployments, and timer marks). Although the data are output in hexadecimal, the binary equivalents are shown below to help in the decoding.

`00000000-11111100`	Heart-rate (in bpm) or temperature (encoded - see below) data
`11111101`	Unused
`11111110`	Unused
`11111111 aaaaaaaa`	indicates an hour change, new sampling regime or new deployment depending on the binary value of *aa*:

`00010001`	Sampling Starts. Followed by five bytes representing month, day, hour, minute, second.
`100`*nnnnn*	Hour marker. *nnnnn* = hour (0 to 23). Followed by one byte to encode battery voltage (not currently used, set to 0)
`101000`*m*`0`	Type of Deployment: *m* = 0 Temperature sampled at set time intervals *m* = 1 Heart-rate sampled at set time intervals Followed by a byte indicating the sampling interval in seconds
`1110`*xxxx*	Start of deployment number *xxxx*. Followed by five bytes representing month, day, hour, minute, second.

Encoding of Stomach-Temperature Bytes (byte values are in decimal):

Reading	Conversion
0 to 180	Unambiguous temperatures: Temperature = 8 + reading * 0.2 (range: 8 - 44°C)
181 to 240	Ambiguous temperatures; either 1 or 2 beats missed: Temperature = -4 + reading * 0.2 (range: 32 - 44°C)
- or -	Temperature = -46 + reading * 0.3 (range: 8 - 26°C)
241 to 252	Errors - no data 241 = beats too far apart 242 = beats too close together 243 to 251 reserved 252 = no input processed

Hexadecimal Listings - Data sampled every pulse

`0xxxxxxx xxxxxxxx` indicates a time interval in 1/100th seconds (0-327.67 seconds)

`1000000m mmmddddd hhhhhmmm mmmsssss shhhhhhh`

Time of beat (for 1st beat in deployment, 1st beat after an hour change or time since last beat > 327.67 seconds).

`mmmm` = month
`ddddd` = day
`hhhhh` = hour
`mmmmmm` = minute
`ssssss` = seconds
`hhhhhhh` = hundredths of seconds

`110xxxxm mmmddddd hhhhhmmm mmmsssss shhhhhhh`

Start of deployment number `xxxx` at date, time

`11111111 101000m1 00000000`

Type of deployment:

m = 0	Temperature measured every pulse
m = 1	Heart-rate measured every pulse

Appendix A: Troubleshooting

1) The first time you try to set up communications you get no response from the HTR.

If you cannot communicate with any of your HTRs then the problem lies with the cable or the communication program.

a) If you plugged the cable into the RS-232 port on your PC and were able to correctly perform steps 1) through 6) described in To Establish Communications, page 6, then the communications interface up to the gray ribbon cable is probably OK. Visually inspect the gray ribbon cable for broken wires. Repair any breaks, or contact Wildlife Computers for replacements.

b) If the communications interface checks out OK but nothing happens when any HTR is connected and the **SPACE** bar is pressed, the problem probably lies with the gray ribbon cable or the external battery pack.

c) Check the voltage of the external battery pack both before and after an HTR is connected. The voltage must be between 6 and 15 Volts before and after connection to the HTR. If less, replace the AA cells ensuring correct orientation of each cell.

d) Check that the communications program's baud rate is one of the acceptable ones (if you are attempting to use one of the faster rates try reducing it to 9600 baud). Check that your set up is for 8 data bits, 1 stop bit, and no parity bit (see Selecting maximum baud rate, page 39, for the appropriate communications setup). If all these setting are correct and characters echo on the screen when the communications cable is not connected to the HTR then the communications software must be OK, and the cable must be at fault.

2) You are getting occasional garbled characters while communicating with the HTR. The L2 listing lines are sometimes too short or too long.

This often happens if the XON/XOFF handshaking parameter is disabled in your communications program.

If the only garbled characters are the boxes around the Wildlife Computers start-up screen, check that the full 8-bit character mode is enabled in your communications program.

See Selecting maximum baud rate, page 39, for the appropriate communications setup.

3) You disconnected the communications box from the HTR and the LED stays on.

This usually happens if you forget to turn off the communications box before disconnecting the HTR. You will need to reset the HTR by passing a magnet over the reset switch (see Figure 1, page 5). This should make the LED turn off. You need to re-establish communications, verify your sampling protocols, time and date, and re-exit.

If passing a magnet over the reset switch does not cause the LED to turn off, the HTR's battery voltage is probably too low for proper functioning. However, you can try the following steps:

- Reconnect the HTR to the communications box
- Turn the box "on"
- Pass a magnet over the reset reed switch (see Figure 1, page 5). This will manually reset the HTR, bypassing some of its internal programming, but no major changes to the HTR's functioning should occur.
- Press the space bar again. If you get no response, try turning the communications box "off" then "on" again, and passing the magnet over the reed switch, keeping the communications cable connected throughout. Press the space bar again. If you still get no response, you have an ex-HTR.

NOTE: This reed switch is not an on/off switch (there is no on/off switch).

4) <u>You are ready to deploy your HTR. You typed the exit **E** command, turned off the blue box and disconnected the HTR. The HTR's LED does not flash.</u>

Re-establish communications and re-exit. If this problem is occurring frequently, you may wish to exit communications with a response of **I** instead of **Y** (see Command E, page 19). If this doesn't help, you probably need to get the battery replaced.

5) <u>You have an HTR and it won't communicate</u>.

Double-check that you have correctly followed the To Establish Communications instructions on page 6.

Additionally, if the unit has been deployed, ensure that the communications socket has been cleaned out adequately, and that absolutely no water is present in the socket.

If you can communicate with other HTRs, then you can try to reset the problem HTR as described in 3) above. If this fails, contact Wildlife Computers.

6) <u>You have recovered a deployed HTR but it's time and date are incorrect.</u>

The battery has probably failed during deployment. Use Command **F** (page 21) to find the collected data. This can now be downloaded with command **L** (page 25). Finally, send the unit back to Wildlife Computers to get a fresh battery installed.

7) <u>Screen fills with garbage characters when communications are first established</u>.

This usually happens when some other character than the space character is received by the HTR during its baud rate determination routine. The solution is to briefly turn the communications "off" then "on" again at the communications interface box, next press the space bar as before. If this remedy fails, perform a manual reset (as in 2 above).

8) <u>The HTR starts to communicate but stops abruptly.</u>

This may occur if your communications package sends the HTR a **CONTROL-S** to halt data flow without a **CONTROL-Q** to re-enable it. Try typing **CONTROL-Q** at the keyboard to restart the HTR. If that does not work, try **CONTROL-C** or **ESC** to abort the current command. Finally, if nothing else has worked, apply the reset magnet, and then press the space bar. If all this fails, your problem lies in the communications cable and you should proceed following instructions 5), above.

Appendix B: Selecting maximum baud rate

All programming of, and data recovery from, your Wildlife Computers heart-rate / stomach-temperature recorder is performed via an RS-232 serial communications link. A prerequisite of using our heart-rate / stomach-temperature recorders is therefore that you have access to a personal computer with a serial interface (known as an asynchronous communications interface by IBM) and communications software (such as HyperTerminal). The electrical link between the 25- (or 9-) pin male connector on your personal computer's serial interface card and the Wildlife Computers heart-rate / stomach-temperature recorder is made using a special cable assembly. This cable assembly contains electronic components which match voltages between the Wildlife Computers heart-rate / stomach-temperature recorder and your computer, and a voltmeter to check the status of the external AA battery pack.

The HTR matches its baud rate to that of the PC when the space bar is pressed at the start of the communications session. The HTR communicates using the following setup:

1) 300, 600, 900, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14400 or 28800 baud
2) 8 data bits, no parity bit, one stop bit
3) XOFF/XON (CTRL-S/CTRL-Q, ^S/^Q, DC3/DC1) software handshaking
4) No hardware handshaking
5) No character filtering.
6) Full 8-bit character mode, using extended IBM character set.

The general rule is the faster the better, so choose the highest baud rate that your communication package and the HTR both support. The primary advantage of a higher baud rate is that it reduces the time taken to list collected data using the **L** commands. A 2M Byte HTR filled with data will take 40 hours to list using an **L2** command if the baud rate is 300. This drops to 80 minutes at 9600 baud and 27 minutes at 28800 baud (if your PC can handle it...). The only problem with higher baud rates is that your communications package may start to miss some characters. This can wreak havoc with your data, so must be avoided at all costs. The best way to determine the highest reliable baud rate is to start with the fastest available, connect the HTR and establish communications. Invoke the **L2** command. This listing will have 64 characters on all lines after the header, so any lost characters are easy to spot as short lines. If you lose characters, reduce the baud rate in the communications package, briefly turn the communications "off" then "on" again at the communications interface box, then **space** and repeat the **L3** command. When you no longer lose characters when writing to your PC's screen, set the communications package to save the incoming data to disk and again invoke the **L3** command. Check for lost characters as before (on the screen display) and again reduce the baud rate if necessary. Finally check that the saved file has no missing characters. You now have the highest reliable baud rate and this setup should be used for all future HTR communications. If your communications package supports it, save these settings to a file called "HTR". If HyperTerminal is set up correctly, it should be able to work at 9600 baud.

Appendix C: Clock setting and temperature drift

The watch crystals used to run the HTR's clock and calendar have a small, but unavoidable, temperature drift. They have their highest frequency at 25°C and the frequency drops off in a parabolic fashion for temperatures above and below. The formula of this parabola is:

$$f_t = f_{25}(1 - 3.5 \text{ x } 10^{-8} \text{ x } (t - 25)^2)$$

The table below shows the timing errors to be expected from your HTR. As you can see, the HTR's clock will run fast for temperatures above 8°C, and run slow for lower temperatures. The calibration was chosen to give minimum errors between 0°C and 25°C.

Temp	Error		Temp	Error	
°C	min/mth	min/yr	°C	min/mth	min/yr
-10	-1.4	-16.8	11	0.2	2.1
-9	-1.3	-15.5	12	0.2	2.6
-8	-1.2	-14.3	13	0.3	3.1
-7	-1.1	-13.1	14	0.3	3.5
-6	-1.0	-11.9	15	0.3	3.9
-5	-0.9	-10.8	16	0.4	4.3
-4	-0.8	-9.7	17	0.4	4.6
-3	-0.7	-8.7	18	0.4	4.8
-2	-0.6	-7.7	19	0.4	5.1
-1	-0.6	-6.7	20	0.4	5.3
0	-0.5	-5.7	21	0.5	5.5
1	-0.4	-4.8	22	0.5	5.6
2	-0.3	-4.0	23	0.5	5.7
3	-0.3	-3.2	24	0.5	5.7
4	-0.2	-2.4	25	0.5	5.8
5	-0.1	-1.6	26	0.5	5.7
6	-0.1	-0.9	27	0.5	5.7
7	-0.0	-0.2	28	0.5	5.6
8	0.0	-0.4	29	0.5	5.5
9	0.1	1.0	30	0.4	5.3
10	0.1	1.6			

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