

Alignment Reference Frame Record

This record is sent in response to an $A\{stationNum\}<>$ command. It returns 9 ASCII floats that were last set with the A command. Each float is represented as 7 characters with 2 digits after the floating point. Units are centimeters.

$2\{stationNum\}A\{OxOyOzXxXyXzYxYyYz\}<>$

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '2'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'A'
4-24	OxOyOz - origin coordinates
25-45	XxXyXz - vector in the direction of the positive x axis
46-66	YxYyYz - vector in the direction of the positive y axis
67-68	CR, LF

Boresight Reference Angles Record

This record is sent in response to a $G\{stationNum\}$ command. It returns 3 ASCII floats that were last set with the G command. Each float is represented as 7 characters with 2 digits after the floating point. Units are degrees.

$2\{stationNum\}G\{yawref\ pitchref\ rollref\}<>$

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '2'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'G'
4-10	<i>yawref</i> - azimuth reference angle
11-17	<i>pitchref</i> - elevation reference angle
18-24	<i>rollref</i> - roll reference angle
25-26	CR, LF

Hemisphere Record

This record is sent in response to an $H\{stationNum\}<>$ command. It returns 3 ASCII floats that were last set with the H command. Each float is represented as 7 characters with 2 digits after the floating point.

$2\{stationNum\}H\{p1p2p3\}<>$

Tip Offset Record

This record is sent in response to an $N\{stationNum\}<>$ command. It returns 3 ASCII floats that were last set with the N command. Each float is represented as 7 characters with 3 digits after the floating point. Units are centimeters.

$2\{stationNum\}N\{Ox Oy Oz\}<>$

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '2'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'N'
4-11	Ox – X-direction tip offset
12-19	Oy – Y-direction tip offset
20-27	Oz – Z-direction tip offset
28-29	CR, LF

Position Operational Envelope Record

This record is sent in response to a $V\{stationNum\}<>$ command. It returns 6 ASCII floats that were last set with the V command. Each float is represented as 7 characters with 2 digits after the floating point. Units are meters.

$2\{stationNum\}V\{Xmax, Ymax, Zmax, Xmin, Ymin, Zmin\}<>$

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '2'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'V'
4-11	$Xmax$ – Maximum X-direction value
12-19	$Ymax$ – Maximum Y-direction value
20-27	$Zmax$ – Maximum Z-direction value
28-35	$Xmin$ – Minimum X-direction value
36-43	$Ymin$ – Minimum Y-direction value
44-51	$Zmin$ – Minimum Z-direction value
52-53	CR, LF

8.5.4. InterSense-specific Records

Manufacturer System Status Record

This record is sent in response to an *MS*<> command. It returns a status record specific to the InterSense system.

31S{statusRecord}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station number. Always '1'
3	Sub-Record type, 'S'
4	Config Hex Char 0
5	Config Hex Char 1
6	Config Hex Char 2
7,8	CR, LF

To decode each of the Config Hex Characters

Config Hex Char 0 Reserved

Config Hex Char 1 Reserved

Config Hex Char 2

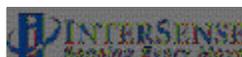
<u>Bit</u>	<u>Meaning</u>
0	Reserved
1	Boresight Compatibility Mode (0 = Firmware Version 2.x, 1 = FASTRACK™)
2	Time units (0 = <i>milliseconds</i> , 1 = <i>microseconds</i>)
3	ReceiverPod LEDs (0 = OFF, 1 = ON)

Manufacturer Station Record

This record is sent in response to the *Ms{stationNum}<>* command. It returns a station status record specific to the InterSense system.

3{stationNum}s{statusRecord}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station number. A hexadecimal number up to C.
3	Sub-Record type, 's'
4	Config Byte 0
5	Config Byte 1
6	Config Byte 2
7,8	CR, LF



To decode each of the Config bytes

Level.

Config Byte 0	Unused
Config Byte 1	Corresponds to the Perceptual Enhancement Level.
Config Byte 2	Can be 0, 1, or 2. The remaining 2 bits are reserved for future expansion of this option.

Config Byte 2	
<u>Bit</u>	<u>Meaning</u>
0	Reserved
1	Heading Compensation Mode bit 1
2	Heading Compensation Mode bit 2
3	Reserved

Heading compensation bits are translated as:
 00 – Compass mode 0 (compass is off)
 01 – Compass mode 1 (Partial compass mode)
 10 – Compass mode 2 (Full compass mode)

Prediction Interval Record This record is sent in response to *Mp{stationNum}<>* command. It returns an ASCII integer for the number of milliseconds of prediction.

3{stationNum}p{interval}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'p'
4-5	Prediction interval.
6,7	CR, LF

Sensitivity Level Record This record is sent in response to *MQ{station number}<>* command. It returns the current sensitivity settings of a station. This setting is only relevant when Perceptual Enhancement level is set to 1 or 2.

3{Station Number}Q{Sensitivity Level}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'Q'
4	Sensitivity level 1 to 5
5,6	CR, LF

Genlock Synchronization Record

This record is sent in response to *MG*<> command. It returns the current synchronization settings of the system.

31G{State}, {Rate}, {Number of cycles per signal}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Always 1.
3	Sub-Record type, 'G'
4	State, 0 to 3
5-11	Strobe rate or Output record rate
12-14	Number of computational cycles tracker performs between sync signals or output records. Multiply this parameter by Rate to determine the internal update rate of the tracker.
15,16	CR, LF

8.5.5. Records Specific to IS-900 Models

Ultrasonic Timeout Record This record is sent in response to the *MU*<> command. It returns an ASCII integer for the number of milliseconds of the ultrasonic timeout.

31U{Interval}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station Number. Always 1.
3	Sub-Record type, 'U'
4,5	Ultrasonic timeout value.
6,7	CR, LF

Ultrasonic Sensitivity Record

This record is sent in response to the *Mg*<> command. It returns an ASCII integer representing current sensitivity setting of the ultrasonic receivers.

31g{Level }<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Station Number. Always 1.
3	Sub-Record type, 'g'
4	Sensitivity Level.
5,6	CR, LF

Fixed PSE Record

This record is sent in response to *MCF*{Fixed PSE number}<> command. It returns the current settings of a single PSE or entire Constellation.

31F{Fixed PSE number}{Fixed PSE record}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type , '3'
2	Constellation Number. Always '1'
3	Sub-Record type, 'M'
4-10	Fixed PSE number in ASCII decimal format.
11-40	x, y, z components of position vector in 10.4f ASCII format. Values are in meters.
41-61	x, y, z components of normal vector in 7.2f ASCII format
62-68	Hardware ID code in ASCII format.
69,70	CR, LF

Tracking Status Record

Sent in response to *MP*<> command. It returns the tracking status information for all 12 stations. Range measurement is defined as an ultrasonic signal received by a single URM. For example, if the system is configured with two URMs and six ultrasonic beacons (SoniDiscs), 12 range measurements per cycle could be received.

31P{Tracking state record}<>

<u>Bytes</u>	<u>Explanation</u>
1	Record type, 3'3'
2	Station Number. Always 1.
3	Sub-Record type, 'P'
4	Tracking state identifier for station 1. State can be L if lost, T for tracking, or X for invalid. Please see Section 4.2.10 of this manual for complete description.
5	Number of range measurements received this cycle.
6	Number of range measurements rejected.
.	...
3+3*N	Tracking state identifier for station N.
.	...
40-44	Update rate per station.
45	Not used, always blank.
46	Genlock identifier. Can be G for Genlock on and synchronized, X if Genlock on but not synchronized, or blank if Genlock is off.
47,48	CR, LF



9. LCD Status & Settings Screen

(Firmware 4.20 and higher)

9.1. Overview

The LCD Status and Settings screen provides a simple and convenient way to view and change most of the tracking parameters, communication protocols, and IS-900 system settings without the requirement of a dedicated Windows PC running ISDEMO. The LCD panel also provides a simple way to place the IS-900 in “file transfer” communication mode for installing firmware updates.

There are 7 buttons provided for status/menu navigation: Up, Down, Right, Left, Enter, F2, and F1 (see **Figure 34**).

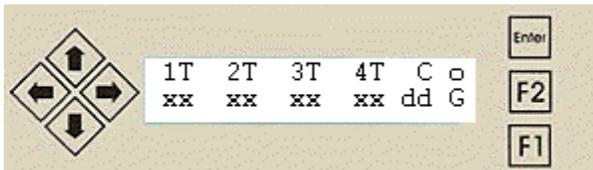


Figure 34 - IS-900 LCD Status & Settings Screen

Command logging indicator is the "C" field. If logging is off, the indicator is blank. If logging is on, it is "C". If logging is on and the log file has wrapped (overflowed), the indicator is "W".

The "G" indicates GENLOCK is on and an "X" in its place indicates GENLOCK in on, but the GENLOCK signal is not valid. A blank field indicates that GENLOCK is off. See Appendix X to learn about GENLOCK.

In display mode, "xx" is the statistic indicated by the "dd" field. The up/down arrows rotate between the possible statistics.

Statistics - when the field "dd" is replaced by:

RC	Indicates the number of measurements received.
RJ	Indicates the number of rejected measurements.
CI	Indicates wireless communication integrity (100% when running wired)*
TQ	Indicates an overall measure of tracking quality (nominally > 80%)

**NOTE: If the tracking device is running wired and the CI is less than 100%, then a faulty wire or connection is probable. Power down and reseal all connections. Contact InterSense if condition continues.*

In display mode, the rotating "~o~" located in the upper right corner of the LCD panel is an indication of IS-900 Processor health operation. If the rotating "~o~" is replaced by an "E", then an error has occurred in the IS-900 processor. Not all errors are serious, and can sometimes be cleared using the LCD menu with no ill effect on the system. The LCD menu will also let you determine the error code(s) which are referenced in **Section 14**.

Buttons for display mode:

Enter	Transitions to menu mode.
Right/Left	Selects next/previous group of stations for status display.
Up/Down	Switches between measurements received, measurements rejected, tracking quality, and communication integrity.

Buttons for menu mode:

Enter	Select menu item at cursor or enter changed setting.
Up/Down	Move cursor to another menu item.
Right/Left	Scroll right/left when viewing error message.
F2	Back up to parent menu.
F1	Return to display mode.

9.2. Normal Operation (Steady State)

During system start-up, the LCD displays a greeting and draws dots along the bottom row. While the dots are being drawn, "file transfer" mode can be invoked by pressing the F1 button. Otherwise, the system begins initializing.

To show progress during initialization, a line of 8 dashes turns into squares from left to right as each port is initialized.

After initialization, the LCD operates in 2 modes; display and menu. In display mode (**Figure 35**), the LCD indicates the tracking status of 4 stations at a time.



Figure 35 - LCD Panel in Normal Display Mode (Tracking One Station)

If the system is running, the station status is displayed and the indicator at the upper right corner of the display should rotate. A number and a letter along the upper row, starting on the left side of the LCD panel, represent each tracking station. Pressing the right arrow button (as shown in **Figure 36**) will bring the status of the remaining stations into view.



Figure 36 - Status Display of Additional Tracking Stations

In **Figure 35**, the “T” indicates that Station 1 (or the Tracker connected into port 1 of the processor) is tracking. The “T” field next to each station number has different letter values that indicate:

- “T” = The station is tracking.
- “X” = The station status is invalid or wireless channel is off.
- “L” = The station is lost.
- “ ” = No station is connected or the station state is “off”.

The statistics field below the station status is used to provide quick feedback of tracking performance for each station. As shown in **Figure 35**, the “RC” shows that 11 ultrasonic measurements were received and used during the last measurement cycle of this tracking station.

Pressing the up/down buttons will cycle through the other statistics displays. **Figure 37** shows a zero value for the “RJ” or rejected measurement field indicating that all ultrasonic measured values were used (none were rejected) during the last measurement cycle.

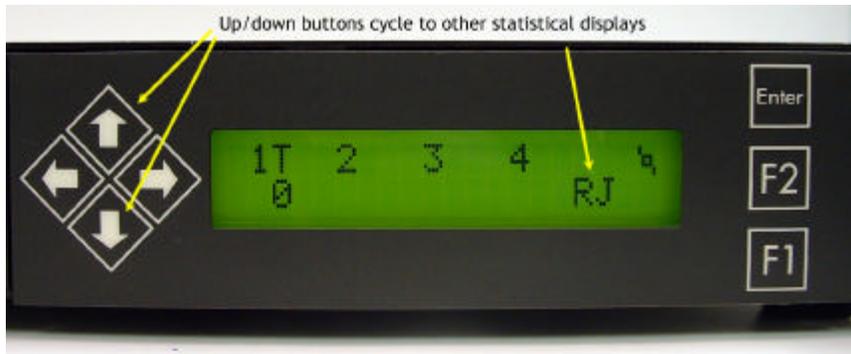


Figure 37 - Rejected Measurement Status for Tracking Station 1

The statistical values for “CI” or communication integrity (shown in **Figure 38**) are represented by a percentage from 0 to 100%. 100% indicates the station is communicating with no errors or missing records. For wired tracking stations, this value will always be 100%. If a station is disconnected, it shows 0%. Anything in between might indicate a poor connection or an excessive length of cable for a wired tracker, or for a wireless tracker, may indicate a weak signal or radio frequency interference.

Wireless stations, typically show 90-100% because some records are lost or corrupted due to the nature of the radio link. Lower percentages can occur when 4 or more radio sets are in range or if interference from a source like a heavy used wireless LAN is present. If a wireless station drops below about 50%, the link is assumed down and shows 0% until it is re-established. A wireless station also shows 0% while it is asleep. When a station drops to 0%, “X” is displayed in place of “T” or “L” for that station on the LCD.



Figure 38 - Communication Integrity Status for a Wired Tracking Station 1

The statistical values for “TQ” or tracking quality (shown in **Figure 39**) are represented by a percentage from 0 to 100%. 100% means that the station is tracking perfectly and 0% means it is lost. When an InertiaCube is plugged into a station port, the tracking quality is always 100% because no ultrasonic measurements are used by 3-DOF devices such as InertiaCubes. For MicroTrax devices, values anywhere in the range are possible.

This statistic is also available in the output data record item #75 indicating communication integrity for a station. It ranges from 0 to 100, the same as the LCD value.



Figure 39 - Tracking Quality Status for a Wired Tracking Station 1

With MicroTrax devices, the number of measurements a station receives and the size of the range errors of each measurement determine tracking quality. A station that receives a measurement at each microphone in almost every measurement cycle, with an average range error of less than 1 mm, will indicate 100%. The quality can drop to 0 if the station stops receiving measurements or range errors get larger than 2 cm. Brisk motions or shock can also temporarily reduce quality. It is typical to see a figure of 90% or higher for a motionless station under good conditions with a well-calibrated Constellation. Loss of data from poor communication integrity will also reduce the tracking quality.

This statistic is also available in the output data record item #40 indicating tracking status for a station. In this data record, the value is 255 x TQ% (a range of 0 to 255).

9.3. Example of LCD Menu Navigation

As example of a typical use for the LCD panel, here are the steps to find out the current firmware revision running on the IS-900. Refer to the menu flow chart in the next section to follow the navigation steps outlined here.



Step 1 – Change to Display mode

When the system is running with one tracker attached at Port 1, the LCD is in display mode as shown in **Figure 35**. The first step is to press the Enter key which brings the LCD into the top menu of Menu mode.



Step 2 – Scroll down to System Config

Use the down arrow keys to scroll to the system configuration menu item.



Step 3 – Access the System Config submenu

Use the ENTER key to access the system configuration submenu.



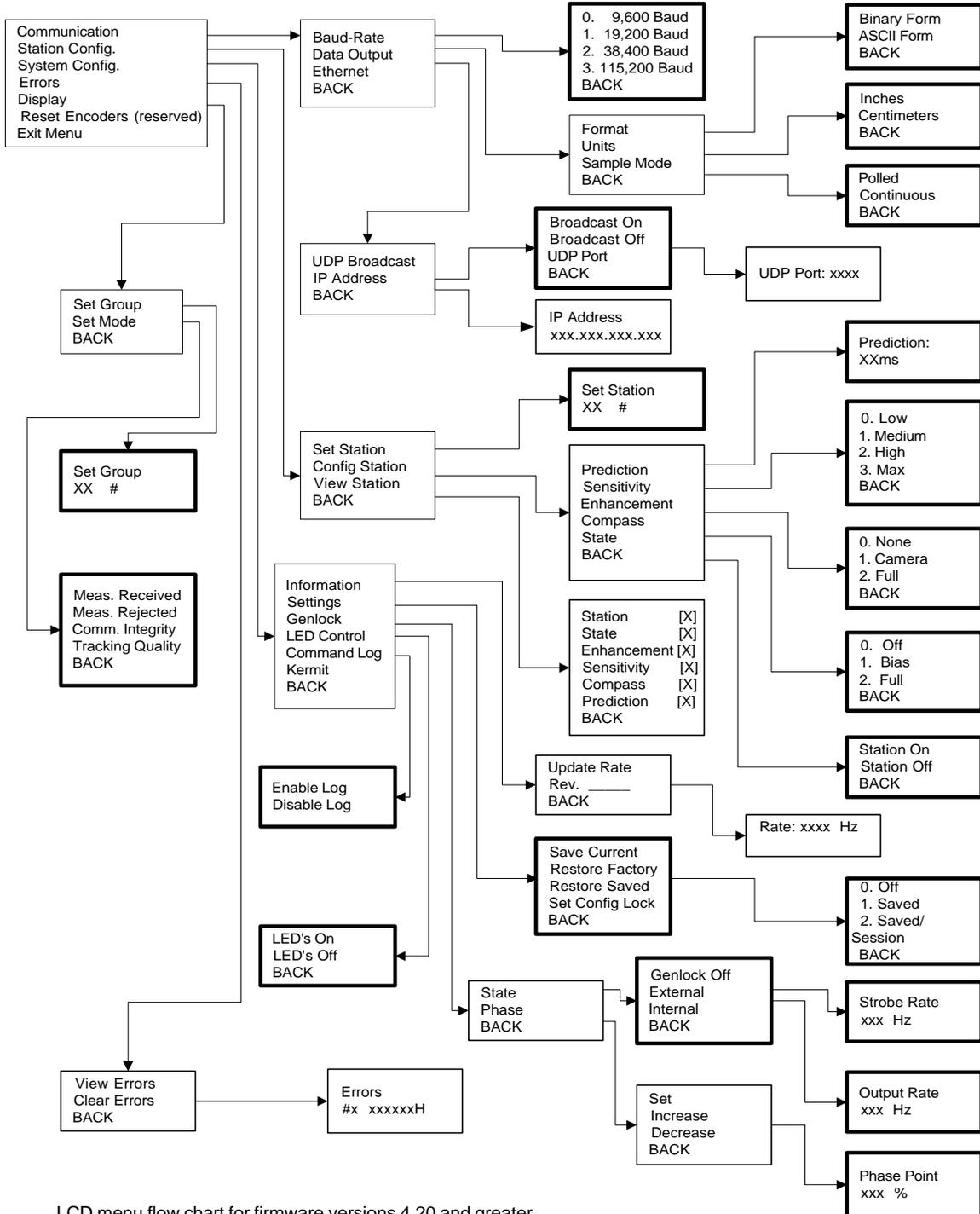
Step 4 – Access the Information submenu

Press enter to access the information submenu which displays the current Firmware Revision of the IS-900.

If left alone, the LCD panel will automatically switch back to Display mode or pressing F1 will exit the Menu mode directly. Pressing F2 will go up a single level in the menu tree.

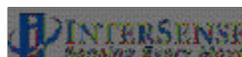
9.4. IS-900 LCD Menu Flow Chart

Figure 40 illustrates the flow chart for the IS-900 LCD menu.



LCD menu flow chart for firmware versions 4.20 and greater.
Bold boxes represent decision points.

Figure 40 - IS-900 LCD Menu Flow Chart



10. Appendix A – Frequently Asked Questions

Q1. What is the maximum length of the cable between the IS-900 MicroTrax Tracked Devices and IS-900 Processor?

The cable between the IS-900 Processor and the MicroTrax Devices has been tested to a length of 15 m (50 feet). This is the total length of cabling including the Tracker cable and the Tracker Extension cable.

Q2. What is the maximum cable length from the IS-900 Processor to the SoniStrips?

The Processor to SoniStrip Cable, Part No. 078-00088-0030, can run a maximum length of 15 meters (50 ft). The maximum length of the total SoniStrip daisy chain measured from the IS-900 Processor to the end of the SoniStrip chain is 24 meters (80 ft.) without external power boosters.

The IS-900 SimTracker configuration can support a maximum of 12 SoniStrips (36 SoniDiscs) per system. The IS-900 VETracker configuration can support 84 SoniStrips (252 SoniDiscs) split between two ports with the use of external power boosters. With the power boosters, the maximum length of the complete SoniStrip daisy chain measured from the IS-900 Processor to the end of the SoniStrip chain can be greater than 90 meters (300 ft.). Please consult InterSense for non-standard configuration support!

See **Section 1.8** for full details on cabling.

Q3. What is the Mean Time Before Failure (MTBF) of each component separately?

Based on supplier data, the MTBF for the IS-900 is estimated at 5 years.

Q4. What type of shock can the MicroTrax Tracked Devices sustain?

The individual inertial components in the MicroTrax Devices are designed to withstand a maximum acceleration of 500 g. Basically this means that a direct impact on the devices is not recommended and will most likely result in damaging the packaging, ultrasonic components and/or calibration of the device.

Should your tracking components experience this type of shock, consult InterSense to determine if repairs or recalibration are needed.

The MicroTrax devices can withstand a higher level of external shock if mounted on rubber, since the acceleration experienced by the MicroTrax device itself is reduced. Also, InterSense manufactures hardened tracking devices for industrial environments. Consult InterSense sales if you require a hardened tracking device.

Q5. What are the PIN assignments on the RS-232 Serial Ports (DB9) on the IS-900 Processor?

Pin	Function
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

Q7. Do you have any advice about working with software packages?

InterSense maintains a full list of supported Third-Party Programs at <http://www.intersense.com/partners.aspx?id=51>. Please check this web page and then consult with the software vendor first to determine compatibility.

If the software package is not listed or you have any questions, contact InterSense technical support at techsupport@intersense.com.

Q8. How do I know whether I have the latest release of ISDEMO?

Check our web site's Support section. The direct URL is <http://www.intersense.com/support.aspx?id=248>. All versions of our product CDs are available for download. We always post the latest release for you to download.

Q9. If my tracker is not working properly, how can I have it examined or repaired?

Please contact InterSense technical support at +1 781-541-7624, or email techsupport@intersense.com. A support representative will assist you with troubleshooting the tracker, and if it is determined that there is a hardware problem, can provide a return authorization number to have it repaired. InterSense has a standard warranty of one year for all serial-numbered items, which covers defects in materials and workmanship. Physical or electrical damaged to equipment is not covered, with the exception of damage that is caused by another InterSense device being properly connected to the damaged device, or in similar instances.

If your device is more than one year old, it can still be repaired by InterSense, but it may incur an examination fee as well as charges for parts and labor. If you require warranty coverage on a device or devices beyond one year, InterSense sells extended warranties in one-year increments – please contact your sales representative for additional information or to purchase such a warranty extension.

11. Appendix B – Troubleshooting & Tips

<u>Problem</u>	<u>Reason/Solution</u>
ISDEMO doesn't work / can't connect to IS-900	<p>Most common reasons (not in any order):</p> <ol style="list-style-type: none">1) Connected to wrong COM port plug on the back of the computer.2) The selected serial port is captured by another program and can't be opened by ISDEMO.3) The RS-232 cable running from the PCTracker Hub to the computer is not a null modem serial cable (crossed TX and RX lines).4) The RS-232 cable running from the IS-900 to the computer is not a straight-through serial cable.5) Not using <i>Start Displaying Data (CTRL-D)</i>. It may be necessary to select <i>Stop Displaying Data (CTRL-X)</i> first.6) Check the communication settings for proper configuration with either Serial or Ethernet, depending on the choice of host communications.7) If connecting over Ethernet, you may need to save the settings and power-cycle the IS-900 for them to take effect. Also, verify that you are using a patch cable if connected to a hub/switch or a crossover cable if connected directly to a PC.8) If connecting over Ethernet, ensure that you are on the correct subnet. This means that the first three dotted numbers are the same between the PC and IS-900, and the subnet mask for the PC's network card is 255.255.255.0.
ISDEMO is running, but system does not track	<p>Check for the following:</p> <ol style="list-style-type: none">1) The IS-900 is not plugged in or the host connection is not plugged in or configured properly. Check all power, connections and Communication configuration in ISDEMO.2) The SoniStrips are not connected to, or detected by, the IS-900 (the port they are connected to should have a corresponding red LED lit to indicate they are connected – if no red LED is lit, then try powering down the IS-900, unplugging and replugging the cable, and turning the IS-900 on again).3) The SoniStrips may be connected to the processor with an incorrect cable. The cables used between SoniStrips and between a SoniStrip and the IS-900 should have 10 pins, and will typically have a blue band around them. If your cable has 8 pins, it is a tracker cable and cannot be used with SoniStrips.

Tracker(s) are lost

Check for the following:

- 1) A valid constellation for the SoniStrips is loaded.
- 2) The small microphones on the MicroTrax Device(s) are covered, upside down or the device is not located under the SoniStrip constellation.
- 3) From the main ISDEMO window, run a self test by selecting menu items “Tools → System Self-Test” and then from the Tracker Hardware and Configuration Test window select menu item “Test → Run Tests”. This creates a window with text information about the configuration of the system and will report is the IS-900 is communicating correctly to both the SoniStrips and Tracker(s). This text file can be saved from the same window using the menu item “File → Save” and sent to InterSense for technical support (techsupport@intersense.com).

Orientation is drifting uncontrollably

After power down, make sure that MicroTrax Device is properly plugged in and if running wireless a communication channel is working.

Specific Troubleshooting Tips for Wireless Devices

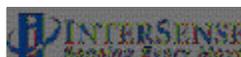
ISSUE: The IS-900 Processor reports an X on the LCD for a wireless station

Run self-test using ISDEMO: Select:

Tools→System Self-Test→Test→Run Tests

At the bottom of the test report, check for error or warning messages:

Message	Possible Cause	Remedy
Link down for station <i>n</i>	Transmitter is powered off or in sleep mode or battery is discharged	Switch module power on, move transmitter to wake it up, plug in charger, respectively
	MicroTrax is not plugged into transmitter	Switch transmitter module off, plug in MicroTrax, switch back on
	Transmitter channel does not match Base Receiver Module channel	In ISDEMO, select Parameters? Wireless Configuration to set up radios
	Transmitter is out of range	Move transmitter and Base Receiver Module closer together until connection is reestablished
	RF interference from another receiver transmitter being used with another IS-900 system in the area	Check for other receiver or transmitter in the area that are powered on and set to the same RF channel.
Link ID for station <i>n</i> doesn't match initial ID	RF interference from other sources	Check for and turn off possible 2.4 GHz sources such as WLANs, cordless phones, Bluetooth devices
	MicroTrax was swapped out with another unit while IS-900 processor was on	Reset IS-900 Processor (if using anonymous mode) or select Parameters? Wireless Configuration in ISDEMO to set up radios (if using normal mode)
	Wireless link could not be established when the IS-900 Processor powered up <i>and</i> the MicroTrax is not the same	Reset IS-900 Processor (if using anonymous mode) or select Parameters? Wireless Configuration



	unit on the station port the last time the system was used	in ISDEMO to set up radios (if using normal mode)
	Interference from a transmitter being used with another IS-900 system	Check for transmitter in the area that is powered on and set to the same channel.
Channels for stations n and m are both set to x	Receivers are set to the same channel	In ISDEMO, select Parameters? Wireless Configuration to set up radios
Link ID for stations n and m are both x	MicroTrax units are not compatible with each other	Contact InterSense

ISSUE: The Base Receiver Module Connection LED intermittently turns on and off while using the system.

⇒ Try moving the Base Receiver Module to a different location, either further away from other Base Receiver Modules or away from any large metal structures and/or closer to the tracking area.

ISSUE: The Transmitter Module does not last more than 6 hours on a single charge.

⇒ Make sure the charge light is off before you start to use the device to get the full charge time.

If the device is over a year old and you have been using it regularly, it may be time to replace the battery. Contact InterSense on how to return the device for the battery replacement.

If the device is fully charged but only lasts a short time (less than 5 hours) there may be a hardware failure. Contact InterSense on how to return the device for service. If you suspect a hardware failure, do not continue to use the device - it could damage the battery and cause a danger. See Battery Warnings at the beginning of this manual.

12. Appendix C - Health & Safety Warnings with Tracker Use Guidelines

Important:

Most of the side effects described in this section usually only occur when a tracking device, like an IS-900, is used with personal displays or 3D glasses. The symptoms listed below usually are referred to as “Simulator Sickness”.



Read and follow the user instructions.

Before using the IS-900, read and follow the user instructions. Also fully read any 3rd party software or HMD instructions. In exceptional circumstances, failure to read and follow the user instructions could result in possible side effects that may lead to accidental injury during or after use.



Recommended.

For use only by persons 15 years of age or older. This system should not be used by:

- Persons under the influence of drugs and alcohol.
- Pregnant women.
- Persons suffering from a heart condition
- Persons with a history of epilepsy.



Take frequent breaks.

It is recommended that the IS-900 should not be used for more than one hour at a time in visually immersive applications. After an hour, you should take a 15-minute rest break before re-use regardless of how you feel. If you feel uncomfortable at any time, stop using immediately.



Rest after using.

Rest for at least 15 minutes after using the IS-900 even if you feel fine and have experienced none of the symptoms described below. If you have experienced any undesirable effects or symptoms, rest until they are completely gone. Do not walk, drive, ride a bike or operate equipment until you have rested, otherwise you risk injury to yourself and others.



Epilepsy and seizures.

A very small part of the population has a condition that may result in epileptic seizures or loss of consciousness. If you or anyone in your family has epilepsy or has experienced seizures or loss of consciousness, do not use PCTracker without first consulting your physician. Persons who have not experienced seizures or loss of consciousness may still have an epileptic condition. We recommend that a non-user is always present when the PCTracker is being used.



Additional possible risks of harm.

While tracking technology has been used for many years, the range of sensors that are used to calculate positional and angular data continues to develop. Over the last twenty years a considerable amount of research has been conducted into possible side effects induced in users of real time computing systems that include various types of tracking sensors. This research has reported the symptoms described below from some users of these systems.

The IS-900 is designed using the latest sensor technologies and we believe that the possibility of such symptoms occurring is minimized. However, it is not possible to design for the individual characteristics of each user and it is possible that users will experience one or more of the side effects described below. Historic research shows that the effects or symptoms ordinarily occur during and immediately after use and should diminish quickly once the user stops using the system.

We want you to make an informed and responsible choice about using the IS-900. Accordingly, we warn you that even if you read and follow the User Instructions, you may experience one or more of the following effects or symptoms when using an IS-900 with a personal display: eye strain, altered vision, eye or muscle twitching, headaches, neck and shoulder strain, nausea and vomiting, disorientation, dizziness, impaired balance and stability, drowsiness, fainting, fatigue, sweating, extreme paleness, impaired hand-eye or other co-ordination.

Each effect or symptom, if it occurs, should be temporary and may last from a few minutes to 30 minutes.

Tracker Use Guidelines

- Keep the IS-900 MicroTrax tracking devices still for the first 10 seconds after starting your application software.
- It is recommended, though not required, that you wait for the MicroTrax devices to warm up (it achieves optimal performance after warming up for at least 15-20 minutes).
- The IS-900 system is tuned for normal head & hand motion. Avoid shaking/vibration. Remember, this precision instrument uses angular rate sensors, which sense smooth, regular movement very well.

If you keep these guidelines in mind, your IS-900 system will deliver superb performance.

13. Appendix D– Care & Maintenance

Care and Cleaning

When not in use, always return your IS900 wireless devices (Wand and Wireless Transmitter) to InterSense's MicroTrax Docking Station or individual charger. The first step to keeping the IS-900 clean is to keep dirt and dust from accumulating. Try to keep the area around the system clear and clean. Open ports in the rear of the base unit can quickly accumulate dust and dirt that can affect their functioning.

Recommended cleaning materials are the same as those for computers. Antistatic cloths, which not only clean the components, but also reduce static electricity, should always be used. Cleaning solutions should be applied to the cloth and not directly on any part of the system components.

Phone & email support

Any questions regarding the care and maintenance of your IS-900 system can be handled by phone (781) 541-7624 (Toll Free in the US 888-359-8478 x624) or by email techsupport@intersense.com. Please see the Support page at www.intersense.com for the technical support contact information.

Returns to InterSense

If you need to return a component to InterSense for replacement or repair, contact InterSense prior to shipment to obtain a Return Authorization (RA) number. When calling, please look on the back of IS-900 Processor to provide the serial number and the serial number of any devices you need to return to help us complete the RA process.

When shipping use the following address:

InterSense, Inc.
36 Crosby Drive
Suite 150
Bedford, MA 01730
USA

RA # _____

Please note that InterSense will not be responsible for materials returned without an RMA number clearly marked on the outside of the shipping package.

Batteries

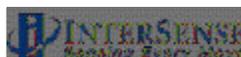
Read the Warnings and Precautionary Statements at the beginning of the manual regarding the Lithium-Ion rechargeable batteries.

Electrical power

IS-900 MicroTrax Charging Station: Input 100-240 VAC, 50/60 Hz; Output +5VDC, 2.5A

Fuses

There are no user replaceable fuses in either the Wireless Transmitter Module or Receiver Base Module.



14. Appendix E – ISDEMO Reference

For ISDEMO Versions 4.1710 and above.

ISDEMO is a tool to help you test, diagnose and configure your system. With ISDEMO, it is possible to test all the features of the tracker. Use it also to set and save tracker configurations.

Software included with your tracking device consists of the following:

ISDEMO32.EXE Win32 version for use with Windows2000/NT/XP or VISTA.

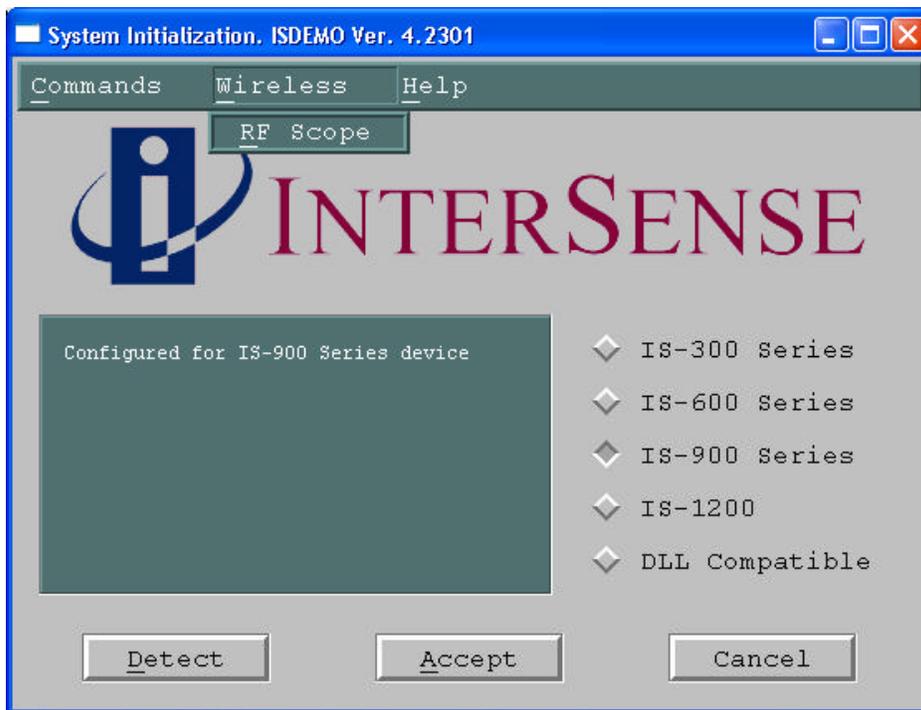
ISDEMO provides a convenient graphical interface that can configure most of the tracker parameters. It does not directly support some features. Sending single line commands through the serial port or via the ISDEMO Command prompt can configure these features. See the section titled “Interface Communication Protocol” for descriptions of all the available commands.

14.1. Getting Started

Install the InterSense product CD on your machine. It will automatically create a directory in your hard drive called “InterSense.”

Using ISDEMO

The first screen you will see is the hardware selection window. This program creates a different interface depending on the tracker model selected.



Select IS-900 Series interface and click Accept to begin. Use the *Detect* option from this first screen to detect serial communication port and baud rate parameters only if you have trouble setting them manually.

The DLL Compatible interface can be used for all InterSense trackers when isense.dll is installed in the \WINDOWS\SYSTEM32 directory of a Windows PC. For set-up and configuration of the IS-900, it is recommended to use the IS-900 Series interface, as some of the interactive controls through the isense.dll interface are inactive in ISDEMO. However, the DLL Compatible option can be useful to test that the IS-900 system is properly interfacing to the isense.dll for verification of an end-user application.

Note: You must select either IS-900 or DLL Compatible (if the isense.dll is installed), or ISDEMO will not be able to correctly configure your tracker.

If you have an InterSense RF analyzer accessory, you can launch the user interface from this first screen by selecting Wireless? RF Scope on the menu bar. See section 14.8 for details.

ISDEMO: Main window

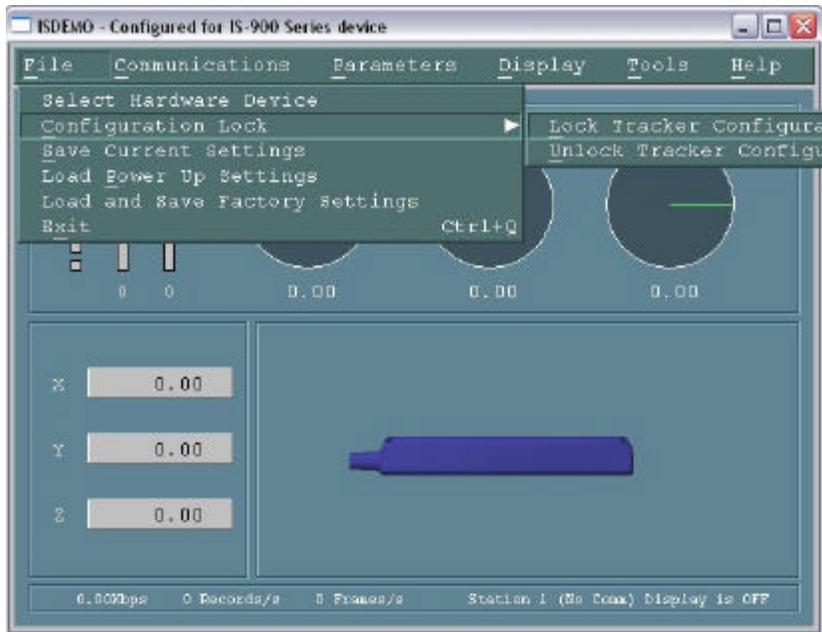
ISDEMO has six primary menus in its main window:

- **File**
- **Communications**
- **Parameters**
- **Display**
- **Tools**
- **Help**



The following sections will walk you through all the menu options.

14.2. File Options

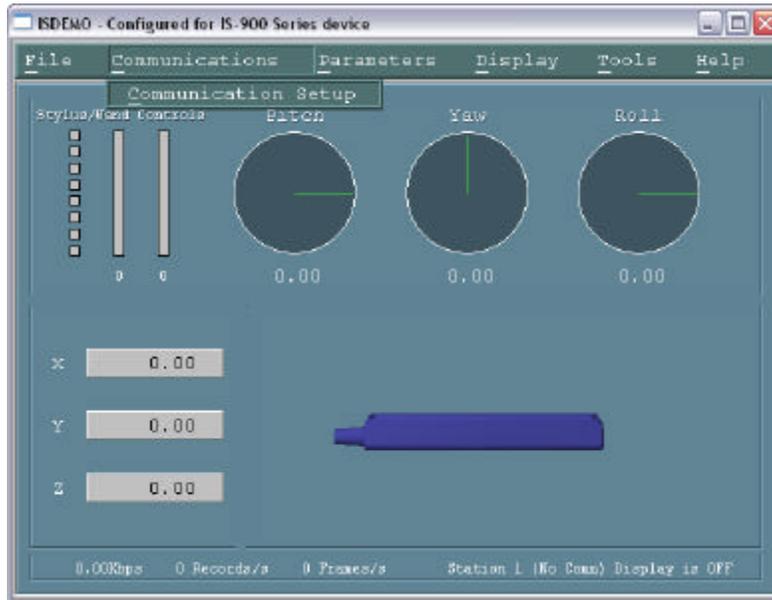


The **File** menu (shown above) provides you with the following options:

- Select Hardware Device** System Initialization window (also seen at initial start-up) is shown when Select Hardware Device is selected. Use this window to select or detect the tracker model connected to your computer.
- Configuration Lock** Configuration lock commands are used to prevent unintentional changes to tracker configurations being saved to permanent memory. They disable or enable the $\wedge K$ command and the W command.
- Save Current Settings** Sends $\wedge K$ command to the tracker. This saves the current settings to nonvolatile memory in the tracker base unit. The next time the tracker is turned on these settings will be restored.
- Load Power Up Settings** Sends $\wedge Y$ commands to the tracker. This restores the firmware to the power up condition. All changes made to the settings since power up or last $\wedge K$ command are lost.
- Load and Save Factory Settings** Sends W command to the tracker. This restores the system settings to the factory defaults.
- Exit** Closes ISDEMO

14.3. Communications Options

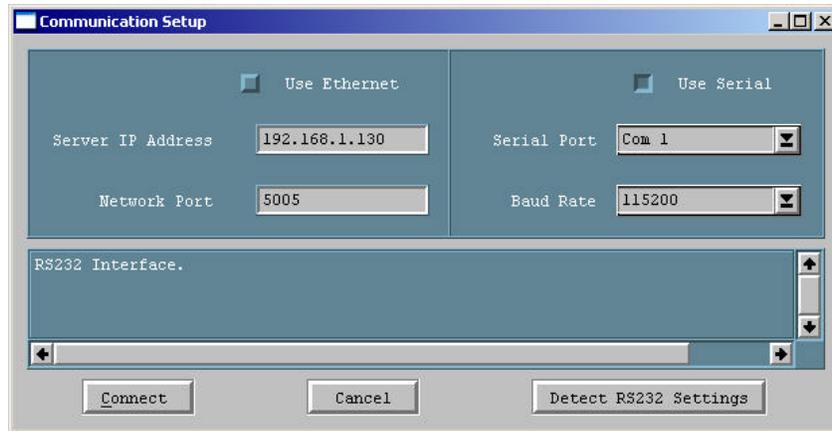
This menu allows the communications port and the baud rate of the computer ISDEMO is running on to be set to match the settings of the tracker. The default settings are COM port 1, with a rate of 115,200 baud.



Communications Setup

The IS-900 allows both Serial communications as well as Ethernet communications. The Ethernet interface is used as a command interface with exactly the same InterSense command protocol used for the serial port. Either communications interface is available as a view port while the host application is communicating through the other interface. Using ISDEMO on one port while communicating tracking data through the second allows performance of basic diagnostics or system configuration while the host application is live.

Selecting the *Communication Setup* menu option brings up of the following configuration window.



Ethernet Configuration

Ethernet is supported with IS-900 firmware version 4.20 and higher. Ethernet is disabled by default. An IP address must be configured using the serial port to enable the Ethernet option. Refer to Section 4.2 to set an IP address for your IS-900 tracker. Two Ethernet interface paths are available - a command interface and a UDP broadcast interface. TCP is used in this case with socket port 5005. Only a single client at a time can connect via the command interface.

Server IP Address

Enter the IP address of the IS-900 in the Server IP Address box, and leave the Network Port set at 5005. After typing the Server IP Address, you must hit enter while the cursor is still in the box, or the program will ignore the change.

Network Port

This setting must be 5005 for TCP.

Serial Configuration

Default settings are for the serial port set to COM 1 with a baud rate of 115,200.

Serial Port

Choose the RS232 port the tracker is connected to.

Baud Rate

Choose the communications speed the tracker is connected at.

Connect

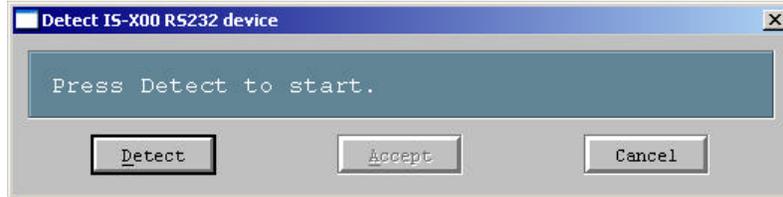
ISDEMO attempts to connect to the IS-900 Processor using the selected communication parameters.

Cancel

Exits the screen saving the current selected communication parameters.

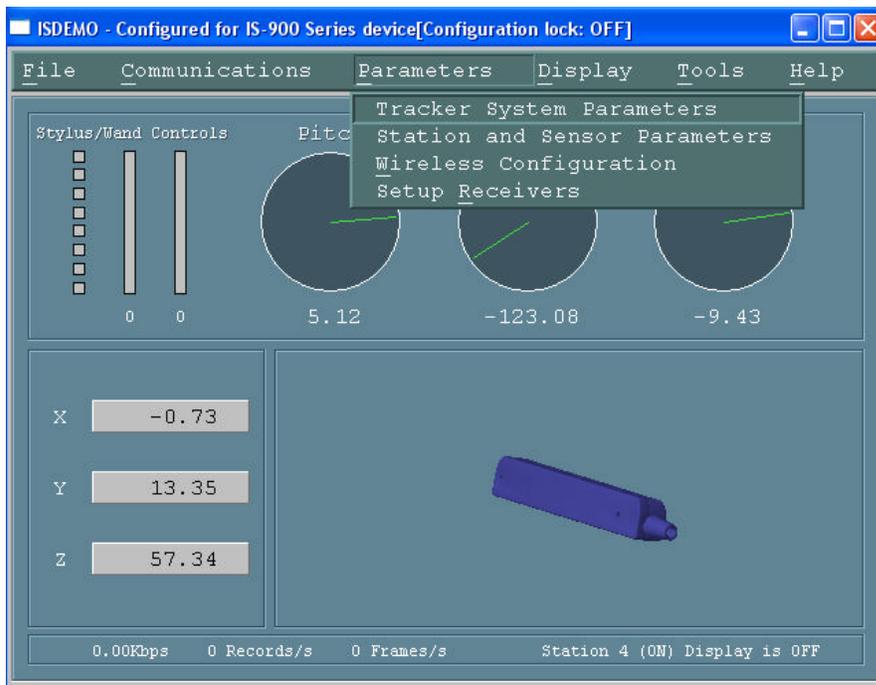
Detect RS232 Settings

When chosen, this option will automatically detect the port and the baud rate being used. The program attempts to establish communication by sending the S command (status record request) and waiting for a response for 2 seconds. If the status record is not received within that time the program tries again with the different communication parameters.



14.4. Parameter Options

Parameters menu allows access to the tracker configuration controls.



Tracker System Parameters



Output Mode

Polled or Continuous. In Polled mode, data records are sent out only in response to a *P* command.

Measurement

(output record)
Inches
Centimeters

Data Format

ASCII
(F command) Numbers are returned in ASCII format. Each number has 7 ASCII characters: a sign, 3 digits, a decimal point, and 2 more digits.

Binary

(f command) Floats are sent as 4 bytes of IEEE 32-bit floats. This can increase the data throughput by minimizing the size of the record.

Genlock

State

(MG command) Off, Automatic (not supported), External (manual, supply strobe rate), Internal (supply output record rate).

Sync Rate

Value in Hertz used with Genlock enabled.

Sync Phase

0-100%.

Please see section 15 for complete details.

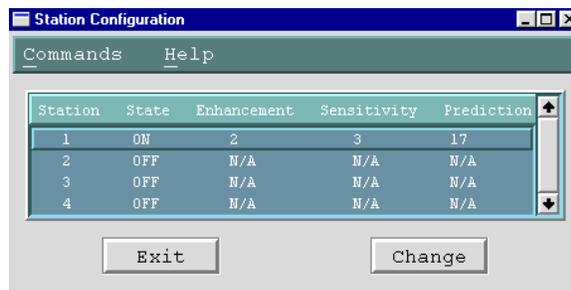
SoniDisc LEDs (ML command) Enable and disable the SoniStrip LEDs.

Ultrasonic Volume Sets the volume of the SoniDiscs (ultrasonic emitters). Ranges between 0 (off) and 3 (maximum volume).

Station and Sensor Parameters

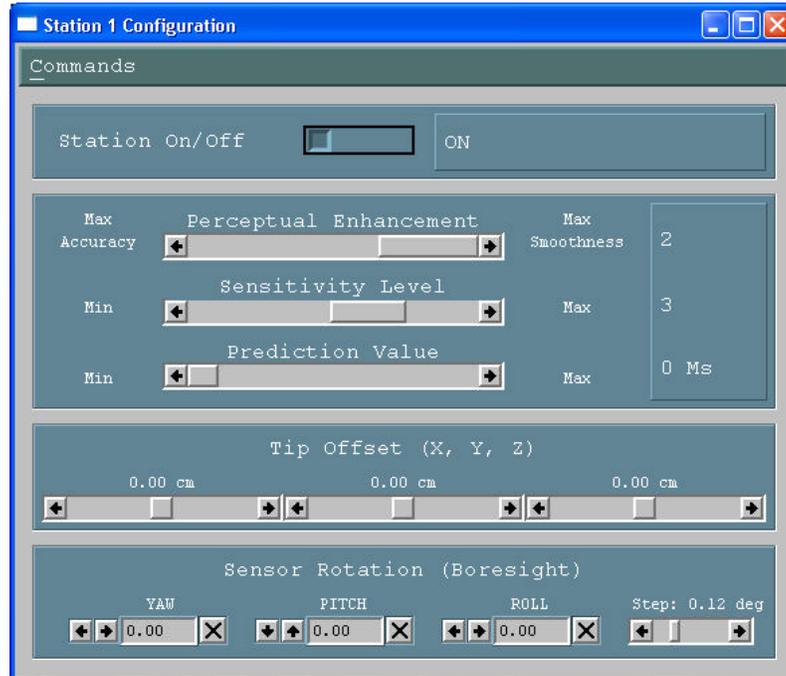
The window shown below lists each station to be configured. A “Station” is a position and/or orientation-sensing unit. IS-900 Series trackers can support up to 7 stations (the 8th port being reserved for SoniStrips).

Before data is displayed in this list, ISDEMO attempts to receive the configuration data from the tracker. If this fails for any reason, an error message is displayed and data in the list may not be reliable.



Double clicking on the Station line or selecting the Change button will bring up the Station Configuration window where changes can be made.

Station Configuration window



Station ON/OFF When a station is ON a data record will be sent for it, even if there is no hardware connected to the base unit.

Perceptual Enhancement Level

In order to provide the best performance for a large range of applications, three levels of perceptual enhancement are available. None of the modes introduce any additional latency.

Mode 0 provides the best accuracy. The inertial tracker uses gyros to measure angular rotation rates for computing the sensor's orientation. To compensate for the drift, tracker uses accelerometers and an ultrasonic range measurement system to measure the actual physical position and orientation of the sensor. That data is then used to compute the necessary correction. In Mode 0 correction adjustments are made immediately, no jitter reduction algorithms are used. This results in most accurate output (not recommended for head tracking) with lower RMS error. Use this mode for accuracy testing or for any application that requires best accuracy.

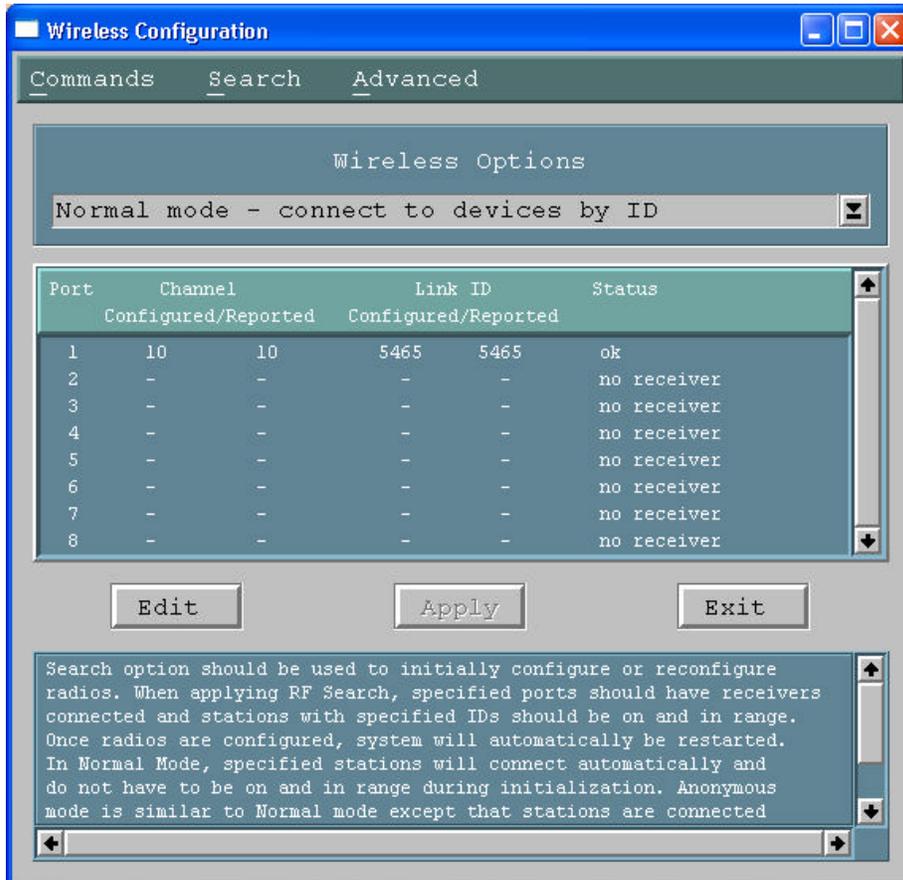
Mode 1 provides accuracy similar to that of mode 0, with an addition of a jitter reduction algorithm. This algorithm reduces the accuracy by only a small amount and does not add any latency to the measurements. Mode 1 is recommended for augmented reality applications (i.e. overlaying or mixing both virtual and real objects in a visualization system.)

Mode 2 is recommended for use with HMD or other immersive applications. The drift correction adjustments are made smoothly and only while the sensor is moving, so as to be transparent to the user.

- Sensitivity Level** This setting is only used when Perceptual Enhancement Level is set to 2. It controls the minimum angular rotation rate picked up by the MicroTrax inertial components. Default is level 3. Increasing sensitivity does not increase latency during normal movements. It may result in some small residual movements for a couple of seconds after the sensor has stopped. If your application requires sensitivity greater than the maximum provided by this control, you must use Perceptual Enhancement level 0 or 1 instead.
- Prediction Value** IS-900 can predict motion up to 50 ms into the future, which compensates for graphics rendering delays and further contributes to eliminating simulator lag.
- Tip Offset** Defines a set of position offsets, so a different point can be tracked. Offsets are measured in the body coordinate frame of the MicroTrax station and are entered in centimeters.
- Sensor Rotation** Sets the boresight reference angles in degrees for the specified station.

14.4.1. Wireless Configuration window

The window shown below lists the wireless status and configuration for each processor port.



Port	Port of the IS-900 Processor.
Configured Channel	The channel that the connected receiver is configured to. No two receivers can be configured to the same channel.
Reported Channel	The channel that the connected receiver is currently on.
Configured Link ID	The link ID that assigned to the receiver. Each wireless tracker has a link ID associated with it when it is shipped. This 5 digit number can be found on a label on your device.
Reported Link ID	The link ID that is currently associated to the receiver.
Status	Port status. Any ports with a status of "no receiver" do not have receivers and cannot be configured

Normal Mode

Use normal mode to set radios to desired channels and station IDs. Only stations with the specified IDs are connected to. Select a port with a receiver connected and click Edit.



In the Port Settings dialog box, enter the channel (0-15) and station ID to use for that port. Each port must be assigned its own channel. To maximize performance, it is recommended that active channels be separated by one unused channel. It is possible to use adjacent channels, but interference may occur under some circumstances.

The link ID is the 5 digit number on a label affixed to the exterior of each tracked device. If the ID cannot be read from the label, run level 3 self test to determine the ID (see section 14.6).

Click Clear to remove settings from a port. Click Apply to dismiss the dialog box. Repeat as needed to configure additional ports.

When done, click Apply configure radios. The operation may take about a minute to complete. If successful, status for each configured port should be "ok." If the status is "station not found," verify that link IDs are correct and devices are on and in range. Select Search? RF Search to reapply configuration.

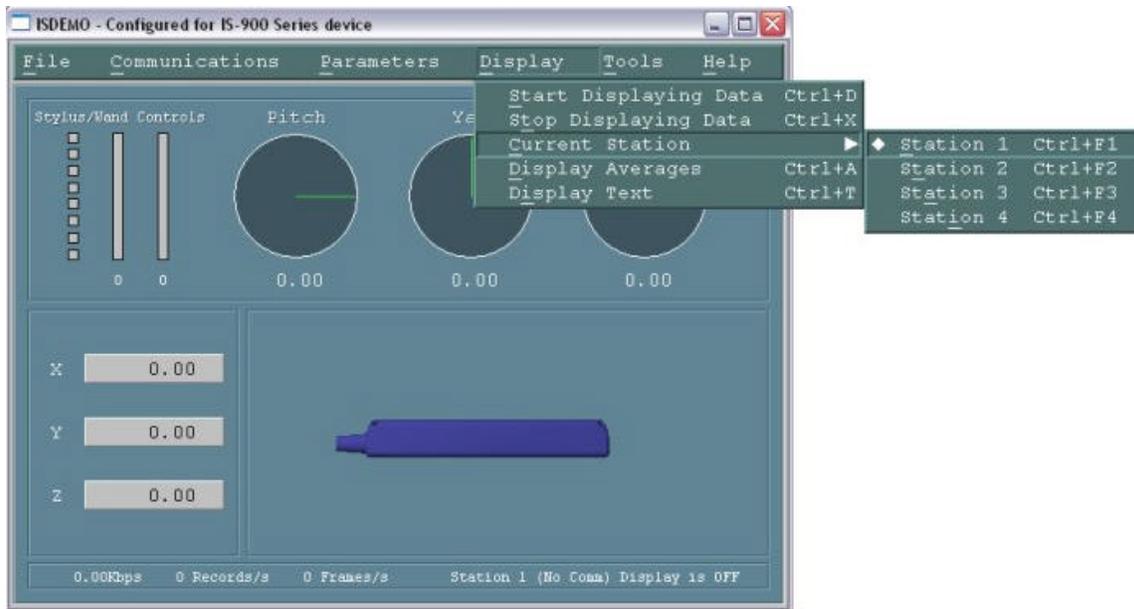
Once configured, stations will connect automatically and do not have to be on and in range during system initialization.

Anonymous Mode

In anonymous mode, stations are connected to if they are on the same channel as a receiver regardless of their ID. This allows a station to be swapped out with another station set to the same channel without reconfiguration (however system reset is required).

It is recommended that normal mode be used in most situations. This is especially true if the IS-900 is operating in the vicinity of wireless InertiaCubes or other IS-900 systems with wireless MicroTrax devices in use. In anonymous mode, the IS-900 may mistakenly connect to these other nearby devices.

14.5. Display Options



Start (and Stop) Displaying Data

To display position and orientation data being received from the tracker, use the *Start Displaying Data* option in the *Display* menu or press Ctrl-D. ISDEMO first attempts to establish communication and get all configuration information necessary to correctly interpret and display incoming data. If it fails to receive a reply to any of the status record requests it will still go into the display mode, but there may be no data to display or it may not be able to display the data correctly. If such errors are detected, stop the display by selecting *Stop Displaying Data* option in the *Display* menu or pressing Ctrl-X and check the connection.

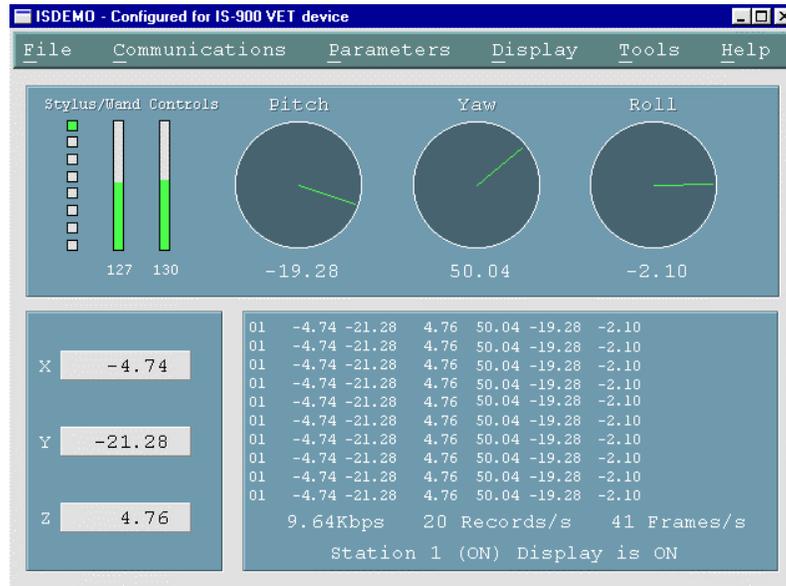
Station Number

Allows the user to choose which station is to be displayed in the main window of ISDEMO. Ctrl-Fx, where x represents the station number, can also be used to switch stations. For example, to switch to station 2, use Ctrl-F2.

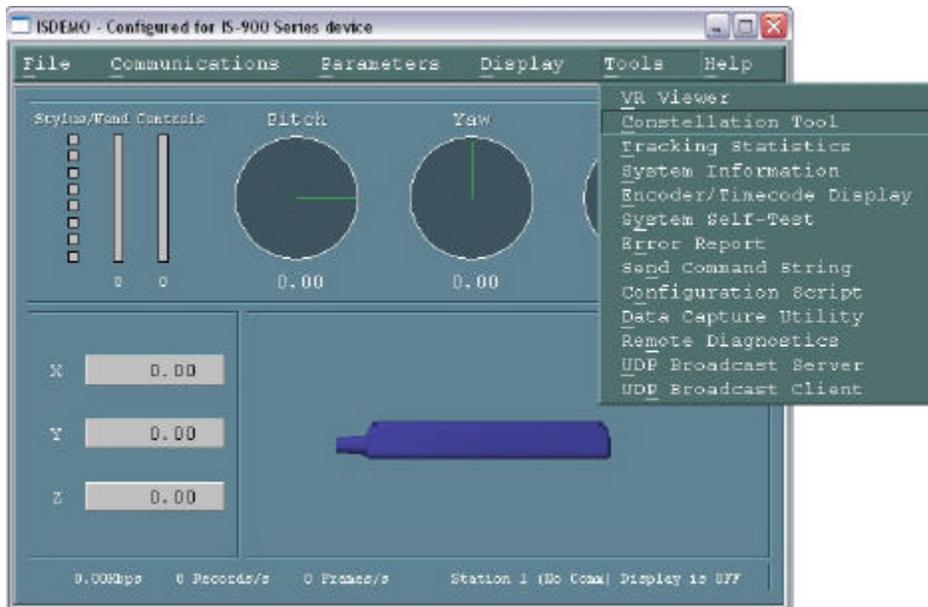
Display Text

When this option is selected all status and some of the data records are displayed in text format in the sensor display area. To prevent graphics updates from taking over most of the processor time, no more than 20 data records per second are displayed.

Please note that whenever your tracker is in continuous mode, records are displayed in the text window even when the display is off.



14.6. Tool Options



Constellation™ Tool

This tool provides a graphical representation of the tracked area. All tracked devices are shown. The Constellation Tool is extremely useful when first installing the IS-900 system. See Section 10.7 of the manual for more information.

Tracking Statistics

This option is used to display tracking status information for all stations. G = Genlock indicator. It appears in the right lower corner of the display if GENLOCK feature is on and working properly. If the "G" is replaced with an "X", this indicates the GENLOCK feature is on, but a valid signal is not being detected. See Appendix F for details about GENLOCK.

	1	2	3	4	5	6	7	8	Update Rate
Stn									
Status	T								
Meas	14								123Hz
Rej	0								
TQ (%)	91								
CI (%)	100								

Row 1 (Stn) lists station numbers.

Row 2 (Status) displays the tracking status. Stations display T when tracking position, and L (Lost) when position tracking is not possible. If a station configuration is invalid or hardware is not connected, X is displayed.

Row 3 (Meas) displays the number of range measurements received by each station during the last cycle. A range measurement is defined as an ultrasonic signal received by a single microphone.

Row 4 (Rej) displays the number of range measurements rejected by the system. This number should normally be zero. Measurements can be rejected for one of the following reasons:

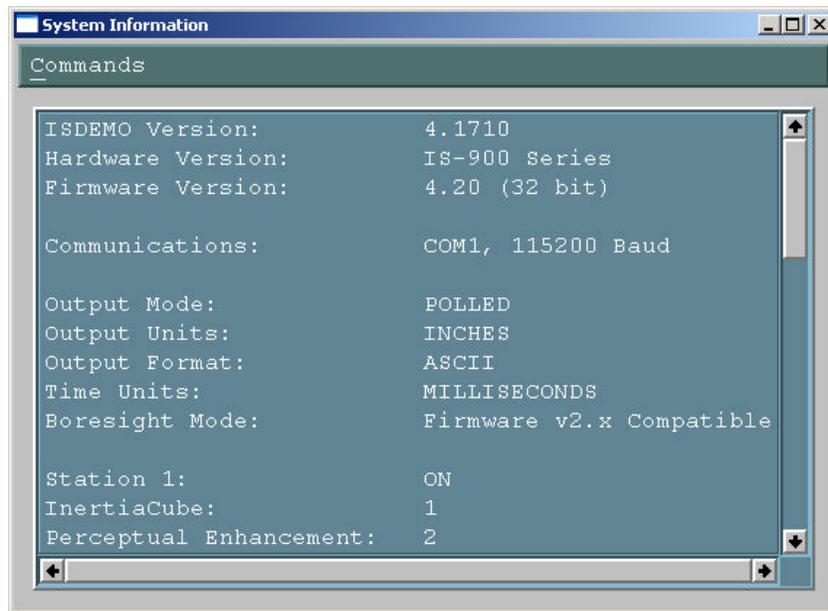
- SoniDisc configuration (Constellation™) is inaccurate
- Ultrasonic interference or reflections are creating false measurements. Try increasing ultrasonic timeout. See *MU* command in section 6.2.1.
- Extremely fast movements can sometimes cause some measurements to be rejected.

Row 5 (TQ) displays the tracking quality of the station as a percentage. It is a measure of the number of measurements a station receives and the size of the range errors of the measurements. 100% means that the station is tracking perfectly and 0% means it is lost. To activate TQ display, right-click and select option to enable.

Row 6 (CI) displays the communication integrity of the station as a percentage. 100% means that the station is communicating perfectly and 0% means that it is not communicating at all. To activate CI display, right-click and select option to enable.

System Information

This window provides a summary of the InterSense tracker system configuration.



System Self-Test

There are three levels of tests supported for this release.

Level 1

Designed to detect and display information on all the connected hardware and compare it to the user configuration to evaluate it for errors. This tool is designed for troubleshooting the system when hardware failure is suspected.

Level 2

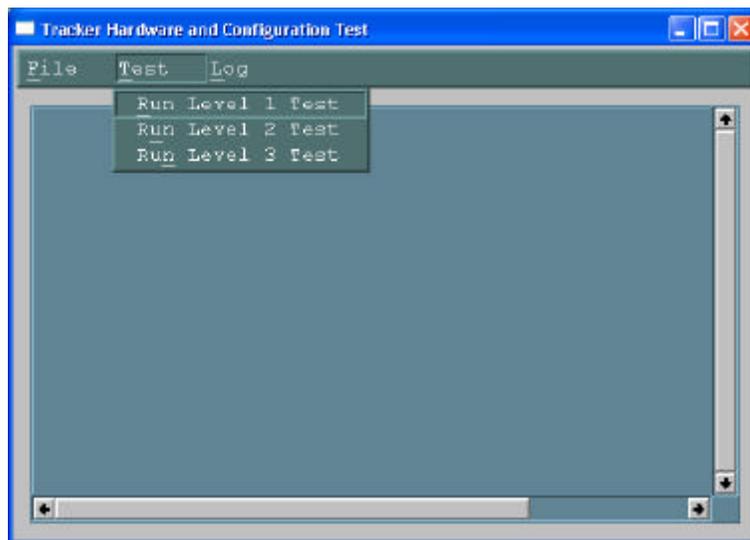
Displays the current Communication status, Tracking quality and URM noise for all active stations. **Communications Status** for wired stations should always show 100%. If a station is disconnected, it shows 0%. Anything in between might indicate a poor connection or an excessive length of cable. Wireless stations, on the other hand, typically show less than 100% because some records are lost or corrupted due to the nature of the radio link. **Tracking quality** is a measure of the number of measurements a station receives and the size of the range errors of the measurements. 100% means that the station is tracking perfectly and 0% means it is lost. **URM noise** is measured by suspending the firing of beacons for a period of time and counting the number of

detections at each microphone. Under good conditions, the percentage is 0% or close to it.

IMU stands for Inertial Measurement Unit, also called InertiaCube. URS stands for Ultrasonic Ranging System and includes interface board, microphones, and transmitters (SoniDiscs).

Level 3

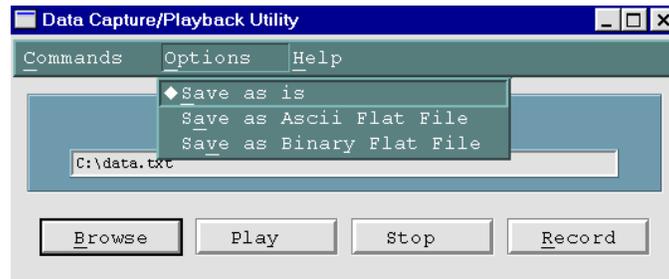
Searches for wireless stations and displays wireless receiver and station configuration. Please note that the search operation can take a minute or so to complete. This tool is useful for identifying a wireless device if its ID is unknown. The ID is needed to use the ISDEMO Wireless Configuration Tool. **Wireless receivers** are listed with their respective port numbers and channel settings plus a field that indicates the type of control (active or manual). MicroTrax receivers have active control, which means channel settings and station pairings can be changed using the Wireless Configuration Tool. Previous-generation receivers have manual control via a mechanical channel switch. **Wireless stations** that were detected during the search are listed with their respective IDs and channel settings. If the station is paired with a receiver, its port and slot number is also shown. The search operation can only detect stations that are powered on and in range. Since the search operation scans through all available channels, be aware that it may temporarily interfere with other InterSense trackers if they are in range.



Self test reports generated here can be saved to the disk using the *Save to a File* option in the *File* menu. Send the reports to InterSense technical support (techsupport@intersense.com) for analysis and help with troubleshooting.

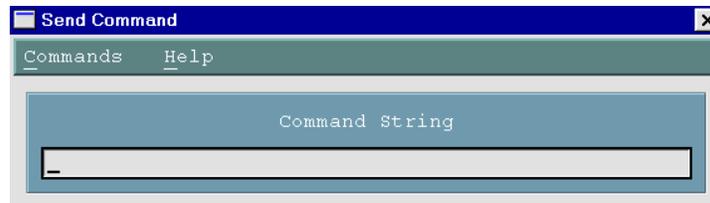
Data Capture/Playback Utility

ISDEMO has the ability to write the data it receives from the tracker to a file. To utilize this feature you must first specify the name and location of the output file. To start data collection, select *Record*. Data can be *Saved as is*, or in an *ASCII* or *Binary Flat File*. When the *Flat File* option is selected, only tracker data is saved, one line per update cycle. To import data to Excel or Matlab the output format must be set to *ASCII* or the *ASCII Flat File* option must be used. Previously recorded data can be displayed through ISDEMO by selecting *Play*. Playback option will only work on files saved with the *Save as is* option.



Send Command String

Allows single line commands to be sent to the tracker. This tool is provided to allow control over the tracker parameters not supported in the ISDEMO menus and dialogs or on the LCD button panel. For instance, this function can be used for test and debug purposes. Type in the command and press Enter or Return. The <CR LF> pair is automatically added to the end of the line before it is written to the serial port. See Section 4—Interface Communications Protocol for the complete list of all available commands.



Configuration Script Tool This utility provides complete control over the tracker parameters, including support for multiple configurations. Contents of the display area of the window can be edited directly, like in any text editor.

File

Load from File Ctrl+O
Opens a file selection dialog box. Configuration file must be a plain text file.

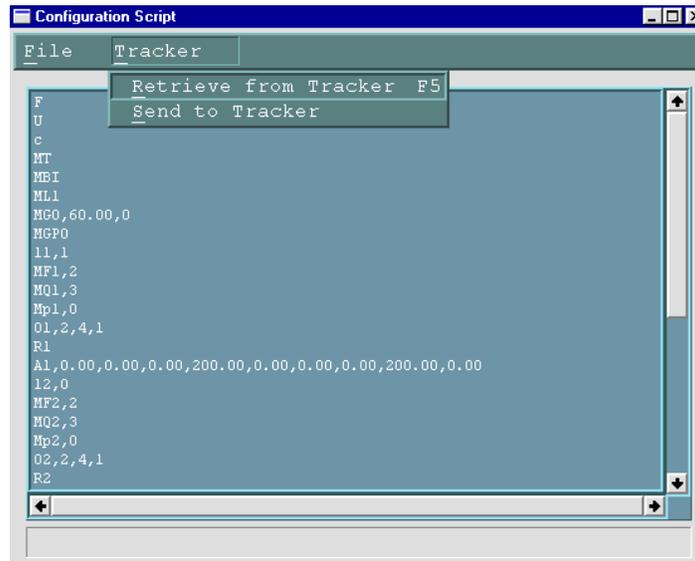
Save to File Ctrl+S
Used to save contents of the window to a text file.

Exit Ctrl+Q

Tracker

Retrieve from Tracker F5
Queries the tracker for all possible configuration parameters, converts them to commands and displays the results in the window. This can then be saved to a file.

Send to Tracker
Sends all interface commands in the display area to the tracker. CR LF pair is automatically added to each line.

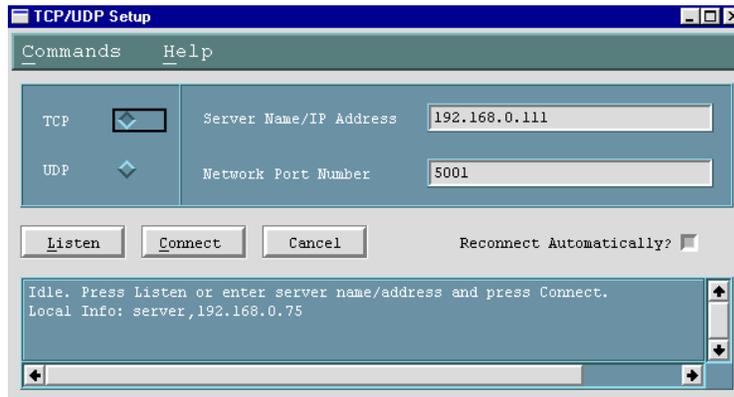


Remote Diagnostics

This feature of ISDEMO is designed to improve technical support by allowing an InterSense engineer to diagnose a tracker remotely, eliminating the need for the customer to spend a significant amount of time on the phone.

To use this feature the tracker has to be connected to a PC with a working connection to the Internet. Firewall introduces

some difficulty, but it should still work. An InterSense technical support engineer will walk you through the required procedure.



When connected, ISDEMO becomes a relay, passing serial port data to a remote host. Commands sent from the remote host are also relayed to the tracker. InterSense engineers at the remote computer can run diagnostics software as if the tracker was connected to that computer directly.

There are two ways of connecting to the remote host. ISDEMO can listen to the connection requests on the specified port, or it can try to connect itself. The first method is preferred as it makes it easier for the InterSense engineer to reconnect if connection is lost for any reason. For this to work the PC can't be behind a firewall (proxy) and InterSense engineer must know its IP address. To diagnose the tracker with this method do the following:

1. Make sure that ISDEMO can communicate with the tracker.
2. Open the Remote Diagnostics tool.
3. Write down the IP address displayed in Local Info line.
4. Make sure protocol selection is set to TCP, port to 5001. If this is not possible, notify InterSense.
5. Click on Listen button and confirm by reading the message.
6. Call InterSense or send email containing the IP address and port number.

If your PC is behind a firewall, ISDEMO will need to connect via the second method. To connect in this way, follow these steps:

1. Make sure that ISDEMO can communicate with the tracker.
2. Open the Remote Diagnostics tool.

3. Call or email InterSense to obtain the Server IP Address.
4. Make sure that protocol selection is set to TCP and port to 5001. If this port is not available, other numbers can be used, provided that InterSense engineer is notified.
5. Enter IP Address and click on Connect button.
6. Watch the message area of the window for status information.
7. If connection is lost prematurely, try to reconnect.

For unattended operation or if link is intermittent, please make sure that Reconnect Automatically option is selected.

It is desirable to have the InterSense technician on the phone during the diagnostics session, as he or she might have questions about the physical configuration and position of the tracker. If this is not convenient, a simple chat client is build into the program. It allows one-line messages to be sent to and from the remote host. Messages are displayed in the text window. To send a message, open Send Message control in the Commands menu.

14.6.1. System Errors

Some basic system errors and their meanings are listed in the table below.

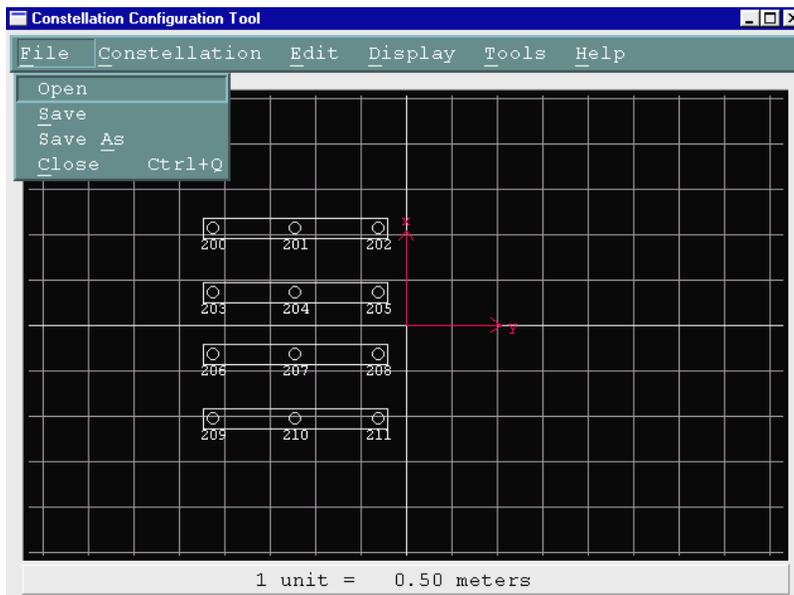
Code	Type	Message	Comments
6401	General	Math exception	Invalid sensor data or bad IMU calibration - if persists contact InterSense.
6402	General	SOS out of range - check PSE configuration	Poor/invalid Constellation™ or microphone configuration.
6404	General	Inconsistent PSE position or obtuse PSE angle	Check beacon normal vectors.
010x	URS	URM start/read failed	Likely communication error.
020x	IMU	IMU start/read failed IMU read timed out	Likely communication error.
0205	IMU	IMU NVRAM read failed	Failure while reading calibration data from MicroTrax device EPROM.
020A	IMU	No MicroTrax device connected to this port	
020B	IMU	Failed reading sensor EPROM	
020C	IMU	IMU get config failed	Driver level error. Occurs during IO Board initialization.
020D	IMU	Can't select IMU channels	IMU read error.
0401	IO Card	Fatal IMU IO board failure	Hardware problem, contact InterSense.
0402	IO Card	Bad IO board status	Hardware problem, run level 1 self-test for details and contact InterSense.
0501	Config	Failed to produce Alignment Reference Frame matrix	Invalid parameters specified in "A" command
0504	Config	SoniDisc Hardware ID out of range	SoniDisc hardware ID is invalid.
0510	Config	Too few SoniDiscs to track	Minimum of 3 SoniDiscs required.
060x	Joystick	Joystick start/read failed Joystick get info failed	Likely communication error.
030A	Wireless	Link ID for stations are both...	Duplicate station ID encountered.
030B	Wireless	Channels for stations are both...	Stations are set to same channel.
030C	Wireless	Mixed radio types not supported	Older radio sets cannot be used in combination with MicroTrax.

Standard Fastrakä error codes

- 1 Field missing, command is invalid.
- 2 Parameter is not a numeric value, command is invalid.
- 3 Parameter value is out of range, command is invalid.
- 4 Not configured (not used by InterSense).
- 5 Buffer limit exceeded (not used by InterSense).
- 99 Invalid command parameter.

14.7. Constellation Configuration Tool

Constellation Configuration tool is used to configure and manage the Constellation of SoniDiscs. This is the most important part of tracker configuration, as it has a direct effect on quality of tracking.



Terminology

IS-900 models contain an ultrasonic subsystem that includes SoniDiscs (Ultrasonic Transponder Beacons) and Microphones (URMs). To generalize the interface protocol and configuration tools for these tracker models, InterSense uses the term: PSE - Position Sensing Element.

A PSE may be Mobile or Fixed. Mobile PSEs are assigned to the stations and their movements are tracked by the system. Fixed PSEs form a CONSTELLATION™ that is used as a reference for tracking. In the case of IS-900 tracking systems, Microphones are mobile and SoniDiscs are fixed.

General Guidelines

The position of a SoniDisc is defined as the coordinates of the center of the grill covering the speaker. All values are entered in meters. The coordinates of the SoniDiscs are entered in a user-defined, locally leveled coordinate frame. The coordinate system is right-handed with X pointing forward, Y to the right and Z pointing down (see **Section 3.1** for details on the InterSense standard coordinate system). Position data for all stations is computed relative to that coordinate system.

Mobile PSE configuration is stored in the EPROM of each station and is configured automatically without user input. Constellation™, however, is custom for each installation and must be configured before the system can be used.

SoniDiscs are available in several types of protective housings, including SoniPods, SoniFrames, SoniWings, and SoniStrips. This Section will focus on the most common form—SoniStrips. For more information about the other SoniDisc housing styles, see their appropriate supplemental manual. For best performance it is generally recommended that SoniStrips be installed in a regular grid over the tracked area. The total distance from a SoniDisc in the Constellation to a tracked station should not exceed 3.05 meter (10 feet) to guarantee good signal detection (4.0 meter with +15 VDC external power boosters).

IS-900 default configuration does not contain a Constellation, so it is up to the user to configure it. The system is shipped with a packing list containing the part numbers of the included SoniStrips. These part numbers and corresponding SoniDisc Hardware IDs are used in the Constellation tool to identify the SoniStrips.

To operate, the system needs to know the position and orientation of each of the SoniDiscs in the Constellation with high degree of accuracy (2 to 3 mm positional accuracy and at least 5 degrees for the normal vectors of each SoniDisc in the Constellation). A high accuracy device, like a total station (also known as a Theodolite with absolute position measuring capabilities), will be required to measure the positions of the SoniDiscs and enter them into the system configuration. The importance of the quality of this data can't be overstated, as the system cannot track better than its configuration would allow.

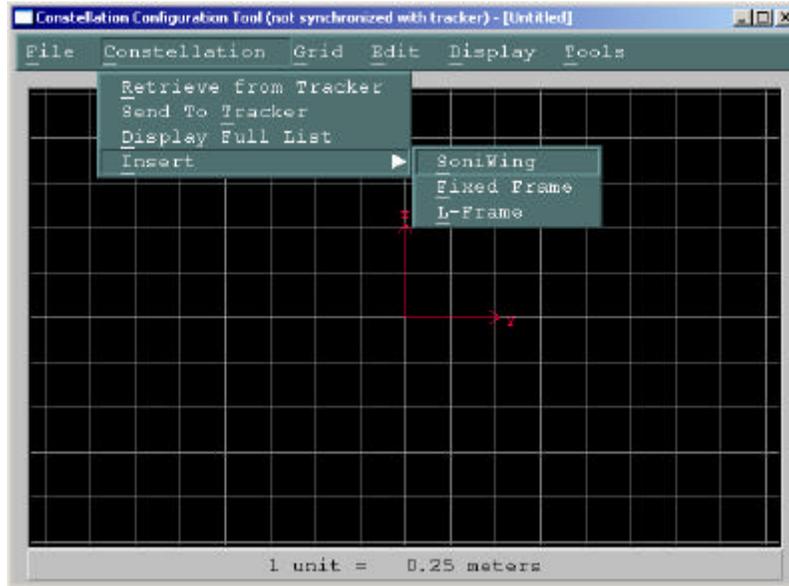
A unit normal vector, as shown in the figure above, defines the orientation of a SoniDisc. The default assumption is that the Constellation is installed horizontally over the tracked area, so the normal vector points straight down with unit normal vector coordinates of 0,0,1. Entering the correct normal vector for each SoniStrip is important. The normal vector information is used by the IS-900 tracking algorithm to correctly schedule the polling of SoniDiscs.

File Menu

<i>Open</i>	Opens a file selection dialog. Select a configuration file and click OK. The file is read in and Constellation™ contained in it replaces the currently displayed configuration.
<i>Save</i>	Currently displayed Constellation™ is saved to a file previously selected with the <i>Open</i> or <i>Save As</i> commands.
<i>Save As</i>	Opens a file selection dialog. Current Constellation™ is written to the selected file, previous contents are overwritten.



Constellation Menu



Retrieve from Tracker

ISDEMO requests the current Constellation™ from the IS-900 base unit and displays the received configuration. Any configuration displayed prior to this command is replaced.

Send To Tracker

Currently displayed configuration is sent to the tracker. This command is used to apply custom configuration once data entry has been completed. Please note that Constellation™ editing is done off line, so this step is required.

Display Full List

PSE	Px	Pz	Nx	Ny	Nz	ID Code
1	1.0861	-2.3194	0.0000	0.00	0.00	1.00 200
2	1.0861	-1.4050	0.0000	0.00	0.00	1.00 201
3	1.0861	-0.4906	0.0000	0.00	0.00	1.00 202
4	0.3861	-2.3194	0.0000	0.00	0.00	1.00 203
5	0.3861	-1.4050	0.0000	0.00	0.00	1.00 204
6	0.3861	-0.4906	0.0000	0.00	0.00	1.00 205
7	-0.3139	-2.3194	0.0000	0.00	0.00	1.00 206
8	-0.3139	-1.4050	0.0000	0.00	0.00	1.00 207
9	-0.3139	-0.4906	0.0000	0.00	0.00	1.00 208
10	-1.0139	-2.3194	0.0000	0.00	0.00	1.00 209

Displayed window contains the entire Constellation™, one SoniDisc per line. Selecting *Change* item under the *Edit* menu or double-clicking on a line opens the SoniStrip Properties window, where position and orientation data can be edited. You can also use this window to selectively delete SoniDiscs.

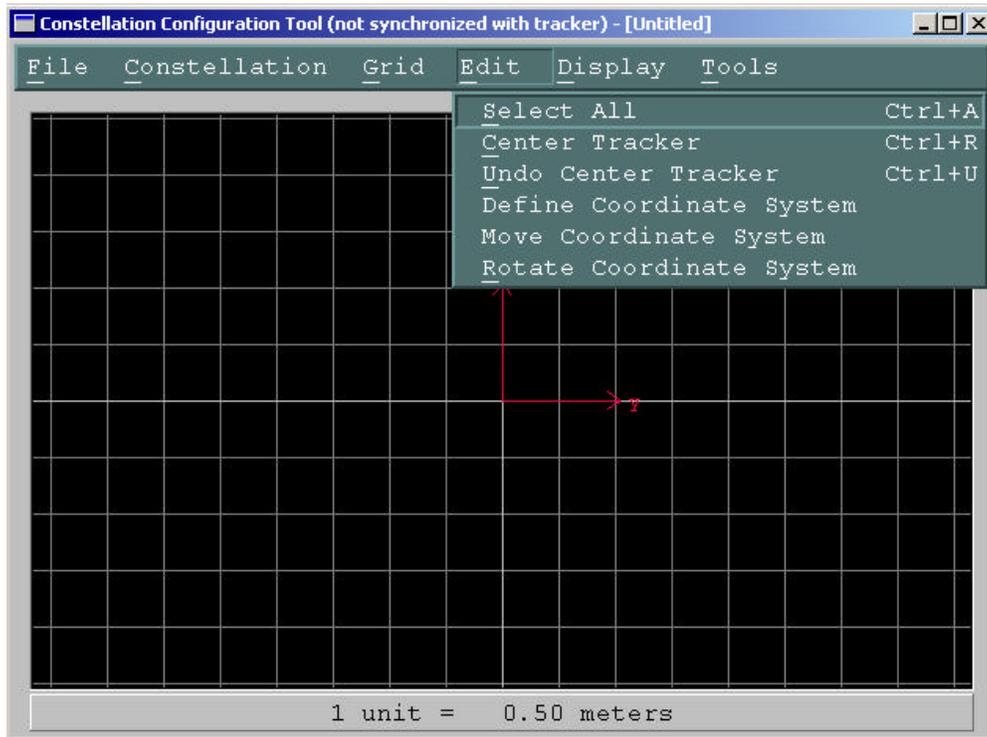
Insert

SoniDiscs in pre-calibrated configurations such as the SoniWing, SoniFrame, and L-Frame can be added to the Constellation with this feature. By selecting one of the three choices, ISDEMO will prompt the user to enter information about the hardware in use. After selecting the proper settings for the hardware you intend to use, ISDEMO will add the associated SoniDiscs to the Constellation.

Grid Menu

This feature is designed for the IS-1200 and should not be used with the IS-900.

Edit Menu



Select All

This action will select all the SoniStrips and corresponding SoniDiscs. Use to perform additional “right mouse click” operations on the entire SoniStrip Constellation.

Center Tracker

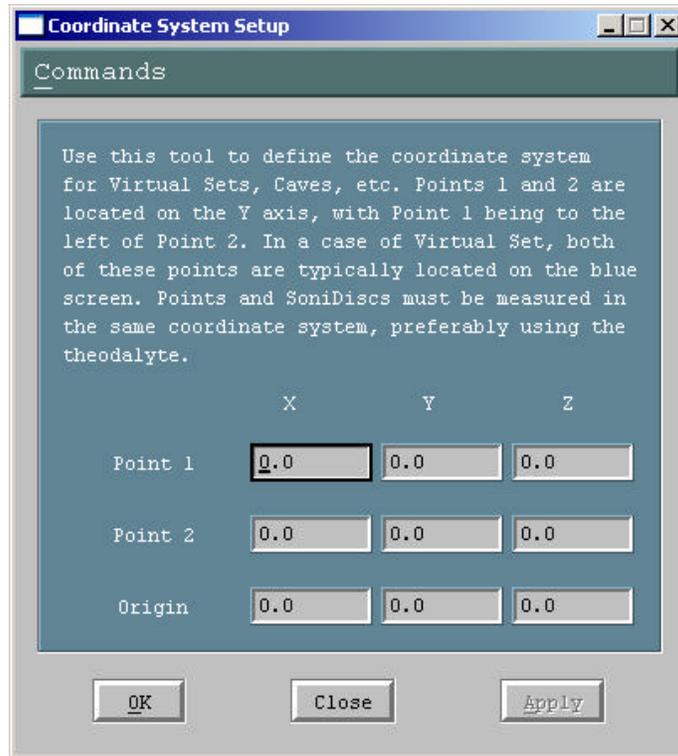
The display origin of the Constellation™, Tool is moved so that station currently selected for display in the main window of ISDEMO is displayed in the center of the screen.

Undo Center Tracker

The effects of *Center Tracker* command are removed and display origin is aligned with the origin of the coordinate system.

Define Coordinate System

Used to specify the exact location of your origin when using a total station to measure the exact XYZ locations of your SoniDiscs.



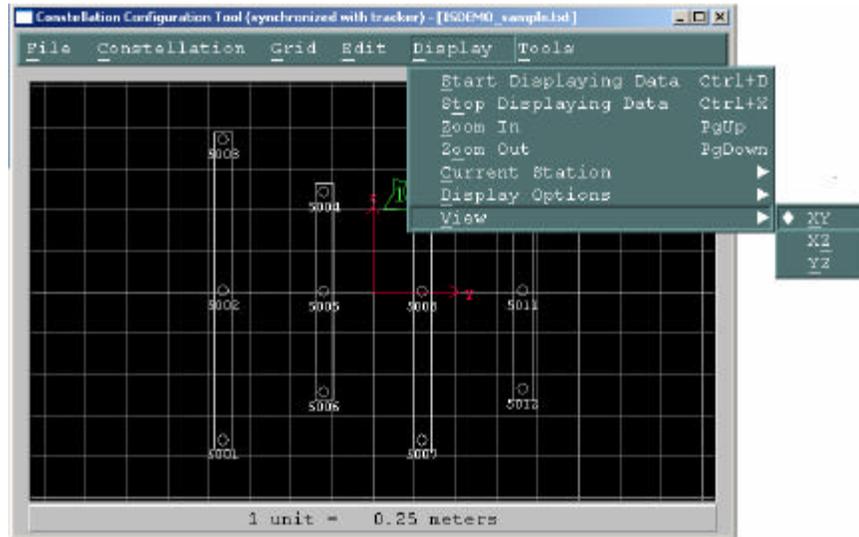
Move Coordinate System

Used to move the origin of the coordinate system to a new location. After this menu item is selected, left-click in the display area and while holding the button down, move the mouse. The coordinate system will then move with the mouse. Release the mouse button when satisfied with the location. Positions of the SoniStrips are recalculated for the new coordinate system and redrawn. This command has the same effect as selecting all SoniStrips and moving them to a new location relative to the origin. To apply the changes use *Send To Tracker* item in the Constellation menu.

Rotate Coordinate System

Used to rotate the coordinate system. After this menu item is selected, left-click in the display area and while holding the button down, move the mouse up or down. The coordinate system will rotate in the clock-wise or counter clock-wise direction. Release the mouse button when satisfied with the new orientation. Positions of the SoniStrips are recalculated for the new coordinate system. To apply the changes use *Send To Tracker* item in the Constellation menu.

Display Menu



Start Displaying Data

Turns the display on. Configured stations are displayed in green when tracking, or in red if lost. When display is on, SoniDiscs in the Constellation™ are displayed in green when they are used for tracking or in red, if range measurements received are rejected by the tracker. During normal operation SoniDiscs should never appear red. If they do, Constellation™ must be examined for configuration errors. Tracker will only query the SoniDiscs in the immediate vicinity of a station, all others are ignored and will be drawn in white.

Stop Displaying Data Turns the display off. Constellation™ editor commands can only be used when display is off.

Zoom In/Out

Changes the scale factor of the display. Current zoom setting is displayed at the bottom of the screen.

Current Station

Changes which station ISDEMO will show as the primary station. Certain functions, such as center tracker (discussed under the TOOLS tab) will depend on which station is the current primary station.

Display Options

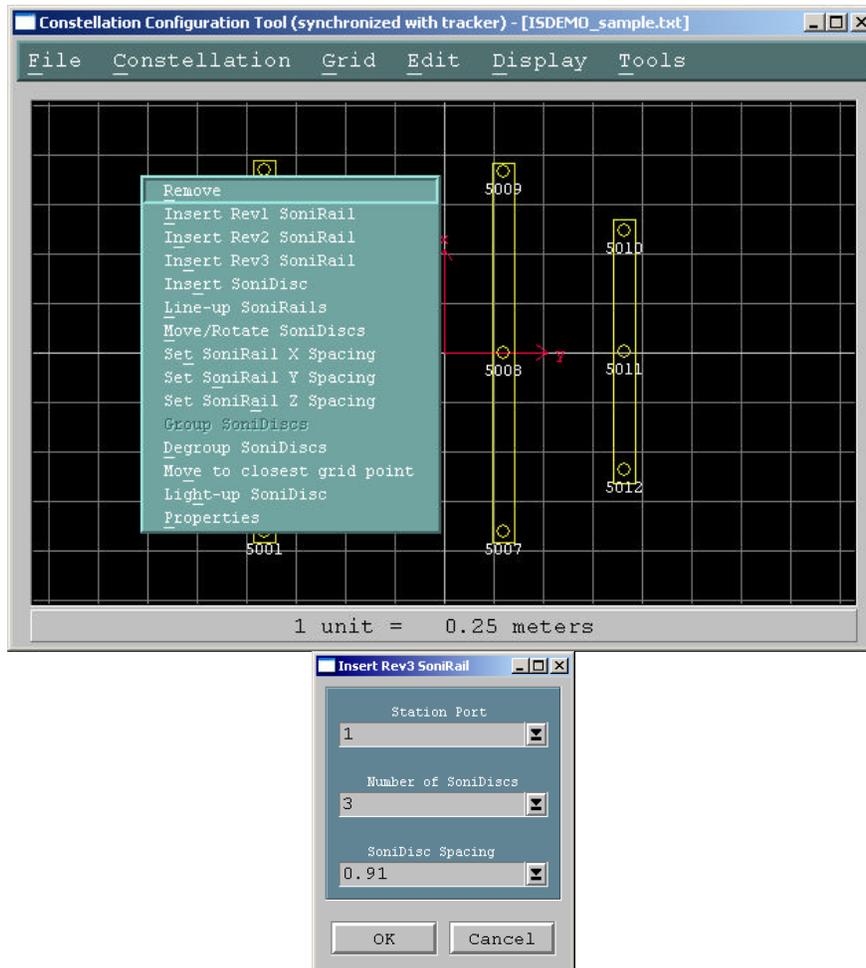
Hardware IDs of the SoniDiscs and ultrasonic range measurements can optionally be displayed along with the positions of the configured stations.

View

In most cases a Constellation™ is installed horizontally over the tracked area, so XY view is the default. In other cases, XZ and YZ views can be used. The coordinate system is right-handed with X forward, Y to the right and Z pointing down.

Using the Constellation Graphical Interface to manually configure a Constellation

By “right-clicking” your mouse in the constellation window, a list of options to manually configure your constellation appears. Use your mouse to select which SoniStrip/SoniDiscs you would like to manipulate.



Remove

Removes selected (highlighted in yellow) SoniStrips or SoniDiscs from the Constellation.

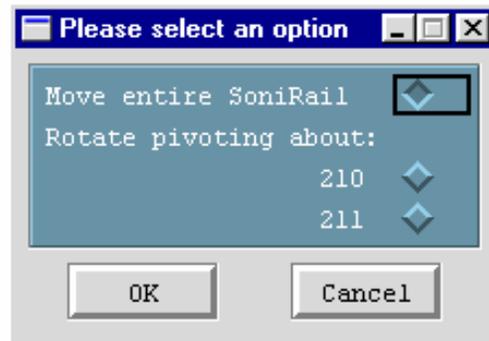
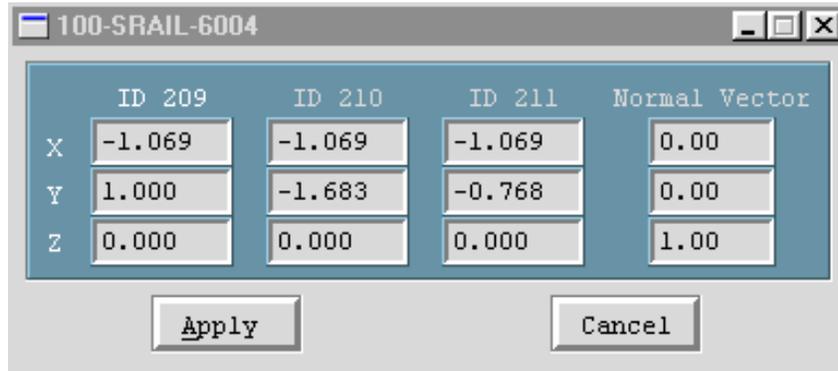
Inserting SoniStrips

1. Right-click in the Constellation Tool window at the position where the new SoniStrip is to be placed.
2. Select Insert Rev3 SoniStrip item. Rev1 and Rev2 SoniStrips are not used with IS-900 SimTracker or VETracker processor configurations. A window listing available SoniStrip options is displayed. Select one and click OK. The new SoniStrip will appear in the display area. It is also removed from the list of available SoniStrip options.

- Using the mouse move the newly added SoniStrip to the desired position.

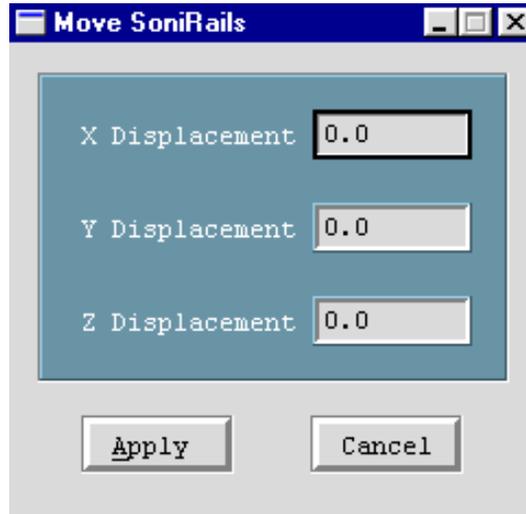
Moving SoniStrips

SoniStrip position and orientation can be changed using the mouse or by using the commands available on the right-click menu. To move with the mouse, select the SoniStrip and drag. Multiple SoniStrips can be selected and moved by keeping the Ctrl or Shift keys pressed while selecting and dragging. To rotate a SoniStrip using the mouse, select one of the SoniDiscs and without releasing the left mouse button, move the mouse up or down. The SoniStrip will rotate about the selected SoniDisc. If more than one SoniDisc is selected, the whole SoniStrip is moved with the mouse.



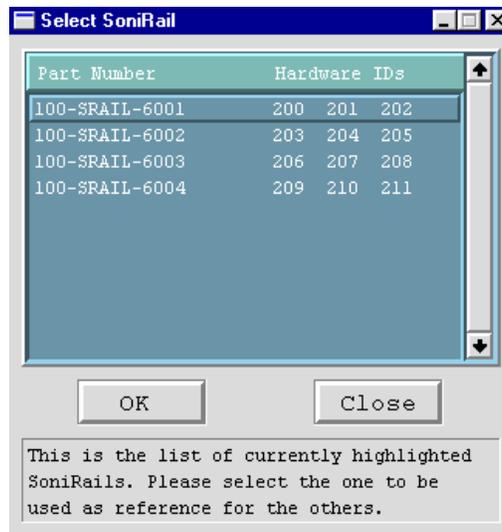
Move SoniStrips (right-click menu)

All selected SoniStrips are moved by the specified distance in X, Y and Z dimension. All values are entered in meters.



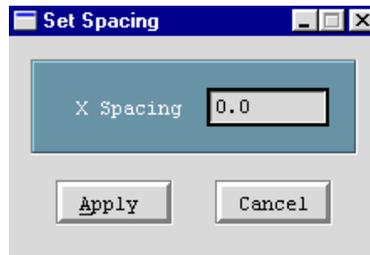
Line-up SoniStrips (right-click menu)

This tool changes the orientation of all selected SoniStrips to match one of them. The selection window displays a list of all the currently selected SoniStrips. Choose one and click OK. All selected SoniStrips become parallel. This is useful when configuring a Constellation™ installed on a regular grid, such as a drop ceiling.



Set X/Y/Z Spacing (right-click menu)

This tool applies a set spacing to the group of selected SoniStrips. Value is entered in meters. The order of the SoniStrips is preserved. For example, when setting up a grid attached to a drop ceiling with 2 foot tiles, enter 0.6096 and click Apply.



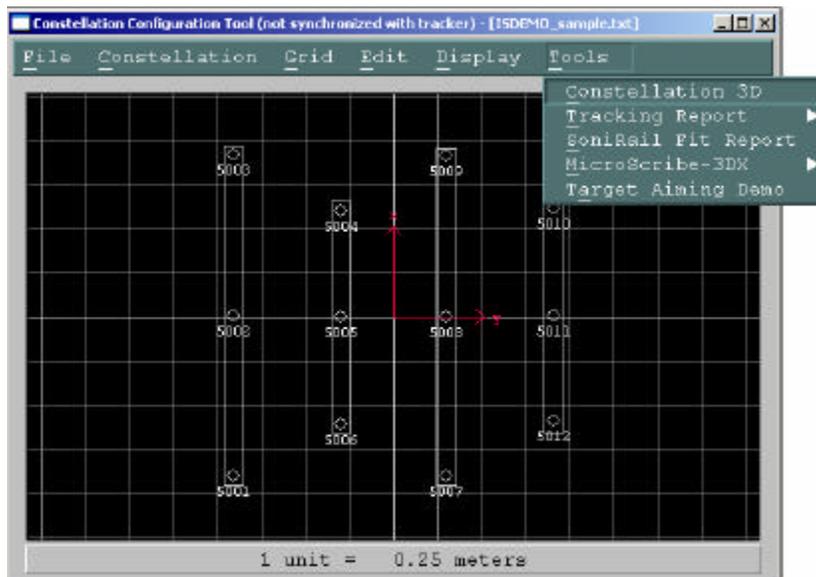
Light Up SoniDisc (right-click menu)

This option is extremely helpful in diagnosing potential cabling and/or configuration problems. By selecting a single SoniDisc and then choosing this option, the blue LED for the selected SoniDisc is turned on for a few seconds. Use this visual confirmation to check that the SoniDisc is connected properly, and that its location in the constellation is consistent with its location in the physical world.

Properties

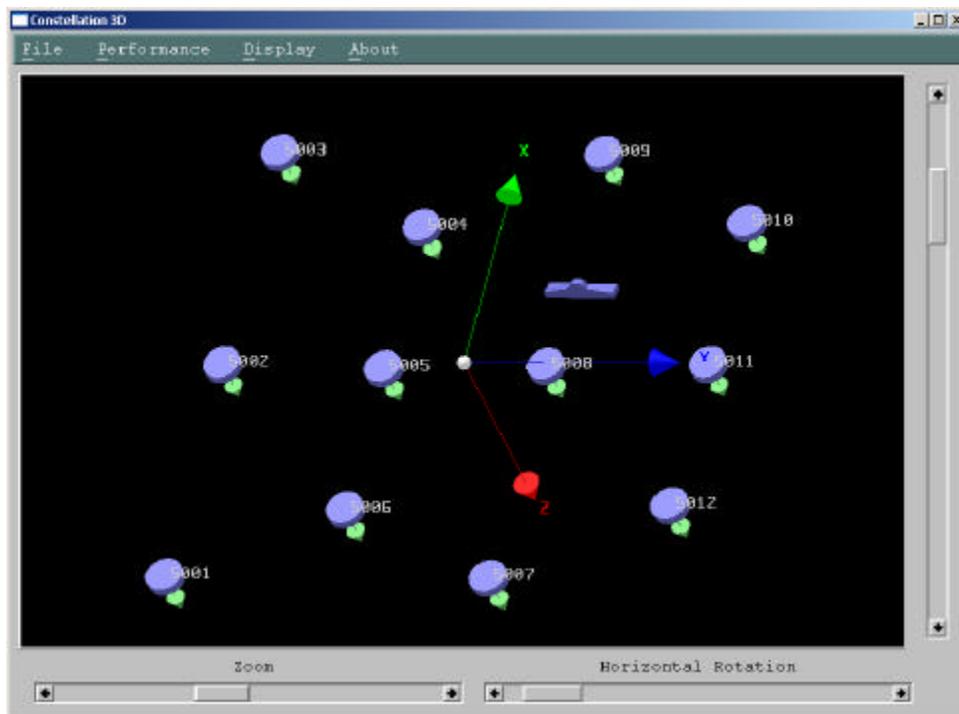
A more precise way to move or rotate a SoniStrip is to use the Properties Window, which is opened by double-clicking on a SoniStrip or selecting Properties in the right-click menu. The properties window lists positions and normal vectors of the 3 SoniDiscs that belong to the SoniStrip. To move or rotate a SoniStrip, change the position values for one of the SoniDiscs. You'll notice that Apply button becomes active and the Hardware IDs of the other 2 SoniDiscs are grayed out and corresponding position fields are disabled. By clicking the Apply button, a dialog box is displayed that allows the action that is to be performed next to be selected. First option (default) will move the entire SoniStrip to the new location without changing its orientation. Alternatively, the SoniStrip can be rotated about one of the remaining SoniDiscs. The rotation algorithm uses the selected SoniDisc as the pivot point and computes the line from that point to the new location of the SoniDisc that had the position data changed. The SoniStrip is then rotated to correspond to that line. Actions can be cancelled at any time.

Tools Menu

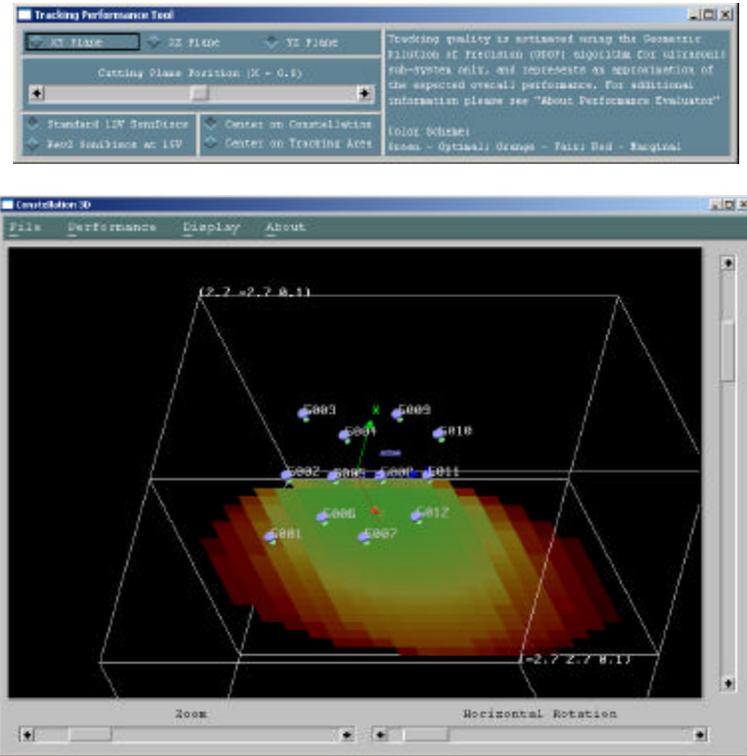


Constellation 3D

This tool gives a three dimensional view of the constellation, as well as all tracked devices. Each SoniDisc is drawn with a normal vector and beacon ID number. Use the slide bars to zoom in and rotate the constellation.



The Constellation 3D tool also includes a three dimensional performance tool. This feature will allow and end user to ‘see’ the ultrasonic signal strength under a constellation. For more information on this tool click on ‘About’.



Tracking Report

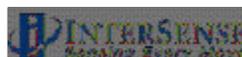
Information is gathered about all PSEs. A history of when stations become ‘lost’ and then reacquire is also recorded at the bottom of the file. This report is helpful when a PSE hardware failure is suspected. The Tracking report file can be saved as a text file and e-mailed to InterSense technical support for review.

SoniRail Fit Report

Useful to estimate the overall accuracy in calibration of a constellation file which uses SoniRails. The positions and distances between three SoniDiscs on one SoniRail are compared to SoniRail manufacturing specifications. Inaccuracies in the calibration of the SoniDiscs will affect the overall accuracy of the IS-900 system.

Microscribe-3DX

Using a Microscribe is an extremely accurate way to measure the positions of your SonisDiscs. First, Set up and initialize the Microscribe. Plug the microscribe into COM1 of your PC. In the main window of ISDEMO, change the communications parameters to COM2. This frees up the resources on the PC to use the Microscribe. Next use the right-click insert function of *ISDEMO Constellation Tool*. Select a SoniDisc you would like to map by highlighting it. Move the pointed end of the



Microscribe to be directly in front of the center of the SoniDisc you are mapping. Use the Microscribe foot pedal to record the position. ISDEMO will move the SoniDisc to the proper location. You will then need to configure the normal vectors of the SoniDisc using the right-click properties feature.

Target Aiming Demo

Designed to show the accuracy and repeatability of the tracking system. When the zero point of a station is pointing at a SoniDisc, the color will change. Targets can be added to the constellation as phantom SoniDiscs with Station ID's less than 100.

14.8. RF Scope

RF Scope is a tool that uses an InterSense RF analyzer accessory to scan the 2.4 GHz frequency range and display detected signal strength. This is useful to characterize your RF environment, determine if sources of interference exist and identify channels to use with your wireless MicroTrax devices to best avoid those sources of interference.

The center frequencies InterSense uses for the 16 available channels range from 2405-2480 MHz in 5 MHz increments as shown in **Figure 41**. There is a 9 MHz overall spread in each channel, causing frequency overlap, which is the primary reason why it is recommended that adjacent channels are not used, if possible.

The frequency spread for each channel results in an overall frequency range from 2400-2483 MHz. Since the radio hardware is limited to 2405-2480 MHz, only half of the range can be scanned for channels 0 and 15.

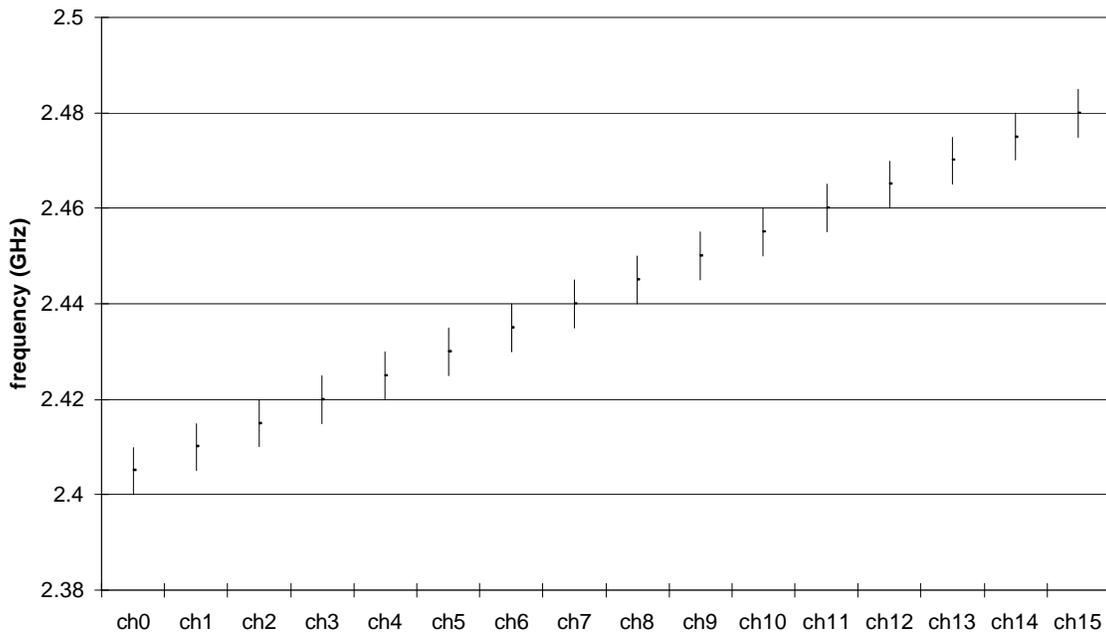


Figure 41 - Frequency Range for Each of the 16 Channels

To use RF Scope you must have an InterSense RF analyzer accessory (or an InertiaCube wireless receiver) connected to your Windows PC. The InterSense interface DLL, isense.dll, version 3.90 or later, must also be properly installed in the \WINDOWS\SYSTEM32 directory of your Windows PC.

Launch RF Scope from the ISDEMO start-up screen by selecting Wireless? RF Scope from the menu bar. The RF Scope display will appear and connect to the RF analyzer. If RF Scope fails to connect, please check the connection to the RF analyzer and verify that the correct version of isense.dll is installed.

To start and stop the display, select the respective option from the Display menu. The display represents the detected signal strength in two different charts.

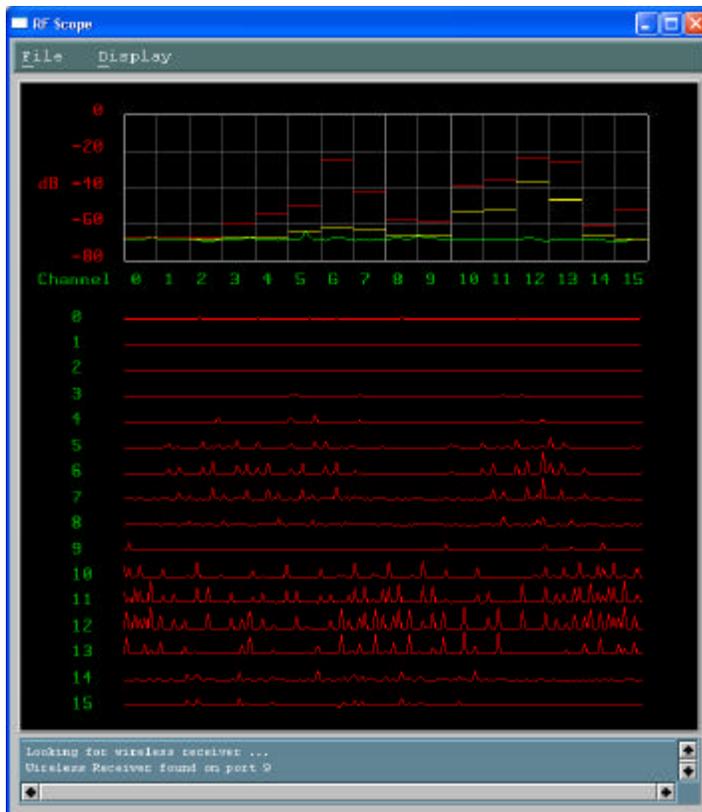
The upper chart indicates the signal strength in dB at 1 MHz increments across the frequency range (in green). It also shows the maximum signal level detected in each of 16 bins corresponding to the available wireless channels (in red). The yellow lines are a visual aid that jump up to the current levels if higher than the lines and then slowly drift down.

The lower chart is a spectrogram or time-frequency plot that displays the average signal level corresponding to each of the 16 channels versus time.

To evaluate the background RF environment, RF Scope should be used with any other wireless InterSense equipment powered off. Ideally, the display should indicate a very quiet environment. Some sporadic activity typically has little effect on wireless MicroTrax communication. However, sustained activity lasting one second or more can interfere with communication and degrade tracking performance.

If interference is detected, first try to identify the source and eliminate it if possible. Wireless LANs, cordless phones and Bluetooth devices are examples of wireless equipment that operate in the 2.4 GHz range. Try to turn such equipment off or move the wireless components away from the IS-900.

Once sources of interference have been minimized, set the wireless MicroTrax devices to channels that exhibit the least interference using the Wireless Configuration tool in ISDEMO (see section 14.4) to configure the MicroTrax radios.



15. Appendix F – GENLOCK Synchronization

15.1. Why Use GENLOCK?

GENLOCK synchronization is used to guarantee constant latency between the sampling of the motion tracking sensor and the current image on the display device. Any change in the amount of latency between these two events appears as jitter in orientation when the head is rotating. For typical head rotation rates of 300 degrees/sec, a timing difference of 6.7 milliseconds will result in orientation jitter of 2 degrees, which can be highly disturbing to the user.

On an IS-900 series product operating with no synchronization, the tracker will update at about 180 Hz, corresponding to a 5.6 ms period. Since the 180 Hz update rate of the tracker is asynchronous with the update rate of the computer graphics rendering and display cycle, the latency will vary by up to 5.6 ms from cycle to cycle, and thus GENLOCK synchronization is essential if smooth response is desired during periods of moderately fast head rotation.

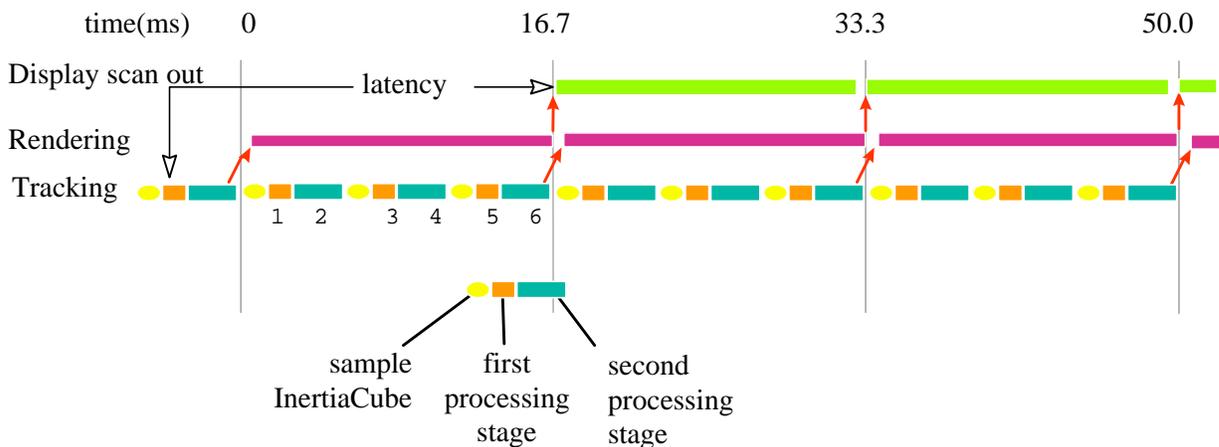


Figure 42 – Timing Diagram: IS-900 Interfaced to PC with 60 Hz Display Refresh

Figure 42 illustrates the timing relationship of the tracking loop to the rendering loop with GENLOCK in effect. The vertical lines at multiples of 16.7 milliseconds represent the vertical sync pulses stripped from the 60 Hz VGA monitor cable. The tracker automatically determines the frequency of the GENLOCK synchronization signal and then decides upon a tracking loop update rate which is the highest multiple of this frequency that it can consistently maintain. In the example in the diagram, the tracker has decided to do 3 internal updates per display refresh cycle.

However, **ONLY ONCE** per display refresh cycle is data output across the serial or Ethernet port to the host. This point, by default, is at the end of the last update cycle in the field, labeled 6 in **Figure 42**. Using this point (or point 5) provides the lowest possible end-to-end latency, only 1 1/3 video fields in this example. So, if the total time to transmit the data across the communication port plus the time to process and render the display is not guaranteed less than 16.7 ms on every single cycle, there will be cycles when the rendering does not complete for the next scan out, resulting in a disturbing glitch in the image.

By choosing to have the data port output occur at one of the earlier numbered phase points, there is a bit more latency, but also more slack to allow for an occasional rendering cycle that just slightly exceeds the allotted 16.7 ms.

Figure 43 illustrates the tracker set up to output data at phase point # 3. The timing slack has absorbed this anomaly so that the image is still rendered with the same 1 2/3 frame latency as the frames before it, resulting in no visual glitch. Of course, if there are several frames in a row that run longer than 16.7 ms, the system will eventually drop a frame, resulting in a jarring transition to 2 2/3 frame latency. To prevent this, the user must insure that the average frame rate before attempting synchronization is ALWAYS above 60 Hz, so that once the synchronization is enabled, the frame rate will be fixed at 60 Hz with no annoying shifts.

As a precaution, if the frame rate of the rendering engine drops below 60 Hz, the software driver that is reading data from the tracker should always check to make sure that it is reading the latest available data record. After reading a complete record, check to see if there are any further bytes in the receive buffer, and if so wait for there to be a complete record and read it in replacing the just read record. If this is implemented in the software driver, multiple data records could become queued up in the 'receive' buffer, resulting in extra latency.

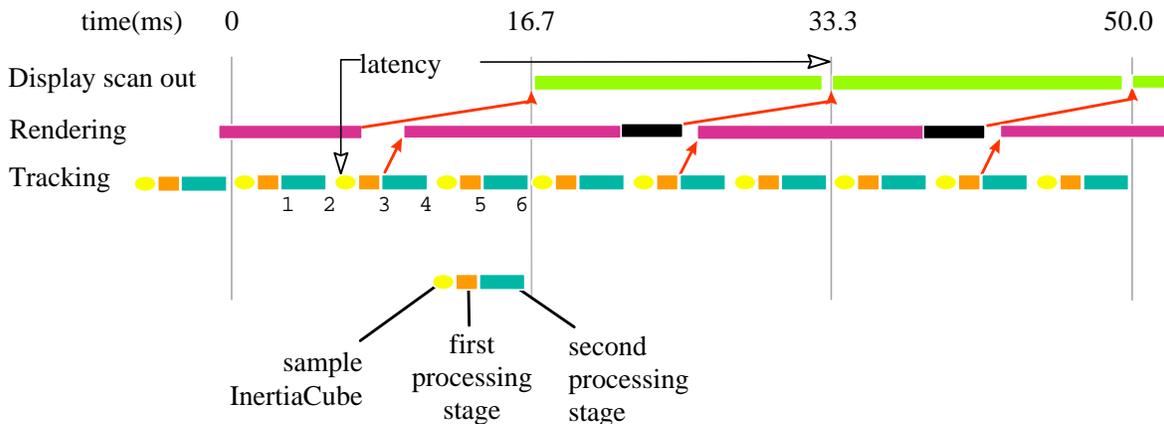


Figure 43 - Timing Diagram: IS-900 Adjusted with Proper Phase for 60 Hz Display Refresh

The second reason why it may be desirable to adjust the output record transmission to an earlier phase point is to allow for serial port transmission time. In the diagrams above, the slant of the arrow pointing up from the tracking loop to the rendering loop represents the delay of transmitting the results from the tracker to the host. If you use binary data mode, and set up the IS-900 to only transmit 6 bytes of data (3 Euler angles plus 3 position values) using the command O1,2,4<>, then the total number of bytes per record will be 29 which corresponds to 290 bits. At a baud rate of 115,200 bits/sec, this record will take about 2.7 ms to transmit. Thus, the tightest timing loop illustrated in the first diagram above can be achieved if the rendering time is always less than $(16.7 \text{ ms} - 2.5 \text{ ms}) = 14.2 \text{ ms}$, but it should probably not be attempted with any longer output data record format or slower baud rate.

15.2. Configuring the IS-900 for GENLOCK

The default operation of the tracker is free run. That is, the tracker performs updates and, in continuous mode, outputs data records as rapidly as it can. GENLOCK operation causes the tracker to synchronize updates and data record output to an external sync signal or to an internal clock. When external GENLOCK is enabled and a valid sync signal is provided, it may take several seconds to stabilize tracking. If a valid signal not present, the tracker will wait an extra period for the signal, dropping the update rate to half the sync rate. Details are discussed below.

Connecting Sync Signal

The external sync signal for GENLOCK on an IS-900 is on the back panel of the processor shown in **Figure 44**.



Figure 44 - Back Panel of IS-900, SYNC IN is External GENLOCK Input

Connect the sync signal to the BNC connector labeled **SYNC IN** on the back of the IS-900 Processor. The input interface setting for **SYNC IN** is controlled by software and access is provided via command or the LCD menu. This setting is saved with the rest of the user settings.

Command: MGS[source]<>

source 1 TTL

2 NTSC

Default is TTL. If source is omitted, the current setting is returned (31GS{source}<>).

From the LCD menu, GENLOCK source is selected by choosing: System config → GENLOCK → Source (TTL and NTSC options only).

Enabling GENLOCK via Command

Send the *C* command to the tracker to place it in continuous mode. If the tracker is used in polled mode, its internal updates will be synchronized to the sync signal but data record output will not.

Send the InterSense-specific GENLOCK command to the tracker.

MG[state],[rate]<>

<i>State</i>	0	Genlock off (free run)
	1	Reserved—has no effect on the GENLOCK state.
	2	Use external sync, strobe rate specified by <i>rate</i> parameter (manual).
	3	Use internal sync, output data records at frequency specified by <i>rate</i> parameter.
<i>rate</i>		For <i>state</i> 2, the sync strobe rate in hertz. For <i>state</i> 3, the data record output rate in hertz. 30 Hz minimum in either case.

Current settings of state and *rate* are reported if the command is issued without parameters (or invalid ones).

The Fastrak™ command *y{state}<>* is not recognized by the IS-900, but has the equivalent function the *MG* command with *state* equal to 0 or 1. If the Fastrak *y{state}<>* command is used in your code, remember to manually configure GENLOCK via the LCD menu to the settings required by the application.

ISDEMO can be used to send the GENLOCK command using the *Send Command String* option. GENLOCK settings can be saved to the tracker using ISDEMO, using the *^K* command or using the LCD (if equipped).

Enabling GENLOCK via LCD Menu

Select *Communication*→*Data Output*→*Sample Mode*→*Continuous* to place the tracker in continuous mode. If the tracker is used in polled mode, its internal updates will be synchronized to the sync signal but data record output will not.

Select *System Config*→*GENLOCK*→*State* and then one of the following choices.

<i>Off</i>	GENLOCK off
<i>Manual</i>	Use external sync (select strobe rate in 5 Hz increments using arrow buttons, then press the enter button)
<i>Internal</i>	Use internal sync (select data record output rate in 5 Hz increments using arrows buttons, then press the enter button)

Verifying Synchronization

To verify GENLOCK is working with the IS-900, check the GENLOCK indicator in the lower-right corner of the LCD on the front panel of the processor. When GENLOCK is on and stable, the indicator displays “G”, otherwise the indicator displays an “X” indicating GENLOCK is enabled but the processor is not synchronized. If “G” or “X” is not displayed, then GENLOCK is off.

Using CrystalEyes™

To configure an IS-900 for use with CrystalEyes™, set the sync signal type to *TTL* and send the command *MG2,120* or *MG2,60* to the tracker (assuming the video refresh rate is 60 Hz or 120 Hz per eye). Connect the external sync signal used for the CrystalEyes™ IR emitter to the **SYNC IN** on the back panel of the IS-900 Processor.

Adjusting Phase Point

A data record is output once per sync period when the tracker is in continuous mode. The phase point is the time within the sync period at which a data record is transmitted and is adjustable for internal and external GENLOCK. The phase point is specified as a percentage of the sync period. 0% (the default) instructs the tracker to output a data record as soon as possible after the sync period begins. 100% delays the output of a record as much as possible before the next sync period begins. To adjust phase point via command:

MGP[+/-]<> Increase/decrease to next/preceding phase point
MGP[p]<> Set phase point to percentage specified by *p* (0 to 100)

The current phase point is reported if the command is issued without parameters (or invalid ones). The tracker will accept the first form of the command only after GENLOCK is established. With the second form of the command, the tracker will match the specified phase point as best it can, but typically with far less resolution than 1/100th of the sync period.

To set the phase point via the LCD menu, select *System Config*→*Genlock*→*Phase*→*Set* and change the value with the arrow buttons, then press the enter button. To increase or decrease to the next or previous phase point, select *System Config*→*Genlock*→*Phase*→*Increase* or →*Decrease*.

Adjust the phase to the latest point in the cycle (for minimum latency) such that the system still behaves smoothly during head rotation (no render cycles last beyond the deadline for the next scan out).

16. Appendix G – Developers Instructions

For InterSense SDK Version 3.58 or higher.

16.1. Introduction

This document describes the interface to be used by the application software to initialize and retrieve data from the InterSense devices using the ISENSE.DLL. This dynamic link library is provided to simplify communications with all models of InterSense tracking devices, including IS-300, IS-600, IS-900, InertiaCube2 and all versions of InterTrax. It can detect, configure, and get data from up to 8 trackers. The DLL maintains compatibility with existing devices, and makes the applications forward compatible with all future InterSense products.

16.2. Sample Program

The DLL is distributed with sample programs written in C and Visual Basic to demonstrate usage. It includes a header file with data structure definitions and function prototypes. Most of the API description below can also be obtained from the header file.

<code>main.cpp</code>	Main loop of the program. All API calls are made from here.
<code>isense.h</code>	Header file containing function prototypes and definitions, some of which are only applicable to InterSense Professional Series devices and are not used with InterTrax. This file should not be modified.
<code>isense.cpp</code>	DLL import procedures. This file is included instead of an import library to provide compatibility with all compilers, not just the VC++ 6.0.
<code>isense.dll</code>	The InterSense DLL. This file should be placed in the Windows system directory, or in the working directory of the application.
<code>dlcompat.c</code> <code>dlcompat.h</code>	Shared object import procedures for Mac OS X, not used in any other cases.

16.3. Usage

The API provides an extensive set of functions that can read and set tracker configuration, but in its simplest form can be limited to just 4 calls, as shown below:

```
void main()
{
    ISD_TRACKER_HANDLE      handle;
    ISD_TRACKER_INFO_TYPE   tracker;
    ISD_TRACKER_DATA_TYPE   data;

    handle = ISD_OpenTracker( NULL, 0, FALSE, FALSE );

    if( handle > 0 )
        printf( "\n      Az      El      Rl      X      Y      Z \n" );
    else
        printf( "Tracker not found. Press any key to exit" );

    while( !kbhit() )
    {
        if( handle > 0 )
        {
            ISD_GetData( handle, &data );

            printf( "%7.2f %7.2f %7.2f %7.3f %7.3f %7.3f  ",
                data.Station[0].Orientation[0],
                data.Station[0].Orientation[1],
                data.Station[0].Orientation[2],
                data.Station[0].Position[0],
                data.Station[0].Position[1],
                data.Station[0].Position[2] );

            ISD_GetCommInfo( handle, &tracker );

            printf( "%5.2fKbps %d Records/s \r",
                tracker.KBitsPerSec, tracker.RecordsPerSec );
        }
        Sleep( 6 );
    }

    ISD_CloseTracker( handle );
}
```

16.4. API

ISD_TRACKER_HANDLE

```
ISD_OpenTracker(  HWND hParent ,  
                 DWORD commPort ,  
                 Bool infoScreen ,  
                 Bool verbose )
```

- hParent** Handle to the parent window. This parameter is optional and should only be used if information screen or tracker configuration tools are to be used when available in the future releases. All included sample programs pass `NULL`.
- commPort** If this parameter is a number other than 0, program will try to locate an InterSense tracker on the specified RS232 port. Otherwise it looks for USB device, then for serial port device on all ports at all baud rates. Most applications should pass 0 for maximum flexibility. If you have more than one InterSense device and would like to have a specific tracker, connected to a known port, initialized first, then enter the port number instead of 0.
- infoScreen** This feature has not been implemented. Its purpose is to display an information window to show the tracker detection progress and results. Currently DLL writes only to Windows console. Most applications should pass `FALSE`.
- verbose** Pass `TRUE` if you would like a more detailed report of the DLL activity. Messages are printed to Windows console.

Bool

```
ISD_CloseTracker( ISD_TRACKER_HANDLE handle )
```

This function call de-initializes the tracker, closes communications port and frees the resources associated with this tracker. If 0 is passed, all currently open trackers are closed. When last tracker is closed, program frees the DLL. Returns `FALSE` if failed for any reason.

- handle** Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

Bool

```
ISD_GetTrackerConfig( ISD_TRACKER_HANDLE handle,  
                    ISD_TRACKER_INFO_TYPE *tracker,  
                    BOOL verbose )
```

Get general tracker information, such as type, model, port, etc. Also retrieves Genlock synchronization configuration, if available. See `ISD_TRACKER_INFO_TYPE` structure definition for complete list of items.

handle Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

tracker Pointer to a structure of type `ISD_TRACKER_INFO_TYPE`. See `isense.h` for structure definition.

Bool

```
ISD_SetTrackerConfig( ISD_TRACKER_HANDLE handle,  
                    ISD_TRACKER_INFO_TYPE *tracker,  
                    Bool verbose )
```

When used with IS Precision Series (IS-300, IS-600, and IS-900) tracking devices this function call will set ultrasonic and synchronization parameters, all other fields in the `ISD_TRACKER_INFO_TYPE` structure are for information purposes only.

handle Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

tracker Pointer to a structure of type `ISD_TRACKER_INFO_TYPE`. See `isense.h` for structure definition.

Bool

```
ISD_GetCommInfo( ISD_TRACKER_HANDLE handle,  
                ISD_TRACKER_INFO_TYPE *tracker)
```

Get `RecordsPerSec` and `KBitsPerSec` without requesting Genlock and other settings from the tracker. Use this instead of `ISD_GetTrackerConfig` to prevent your program from stalling while waiting for the tracker response. This call is used to obtain data rate information.

handle Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

tracker Pointer to a structure of type `ISD_TRACKER_INFO_TYPE`. See `isense.h` for structure definition.

```
Bool
ISD_SetStationConfig( ISD_TRACKER_HANDLE handle,
                     ISD_STATION_INFO_TYPE *station,
                     WORD stationID,
                     BOOL verbose )
```

Configure station as specified in the `ISD_STATION_INFO_TYPE` structure. Before this function is called, all elements of the structure must be assigned valid values. General procedure for changing any setting is to first retrieve current configuration, make the change, and then apply them. Calling `ISD_GetStationConfig` is important because you only want to change some of the settings, leaving the rest unchanged.

This function is ignored if used with InterTrax products. IS-900, IS-600, IS-300 and InertiaCube2 allows the `AngleFormat`, `Compass prediction`, `enhancement`, and `sensitivity parameters` fields to be changed.

`handle` Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

`station` Pointer to a structure of type `ISD_STATION_INFO_TYPE`. See `isense.h` for structure definition.

`StationID` Number from 1 to `ISD_MAX_STATIONS`.

```
Bool
ISD_GetStationConfig( ISD_TRACKER_HANDLE handle,
                     ISD_STATION_INFO_TYPE *station,
                     WORD stationID,
                     Bool verbose )
```

Fills the `ISD_STATION_INFO_TYPE` structure with current settings.

`handle` Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

`station` Pointer to a structure of type `ISD_STATION_INFO_TYPE`. See `isense.h` for structure definition.

`StationID` Number from 1 to `ISD_MAX_STATIONS`.

```
Bool
ISD_GetData( ISD_TRACKER_HANDLE handle,
             ISD_TRACKER_DATA_TYPE *data )
```

Get data from all configured stations. Data is placed in the `ISD_TRACKER_DATA_TYPE` structure. Orientation array may contain Euler angles or Quaternions, depending on the settings of the `AngleFormat` field of the `ISD_STATION_INFO_TYPE` structure. `TimeStamp` is only available if requested by setting `TimeStamped` field to `TRUE`. Returns `FALSE` if failed for any reason.

`handle` Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

`data` Pointer to a structure of type `ISD_TRACKER_DATA_TYPE`. See `isense.h` for structure definition. The structure is designed to accommodate InterSense Professional Series devices that support multiple sensors. In the case of the InterTrax series trackers, the only data available is Euler angles in the first element of the `Station` array. Orientation data order is Yaw, Pitch, and Roll.

```
Bool
ISD_SendScript( ISD_TRACKER_HANDLE handle,
                char *command )
```

Send a configuration script to the tracker. Script must consist of valid commands as described in the interface protocol. Commands in the script should be terminated by the New Line character `\n`. Line Feed character `\r` is added by the function and is not required.

Should only be used with IS Precision Series tracking devices, except InertiaCube2, not valid and will be ignored if used with InterTrax.

`handle` Handle to the tracking device. This is the handle returned by `ISD_OpenTracker`.

`command` Pointer to a string containing the command script.

```
Bool
ISD_NumOpenTrackers( WORD *count )
```

Number of currently opened trackers is stored in the parameter passed to this function.

```

Bool
ISD_BoresightReferenced( ISD_TRACKER_HANDLE handle,
                        WORD stationID,
                        float yaw,
                        float pitch,
                        float roll )

```

Boresight station using specific reference angles. This is useful when you need to apply a specific offset to system output. For example, if a sensor is mounted at 40 degrees relative to the HMD, you can enter 0, 40, 0 to get the system to output zero when HMD is horizontal.

handle Handle to the tracking device. This is the handle returned by ISD_OpenTracker.

command Pointer to a string containing the command script.

stationID Number from 1 to ISD_MAX_STATIONS.

yaw, pitch, and roll Boresight reference angles.

```

Bool
ISD_Boresight ( ISD_TRACKER_HANDLE handle,
                WORD stationID,
                Bool set )

```

Boresight, or unboresight a station. If 'set' is TRUE, all angles are reset to zero. Otherwise, all boresight settings are cleared, including those set by ISD_ResetHeading and ISD_BoresightReferenced

handle Handle to the tracking device. This is the handle returned by ISD_OpenTracker.

stationID Number from 1 to ISD_MAX_STATIONS.

set TRUE OR FALSE, to set to clear boresight.

```

Bool
ISD_ResetHeading( ISD_TRACKER_HANDLE handle,
                  WORD stationID )

```

Reset heading to zero.

handle Handle to the tracking device. This is the handle returned by ISD_OpenTracker.

stationID Number from 1 to ISD_MAX_STATIONS.

16.5. Data Structures

16.5.1. ISD_TRACKER_INFO_TYPE

```
typedef struct
{
    float    LibVersion;
    DWORD    TrackerType;
    DWORD    TrackerModel;
    DWORD    Port;
    DWORD    RecordsPerSec;
    float    KBitsPerSec;
    DWORD    SyncState;
    float    SyncRate;
    DWORD    SyncPhase;
    DWORD    Interface;
    DWORD    UltTimeout;
    DWORD    UltVolume;
    DWORD    dwReserved4;
    float    fReserved1;
    float    fReserved2;
    float    fReserved3;
    float    fReserved4;
    Bool     LedEnable;
    Bool     bReserved2;
    Bool     bReserved3;
    Bool     bReserved4;
}
ISD_TRACKER_INFO_TYPE;
```

LibVersion

InterSense Library version.

TrackerType

One of the values defined in ISD_SYSTEM_TYPE

TrackerModel

One of the values defined in ISD_SYSTEM_MODEL

Port

Number of the hardware port the tracker is connected to. Starts with 1.

RecordsPerSec

Communications statistics.

KBitsPerSec

Communications statistics.

SyncState

Applies to IS-X Series devices only. Can be one of 4 values:

- 0 - OFF, system is in free run
- 1 – Unknown State
- 2 - ON, hardware genlock frequency is specified by the user
- 3 - ON, no hardware signal, lock to the user specified frequency

SyncRate

Sync frequency - number of hardware sync signals per second, or, if SyncState is 3 - data record output frequency.

SyncPhase

The time within the sync period at which a data record is transmitted. The phase point is specified as a percentage of the sync period. 0% (the default) instructs the tracker to output a data record as soon as possible after the sync period begins. 100% delays the output of a record as much as possible before the next sync period begins.

Interface

Hardware interface type, as defined in ISD_INTERFACE_TYPE.

UltTimeout

IS-900 only, ultrasonic timeout (sampling rate).

UltVolume

IS-900 only, ultrasonic speaker volume.

LedEnable

IS-900 only, blue led on the SoniDiscs enable flag.

16.5.2. ISD_STATION_INFO_TYPE

This data structure is used to get and set station configuration.

```
typedef struct
{
    DWORD    ID;
    Bool     State;
    Bool     Compass;
    LONG     InertiaCube;
    DWORD    Enhancement;
    DWORD    Sensitivity;
    DWORD    Prediction;
    DWORD    AngleFormat;
    Bool     TimeStamped;
    Bool     GetInputs;
    Bool     GetEncoderData;
    Bool     GetAnalogData;
    DWORD    CoordFrame;
    DWORD    dwReserved2;
    DWORD    dwReserved3;
    DWORD    dwReserved4;
    float    TipOffset[3];
    float    fReserved4;
    Bool     GetCameraData;
    Bool     GetAuxInputs;
    Bool     bReserved3;
    Bool     bReserved4;
}
ISD_STATION_INFO_TYPE;
```

ID

A unique number identifying a station. It is the same as that passed to the `ISD_SetStationState` and `ISD_GetStationState` functions and can be 1 to `ISD_MAX_STATIONS`.

State

TRUE if on, FALSE if off. `InertiaCube2` is considered to be a tracking system consisting of one station, which cannot be turned off, so this field will always be TRUE.

Compass

Only available for IS-X Series devices and `InertiaCube2`. For all others this setting is always 2. This controls the state of the compass component of the `InertiaCube`. Compass is only used when station is configured for GEOS or Dual modes, in Fusion mode compass readings are not used, regardless of this setting. When station is configured for full compass mode, the readings produced by the magnetometers inside the `InertiaCube` are used as absolute reference orientation for yaw. Compass can be affected by metallic objects and electronic equipment in close proximity to the `InertiaCube`. When station is configured for partial compass mode, magnetometer readings are used to reduce

drift and maintain stability, but not as an absolute measurement system. In this mode system is much less susceptible to magnetic interference, but heading drift will accumulate. If compass is off, no heading compensation is applied. Older versions of tracker firmware supported only 0 and 1, which stood for ON or OFF. Please use the new notation. This API will correctly interpret the settings.

InertiaCube

InertiaCube associated with this station. If no InertiaCube is assigned, this number is -1. Otherwise, it is a positive number 1 to `ISD_MAX_STATIONS`. Only relevant for IS-300 and IS-600 Series devices. For IS-900 systems, it is always the same as the station number, for InterTrax and InertiaCube2 it's always 1.

Enhancement

In order to provide the best performance for a large range of various applications, three levels of perceptual enhancement are available. None of the modes introduces any additional latency. The InterTrax is restricted to Mode 2.

Mode 0 provides the best accuracy. The inertial tracker uses gyros to measure angular rotation rates for computing the sensor's orientation. To compensate for the gyroscopic drift, depending on the configuration, the tracker may use accelerometers, magnetometers or SoniDiscs to measure the actual physical orientation of the sensor. That data is then used to compute the necessary correction. In Mode 0 correction adjustments are made immediately, no jitter reduction algorithms are used. This results in somewhat jumpy output (not recommended for head tracking) but with lower RMS error. Use this mode for accuracy testing or for any application that requires best accuracy.

Mode 1 provides accuracy similar to that of mode 0, with an addition of a jitter reduction algorithm. This algorithm reduces the accuracy by only a small amount and does not add any latency to the measurements. Mode 1 is recommended for augmented reality applications (i.e. overlaying or mixing both virtual and real objects in a visualization system.)

Mode 2 is recommended for use with HMD or other immersive applications. The drift correction adjustments are made smoothly and only while the sensor is moving, so as to be transparent to the user.

Sensitivity

This setting is only used when Perceptual Enhancement Level is set to 1 or 2. It controls the minimum angular rotation rate picked up by the InertiaCube. Default is level 3. Increasing sensitivity does not increase latency during normal movements. It may, however, result in some small residual movements for a couple of seconds after the sensor has stopped. If your application requires sensitivity greater than maximum provided by this control, you must use Perceptual Enhancement level 0. For InterTrax this value is fixed to default and can't be changed.

Prediction

Inertial sensors can predict motion up to 50 ms into the future, which compensates for graphics rendering delays and further contributes to eliminating simulator lag. Supported by IS-300, IS-600, IS-900 and InertiaCube2. Not available for the InterTrax.

AngleFormat

ISD_EULER or ISD_QUATERNION. The Euler angles are defined as rotations about Z, then Y, then X in body frame. Angles are returned in degrees. Default is ISD_EULER.

TimeStamped

TRUE if time stamp is requested, default is FALSE.

GetInputs

TRUE if button and joystick data is requested, default is FALSE.

GetEncoderData

TRUE if raw encoder data is requested, default is FALSE.

CoordFrame

Coordinate frame in which position and orientation data is reported. Can be ISD_DEFAULT_FRAME or ISD_VSET_FRAME. Second is used for camera tracker only. Default is ISD_DEFAULT_FRAME.

TipOffset

Offset of the reported position from the physical point being tracked. This is only applicable to system capable of tracking position.

GetCameraData

TRUE to get computed FOV, aperture, etc. default is FALSE.

GetAuxInputs

TRUE to get values from auxiliary inputs connected to the I²C port in the MicroTrax device.

16.5.3. ISD_STATION_STATE_TYPE

This data structure is used to return current data for a station, including position, orientation, time stamp, button and analog channel state. It is passed to `ISD_GetData` as part of `ISD_TRACKER_DATA_TYPE`

```
typedef struct
{
    ISD_STATION_STATE_TYPE Station[ISD_MAX_STATIONS];
}
ISD_TRACKER_DATA_TYPE;
```

```
typedef struct
{
    BYTE    TrackingStatus;
    BYTE    NewData;
    BYTE    CommIntegrity;
    BYTE    bReserved3;
    float   Orientation[4];
    float   Position[3];
    float   TimeStamp;
    Bool    ButtonState[MAX_NUM_BUTTONS];
    short   AnalogData[MAX_ANALOG_CHANNELS];
    BYTE    AuxInputs[ISD_MAX_AUX_INPUTS];
    LONG    lReserved2;
    LONG    lReserved3;
    LONG    lReserved4;
    DWORD   dwReserved1;
    DWORD   dwReserved2;
    DWORD   dwReserved3;
    DWORD   dwReserved4;
    float   fReserved1;
    float   fReserved2;
    float   fReserved3;
    float   fReserved4;
}
ISD_STATION_STATE_TYPE;
```

TrackingStatus

Tracking status byte. Available only with IS-900 firmware versions 4.13 and higher, and `isense.dll` versions 3.54 and higher. It is a value from 0 to 255 that represents tracking quality.

NewData

`TRUE` if this is new data. Every time `ISD_GetData` is called this flag is reset.

CommIntegrity

Communication integrity of wireless link.

Orientation

Orientation in Euler or Quaternion form, depending on the setting of `AngleFormat` in `ISD_STATION_INFO_TYPE` structure. Euler angles are returned in degrees.

Position

Station position in meters.

TimeStamp

Only if requested, in seconds.

ButtonState

Only if requested.

AnalogData

Only if requested. Current hardware is limited to 10 channels, only 2 are used. The only device using this is the IS-900 wand that has a built-in analog joystick. Channel 1 is x-axis rotation, channel 2 is y-axis rotation. Values are from 0 to 255, with 127 representing the center.

AuxInputs

Only if requested.

17. Appendix H – Interface Protocol Commands – Quick Reference

For further detail, see:

Section 8.2 Standard Fastrak™ Interface Commands, pages 61-69.

Section 8.3 Fastrak™ Commands Implemented for Compatibility, page 69.

Section 8.4 InterSense specific Commands, pages 69-77.

Command	Syntax
Data Record Request	<i>P</i>
Output mode	<i>C, c</i>
Alignment Reference Frame	<i>A{stationNum},[Ox,Oy,Oz, Xx,Xy,Xz, Yx, Yy, Yz]<></i>
Reset Alignment Reference Frame	<i>R{stationNum}<></i>
Boresight Reference Angles	<i>G{stationNum},[yawref, pitchref, rollref]<></i>
Boresight Compatibility Mode	<i>MBF<></i> Switch to Fastrak™ Compatible mode. <i>MBI<></i> Switch to Version 2.x Compatible mode.
Boresight	<i>B{stationNum}<></i> (Fastrak™ compatibility mode) <i>MB{stationNum}<></i> (Version 2.x compatibility mode)
Unboresight	<i>b{stationNum}<></i> (Fastrak™ compatibility mode) <i>Mb{stationNum}<></i> (Version 2.x compatibility mode)
Heading Boresight	<i>B{stationNum}<></i> (Version 2.x compatibility mode) <i>MB{stationNum}<></i> (Fastrak™ compatibility mode)
Heading Unboresight	<i>b{stationNum}<></i> (Version 2.x compatibility mode) <i>Mb{stationNum}<></i> (Fastrak™ compatibility mode)
Set Serial Communication Parameters	<i>o{rate,parity,bits,HHS}<></i>
System Record Request	<i>S</i>
Station Status	<i>l{stationNum},[state]<></i>
Output Units Control	<i>U</i> Set units to inches. <i>u</i> Set units to centimeters.
System control	<i>^K</i> Save current settings to non-volatile memory. <i>W</i> Restore factory default settings. <i>^Y</i> Restart the firmware to the power up condition. <i>^S</i> Suspend data transmission. <i>^Q</i> Resume data transmission.
Output record mode	<i>F</i> Put in ASCII output mode. <i>F</i> Put in Binary output mode.

Output record list settings	<i>O{stationNum},{p1},{p2},{p3},.....,{pn}<></i>
Define Tip Offsets	<i>N{stationNum},{Ox, Oy, Oz}<></i>
Position Operational Envelope	<i>V{stationNum},{Xmax, Ymax, Zmax, Xmin, Ymin, Zmin}<></i>
Hemisphere	<i>H{stationNum},{p1,p2,p3}<></i>
Time Units	<i>MT<></i> Sets to milliseconds. <i>Mt<></i> Sets to microseconds.
Set Current Time to Zero	<i>MZ<></i>
Ethernet Communication Parameters	<i>MEthIp[address]<></i> <i>MEthUdp[state]<></i> <i>MEthUdpPort[port]<></i>
InterSense System Status Record Request	<i>MS<></i>
Tracking Status Record Request	<i>MP<></i>
Genlock Synchronization	<i>MG[State, Rate]<></i>
Genlock Phase	<i>MGP[Param]<></i>
Configuration Lock	<i>MConfigLockMode{Mode}<></i>
SoniStrip LED Control	<i>ML[state]</i>
Error reporting	<i>ME<></i> <i>MEC<></i> <i>ME1<></i> <i>ME0<></i>
Command Logging	<i>MLogOpen<></i> <i>MLogClose<></i> <i>MLogClear<></i> <i>MLogState<></i> <i>MLogSend<></i>
InterSense Station Status Record Request	<i>Ms{stationNum}<></i>
Prediction Interval	<i>Mp{stationNum},{Interval}<></i>
Perceptual Enhancement Level	<i>MF{stationNum},{Mode}<></i>
Compass Heading Correction	<i>MH{stationNum},{state}<></i>
Rotational Sensitivity Level	<i>MQ{stationNum},{Sensitivity Level}<></i>
Associate Fixed PSE with a Constellation	<i>MCF[FPSE number], [xp, yp, zp, xn, yn, zn, IDcode]<></i>
Disassociate Fixed PSE from Constellation	<i>MCI[Fixed PSE number, IDcode]<></i>
Clear All Fixed PSEs (Constellation)	<i>MCC<></i>
Apply New Configuration	<i>MCE<></i>
Cancel Configuration Session	<i>MCX<></i>