InterSense
Sensing Every Move

User Guide

IS-900 SimTracker & VETracker with MicroTrax™ Devices

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User Guide for the IS-900 SimTracker & VETracker

Firmware 4.20 and higher
DLL Version 3.75 and higher

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Warnings and Precautionary Statements

⚠   *Any changes or modifications to the IS-900 SimTracker/VETracker, MicroTrax Tracking Devices and other components of the IS-900 System not expressly approved by InterSense will void the warranty and any regulatory compliance issued for the system. This could also void the user's authority to operate the equipment.*

⚠   *Wand and Head tracker microphones are susceptible to ESD and may require power cycling to recover from communication failure.*

⚠   *Do not drop or otherwise shock the tracking devices for they can be permanently damaged.*

⚠   *Do not bend, twist, pull strongly or tamper in any way with any part of the cabling.*

⚠   *Take care to avoid electric shocks. Do not plug-in or unplug the power cable with wet hands.*

⚠   *Please see Appendix C for Health and Safety warnings and guidelines*

Wireless Devices

This device contains a Lithium Ion battery that should only be used with the following warnings and precautions.

- Avoid short circuits

- Do not dispose of the battery in fire

- Do not heat the batteries above 60°C

- Do not solder directly to the batteries

- Do not charge above 4.2V

- Do not charge below 0°C or above 45°C

- Do not discharge below 2.7V

- Do not discharge below 20°C or above 60°C

- Do not insert the batteries in reverse polarity

Warning: Fire, Explosion, and Severe Burn Hazard

Equipment Design:

- To avoid damage to the battery pack, make sure that the battery pack is positioned away from heat sources in the equipment.

- If the battery pack is designed into other equipment, use caution to strictly avoid designing airtight battery compartments.

When using the battery

Misusing the battery may cause the battery to get hot, explode, or ignite and cause serious injury. Be sure to follow the safety rules listed below:

- ❖ Do not place the battery in fire or heat the battery.

- ❖ Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.

- ❖ Do not expose the battery to water or salt water or allow the battery to get wet.

Do not disassemble or modify the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite.

Do not place the battery on or near fires, stoves, or other high-temperature locations. Do not place the battery in direct sunshine, or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode, or ignite. Using the battery in this manner may also result in the loss of performance and shortened life expectancy.

When the battery will no longer hold a charge, contact InterSense for servicing options. Do not exchange with any other battery.

Immediately discontinue use of the battery if, while using, charging or storing the battery the battery emits an unusual smell, feels hot, changes color, changes shape or appears abnormal in any other way. Contact InterSense if any of these problems have been observed.

Do not place the batteries in microwave ovens, high-pressure containers, or on induction cookware.

In the event that the battery leaks and fluid gets into one's eye, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated the battery fluid could cause damage to the eye.

While charging the battery

Follow the rules listed below while charging the battery. Failure to do so may cause the battery to become hot, explode, or ignite and cause serious injury.

- When charging the battery only InterSense's charging station (ISC-900MW-CRA*) or individual device charger (099-00076-0000)

Note: * means that the suffix is U, E or K depending on voltage requirements of your country.

- Do not place the batteries in or near fire, or into direct sunlight. When the battery becomes hot, the built in safety equipment is activated, preventing the battery from charging further. Over-heating the battery can destroy the safety equipment and can cause additional heating, breaking or ignition of the battery.

Do not continue charging the battery if it does not recharge within the specified charging time. Doing so may cause the battery to become hot, explode or ignite.

The temperature range over which the battery can be charged is 0 degrees Celsius to 45 degrees Celsius. Charging the battery at temperatures outside of this range may cause the battery to become hot or to break. Charging the battery outside this temperature range may also harm the performance of the battery or reduce the battery's life expectancy.

When discharging the battery

Do not discharge the battery using any devices except for the specified device. When the battery is used in devices aside from the specified device, it may damage the performance of the battery or reduce its life expectancy, and if the device causes an abnormal current to flow, it may cause the battery to become hot, explode or ignite and cause serious injury.

The temperature range over which the battery can be discharged is –20 degrees Celsius to 60 degrees Celsius. Use of the battery outside of this temperature range may damage the performance of the battery or may reduce its life expectancy.

General Warnings & Precautionary Statements

Do not drop or otherwise shock the tracking devices for they can be permanently damaged.

Do not plug in any devices while the electrical power is applied.

Any changes or modifications to the IS-900 not expressly approved by InterSense will void the warranty and any regulatory compliance issued for the system.

⚠ Do not bend, twist, pull strongly or tamper in any way with any part of the IS-900 cabling.

⚠ Take care to avoid electric shocks. Do not plug-in or unplug the power cable with wet hands.

⚠ During normal operation, the user should not make contact with the metal surfaces, including the microphone housings and the connector hood, of the tracking stations. Such contact could result in invalid data or a tracker reset.

⚠ Please see the section titled Health and Safety Warnings and Guidelines

Radio System Information

This device contains a commercially available 2.4 GHz non-frequency hopping wireless data communication link.

The wireless link is intended for use in normal commercial applications. Applications requiring extended temperature range or unusual environmental requirements such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional testing for such applications.

The following devices:

- IS-900 MicroTrax Wireless Transmitter (part number 100-91000-EWTX)

These devices with their antenna comply with FCC's RF radiation exposure limits set forth for an uncontrolled environment. To maintain compliance, it must not be co-located or operating in conjunction with any other antenna or transmitter.

Complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. These devices may not cause harmful interference

2. These devices must accept any interference received, including interference that may cause undesired operation.

The following devices:

- IS-900 MicroTrax Wireless Wand (part number 100-9100-EWWD)

- IS-900 16 Channel Receiver (part number 100-IS9MW-RX16)

This device complies with FCC's RF radiation exposure limits set forth for an uncontrolled environment. It should be installed and operated such that; a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby people's body at all times. This device must not be co-located or operating in conjunction with any other antenna or transmitter.

Comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

3. These devices may not cause harmful interference

4. These devices must accept any interference received, including interference that may cause undesired operation.

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1. System Description

The IS-900 product family delivers precision motion tracking technology for simulators, training, virtual, and immersive display systems. The IS-900, designed for dedicated, precision 6 degree of freedom (6-DOF) motion tracking for both small tracking area simulators and large area virtual environments.

This manual covers two IS-900 product configurations—the IS-900 SimTracker (Simulation Tracker) and the IS-900 VETracker (Virtual Environment Tracker). The SimTracker is ideal for smaller 3D environments such as cockpit or desktop simulators while the VETracker is ideal for large immersive 3D environments. This manual also covers the wireless MicroTrax^{TM} devices for the IS-900 System. Please note that OEM configurations are also available.

The IS-900 product design provides a great deal of flexibility for custom or OEM configurations. While the specific configuration of your IS-900 system may vary from the SimTracker and VETracker standard products, the fundamental set-up, calibration, and operation principles remain the same as described in this manual.

The system operates on hybrid technology combining inertial and ultrasonic tracking. The output of the miniature inertial components (both accelerometers and gyros found in each tracking device) determines position and orientation of the tracking stations. Using advanced Kalman filters, constant drift correction is applied by fusing the output of the inertial sensors with range measurements obtained from the ultrasonic components. The result is full 6-DOF data that is very smooth, precise, and free from jitter.

Advantages of the IS-900 technology include:

- Low cost system utilizes IS-900 technology for small area tracking
- Immune to metallic, most acoustic, and optical interference
- Sensor design eliminates acoustic transmitter "line of sight" blockage
- Consistent accuracy over entire tracking volume
- Factory calibration configurations available for accurate position mapping of acoustic transmitters
- Superior motion prediction algorithms
- Integration of tracking devices into OEM applications

Wireless MicroTrax^{TM} Devices

The MicroTrax^{TM} wireless tracker modules for the IS-900 allow for untethered 6 degree of freedom (6-DOF) tracking. They can be used along side wired tracking devices and the devices themselves can be converted from wired to wireless by using different cable adapters.

The radio/battery modules (Wireless Transmitter Modules) have lithium polymer batteries with enough capacity to provide 6-8 hours of continuous use and can be fully recharged in 3 hours. The Transmitter Modules have a processor that detects if the unit has not moved within 10 minutes and will automatically stop tracking and turn itself off to extend the battery life / tracking time. The device monitors the battery voltage and has an indicator that will flash to indicate a low battery condition at approximately 1 hour of tracking left before the unit must be recharged. The batteries can be recharged about 500 times before the length of time the charge lasts starts to decline. The batteries are field replaceable when charge cycle deterioration renders them ineffective.

In June 2007, we introduced the new MicroTrax™ wireless devices for the IS-900 System. These devices include a Head Tracker, Wand and a new Docking Station. The docking station is a new component in our offering that allows you to recharge your wireless devices and spare batteries in-situ via contacts while they rest in the cradle. The MicroTrax devices use a 2.4 GHz non-frequency hopping spread spectrum radio module that allows up to 16 different channel selections.

1.1. IS-900 Configuration

As shown in the block diagram in **Figure 1**, the IS-900 offers a wide range of tracking options. InterSense's SensorFusion code for calculating the full 6-DOF tracking solution is performed by the dedicated IS-900 processor. The MicroTrax tracking devices and SoniStrips plug into the serial interface ports and the IS-900 processor interfaces directly to a host computer via RS-232 serial port or Ethernet.

The IS-900 SimTracker supports a maximum of 4 MicroTrax devices and 12 SoniStrips (36 SoniDisc ultrasonic emitters). The IS-900 VETracker supports a maximum of 7 MicroTrax devices and up to 42 SoniStrips (126 SoniDiscs) on an interface port. The VETracker can also be configured to support 7 MicroTrax devices and up to 84 SoniStrips split between two interface ports (42 SoniStrips or 126 SoniDiscs per port).
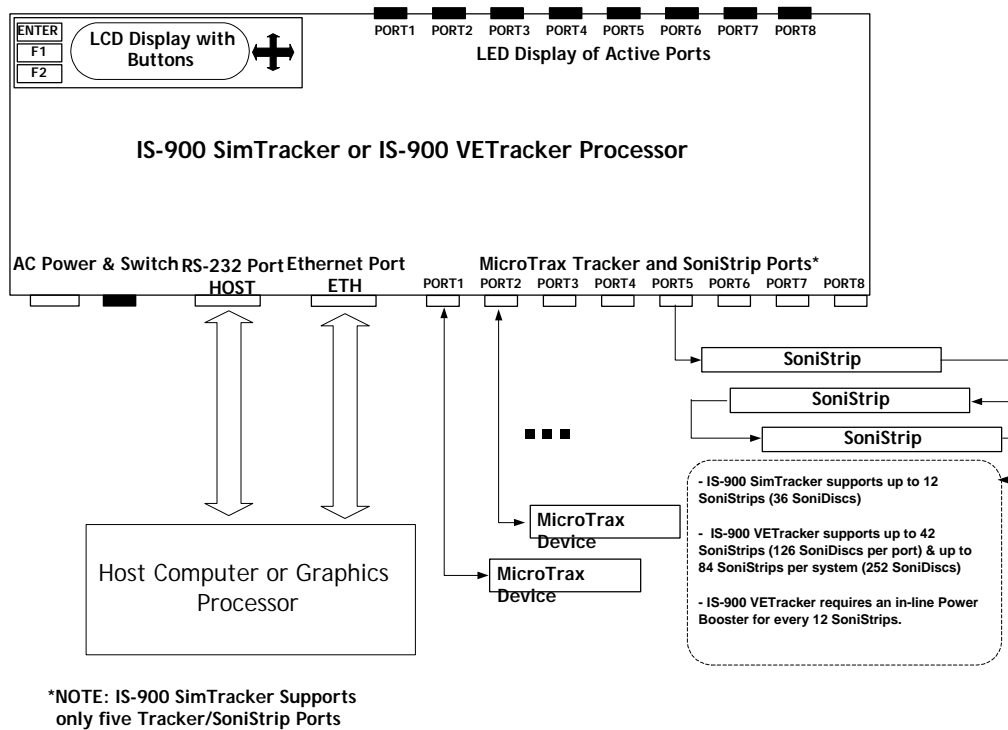
Figure 1 - IS-900 Functional Diagram

The IS-900 SimTracker and VETracker works with all of InterSense's standard wired & wireless MicroTrax devices (Head Tracker and Wand) plus several specialized devices developed for OEM applications (Helmet Tracker, NVIS Virtual Binoculars & HMD, plus others).

Note that some early versions of InterSense's devices are not compatible with the SimTracker & VETracker components. Please check with InterSense Technical Support (techsupport@intersense.com) to see if upgrades are required if you plan to use previously purchased devices with the IS-900 SimTracker or VETracker system.

1.2.   IS-900 SimTracker Components

The IS-900 SimTracker System ships in a standard configuration package with an IS-900 Processor, four SoniStrips, two MicroTrax Tracking Devices, the IS-900 Product CD (version 4.23 or higher), and all the required interface cables.

IS900 SimTracker Wireless 4R36 System	Qty	ISC-900MW-SIM(U, E, or K)*
IS900-1U 5Port Serial Base Unit	1	100-IS900-PCU5
MicroTrax Head Tracker with 3' Cable	1	100-91003-AWHT
IS-900,MicroTrax Transmitter Wireless	1	100-91000-EWTX
MicroTrax Wireless Wand	1	100-91000-EWWD
IS900 RS422 16 Channel Receiver	2	100-IS9MW-RX16
IS900 Acoustic Timing Adjuster	1	100-IS9MW-ATA1
IS-900,MicroTrax TTL-RS422 Dongle	1	100-91000-AWDG
MicroTrax Charging Station	1	100-91000-EWBS
Power Cord	1	078-2COND-XX06*
Rev3 10 to 10 pin RJ48 1 Foot	1	078-00088-0001
Cable Null Modem FD9-FD9	1	078-00001-0000
Battery, Lithium Polymer,3.7V,550mA-Hr	4	060-LPEZP-K550
Power Cord 18AWG, 9foot	1	078-00003-XX09*
6 Foot SoniStrip Rev.3	4	100-SRAL3-6000
Rev3 10 to 10 pin RJ48 30 Foot	2	078-00088-0030
Rev3 10 to 10 pin RJ48 4 Foot	3	078-00088-0004
Ceiling Clip, 1/4-20 x 5/8	8	068-HDP00-0000
45 deg Angle Bracket	8	082-00069-0000
Screw,1/4-20x1/2,PH,Pan,black	8	092-P1420-BP08

IS900 SimTracker WIRED 4R36 System	Qty	ISC-900M0-SIM(U, E, or K)*
IS900-1U 5Port Serial Base Unit	1	100-IS900-PCU5
MicroTrax Head Tracker with 3' Cable	1	100-91003-AWHT
IS-900,MicroTrax TTL-RS422 Dongle	1	100-91000-AWDG
MicroTrax Wired Wand with 12' Cable	1	100-91012-AWWD
Mini/uTrax 232 TO 422 SDP Dongle	1	100-SDPDL-0001
Rev3 10 to 10 pin RJ48 30 Foot	3	078-00088-0030
Cable Null Modem FD9-FD9	1	078-00001-0000
Power Cord 18AWG, 9foot	1	078-00003-XX09*
6 Foot SoniStrip Rev.3	4	100-SRAL3-6000
Rev3 10 to 10 pin RJ48 4 Foot	3	078-00088-0004
Ceiling Clip, 1/4-20 x 5/8	8	068-HDP00-0000
45 deg Angle Bracket	8	082-00069-0000
Screw,1/4-20x1/2,PH,Pan,black	8	092-P1420-BP08

*Suffix or "XX" depends on geography

1.3. IS-900 VETracker Components

The IS-900 VETracker System ships in a standard configuration package with an IS-900 Processor, six SoniStrips, two MicroTrax Tracking Devices, the IS-900 Product CD, and all the required interface cables.

IS900 VETracker WIRELESS 6R36 System	Qty	ISC-900MW-VET(U, E, or K)*
IS900-1U 8Port Serial Base Unit	1	100-IS900-PCU8
MicroTrax Head Tracker with 3' Cable	1	100-91003-AWHT
IS-900,MicroTrax Transmitter Wireless	1	100-91000-EWTX
MicroTrax Wireless Wand	1	100-91000-EWWD
IS900 RS422 16 Channel Receiver	2	100-IS9MW-RX16
IS900 Acoustic Timing Adjuster	1	100-IS9MW-ATA1
IS-900,MicroTrax TTL-RS422 Dongle	1	100-91000-AWDG
MicroTrax Charging Station	1	100-91000-EWBS
Power Cord	1	078-2COND-XX06*
Rev3 10 to 10 pin RJ48 1 Foot	1	078-00088-0001
Cable Null Modem FD9-FD9	1	078-00001-0000
Battery, Lithium Polymer,3.7V,550mA-Hr	4	060-LPEZP-K550
Power Cord 18AWG, 9foot	1	078-00003-XX09*
6 Foot SoniStrip Rev.3	6	100-SRAL3-6000
Rev3 10 to 10 pin RJ48 30 Foot	2	078-00088-0030
Rev3 10 to 10 pin RJ48 4 Foot	5	078-00088-0004
Ceiling Clip, 1/4-20 x 5/8	12	068-HDP00-0000
45 deg Angle Bracket	12	082-00069-0000
Screw,1/4-20x1/2,PH,Pan,black	12	092-P1420-BP08

IS900 VETracker Wired 6R36 System	Qty	ISC-900M0-VET(U, E, or K)*
IS900-1U 8Port Serial Base Unit	1	100-IS900-PCU8
MicroTrax Head Tracker with 3' Cable	1	100-91003-AWHT
IS-900,MicroTrax TTL-RS422 Dongle	1	100-91000-AWDG
MicroTrax Wired Wand with 12' Cable	1	100-91012-AWWD
Mini/uTrax 232 TO 422 SDP Dongle	1	100-SDPDL-0001
Rev3 10 to 10 pin RJ48 30 Foot	3	078-00088-0030
Cable Null Modem FD9-FD9	1	078-00001-0000
Power Cord 18AWG, 9foot	1	078-00003-XX09*
6 Foot SoniStrip Rev.3	6	100-SRAL3-6000
Rev3 10 to 10 pin RJ48 4 Foot	5	078-00088-0004
Ceiling Clip, 1/4-20 x 5/8	12	068-HDP00-0000
45 deg Angle Bracket	12	082-00069-0000
Screw,1/4-20x1/2,PH,Pan,black	12	092-P1420-BP08

*Suffix or "XX" depends on geography

1.4.   IS-900 SimTracker & VETracker Processor

The IS-900 Processor uses specialized firmware running on a dedicated processor to control motion sensor data acquisition and then calculate tracking and related data for output over serial or Ethernet interfaces. Shown in **Figure 2**, the SimTracker Processor has five front panel LEDs which indicate active ports during normal operation. Shown in **Figure 3**, the VETracker Processor has eight front panel LEDs to indicate active ports. Both processor configurations have a front panel LCD display and selection buttons for checking and changing tracking system parameters. The tracking devices, SoniStrip, host computer, and power connectors are accessed from the rear panel (described in detail in Section 3).

Figure 2 - IS-900 SimTracker Processor

Figure 3 - IS-900 VETracker Processor

1.5.   SoniStrips, SoniFrame SoniWing Constellation™ & SoniPods acoustic pulse transmitters

The SoniStrips (**Figure 4**), SoniWing (**Figure 5**), SoniFrame (**Figure 6**) and SoniPods (**Figure 7**) have ultrasonic SoniDisc transmitters that receive addressed signals from the Base Processor Unit and transmit ultrasonic pulses in response. The acoustic transmission beam width for each SoniDisc is adjusted for wide-angle coverage (approx. 70-degree cone angle) to maximize the tracking area.

Figure 4 - IS-900 SoniStrips

Figure 5 - IS-900 SoniWing

Figure 6 - IS-900 SoniFrame with three 6 ft. SoniStrips Assembled and Mounted on a Ceiling

Figure 7 - Discrete SoniDisc Transmitter (SoniPod)

The IS-900 uses an acoustic time-of-flight (TOF) ranging system to prevent position and orientation drift. For maximum accuracy and resolution, acoustic range measurements are made with unidirectional TOF measurements from the SoniStrip transmitters to the Tracked Stations.

The SoniDiscs' acoustic pulses are detected by miniature microphones integrated in the Tracked Stations.

Details of the assembly and set up of the SoniFrame and SoniWing are found in a supplemental manual in your IS-900 product CD.

1.6. Acoustic Constellation Mounting Considerations

The IS-900 product family offers a wide range of options to meet the needs of many different tracking environments.

SoniStrips are normally mounted from the ceiling over the desired tracking workspace. To increase the flexibility of this system, the IS-900 has been designed with different sized SoniStrips for mounting in a variety of immersive environments (CAVE®/CAVE-like, Reality Center, iCenter, ImmersaDesk, ReaCTor, PowerWall, CUBE, etc.). The user is able to position SoniStrips in most environments, including confined spaces such as virtual workbenches, automobiles, and cockpit simulators. Once installed, the user must calibrate the SoniStrip Constellation by measuring the Cartesian x, y, z coordinates of each SoniStrip and enter this information using the Constellation Configuration Utility Program provided with the system. A trained technical representative should perform the process of calibration. InterSense provides installation and training upon request.

Adjusting the tracking volume is easily accomplished by selecting the appropriate ultrasonic Constellation components. Options include different sized SoniStrips, discrete SoniPods and pre-calibrated SoniFrame or SoniWing structures.

1.6.1. SoniFrame & SoniWing Fixed Constellations

The fixed frame SoniFrame assembly provides up to a 2 x 2 x 3 meter tracking volume with no special sighting or calibration of the SoniStrips. The three SoniStrips easily mount to the SoniFrame assembly to produce a repeatable rigid structure that is portable and convenient to use. The SoniFrame provides a quick and convenient method for setting the IS-900's tracking area that does not require optical sighting for calibration.

The aluminum frame is made from a standard extrusion product that when assembled properly will provide an accurate mounting platform for InterSense's ultrasonic SoniStrip and SoniDisc tracking referencing components.

The design of the Fixed Frame provides mechanical mounting options for all InterSense SoniStrips in all lengths (2-foot, 4-foot and 6-foot) and combinations. **Figure 6** shows a typical SoniFrame fully assembled and ceiling mounted with three 6 ft. SoniStrips.

Interconnect bars are available to assemble multiple SoniFrames together as one structure. NOTE: When using multiple SoniFrames connected with InterSense's interconnect bars, the fully assembled & interconnected frames must be mounted to a rigid structure (i.e. a lighting grid or ceiling structure). Furthermore, the mounted SoniFrames must be leveled and co-planer in order to achieve accurate tracking.

The SoniWing is a smaller fixed frame assembly ideal for cockpit simulators or desktop tracking applications. The SoniWing, like the SoniFrame, does not require special measurement or calibration. The exact location of the SoniDiscs is measured by InterSense and included in the ISDEMO Constellation configuration utility program provided with the system. As with SoniFrames, multiple SoniWings can be utilized with a single system (i.e. a dual cockpit flight simulator configuration can use two SoniWings to simultaneously track two pilot head positions).

1.6.2. SoniPods

The SoniPod is a discrete SoniDisc packaged in its own enclosure with mechanical and electrical interfaces. SoniPods provide the most flexible Constellation configuration option for closed spaces, cockpits, or spaces that do not offer simple mounting spaces for fixed frames or SoniStrips. Each SoniPod is connected by "daisy chain" to the next with one cable from the IS-900 processor. It is highly recommended that InterSense installation engineers are consulted for configuration, installation and calibration of an IS-900 SoniPod Constellation array.

1.7. *Tracking Station Description*

For InterSense motion tracking systems, a "station" is the tracked object or device, which by industry jargon may also be called a sensor or tracker. An IS-900 tracks all stations in a 6-DOF mode, meaning each tracked device outputs X, Y, Z position information along with a pitch, yaw and roll orientation information. In addition, the Wand Tracking Station output joystick and button information for use with the immersive environment software. **Figure 8** summarizes InterSense's IS-900 Tracking Stations.

Tracked Station	Function
MicroTrax Wand w/ Joystick Tracking Station	Five button with center push button joystick
MicroTrax Head Tracking Station	Stereo glasses and Head Mounted Display (HMD) mounted
MicroTrax OEM Tracking Stations	Specific to OEM application

Figure 8 - IS-900 Tracked Stations

Each tracked station sends inertia measurement unit (IMU) data (angular & acceleration rates) with Ultrasonic Receiver Module (URM) acoustic range data for transmission to IS-900 base processor via wired or wireless links.

InterSense provides the different types of tracked stations listed above for use in immersive environments. All of these tracked stations use InterSense's advanced inertial MicroTrax technology combined with miniaturized digital acoustic position referencing components.

In addition to InterSense's standard tracked stations, there are also new OEM devices being delivered with some IS-900 systems that integrate the IS-900 technology into custom 3rd party tracked stations. IS-900 systems shipped with 3rd party devices come with documentation specific to these devices.

All of InterSense's MicroTrax tracking devices can be configured with a wireless transmitter & receiver for unencumbered tracking over larger areas.

The following sections summarize all of the options available from your local reseller or InterSense.

1.7.1. MicroTrax Wand with Joystick

Figure 9 - MicroTrax Wand

The MicroTrax Wand with center-click Joystick (**Figure 9**) is a tracked device that provides a simple and convenient way for the user to interact with virtual environments.

There are four miniature acoustic receiver microphones integrated into the MicroTrax Wand. During operation, all four miniature microphones are sampling the ultrasonic signals. Based on the trackers position with respect to ultrasonic Constellation array, only signals from the two best microphones are used for combination with the inertial data and calculation of the 6-DOF output. Each miniature receiver microphone has a reception cone angle approaching 180°. With two pairs of microphones located on the top and bottom of the MicroTrax Wand, the wand will consistently track over a full 360° range of motion in all axes while under the active Constellation array. The Wand will continue to track during brief (less than 1 minute) occlusion of one of the active pair microphones.

Each of the five buttons (four on top and one below plus sixth button on the joystick can be accessed from the IS-900 data stream by calling the output record Data Item 22. The two axis analog joystick provides an easy "fly-through" navigation interface used in most immersive virtual environments. The access to joystick data comes by calling the output record Data Item 23.

The device powers on by pressing the left button for ~ 3seconds. The unit will auto-off after 10 minutes of no movement to preserve battery power. To shut the unit off, press the left button and right button simultaneously (pressing the left button for ~ 2minutes will also power off the device).

Details of format, definition, and programming your application to use the buttons and joystick can be found in Section 8.

1.7.2. MicroTrax Head Tracker

Figure 10 - MicroTrax Head Tracker

The MicroTrax Head Trackers (**Figure 10**) are tracked devices that provide accurate 6-DOF data needed to give the user a correct visual viewpoint in an immersive visual environment. The MicroTrax head tracker is suitable for use in both projected (Simulators, CAVE®s, PowerWalls, etc…) and head worn (HMDs) application where head tracking is required.

The device powers on by pressing the button for ~ 3seconds. The unit will auto-off after 10 minutes of no movement to preserve battery power. To shut the unit off, press and hold the button for 6 seconds.

There are two miniature acoustic receiver microphones integrated into the MicroTrax Head Tracker. During operation, all miniature microphones are sampling the ultrasonic signals. Each miniature receiver microphone has a reception cone angle approaching 180°.
The MicroTrax Head Tracker has the receiver microphones placed at a 45° angle off the front of the device assuring continual tracking with all normal head positions in standard ceiling or wall mounted Constellation arrays. The head trackers will continue to track during brief (less than 1 minute) occlusion of one of the microphones.

1.7.3. MicroTrax Docking Station

Figure 11 - MicroTrax Docking Station

The MicroTrax Docking Station (**Figure 11**) is an optional component that serves to hold all the MicroTrax devices in one handy place. InterSense offers the docking station in two different configurations:

Housing for Wired Devices
The first configuration is primarily useful for wired devices where the docking station is a simple cradle to hold all the devices in one place.

Charging Station for Wireless Devices
The second configuration is useful for wireless devices where charging contacts are incorporated enabling recharging in-situ. In this configuration, LEDs next to each slot indicate when the device is in the process of charging or is completely charged. When the LED light is illuminated and the color is:

- Orange — Device is in the process of recharging
- Green — Device is fully charged.
- Off — Device is either not in contact (not fully seated) or the docking station is not powered.

1.7.4. Wireless MicroTrax Modules

All MicroTrax tracked stations can be operated without cabling to the IS-900 processor by using the IS-900 Wireless Modules. The Wireless Modules have two components—a receiver component that plugs into the IS-900 Processor and a rechargeable, battery operated transmitter that is either integrated into the tracked station (e.g. IS-900 Wireless MicroTrax Wand), or connected to a small, body worn transmitter that plugs directly in to the MicroTrax Station (e.g. IS-900 Wireless MicroTrax Head Tracker).

1.7.5. OEM Tracking Devices

InterSense works with Value Added Resellers, Systems Integrators and Partners to provide tracked devices tailored to specific applications. InterSense uses the Inter-IC bus (I2C) interface to all MicroTrax devices. The I2C is an industry standard interface developed by Philips nearly 20 years ago to establish a simple 2-wire communication standard between a variety of IC's and interface devices.

By choosing this standard board level interface, OEM's and systems integrators have the flexibility of integrating the InterSense's IS-900 wireless tracking technology and device interface into custom 3D interaction devices. InterSense can assist you with the development of a custom device, providing technical interface details and reference designs, or be contracted to develop the custom device to your specifications. For additional information about custom system development, call or email us at info@intersense.com.

1.8. IS-900 Cables, Connectors, Adaptors, Power Boosters and Wireless Radios

The IS-900 SimTracker & VETracker configurations ship with a standard set of cables and converters, listed in Sections 1.2 and **Error! Reference source not found.**, needed for system operation. Due to the flexible design of the IS-900, many systems are custom configured and installed by trained service representatives and may come with additional cabling and interconnect items not listed in the sections above. The items and their descriptions in this section cover all standard and optional interconnect components available for the IS-900.

Contact InterSense for detailed cable, adapter, or power booster specifications/questions.

1.8.1. Wired System

Figure 12 illustrates how the cables, connectors and adaptors are set-up for the wired version of the IS-900 System and MicroTrax devices.
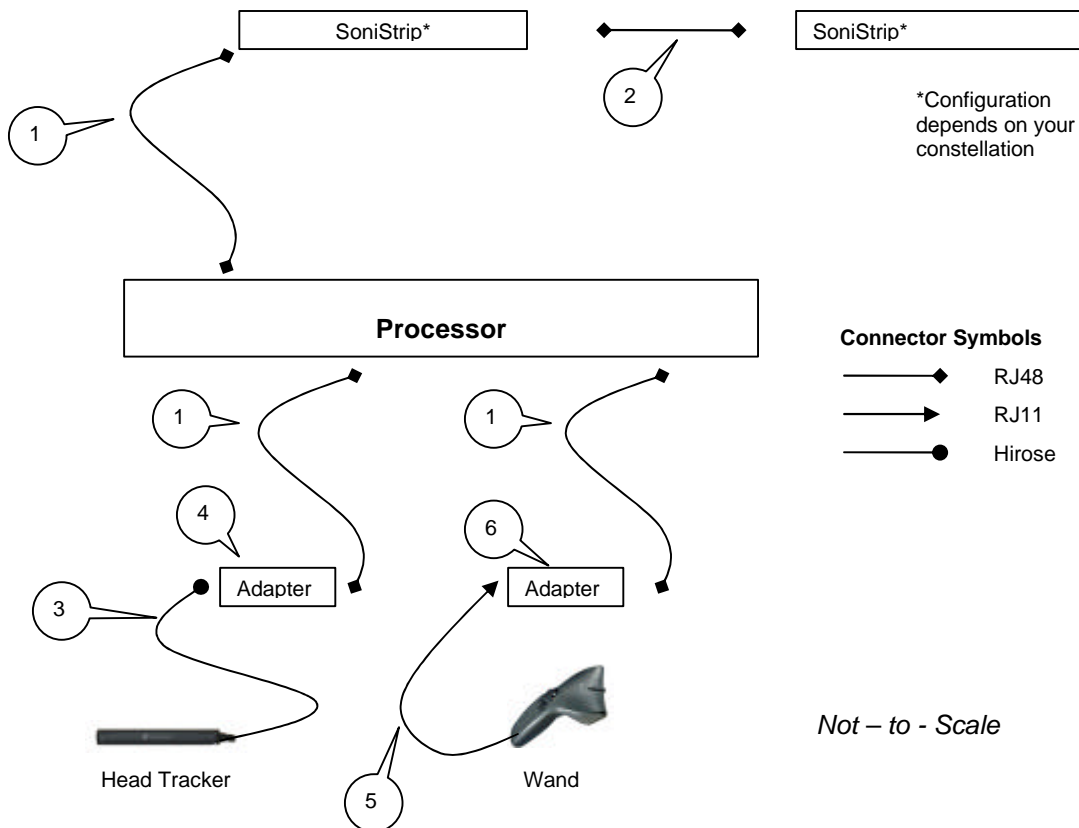
Figure 12 - Wired IS-900 and MicroTrax Cables, Connectors and Adapters

1. **Cable: Processor to SoniStrip or to MicroTrax device Adapter.**
   - Part no. 078-00088-0030
   - 30 feet long
   - RS422 communication
   - 10-pin RJ-48 cable connector

This 30 foot cable provides basic +12 VDC power and transmits the SoniDisc trigger signals to the SoniStrip Constellation array. It connects from the back of the IS-900 Processor (any PORT #) to the SoniStrips and can run a maximum length of 15 meters (50 ft.)*.

NOTE: 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.) <u>without</u> external power boosters.

This same cable is also used to connect the MicroTrax adapter to the processor.

2. **Cable: SoniStrip to SoniStrip**
   - Part no. 078-00088-0004
   - 4 feet long
   - RS422 communication
   - 10-pin RJ-48

The 4 foot SoniStrip to SoniStrip cable provides standard connectivity between each SoniStrip in the Constellation array. The cable and connector type (10-pin RJ-48) are identical to the Processor to SoniStrip Cable. 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**.

**NOTE: Maximum length of total SoniStrip daisy chain measured from the IS-900 Processor to the end of the SoniStrip chain and configured with power boosters can be greater than 90 meters (300 ft.). Consult with InterSense for non standard configuration support!*

3. **Cable (Integral to the Head Tracker):** Head Tracker to Adapter (ref. item 4)
   - Part no. 100-91003-AWHT
   - 3 feet long
   - TTL communication
   - Hirose connector

In order to keep the Head Tracker lightweight and unobtrusive, we use a TTL cable. However this cable has limited length to processor capability. Therefore, we convert it to an RS-422 downstream closer to the processor.

4. **Adapter: TTL to RS422**
   - Part no. 100-91000-AWDG
   - Hirose Connector for TTL
   - 10 pin RJ-485 connector for RS422

This adapter simply converts the TTL MicroTrax interface signals to a differential serial signal (RS-422) in order to transmit the signals long distance to the IS-900 Processor. The interface RJ-48 connector labeled "BASE" attaches to the Cable (ref. item 1). The Hirose connector connects directly to the MicroTrax Head Tracker integral cable (ref. item 3).

5. **Cable (Integral to Wand): Wand to Adapter (ref. item 6)**
   - Part no. 100-91012-AWWD
   - 12 feet long
   - RS232 Communication
   - 6-pin RJ-11

This cable is fixed to the wand and uses RS-232 communication. It has limited length capability therefore must be converted to an RS-422 downstream closer to the processor.

6. Adapter: RS232 to RS422
- Part no. 100-SDPDL-001
- 10 pin RJ-45 connector for RS422
- 6-pin RJ-11 connector for RS232

This adapter simply converts the RS-232 MicroTrax interface signals to a differential serial signal (RS-422) in order to transmit the signals long distance to the IS-900 Processor. The interface RJ-48 connector labeled "BASE" attaches to the Cable (ref. item 1). The RJ-11 connector labeled "TRACKER" connects to the MicroTrax Wand integrated cable.

1.8.2. Wireless System

Figure 13 illustrates how the cables, connectors and adaptors are set-up for the wireless version of the IS-900 System and MicroTrax devices.
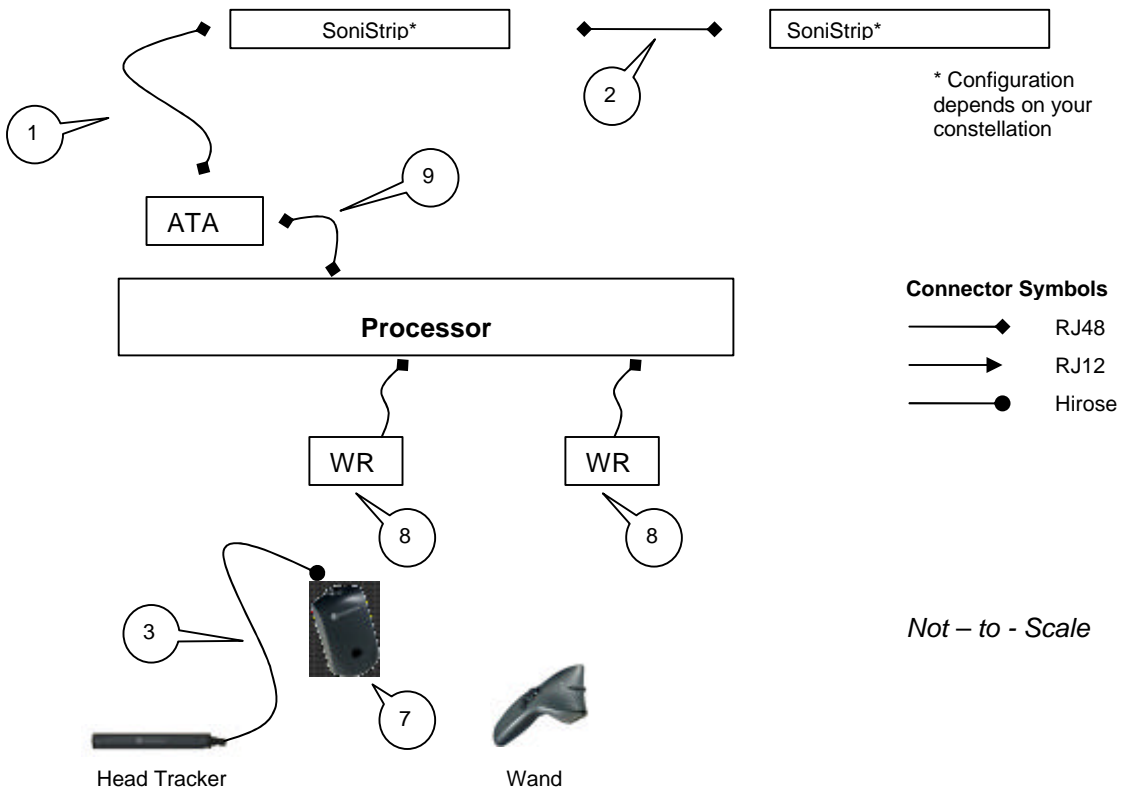
Figure 13 - Wireless IS-900 and MicroTrax Cables, Connectors and Adapters

1. Cable: Processor to SoniStrip
- Part no. 078-00088-0030
- 30 feet long
- RS422 communication
- 10-pin RJ-48 cable connector

This 30 foot cable provides basic +12 VDC power and transmits the SoniDisc trigger signals to the SoniStrip Constellation array. It connects from the back of the IS-900 Processor (any PORT #) to the SoniStrips and can run a maximum length of 15 meters (50 ft.)*.

NOTE: 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.) underline external power boosters.

2. Cable: SoniStrip to SoniStrip
- Part no. 078-00088-0004
- 4 feet long
- RS422 communication
- 10-pin RJ-48

The 4 foot SoniStrip to SoniStrip cable provides standard connectivity between each SoniStrip in the Constellation array. The cable and connector type (10-pin RJ-48) are identical to the Processor to SoniStrip Cable. 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**.

**NOTE: Maximum length of total SoniStrip daisy chain measured from the IS-900 Processor to the end of the SoniStrip chain and configured with power boosters can be greater than 90 meters (300 ft.). Consult with InterSense for non standard configuration support!

3. Cable (Integral to the Head Tracker): Head Tracker to MicroTrax Wireless Transmitter (ref. item 7)
- Part no. 100-91003-AWHT
- 3 feet long
- TTL communication
- Hirose connector

7. MicroTrax Wireless Transmitter for Head Tracker
- Part no. 100-91000-EWTX

This module transmits the data from the wireless head tracker to the head tracker's receiver.
The Hirose connector attaches to the TTL cable integral to the head tracker.

8. MicroTrax Wireless Receiver
- Part no. 100-IS9MW-RX16
- Has integral cable that connects to the processor
- RS422 communication
- 10-pin RJ-48 cable connector

9. Cable for Acoustic Timing Adjuster
- Part no. 078-00088-0001
- 1 foot long
- RS422 communication
- 10pin RJ-48 cable connector
- Adjusts the timing of the beacons in the SoniStrips to match the timing of the MicroTrax wireless devices.

1.8.3. All Systems

AC Power Cable, Part No. 078-00003-xx09 ("xx" for US/JP, UK, EU country code)

The IS-900 system ships with a 9 foot AC Power Cord to match the country voltage specification on your order. The IS-900 Processor has an auto switching power supply module to supporting AC voltage inputs from 100 to 240 VAC.

RS-232 Null Modem Serial Cable, Part No. 078-00001-0000 (IS-900 Processor to PC cable)

The null modem cable provides both data and control communication between the IS-900 System and your host computer. InterSense ships a 1.8 meter (6 foot) cable with the system. The maximum specified length for RS-232 communication cabling is 7.6 meters (25 feet). A pin-out and cable specification is located in FAQ's Appendix below. The null modem cable connects to the port labeled HOST on the IS-900 Processor.

(Optional) SoniStrip Power Booster, Part No. ISC-REV3X-POWR

The optional SoniStrip Power Booster kit shown in **Figure 14** comes with a +15 VDC power supply w/ country specific line cord, a 4 ft. SoniStrip Cable (Part No. 078-00088-0004), and an in-line power booster module (Part No. 100-REV3X-POWR). SoniStrip Power Booster Kits are required for SoniStrip Constellation Arrays that meet at least one the following conditions:

- The initial Processor to SoniStrip Cable, Part No. 078-00088-00xx, is greater than 30 ft.

- The SoniStrip Constellation Array is configured with more than 12 SoniStrips.

- Any SoniStrip Constellation array requires an extended measurement range of up to 4 meters (13 ft.).

For condition (a) with just 12 SoniStrips in a Constellation Array, the Power Booster is inserted in-line with the SoniStrip just before the first SoniStrip in the array. For condition (b), a Power Booster is required after every 12th SoniStrip in a Constellation (i.e. it is added in-line after between the 12th and 13th SoniStrip, the 24th and 25th SoniStrip, etc…). For condition (c), the Power Boosters deploy as in-line components before the 1st SoniStrip and after every 12th SoniStrip thereafter.
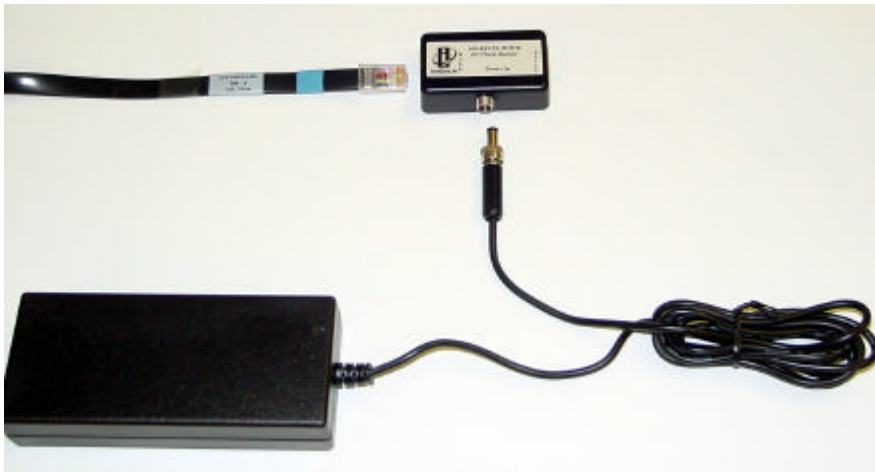
Figure 14 - SoniStrip Power Booster (Optional)

(Optional) Serial Wireless Radio Links, Part No. ISC-IS9S0-RFX0

For wireless conversion of MicroTrax Head Trackers, the Wireless Receiver and Transmitter essentially replaces the Adapter: TTL to RS-422 and the cable from this adapter to the processor.

(Optional) Ethernet Communications, Part No. ISC-LICEN-ETS0

The Ethernet communications option enables the IS-900 Processor to communicate through a standard Ethernet network. The details of this interface are application specific, but in general,

Ethernet communication is automatically supported by the InterSense libraries (isense.dll). When connecting directly to another computer, an Ethernet cross-over cable is required. When connecting to a standard network, where Ethernet hubs and routers are used, a straight through Ethernet cable is required. Please consult with InterSense Technical Support (techsupport@intersense.com) for specific questions about using the IS-900 Ethernet communication interface.

⚠️ ***Failure to power down the IS-900 Processor when connecting or disconnecting tracked stations will cause damage to the tracked stations.***

⚠️ ***Exceeding maximum cable lengths will cause IS-900 to operate unreliably due to signal transmission and timing errors.***

1.9.   IS-900 Support CD

The provided support CD has the latest version of all InterSense product specifications, InterSense technical papers/notes, and IS-900 product documentation. The current version of InterSense's ISDEMO set-up, calibration, and product testing software is also available on the support CD.

2. Specifications

2.1.   Performance Specifications

Degrees of Freedom: 6 (X, Y, Z, Yaw, Pitch, and Roll)

Tracking Device(s):   MicroTrax Wired Head Tracker
                                   MicroTrax Wired Wand (Standard with VETracker only)
                                   Custom/OEM Devices (Consult InterSense)

Tracking Volume: Up to 20 m^2 with 12 SoniStrips (SimTracker maximum)
                                   Up to 140 m^2 with 84 SoniStrips (VETracker maximum)
                                   2.0 m x 2.0 m x 3.0 m maximum w/ SoniFrame (optional)
                                   1.5 m x 1.5 m x 3.0 m with SoniWing (optional)

Angular Range: Full 360º - All Axes

Resolution: 0.75 mm (1.5 mm Wireless)
                                   0.05º (0.10º Wireless)

Static Accuracy: 2.0 to 3.0 mm (3.0 to 5.0 mm Wireless)
                                   0.25º RMS in Pitch & Roll, 0.50º RMS in Yaw
                                   0.50º RMS in Pitch & Roll, 1.00º RMS in Yaw (Wireless
                                   MicroTrax)

Update Rate: 180 Hz Nominal
                                   120 Hz Minimum (Wireless SimTracker & VETracker)

Latency: 4 ms Typical (without prediction @ 115 kbaud)

Maximum number of devices   4 for SimTracker (Wired or Wireless)
                                   7 for VETracker (Wired or Wireless)

Interface: RS-232 Serial Port
                                   Ethernet (Optional)
O/S Compatibility: Windows /2000/Millenium/XP, Linux, SGI IRIX, Sun Solaris,
                                   HP AUX, Mac OS X, VISTA
Software Support: SDK with full InterSense API
                                   ISDEMO control & connectivity software

Additional Specification for Wireless Devices

Device charge time   3 hours

Number of charges   500
Constant Tracking Time   6-8 hours on one charge
Radio Technology   2.4 GHz non-frequency hopping spread spectrum
Radio Range (Indoor)   100 Feet (with no major obstructions)
Radio Channels   16

2.2. Physical Specifications

AC Input: 100 to 120 V/200 to 240 V, 60/50 Hz, 6/3 A (auto switching)

Operating Temperature: 0^0 C to 50^0 C (32^0 F to 122^0 F)

Storage Temperature: -20^0 C to 70^0 C (-4^0 F to 158^0 F)

Standard Cable Lengths:
IS-900 to SoniStrips – 10.7 m
IS-900 to Tracking Devices – 12.0 m
IS-900 to Host (RS-232 Serial) – 1.8 m

Maximum Cable Lengths: System configuration dependent – Consult InterSense

Processor Size: 1 U rack mounted (44.45 cm wide x 40.64 cm deep x 4.45 cm tall)

Processor Weight: 6.8 kg

SoniStrip	Size	Weight
2 foot	0.61 m x 3.7 cm x 2.5 cm	0.4 kg
4 foot	1.22 m x 3.7 cm x 2.5 cm	0.9 kg
6 foot	1.83 m x 3.7 cm x 2.5 cm	1.3 kg

MicroTrax Devices	Size (outside dimensions)	Weight
Standard Head Tracker	10.15 x 1.54 x 1.38 cm	40 g (Includes wire)
Wand	17.48 x 10.16 x 5.38 cm	140 g wired (170 g wireless)
Wireless Transmitter	7.62 x 4.45 x 3.40 cm	65 g
Wireless Receiver	5.3 x 3.5 x 2 cm	45.4g (includes wire)

2.3. Environmental Specifications

When disposing of electronic equipment please do so responsibly in accordance with local requirements.

Normal environmental conditions

This standard applies to equipment designed to be safe at least under the following conditions:
a) indoor use;
b) altitude up to 2 000 m;
c) temperature 0 °C to 50 °C;
d) maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
e) MAINS supply voltage fluctuations up to ±10 % of the nominal voltage;
f) transient over voltages typically present on the MAINS supply.
g) Applicable rated pollution degree 2 environment.

10		ISO 7000-0434	Attention, consult **accompanying documents** In case of application as a safety sign, the rules according to ISO 3864-1 are to be adhered to. See safety sign ISO 3864-1, B.3.1, "General warning, caution, risk of danger".

3. Installation and Set-up

This section reviews the background information needed to understand how the IS-900 system works. It then covers the detailed steps required for set-up and calibration of the IS-900 tracking system in typical virtual or simulation environments. References made to other parts of this manual or to supplemental manuals provide additional background material.

The detailed set-up steps below assume an IS-900 VETracker is being used for a typical immersive display environment with a wired MicroTrax Head Tracker and a wired MicroTrax Wand. Systems purchased for different applications, such as cockpit simulators, may require technical support from InterSense to complete the installation, although the basic steps covered here are applicable for all IS-900 tracking configurations.

Check IS-900 Firmware Version

Upgrades to an existing IS-900 System may require you to upgrade also the firmware in the IS-900 Processor. The Wireless Tracking modules with the IS-900 VWT or VET processors require firmware version 4.14 or higher to operate.

Wireless Tracking Modules with the IS-900 SimTracker or VETracker processors require firmware version 4.20 (MiniTrax) or 4.23 (MicroTrax) or higher to operate.

To check if your IS-900 system needs a firmware upgrade, follow these steps:

1. Power on the IS-900 ***Shortcut***® *Use the front panel buttons and LCD menus to determine the IS-900 firmware version by pressing the Enter key, arrow key down to System Config, select Enter again, select Information to read Firmware revision number. Or use ISDEMO as follows.*
2. Connect the PC to the IS-900 processor using the null modem cable provided with your system.
3. Launch ISDEMO to determine the firmware version installed in the IS-900 Processor (with ISDEMO, this information is found under the Tools→System Information menu).
4. If the version number shown is lower than the version specified above for your IS-900 processor configuration, you will need to upload a new version of firmware to the IS-900 processor.

If you believe you require a Firmware Upgrade for the IS-900 System, please contact InterSense Technical (techsupport@intersense.com or +1 781 541-7624) support for assistance with selecting the correct firmware needed with your system. The necessary download and instructions can also be found by logging into the support section of our website.

3.1.   *InterSense Coordinate Reference Frame*

Before setting up the IS-900, it is important to review the standard InterSense coordinate reference system. As a 6-DOF tracker, use of the "InterSense Coordinate Reference Frame" throughout this manual helps explain the installation, calibration and tracking performance.
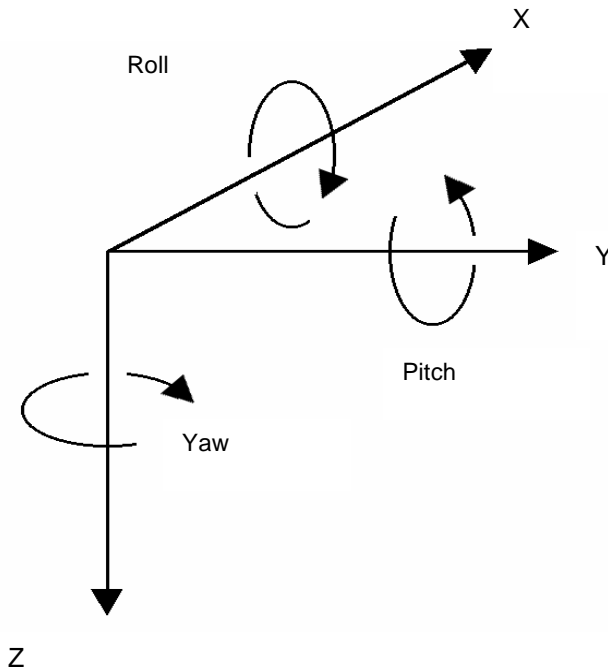
Figure 15 - InterSense Coordinate Reference Frame

Figure 15 shows the standard reference frame for both position and orientation of all InterSense tracker systems.

The reference frame (hereafter referred to as Navigation frame or Nav frame or N frame) is the locally-level geographic frame with its x-axis pointing north, y-axis east, and z-axis down.

It is important to understand that when setting up any InterSense system, *the z-axis of the tracking system's coordinates must always point in the direction of gravity*, whereas the x and y axes may be set to any direction rotated about the z-axis.

Subsequent coordinate transformations by application software to change the direction of the z-axis are normal, but the underlying reference of InterSense's inertial components to gravity must be maintained by the tracking system. The Euler angles reported by the tracker are described as a sequence of rotations applied to the tracking device starting with its body axes initially aligned with the Nav frame axes and resulting in the current orientation. The sequence starts with a rotation by (+yaw) about the Z axis, followed by a rotation by (+pitch) about the new Y axis (i.e. body frame axis), followed by a rotation by (+roll) about the new X axis (i.e. body frame x axis).

3.2.   Hardware Set-up

General Equipment Handling Warnings

⚠️ *The ultrasonic transmitters (SoniDiscs) are sensitive electronic components. Take care not to allow any dirt or moisture in or around the SoniDiscs install the SoniStrips, SoniFrame, SoniWing or SoniPods.*

⚠️ *Mishandling can damage both the ultrasonic receiver microphones and the embedded InertiaCube in each tracked station.*

⚠️ *Do not drop the tracked stations. While InterSense has designed the devices for normal usage in simulators and virtual environments, excessive shock can damage the internal components.*

⚠️ *Always turn off the IS-900 Processor (remembering to save any configuration changes) before plugging or unplugging the tracked stations. Failure to do this could result in damage to the stations.*

⚠️ *Always store the tracked devices in a secure location when not in use. Leaving them on the floor or on an unsecured surface can result in accidental damage.*

This section covers a typical installation of the IS-900 with standard components. Consult InterSense for non-standard or OEM installations.

The basic steps covered in this section include:

- Installation of SoniStrips
- Mount and Calibration of SoniStrips
- Connection and Test with the IS-900 Processor.
- Special Instructions for Wireless Devices

Unpack all components and check against packing list (standard configuration referenced in Section 1.2 for the IS-900 SimTracker and 1.3 for the IS-900 VETracker). Check the packing list that came with the system as many orders will not match the standard configurations shown in Section 1. Contact InterSense if any components are missing or appear damaged.

3.3. Installation of SoniStrips

In order to install the SoniStrips, you need the following (that are not supplied in the standard IS-900 System):

1. An optical surveying tool or Total Station. We recommend a Nikon DTM 420 or equivalent for measuring absolute x, y, and z coordinates of all SoniDiscs.

> *Note: If your IS-900 system comes with a fixed constellation frame (SoniFrame or SoniWing), then the optical surveying equipment is not needed.*

2. A Windows FC capable of running the latest version of ISDEMO (check www.intersense.com/support for current version).

General Guidelines

The position of a SoniDisc is defined as the coordinates of the center of the grill covering the speaker. When measuring the position of each SoniDisc in an installed Constellation Array, 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. Position data for all stations is computed relative to that coordinate system.

SoniStrips come in 0.6, 1.2 or 1.8 meter (2, 4 or 6 foot) lengths. The 2-ft. SoniStrip has two SoniDiscs per SoniStrip and the 4-ft SoniStrip has 3 SoniDiscs installed with each SoniDisc spaced at 0.61 m (2 foot). The 6-ft SoniStrip has 3 SoniDiscs with each spaced at 0.91 m (3 foot) spacing. For best performance, it is generally recommended that SoniStrips be installed in a regular grid over the tracked area. Total distance from a SoniDisc in the Constellation to a tracked station should not exceed 3.0 meters (10 feet) to guarantee good signal detection (4 meters with external power boosters installed).

IS-900 default configuration does not contain a Constellation, so it is up to the user to configure it. To properly track, the system needs to know the position and orientation of each of the SoniDiscs in the Constellation? with high degree of accuracy. The best way to measure position of each SoniDisc is with the use of an optical sighting tool known as a Total Station. The quality of the measured position data input for the SoniStrip Constellation Array is directly proportional to the accuracy of the IS-900 system's tracking data output.

A second parameter needed for each SoniDisc in the installed Constellation Array is the unit normal vector, as shown in **Figure 16**. The unit normal vector 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. The unit normal vector is the same for each SoniDisc on the same SoniStrip. Entering the correct normal vector for each SoniDisc is important. The normal vector information is used by the IS-900 tracking algorithm to correctly schedule the polling of each SoniDiscs.

SoniStrips

SoniDisc Emitter

Normal vector pointing down
0, 0, 1
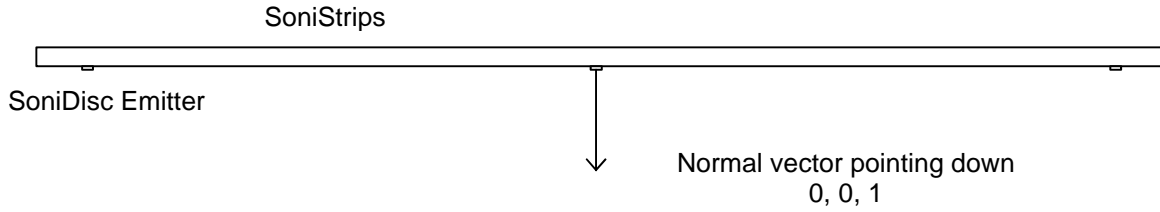
Figure 16 - Unit Normal Vector Definition for Ceiling Installed SoniStrip

The SoniStrip Constellation Array provides an absolute positional reference to the tracked environment. The idea behind providing SoniDiscs (beacons) in groups of three in each SoniStrip (rail) is to give flexibility in both the configuration and installation to cover a wide range of tracking environments in a convenient package for ease of installation. To establish a minimum criterion for a tracked environment, at least two SoniStrips are required to provide proper tracking. A conceptual diagram using two SoniStrips, shown in **Figure 17**, provides the fundamental relationship established by the SoniStrip Constellation with respect to the tracking environment.

Side view of SoniStrips

0.67 m

70 degree acoustic cone

3 m

Floor

Top view of SoniStrips

Area of optimal tracking at 1m to 2 m from SoniStrip Constellation

Area of Single SoniDisc Coverage at 2 m from SoniStrip Constellation

0.67 m
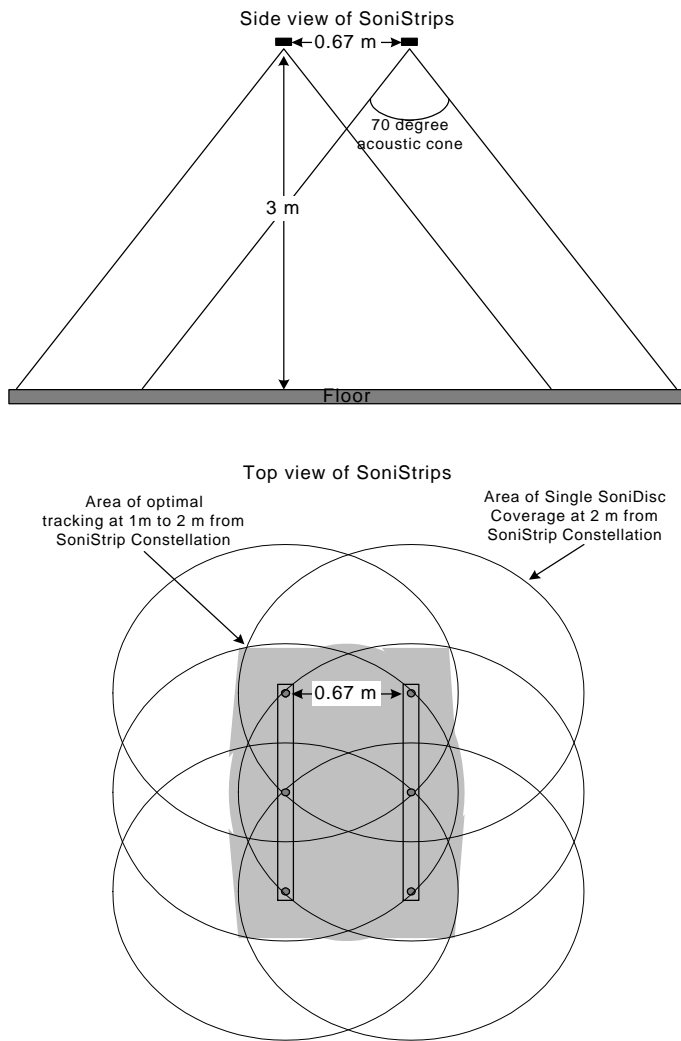
Figure 17 - Tracking Coverage with Two SoniStrips

When preparing the installation for SoniStrips or SoniPods, it is very important to assure the following in order to maintain stable tracking conditions:

1. The mounting surface is rigid and stable
2. The relative position between SoniStrips or SoniPods remains fixed

Note: If either of these two conditions is not met, then the performance of the tracking system will degrade and possibly fail. InterSense will not warrant a system to track with improper installation.

For larger or first time installations, we recommend you contract InterSense to perform on-site installation and training. Please contact your InterSense representative for details.

Sections 3.3.1, **3.3.2 and 3.3.3** describe three examples of typical tracking system installations:

- SoniStrip Mounting for Ceiling Installations
- SoniStrip Mounting for Power Wall Installations
- SoniStrip Mounting for CAVE-like Installations

3.3.1. SoniStrip Mounting for Ceiling Installations

The following is an example of an installation for a large area immersive room environment.

Important Note:
For customers upgrading existing MiniTrax systems to work with wireless MicroTrax devices – an InterSense acoustic timing adjuster (ATA) must be inserted in series with the rails in between the processor and the first beacon in the chain. The ATA allows users with revision 3.0 rails to use wireless MicroTrax devices more effectively (improves tracking at close range). New systems using the revision 3.1 rails do not need this ATA.

Most applications for IS-900 systems are best realized with a ceiling mounting of several SoniStrips in either a grid-like pattern or a staggered pattern as depicted in **Figure 18** below. In both cases, 6-ft. SoniStrips are mounted to the ceiling using InterSense provided ceiling clips that attach directly to most all suspended ceiling systems.

The SoniStrips are mounted approximately 2 to 3 feet apart, depending on the ceiling height. For ceilings that are 8 feet high, mount SoniStrips with 2 ft separation. For lower ceilings, consider using 4-ft. SoniStrips mounted 2 feet apart. For ceiling mounts from 9 to 12 feet high, mount 6-ft SoniStrips approximately 3 feet apart and plan on using external power boosters to maximize the acoustic measurement range of the IS-900.
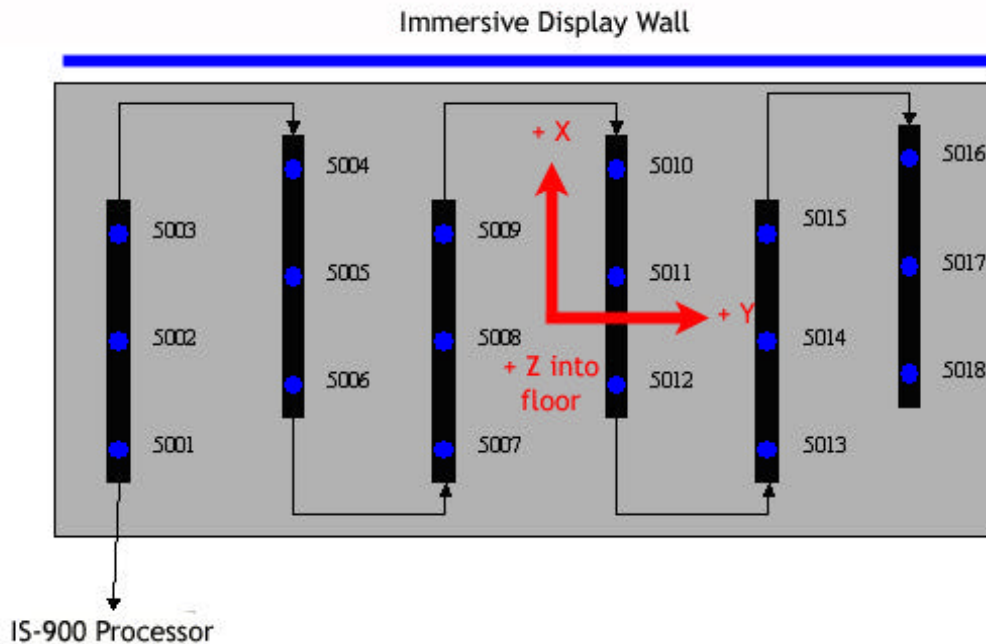
Figure 18 - Immersive Room Ceiling Mounting (top down view)

In **Figure 18**, the coordinate system is shown from a "top down view", identical to the default Constellation Array view used with the InterSense set up software ISDEMO. Each SoniStrip is wired in sequence from the lower left hand corner of the SoniStrip Constellation Array connecting to Port 5 on the IS-900 Processor.

Definition of the SoniStrip ID numbers come from the wiring sequence, or "daisy chain", and IS-900 Processor port number that is used to connect to the Constellation Array. Here, the SoniStrip

Array is plugged into Port 5 thus becoming a sequence with SoniDisc ID numbers from 5001 to 5018.

With each SoniStrip mounted in the same orientation on the ceiling and pointing down, the normal vectors then for the installation and wiring shown in **Figure 18** become:

SoniDisc ID Nos.   Normal Vectors used in Constellation Array
5001 – 5018   0.000, 0.000, 1.000

3.3.2. SoniStrip Mounting for Power Wall Installations

The following is an example of an installation for a typical power wall.

A typical immersive display wall consists of one or more stereo projectors that illuminate a flat (or curved) screen. This type of display is ideal for mounting the IS-900 SoniStrips surrounding the screen with each SoniStrip angled at 45 degrees towards the center of the screen. **Figure 19** shows a typical, two-projector, flat display using six, 6-foot SoniStrips in a perimeter mount configuration.
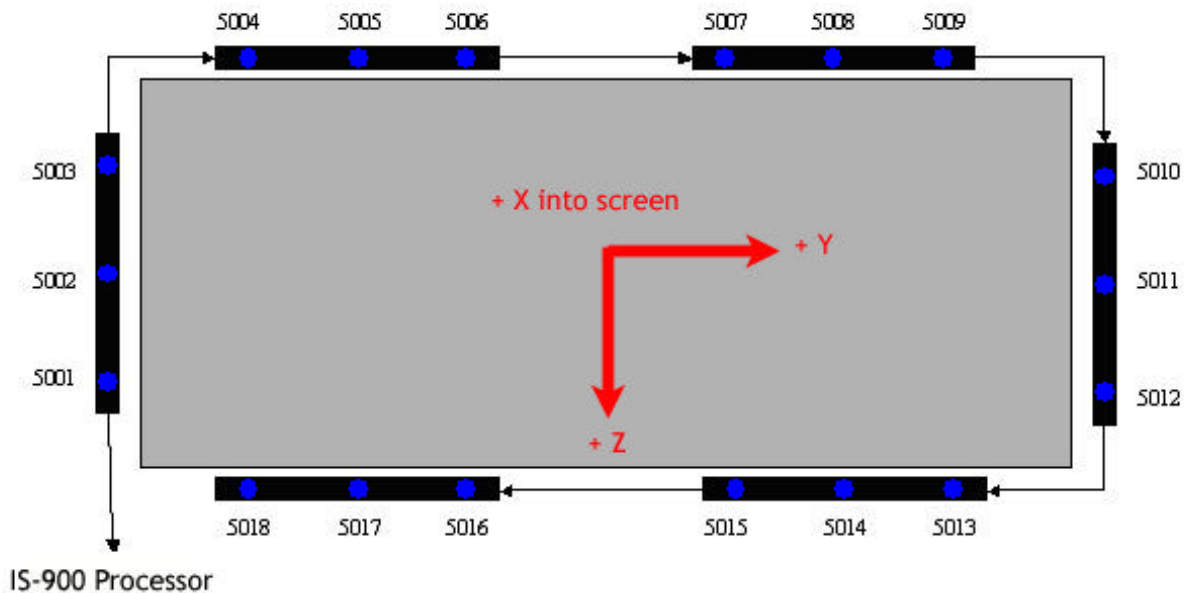
Figure 19 - Power Wall Perimeter mounting (front forward view)

Each SoniStrip is mounted along the edge of the display using the InterSense provided angle brackets. The SoniStrips on the top and bottom of the display are spaced approximately 2 to 3 feet apart, depending on the size of the display wall. The InterSense coordinate system for **Figure 19** has X forward looking into the screen, Y positive to the right, and Z positive down in the direction of gravity.

Each SoniStrip is wired in sequence with the bottom left corner connecting to Port 5 of the IS-900 Processor. The SoniStrip ID numbers are defined by the wiring and port number and become a sequence with numbers from 5001 to 5018.

With each SoniStrip angled at 45 degrees toward the screen center, the normal vectors for the installation and wiring shown in Figure 19 become:

SoniDisc ID Nos.	Normal Vectors used in Constellation Array
5001 – 5003	-0.707, 0.707, 0.000
5004 – 5009	-0.707, 0.000, 0.707
5010 – 5012	-0.707, -0.707, 0.000
5013 – 5018	-0.707, 0.000, -0.707

3.3.3. SoniStrip Mounting for CAVE-like Installations

The following is an example of an installation for a typical CAVE-like environment.

The IS-900 excels over magnetic or optical trackers in CAVE-like installations. As shown in **Figure 20**, the SoniStrips are positioned to provide uniform tracking coverage throughout the entire immersive display environment with no distortion or occlusion issues.
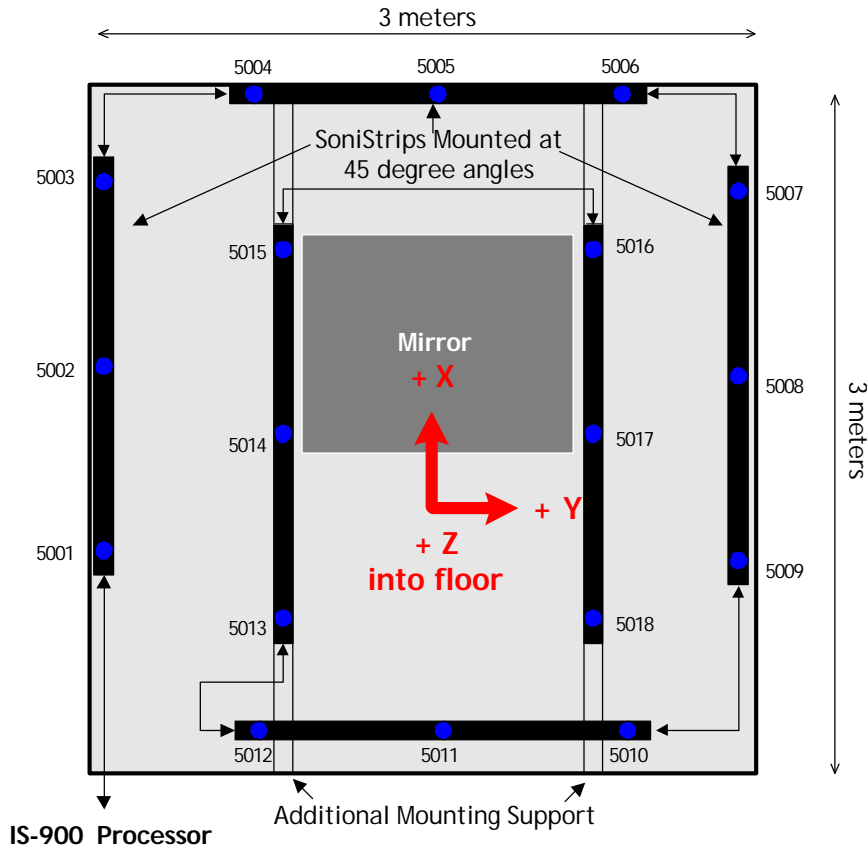
Figure 20 - CAVE-like Installation (top down view)

The example above is a 3 meter cube, 4 walled immersive display system which uses six 6-ft. SoniStrips. Depending of the number of display walls, display volume and mirror position/size, it may be necessary to use a variety of different sized SoniStrips (6, 4, and 2 foot) or SoniPods discretely located to provide the optimum tracking coverage. Please consult with InterSense regarding all CAVE-like installations to maximize the tracking performance.

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The first three SoniStrips mounted along the top and around the perimeter of the CAVE walls, are angled in towards the CAVE center at 45 degrees. The remaining three SoniStrips are mounted with the normal vectors pointing straight down on each side of the center ceiling mirror and along the back side of the CAVE. The mounting of these three interior SoniStrips may require the addition of two U-Channels, positioned front to back, on each side of the mirror at the top, center of the CAVE.

Each SoniStrip is wired in sequence with the bottom left corner connecting to Port 5 of the IS-900 Processor. The SoniStrip ID numbers are defined by the wiring and port number and become a sequence with numbers from 5001 to 5018.

With three perimeter SoniStrips angled at 45 degrees toward the CAVE center and the three interior SoniStrips pointing straight down in the Z-axis, the normal vectors then for the installation and wiring shown in Figure 24 become:

SoniDisc ID Nos.	Normal Vectors used in Constellation Array
5001 – 5003	0.000, 0.707, 0.707
5004 – 5006	-0.707, 0.000, 0.707
5007 – 5009	0.000, -0.707, 0.707
5010 – 5018	0.000, 0.000, 1.000

3.3.4. SoniFrame and SoniWing

Please refer to the IS-900 Product Supplement Manual titled "IS-900 Fixed Frame Assemblies—SoniFrame & SoniWing", Doc. No. 072-00088-0G04, for details on the assembly and set up of these pre-calibrated SoniDisc Constellation Arrays.

The InterSense installation and testing software, ISDEMO, has commands in the Constellation Tool that allow rapid installation and calibration of the SoniWing and SoniFrame. This tool automatically generates both the position and normal vectors for these fixed frame, factory calibrated SoniDisc Constellation options. Refer to **Section 14.7** for information about using ISDEMO to install SoniWing and SoniFrame Constellation Arrays.

3.4.   *Measurement and Calibration of SoniStrips*

Once the SoniStrip Constellation array is installed and wired, the next step is to accurately measure the absolute positions of each SoniDisc in the array.

Two methods can be used to calibrate the installed SoniStrip beacon array:

1. Optical Surveying (sighting with a surveying tool, i.e. a Nikon total station). This is the most precise method of calibration. Use this method for installations in all virtual environments.

2. Direct Measurement (hand measurement with a tape measure). This technique is not recommended for most installations; but, can be used to quickly test an IS-900 installation when the first technique cannot be done. ISDEMO has SoniStrip positioning and alignment tools that help when performing a quick installation using the direct measurement approach. Refer to **Section 14.7** for details.

*NOTE: In calibrating the SoniStrip constellation array, it is **very important that the measurements are as accurate as possible**. Accurately measuring the SoniStrip beacon*

constellation array will directly impact tracking performance. Use a Total Station (Nikon DTM 420 or equivalent), or other means to accurately measure the absolute position vector for each SoniDisc. Contact InterSense for Total Station recommendations or installation support.

When measuring the SoniStrip Constellation Array with a Total Station:
1. Read the manufacturer's instructions on the set-up and operation of the surveying tool. Make sure the measurement tool can report absolute X, Y, and Z coordinates for each measurement. The IS-900 Tracking system needs the X, Y, and Z position measurement for each SoniDisc location in order to properly track.

2. Measure the X, Y, Z coordinates of each SoniDisc and write down the measurements in a table listing beacon position (x, y, z values in meters), normal vector (for ceiling applications the normal vector nx, ny, nz are always 0.00, 0.00,1.00). The SoniDisc ID number is determined by the port the SoniStrip "daisy chain" is plugged in to (i.e. Port 5 for our examples is Section 3.3) and the sequence number in the daisy chain (i.e. the first SoniStrip in a daisy chain will have SoniDisc ID's 5001, 5002 and 5003).

   For example: 1.2000, 0.0000, 0.0000, 0.00, 0.00, 1.00, 5001

   Sample sheet to enter X, Y, Z measurements of each beacon

X	Y	Z	Nx	Ny	Nz	Beacon #

3. Using the InterSense command format:

MCF{beaconNum}, X, Y, Z, Nx, Ny, Nz, beacon ID

Where,
{beaconNum} is a sequential number (i.e. 1, 2, 3, …)

X, Y, Z are the beacon locations in meters in nav-space (x forward, y to the right, z down),

Nx, Ny, Nz are the pointing vectors of the beacon, usually they point down in the +Z direction so entering 0,0,1, is correct; and,

BeaconID is the SoniDisc number determined by the "daisy chain" sequence of the SoniStrips for that specific beacon (i.e. with SoniStrips plugged into port 5, the sequence starts at 5001, 5002, 5003, 5004, etc…).

Enter beacon locations in meters into comma delimited text file (.txt) using WordPad or any text editing application on your PC in the following format shown in the example below.

Example of .txt file with X, Y, Z measurements

```
MCC
MCF1,  0.0000,  0.0000, -3.0000,  0.00, 0.00, 1.00, 5001
MCF2,  0.0000,  0.9144, -3.0000,  0.00, 0.00, 1.00, 5002
MCF3,  0.0000,  1.8288, -3.0000,  0.00, 0.00, 1.00, 5003
MCF4,  0.6000, -0.5050, -3.0000,  0.00, 0.00, 1.00, 5004
MCF5,  0.6000,  0.4094, -3.0000,  0.00, 0.00, 1.00, 5005
MCF6,  0.6000,  1.3238, -3.0000,  0.00, 0.00, 1.00, 5006
MCF7,  1.2000,  0.0000, -3.0000,  0.00, 0.00, 1.00, 5007
MCF8,  1.2000,  0.9144, -3.0000,  0.00, 0.00, 1.00, 5008
MCF9,  1.2000,  1.8288, -3.0000,  0.00, 0.00, 1.00, 5009
MCF10, 1.8000, -0.5030, -3.0000,  0.00, 0.00, 1.00, 5010
MCF11, 1.8000,  0.4114, -3.0000,  0.00, 0.00, 1.00, 5011
MCF12, 1.8000,  1.3258, -3.0000,  0.00, 0.00, 1.00, 5012
MCF13, 2.4000,  0.0030, -3.0000,  0.00, 0.00, 1.00, 5013
MCF14, 2.4000,  0.9174, -3.0000,  0.00, 0.00, 1.00, 5014
MCF15, 2.4000,  1.8318, -3.0000,  0.00, 0.00, 1.00, 5015
MCF16, 3.0000, -0.5030, -3.0000,  0.00, 0.00, 1.00, 5016
MCF17, 3.0000,  0.4114, -3.0000,  0.00, 0.00, 1.00, 5017
MCF18, 3.0000,  1.3258, -3.0000,  0.00, 0.00, 1.00, 5018
MCe
```

3.5.   Connections with IS-900 Processor

This section describes the final steps to setting up the IS-900 system.

1. Connect all the tracking devices and SoniStrip Constellation Array to the IS-900 Processor

*Important! Always power down the IS-900 Processor and any external power boosters prior to connecting or removing any cables. **DO NOT** "hot plug" any devices into the IS-900 Processor – connecting devices to the IS-900 while the power is on will result in damage to both the IS-900 Processor and the tracking devices.*

Wired MicroTrax Devices
For wired MicroTrax Devices, please see **Figure 12**. If you have a MicroTrax Head Tracker, it connects directly to the Adapter: TTL to RS422, (item 4 in **Figure 12**). If you have a wand, it connects directly to the Adapter:RS232 to RS422, (item 6 in **Figure 12**).

Next, connect the adapter(s) to the processor using the 30 ft. cable (part number 078-00088-0030). Either adapter uses the same cable to the processor. You can use Ports 1, 2, 3, 4, 6, 7 or 8 on the VETracker for tracking devices or a second SoniStrip Constellation "daisy chain." However the SimTracker has only Ports 1, 2, 3 and 4 available for tracking devices or a second SoniStrip Constellation "daisy chain."

Next, connect the SoniStrip Constellation Array into **Port 5** on the back of the IS-900 Processor using the 30 ft. cable (part number 078-00088-0030).

Wireless MicroTrax Devices
For wireless MicroTrax devices, please see **Figure 13.** If you have a MicroTrax Head Tracker, it connects directly to the MicroTrax Wireless Transmitter (item 7 in **Figure 13**). Whether you have a Head Tracker, a Wand or both, each needs a Wireless Receiver. Simply connect the integrated cable on the Wireless Receiver into the Processor.

Connect the SoniStrip Constellation Array into the Acoustic Timing Adapter (item 9/ATA in **Figure 13**). Then connect the ATA into Port 5 on the back of the IS-900 Processor. Similar to wired devices, additional tracking devices or a second SoniStrip Constellation "daisy chain" can use Ports 1, 2, 3, 4, 6, 7, or 8 on the VETracker. The SimTracker has only Ports 1, 2, 3 and 4 available for additional tracking devices or a second SoniStrip Constellation "daisy chain."

Important Note: Each SoniStrip Constellation "daisy chain" needs one ATA. If you use additional constellations, then you will need an additional ATA for each additional constellation.

When connecting the cables to the IS-900 system, please always follow these guidelines:

- Only use supplied cables to connect the SoniStrips to the IS-900 Processor. **DO NOT** use standard phone cables or network cables, as they do not have the correct pin-outs used with the IS-900 tracking system.

- If a need arises to build additional cables, use RJ48 flat cabling and RJ48 connectors. Call InterSense Technical Support for a detailed specification or with any cabling questions (+1 781 541 7624).

A Power booster **(Figure 21**) must be connected in between the end of the SoniStrip "daisy chain" and Port 5 of the IS-900 Processor to supply the additional power to the SoniDiscs for:

- Measurement ranges greater than 3 meters or,
- SoniStrip Arrays configured with greater than 12 SoniStrips where an additional power booster is required after every 12th SoniStrip in a large SoniStrip Constellation Array.
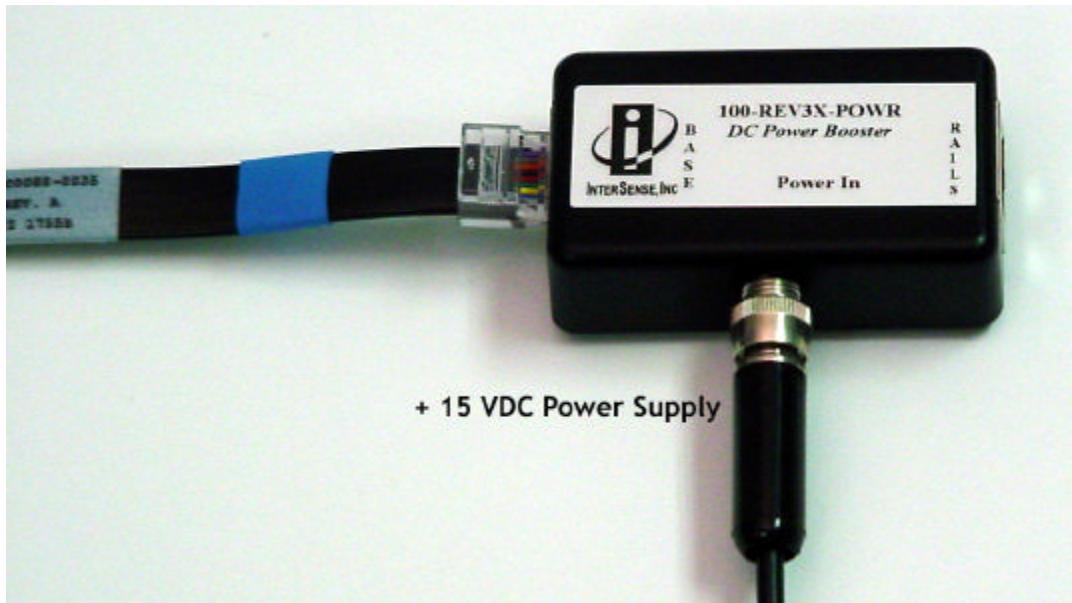
Figure 21 - External Power Booster for SoniStrips

2. Setup your PC and launch ISDEMO

Follow the directions in **Section 14** to install and run ISDEMO on a PC.

3. Connect the communications to the IS-900 system

Choose a communication option for connecting to the PC running ISDEMO. **Section 14.3** details the communication options for connecting with either serial or Ethernet.

3.6. *Wireless MicroTrax Setup*

Skip this step if you are using wired tracking devices.

IMPORTANT NOTE: Additional wireless IS-900 tracking systems in the immediate area should be shut down while a new system is being configured to avoid the possibility of interference during setup.

If you are using wireless devices, we recommend fully charging the Radio/Battery Modules prior to use. If the power LED on the wireless Wand or Head tracker transmitter is flashing, that is an indication of a low battery. Once the wireless receiver / transmitter combinations have been configured below, each receiver will be matched to exactly one transmitter via an "RF Channel" and "Link ID". The system will not need to be configured again unless the user wishes to change which receiver matches with which transmitter.

1. Make sure the IS-900 Processor is powered off.

2. Plug the Base Receiver Modules into the IS-900 Processor.

    Plug the cable coming from the Base Receiver Modules directly into one of the IS-900 Processor Ports (Ports 1 to 5 on the SimTracker processor or Ports 1 to 8 on the VETracker processor) on the rear of the processor.

    Turn on the wireless tracking devices by holding the power buttons for approximately 2 seconds.
    - On the wireless wand, the power button is the button farthest to the left (under the joystick).
    - On the wireless head tracker, the power button is the only button available on the transmitter pack that connects to the tracker itself.

3. Turn on the IS-900 processor. When the system has finished booting, verify that each receiver has a green power LED lit. (If there are no LEDs on any of the receivers, then they are not receiving power and they will not be configurable. Check that the cable was inserted securely).

4. Run ISDEMO and connect to the processor via the "IS-900" configuration. Click "Parameters->Wireless Configuration" from the menu. You will be presented with the following dialog:
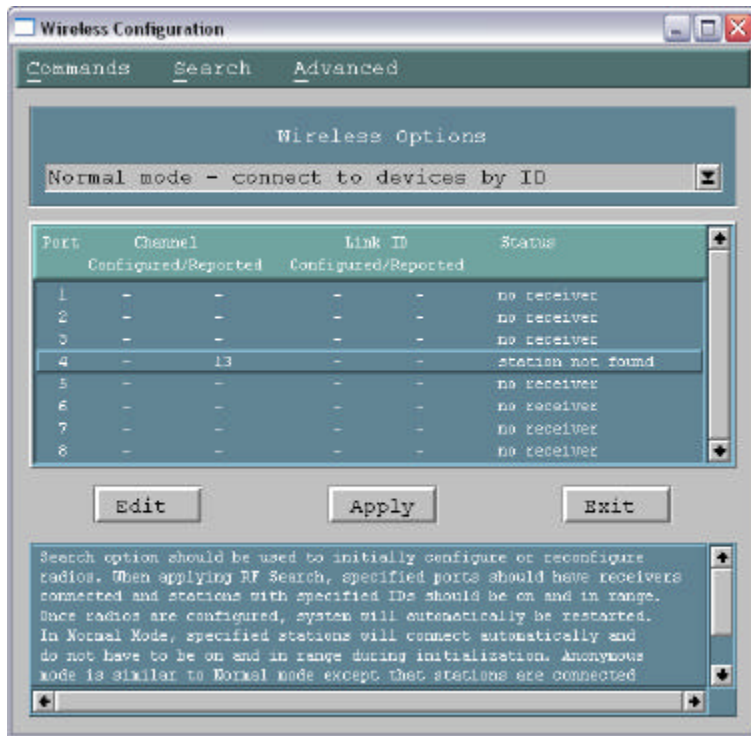
Port	Port of the IS-900 Processor.
Configured Channel	The channel that the connected receiver is configured to. No two receivers can be configured to the same channel.
Reported Channel	The channel that the connected receiver is currently on.
Configured Link ID	The link ID that assigned to the receiver. 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

Steps 5-7 should be repeated for every receiver / transmitter combination in the system.

5. Click a row that corresponds with a receiver and click the "Edit" button. The following dialog will be presented:
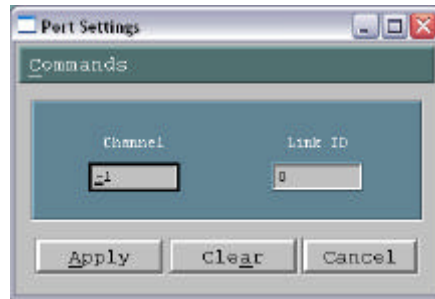
6. Enter a channel into the first input box. The valid range of channels is 0-15. Again, be aware that no two receivers can use the same channel. For best results, it is recommended that channels be configured such that they are separated by one unused channel. If multiple IS-900 systems are in use in the same immediate area, verify that they are also set to different channels.

7. The receiver will now be linked to a specific tracker via the "Link ID" input box. Enter the Link ID of an appropriate device and click "Apply". The wireless configuration dialog should now look something like this:
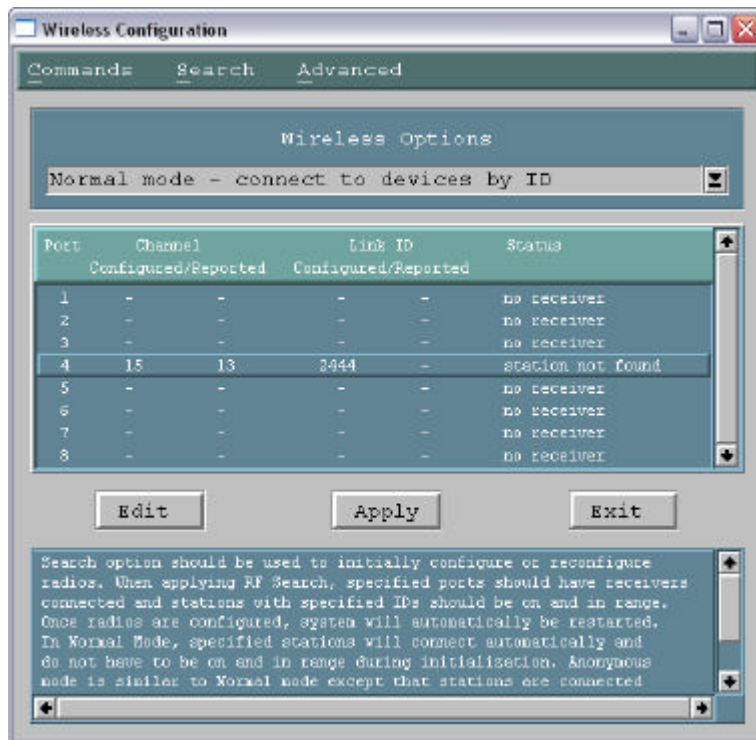
8. Make sure that all configured transmitters are powered on and click the "Apply" button. It may take a minute or two for the processor to apply the configuration. If the devices are communicating properly, both green LEDs should now be lit on both the transmitters and receivers. The status should also be listed as "ok". If the status is "station not found" click Search? RF Search.

Wireless Configuration

Commands   Search   Advanced

Wireless Options

Normal mode - connect to devices by ID

Port	Channel Configured/Reported		Link ID Configured/Reported		Status
1	-	-	-	-	no receiver
2	-	-	-	-	no receiver
3	-	-	-	-	no receiver
4	15	15	2444	2444	ok
5	-	-	-	-	no receiver
6	-	-	-	-	no receiver
7	-	-	-	-	no receiver
8	-	-	-	-	no receiver

Edit   Apply   Exit

Search option should be used to initially configure or reconfigure radios. When applying RF Search, specified ports should have receivers connected and stations with specified IDs should be on and in range. Once radios are configured, system will automatically be restarted. In Normal Mode, specified stations will connect automatically and do not have to be on and in range during initialization. Anonymous mode is similar to Normal mode except that stations are connected

Helpful Tip: Placement of Wireless Base Receiver Module

You should not place the Base Receiver Module inside a metal container. If the IS-900 is in a rack mount situation we recommend placing the adapters outside of the rack mount. In a typical situation, the Base Receiver Module can be as far away as 100 feet from the Transmitter Module. But if you are having an interference issue, you may want to move the Base Receiver Module closer to the tracking area and try to insure line of sight. Extension cables are available to extend the distance from the Base Receiver Module to the IS-900 Processor. You should keep the Base Receiver Modules at least 10 cm (4 inches) apart from each other.

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Checking the installation

Make sure you have followed the steps in the Software and Hardware Setup sections.

1. Turn off the IS-900 Processor.
2. Turn the Wireless Transmitter Module.
3. The "Power" LED should be on. The "In Range" LED should be off. If the power LED is flashing, the battery is low and you should charge it before you continue or replace the battery with a charged one. If no LEDs come on you may need to charge the battery or replace it with a charged one.

Note: If you turn the Wireless Transmitter Module ON but do not move it for more than 10 minutes it will go into sleep mode and you will have to switch the power ON again.

4. Turn on the power to the IS-900 processor. The LEDs on the front panel next to each port should come on and then stay on for each occupied port. The "Power" LED on the Base Receiver Module should turn on. In less than 10 seconds after the Power LED comes on, the Base Receiver Module red LED should turn on and the Wireless Transmitter Module "Connection Status" LED should also come on.

If any of these steps failed or if the LCD on the front panel of the IS-900 processor indicates X for the wireless station, refer to the Troubleshooting section in this manual.

5. Place the MicroTrax device(s) under the IS-900 SoniStrip Constellation Grid. The LCD on the front panel of the IS900 Processor should show a T for each station indicating it is tracking. If it indicates L (lost), then you need to confirm that MicroTrax is within the tracking volume and the SoniStrip Constellation has been properly set up on the IS-900 Processor using ISDEMO. If you are unable to get the tracker to work properly please contact Technical Support using the information in the Contact section of this manual.

3.7.   Loading the Constellation File

1. Open the Configuration Script window in ISDEMO

Under the Tools menu in ISDEMO, click on Configuration Script (**Figure 22**) to open the Configuration Script window.
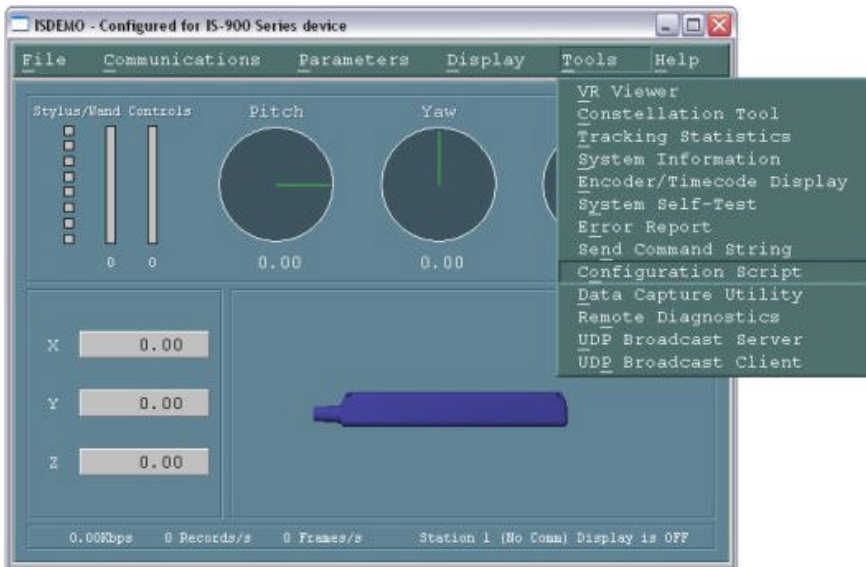
Figure 22 - Configuration Script Menu for loading SoniStrip Constellation array file

From the Configuration Script window under File menu, select Load from File (**Figure 23**). Locate the SoniStrip Constellation Array .txt file created in Step 3.4 above. Double click on the file and click on OK.
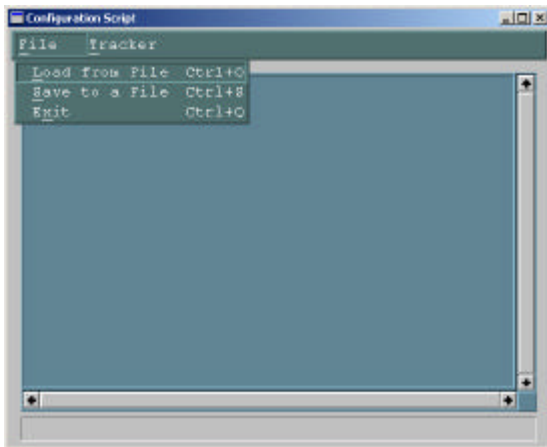
Figure 23 - Configuration Script File Menu

From the Configuration Script window under Tracker menu, select Send to Tracker (**Figure 24**). The SoniStrip Constellation Array is now downloaded into the IS-900 Processor.
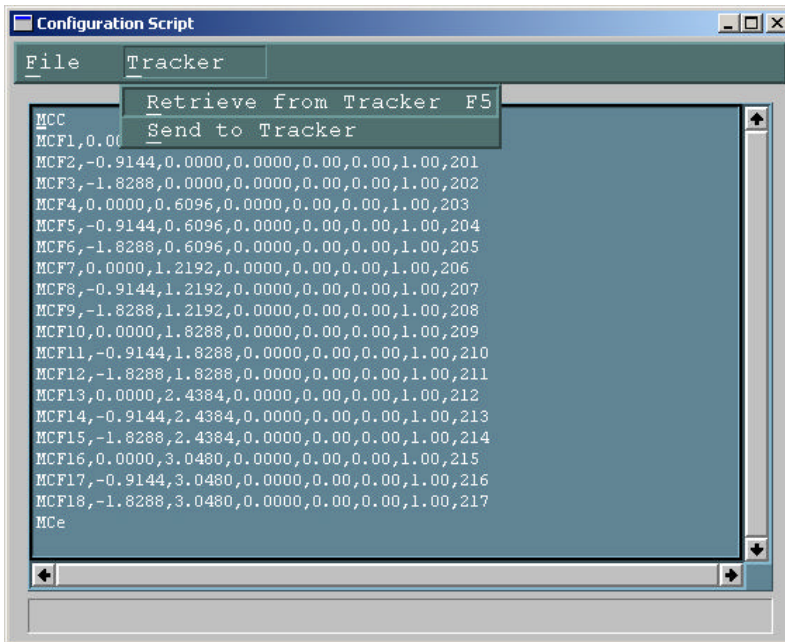
Figure 24 - Sending Configuration Script to Tracker

2. Check the Configuration

To check the configuration, open the *Constellation Configuration Tool* window by selecting **Tools? Constellation Tool** from the **Tools** menu in the main window of ISDEMO (**Figure 25**).
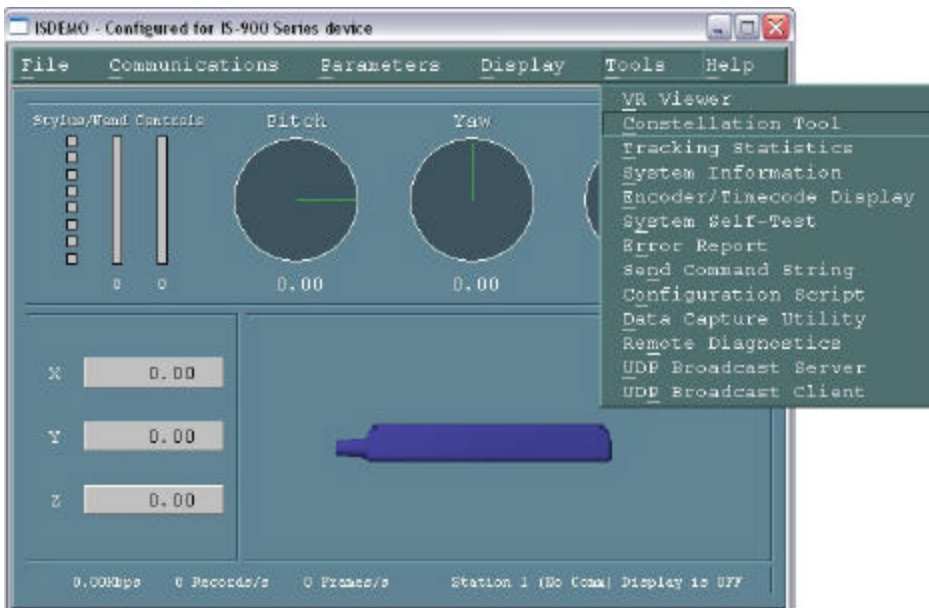
Figure 25 - Constellation Tool Selection

3. **From the *Constellation Configuration Tool* window,** select Retrieve from Tracker from the menu item Constellation (**Figure 26**).
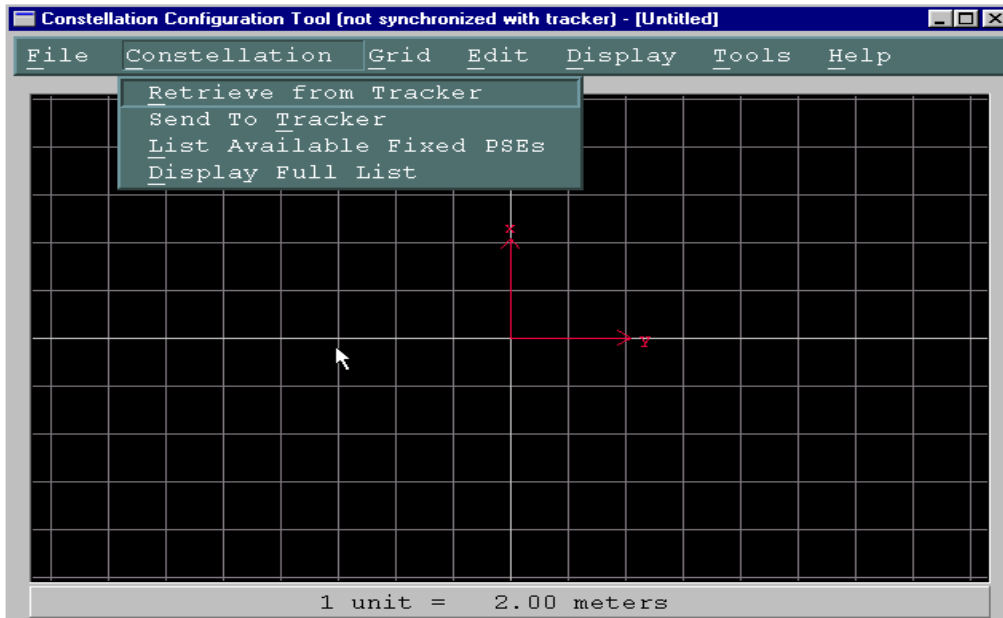
Figure 26 - Checking installed SoniStrip Constellation Array

This will upload the grid into the *Constellation Configuration Tool* window from the IS-900 Processor. At this point, you should see SoniStrip Constellation Arrays similar to examples covered in Section 3.3 for typical configurations (**Figure 27, Figure 28, and Figure 29**).
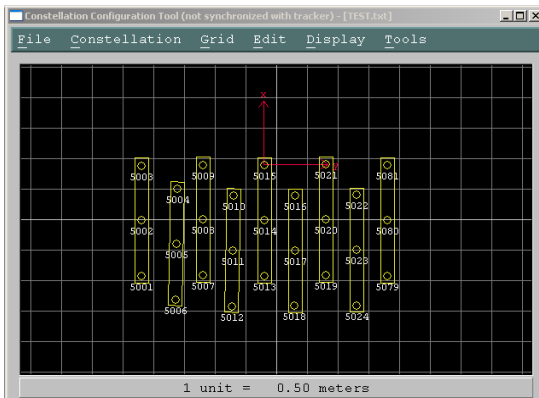
Figure 27 - ISDEMO Constellation Tool Screen for Ceiling Mount Power Wall Applications
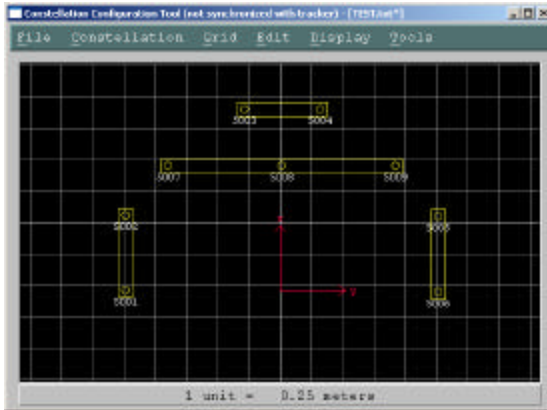
Figure 28 - ISDEMO Constellation Tool Screen for Wall Mount Power Wall Applications
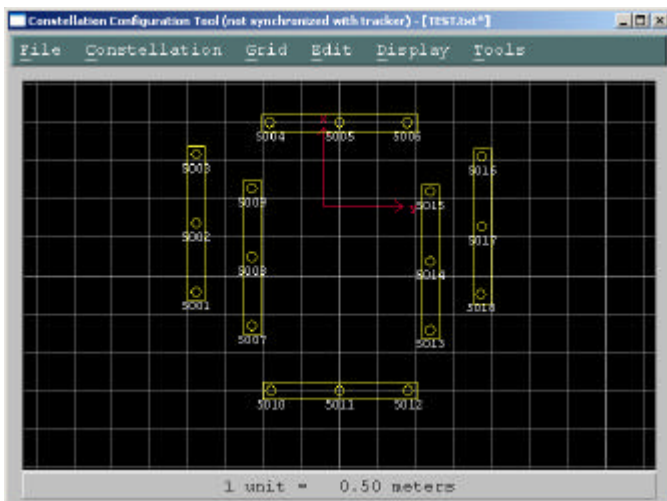
Figure 29 - ISDEMO Constellation Tool Screen for CAVE-like Applications

4. Verify system is tracking

While still in the *Constellation Configuration Tool* window, type CNTL-D (or select menu item *Display*? *Start Displaying Data* as shown in **Figure 30**) to verify the Constellation Array is correctly installed and the system is tracking. The tracked device will appear green in the center of the display window indicating correct tracking. Move the physical tracker around and see it move in the display window.
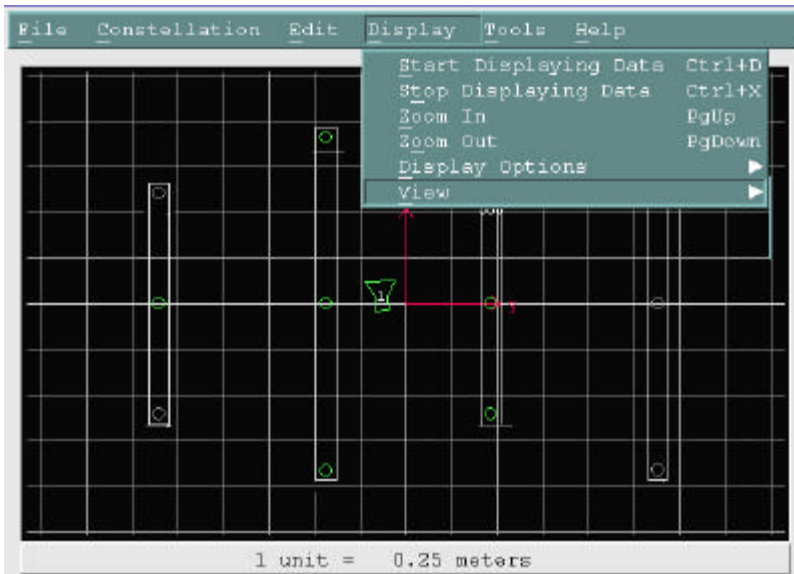
Figure 30 - ISDEMO Constellation Tool Screen with Tracking Device

Also check the LCD panel of the IS-900 Processor. For each connected tracking station, "T" should appear on the IS-900 Processor's front LCD panel to indicate proper tracking (**Figure 31**). If an "X", appears you may not have properly saved or loaded in the SoniStrip Constellation Array. The "X" could also indicate hardware, cabling or wireless link issues. Go back to Steps 5 & 6 to reload the proper configuration script containing the correct Constellation Configuration Array. Refer to **Section 11** for troubleshooting hardware, cabling and wireless connectivity issues.

Figure 31 - Tracking Status Display on IS-900 LCD Panel

5.   Saving the Configuration

Save the current settings into firmware of the IS-900 Processor by selecting the menu item *File? Save Current Settings* from the main ISDEMO (**Figure 32**). A window will come up asking to save into permanent memory. Select YES to save into permanent memory.

Figure 32 - Saving All Configuration Settings to IS-900 Processor

6. Locking the configuration

Locking the settings will prevent inadvertently changing settings when not desired. Lock the settings by selecting menu item *File? Configuration Lock* in main ISDEMO window (**Figure 33**). A window will come up asking to *Lock* tracker configuration. Click on *Lock Tracker Configuration*.
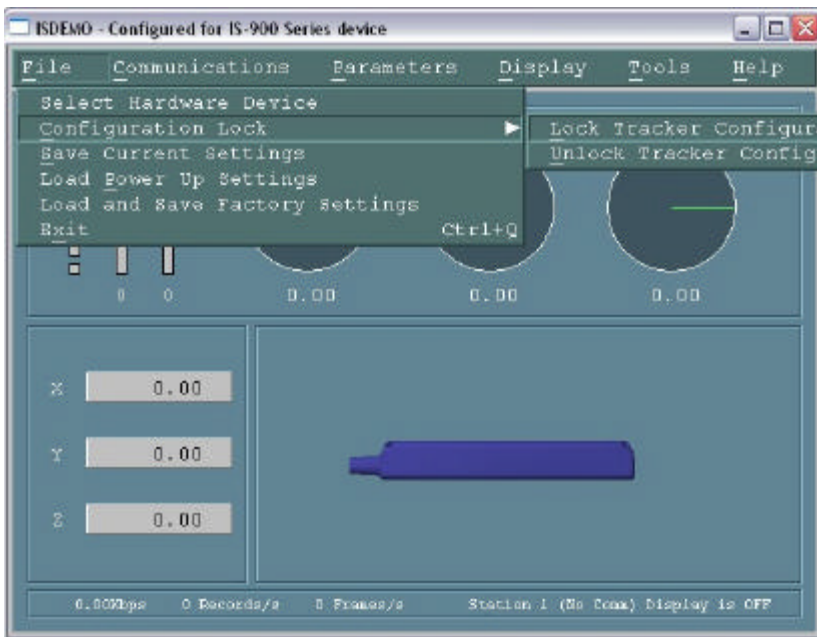
Figure 33 - Locking Configuration Settings in IS-900 Processor

7. Connecting to application

Follow the instructions or manual that came with the tracked application for using the IS-900 tracking system. If you have problems connecting to your application, first contact the application developer for detailed information about connecting to InterSense tracking systems. If you still need assistance, contact InterSense for technical support.

The IS-900 CD delivered with this system contains InterSense Software Development Kit (SDK) for developing interfaces specific to new applications. The application programmers interface (API) and library calls to the InterSense libraries are documented in **Section 16**.

3.8. *Using Wireless MicroTrax Devices*

When power is powered on, the Transmitter Module "Power" LED will turn on. When the battery voltage gets to a low level, the Transmitter Module "Power" LED will begin to flash. This indicates the devices should have about an hour of tracking left before the charger must be plugged in for it to work.

If the MicroTrax Transmitter establishes communication with the Receiver, then the "In Range" LED on the Transmitter will light and remain on as long as the device in either "In range" or not in sleep mode.

Sleep Mode: If no motion is detected by the Transmitter for about 10 minutes, it and the MicroTrax will power down and the LEDs will turn off. Once the transmitter has shut itself off, it must be manually powered on again before it can be used.

NOTE: While the Wireless Transmitter Module is turned off or out of range, the IS-900 Processor will show an X in the LCD and the IS-900 trackers' output of position and orientation will remain fixed at their last value.

Summary of LEDs on Wireless Transmitter Module

Power:
> **ON** – The MicroTrax and wireless Transmitter have power.
> **OFF** – If the Power Switch is on may mean the battery is too low to operate the device.
> **FLASHING** – The battery is low.

Connection Status:
> **OFF** – If the Power LED is on, no connection has been made to a Base Receiver.
> **ON –** The Transmitter is connected to a Base Receiver Module.
> **FLASHING –** Device is losing communication.

Summary of LEDs on Base Receiver Module

Power:
> **ON –** Base Receiver Module has power from IS-900 Processor
> **OFF –** IS-900 is off or is not supplying power to this port.

Connection Status:
> **ON – The Receiver is communicating (or attempting to communicate)** with a Wireless Transmitter Module.

OFF – A connection has not been established with a Wireless Transmitter Module.

Charging Instructions

⚠️ Only use the power supply from InterSense when charging the Radio/Battery board. Other chargers could cause failures. See the battery handling instructions at the beginning of this manual.

When the "Low Power" LED on the Transmitter Module is ON or when you want to make sure that the module is fully charged, you should connect the Transmitter Module to the charger. You may leave the Transmitter Module on while charging; but, if you plan on using another Transmitter Module– Base Receiver Module pair with the same channel selected, you must turn off the Wireless Transmitter Module while it is being charged.

While it is charging the LED next to the charger port will be on (Orange). When it turns solid Green, the battery is finished charging (flashing green indicated that the battery is being "topped off". A fully discharged battery takes less than 4 hours to charge. If the green charging LED does not turn off after 6 hours, there may be a problem. Please disconnect the charger and contact technical support.

Changing a MicroTrax head tracking device from a wireless to wired configuration

To convert the MicroTrax devices from wireless to wired mode, follow these steps:

1. Turn off the IS-900 processor

2. Disconnect the appropriate receiver cable from the IS-900 Processor to the Base Receiver Module.

3. Turn off the power on the Wireless Transmitter Module connected to the MicroTrax device.

4. Unplug the MicroTrax device from the Transmitter Module and plug it into the MicroTrax IS-900 Wired Adapter device.

5. Connect the wired adapter in the IS-900 Processor and turn the power on. No software or configuration will need to be changed.

8. Interface Communication Protocol

For firmware version 4.20 or higher

Terminology

Throughout this section and the ISDEMO program described in **Section 14**, certain terms and acronyms are used to reference functional components of all InterSense tracking systems. Specifically, IS-900 models contain an ultrasonic subsystem that includes SoniDiscs (Ultrasonic Transponder Beacons) and Microphones (Ultrasonic Receiver Modules – 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 (i.e. MicroTrax Microphones). Fixed PSEs form a CONSTELLATION? that is used as a reference for tracking (i.e. SoniStrips & SoniDiscs). In the case of IS-900 tracking systems, Microphones are mobile and SoniDiscs are fixed.

8.1.   Commands Sent from the Host to the Tracker

<>   Carriage return line feed pair- not needed for single character commands.
        CR – ASCII value 13, LF – ASCII value 10.
{}   List of parameters required for command.
[]   List of optional parameters for command. Omitting those results in a query.

The IS-900 emulates most (but not all) of the commands in the Polhemus Fastrak™ protocol, thus it is possible to use the IS-900 with most applications without writing new driver code. There are also several additional commands added to access some of the advanced features of the IS-900 that do not have any counterpart in the Fastrak™ protocol.

Note:
Firmware version 3.xx extended Fastrak™ protocol to support up to 32 stations (actual number allowed is determined by your hardware configuration). StationNum in commands, status and data records is now encoded in an extended hexadecimal notation. Numbers 1 to F conform to standard hexadecimal notation, with numbers greater that F represented by additional upper case letters of the alphabet. For example, number 16 is displayed as G.

8.2.   Standard Fastrak™ Interface Commands

Data Record Request   *P*   Request a data record from all active stations.
                                      Only used in polled mode.

Output mode   *C*   Put in continuous output mode.
                     c   Put in polled output mode.

                     Default Polled mode
Alignment Reference Frame
                     A{stationNum},[Ox,Oy,Oz,Xx,Xy,Xz,Yx,Yy,Yz]<>

Sets the coordinate frame with respect to which outputs for that station will be reported. The coordinate frame is defined by a set of three points. *Ox,Oy,Oz* defines the origin of the new coordinate system, *Xx,Xy,Xz* defines a point on the positive x-axis and *Yx,Yy,Yz* defines a point on the positive y-axis. The effect of this command is incremental, or relative to any current alignment reference frame already in place. If optional parameters are omitted, current values are returned. Units are centimeters.

Default   Fusion Mode: X=North,   Y=East,   Z=Down, position origin is defined by SoniStrip Constellation Array horizontally leveled.   See Section 3.1.

Reset Alignment Reference Frame

R{stationNum}<>

Resets reference frame to the default.

Boresight Reference Angles

G{stationNum},[yawref, pitchref, rollref]<>

Sets the boresight reference angles for the specified station. If set, these values are then used by the next Boresight command instead of current orientation. If optional parameters are omitted, current reference angles are returned. Units are degrees.

Default   0,0,0

Boresight Compatibility Mode

MBF<>   Switch system to Fastrak™ Compatible mode.

MBI<> Switch system to Firmware Version 2.x Compatible mode.

In firmware versions prior to 3.00 the B{stationNum}<> command was implemented as the Heading Boresight (see below) and full boresight was not available. To maintain compatibility with the user software written at that time, two Boresight Compatibility modes are available. In Fastrak™ Compatible mode B{stationNum}<> command executes full 3-DOF boresight and MB{stationNum}<> effects heading only. In the Firmware Version 2.x Compatible mode the meanings of these commands are reversed.

Default   Firmware Version 2.x Compatible, *MBI<>*

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| **Boresight** | *B{stationNum}<>* | (Fastrak™ compatibility mode) |
| | *MB{stationNum}<>* | (Firmware Version 2.x compatibility mode) |

Boresight a station. If boresight reference angles have been specified by the *G{stationNum}[yawref, pitchref, rollref]<>* command prior to issuing of Boresight command then that orientation becomes the new reference point. The angles output by the tracker at that orientation become zero. Otherwise, system uses current station orientation and that becomes the new reference line of sight. Please make sure that the object being tracked (like an HMD) is leveled and is pointing down the x-axis when boresighting a station.

| **Unboresight** | *b{stationNum} <>* | (Fastrak™ compatibility mode) |
| | *Mb{stationNum}<>* | (Firmware Version 2.x compatibility mode) |

Unboresight a station. Reference angles are cleared for the specified station.

| **Heading Boresight** | *B{stationNum}<>* | (Firmware Version 2.x compatibility mode) |
| | *MB{stationNum}<>* | (Fastrak™ compatibility mode) |

This command has no effect with the IS-900.

| **Heading Unboresight** | *b{stationNum}<>* | (Firmware Version 2.x compatibility mode) |
| | *Mb{stationNum}<>* | (Fastrak™ compatibility mode) |

This command has no effect with the IS-900.

Set Serial Communication Parameters

o{rate,parity,bits,HHS}<> Change the serial communication parameters

rate	is one of 3,12,24,48,96,192,384,576,1152 (rate is multiplied by 100)
parity	N = none
	O = odd
	E = even
bits	7 or 8
HHS	(Hardware handshake)
	0 = OFF
	1 = ON

Default serial communications settings:
Baud **1152**

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Parity	**N**
bits	**8**
HHS	**OFF**

System Record Request   *S*   Request a system status record to be sent.

Station Status   l{stationNum},[state]<> Set the stationNum on or off.

state   0 = OFF, 1 = ON

Default   All connected stations are on

Output Units Control   *U*   Sets output data record position units to inches.
       u   Sets the position units to centimeters. These only matter in 6-DOF mode.

Default   U

System control   *^K*   Save the current settings to nonvolatile memory.
      W   Restore the system settings to the factory defaults.
      ^Y   Restart the firmware to the power up condition.
      ^S   Suspend data transmission.
      ^Q   Resume data transmission.

Caution: *Sending W command will cause all the user configuration information to be lost.*

Output record mode   *F*   Put in ASCII output mode
      f   Put in Binary output mode.

Default   F

Output record list settings *O{stationNum},[p1],[p2],[p3],.....,[pn]<>*

Sets the output data list for *stationNum*. If optional parameters are omitted, a data record containing current output list settings for the station is returned.

Item	Description	Output Format
0	ASCII space character	1 ASCII byte
1	ASCII CR, LF pair	2 ASCII bytes
2	x, y, z position coordinates	3 floats
4	yaw, pitch and roll Euler angles	3 floats
5	X-axis direction cosines	3 floats
6	Y-axis direction cosines	3 floats
7	Z-axis direction cosines	3 floats
11	orientation quaternion	4 floats
16	stylus switch status (always 0)	1 byte (ASCII or binary
18	x, y, z in 16 bit binary format	see below
19	yaw, pitch and roll in 16 bit binary format	see below
20	quaternion in 16 bit binary format	see below
21	time stamp, in selected time units	see section 5.3.1
22	buttons	see below
23	joystick	see below
40	tracking status	0-255
68 – 71	auxiliary inputs	
75	communication integrity	0-100

Default 2,4,1
Data Item 4 – Euler Angles.

The Euler angles are defined as rotations about Z, then Y, then X in body frame. Angles are returned in degrees
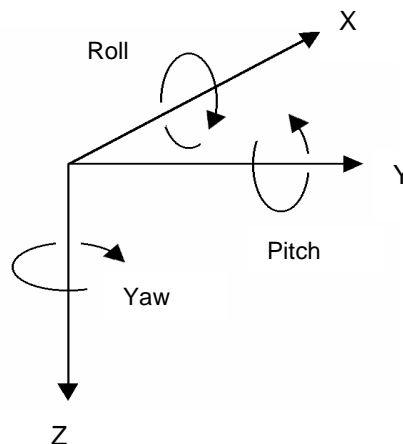
Data Items 5, 6, 7 – Direction Cosines.

X-axis, Y-axis and Z-axis direction cosines can be used to construct a 3x3 rotation matrix.

$$
\begin{bmatrix}
x1 & x2 & x3 \\
y1 & y2 & y3 \\
z1 & z2 & z3
\end{bmatrix}
\qquad
\begin{array}{l}
\text{X direction cosines.} \\
\text{Y direction cosines.} \\
\text{Z direction cosines.}
\end{array}
$$

This matrix can also be constructed from Euler angles:

$$
\begin{bmatrix}
\cos(P)*\cos(Y) & \sin(R)*\sin(P)*\cos(Y) - \cos(R)*\sin(Y) & \cos(R)*\sin(P)*\cos(Y) + \sin(R)*\sin(Y) \\
\cos(P)*\sin(Y) & \sin(R)*\sin(P)*\sin(Y) + \cos(R)*\cos(Y) & \cos(R)*\sin(P)*\sin(Y) - \sin(R)*\cos(Y) \\
-\sin(P) & \cos(P)*\sin(R) & \cos(P)*\cos(R)
\end{bmatrix}
$$

Data Item 11 – Orientation Quaternion.

Quaternion is returned as q = [w, x, y, z]. Quaternion to rotation matrix conversion can be accomplished using the following formula:

$$
\begin{bmatrix}
1-2y^2 - 2z^2 & 2xy - 2wz & 2xz + 2wy \\
2xy + 2wz & 1 - 2x^2 - 2z^2 & 2yz - 2wx \\
2xz - 2wy & 2yz + 2wx & 1 - 2x^2 - 2y^2
\end{bmatrix}
$$

Data Items 18, 19, 20 – 16 bit binary format.

16 bit binary format can be used in applications requiring fastest possible serial I/O. Each floating point number is stored in 2 bytes with only 14 bits containing actual data. This results in lower accuracy than the standard IEEE floating point format.

Data is 2's-complement. The first byte of the data set has its high-order bit set to 1; all others have them set to zero. This can be used for data synchronization. Data is returned low-order byte, then high-order byte. Use following code sample as an example on how to decode this format:

To decode position:

```
lo = (dataRecord[3] & 0x007F);
hi = (dataRecord[4] & 0x007F);
int14bit = (lo « 2) | (hi « 9);
result = (float) int14bit * 3.0 / 32768.0;
```

Result is a number representing position (in meters) and has a full range of ± 3.0 meters (-300.0 to$+299.963$ centimeters or -118.110 to 118.096 inches).

To decode Euler angles:

```
lo = (dataRecord[3] & 0x007F);
hi = (dataRecord[4] & 0x007F);
int14bit = (lo « 2) | (hi « 9);
result = (float) int14bit * 180.0 / 32768.0;
```

Resulting number represents orientation and has a full range of ± 180.0 (-180.0 to $+179.978$) degrees.

To decode Orientation Quaternion:

```
lo = (dataRecord[3] & 0x007F);
hi = (dataRecord[4] & 0x007F);
int14bit = (lo « 2) | (hi « 9);
result = (float) int14bit * 1.0 / 32768.0;
```

Resulting quaternion value has range of ± 1.0.

Data Item 22 – Buttons.

One 3-digit integer in ASCII format or one byte in binary format.

Bits represent the button states of a station's buttons. If a button is pressed, the corresponding bit is 1 otherwise it is 0. The bit assignments for the wand are (where bit 0 is the least significant bit):

Bit	Button	MicroTrax Wand button
0	1	1 on wand image
1	2	2 on wand image
2	3	3 on wand image
3	4	4 on wand image
4	5	center (press joystick)
5	6	trigger

Data Item 23 – Joystick.

Two integers, one for each axis, values ranging from 0 to 255. Two 3-digit integers in ASCII format or two 1-byte unsigned values in binary format. Values at limits and at center are:

Axis	Position	Value
left/right (1st integer)	left	0
	center	127
	right	255
front/rear (2nd integer)	rear	0
	center	127
	front	255

Define Tip Offsets   *N{stationNum},[Ox, Oy, Oz]<>*

By default, the point being tracked is for each station is:

Wand Station: Tip.

Head Tracking Station: Intersection of front surface, bottom surface and at mid length, see image to the left.

Tip Offset: intersection of front surface and bottom surface and at mid length.

This command allows the user to define 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. If optional parameters are omitted, current settings are returned.

Default   0,0,0

Position Operational Envelope
                    V{stationNum},[Xmax, Ymax, Zmax, Xmin, Ymin, Zmin]<>

This command sets the boundaries of the area where position is to be tracked. Whenever a station leaves the defined range, position tracking is stopped and only resumed once it is back within the defined boundaries. Parameters are entered in meters. If optional parameters are omitted, current settings are returned. Units are meters.

Default   200,200,200,-200,-200,-200

8.3. Fastrak™ Commands Implemented for Compatibility

Hemisphere   *H{stationNum},[p1,p2,p3]<>*

Sets the tracking hemisphere for a magnetic tracking system. Because InterSense trackers are not magnetic the parameters are ignored. However, they can be set and then queried for compatibility with software such as MultiGen SmartScene or Immersion Corporation haptic Software. If optional parameters are omitted, a data record containing current Hemisphere settings for the station is returned.

Default   1,0,0

8.4. InterSense specific Commands

All InterSense specific commands start with the letter M (for "Manufacturer-specific") and must be completed by a CR,LF pair.

8.4.1. System Configuration Commands

Time Units   The time stamp recorded is the time when the tracker data was collected from the hardware. The time index is set to zero when tracker is first turned on.

MT<> Sets the units for the data record time stamp to milliseconds.

Mt<> Sets the units for the data record time stamp to microseconds.

Default   T

Set Current Time to Zero *MZ<>* This command sets current time index of the tracker to zero.

Set Ethernet Communication Parameters

MEthIp[address]<> Sets System IP address.

Use dotted format like 192.168.1.1. If address is omitted, the current address is returned, 31EI[address]<>. The IP address takes effect immediately unless an address was already set, in which case system settings must be saved and the system must be restarted.

MEthUdp[state]<> Sets state of UDP broadcast.

state=1 to enable, *state*=2 to disable (default).

MEthUdpPort[port]<> Sets UDP broadcast port.

Default Ethernet communications settings:
UDP state   OFF
UDP port   5001
IP address   None

InterSense System Status Record Request

MS<> Request the manufacturer-specific system status record. This is information about parameters which are specific to the InterSense product, additional to the standard system status information obtained using the *S* command.

Tracking Status Record Request

MP<> Requests tracking status information for all 12 stations. See Section 5.5.5 for the description.

Ultrasonic Timeout Interval

MU[interval]<> This command has no effect with the IS-900.

Default   N/A

Ultrasonic Receiver Sensitivity

Mg[Level]<> This command has no effect with the IS-900.

Default   N/A

Genlock Synchronization   *MG[State, Rate]<>*

State	0 – Genlock is off
	1 – Reserved
	2 – External sync, manual (supply strobe rate)
	3 – Internal sync, supply output record rate
Rate	Value in Hertz used with *State* = 2 and 3

Default   0

Genlock Phase   *MGP[Param]<>*

Param can be the Phase (0 to 100%) or '+' to increase to the next phase point, or '-' to decrease to the next phase point. Please see Appendix F for complete details.

Default   0

Genlock Sync Source   *MGS[source]<>*

source	1 – TTL
	2 – NTSC

Configuration Lock   Configuration lock commands are used to prevent unintentional changes to tracker configuration. Two Levels of protection are provided. The First prevents changes to saved settings. The second prevents changes to current unsaved (session) settings as well as saved settings.

MConfigLockMode[mode]<>

Mode
   0 Lock off
   1 Lock saved settings
   2 Lock saved and session settings

Default   0

In mode 1 (lock saved settings), the Fastrak commands to save current (^*K*) and restore factory (*W*) settings are disabled. In mode 2 (lock saved and session settings), the Fastrak command to restore saved settings (^*Y*) is disabled as well as ^*K* and *W*. In mode 0 (lock off), ^*Y*, ^*K* and *W* are all enabled. When mode is changed, it is saved to nonvolatile memory without affecting any other saved settings. If mode is omitted, the current setting is returned. The LCD menu options to save and restore settings are not affected by lock mode.

SoniStrip LED control   *ML[state]<>*

If *state* is 0, the blue LEDs on the SoniStrips are disabled. Visual confirmation of the operation of the ultrasonic system is important, so don't disable the LEDs unless they interfere with your application.

Default   1

Beacon Scheduler   MSchAlg[*n*]<>

Selects beacon Scheduling Algorithm. If *n* is 1, a distance-based algorithm is used. This algorithm chooses beacons based on distance only. If *n* is 2 a directional algorithm is used which chooses beacons based on orientation as well as distance.

Default 2

Error reporting   Hardware and configuration errors are stored internally and can be reported to the application. If the application is not setup to accept error messages, or if you are not sure, error reporting should be disabled. This setting is not saved with tracker configuration, so error reporting is off every time tracker is turned on.

ME<>	Returns all errors, one per error message.
MEC<>	Clear all errors from internal list.
ME1<>	Enable error reporting.
ME0<>	Disable error reporting.

Default   Error reporting is OFF

Command logging   Command logging captures all host commands into a file for debugging purposes. The log file holds a maximum of 500 kB. When the max size is reached, the file is rewound and overwritten with new entries. Long series of P and MP commands are abbreviated to save space. The command logging state is also indicated on the LCD (see Section 9). Command logging control is available on the LCD menu under System Config→Command Log: Enable Log, Disable Log and Clear Log. It is accessed by the following command set.

MLogOpen<>	Enables logging. If settings are saved, logging will remain on through reset. An existing log file is always appended to.
MLogClose<>	Disables logging.
MLogClear<>	Disables logging and deletes log file. Use MLogOpen to resume logging.

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MLogState<>	Returns logging state (0=off, 1=on), 31LS{0,1}<>
MLogSend<>	Outputs log file to host one command per line. 31LF<timestamp in ms>:<command><> the timestamp is a decimal number and is not zero-padded. The log file can alternatively be retrieved using ISDEMO (see section 14).

8.4.2. InterSense-specific Station Parameters

InterSense Station Status Record Request

Ms{stationNum}<>

Request an individual sensor status record for stationNum. This is information about parameters which are specific to the InterSense product.

Prediction Interval   *Mp{stationNum},[Interval]<>*

Sets the time-interval of prediction for *stationNum*. *Interval* is an integer number of time in milliseconds. Suggested range is 0-50 ms. This parameter is used for both position and orientation prediction. If optional parameter is omitted, current prediction value is returned.

Default   0

Perceptual Enhancement Level

MF{stationNum},{Mode}<>

In order to provide the best performance for a large range of various applications, 3 levels of perceptual enhancement are available. None of the modes introduces any additional latency.

Mode 0 provides the best accuracy. The drift 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 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.

Default   2

Compass Heading Correction

MH{stationNum, mode}<>

Turns on the *stationNum's* compass heading correction. To operate effectively, the magnetic field in the environment needs to be homogeneous. **Only valid when an InertiaCube is being used as a station (i.e. not valid for MicroTrax devices)**.

For an InertiaCube, the modes are defined:

Mode 0 - Compass is OFF, no heading compensation is applied. Not recommended, Modes 1 or 2 are preferred.

Mode 1 - 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 slowly accumulate. This mode is particularly useful when high rotational sensitivity settings are used.

Mode 2 - FULL compass mode. Readings produced by the magnetometers inside the InertiaCube are used as the absolute reference orientation for yaw.

Default   2

Mh{stationNum}<>

Turns off the *stationNum's* compass heading correction. There can be slow drift in the yaw direction. **Only valid when an InertiaCube is being used as a station (i.e. not valid for MicroTrax devices).**

Rotational Sensitivity Level

MQ{stationNum},[Sensitivity Level]<>

Adjusts rotational sensitivity of a station when the Perceptual Enhancement Level is set to level 2. Sensitivity Level is an integer 1 to 4 where 1 is the lowest and 4 is the highest sensitivity. It is recommended that sensitivity be set to 4 when enhancement is set to level 1. If optional parameter is omitted, current value is returned.

Default   3

8.4.3. Station and Constellation Configuration Commands

This section describes the commands used to assign sensing devices to the logical components of the tracking system. Such devices with the IS-900 are SoniStrips and the SoniDiscs (beacons) that make up the Constellation Array. All commands in this section start with MC.

A Configuration Session is the period during which MC commands are received and accepted. It starts when the first MC command arrives and ends when these commands are explicitly activated with the MCe<> (or discarded with the MCx<>) command.

Associate Fixed PSE with a Constellation

MCF[FPSE number],[xp, yp, zp, xn, yn, zn, IDcode]<>

Configures or adds a Fixed PSE. For IS-900 FPSE is a SoniDisc ultrasonic transponder beacon. If only the FPSE number parameter is present then current data for that PSE is returned on the serial port. If that PSE is not configured, record will contain Hardware ID of -1. If no parameters are provided then data for all configured Fixed PSEs is returned, each PSE in a separate record. This command does not take effect until explicitly activated by the *MCe<>* command.

FPSE number

A Unique number identifying a Fixed PSE (beacon) within a Constellation (a complete set of fixed PSEs). Numbering starts at 1.

xp, yp, zp	FPSE position in meters.
xn, yn, zn	Normal vector.
IDcode	Hardware ID of the PSE.
<>	CR LF pair.

Disassociate Fixed PSE from the Constellation

MCf[Fixed PSE number, IDcode]<>

If PSE number and *IDcode* are not associated in the current configuration, this command is ignored. This command does not take effect until explicitly activated by the *MCe<>* command.

Clear All Fixed PSEs (Constellation) Command

MCC<>

Delete all Fixed PSEs from the configuration. This command does not take effect until explicitly activated by the *MCe<>* command.

Apply New Configuration   *MCe<>*

This command reconfigures the system with the new MicroTrax station and SoniDisc information. A Configuration Session is the period during which the station and constellation configuration commands are received and accepted. The configuration session starts when the first *MC* command arrives. *MC* commands are saved but not applied to the system configuration until the *MCe<>* command is received. This command executes all *MC* commands received since the start of the Configuration Session and computes the new system state.

Cancel Configuration Session

MCx<>

Cancel the configuration session command. All *MC* commands received during the session are discarded.

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8.5.   Records Returned from the Tracker to the Host

8.5.1. Format Considerations

Record Headers

The first byte of each record is used to identify its type.

0 – Data record.
2 – Fastrak™ status record.
3 – InterSense manufacturer-specific status record.

Floating Point Numbers

Floating point numbers can be returned as IEEE 32 bit floats or as ASCII numbers in X.xf
notation, where:

X   is the total number of characters used to represent the float.
x   is the number of digits after the floating point.
f   is a symbol indicating that number is a float.

For example, number -42.6 in 10.4f format would look as follows: "-42.6000"

8.5.2. Status Record Hexadecimal Character Decoding

System Status, Manufacturer Status, and Manufacturer Station records use Hexadecimal
Characters to encode status data. Each character can be 0 to F and can encode 4 bits. Logical
AND operator can be used to test specific bits. Please see following code example:

```
unsigned short byte1, byte2, byte3;
char hexChar[2];

hexChar[1] = 0x00;

hexChar[0] = statusRecordBuffer[3];
sscanf(hexChar,"%x", &byte1);
hexChar[0] = statusRecordBuffer[4];
sscanf(hexChar,"%x", &byte2);
hexChar[0] = statusRecordBuffer[5];
sscanf(hexChar,"%x", &byte3);
```

8.5.3. Fastrak™ System and Data Records

Data Record This record is sent in response to the *P* command in polled mode or continuously in continuous mode. A separate data record is sent for each active station. The list of data items in each station record depends on how the list was set up with the *O* command. For most of the commonly used data list items, the format depends on commands *F, f, U, u, MT, Mt.*

0{stationNum}{status}{dataItem1,dataItem2,....}

stationNum
>A hexadecimal number up to C (decimal 12)

status An ASCII space character. This status byte is currently unused.

dataItemX
ASCII In ASCII numbers, set with the *F* command, any numbers returned as floats are returned as ASCII numbers. Each number is 7 ASCII characters: a sign, 3 digits, a decimal point and 2 more digits. If programming in C use *scanf("%7.2f", &value)* to read them.
Binary In binary mode, set with the 'f' command, the floats are sent as 4 byte IEEE 32-bit floats.

Time Stamp 32 bit floating point number
ASCII In ASCII mode it is allowed 14 characters and is displayed as an integer (digits after the floating point are ignored).
Binary In binary mode it is returned as a 32 bit float.

Binary16 mode
>Set by selecting 18, 19 and/or 20 only with the *O* command. This is the fastest way to get data but the most difficult to decode and the least accurate.

<u>Example:</u>

For the default data record O1,2,4,1<> in ASCII mode 'F'. The output record set for the active stations 1 and 2 would look as follows:

```
'01    1.23    41.83    12.18    13.04    76.11
34.12CRLF'
'02   23.01 -452.94    0.01    -1.01    23.32
12.34CRLF'
```

For station 1: x=1.23, y=41.83, z=12.18, yaw=13.04, pitch=76.11 and roll=34.12
For station 2: x=23.01, y=−452.94, z=0.01, yaw=−1.01, pitch=23.32 and roll=12.34

System Status Record

This record is sent in response to the *S* command. It contains system wide status information. Some of the information in the status record must be bit decoded.

21S{statusRecord}<>

Bytes	Explanation
1	Record type, '2'
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
7-9	BIT error. Currently unused.
10-15	Blank
16-21	Firmware version ID
22-53	System Identification
54-55	CR, LF

To decode each of the Config bytes

Config Hex Char 0	Unused
Config Hex Char 1	Unused

Config Hex Char 2

Bit	Meaning
0	Output Format (0= ASCII, 1=Binary)
1	Output Units (0=Inches, 1= Centimeters)
2	Unused
3	Transmit Mode (0 = Polled, 1 = Continuous)

Output List Record

This record is sent in response to an *O{stationNum}<>* command. It returns the list of currently selected output parameters for that station, 2 bytes per item.

2{stationNum}O{par1par2...parN}<>

Bytes	Explanation
1	Record type , '2'
2	Station Number. A hexadecimal number up to C.
3	Sub-Record type, 'O'
4-5	*par1*
6-7	*par2*
…	CR, LF

For example, the default data list would be returned as:
'21O 2 4 1<>'

Station State Record   This record is sent in response to an *l{stationNum}<>* command. If the *stationNum* parameter is omitted the record returns the state of the first four stations. This maintains compatibility with the Fastrak™ protocol. If *stationNum* is stated then byte 4 of the record will contain the state of the requested station. Bytes 5, 6, and 7 will contain the state of stations 2, 3, and 4. If *stationNum* is replaced with the '*' wild-card character, then status for 32 stations is returned in a single record.

Output of values are interpreted as 1 for ON and 0 for OFF.

2{stationNum}l{stat1stat2stat3stat4}<>

Bytes	Explanation
1	Record type , '2'
2	Station Number. 1, 2, 3, 4
3	Sub-Record type, 'l'
4	State of station *stationNum*, or station 1 if omitted.
5	State of station 2.
6	State of station 3.
7	State of station 4.
8-35 (if '*')	Status of stations 5 to 32.
8,9 or 36,37	CR, LF

For example, if stations 1 and 3 are on:

l1<> command will return '21l1010<>'
l<>* command will return '21l101000000000000000000000000000000<>'