INTERSENSE

Wireless InertiaCube3™

Wireless InertiaCube3 and Receiver

Supplemental Product Manual for use with Wireless InertiaCube3 Serial and USB Interfaces

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Supplemental User Manual for InertiaCube3
Library Version 3.8x and higher

This supplemental user's manual for the Wireless InertiaCube3 covers the set up and use of the wireless sub-system integrated with the InertiaCube3. Please refer to the "Product Manual for use with InertiCube3 and the InertiaCube3 Processor" (InterSense Document No. 072-00094-0D05) for information about the set-up and operation of the InertiaCube3. This document is referenced herein at the InertiaCube3 Manual.

Contacting InterSense

Please do not hesitate to contact us for any reason. We are here to help and we value your business.

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Regulatory Statements and Approvals

FCC Statements:

Tested To Comply
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FOR HOME OR OFFICE USE

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

Caution: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

Canada - Industry Canada (IC)

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
cet appareil de la class B respecte toutes les exigences du Reglement sur le matereil brouiller du Canada.

Europe - European Union Notice

All products with the CE marking comply with the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.
Compliance with these directives implies conformity to the following European Norms (in brackets are the equivalent international standards).

- EN 55022 (CISPR 22) - Electromagnetic Interference
- EN 55024 (IEC61000-4-2,3,4,5,6,8,11) - Electromagnetic Immunity
- EN 61000-3-2 (IEC610000-3-2) - Power Line Harmonics
- EN 61000-3-3 (IEC610000-3-3) - Power Line Flicker
- EN 60950 (IEC60950) - Product Safety

Products labeled with the CExxxx or the CE alert marking contain a radio transmitter that complies with the R&TTE Directive (1999/5/EC) issued by the Commission of the European Community.
Compliance with this directive implies conformity to the following European Norms (in brackets are the equivalent international standards).

- EN 60950 (IEC60950) - Product Safety
- EN 300 328 Technical requirements for radio equipment.
- ETS 300 893 and ETS 301 489-17 General EMC requirements for radio equipment.
- ETS 301489-1

To determine the type of transmitter, check the identification label on your Product.

Precautionary Statements

Any changes or modifications to the InertiaCube3 not expressly approved by InterSense will void the warranty and any regulatory compliance issued for the system.

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.

Do not mount InertiaCube3 with steel or other ferrous metal fasteners and do not use a magnetic tipped or ferrous metal screwdriver when mounting the InertiaCube3. Use only non-ferrous fasteners and tools around the InertiaCube3. FAILURE TO FOLLOW THIS PROCEDURE WILL VOID WARRANTY AND MAY REQUIRE FACTORY RECALABRATION OF SENSOR.

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1 System Description

Congratulations for buying the smallest, precision orientation tracker on the market! This technology offers you several advantages:

- Very low latency
- Wireless range up to 100 feet (30 meters)
- Smooth, jitter-free tracking
- Low power consumption

The Wireless InertiaCube3 is an inertial 3-DOF (Degree of Freedom) orientation tracking system. It obtains its motion sensing using a miniature solid-state inertial measurement unit, which senses angular rate of rotation, gravity, and earth magnetic field along three perpendicular axes. The angular rates are integrated to obtain the orientation (yaw, pitch, and roll) of the sensor. Gravitometer and compass measurements are used to prevent the accumulation of gyroscopic drift. The Wireless InertiaCube3 sensor can be remotely powered providing orientation data via a wireless link to a host PC computer.

1.1 Wireless InertiaCube3 Operation

The InertiaCube3 is a monolithic part based on micro-electro-mechanical systems (MEMS) technology involving no spinning wheels that might generate noise, inertial forces, and mechanical failures. The InertiaCube simultaneously measures 9 physical properties, namely angular rates, linear accelerations, and magnetic field components along all 3 axes. The theory of operation and performance characteristics of the InertiaCube3 are covered in the InertiaCube3 Users Manual (http://www.intersense.com/products/downloads/InertiaCube3_Manual.pdf}.

The wireless option for the InertiaCube3 uses a 2.4 GHz non-frequency hopping spread spectrum radio module that allows up to 16 different channel selections. The radio modules have very low latency, high bandwidth, built in CRC checking, good range, and 60 mA used by the Wireless InertiaCube3.

When a wireless device is purchased from InterSense, the InertiaCube3 Receiver and the Wireless InertiaCube3 are on the same channel and should communicate upon initial set-up with no further configuration. If multiple InertiaCube3 wireless channels are operating in the same area, then the wireless channel configuration software, deviceTool, is used to change channels and pair devices. See the Section 3 for information about using deviceTool.

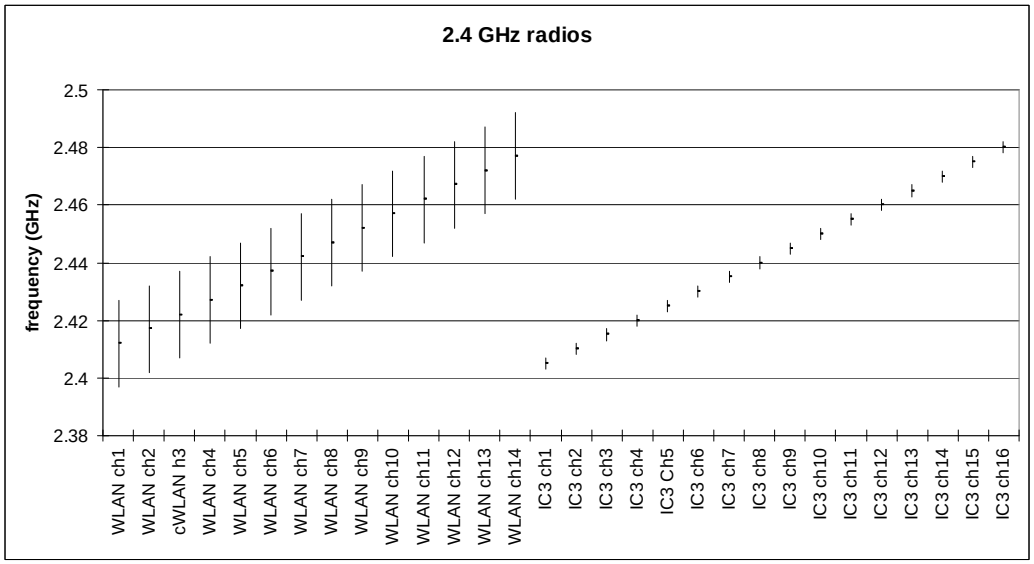
There are two LEDs on the Wireless InertiaCube3 and the InertiaCube3 Receiver. The green LED on both is a power indicator. When power if first applied to either device, the green LED will flash 4 times and then stay on steady. If the power to the Wireless InertiaCube3 drops below 5.1 Volts (i.e. if the battery power is failing), the green LED will start to flash indicating a low power condition and continue flashing until the power is above 5.5 Volts.

Warning: The InertiaCube3 requires 6-9 Volts DC. Voltages above 9 VDC may cause permanent damage to the device.

The amber LED on both devices indicates wireless traffic. It should be off at start up then turn on and stay on when the InterSense Library (i.e. isense.dll) is active.

The both devices have PCB antennas. For optimal performance, do not enclose either the Wireless InertiaCube3 or InertiaCube3 Receiver in metal containers or place close to large metal surfaces.

Because these devices use the same frequency at Bluetooth and 802.11 devices there could be some interference issues if there is heavy wireless traffic in the same area as our devices. ***Because the InertiaCube3 devices do not frequency hop but the other major standards do (like 802.11), it probably will not help to change channels to avoid interference with them.*** Using the default lower channels (InertiaCube3 Wireless channels 1 to 4) is recommend to avoid interference in typical environments. The chart below shows the Wireless InertiaCube3 channel frequency bands with the 802.11b shown as a reference.

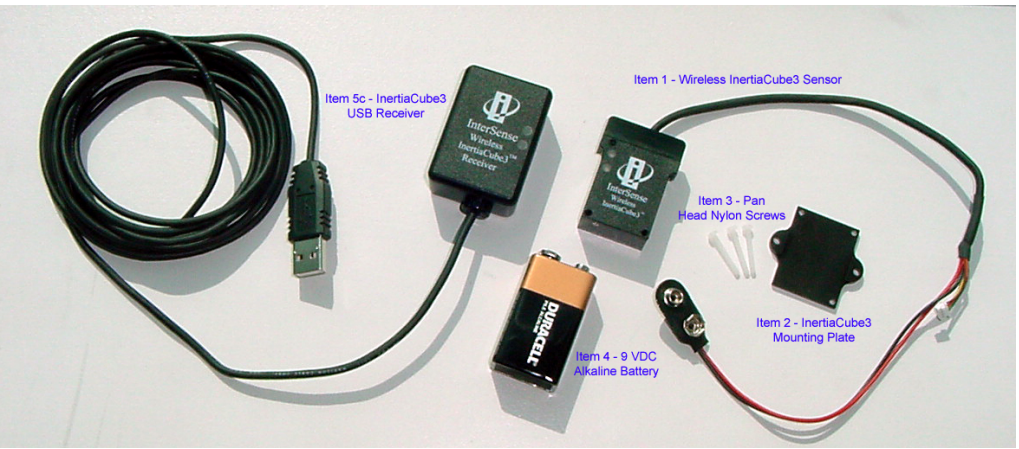


Wireless InertiaCube3 Frequency Channels (right) vs 802.11b Channel Bands (left)

InertiaCube3 Components

The following parts list shows all components that ship with a standard Wireless InertiaCube3 (IC3) under InterSense order number ISC-IC30W-PAK0.

	Item	Part No.	Quantity
1)	Wireless IC3 Sensor Cube	100-IMU0W-0301	1
2)	IC3 Mounting Plate	083-00104-IC3F	1
3)	2-56 x ¾ Pan Head Nylon Screws	092-P0256-NP12	3
4)	9 VDC Alkaline Battery	060-9VOLT-001	1
5)	IC3 Receiver Options	*one of the two options below*	*1*
	IC3 RS232 16 Channel Receiver	100-IC3SW-RX16	
	IC3 USB 16 Channel Receiver	100-IC3UW-RX16	
6)	IC3 Serial Receiver Options	*included if RS232 receiver is chosen*	
	DB Female to RJ11/RJ12 Connector	100-23750-RJ12	*Optional*
	AC/DC +6VDC Power Supply	066-CUI06-0200	*Optional*
	AC Power Cable (country specific)	078-2COND-xx06	*Optional*
7)	Wireless IC3 Product CD	Ver. 3.8x or higher	1



Wireless InertiaCube3 Components with USB Receiver Version (Product CD not shown)

1.2 Wireless InertiaCube3 Specifications

Degrees of Freedom	3 (Yaw, Pitch and Roll)
Angular Range	Full 360° - All Axes
Maximum Angular Rate*	1200° per second
Minimum Angular Rate*	0° per second
RMS Accuracy*	1° in yaw, 0.25° in pitch & roll at 25°C
RMS Angular Resolution*	0.03°
USB Receiver Update Rate	180 Hz (up to two sensors) 120 Hz (three to four sensors)
Serial Interface Update Rate	180 Hz (single sensor only)
Minimum Latency	< 6 ms (host OS dependent)
Prediction	up to 50 milliseconds
Serial Rate	115.2 kbaud
Interface	USB (supports four wireless sensors per receiver) RS-232 Serial (supports only one wireless sensor)
Size (without mounting plate)	1.232 in x 1.700 in x 0.581 in (31.3 mm x 43.2 mm x 14.8 mm)
Weight (without battery)	0.7 ounces (20.0 grams)
Battery/I^2C Cable Length	IC3 Sensor to Battery 9.0 inches (23 cm)
Power	InertiaCube3 - 6 VDC, 40 milliamps InertiaCube3 Radio – 6 VDC, 20 milliamps
Operating Temperature Range	0° to 70° C
O/S Compatibility	.dll for Windows 98/2k/NT/XP/CE .so for Linux and SGI IRIX libisense.dylib for Mac OS X
Software Support	SDK with full InterSense API Ethernet via Windows Control Software Heading Calibration Software Windows Wireless Configuration Software
Receiver Power Source	USB (direct from USB Host) Serial (6 VDC External Supply)
Wireless Receiver Size	2.36 in x 1.38 in x 0.79 in (60 mm x 35 mm x 20 mm)
Wireless Receiver Cable Length	9.84 ft. (3.0 m)
Wireless InertiaCube3 Range	up to 100 ft. (30 meters)

*Measurements with perceptual enhancement algorithm turned off (= 0)

2 Wireless InertiaCube3 Support Software

Test software and the InterSense Software Development Kit (SDK) delivered with the InertiaCube3 are provided on the **InterSense Support CD** with the system. Use the auto install tool to extract and install the software on your Windows PC.

The core of all InterSense software running on a Windows PC is the **isense.dll**. When installed with the auto installer Product CD, the isense.dll is automatically place in the WINDOWS or WINNT system directory. This library, along with all other InterSense libraries used with other operating systems, provides a standard interface to all InterSense tracking systems.

Isdemo32.exe is installed in the InterSense\Programs folder. It provides a convenient graphical interface for testing and configuring the tracker.

IServer.exe (the InterSense Server Application) provides multiple services to applications requiring tracker data. IServer runs in the system tray, reading the data from the connected devices at the maximum speed allowed by the operating system. That data is then made available to other applications that use the InterSense DLL to communicate with the tracker. This allows multiple applications running at the same time to read data from the same tracking device.

Joystick Emulation Drivers can present any InterSense tracker as a joystick to the operating system. This provides games, like the Microsoft Flight Simulator, use of the tracker to control the line of sight. IServer reads tracker data in real time and passes it to the InterSense Joystick Driver, where it becomes available to all applications capable of reading joystick through DirectInput Interface.

The **JMouse** program allows any joystick device to control the "line of sight" in 3D applications, such as games, flight simulators, etc. It works by converting joystick movement to simulated mouse commands. JMouse uses DirectInput to detect and read data from joystick devices, so it requires DirectX version 8.0 or higher. To work with InterSense tracking devices, JMouse requires InterSense Joystick drivers and IServer to be installed and running.

The **InterSense SDK** sample programs and instructions are also installed from the CD. The SDK folder contains InterSense libraries for Windows, WindowsCE (PocketPC), Linux, HP-UX, SGI IRIX and Mac OS X. Sample code is provided to demonstrate the SDK use in Microsoft Visual C++, Visual Basic, WindowsCE, Linux and IRIX applications.

USB Drivers are installed in the InterSense\USBDrivers folder. This third party software supports the USB interface with the Wireless InertiaCube3 Receiver. Depending on your operating system, you may need to install the USB Drivers as outlined in Appendix B of the InertiaCube3 Product Manual. Details on the USB drivers and product updates are at http://www.ftdichip.com.

The **deviceTool** utility is used to set or change wireless communication channels and is installed in InterSense\DeviceTool. Use of this utility is described in Section 4 of this manual.

Please review the installed documentation in InterSense\Documents for additional information and Product Manuals.

3 Wireless Configuration with deviceTool

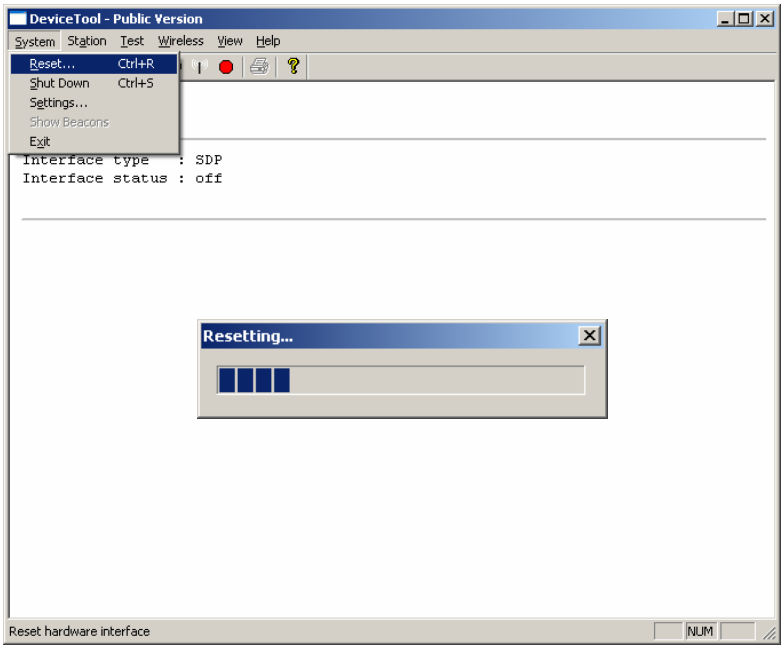
deviceTool is an application used to test and configure the Wireless InertiaCube3 and the Wireless InertiaCube3 Receiver. To use deviceTool, you must have the Wireless InertiaCube3 Receiver(s) connected to the Windows PC running deviceTool. Also, any of the Wireless InertiaCube3(s) that are being tested or configured, must be powered and within range of the Wireless InertiaCube3 Receiver(s).

There are 16 channels available for the InertiaCube3 to use. Only one channel number can be assigned to each receiver that is in the same area (within a 100 foot diameter of the Wireless InertiaCube3 Receiver). Each receiver can have multiple InertiaCube3s (up to four) associated with it. You may need to use deviceTool to change the channel of a receiver and its associated InertiaCube3s or to change the association between InertiaCube3s and their receivers.

Warning: When using Device tool, it's a good idea to make sure that only the devices that you want to change are powered on so other devices are not accidentally changed.

3.1 Finding all Wireless InertiaCube3 Devices

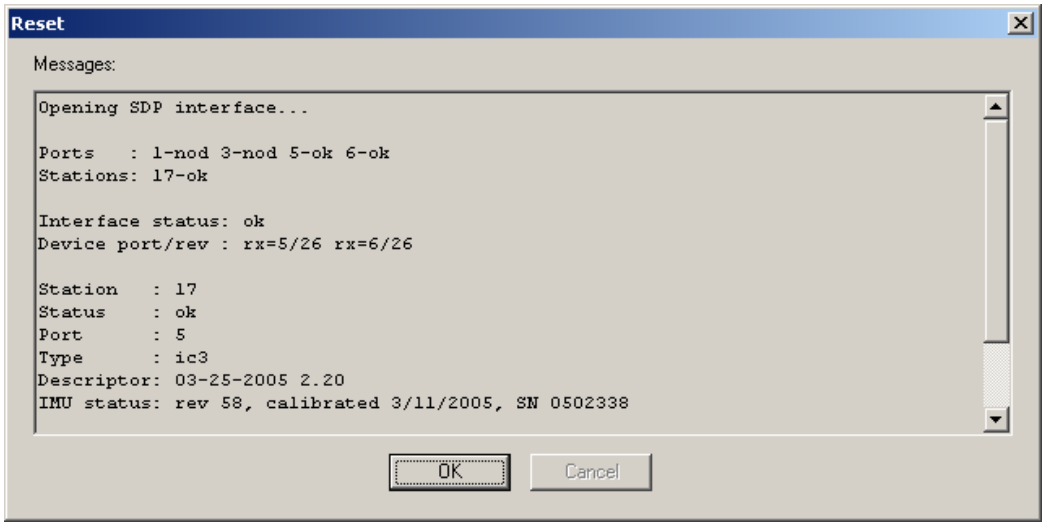
To use deviceTool go to the InterSense\DeviceTool directory from your installed InterSense support software, then start the *deviceTool.exe* program. The following window appears.



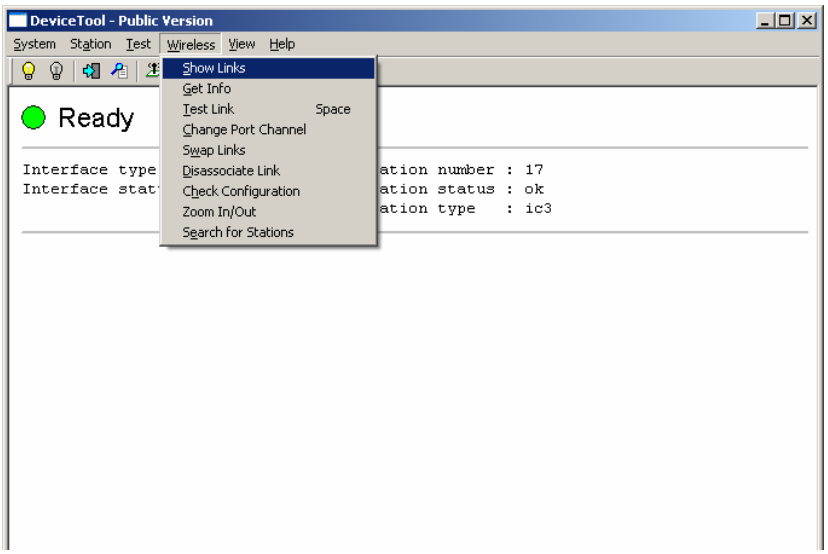
Under the System menu item, select Reset (or click on the yellow light bulb icon in the tool bar). This will initialize the interface and cause deviceTool to search all the communication ports for attached receivers and any InertiaCube3s that are paired with them.

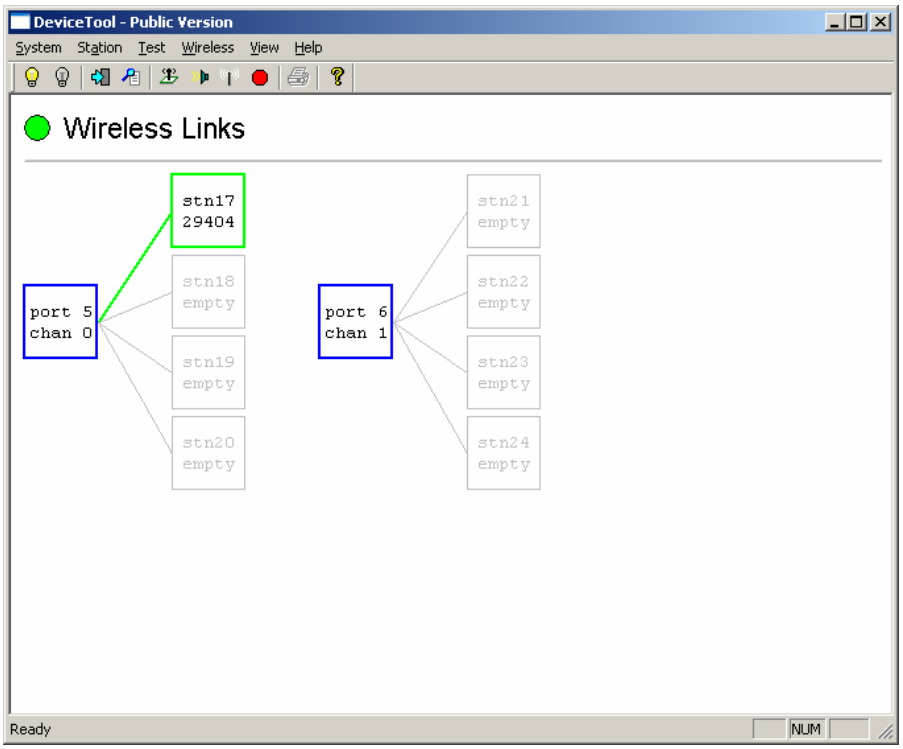
DeviceTool will then prompt you to choose an InertiaCube3 if more than one is detected (as shown below).

Some information about the InertiaCube3 will then be displayed. Click OK. (If a warning appears to say that no station was found, click OK as well).



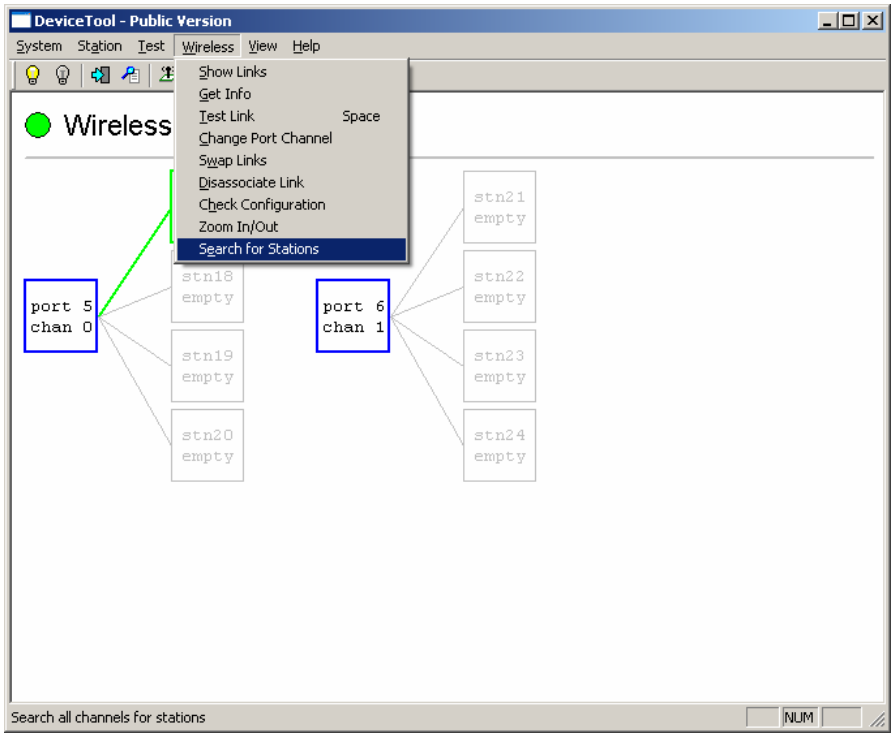
Then under the Wireless menu item select “Show Links” (or click on the antenna icon in the tool bar). A new display will show representations of the communication ports with receivers attached to the computer and associated links to InertiaCube3s.



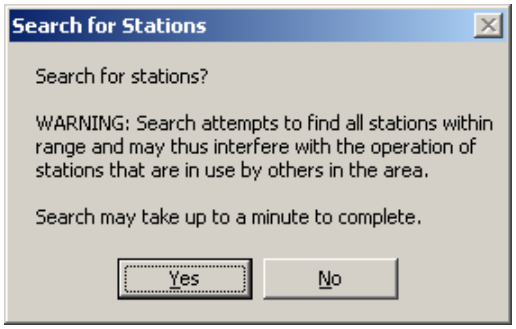


Wireless Links shown for Two InertiaCube3 Receivers and one Wireless InertiaCube3

Next, make sure power is applied to all Wireless InertiaCube3s and then select "Search for Stations" under the Wireless menu to find all Wireless InertiaCube3s in the area.

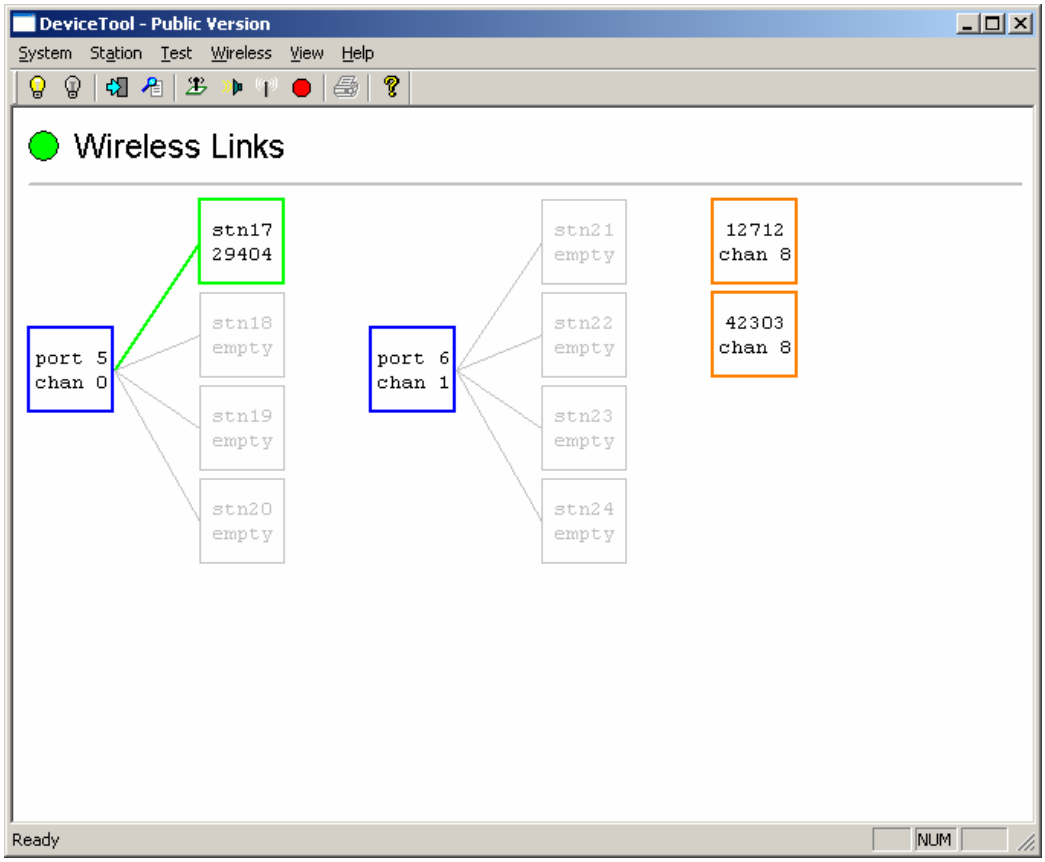


The dialog box appears warning you to make sure other Wireless InertiaCube3 devices are not being used by others in the area. Select Yes to continue.



While searching, the yellow light on the Wireless InertiaCube3 Receiver(s) flashes.

Once the search is complete, following window displays all Wireless InertiaCube3 devices found in the area. The display will also summarize the device, port, channel, and InertiaCube ID number.



Two Wireless InertiaCube3 Receivers and three Wireless InertiaCube3s

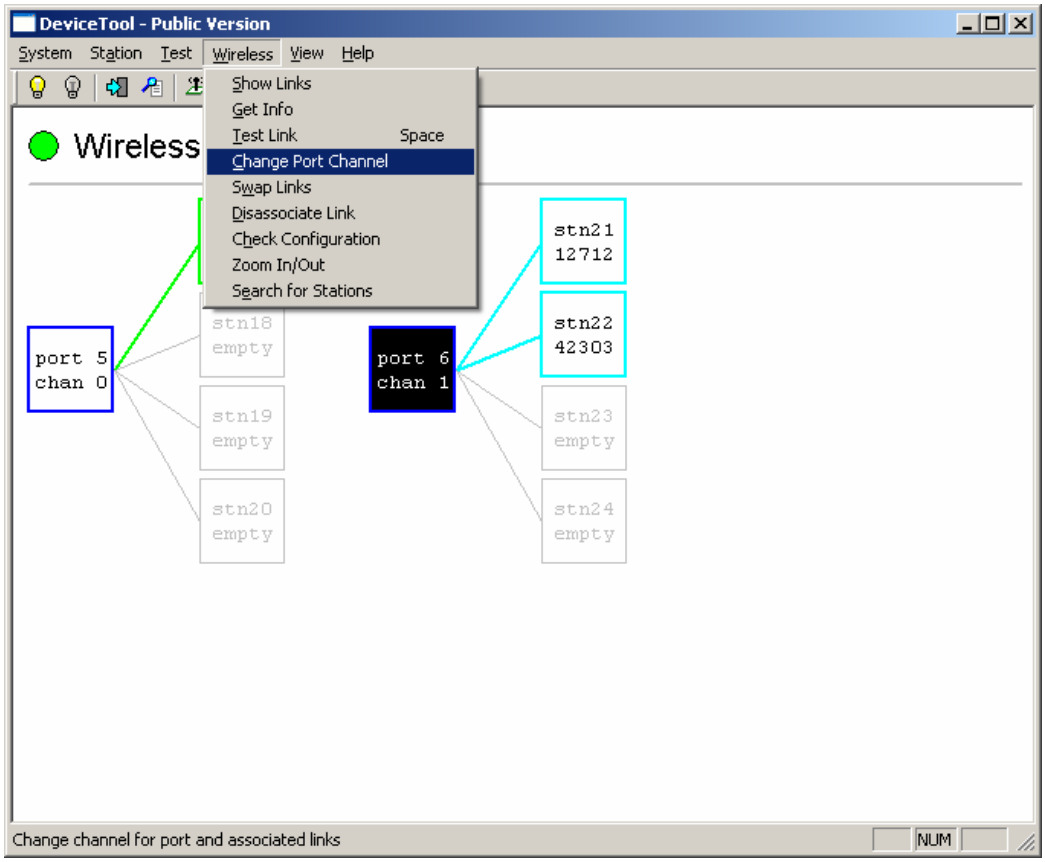
Ports with receivers attached are shown as blue boxes. Links associated with a port are shown as boxes to the right of the port and are each connected with line to the port (normally colored green). Links that are not associated with a port (orange) must be assigned to a port before they can be used. Empty links (gray) have no associated station. Links for InertiaCube3s that are not operational are shown in red. Links that are not ready (cyan) cannot be used until after a reset.

For the example shown in the deviceTool window above, the search resulted in finding two Wireless InertiaCube3 Receivers and three Wireless InertiaCube3s. One Wireless InertiaCube3 (ID # 29404) is connected to a receiver on COM port 5 of the Windows PC via wireless channel 0. The second Wireless InertiaCube3 Receiver is connected on COM port 6 of the Windows PC and is set to wireless channel 1 with no IneriaCube3s connected. The two additional Wireless InertiaCube3s (ID #'s 12712 & 42303) are set to wireless channel 8.

Note: The COM port reported by deviceTool can either be a physical or virtual COM port depending on your Wireless InertiaCube3 Receiver configuration. For USB InertiaCube3 Receivers, the USB driver software assigns a virtual COM port to Windows OS for communications. For RS-232 Serial receivers, the physical COM port is used & reported by deviceTool.

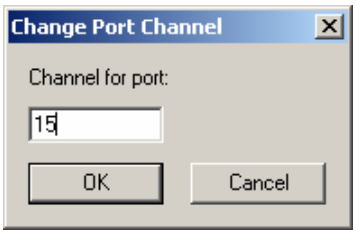
3.2 Changing Receiver Channels

To change the channel used by a receiver InertiaCube3 pair, select the receiver with the mouse and then under the Wireless menu select "Change Port Channel". In the dialog box select the new channel, (Make sure it is not already used by another attached receiver). Valid channels are 0-15. deviceTool will change the receiver and associated InertiaCube3 to the new channel. The new settings will automatically be stored in non-volatile memory. See deviceTool windows below.

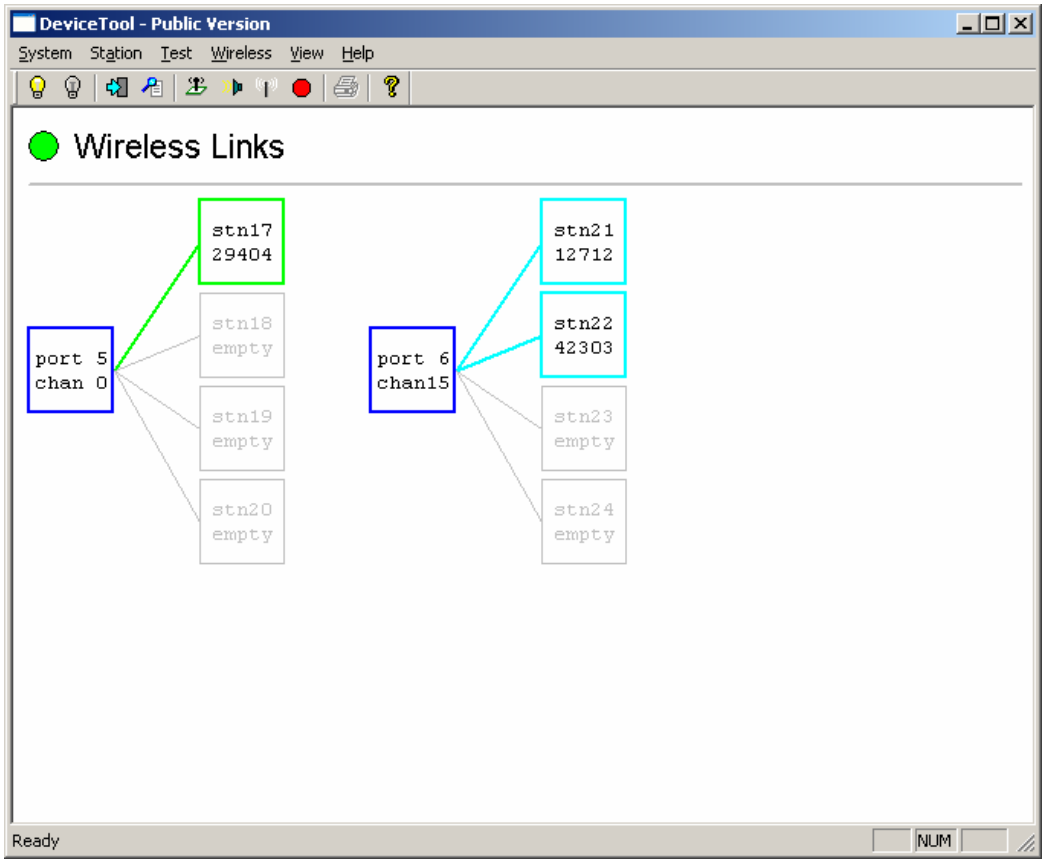


Changing Receiver Port Number

The following dialog box appears asking for a wireless channel number.

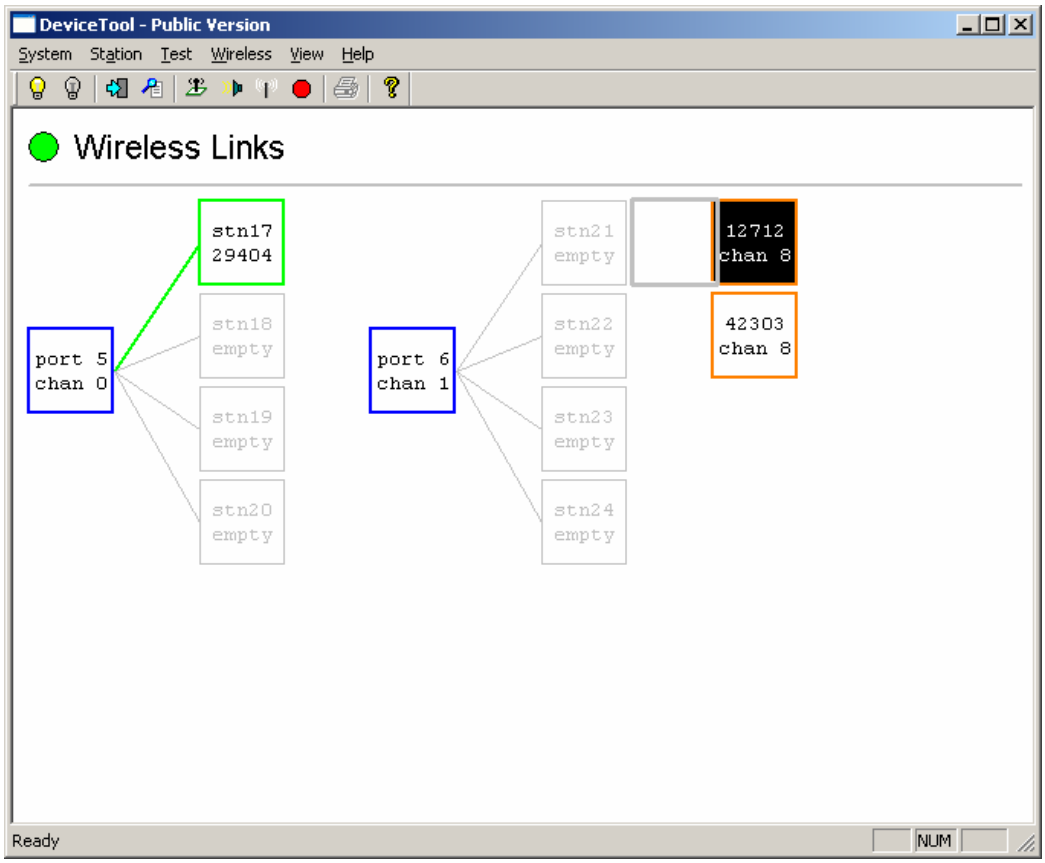


Finally the window below confirms the wireless channel number change (here the channel is changed from 1 to 15).

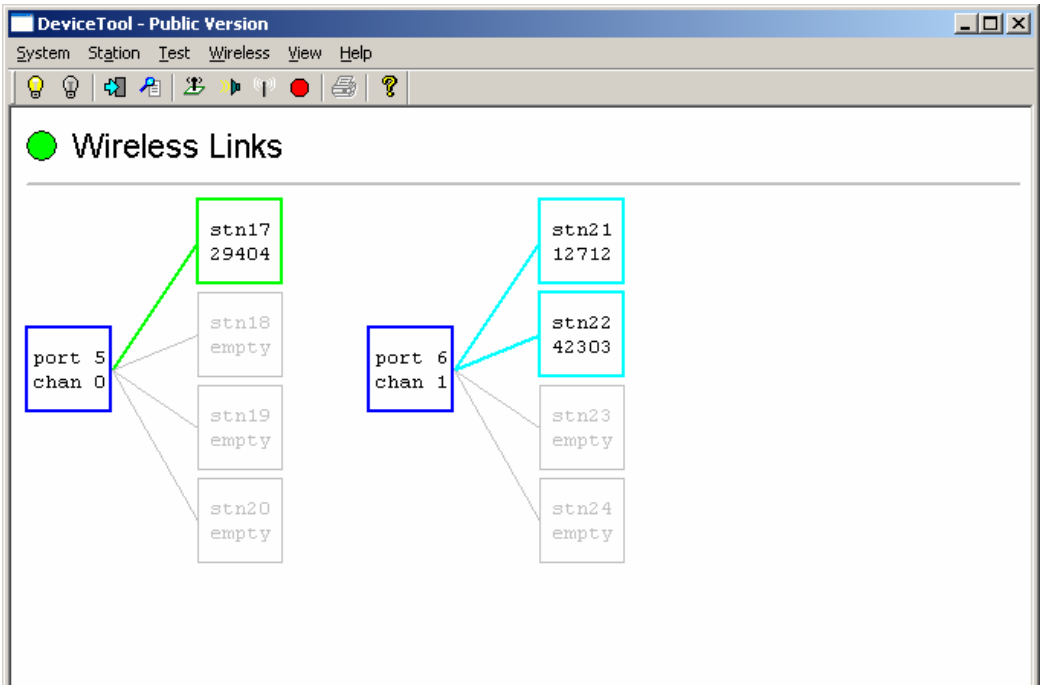


3.3 Attach Wireless InertiaCube3 to Wireless Receiver

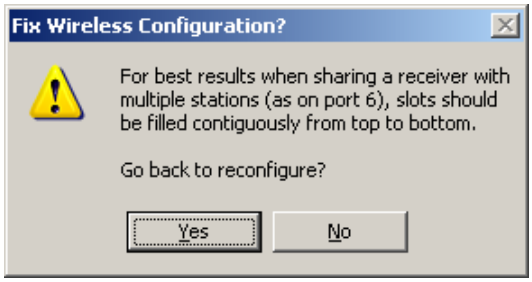
First, find all available InertiaCube3s on all channels. Under the Wireless menu item select "Search for Stations". This causes one of the receivers to sequentially go through all 16 channels searching for available Wireless InertiaCube3s. When deviceTool is done searching, it will display wireless InertiaCube3s that are not associated to a receiver as orange boxes and those already attached to a receiver are displayed as green boxes. To associate one of these InertiaCube3s on another channel to the receiver, just drag the InertiaCube3 to an empty link of a receiver (outlined in grey). The following dialog box appears.



The deviceTool Window below shows that all Wireless InertiaCube3 devices are assigned a channel and linked to a receiver.



If you attempt to link a Wireless InertiaCube3 to a non-contiguous of the receiver, the following suggestion will appear.

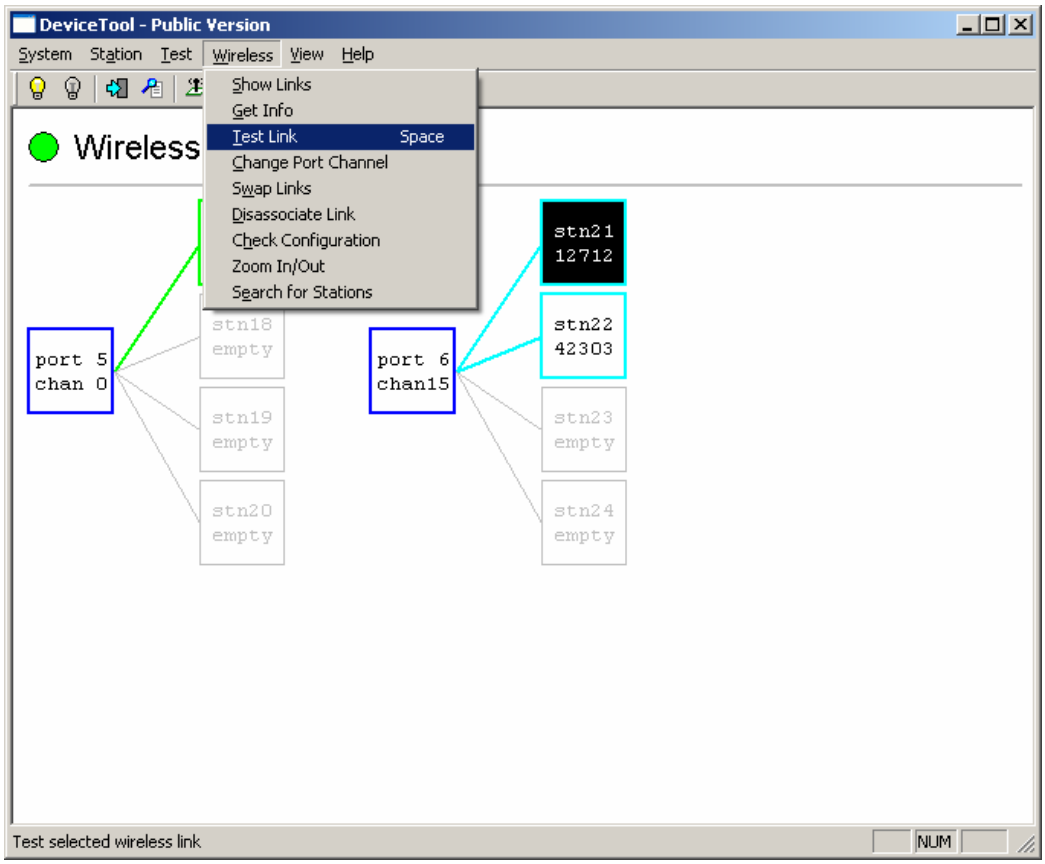


For optimal performance, follow the suggestion above by clicking Yes and reconfigure the system to use contiguous links to the receiver.

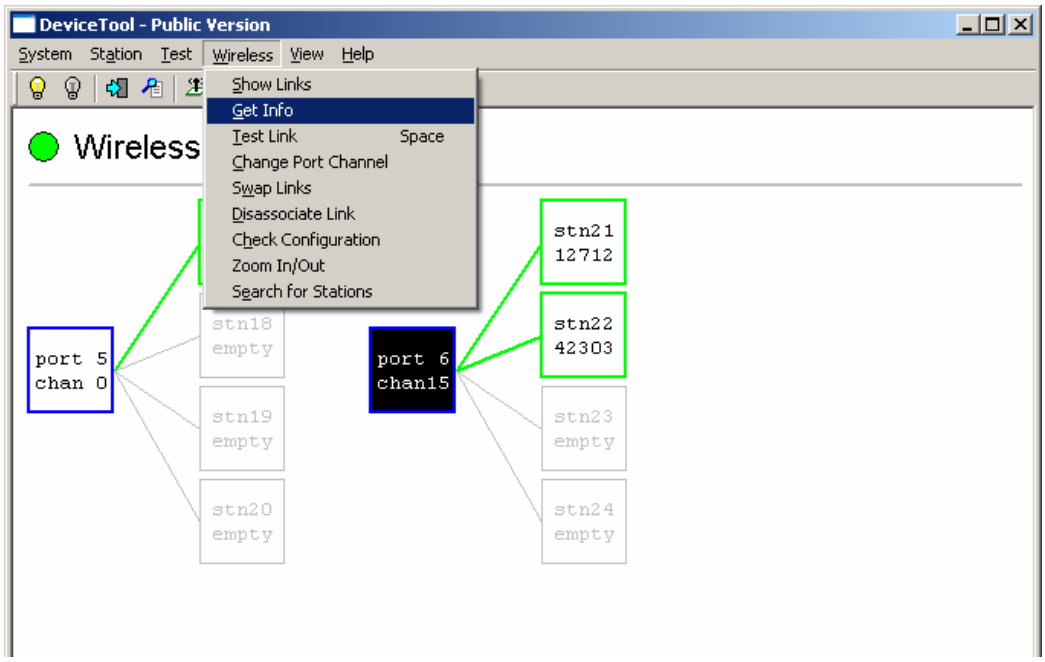
You can exit the deviceTool program when done. As you perform each step, the changes made are automatically saved in the Wireless InertiaCube3 devices.

3.4 Testing the Wireless Link of InertiaCube3 Devices

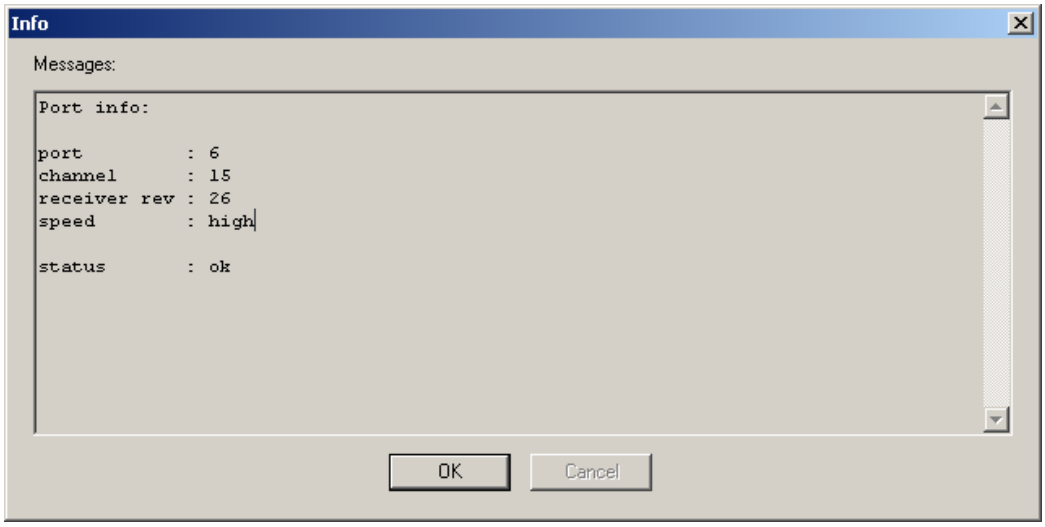
deviceTool is also used to test and verify the wireless communication channels used with the InertiaCube3. To verify which physical InertiaCube3 corresponds to each box in the window, select a Wireless InertiaCube3 box and choose "Test Link" from the Wireless menu or press the space bar. The yellow LED for the InertiaCube3 will light up. Again, if possible, it is best to do this with just the receivers and InertiaCube3 that you want to associate powered-on (with all others already configured powered-off) so you don't accidentally pair the wrong devices.



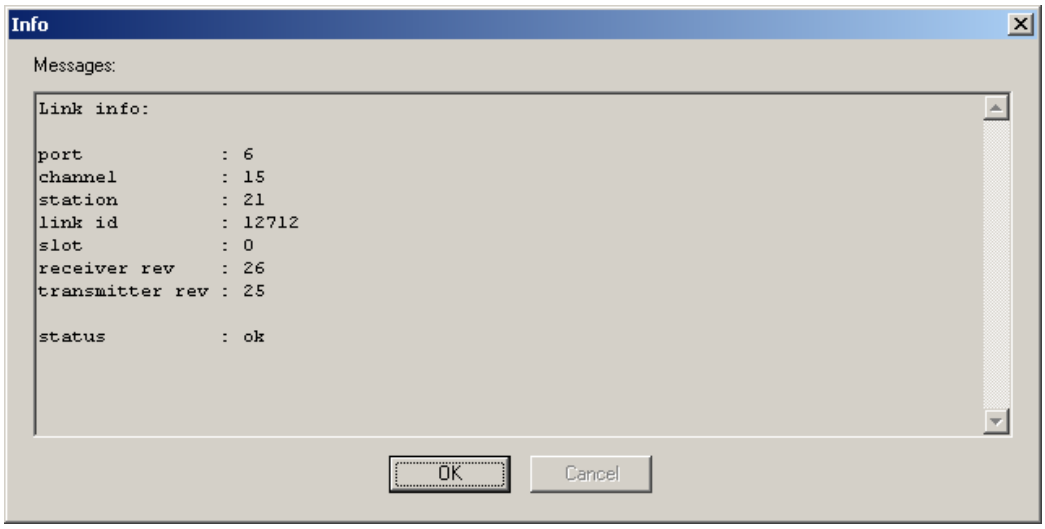
To verify Wireless InertiaCube3 device information (i.e. version number, port number, channel number, etc…), select either the Wireless Receiver or Wireless InertiaCube3 box in the main deviceTool window then choose "Get Info" from the Wireless menu. See window below.



A dialog box appears with the device information.



Wireless InertiaCube3 Receiver Information Window



Wireless InertiaCube3 Information Window

4 Wireless InertiaCube3 Power Requirements (Battery)

The Wireless InertiaCube3 requires 5.2 to 9 VDC at a drain of 60 mA. Voltages above 9 Volts can cause permanent damage to regulators. Voltages below 5.2 VDC will cause the accuracy of the InertiaCube3 to degrade. The green LED will flash when the detected voltage is at 5.2 VDC, indicating a low power situation and will continue flash until the power is raised above 5.5 VDC. If the detected voltage drops below 4.5 VDC, the device will stop operating and go into a very low drain mode. A non-rechargeable (alkaline) 9 VDC high performance battery can last over 8 hours. Four, non-rechargeable (alkaline), AA or AAA will work as well. Rechargeable AAA batteries typically only produce 1.2Volts so 4 of them are not sufficient.

5 InertiaCube3 Mounting Recommendations

Magnetometers in 3 axes of the InertiaCube3 are used to establish an absolute heading reference and to correct for heading gyro drift. To get the best accuracy, the InertiaCube3 should be mounted as far away from large magnetic sources; either ferrite materials like steel, some types of batteries or magnets sometimes used in Head/Helmet Mounted Displays (HMDs). For this same reason you should use the nylon mounting screws supplied with the IC3. Even long non-magnetic metal screws can effect the magnetic calibration.

Please review the detailed information about mounting and orienting the InertiaCube3 for optimum performance in Section 3.6 of the InertiCube3 Manual.

The IC3 will produce the same accuracy of results no matter what orientation it is mounted in, but its natural coordinate system is with the base down and cable coming out the back. If it is mounted in another orientation then coordinate transformation will either have to occur in your application or using boresight commands.

6 Dynamic Magnetic Calibration

If there are **static field** magnetic disturbances even after you have followed the mounting recommendations closely, you sometimes can compensate for these disturbances by performing a dynamic magnetic calibration **(the full procedure is covered in Section 4.7 of the InertiaCube3 Manual under Compass Calibration Tool)**.

Indications of the need to perform a magnetic calibration are seen during a 90 degree rotation in yaw with the InertiaCube reporting a turn close to 90 degrees but then settling at a number off by more than 10 degrees. If the suspected source of the error if rigidly attached to the IC3, like in a HMD or a weapons simulator, then a dynamic magnetic calibration may be able to compensate for most of the offset induced by this source. If the source of error is not attached to the InertiaCube3, (i.e. the sensor is used within an enclosed metallic environment—automobile cockpit—but not rigidly attached to this environment) then the magnetic field errors are not static and cannot be mitigated by using this calibration procedure.