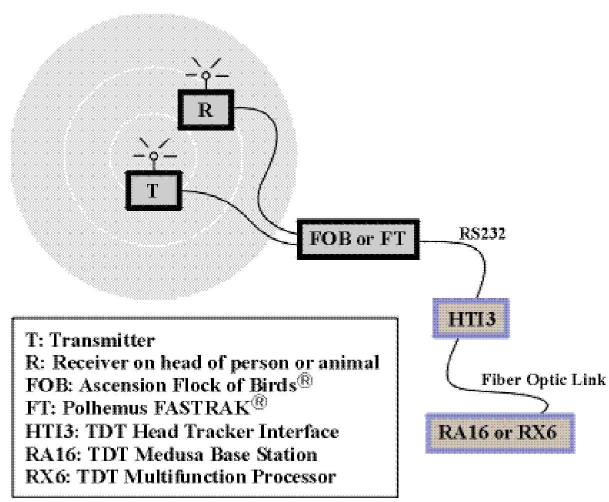
# HTI3 Head Tracker Interface


## Overview

The HTI3 is an interface between your System 3 processor and either the Polhemus FASTRAK® or Ascension Flock of Birds® or miniBIRD® motion trackers and can acquire X, Y, and Z coordinates as well as azimuth, elevation, and roll (AER) data from two receivers/sensors. A boresight signal can be used to zero the AER values to a relative position. This can be accomplished by a manual button press on the front panel of the HTI3 or from an external 3V digital source via the boresight input BNC.

Data can be transferred directly to any System 3 processor with a fiber optic input, bypassing the host computer and enabling movement and positional information to be integrated into experiments in real-time without any increase in latency. Positional information from motion trackers can be efficiently stored and synchronized with biological signals such as EMG, EEG and extracellular neurophysiology or used to update a 3D audio signal presentation in real-time.




**The HTI3 parses the incoming signals from the motion tracker into the following data components:**

**Receiver #:** Each HTI3 can handle up to 2 channels of motion tracker receivers.

**Error code:** The HTI3 will generate four channels that encode the decimal error codes from the Fastrack motion tracker.

**XYZ coordinate space:** The HTI3 will generate three channels of coordinate space distance from each receiver in either inches or centimeters based on information from the motion tracker.

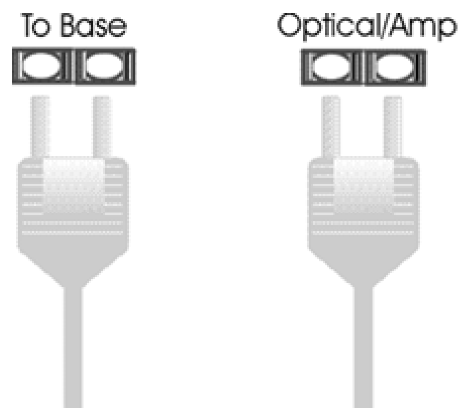
**Azimuth, Elevation and Roll (AER):** The HTI generates three channels of AER information for each receiver based on signal information from the motion tracker.

**Note:** The XYZ space is absolute distance from the transmitter while the AER information is relative to the boresight point.

The raw HTI3 output signals must be scaled to achieve the appropriate signal range before the data can be used. Special processing must be implemented in RPvdsEx to perform the necessary scaling and to reduce redundancy in the data. See "HTI3 Circuit Design" on page 18-11, for more information about this processing and techniques for using the data with HRTF filter components.

## Power and Interface

The device is powered via the System 3 zBus (ZB1PS) and requires an interface to the PC. If the HTI3 is housed in one of several ZB1PS chassis in your system, ensure that it is connected in the interface loop according to the installation instructions: Gigabit, Optibit or USB Interface.




### To Base

The HTI3 sends information to the base station over a fiber optic cable. When connecting the HTI3 to a base station, make sure that the fiber optic cable is connected as shown to the right.

# HTI3 Features

## Reset/Boresight

Pressing the Reset/Boresight button momentarily will issue a boresight command to the tracker unit. This signal will zero the AER values respective to the boresight position. Holding the button down for one second will issue a reset command to the tracker unit and undo the boresight command. The AER values will now be returned with respect to the default initial positioning.

## To Tracker

The To Tracker DB9 input connects the motion tracker to the HTI3.

**Note:** When using the FOB or miniBIRD® motion tracker, data will be properly transferred to the interface if only pins 2, 3 and 5 are connected. A special connector is shipped with the HTI3 to make this transition from the RS232 cable to the tracker. This connector also performs the required RS232 gender change.

## Polhemus/FOB

The toggle switch is provided to select between the FT or FOB motion tracker. This switch must be in the correct position on power up of the HTI3 for correct operation.

### Using the miniBIRD® Set to FOB

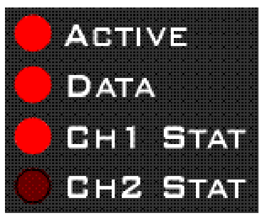
The miniBIRD® tracker must be set to Normal Addressing Mode and the DIP settings should be configured as below:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| ON | ON | ON | OFF | OFF | OFF | ON | OFF |

## Boresight

A boresight command can be issued from an external 3V digital source via the Boresight BNC input. This signal needs to be a logical high ('1') pulse of at least 200 ns in length. The signal then needs to be set logic low ('0') for at least 200 ns before another boresight command can be issued.

## Activity Lights




### Active

The Active LED indicates if the HTI3 is connected to a base station via a fiber optic cable. This LED will flash slowly (~1 Hz) if this connection is not properly made.

### Data

The Data LED indicates if the HTI3 is receiving data from the motion tracker unit. This LED will also flash slowly (~1 Hz) if the tracker is not properly connected to the HTI3.

### CH1 Stat/Ch2 Stat

The Ch1 Stat and Ch2 Stat LEDs indicate if the interface is receiving data from receiver 1, receiver 2 or both. The figure below shows the LED pattern for the HTI3 properly connected to a base station and a motion tracker while acquiring data from receiver 1.

# HTI3 Circuit Design

The HTI3 parses incoming signals from a motion tracker into 16 channels of data and sends it to a base station (such as RZ5, RX6, or RA16BA) at rates up to 25 kHz. Most motion trackers send data at a slow rate (~120 Hz). This means that there is a large amount of redundancy in the data acquired by the base station. The circuit designs described below will reduce the resulting redundancy and convert the raw HTI3 output signals into useful information such as error codes, distance measures and relative positional information such as Azimuth, Elevation, and Roll.

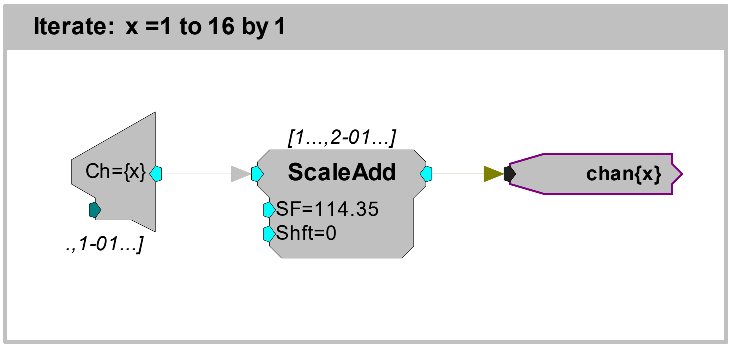
## Acquiring and Scaling Motion Tracker Signals

Motion tracker signals are acquired via a fiber optic cable connecting the HTI3 to a base station. The most common signals input via the fiber optic port are biological signals amplified using one of the TDT preamplifiers; so all signals input through one of these ports are automatically scaled accordingly. When the fiber optic inputs are used to acquire signals from other devices, such as the HTI3, the signals must be scaled according to the signal characteristics of the specific device. With the HTI interface, the signal from each channel must be scaled by 114.35. This adjusts the signal to a range of +/- 1.0 V. Additional scaling is required to convert signals on some input channels to the appropriate units or values. The table below describes the scale factor(s) for each signal input from the HTI3 and for each device.

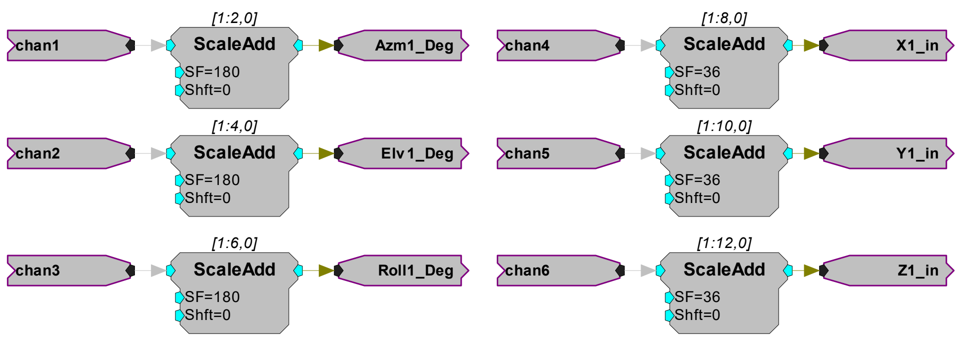
| Device | Receiver | Chan. | Data | SF (base) | SF (cm) or SF(ASCII) for err | SF (in) | SF (rad) | SF(deg) |
|---|---|---|---|---|---|---|---|---|
| FT | 1 | 1 | Azm | 114.35 | NA | NA | 3.14159 | 180 |
| | | 2 | Ele | | NA | NA | 3.14159 | 180 |
| | | 3 | Roll | | NA | NA | 3.14159 | 180 |
| | | 4 | X | | 300 | 118.11 | NA | NA |
| | | 5 | Y | | 300 | 118.11 | NA | NA |
| | | 6 | Z | | 300 | 118.11 | NA | NA |
| | 2 | 7 | Azm | | NA | NA | 3.14159 | 180 |
| | | 8 | Ele | | NA | NA | 3.14159 | 180 |
| | | 9 | Roll | | NA | NA | 3.14159 | 180 |
| | | 10 | X | | 300 | 118.11 | NA | NA |
| | | 11 | Y | | 300 | 118.11 | NA | NA |
| | | 12 | Z | | 300 | 118.11 | NA | NA |
| | 1 | 13 | err | | 16384.2 | | | |
| | | 14 | err | | 16384.2 | | | |
| | | 15 | err | | 16384.2 | | | |
| | | 16 | err | | 16384.2 | | | |
| FOB | 1 | 1 | Azm | 114.35 | NA | NA | 3.14159 | 180 |
| | | 2 | Ele | | NA | NA | 3.14159 | 180 |
| | | 3 | Roll | | NA | NA | 3.14159 | 180 |
| | | 4 | X | | 91.44 | 36 | NA | NA |
| | | 5 | Y | | 91.44 | 36 | NA | NA |
| | | 6 | Z | | 91.44 | 36 | NA | NA |
| | 2 | 7 | Azm | | NA | NA | 3.14159 | 180 |
| | | 8 | Ele | | NA | NA | 3.14159 | 180 |
| | | 9 | Roll | | NA | NA | 3.14159 | 180 |
| | | 10 | X | | 91.44 | 36 | NA | NA |
| | | 11 | Y | | 91.44 | 36 | NA | NA |
| | | 12 | Z | | 91.44 | 36 | NA | NA |
| | 1 | 13 | NA | | | | | |
| | | 14 | NA | | | | | |
| | | 15 | NA | | | | | |
| | | 16 | NA | | | | | |

**Note:** The scale factor for the FT error codes converts the values to ASCII codes.

These scale factors must be incorporated into any circuit design. The circuit below performs the initial scale factor. The circuit uses the iterate function to efficiently scale all 16 channels. The circuit uses only single processor components and works on all devices. The iterate function duplicates the construct 16 times, with an input signal from channel 'x' scaled by 114.35 and then sent to a hop out.



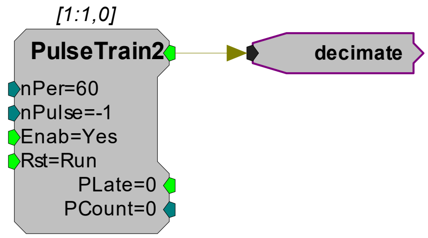

The next circuit segment scales each channel based on the table above for the FOB motion tracker. The first three channels in this example scale Azimuth, Elevation, and Roll. If the input to the HTI3 includes two motion tracker channels, then channels 7, 8 and 9 will contain the Azimuth, Elevation, and Roll information for the second motion tracker. To return this information in radians, the scale factor should be changed to 3.14159. Channels 4-6 are scaled to inches. To scale the XYZ coordinate space to centimeters the scale factor would be 91.44. This circuit can be easily modified to use with the FT motion tracker by inserting the appropriate scale factors from the table above.



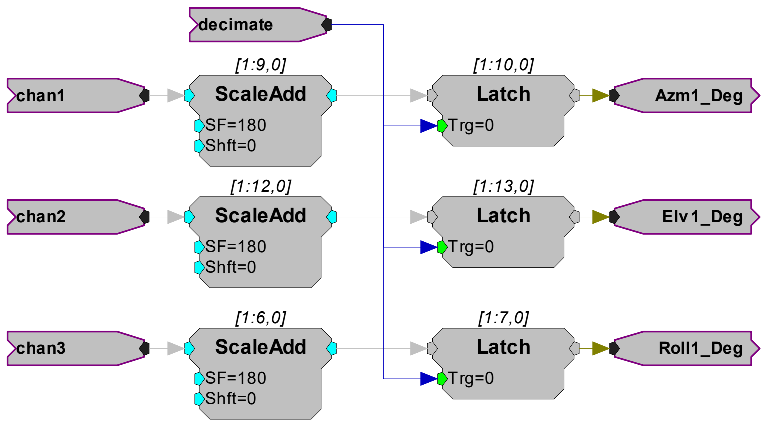

## Data Storage and Visualization of Signal Input

Motion tracker signals are updated/transferred to the HTI3 at rates up to 120Hz. The HTI3 sends signals to the RX/RP device at sample rates up to 25 kHz. This means that each value from the motion tracker may be repeated on the DSP up to 200 times. To minimize the redundancy of the signal, the channel outputs can be decimated by a fixed value. This will decrease the amount of data stored on either the DSP or transferred to a computer. The construct below shows two ways to decimate the signal. One way shows real-time visualization of the signal and the other illustrates storage of the signal to disk.

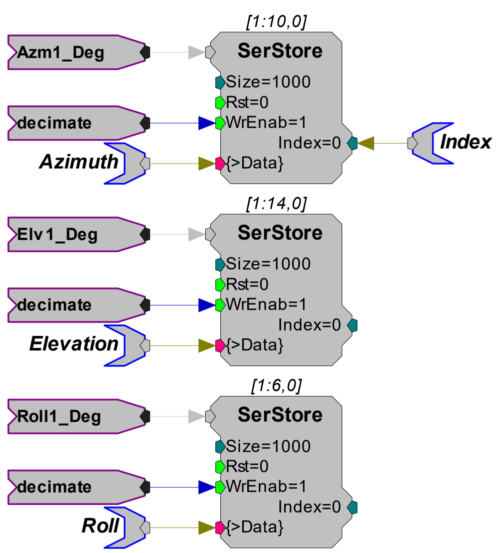
Since the following circuit segments are based on the data transfer rate of the motion tracker itself, users should review the documentation provided with their device before using the parameter values shown.




The PulseTrain2 component sends out a pulse every 60 samples. The output from the PulseTrain2 is sent to the Trigger line on a latch. Therefore the output from the latch is updated once every 60 samples. This generates an updated output that more closely matches the data transfer rate of the motion tracker. The output can then be sent to a head related transfer function (HRTF) coefficient generator (see "Using the HTI3 with HRTF Filters" on page 18-15).

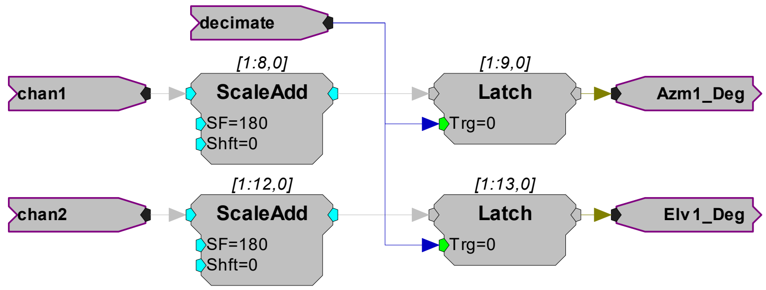



Another way to use the decimated signal would be to send it to a Serial Buffer input. In this case the values are stored once every 60 samples. If you were using this with OpenEx this would be the primary way to save the data set.

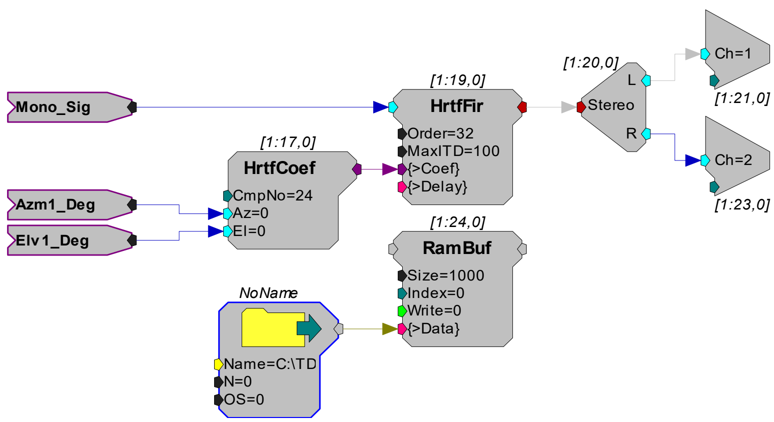


## Using the HTI3 with HRTF Filters

One great advantage of the HTI3 setup is that users can connect the device to an RX6 Multifunction Processor. With the RX6 system, a virtual 3D audio environment can be generated. The following circuit uses the Azimuth and Elevation information to change the perception of a signal input. Channels 1 and 2 are latched via the PulseTrain2 decimation construct discussed earlier.




The output of the HTI3 is sent to an HRTF filter that converts the mono input into a stereo output that can be sent to Headphone buffers etc. A random access buffer stores the HRTF filter values.



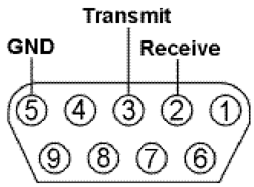

## About the Sample Circuit

The sample circuit HTIFLOCKOFBIRDS.rpx illustrates the scale factors for all incoming channels from the FOB motion tracker. Page 0 shows the initial scaling and the secondary scaling for channels 1-3 (deg) and 4-6 (in). Page 1 shows the scaling of the channels relating to the optional 2nd motion tracker input (channels 7-12).

# HTI3 Technical Specifications

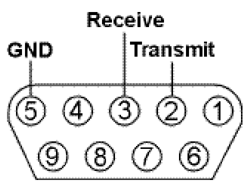
| | |
|---|---|
| **Max update rate** | 120 Hz |
| **Boresight trigger** | External |
| **RS232 acquisition rate** | 115 kbaud |

### To Tracker - DB9 Pinout for Ascension Flock of Birds®




| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | NA | Not Used | 6 | NA | Not Used |
| 2 | Receive | Serial Receive Line | 7 | | |
| 3 | Transmit | Serial Transmit Line | 8 | | |
| 4 | NA | Not Used | 9 | | |
| 5 | GND | Ground | | | |

### To Tracker - DB9 Pinout for Polhemus FASTRAK®




| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | NA | Not Used | 6 | NA | Not Used |
| 2 | Transmit | Serial Transmit Line | 7 | | |
| 3 | Receive | Serial Receive Line | 8 | | |
| 4 | NA | Not Used | 9 | | |
| 5 | GND | Ground | | | |