



**Ascension**  
Technology Corporation

Tracking  
3D Worlds

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# 3D Guidance

# trakSTAR 2<sup>TM</sup>

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## Installation and Operation Guide

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# 3D Guidance trakSTAR 2<sup>TM</sup>

## Installation and Operation Guide

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# Introduction

Congratulations on your purchase of our Ascension Technology Corporation (ATC) 3DGuidance **trakSTAR 2**. Our company is proud of the quality of all our trackers and is committed to making your experience with this device a good one.

**trakSTAR 2** is a high-accuracy electromagnetic tracker designed for short-range motion tracking applications. It employs our latest pulsed DC technology to track the position and orientation (up to six degrees-of-freedom or 6DOF) of multiple sensors within the operating range of the transmitter. Sensor data is reported serially to a host computer via a USB or RS232 interface.

This User's Guide will help you set up and install the 3DGuidance **trakSTAR 2** hardware and software as well as configuring it for optimal tracking. Please read this document carefully. Proper set up will maximize tracking performance for your particular application.

## About This Guide

This Guide – along with its Quick Set-up Handout-- contains everything you'll need to install and run the tracker. It provides valuable information about testing performance and communicating with **trakSTAR 2**. You will also find descriptions of tools available for configuring your tracker and finding immediate help.

## How This Guide is Organized

This manual contains eight chapters.

### **Chapter 1: Preparing for Setup and Safe Performance**

States the Intended Use

Lists tracker software and hardware requirements

Outlines the components of your system

Describes safe use and handling precautions

### **Chapter 2: Quick Start: Setup and Checkout**

Describes how to connect your system components

Guides you through a quick checkout, using the demo software

### **Chapter 3: Configuration and Basic Operation**

Outlines default configuration parameters and reference frames

Provides component mounting information

Details the basic principles of tracker operation

Describes factors that affect tracker performance

**Chapter 4: Software -Tools for Successful Tracking**

Outlines the methods for communicating with trakSTAR 2.

Contains sample programs -- included on your CD-ROM --- that demonstrate the tracker's communication structure

**Chapter 5: 3DGuidance API Reference**

Details the 3DGuidance Application Programming Interface (API) for communicating with the tracker using USB

**Chapter 6: RS232 Command Interface Reference**

Describes an alternate method for communicating directly with the tracker using the Ascension RS232 Interface protocol

**Chapter 7: Troubleshooting, Maintenance, Repair and Disposal**

Offers user-troubleshooting suggestions including setup problems and solutions.

Addresses maintenance suggestions including cleaning and disinfecting methods.

Explains how to contact Ascension Technology Corporation if you need assistance.

Lists replacement part numbers

Identifies disposal guidance.

**Chapter 8: Regulatory Information and Product Specifications**

Lists applicable standards, specifications, and certifications.

## Guide Conventions

This guide uses a number of conventions to explain procedures, and present information clearly.



**Note:** This call-out explains important information about the features of your system



**Tips:** This call-out provides advice for maximizing the performance of your system



**CAUTION!** This call-out points out steps that should be avoided to prevent damage to your system.

# Getting Assistance

If you are experiencing a problem with the installation, set up, or operation of your tracker, we suggest that you first consult the troubleshooting table in Chapter 7. It describes common setup problems and suggested solutions.

If you continue to experience problems after following the recommended actions, contact us for expert support.

<b>World Wide Web:</b>	<a href="http://www.ascension-tech.com/support/">http://www.ascension-tech.com/support/</a>
<b>E-mail:</b>	<a href="mailto:support@ascension-tech.com">support@ascension-tech.com</a>
<b>Telephone:</b>	Call (802) 893-6657 9 a.m.-- 5 p.m. U.S. Eastern Standard Time, Monday through Friday.
<b>Fax:</b>	(802) 893-6659

# Preparing for Setup

*This chapter describes everything you will need to setup your 3DGuidance trakSTAR 2.*

## System Requirements

### Intended Use Statement

The 3DGuidance trakSTAR 2 is designed to be integrated as part of a larger host system, requiring real-time tracking or measurement of an object's position and orientation in free space.

## Software Requirements

Several Windows® based utilities are included on the **trakSTAR 2** CD-ROM:

1. **Cubes** - a demonstration utility that communicates using USB and the 3DGuidance USB API.
2. **APITest** – An application that allows you to send any command defined in the 3DGuidance API to the tracker, and to view the associated response.
3. **driveBAY 2 Utility** - a utility for changing default configuration parameters of your system, or loading firmware upgrades. This same utility is applicable to both driveBAY 2 and trakSTAR 2 systems.

These utilities and communication with the tracker via the 3DGuidance API require:

**Windows XP®, Windows Vista®, or Windows 7®**

## Hardware Requirements

**USB port:** trakSTAR 2 can report data serially to a host computer using a USB cable. To do this, an unused USB 2.0 port on your computer is required.

**COM port:** For legacy Ascension tracker users, the trakSTAR 2 can report data serially to a host computer via a RS232 cable. To do this, an unused COM port on your computer is required.

**Power:** trakSTAR 2 contains an internal power supply that will operate from 100 to 240V AC, at frequencies of 50-60 Hz, and using up to 70 VA of power.

**CD-ROM drive:** Only required for accessing the utilities and drivers shipped on a CD-ROM.

You may also download these utilities from the Internet by visiting Ascension's web site.

([www.ascension-tech.com](http://www.ascension-tech.com))

# Unpacking the System

## Package Checklist

The trakSTAR 2 will arrive in one or two shipping boxes (depending on the configuration). Make sure you have received the following items before proceeding to the setup and checkout section:

### Electronics Unit:



Figure 1 trakSTAR 2 Electronics Unit

### Sensor(s):

Valid sensor options for the trakSTAR 2 include:

6DOF: Model 800, Model 180, Model 130, Model 90, and Model 55.

5DOF versions of many sensors are also now supported via a Junction Box (see below).

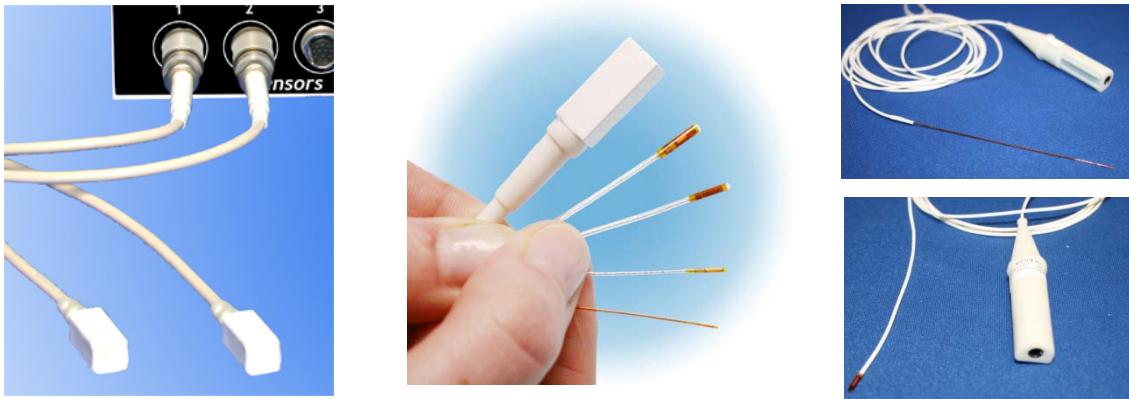


Figure 2 trakSTAR 2 Sensors

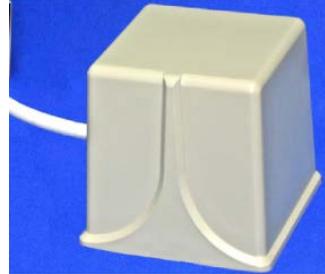
**One or more of the following transmitters:**



**Note:**  
Transmitters  
are  
specifically  
calibrated  
for use with  
the  
driveBAY 2  
and  
trakSTAR 2  
systems.

**6DOF Transmitters:**

These transmitters support operation with 6DOF sensors



Mid-Range Transmitter



Short-Range Transmitter

**Figure 3 trakSTAR 2 6DOF Transmitters**

**5DOF/6DOF Transmitters:**

These transmitters support operation with 6DOF sensors AND 5DOF sensors



5DOF/6DOF Flat  
Transmitter



5DOF/6DOF MAGnet  
Transmitter



5DOF/6DOF miniMAG  
Transmitter

**Figure 4 trakSTAR 2 5DOF/6DOF Transmitters**

## 3D GUIDANCE TRAKSTAR 2™ INSTALLATION AND OPERATION GUIDE

Junction Box (Required for 5DOF Sensor connections):



**Figure 5 5DOF Junction Box**

Cables:



**AC Power Cable**



**USB Cable**



**RS232 Cable**

**Figure 6 trakSTAR 2 Cables**

trakSTAR 2 CD-ROM:



**Figure 7 3D Guidance trakSTAR 2 CD-ROM**

**Quick Setup Guide:** Condensed list of procedures for quick and easy setup.

If there are any discrepancies or the shipment is damaged, contact us by any of the following means:

<b>World Wide Web:</b>	<a href="http://www.ascension-tech.com/support/">http://www.ascension-tech.com/support/</a>
<b>E-mail:</b>	<a href="mailto:support@ascension-tech.com">support@ascension-tech.com</a>
<b>Telephone:</b>	Call (802) 893-6657 9 a.m.-- 5 p.m. U.S. Eastern Standard Time, Monday through Friday.
<b>Fax:</b>	(802) 893-6659

## Safe Performance and Handling Precautions

Ascension sensors and transmitters, along with their attached cables and connectors, are sensitive electronic components. To obtain consistent performance and maintain your warranty, treat them carefully.



- Caution - Read this Guide. This symbol cautions you to please refer to the safety-related notes in this manual
- The trakSTAR 2 is a Safety Class I instrument (provided with protective earthing). Before turning on the instrument, make sure the mains plug is inserted in a socket outlet with a protective earth contact. Do not negate the protective action by using an alternate power cord without a protective grounding conductor.



- When power is applied or the tracker is running, do not open the cover and touch exposed electronic components. Contact with exposed components could cause injury.
- Never power up the system or place the transmitter in an explosive atmosphere.
- Handle the section of cable near the sensor and transmitter housing carefully. Repeated bending of the cable near the sensor or transmitter housing is the most common cause of tracker failure.
- Remove the sensor or transmitter from mounting brackets or holders gently. Do not yank or pull on the cable.
- Sensors and transmitters can easily be damaged if you carry, throw, or swing them by their cables or if you drop them against a hard surface.



- The Mid-Range (~5 lbs), Flat (~23lbs), and MAGnet (~7 lbs) transmitters are heavy and may cause injury if dropped on a foot. Use caution when mounting or carrying them.
- Be sure to implement a strain relief if you embed a sensor and its cable in an instrument or tool. The point where the sensor cable exits from your tool needs protection. Your sensor will last a long time if you take steps now to distribute forces over an extended region of the cable.
- Our sensor and transmitter cables are precisely bundled, shielded, and calibrated to minimize noise and ensure accurate performance. If add your own extension cables or connectors, you will compromise performance and void both regulatory approvals and your warranty.

- For **Periodic Maintenance and Inspection** recommendations, be sure to checkout the [User Maintenance](#) section (in Chapter 7)



- This unit contains fuses. If replacing one, be sure to replace with the same type and rating. See [Fuses](#) section in Chapter 7
- To clean components, wipe them with a cloth dampened with a general purpose cleaning solution such as soap and water, isopropyl alcohol, etc. Do not immerse the

transmitters sensors, or cables in liquid. See [Cleaning and Disinfecting](#) (in Chapter 7) for additional details

- Keep the transmitter, sensors, and cables away from sources of heat.
- If mounting the transmitter inside an enclosure, be sure to provide adequate ventilation.
- To extend tracker life, be sure to shut down the transmitter when not in use. You can do this in several ways:
  - i. Turn off the Power switch on the rear panel
  - ii. Select “No Transmitter” by setting the System parameter: [SELECT TRANSMITTER](#) value to ‘-1’ in the 3D Guidance API.
  - iii. Disconnect and reconnect the USB cable.
- Tracker components may be **subject to interference from or may interfere with other electrical equipment in your environment**. Be sure to identify sources of interference in your particular environment as well as devices that might be affected by tracker operation. See the section [Electromagnetic and Other Interference in Tracking](#) for additional details.

## Environmental Conditions

The **trakSTAR 2** must be used and maintained in the following ranges only:

### Temperature

The tracker operates within specification when the ambient air temperature is between 5 degree C and 40 degree C. The **trakSTAR 2** can be packaged and shipped in environments with an ambient air temperature between -40 degree C and 70 degree C without degradation of its components.

### Humidity

The tracker operates in non-condensing environments with relative humidity between 10% and 90%. It is capable of being packaged and shipped in environments with a relative humidity between 5% and 95%

## Quick Start: Setup and Checkout

*This chapter demonstrates how to install the software and connect your components so that you can quickly checkout your device and begin tracking.*

### Install the Software

The trakSTAR 2 CD-ROM has an installer that will copy all required software (utilities, sample code, API, etc) and user documentation onto your host PC.

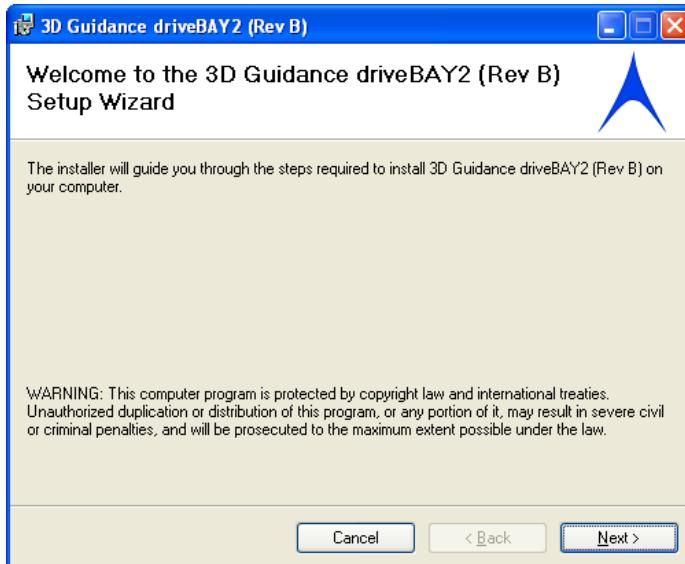
**Note that you must have administrator privileges for the installer to run.**



**Note:** Install the software before connecting the trakSTAR 2.

1. To begin the installer, place the CD-ROM in the tray, and close the drive door.

**NOTE: If the installer does not start (drive not set to ‘Autoplay’), then browse to the CD-ROM folder and run the ‘setup.exe’ file.**



**Figure 8 3D Guidance Setup Wizard**

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- Follow the prompts in the Setup Wizard, confirming the target folder and selecting the user access (install for everyone or just current user).

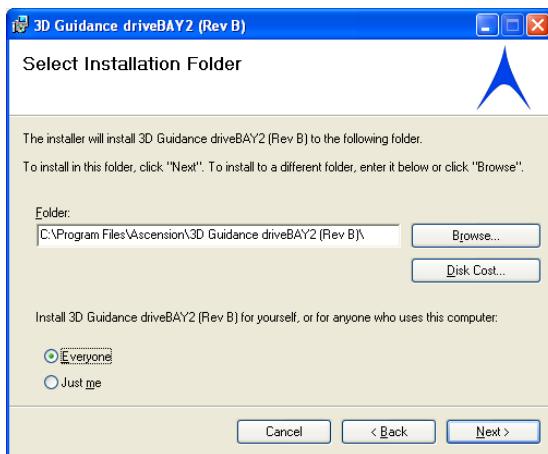


Figure 9 3D Guidance Setup Wizard – Confirming Target Folder

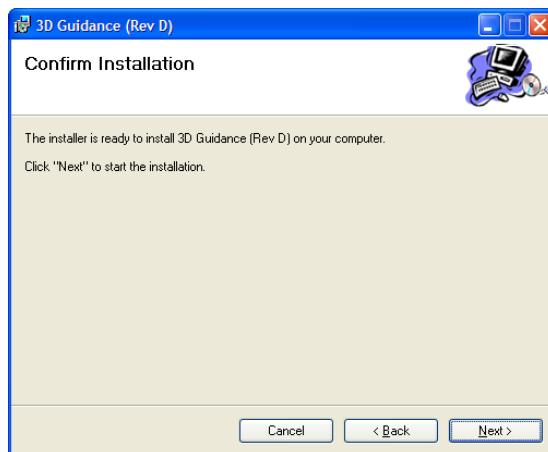


Figure 10 3D Guidance Setup Wizard – Confirming Installation

- Select a USB driver. For new installations or systems running a 64-bit operating system, select the **'Windows USB driver device driver'** (winusb.sys) - recommended. For continued use of the legacy USB driver (cyusb.sys), select the **'Cypress USB device driver'**.



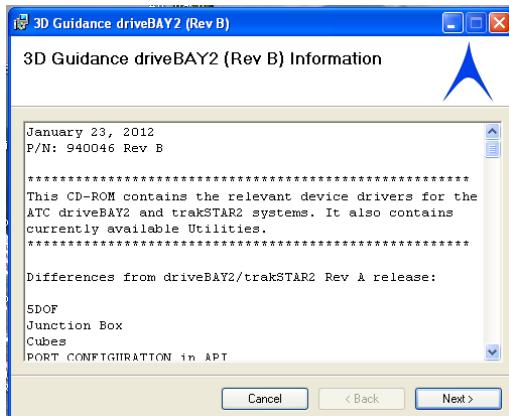
**Figure 11 3D Guidance Setup Wizard – Installing USB Driver**

- When the **Windows Logo Testing** message box displays, click *Continue Anyway* to proceed with the installation.



**Figure 12 Windows Logo Testing Message Box**

After installation is complete, the *Readme.txt* file is displayed providing important information about the software.



**Figure 13 3D Guidance Readme File**

## Windows Vista-32 Bit Installation

Windows Vista32-bit systems prompt users to run the Driver Installation Wizard. Follow the prompts in the Wizard to copy over the required driver installation files.



**Figure 14 Windows-Vista Driver Installation Wizard**

## Cable Connections

The trakSTAR 2 hardware can be connected and ready to run in four easy steps:

1. **Connect the Transmitter** –Plug the transmitter cable into the corresponding connector on the left side of the Electronics Unit's front panel.

 Note: For optimum performance, keep the transmitter at least 24 inches away from the Electronics Unit. See the [Mounting the Hardware](#) section for additional mounting information.



**Figure 15 Connecting the Transmitter**

2. **Connect the 6DOF Sensor(s) to the Electronics Unit** – Plug the connector of each 6DOF sensor into a receptacle on the electronics unit. Be sure to fully insert the connector, until audible ‘click’ is heard.

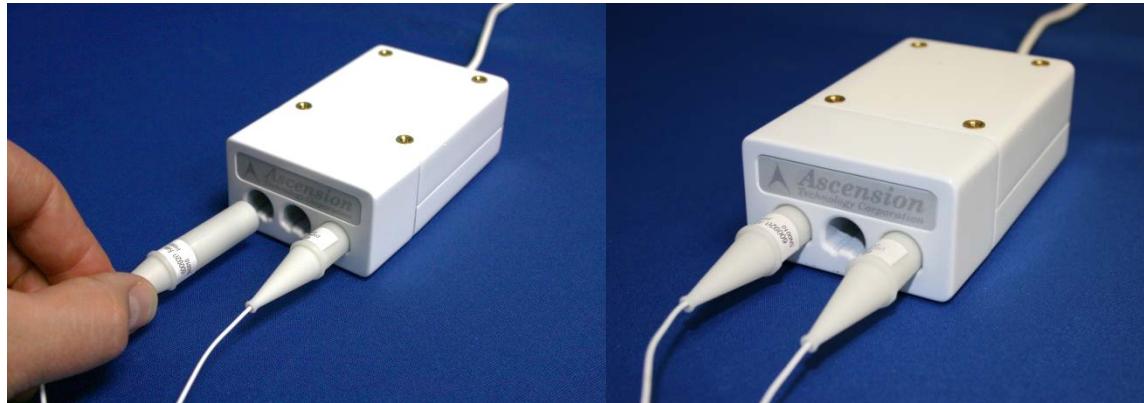


**Note:** The sensor and transmitter connectors are specifically keyed to mate. You may need to rotate the connectors before they will click into place.



**Figure 16 Connecting the 6DOF Sensors**

3. **Connect the Junction Box to the Electronics Unit** – If your system came with a Junction Box and 5DOF sensors, plug the metal connector of the Junction Box into any of the 4 ‘Sensor’ receptacles on the electronics unit (labeled ‘1’,‘2’,‘3’, or ‘4’). Be sure to fully insert the connector, until audible ‘click’ is heard.
  - a. **Connect the 5DOF sensor(s) to the Junction Box** – Plug the plastic 5DOF sensor connector into the front of the Junction Box.



**Note:** trakSTAR 2 electronics units are pre-configured for 6DOF operation. If you are connecting 5DOF sensors (via the Junction Box), there are a few power-up settings you’ll need to change after you get the system running. See [Configuring for 5DOF operation](#) in Chapter 3.

4. Connect the Interface Cable –

**RS232 Interface:** To communicate with the trakSTAR 2 using the legacy Ascension RS232 Interface protocol (RS232 link), connect the RS232 cable to the RS232 port on the rear panel of the trakSTAR 2 and an open COM port on the Host PC.



Figure 17 Connecting RS232 Interface Cable (trakSTAR 2 Rear Panel)

**USB Interface:** To use the 3DGuidance API (USB interface), connect the USB Cable to the trakSTAR 2 rear panel and any open USB port on the Host PC.



Figure 18 Connecting USB Interface Cable (trakSTAR 2 Rear Panel)

5. **Apply Power** – Connect the AC Power cord to the AC Power Input Connector on the trakSTAR 2 rear panel and to an AC power source (wall outlet). Then set the power switch to ON (up position).



Figure 19 Location of AC Power Input Connector (trakSTAR 2 Rear Panel)



**Figure 20 Location of AC Power Switch (trakSTAR 2 Rear Panel)**



Note: The AC inlet on the **trakSTAR 2** is mounted such that the **ON/OFF** switch is **UP** and **Down**. **ON** and **OFF** is denoted by the following symbols



OFF Position – Switch DOWN to turn AC Power OFF



ON Position – Switch UP to turn AC Power ON



Note: When AC power is applied, the **trakSTAR 2** internal processors initialize and read data stored in the transmitter and sensor programmable read-only (PROMs) and/or Flash memories. Do NOT send commands to the **trakSTAR 2** until the front panel LED is blinking GREEN -(see the [LED Definitions](#) table in Chapter 7 for more information).



**Figure 21 Location of Front Panel LED**

## Installing the Driver

The **New Hardware Wizard** displays after plugging in the USB cable indicating new hardware is detected. (Note that Vista, Win7 systems will initiate the driver install automatically)

1. Follow the New Hardware Wizard prompts, allowing Windows to automatically search for a suitable driver. (This is the default option.)

 **Note:** If the installer (on CD-ROM) was run prior to connecting the hardware, the *Found New Hardware Wizard* will automatically find the drivers.

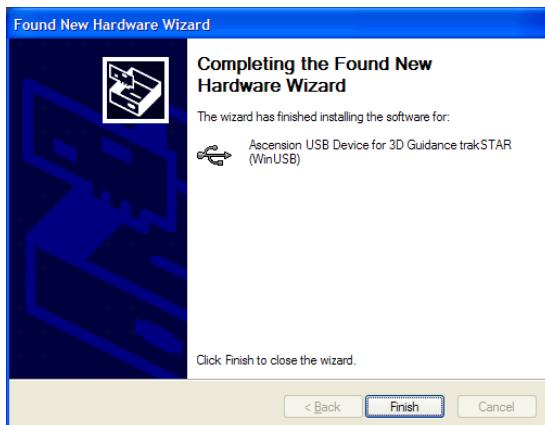


**Figure 22 Found New Hardware Wizard**

2. Follow the steps in the *New Hardware Wizard*, allowing Windows to install the USB driver.

 **Note:** If a message displays that the software has not passed 'Windows Logo' testing, select *Continue Anyway*.

3. Click **Finish** when the *Found New Hardware Wizard* has completed installing the driver to close the wizard.



**Figure 23 Found New Hardware (Closing Wizard)**

## System Checkout: Running the USB Demo Software

With the **trakSTAR 2** running and the drivers and utilities installed, you are ready to run the demo software and checkout the operation of your tracker. If you've elected to run with the RS232 interface, you can checkout the system using the driveBAY2 Utility. See [Appendix II : driveBAY 2 Utility](#) for details.

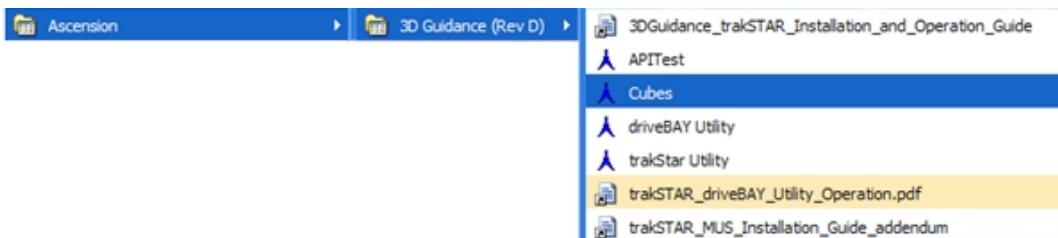


**Note:** For 5DOF sensor operation you'll need to first change your front panel port configuration. See [Configuring for 5DOF Operation](#) in Chapter 3.



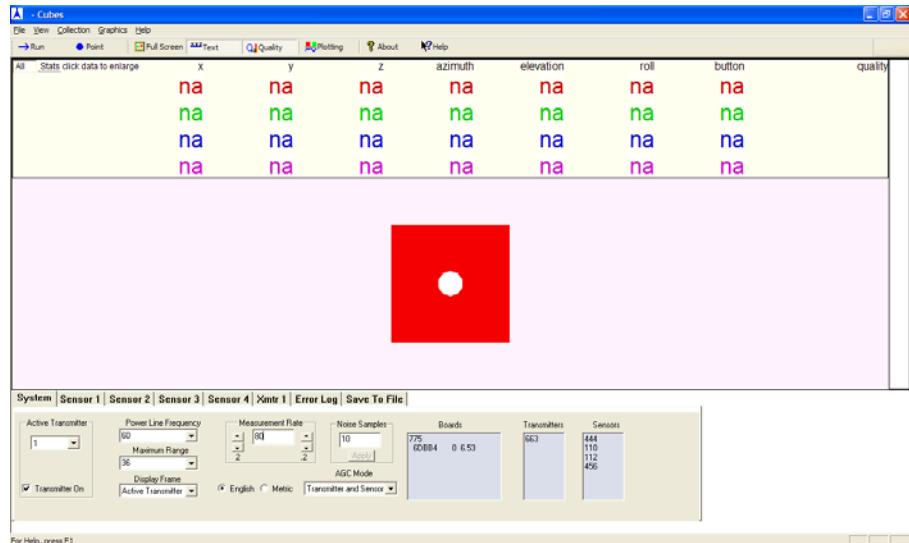
**Note:** While the Cubes demo utility is an excellent way to become familiar with the features of the tracker, it has some limitations as a data collection tool. For example, it is not possible to obtain the full update rate from the tracker (typical update rates from Cubes are about 60Hz). If regular, consistent sampling and full update rates are required for your application, consider starting with the source code for our [GetSynchronousRecordSample](#) application, and modifying it to meet your application needs.

1. Select **CUBES** from the **Ascension Program Group** in the **Windows® Start** menu to start the Demo Utility.



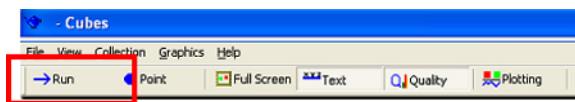
**Figure 24 Location of Demo Utility (CUBES)**

After a brief pause (~20sec), the CUBES window displays



**Figure 25 CUBES Window**

- Click **Run** to start collecting data from the system.



**Figure 26 Location of CUBES Run Button**

### What you will see:

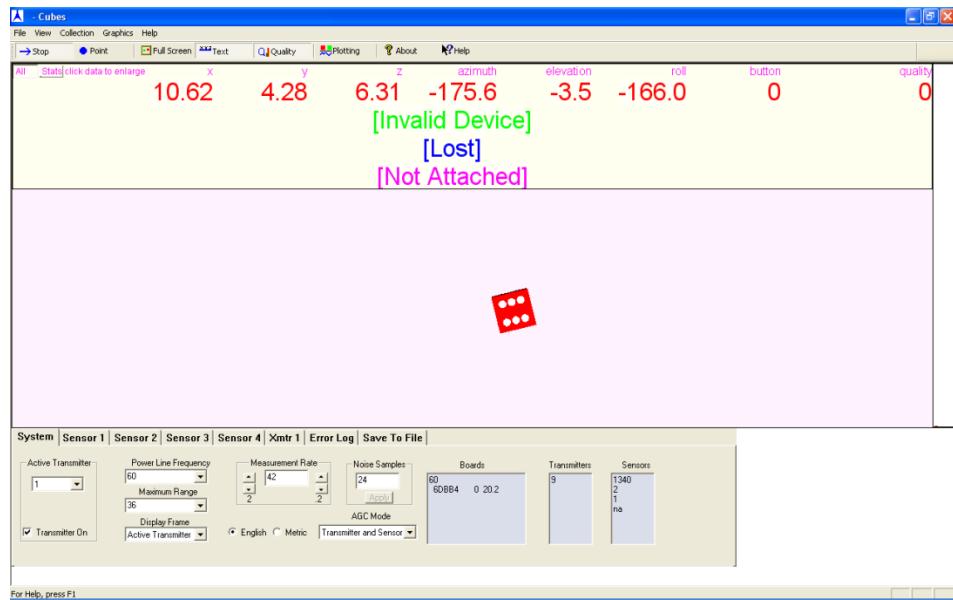
The top of the window displays the reported position and orientation data for each sensor attached to the tracker electronics unit. Each color-coded row contains outputs for a single sensor. The first three values in a row represent sensor position (*in inches*) relative to the transmitter's coordinate origin. The next three values in the row give sensor orientation *in degrees*, relative to the transmitter's default [reference frame](#).

NOTE that if a data record for a sensor is not displayed, Cubes will display a message in that sensor's row which reflects the Run Time Device Status Code being returned by the tracker. In [Figure 27](#) for example:

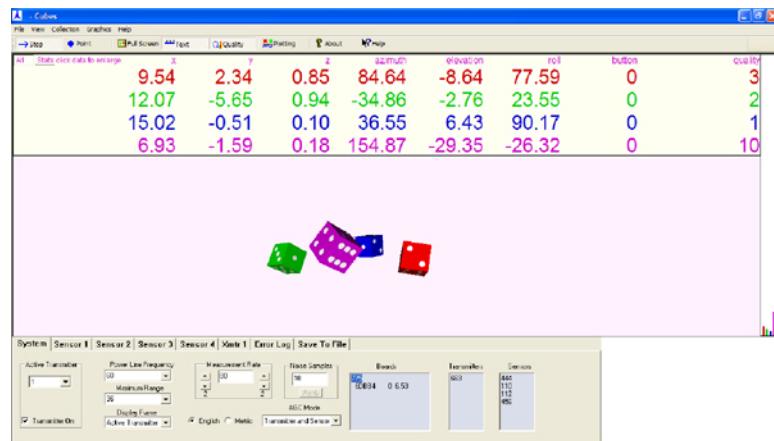
- The sensor plugged into Port 2 is the wrong type for the unit's current Port setting (i.e. 5DOF sensor in 6DOF port). See [Configuring for 5DOF Operation](#). The status code returned is 'INVALID\_DEVICE'.
- The sensor in Port 3 does not have enough data yet to satisfy the Position/Orientation algorithm. The status code returned is 'ALGORITHM\_INITIALIZING'.

See the [Status Codes](#) paragraph in the Quick Reference section.

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**Figure 27 Sensor Device Status Code (run-time) displayed in Cubes**



**Figure 28 Typical Data Collection Position and Orientation Display**

The **Button** column indicates the status of an external switch or contact closure that has been connected to the rear panel of the electronics unit. See the [Switch](#) rear panel connector description for details.

The last column in each row (and the vertical bar on the far right) shows the reported **QUALITY** number. This value gives you an indication of the extent to which position and angle measurements are in error. Error may often be attributed to “uncompensated” metal in the environment. See the “[Performance Factors](#)” section of Chapter 3 for details.

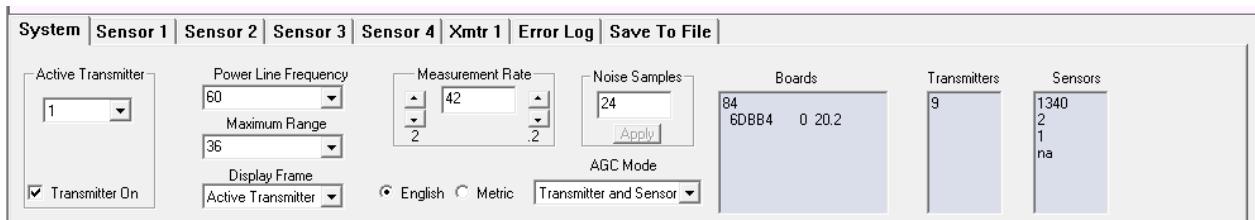


Note: The value of the Quality number displayed in this Cubes demo utility has been scaled down by 256 from the value returned by the API.

 Tip: For additional information and assistance on using the **QUALITY** number, see [QUALITY](#) in Chapter 5.

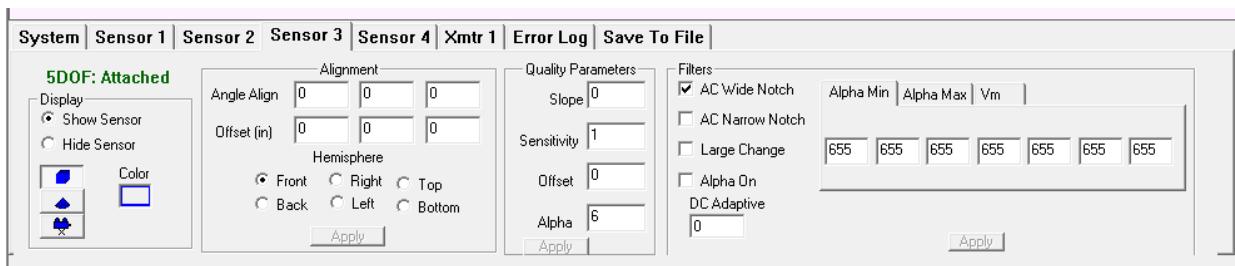
The center of the window displays a colored cube for each sensor attached to the tracker. Note that cube colors correspond to both the color of the numbers shown in the rows of sensor data, and the color of the quality indicator on the right.

The bottom of the window includes a ‘System’ tab that allows you to configure and adjust all [System](#) parameters (Measurement Rate, Metric units, Max Range Scale Factor, Power Line Frequency), turn on and off the transmitter, and to display the serial number of all connected components.



**Figure 29 Cubes System Tab**

It also includes tabs providing information and access to current parameter settings for the individual components – sensors and transmitters.



**Figure 30 Cubes Sensor Tab**

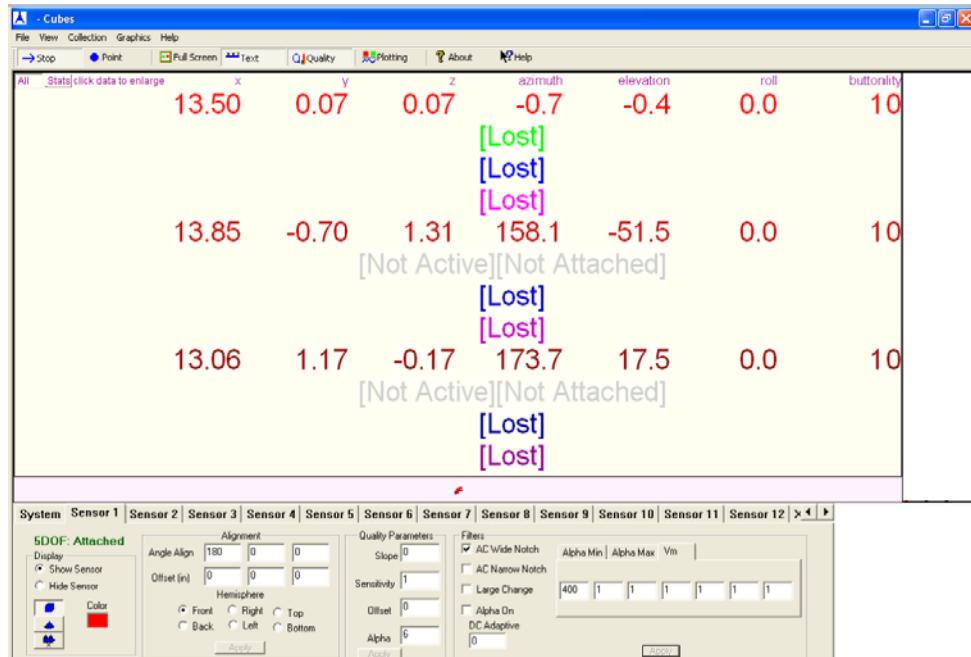
 Note: To enable 5DOF sensor operation, you must first change your front panel port configuration. See [Configuring for 5DOF Operation](#) in Chapter 3.

## MORE SENSORS:

If you’ve connected more than one 5DOF sensor per front panel port (i.e. two or more in a Junction Box) and you’d like to have Cubes display ALL connected sensors, you’ll need to do two things:

- 1) Configure the corresponding front panel ports of your electronics unit for 5DOF Operation. See [Configuring for 5DOF Operation](#)
- 2) Set the AUTOCONFIG parameter to ‘12’. See [AUTOCONFIG](#).

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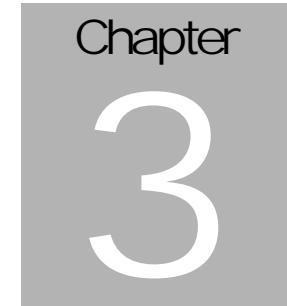


**Figure 31 Running Cubes with AUTOCONFIG set for 12 Sensors**

Use the demo utility to become familiar with the sensor motion region and the tracker's capabilities. If the utility does not run or the tracker does not operate as described, please consult the troubleshooting table in the [Troubleshooting](#) section.



Note: While the Cubes demo utility is an excellent way to become familiar with the features of the tracker, it has some limitations as a data collection tool. For example, it is not possible to obtain the full update rate from the tracker (typical update rates from Cubes are about 60Hz). If regular, consistent sampling and full update rates are required for your application, consider starting with the source code for our [GetSynchronousRecordSample](#) application, and modifying it to meet your application needs.



# Configuration and Basic Operation

*A method for configuring the trakSTAR 2 is presented in this chapter, along with a description of the basic operating characteristics and factors that affect performance.*

When the trakSTAR 2 is configured at the factory, settings are optimized to meet the needs of most applications. However, you may find it helpful to customize the power-up behavior of the tracker to better meet your specific requirements.

Follow these steps to customize your tracker:

3. Review the list of configurable default settings.
4. Determine which (if any) of the settings you would like to change.
5. Follow the steps in the [Changing Your Settings](#) section to change the power up defaults with the driveBAY 2 Utility.

## Default Configuration

The following settings are installed as power-up defaults. The **driveBAY 2 Utility** included on the CD-ROM may be used to alter this default power-up configuration for both the **driveBAY 2** and the **trakSTAR 2** tracking systems. Those settings not accessible with the driveBAY 2 Utility may be changed during normal operation, through the appropriate software command.

Note that settings are divided into 2 sections. These sections reflect the settings appropriate for the type of transmitter that is used.

- **Dipole Settings (Table1):** These are the default settings that the tracker will use when a Dipole transmitter is detected on power-up. Dipole transmitters include the **Short Range** (SRT), and **Mid-Range** (MRT) transmitters.
- **NonDipole Settings (Table2):** These are the default settings that the tracker will use when a NonDipole transmitter is detected on power-up. NonDipole transmitters include the **5DOF/6DOF Flat** (Flat9), **5DOF/6DOF MAGnet** (MAG), **5DOF/6DOF miniMAG** (miniMAG) transmitters.

**Table 1 Power Up Default Dipole Settings:**

<b>Feature</b>	<b>Setting</b>	<b>Utility</b>	<b>SW call</b>
<u>System Settings:</u>			
Baud Rate: (RS232 only)	115200		
Sync Mode:	Internal	✓	
Multi-Unit ID	0	✓	
Measurement Rate:	80.0 Hz	✓	✓
	 Note: that the Available Update Rate is always X times the measurement rate, where X is 3 for the SRT and MRT transmitters.		
Scale:	SRT and MRT Systems: 36 inches	✓	✓
Sleep on Reset:	Enabled	✓	
Full POST on Reset:	Disabled	✓	
Enable LED:	Enabled	✓	
Power Line Freq:	60Hz	✓	✓
Report Rate:	1	✓	
Commutation:	Disabled	✓	✓
<u>Transmitter Settings:</u>			
Reference Frame (deg):	az = 0, el = 0, rl = 0	✓	✓
Enable XYZ Reference Frame	Disabled	✓	✓
<u>Sensor Settings (per port)</u>			
Hemisphere:	Front	✓	✓
Sensor Offsets (deg):	x = 0, y = 0, z = 0	✓	✓
Angle Align (deg):	az = 0, el = 0, rl = 0	✓	✓
Data Format:	POSITION/ANGLE	✓	✓
AC Wide Notch:	Enabled	✓	✓
AC Narrow Notch:	Disabled	✓	✓
Adaptive Filter (DC):	Enabled	✓	✓
Alpha Min:	0.02	✓	✓
Alpha Max:	0.90	✓	✓
Vm Table:	2, 4, 4, 4, 4, 4, 4, 4, 4, 4	✓	✓

**Table 2 Power Up Default NonDipole Settings:**

<b>Feature</b>	<b>Setting</b>	<b>Utility</b>	<b>SW call</b>
System Settings:			
Baud Rate: (RS232 only)	115200		
Measurement Rate:	42.0 Hz  <div style="border: 1px solid black; padding: 5px;">  <b>Note:</b>  <b>The Available Update Rate for Flat9 transmitter is always: 42 x9 = 378 updates/sec</b>   <b>Available Update Rate for MAGnet and miniMAG transmitters is always: 42x12 = 504 updates/sec</b> </div>	✓	✓
Scale:	36 inches	✓	✓
Sleep on Reset:	Enabled	✓	
Full POST on Reset:	Disabled	✓	
Enable LED:	Enabled	✓	
Power Line Freq:	60Hz	✓	✓
Report Rate:	1	✓	
Commutation:	Disabled	✓	✓
<u>Transmitter Settings:</u>			
Reference Frame (deg):	az = 0, el = 0, rl = 0	✓	✓
Enable XYZ Reference Frame	Disabled	✓	✓
<u>Sensor Settings (per port)</u>			
<b>Algorithm</b>	6DOF  <div style="border: 1px solid black; padding: 5px;">  <b>Note:</b>  <b>This setting must be changed to 5DOF to utilize sensors connected to the 5DOF Junction Box. See below</b> </div>	✓	
Hemisphere:	NonDipole transmitters only operate in FRONT hemisphere		
Sensor Offsets (deg):	x = 0, y = 0, z = 0	✓	✓
Angle Align (deg):	az = 0, el = 0, rl = 0	✓	✓

Feature	Setting	Utility	SW call
Data Format:	POSITION/ANGLE	✓	✓
AC Wide Notch:	Enabled	✓	✓
AC Narrow Notch:	Disabled	✓	✓
Adaptive Filter (DC):	Disabled	✓	✓
Alpha Min:	0.02	✓	✓
Alpha Max:	0.90	✓	✓
Vm Table:	400, 1, 1, 1, 1, 1, 1, 1, 1	✓	✓

## Configurable Power-up Settings:

Here is an explanation of the power-up settings that can be re-configured using the driveBAY 2 Configuration Utility.

**Table 3 Configurable Power Up Settings**

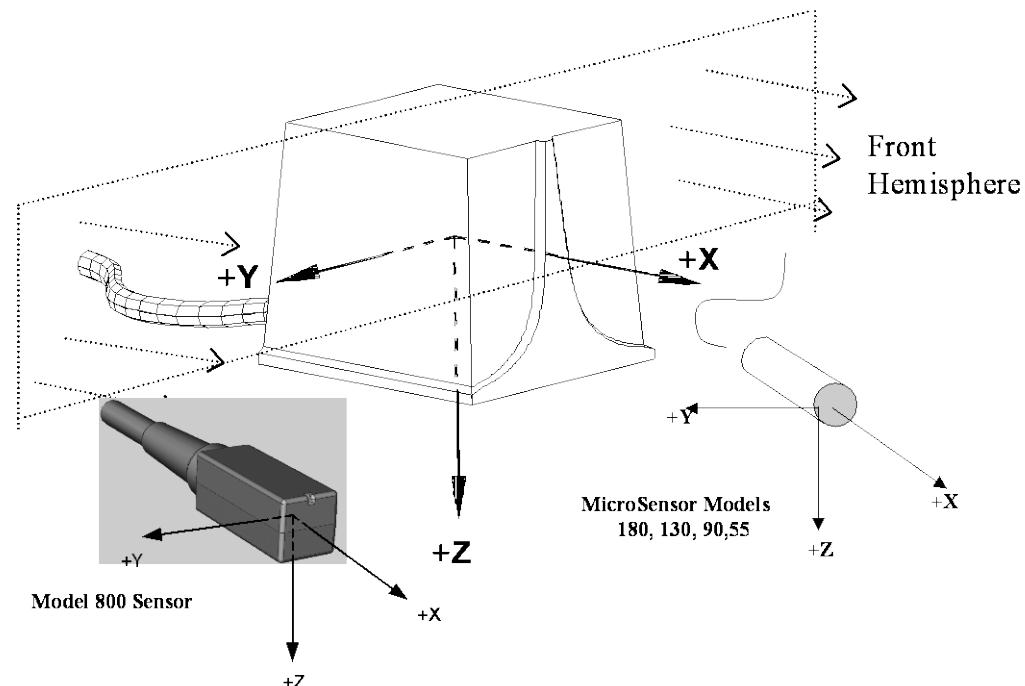
Setting	Description
Baud Rate	<p>Establishes the default RS232 communication rate for power-up. Only supported Baud Rate for the system is 115200.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  <b>Note:</b> Currently the only supported Baud Rate for RS232 communication is 115200.         </div>
Sync Mode	<p>This setting establishes the mode the tracker should use for synchronization of data acquisition. Note that the Internal mode is used for both stand-alone and multi-unit configurations, where one of the tracker units establishes the data synchronization signal internally.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  <b>Note:</b> Multi-Unit synchronization (MUS) not supported at this time.         </div>
Multi-Unit ID	<p>In multi-unit tracker configurations (i.e. 5-16 sensors), this setting lets the tracker know how the 4 attached sensors should be enumerated for the 3DGGuidance API. Sensors connected to the unit with an ID of 0 will be enumerated 0 through 3, sensors connected to the unit with an ID of 1 will be enumerated 4 through 7, etc. See the Multi-Unit Sync Installation Guide Addendum (included with the installation) for details.</p>

Setting	Description
Measurement Rate	Sets the acquisition rate for the system. This can be altered to optimize susceptibility to distortion from certain metals. See <a href="#">Performance Factors</a> section below.
Scale	Sets the scale factor used by the tracker to report the position of the sensor with respect to the transmitter. Valid values of 36, 72, and 144 represent the full-scale position output <u>in inches</u> .
Sleep on Reset	When enabled, this setting will cause the <b>trakSTAR 2</b> to enter SLEEP mode after completing a reset or following power-up. In the SLEEP mode, the transmitter is turned off, but the unit will continue to respond to commands. Issue the RUN command (or 3DG guidance API equivalent) to resume normal operation.
Full POST on Reset	<p>When enabled, this setting will cause the tracker to run through the extended Power On Self Test (same POST that the tracker normally executes on power-up) every time the tracker is reset. By default, the tracker will perform a reset for every call to <a href="#">InitializeBIRDSystem</a> (Note that this assumes that default ATC3DG.ini setting has been left as: reset = yes. See the <a href="#">System Parameter RESET</a> for details). For Dipole Transmitter configurations, this ‘Cold-start’ reset with extended POST takes about 18 seconds to complete for a single unit. The ‘warm-start’ reset that results with this setting disabled (default) takes about 6 seconds.</p> <p>The reset for ‘programmed’ Non-Dipole Transmitter configurations takes about 12seconds. When a Non-Dipole Transmitter and electronics unit are paired for the very first time, this time extends up to 2 min. See the <a href="#">LED Definitions</a> table in Chapter 7 for more information</p>
Enable LED	By default, the tracker will illuminate/flash the front panel LED to help indicate status. Disabling this setting will cause the LED to be turned off as soon as the initial POST has completed.
Power Line Freq	Sets the frequency (in Hertz) of the AC Power Source that the tracker should assume is in use. Valid values include 60 and 50Hz.
Report Rate	Output rate divisor setting. Reduces the number of records output during STREAM mode (also set by the <a href="#">GetSynchronousRecord</a> call), to that determined by the setting. Default setting of 1 makes all outputs available.
Commutation	This is an alternate acquisition mode utilized by the tracker when running integrated sensor modules (i.e. M1525). This mode should be disabled unless running these integrated sensor types. Note that the system’s sensitivity to conductive metal will increase slightly when it is being used.
Reference Frame	The default <b>trakSTAR 2</b> Reference Frame is defined by the Transmitter’s X, Y, and Z axes (see <a href="#">Figure 26</a> ). This Reference Frame setting allows you to enter the angles required to mathematically align the axes of the Transmitter to those of a new reference frame.

Setting	Description
Enable (XYZ) Reference Frame	The angles entered in the Reference Frame fields will only specify a new reference frame for measuring orientation angles. If you need the XYZ position measurements to correspond to the new reference frame then enable this setting.
<b>SENSOR SETTINGS</b>	
Algorithm	<p>When using a non-dipole (flat) transmitter, each sensor port can either track a single 6DOF sensor or up to three 5DOF sensors, connected to the unit via a Junction Box. The tracking mode is chosen at startup based on this setting. There are three options:</p> <ul style="list-style-type: none"> <li>• 6DOF - the port always computes a 6DOF tracking solution; A solution with six degrees of freedom (6DOF), includes three positional coordinates (X,Y,Z) and three orientation angles <ul style="list-style-type: none"> <li>○ Azimuth – rotation about Z sensor axis</li> <li>○ Elevation – rotation about Y sensor axis</li> <li>○ Roll – rotation about X sensor axis</li> </ul> </li> <li>• 5DOF – the port always computes a 5DOF tracking solution; A solution with five degrees of freedom (5DOF), includes three positional coordinates (X,Y,Z) and two orientation angles <ul style="list-style-type: none"> <li>○ Azimuth – rotation about Z sensor axis</li> <li>○ Elevation – rotation about Y sensor axis</li> </ul> </li> <li>• Auto – the port will configure itself at startup based on what sensor is plugged into the port. A 6DOF sensor will cause the port to be configured for 6DOF tracking. A 5DOF sensor or no sensor will cause the port to be configured for 5DOF tracking. Once the port is set on power-up, it cannot be changed without restarting the tracker.</li> </ul>
Hemisphere	<p>This parameter is used to tell the <b>trakSTAR 2</b> in which hemisphere, centered about the transmitter, the sensor will be operating. For Dipole transmitter types, there are six hemispheres from which to choose: the FRONT (forward), BACK (rear), TOP (upper), BOTTOM (lower), LEFT, and the RIGHT. If no HEMISPHERE parameter is specified, the FRONT is used by default.</p> <p><b>NOTE:</b> NonDipole transmitters (Flat, MAGnet, miniMAG) only support the FRONT hemisphere.</p>

Setting	Description
Sensor Offsets	Default position outputs from the trakSTAR 2 represent the X, Y, and Z position of the magnetic center of the sensor coil (approximate center of sensor housing) with respect to the transmitter origin. The Sensor Offsets allow you to configure the position outputs such that the tracker is reporting the position of a location that is offset from the center of the sensor. See the Sensor Parameter type <a href="#">SENSOR_OFFSETS</a> for details.
Angle Align	The Angle Align settings allow you to mathematically align the sensor's coordinate frame to the coordinate frame of the object being tracked. This is beneficial if you find that, when a sensor(s) is mounted to the object you are tracking, the angle outputs are not zero when in the normal 'resting' position.
Data Format	Sets the default data format for returned data records. Many data formats are available from the tracker – See <a href="#">Data Format Types</a> for details
AC Wide Notch	The AC WIDE notch filter refers to an eight-tap finite impulse response (FIR) notch filter that is applied to the sensor data to eliminate sinusoidal signals with a frequency between 30 and 72 hertz.
AC Narrow Notch	The AC NARROW notch filter refers to a two tap FIR notch filter that is applied to signals measured by the tracker's sensor. Use this filter in place of the AC WIDE notch filter when you want to minimize the delay between trakSTAR 2's measurement of the sensor's position/orientation and the output of these measurements. The transport delay of the AC NARROW notch filter is approximately one third the delay of the AC WIDE notch filter.
Adaptive Filter	<p>When set to ON, an adaptive low pass filter is applied to the sensor data to eliminate high frequency noise. For Dipole transmitter configurations, this filter is usually required in the system unless your application can work with noisy outputs.</p> <p>When the filter is ON, you can modify its noise/lag characteristics by changing ALPHA_MIN, ALPHA_MAX and Vm. See the Interface Reference Chapters for details.</p> <p><b>NOTE:</b> Non-Dipole transmitter configurations (Flat9, MAGnet, miniMAG) should not be run with this filter enabled, as the Kalman Filter utilized in the Non-Dipole solution has similar properties and enabling this Adaptive filter there will only add latency.</p>
Kalman Filter	These parameters are used to tune the static and dynamic tracking performance when using non-dipole transmitters. Most of these settings should be altered by the factory only. If you think that tuning these parameters may be appropriate for your application, please contact us first.

## Default Reference Frame



**Figure 32 Default Transmitter/Sensor Coordinate Frames**

**NOTE:** The origin of the Mid and Short Range Transmitters' default Reference Frames are defined to be at a location approximately in the center of the transmitter coil set. This location is approximately (with respect to the housing surfaces):

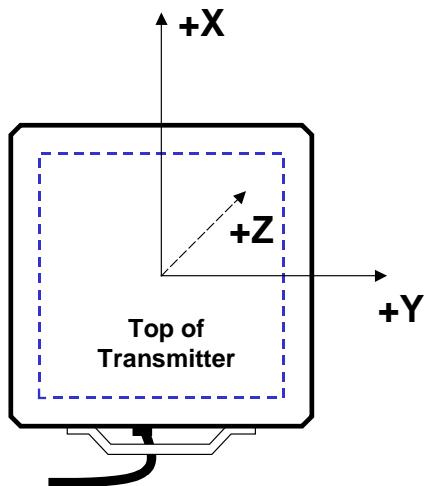
Mid-Range:

- 1.88 " from bottom left edge
- 1.60 " from the top face
- 1.80 " from bottom front edge

Short Range: (cable exits lower rear face) -

- 1.1 " from bottom front edge / 1.51" from bottom rear edge
- 0.90 " from the top face
- 1.02" from bottom left edge

## Flat Transmitter



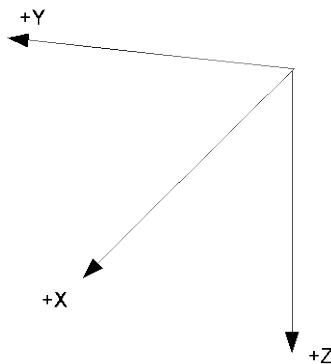
**Figure 33 Flat Transmitter Coordinate Frame**

### 5DOF/6DOF Axis Flat Transmitter Origin:

In the middle of the square that defines the top surface

- 11.0 " from left/front edge
- 11.0" from right/rear edge
- 0 " from the top face

## MAGnet Transmitter



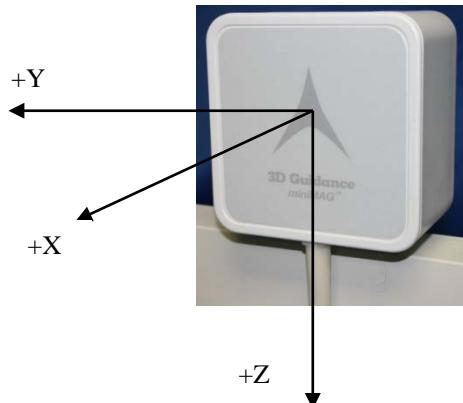
**Figure 34 MAGnet Transmitter Coordinate Frame**

### 5DOF/6DOF MAGnetTransmitter Origin:

In the middle of the square that defines the top surface

- 4.0 " from left/right edge
- 4.0" from top/bottom edge
- 0 " from the top face

miniMAG Transmitter

**Figure 35 miniMAG Transmitter Coordinate Frame**

5DOF/6DOF MAGnetTransmitter Origin:

- 4.0 " from left/right edge
- 4.0" from top/bottom edge
- Approx. -1.0 " from the top face (inside the transmitter)

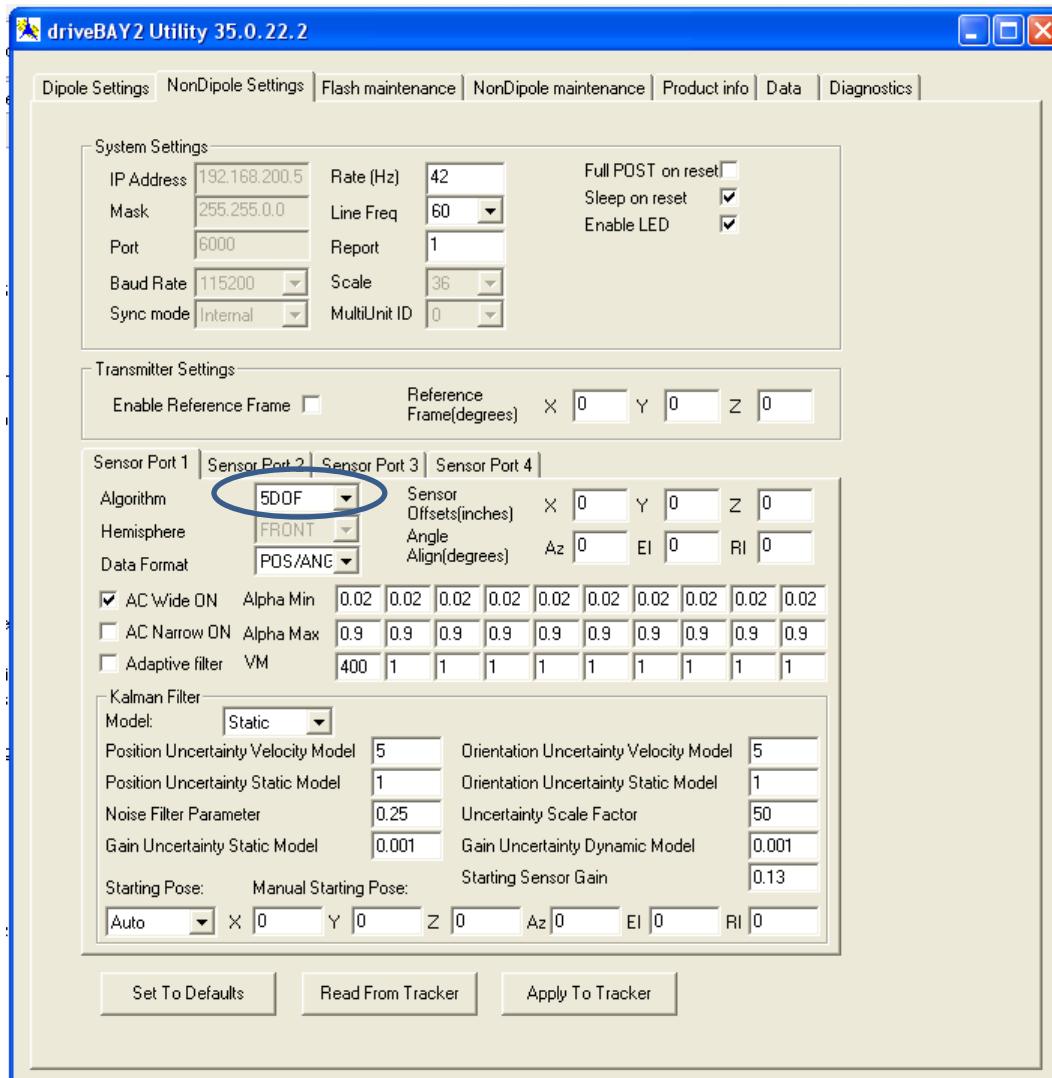
## Changing Your Settings

The **driveBAY2 Utility** may be used to alter power-up defaults for **driveBAY 2** and **trakSTAR 2** systems. See [Appendix I: driveBAY 2 Utility](#) for full details on using the Utility.

### Configuring for 5DOF Operation

The default configuration for the **driveBAY 2** and **trakSTAR 2** front panel sensor ports is to return a 6DOF solution (for 6DOF sensors). However, the units can also be setup to run 5DOF sensors as follows:

- 1) Power on the tracker, connect to your host PC, and run the **driveBAY2 Utility**.
- 2) On the '**NonDipole Settings**' tab, find the Sensor tab for the front panel connector that you'd like to use for your 5DOF sensor connections (i.e. Sensor Port 1,2,3, or 4).
- 3) Change the following setting to utilize your 5DOF sensor (see [Figure 36](#) below):
  - a. Algorithm : **5DOF**
- 4) Click 'Apply to Tracker' to change these power-up default settings, and re-boot the tracker.



**Figure 36 Changing settings for 5DOF operation on Sensor Port1**

- 5) If you'll be running more than one 5dof sensor in the same port (i.e. 3-sensor Junction Box), then you'll also want to change the default AUTOCONFIG parameter. Read the next sections [Sensor Mapping](#) and [AUTOCONFIG](#) for details.

## Sensor Mapping

The electronics unit of the tracking system has four sensor ports (connectors) on the front panel. On each of these, a user can pre-configure the the sensor port to optionally connect:

- A single six degree of freedom (6DOF) sensor
- A single, double or triple five degree of freedom (5DOF) sensor
- A 5DOF Junction Box (containing one, two or three 5DOF sensors)
- No sensor –connector port left blank

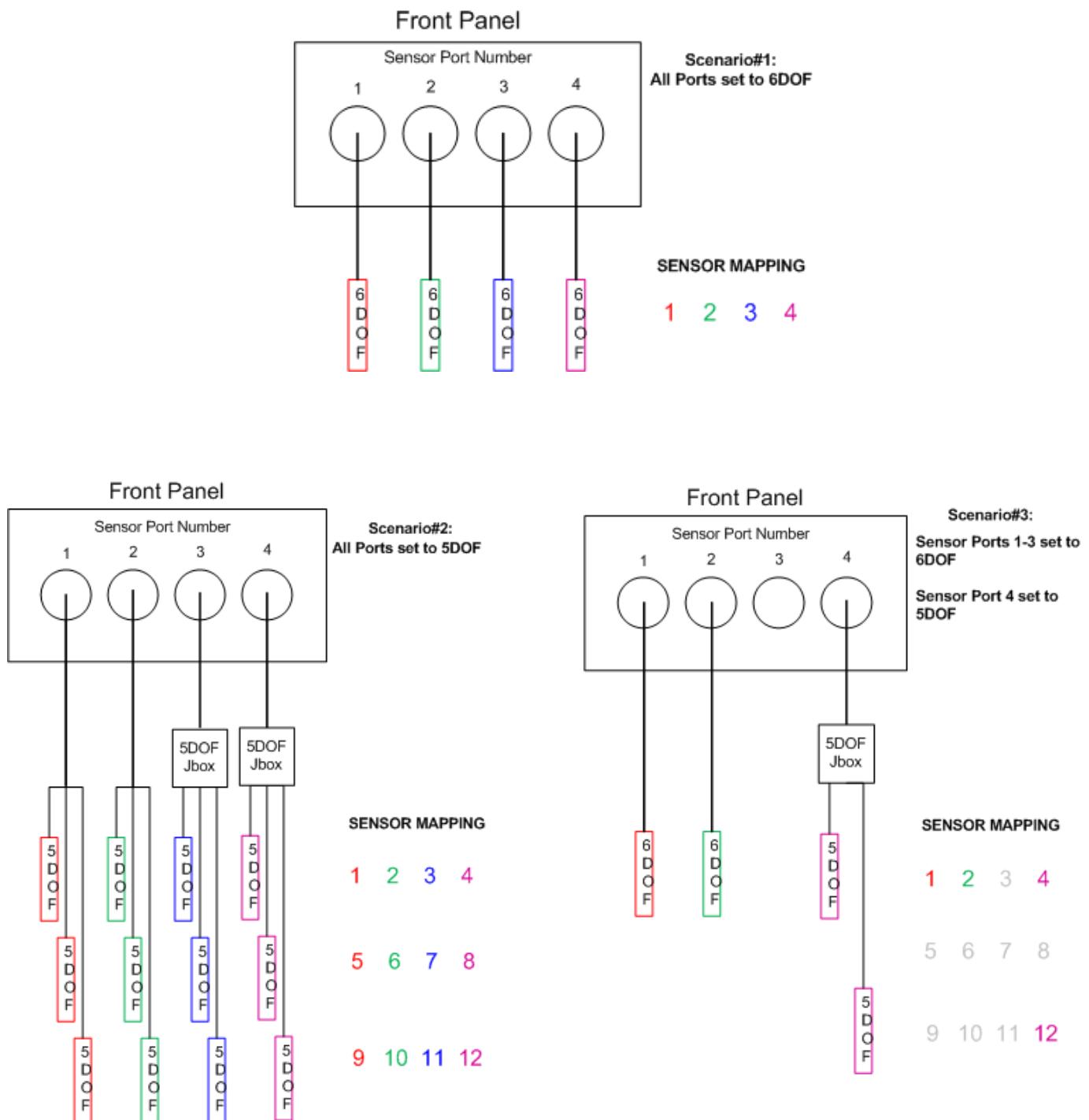
This allows a total from 1 to 12 tracked object channels to be supported by the system.

The question is how does an application make the association between the physical tracking device (the sensor) and the logical channel number?

The tracking system addresses this by assigning **Fixed Sensor ID** numbers to the tracking device(s) plugged into a connector. This ‘sensor mapping’ is as shown in [Figure 37](#) below.

The figure shows three scenarios

- Scenario#1:
  - All sensor ports have been pre-configured for 6DOF sensors;
  - All ports are full.
- Scenario#2:
  - All sensor ports have been pre-configured for 5DOF sensors;
  - 2 contain 5DOF sensors that share a single front panel connector;
  - 2 contain a 5DOF Junction Box with three 5DOF sensors plugged into each slot.
- Scenario#3:
  - Sensor ports 1 – 3 have been pre-configured for 6DOF sensors;
  - Sensor port 4 has been preconfigured for 5DOF sensors
  - Sensor port 3 is empty
  - Sensor port 4 contains a 5DOF Junction Box with 2 5DOF sensors plugged into the first and third slot.



**Figure 37 Three scenarios demonstrating the Fixed ID sensor mapping**

## AUTOCONFIG

The AUTOCONFIG parameter allows the host software to specify the number of sensors the tracking system should monitor and report data for when queried. It is set to ‘4’ by default, but can easily be changed using either of the two methods listed below.

### WHEN TO USE:

The scenarios depicted in the previous section on Sensor Mapping (Figure 37), demonstrate that the host software may elect to set the AUTOCONFIG parameter differently depending on what connections are expected in the application. In Scenario #1 for example, leaving the AUTOCONFIG parameter set to ‘4’ will provide access to all possible sensors. For Scenario#2 and Scenario#3 however, the AUTOCONFIG parameter must be set to ‘12’ to access all possible sensors being tracked by the system.

For Non-Dipole configurations, 4-12 are valid values for this parameter.

When running Dipole configurations, any setting of the AUTOCONFIG parameter greater than 4 will be ignored by the system.

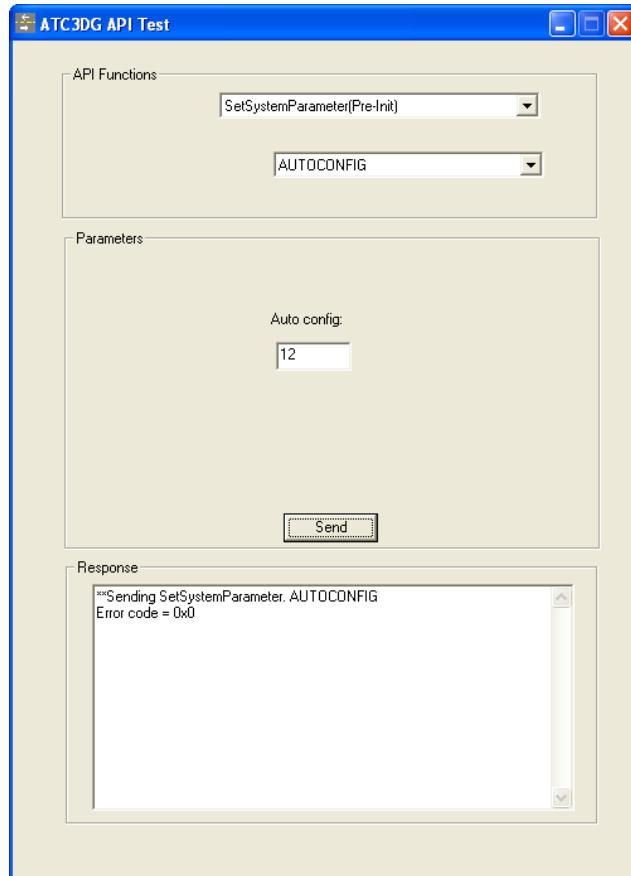
### HOW TO CHANGE IT:

- 1) Change the parameter prior to an InitializeBIRDSystem() function call, using the [SetSystem Parameter](#) Command and the AUTOCONFIG [SYSTEM PARAMETER TYPE](#).

 **Note:** See the Pre-Init Commands section for details of additional parameters that can be changed prior to Initialization.

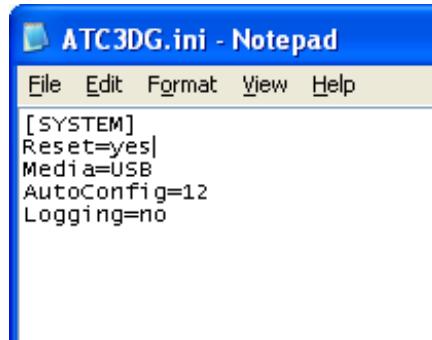
 **Tip:** Start the APITest.exe utility (from the Ascension Program Start Menu) to quickly change the AUTOCONFIG parameter.

**Figure 38 Setting the AUTOCONFIG parameter to ‘12’ using the APITest Utility**



OR:

- 2) Change the parameter directly in the ATC3DG.ini file:



**Figure 39 Setting the AUTOCONFIG parameter to '12' directly in the ATC3DG.ini file**

Per Microsoft's intent, the 3DGuidance API now places the ATC3DG.ini file in the %APPDATA%\Ascension\ATC3DG\ folder which is typically:

C:\Documents and Settings\[username]\Application Data

or

C:\Users\[username]\AppData\Roaming\Ascension\ATC3DG\

This is a hidden, but user-writable, folder. The %APPDATA% folder can be easily opened by selecting Run... from the Start Menu and entering "%APPDATA%".

## Mounting the Hardware

### Mid-Range Transmitter Mounting

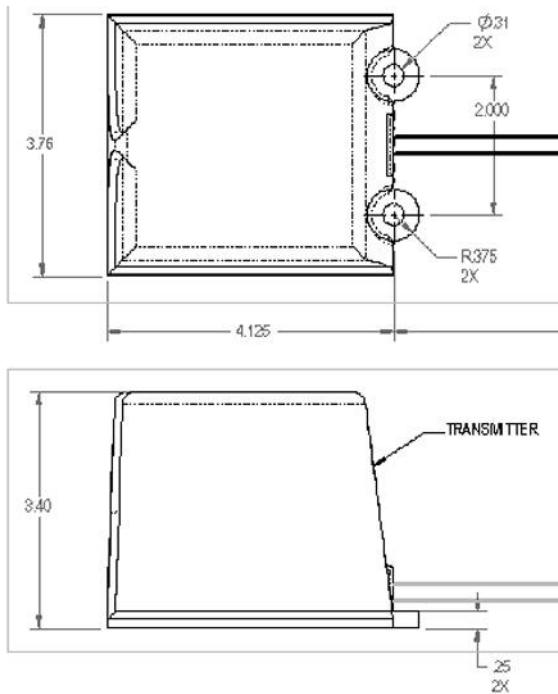
Mount the mid and short range transmitters on a non-metallic surface such as wood or plastic, using non-metallic bolts or 300-series stainless steel bolts. For optimum performance, keep the transmitter at least twenty-four inches away from the electronics unit.

The mid-range transmitter's mounting holes are not strong enough to support the transmitter's weight if it is mounted upside down. If you choose to mount the transmitter upside down, use hardware that firmly holds the flanges along both sides of the transmitter in addition to bolting the two mounting holes.

Never mount the transmitter on the floor (including concrete), ceiling, or walls. Often these surfaces contain hidden metal objects.



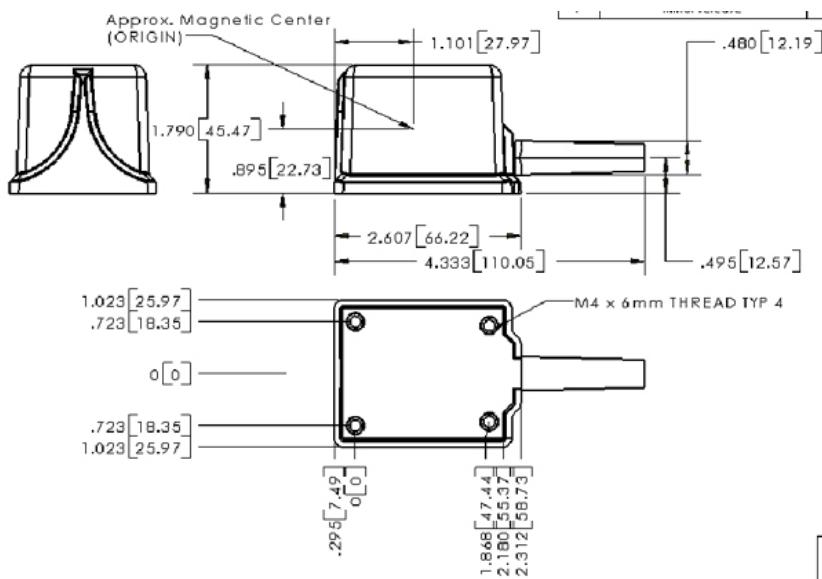
**Note:** The Mounting holes are not strong enough to hold the Mid-Range Transmitter upside down.



**Figure 40 Mid-Range Transmitter Mounting Dimensions (inches) -Top and Side Views**

## Short-Range Transmitter Mounting

Mount the short-range transmitter on a non-metallic surface such as wood or plastic, using non-metallic or 300-series stainless steel screws.



**Figure 41 Short-Range Transmitter Mounting Dimensions (inches) Top and Side Views**

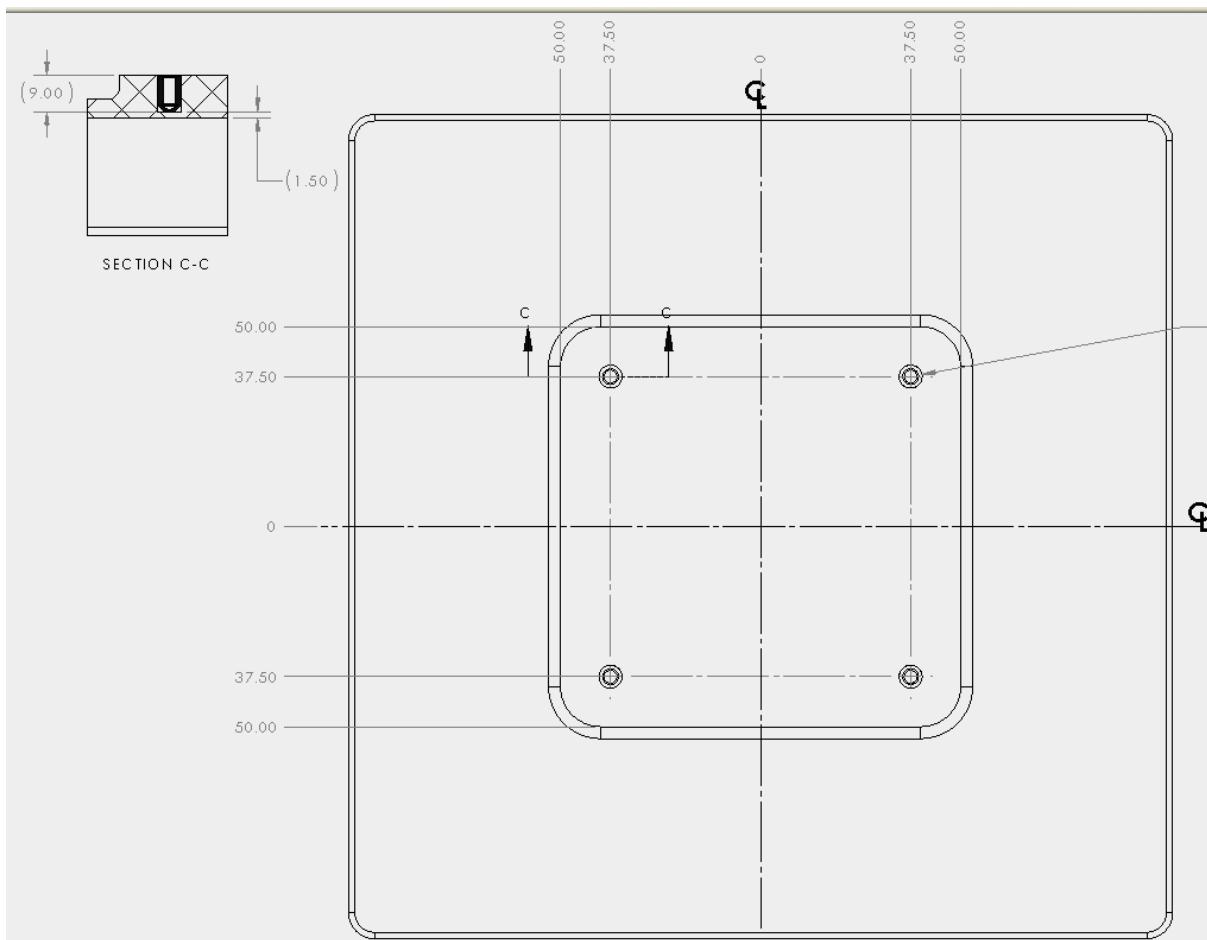
The mounting provisions for the short-range transmitter are located in the base of its housing. The four threaded inserts molded into the base material, accept an M4 threaded screw. Never mount the transmitter on the floor (including concrete), ceiling, or walls. Often these surfaces contain hidden metal objects.

## Flat Transmitter Mounting

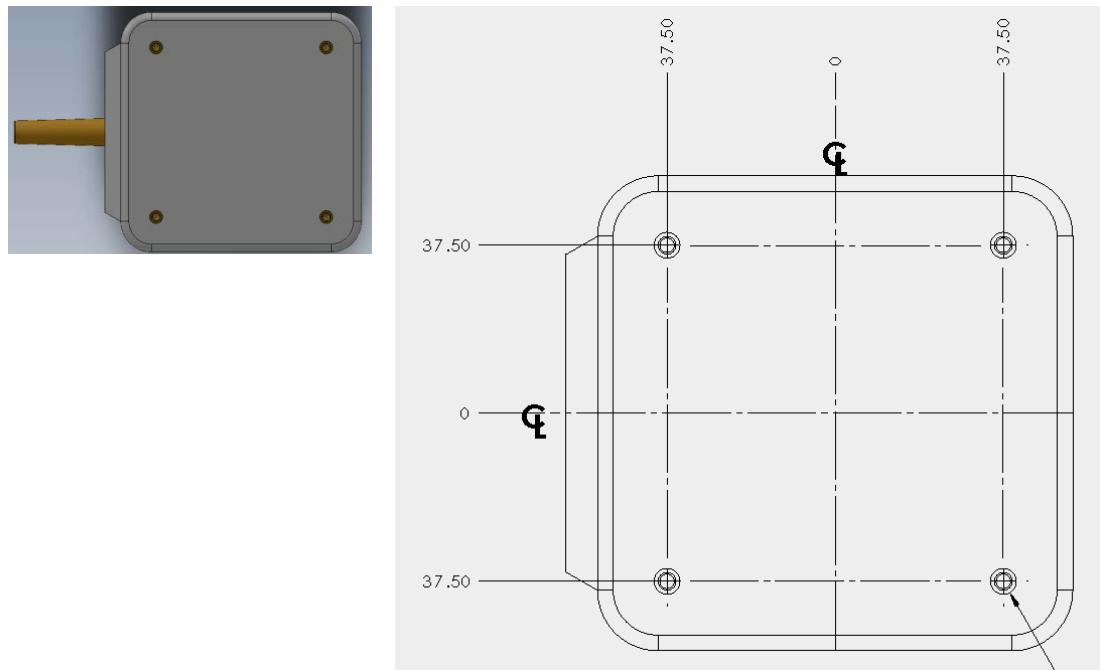
The flat transmitter should lie on an even surface such that it is fully supported. To provide optimal shielding, the flat transmitter should be positioned directly above the distorter.

## MAGnet and miniMAG Transmitter Mounting

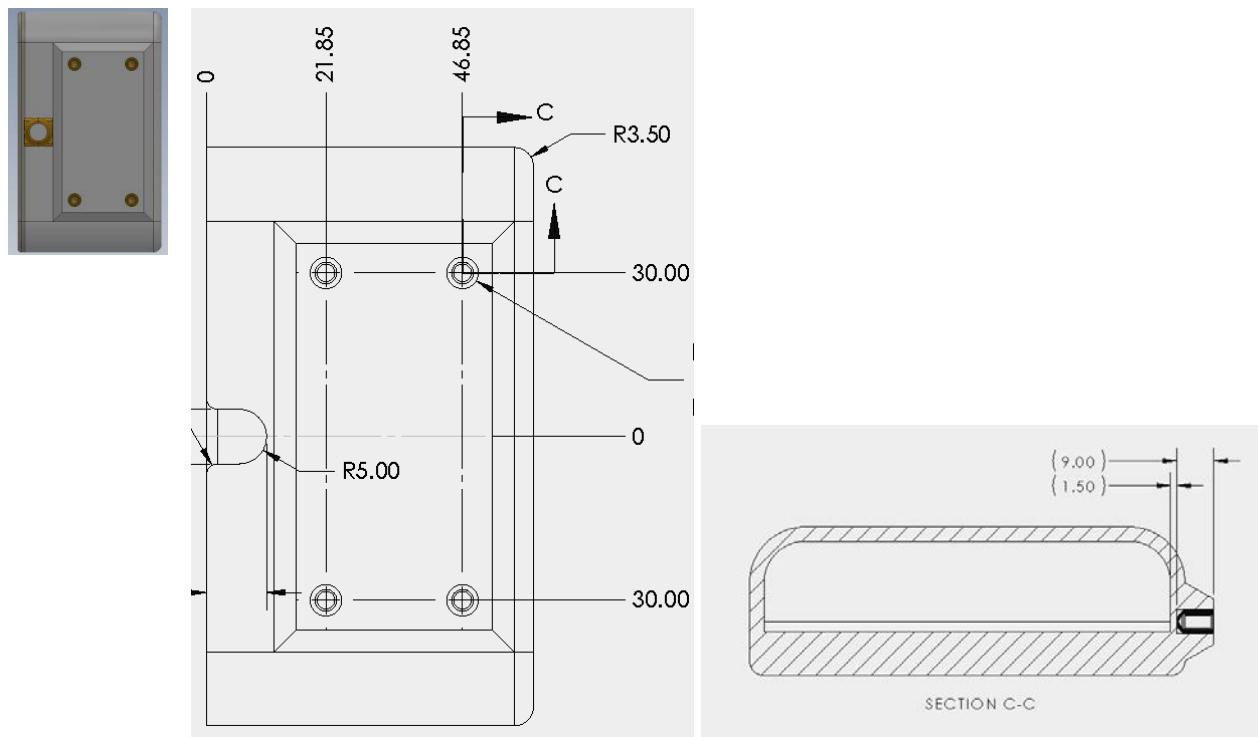
Mount the MAGnet and miniMAG transmitters to a non-metallic surface such as wood or plastic, using non-metallic bolts or 300-series stainless steel bolts. All mounting inserts sized for **M4** thread. For optimum performance, keep the transmitter at least twenty-four inches away from the electronics unit.



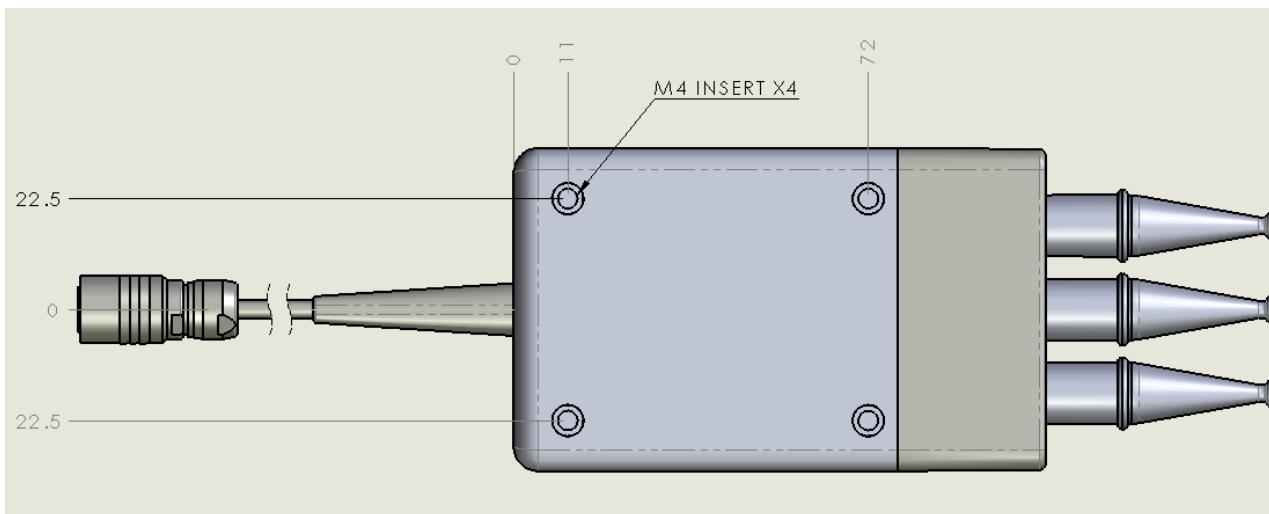
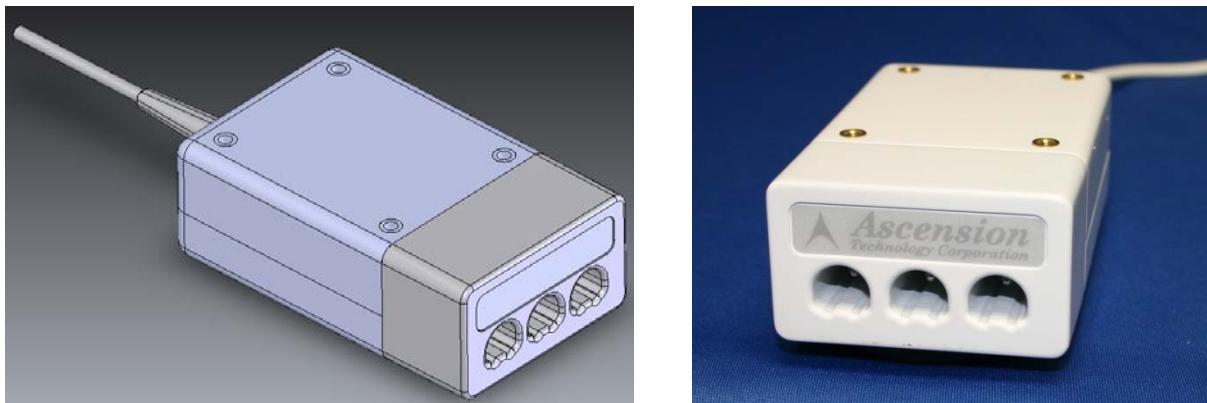
**Figure 42 MAGnet Transmitter Mounting Hole Dimensions (mm)**



**Figure 43 miniMAGTransmitter Mounting Hole Dimensions (mm);  
Rear (upper) and Bottom (lower) mounting surfaces shown**



## Junction Box Mounting



**Figure 44 5DOF Junction Box Mounting Dimensions (mm)**

## Sensor Mounting

Mount the sensors on non-metallic surfaces (such as wood or plastic). Do not place sensors near power cords, power supplies, or other low frequency current generating devices (for example, CRT displays).

The cables used in the Microsensors (Models 55, 90, 130 and 180) are designed for integration into the devices and cables of many OEM products. If using microsensors and cables independently, treat them carefully. Repeated bending, pulling, or yanking of the cable will result in damage and failure to track.

Model 800 sensors (8x8 mm) should maintain a minimum center-to-center separation distance of 1.3" (33mm). Positioning sensors too close to each other can cause distorted measurements.

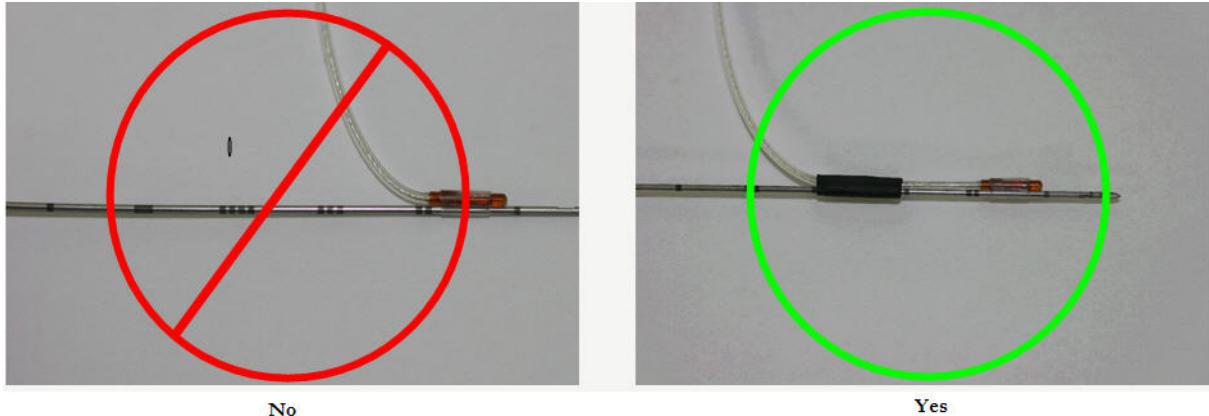
Model 130 and Model 180 sensors should maintain a minimum center-to-center separation distance of 0.47" (12mm).

Adequate strain relief should be provided for the microsensors. The junction between the sensor head and the cable is a potential failure point and bending at this junction should be prevented.

If the cable is allowed to flex or bend through a large angle at the sensor, then **the sensor will break**. Restrain the cable near the sensor head to eliminate this problem.



**Note:** To ensure proper sensor operation, treat the sensor cable very carefully.



**Figure 45 Cable Mounting Requirements**

## Electronics Unit Mounting

Mount the electronics unit on a secure flat surface such as a table or desk. If placed on a rolling cart or shelf, be sure to secure the unit with straps or fasteners, such that a tug on the cables will not allow the unit to fall on the floor.

For best performance, keep the mounted electronics unit **at least 24 inches away** from the transmitter.

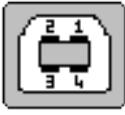
## Rear Panel Connectors

There are five connectors on the rear panel of the electronics unit.



**Figure 46 trakSTAR 2 Rear Panel Connectors**

**Table 4 trakSTAR 2 Rear Panel Connections**

Name	Description
Power	Standard 3-prong AC power inlet. Accepts power from 100 to 240V, at 50/60Hz.
RS232	This is one of the two communication interfaces for the trakSTAR 2. A pin-out and signal description of the RS-232C interface is included in Chapter 6. Note that the tracker requires connections only to pins 2, 3 and 5 of the 9-pin interface connector.  Note: See the <a href="#">RS232 Signal Description</a> in Chapter 6.
USB	The USB 2.0 connector is a standard USB TYPE B -Female for peripheral devices. PIN: 1: VCC +5VDC PIN: 2: DATA- PIN: 3: DATA+ PIN: 4: GROUND   <b>B</b>
Switch	The SWITCH connector may be used as an input from any analog switch. The contact closure (such as a button or footswitch) should be connected between the center conductor and the barrel of a mating BNC connector, and exhibit less than 50 ohms total when in the closed position. To be correctly detected and reported by the unit, the switch must be closed for not less than 17mS.  Note: See the API reference section for data formats that support the Button  

Name	Description
UNIT SYNC	<p>This connector is used in Multi-Unit Sync (MUS) configurations, for synchronizing the data acquisition across multiple electronics units. Up to 4 electronics units can be synchronized, providing tracking for up to 16 sensors simultaneously. See the MUS Installation Guide Addendum for details on the setup and checkout of these MUS configurations.</p> <p> <b>Note:</b> Multi-Unit Sync (MUS) not active at this time</p>



## Basic Operation

The tracker determines six degrees-of-freedom (6DOF) position and orientation (X, Y, Z, Azimuth, Elevation, and Roll) of one or more sensors referenced to a fixed transmitter. In five degree of freedom (5DOF) sensor tracking, the Roll angle of the orientation is omitted. The transmitter sequentially generates magnetic fields and the sensor instantly measures the transmitted field vectors at a point in space. From theoretical knowledge of the transmitted field, the tracker accurately deduces the real-time location of the sensor(s) relative to the transmitter. The **trakSTAR 2** tracker is designed to work with two basic types of transmitters: Dipole and NonDipole.

### Dipole Transmitters

Three Dipole transmitter options are available with **trakSTAR 2**.

The Short-Range, Mid-Range, and Wide-Range transmitters consist of a high permeability core with three concentric sets of coils, each coil having an axis at right angles to the other two. Magnetic fields along the X, Y, and Z axes of the transmitter are created when current flows in their respective windings. The strength of the magnetic field is highest near the transmitter and falls off with the cube of distance from the transmitter.

The transmitted field of a given axis has a trapezoidal magnitude characteristic as a function of time. Each of the three coils in the dipole transmitter are sequentially energized in this manner during each measurement cycle.

Only 6DOF sensors can be used with dipole transmitters.

### NonDipole Transmitters

Non-dipole transmitters contain 9 (Flat) and 12 (MAGnet and miniMAG) coils arranged in complex geometries within their respective housings. They employ advanced tracking algorithms to track sensors in the volume above (in front of) their surfaces. Algorithms and proprietary construction techniques in the 5DOF/6DOF Flat are designed to shield the tracking volume from magnetic distorters below the transmitter and prevent performance degradation.

NOTE: The construction of the MAGnet and miniMAG transmitters does NOT provide this shielding.

Both 6DOF and 5DOF sensors can be used with all non-dipole transmitters.

### 6DOF Sensor

A 6DOF sensor uses three receiving coils to measure and provide a tracking solution that includes the position in three dimensions and the orientation of the three sensor axes relative to the tracker reference frame. 6DOF sensors are factory-calibrated and the calibration data is stored on a memory chip in the sensor's connector housing. This calibration information is read by the electronics unit upon power-up, and when a hot-swap of a sensor into a sensor port is detected.

## 5DOF Sensor

A 5DOF sensor uses a single receiving coil to measure the position in three dimensions and the pointing direction of the sensor relative to the tracker reference frame. The roll of a 5DOF sensor is not tracked. 5DOF sensors utilize a proprietary run-time calibration. Identifying data such as part number and serial number are stored in a memory chip in the sensor's connector housing. Because of the simplicity of their design, 5DOF sensors can be fabricated in much smaller form factors than 6DOF sensors.

## Electronics Unit

In addition to computing tracking solutions, the electronics unit, contains the transmitter drive circuitry, sensor signal processing, power conditioning, and host interface functions.

The transmitter drive is a precision current source, with a maximum output of 3.0A. The system detects the absence of a transmitter by monitoring the current. If current is interrupted, the transmit driver will turn off until a valid transmitter EEPROM is detected. This ensures that the connector is de-energized when open. Also, the transmitter is fault-protected for ground shorts. In the event of a short to ground on any transmitter pin, no damage will result to the tracker and no excessive current hazard conditions will occur.

The sensor signal processing circuitry acquires the signal from the sensor (each of the receiving coils) for each of the transmitter coils and continuously converts it to a digital value during the entire transmitter axis time. This input digital value is summed in an accumulator (digital integrator) and the final value is output and used by the algorithm. The sensor connector is also fault protected for ground shorts. No damage to the system or excessive current hazards will result from shorting any sensor connector pin to ground.

The electronics unit contains up to six onboard processors:

- POServer: It handles all communications to and from the host PC. It also computes the tracking solutions when using dipole transmitters.
- Acquisition/MDSP: It performs all acquisition and digital signal processing of the sensor data.
- PODSP: When using non-dipole transmitters, an additional co-processor per sensor port computes the tracking solutions.

## Measurement Cycle

The tracking system activates transmitter coils sequentially and produces a data record (i.e. full tracking solution) following each coil measurement. Once each transmitter coil has been activated, a system measurement cycle is complete and a new cycle begins. Thus, a dipole (3-coil) transmitter running at measurement rate of 50 Hz will compute 150 tracking solutions per second.

 **Note:** The Update rate available from the tracker with a dipole transmitter is always 3 times the system Measurement Rate. See [Appendix II: Application Notes](#) for additional details.

See the Default Measurement Rate paragraph below for a discussion of measurement rate effects on performance.

## Calibration

Each component is manufactured within tight tolerances, but differences always exist between components. These differences are measured, recorded, and adjusted for by a tracking algorithm. Calibration values represent the measured difference between any particular component and the ideal for that component.

Calibration allows components to be interchanged with minimal effect on the resulting tracking values. The calibration values for each component are stored within the hardware of the individual component. For the Transmitter and Sensor, the values are stored in an EEPROM at the connector. For the Electronics unit, the calibration values are stored in an EEPROM mounted on the printed circuit board. Non-dipole Transmitters include an additional Flash memory chip in the connector.

The calibration data in each component is programmed at the factory and is read-only.

## Performance Factors

### Electromagnetic and Other Interference in Tracking

Other electrical and magnetic devices sharing the immediate near volume with the Ascension tracking device may influence tracking data.

These two factors may affect the stability of the tracking area and thus the tracking accuracy:

Excessive electrical noise

Magnetic distortion

### Noise

If the background magnetic field is not constant during the measurement cycle, the tracking data will have noise. Noise is the seemingly random jumps in position and orientation.

When the sensor is at rest, evaluation of noise in the data will show that the jumps are random and centered on a stable position. Calculation of the mean of the position data will provide the true sensor position.

### Causes of Noise

There are two types of noise in tracking data, generated from both internal and external sources. The larger of these are external sources. External sources of electrical noise may be generated by electrical motors, switching power supplies, fluorescent lighting, video CRT monitors, Uninterruptible Power Supplies, and wiring or devices which use or carry large amounts of current that vary over time.

These external factors can alter the background magnetic field from one moment to the next. This makes absolutely correct magnetic background subtraction in the tracking device impossible, resulting in slightly unstable results.

Internal sources include small variations in measurement timing, amplified electronic component thermal activity, algorithm division by very small numbers, electrical power line noise which is not fully suppressed, and other sources.

## Reducing Noise

Powering off suspect electrical equipment is often the best method of determining sources of noise. Once a source of noise is discovered, removal of the device from the area or turning the power off during tracking is effective in reducing noise. Critical equipment may be shielded as long as the shielding does not result in metal distortion (see “Distortion” section below).

Increasing the distance between the noise source and the sensor, or decreasing the sensor distance from the transmitter will reduce the noise. These actions will result in an increase of measured signal from the transmitter relative to the noise level (increased signal-to-noise ratio).

## Distortion

Distortion is a constant deviation from the correct value. The significant difference between distortion and noise is that distortion is a constant deviation as a function of position. The distorted tracking values are incorrect, and averaging the data does not improve the values.

When the sensor takes measurements in the presence of distortion, the tracking device continues to calculate position and orientation based on theoretical knowledge of the undistorted transmitted field. The resulting difference between the calculated location and orientation, and the actual location and orientation, is distortion.

## Causes of Distortion

Most often the cause of distortion is magnetic and/or electrically conductive metal near the area of tracking system operation. The ferrous magnetic property of the metal, the electrical conductivity of the metal, the physical orientation, and other physical features will all alter the level of tracking distortion.

The ferrous magnetic property of the metal will distort the transmitted magnetic field from the tracker.

The electrical conductivity of the metal may distort the transmitted magnetic field. The Ascension DC-based tracking technology has a high immunity to distortion caused by residual eddy currents. Physical factors such as electrically complete loops can sustain eddy current loops long enough to interact with the tracking field during sensor measurements.

The metal will interact with the transmitted fields, altering the field relative to the tracking system algorithm expectation.

Another common source of distortion is altered tracking components. For example, sensor and transmitter extension cables can cause a change in the electrical characteristics of the device. If this alteration is performed without the direction of Ascension, the change will not be compensated for in calibration. Any physical change to the core tracking electronic components or in the physical connection of the system has the potential of causing distortion.

## Reducing Distortion

Metal is the primary cause of distortion. Removal and reduction of the amount of metal in and around the tracking system is the most effective strategy. Sources of metal distortion cannot be shielded, as is often the case with noise sources.

Many alternatives to metal exist. Structural fiberglass, plastics, woods, and ceramics are just a few of the nonmetal alternatives available for your use. Of the metals available, nonmagnetic and high electrically resistive metals are the next desirable. Some alloys of stainless steel (medical grade) can be used with the tracker resulting in no or minimal distortion. Brass and aluminum are less desirable and are not recommended, but they may be used in some situations. Care must be observed, as machined metal

may become magnetic. All metal should be tested with the tracker before being incorporated into a product or protocol that employs magnetic tracking.

We recommend that you always try to eliminate and reduce the presence of metals in your immediate tracking area. Since the tracker is not a line-of-sight device, care must be taken that the entire area around the transmitter is considered with regard to metal. The area behind and under the transmitter should be examined and modified as closely as the area between the sensor and the transmitter.

## Metal Detection

Distortion due to metal may be monitored through the use of an extra sensor mounted a fixed distance from the transmitter. Mount the fixed sensor at or near the maximum distance used by the unhindered sensors. Monitor the fixed sensor's position and orientation for significant deviations. Factors that distort the fixed sensor's measurements will distort the rest of the system. The application should flag the user during one of these distortion events.

## Quality/Metal Number

Alternatively, you may wish to experiment with the use of the QUALITY number computed by the tracker. Also referred to as the METAL error or Distortion number, this returned value gives you an indication of the extent to which the position and angle measurements are in error. See the [Quality Sensor Parameter Type](#) for details.

## Tracker as the Cause of Interference

Just as some tracker components may be subject to interference from electrical equipment in the immediate environment, so too the tracker's magnetic fields may possibly interfere with nearby electrical systems, e.g., an EKG. It is up to you to identify nearby devices and make sure their performance is not degraded when you are simultaneously using the tracker. If you or anyone in the tracker vicinity rely on life-sustaining equipment, such as a pacemaker or defibrillator, be sure to consult with a physician prior to powering up this tracking device.

## Factors in Tracker Accuracy

### Warm-up

As with most electrical components, the tracker goes through a period of drift before it reaches a thermal equilibrium. **trakSTAR 2** is designed to meet accuracy specifications within five minutes of power up. For effective warm up, the system must be active.

A previously unused sensor may be swapped without concern of sensor warm-up or drift.

### Measurement Rate

Usually you will track motions using our default measurement rate. However there are times when you may wish to adjust it higher or lower. Here are a few examples:

The application requires a specific measurement rate (e.g. must be in synchronization with video update rate or another measurement tool).

The environment is electrically unstable at the default measurement rate or significantly more stable at another measurement rate.

## Equipment Alteration

Each tracking component has been calibrated to measure the difference between it and the ideal component of that type. This calibration information is stored on an EEPROM in the respective component.

Any alteration that will affect the electrical properties of a component or change the access to the calibration data should be avoided. Changes in cable length through addition of an extension cable, adding a connector, or cutting and shortening any cable will result in tracking problems. Altering any of the board jumpers or dipswitch settings will degrade accuracy. Changing any component on the tracking board will degrade accuracy.

## Power Grid Magnetic Interference

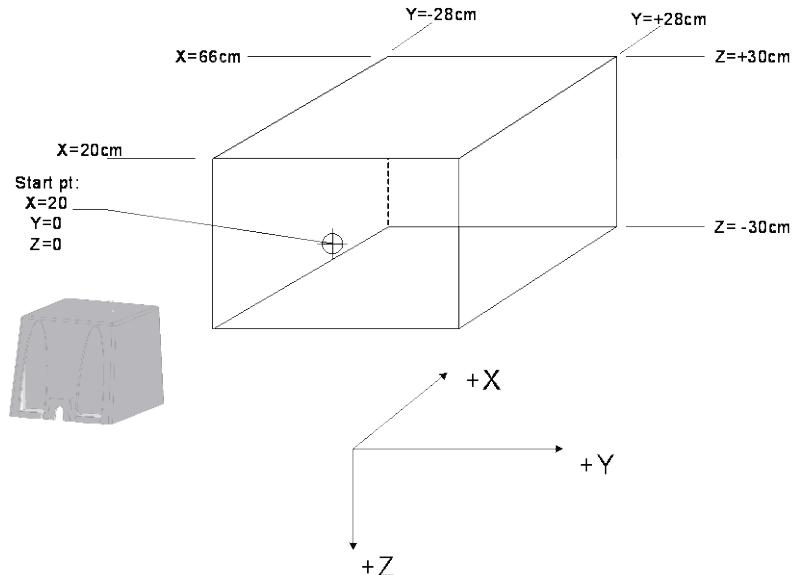
The power grid frequency in North America is 60 Hz. In Europe it is 50Hz. Magnetic radiation from the power grid can interfere with the tracking system.

Advanced software filters are implemented in the **trakSTAR 2** to reduce this effect without compromising dynamic performance, but the power line is still a potential source of tracker noise. . Highest performance will be achieved by operating the system away from walls, floors, or other structures in which electrical wiring is routed. Also, high current devices such as heaters, motors, and transformers should be kept as far away from the system as practical. The filters used to reduce power grid magnetic interference require the correct power line frequency value to operate effectively. Make sure you input the correct frequency to the **trakSTAR 2** through the API.

## Performance Motion Box

All tracking components are subjected to a calibration procedure that optimizes performance over a given region. This region is referred to as the **Performance Motion Box**

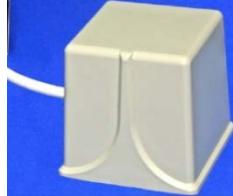
In these regions, tracking accuracy is the greatest. If you are developing an application that requires high tracking accuracy, be sure to position the transmitter such that critical measurements are taken in these regions. Tracking outside the box may not yield results with equivalent accuracy. Dimensions of the Performance Motion Box for each transmitter sensor combination are listed below.



**Figure 47 Performance Motion Box – MRT and Model 800 (8 mm) Sensors**

## Dipole Transmitters

**Table 5: Performance Motion Box for Dipole Transmitters**

6DOF SENSOR OPTIONS	DIPOLE TRANSMITTER OPTIONS - FOR 6DOF SENSORS	
	<b>PERFORMANCE MOTION BOX</b> (Translation Range for Spec Performance) (Static Accuracy: Position = 1.4mm RMS/Orientation = 0.5° RMS) Volumes are in the FORWARD Hemisphere only Dimensions listed are from the Transmitter <a href="#">Origin</a> (center)	
MID-RANGE TRANSMITTER MRT	SHORT-RANGE TRANSMITTER SRT	
		
MODEL 55	X: 16-32cm Y: ±10cm Z: ±10cm  *Note -Recommended max range for the Model 55 sensor with the MRT is 25cm (10")	Not recommended
MODEL 90	X: 20-36cm Y: ±20cm Z: ±20cm  *Note -Recommended max range for the Model 90 sensor with the MRT is 36cm (14")	Not recommended
MODEL 130	X: 20-36cm Y: ±20cm Z: ±20cm	Not recommended
MODEL 180	X: 20-51cm Y: ±23cm Z: ±15cm	Not recommended
MODEL 800	X: 20-66cm Y: ±28cm Z: ±30cm	X: 15-41cm Y: ±12cm Z: ±12cm

## NonDipole Transmitters

**Table 6: Performance Motion Box for NonDipole Transmitters**

6DOF SENSOR OPTIONS	NONDIPOLE TRANSMITTER OPTIONS - FOR 6DOF AND 5DOF SENSORS		
	PERFORMANCE MOTION BOX (Translation Range for Spec Performance) (Static Accuracy: Position = 1.4mm RMS/Orientation = 0.5° RMS)		
	FLAT 9-COIL TRANSMITTER FLAT9 	MAGNET 12-COIL TRANSMITTER MAGNET 	MINIMAG 12-COIL TRANSMITTER MINIMAG 
	MODEL 55 10-20 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-20 cm from surface ±10 cm other 2 axes (10 cm off-set from surface)	5-12 cm off surface ±10 cm other 2 axes (5 cm off-set from surface)
MODEL 90	10-30 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-30 cm from surface ±15 cm other 2 axes (10 cm off-set from surface)	5-18 cm from surface ±10 cm other 2 axes (5 cm off-set from surface)
MODEL 130	10-40 cm off surface ±20 cm other 2 axes (10 cm off-set from surface)	10-40 cm from surface, ±20 cm other 2 axes (10 cm off-set from surface)	10-28 cm from surface ±15 cm other 2 axes (10 cm off-set from surface)
MODEL 180	10-40 cm off surface ±20 cm other 2 axes (10 cm off-set from surface)	10-40 cm from surface ±20 cm other 2 axes (10 cm off-set from surface)	10-33 cm from surface ±15 cm other 2 axes (10 cm off-set from surface)
MODEL 800	10-45 cm off surface ±20 cm other 2 axes (10 cm off-set from surface)	10-45 cm from surface ±20 cm other 2 axes (10 cm off-set from surface)	10-38 cm from surface ±15 cm other 2 axes (10 cm off-set from surface)

5DOF SENSOR OPTIONS	FLAT9	MAGNET	MINIMAG
MODEL 55	10-30 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-30 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-20 cm off surface ±13 cm other 2 axes (10 cm off-set from surface)
MODEL 90	10-30 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-30 cm off surface ±15 cm other 2 axes (10 cm off-set from surface)	10-20cm off surface ±13 cm other 2 axes (10 cm off-set from surface)
MODEL 130	10-35cm off surface ±20 cm other 2 axes (10 cm off-set from surface)	10-35cm off surface ±20 cm other 2 axes (10 cm off-set from surface)	10-20cm off surface ±13 cm other 2 axes (10 cm off-set from surface)

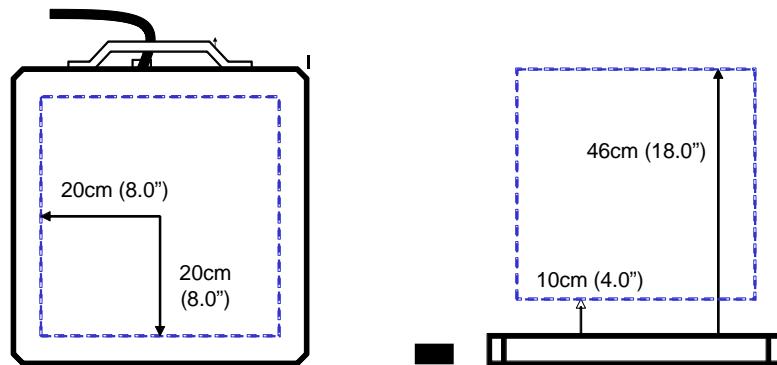
## Flat Transmitter Motion Box

When operating the tracker with a Flat Transmitter, it is important to note that the motion box for the tracked sensors is **smaller** than the area covered by the dimensions of the transmitter's housing. It also **does not start immediately above the transmitter's top surface**.

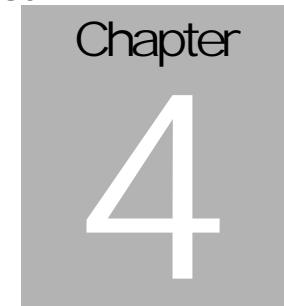
Specified accuracy with a given sensor will only be achieved over the motion boxes listed in the Table. The full Motion Box of the transmitter is:

- Motion Box **begins 10.2cm (4.0 inches) above** the top surface of the transmitter
- Motion Box is **7.6cm (3.0 inches) in from each side** of the transmitter
- Motion Box **ends 40.6cm (16.0 inches) above** the top surface of the transmitter

 **Note:** The motion box for the flat transmitter is smaller than the dimensions of the housing. Specified accuracy will only be achieved over the volumes listed in the Table.



**Figure 48 Full Motion Box – Flat Transmitter**



# Software Operation - Tools for Successful Tracking

*This chapter outlines the interface and method for communicating with the 3DG guidance tracker and lists the sample programs available for the USB and RS232 interface protocols.*

## 3DG guidance Windows API

You can communicate with the tracker via USB using our 3D Guidance Windows interface. This interface is standard in our legacy magnetic tracking products and has been continued for the new generation of 3D Guidance trackers.

If you are new to the 3DG guidance trackers and the 3DG guidance API, you will find several tools included on the CD-ROM to assist in experimenting with the tracker's capabilities and in quickly creating custom code. These tools include two demo applications, CUBES and APITest, and three utility programs containing sample C++ project files. The tables below describe both the tools available and where they can be found following software installation. See Chapter 5 [3DG guidance API Reference](#) for full details.

**Table 7 Location of API Files and Demo Applications**

API Components	Description	Location (After software installation)
ATC3DG.h	Header file that contains the definitions of the constants, structures, and functions needed to make calls to the API. Calls defined here can be used in a developer's code by including this file in the project that makes calls to the API	Program Files\Ascension\3D GuidanceXXXX\3D G API Developer\3DG API
ATC3DG.lib	Library file required during compiling of any code that makes calls to the API	
ATC3DG.DLL	Dynamic Link Library - This file is needed in the Windows System folder (or DLL search path) to support all the function calls described in the header file.	

API Components	Description	Location (After software installation)
<i>Cubes.exe</i>	<p>A Demo Windows application (32-bit) that displays tracking data (both test and graphical representation) for all sensors connected to the system. Supports the following functions:</p> <ul style="list-style-type: none"> <li>• TX On/off -turn the transmitter on or off</li> <li>• System RESET - reset/re-initialize the tracker</li> <li>• System settings - change measurement rate, line frequency, AGC mode, English vs. metric units</li> <li>• Sensor settings- change quality parameters, angle align, and filter settings</li> <li>• Transmitter - change reference frame</li> <li>• Graph Mode - Plot up to 3 parameters</li> <li>• Noise Statistics - Collects X samples and shows AVG, pk-to-pk and RMS deviation</li> </ul> <p><b>NOTE: Cubes is a demo program and should NOT be used when fast data collection is required.</b></p>	Program Files\Ascension\3D GuidanceXXXX\Applications\Cubes.exe
<i>APITest.exe</i>	<p>A Windows application that allows the user to send any command defined in the API to the tracker, and to view the associated response. All function calls and the possible arguments for those calls are selected via pull-down menus, so re-compiling/re-build is not necessary. This allows user to:</p> <ul style="list-style-type: none"> <li>• Check response to particular command without implementing it in their original code.</li> <li>• Check response using a particular non-default setting (filter, etc.) without implementing in their code.</li> <li>• Confirm/Debug hardware and their code by reproducing chosen settings and viewing response.</li> <li>• Save system settings that have been tried to an .ini file (using SaveSystemConfig call).</li> </ul> <p>NOTE: It's important to know how commands are defined and the sequence of commands to send, for this tool to be used effectively.</p>	Program Files\Ascension\3D GuidanceXXXX\Applications\APITest.exe

**Table 8 Location of Sample Utility Programs**

<b>Sample Code</b>	<b>Description</b>	<b>Location</b>
<i>Sample</i>	<p>This C++ project contains sample code for a very simple console application that demonstrates fundamental communication with the tracker using the 3DGuidance™ API. Specifically, it:</p> <ul style="list-style-type: none"> <li>• Initializes the Tracker           <ul style="list-style-type: none"> <li>▪ Reads in the system configuration (status of board, sensors, tx, etc.)</li> </ul> </li> <li>• Turns on the transmitter.</li> <li>• If all above is valid, it then collects 100 records (POS/ANG format) from each of the sensors and streams these records to the screen.</li> <li>• Error Handler - A simple error handler is included. It takes any error codes returned from the DLL/Tracker, and sends them to the screen.</li> <li>• TX Off - Before closing the application, shows how to turn off the TX.</li> </ul> <p>All necessary source files to re-build and run the application are included, and each of the above steps is accompanied by detailed comment descriptions directly in the code.</p>	<p>Program Files\Ascension3D GuidanceXXXX\API Developer\Samples\ Sample\ Sample.vcproj</p>
<i>Sample2</i>	<p>This C++ project also contains sample code for a very simple console application using the 3DGuidance™ API. It is more comprehensive than "Sample", in that it shows how to use each of the GETXXX/SETXXX calls appropriately. These calls give access to all configurable tracker parameters.</p> <p>An additional feature: also shows command for saving configuration settings to an .ini file.</p> <p>All necessary source files to re-build and run the application are included, and each of the above steps is accompanied by detailed comment descriptions directly in the code.</p>	<p>Program Files\Ascension3D GuidanceXXXX\API Developer\Samples\ Sample2\Sample2.vcproj</p>

Sample Code	Description	Location
<i>GetSynchronousRecordSample</i>	<p>This C++ project is a version of the Sample project described above, which has been modified to collect as much data from the tracker as possible using the GetSynchronousRecord() call.</p> <p>Specifically, it:</p> <ul style="list-style-type: none"> <li>• Initializes the Tracker</li> <li>• Reads in the system configuration (status of board, sensors, tx, etc.), and sets the measurement rate to the maximum supported for the tracker.</li> <li>• Turns on the transmitter</li> <li>• If all above is valid, collects 10000 records (POS/ANG/TimeStamp format) from each of the attached sensors and streams these records to a file. The status of the sensors is queried after each record is received.</li> <li>• Error Handler - A simple error handler is included. It takes any error codes returned from the DLL/Tracker, and sends them to the screen.</li> </ul> <p>TX Off - Before closing the application, shows how to turn off the TX</p> <p>All necessary source files to re-build and run the application are included, and each of the above steps is accompanied by detailed comment descriptions directly in the code.</p>	Program Files\Ascension\3D GuidanceXXXX\ API Developer \Samples\ GetSynchronousRecord Sample\ GetSynchronousRecordSa mple.vcproj

## Ascension RS232 Interface

Communicating with the tracker via RS232 can be done using the Ascension Technology RS232 Interface protocol. If you are familiar with the legacy Flock of Birds products, you will find the **trakSTAR 2** is compatible with most applications written using this protocol. Using the protocol gives instant access to a wide range of motion capture, virtual reality, and biomechanics applications.

For users wishing to access the tracker via this RS232 interface, there are two options:

1. Use an existing driver for the legacy protocol (i.e. Bird.dll - Win32)
2. Communicate directly via the ATC RS232 Interface protocol

Documentation and source files for these options can be downloaded directly from the Ascension website: <http://www.ascension-tech.com/technical/index.php>

### RS232 Windows Driver

The RS232 Windows driver (Bird.dll) provides an interface to the Ascension Technology trackers for WIN32 applications. With the exception of the initialization routines, this interface is standardized across many platforms and devices. The following Ascension Technology products are supported by this driver: Flock of Birds, pcBIRD, miniBIRD, MotionStar, MotionStar Wireless, laserBIRD, phasorBIRD, and 3DGuidance systems. To use the driver, simply include the header file Bird.h in your source code, link with the library module Bird.lib, and put the dynamic-link library Bird.dll anywhere on the DLL search path. Definitions for the data structures and API calls documented here are in the file bird.h.

**The Windows Driver User Manual and driver files can be downloaded from the Technical Support page of the Ascension website: <http://www.ascension-tech.com/technical/index.php>**

### Direct Communication: ATC RS232 Interface Protocol

The RS232 Interface protocol involves interpreting RS232 commands sent directly to the tracker. The command set supported by this protocol are detailed in [Chapter 6: Ascension RS232 Interface Reference](#).



## 3DGuidance API Reference

*This chapter is designed to show you how to write an application that will access the tracker using the 3DGuidance API that is provided in the ATC3DG.dll. This chapter also describes the setup of the tracker and defines various parameters.*

### Using 3DGuidance

These sections describe how to use the 3DGuidance API to perform the following operations:

[Quick Reference](#)

[Pre-Initialization Setup](#)

[System Initialization](#)

[System Setup](#)

[Transmitter Setup](#)

[Sensor Setup](#)

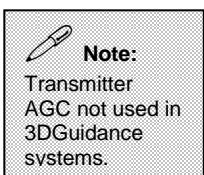
[Acquiring Position and Orientation Data](#)

[Error Handling](#)

## Quick Reference

### SYSTEM

The following system setup operations are available. All these parameters may be set up or the current status may be interrogated by calling [SetSystemParameter](#) and [GetSystemParameter](#). All of these parameters affect the operation of all transmitters and sensors in the system and cannot be modified on a sensor-by-sensor or transmitter-by-transmitter basis. The power up system defaults for short and mid-range transmitter configurations are as follows:



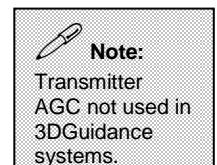
- Transmitter: No transmitter selected
- Power Line Frequency: 60.0 (Hz)
- AGC Mode: Transmitter and Sensor AGC
- Measurement Rate: 80.0 (Hz)
- Position Scaling: 36.0 (inches, Maximum range)
- Metric: False (floating point output representation is in inches)
- Report Rate: 1 (no downsampling of the GetSynchronousRecord() function call)
- Auxiliary Port: None selected
- Commutation Mode: Disabled
- Communications: USB
- Reset on initialization: True (resets tracker to a known state)
- Logging: False (log file not generated)
- Auto Configuration: 4 (4 sensors)

- **TRANSMITTER**

This command allows us to turn on or turn off the current transmitter in the 3DGuidance system. A full description of the operation is found at [SELECT\\_TRANSMITTER](#).

- **POWER LINE FREQUENCY**

This parameter represents the frequency of the AC power source used by the system. It is necessary to set this for proper operation of the [AC\\_Wide\\_Notch\\_Filter](#).



- **AGC MODE**

The 3DGuidance tracking systems have one mode of operation, and thus will operate the same way regardless of the setting. This mode is best described by the ‘Sensor’ section of the AGC (see [SENSOR AGC ONLY](#)). In this mode the firmware will only adjust the gain of the VGA. The power level of the transmitter is never altered and remains set at full power.

- **MEASUREMENT RATE**

The measurement rate is the system sampling rate. 3DGuidance trackers running Mid-Range transmitters are nominally set at 80.0 measurements/second. You can increase the measurement rate to a maximum of 255 measurements/sec for these configurations. The downside of selecting rates faster than ~150 measurements/sec is that the errors introduced by nearby metals may increase. You can decrease the tracker’s measurement rate to no less than 20 measurements/sec. Decreasing the measurement rate is useful if you need to reduce errors resulting from highly conductive metals such as aluminum. If you have low-conductive, highly permeable metals in your environment such as carbon steel or iron, changing the measurement rate will not change the distortions. For low-conductive, low permeability metals, such as 300-series stainless steel or nickel, speed changes will have minimal effect. In such a case the metal is not inducing errors into the tracker’s measurements.

- **REPORT RATE**

The report rate is the decimation factor used when streaming data records from the tracking device to the user’s application. Stream mode is automatically set when using the GetSynchronousRecord() API. The tracking device can compute a new P&O solution at 3 times the measurement rate, so at 80hz, an application will actually receive streaming data records at 240hz. In some cases an application may not be able to keep up with the streaming bandwidth. The REPORT RATE provides a mechanism to decimate the streaming data records. A report rate of 2 would send every other data record, a report of 3 would send every 3<sup>rd</sup>, etc.

- **POSITION SCALING**

This represents the scale factor for position data returned as signed binary integers. The position scaling can be set to 36, 72, or 144 (inches). It is referred to in the documentation as the [MAXIMUM RANGE](#) parameter. The value set will be the maximum possible full-scale value returned by the system. Note that the selection of scale factors greater than the default of 36 will reduce the resolution provided by the binary integer value accordingly.

- **METRIC Position Representation**

There is a system option that allows the data formatted in double precision floating point format to be output pre-scaled to either inches (the default) or millimeters. Setting the METRIC flag true will cause output to be in millimeters.

- **AUXILIARY PORT**

For 3DGuidance trackers equipped with one or more auxiliary sensor ports, this system parameter allows selection between the front panel port and it's paired auxiliary port. Only one or the other can be selected at a time. All sensor operations and data requests will be referred to the selected port. In Multi-Unit Sync configurations, auxiliary ports can only be selected for the first board.

- **COMMUTATION MODE**

Integrated Sensor Modules (i.e. M1525) available for oem custom installations of the 3DGuidance tracker require this alternate data acquisition mode for optimum operation. Note that this system parameter should only be enabled when sensors of this type are in use, as the system's sensitivity to conductive metal will increase slightly when this mode is being used.

## SENSOR

The following operations and set up can be performed individually for each sensor. The parameters can be set and read by making calls to [SetSensorParameter](#) and [GetSensorParameter](#). Upon power up with a **DIPOLE** transmitter (provided power-up defaults have not been configured differently), each sensor channel is setup with the following **defaults**:

- Data Format: Double precision floating point Position/Angles
- Angle Align: 0, 0, 0
- Filters:
  - AC WIDE Notch: Enabled
  - AC Narrow Notch: Disabled
  - DC ADAPTIVE: Enabled
  - All values in **Alpha max** table = **0.9000**, all values in **alpha min** table = **0.0200**, **Vm** table values = **2, 4, 4, 4, 4, 4, 4**
- Hemisphere: Front hemisphere (in front of the ATC logo on the transmitter)
- Metal Distortion: Filter alpha = 12, Slope = 0, Offset = 0 and Sensitivity = 2.
- Sensor Offsets 0, 0, 0
- Vital Product Data Storage (sensor and preamp): Empty

- **DATA FORMAT**

The following data record formats are available in integer and floating point representation. Combinations of these formats are also available in the same data record.

- **ANGLES:**

Data record contains 3 rotation angles. See [SHORT\\_ANGLES\\_RECORD](#), [DOUBLE\\_ANGLES\\_RECORD](#)

- **POSITION:**

Data record contains X, Y, Z position of sensor. See [SHORT\\_POSITION\\_RECORD](#), [DOUBLE\\_POSITION\\_RECORD](#)

- **MATRIX:**

Data record contains 9-element rotation matrix. See [SHORT\\_MATRIX\\_RECORD](#), [DOUBLE\\_MATRIX\\_RECORD](#)

- **QUATERNION:**

Data record contains quaternion. See [SHORT\\_QUATERNIONS\\_RECORD](#), [DOUBLE\\_QUATERNIONS\\_RECORD](#)

- **TIME\_STAMP and METAL DISTORTION** status:

Some data formats include a TIME\_STAMP and/or a METAL\_DISTORTION status field. See [DOUBLE\\_POSITION\\_TIME\\_STAMP\\_RECORD](#), [DOUBLE\\_POSITION\\_TIME\\_Q\\_RECORD](#)

- **BUTTON** status:

Data record contains a Button field. This field gives the open/close state of a contact closure connected to the BNC connector on the rear panel of the tracker labeled SWITCH. See

[DOUBLE\\_POSITION\\_ANGLES\\_TIME\\_Q\\_BUTTON\\_RECORD](#),  
[DOUBLE\\_POSITION\\_MATRIX\\_TIME\\_Q\\_BUTTON\\_RECORD](#),  
[DOUBLE\\_POSITION\\_QUATERNION\\_TIME\\_Q\\_BUTTON\\_RECORD](#)

These data formats can be set up by using the [SetSensorParameter](#) command for each individual sensor.

See [DATA\\_FORMAT\\_TYPE](#) for all available data format combinations.

- **ANGLE ALIGN**

Aligns sensor to reference direction. These parameters can be set up for each individual sensor by using the [SetSensorParameter](#) command. The current setting of ANGLE ALIGN can be accessed using the [GetSensorParameter](#) command. See [ANGLE\\_ALIGN](#) for a full description of its meaning and usage.

- **FILTERS**

- **DC Filter**

- This filter is an adaptive alpha filter. It is initialized to a default condition but its operation can be modified by changing the values in 3 tables, which are contained in the [FILTER\\_ALPHA\\_PARAMETERS](#). These parameters are changed through use of the [SetSensorParameter](#) function call and the current state of the alpha filter parameters may be observed by calling the [GetSensorParameter](#) function call. See [FILTER\\_ALPHA\\_PARAMETERS](#) for a complete description of their meaning and use.

- **AC Narrow Notch Filter**

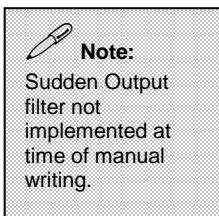
- This filter is a 2 tap finite impulse response (FIR) notch filter that is applied to signals measured by the tracker's sensor to eliminate a narrow band of noise with sinusoidal characteristics. This filter can be selected/deselected and interrogated through the [SetSensorParameter](#) and [GetSensorParameter](#) function calls. See [FILTER\\_AC\\_NARROW\\_NOTCH](#) for a full description of its use.

- **AC Wide Notch Filter**

- This filter is an 8 tap finite impulse response (FIR) filter that is applied to the sensor data to eliminate signals with a frequency between 30 and 72 Hz. Note: for this filter to work properly the system parameter: [POWER\\_LINE\\_FREQUENCY](#) must be correctly initialized using the [SetSystemParameter](#) function call.

- **Sudden Output Change Filter**

- If selected this filter will lock the output data to the current position and orientation if a sudden large change in position or orientation is detected. See [FILTER\\_LARGE\\_CHANGE](#) for a full description of its meaning and use.



- **HEMISPHERE**

The HEMISPHERE command tells the Tracker the desired hemisphere of operation. This parameter determines which of the 6 possible hemispheres of the transmitter the sensor is operating in. It can be set up for each individual sensor by using the [SetSensorParameter](#) command. The current setting of HEMISPHERE can be accessed using the [GetSensorParameter](#) command. See [HEMISPHERE](#) for a full description of its meaning and usage.

- **METAL DISTORTION**

This command outputs an accuracy degradation indicator. It is also known as the “quality” number. The metal distortion value is output in certain of the data record formats. See [DOUBLE POSITION TIME Q RECORD](#), [DOUBLE ANGLES TIME Q RECORD](#), [DOUBLE POSITION ANGLES TIME Q RECORD](#) for examples. See also [DATA FORMAT TYPE](#) for a list of all data formats. Those format types containing “\_Q\_” indicate the presence of the “quality” value.

You can modify the sensitivity and response of the quality number returned.. These parameters can be set up for each individual sensor by using the [SetSensorParameter](#) command. The current setting of The METAL DISTORTION parameters can be accessed using the [GetSensorParameter](#) command. See [QUALITY](#) for a description of the meaning and usage of the METAL DISTORTION parameters.

- **SERIAL NUMBER**

The sensor’s serial number can be obtained by calling [GetSensorParameter](#).

- **SENSOR OFFSETS**

Default position outputs from the trakSTAR represent the X, Y, Z position of the magnetic center of the sensor coil (approximate center of sensor housing) with respect to the transmitter origin. The Sensor Offsets allow you to configure the position outputs such that the tracker is reporting the position of a location that is offset from the center of the sensor. See the Sensor Parameter type [SENSOR\\_OFFSET](#) for details.

- **VITAL PRODUCT DATA STORAGE**

 Note: VPD storage not available in Junction Box 5DOF sensors

User application data that is tied to a particular tracking sensor can be stored in the Vital Product Data (VPD) storage area on the individual sensor (or preamp – if applicable). The Vital Product Data parameter provides a mechanism for reading or writing individual bytes to this storage area. The VPD section comprises 112 bytes of user modifiable data storage. It is the user’s responsibility to define the contents and structure and to maintain that structure. See the Sensor Parameter type [VITAL PRODUCT DATA RX](#)

- **MODEL STRING**

The sensor’s model string can be obtained by calling [GetSensorParameter](#).

- **PART NUMBER**

The sensor’s part number can be obtained by calling [GetSensorParameter](#).

- **POINT**

One data record is output from the selected tracking sensor for each command issued. This command is performed when the [GetAsynchronousRecord](#) function call is issued.

Note that a record containing data from all sensors can be obtained by setting the sensor ID to ALL\_SENSORS. For legacy tracker users, this is the equivalent of Group Mode.

- **STREAM**

This is the mode the tracker is placed into when the [GetSynchronousRecord](#) function call is issued. Its usage and formatting is identical to the GetAsynchronousRecord function. Unlike the POINT command however, STREAM mode commands the tracker to begin sending continuous data records to the host PC (DLL) without waiting for the next data request, thus ensuring that each and every data record computed by the tracker is sent. While this prevents the occurrence of duplicate records (as can occur when calling the GetAsynchronousRecord faster than the tracker update rate), it does not guarantee that records are not overwritten. The buffer available to the system for each sensor is 8 records long. If the host application does not keep up with the constant stream of data being provided in this mode, this buffer will overflow and records will be lost.

Note that issuing commands (other than GetSynchronousRecord) that must query the unit for a response, will cause the unit to come out of STREAM mode (i.e GetXXXX). Also note that hot-swapping sensors during STREAM mode operation will introduce delay in data for all sensor channels, as the unit must be taken out of this mode to detect and process info from the inserted sensor, then commanded to resume the STREAM mode operation.

Note that the rate at which records are transmitted when using the GetSynchronousRecord can be changed through use of the [SetSystemParameter](#) function with the REPORT\_RATE parameter. This divisor reduces the number of records output during STREAM mode, to that determined by the setting. For example, at a system measurement rate of 80Hz and a REPORT\_RATE of 1, a dipole system will transmit  $80 * 3 = 240$  Updates/sec (1 record every 4mS) for each sensor. Changing the REPORT\_RATE setting to 4 will reduce the number of records to  $240 / 4 = 60$  Updates/sec (1 record every 17mS) for each sensor. The default REPORT\_RATE setting of 1 makes all outputs computed by the tracker available. See the [Configurable Settings](#) section in Chapter 3 for details on changing the default setting.

As with the GetAsynchronous call, a record containing data from all sensors can be obtained by setting the sensor ID to ALL\_SENSORS. For legacy tracker users, this is the equivalent of GROUP Mode.

## BOARD

Some specific information of interest to the user concerning the Main PCB hardware is available.

- **SERIAL NUMBER**

The board's serial number can be obtained by calling [GetBoardParameter](#).

- **SOFTWARE REVISION NUMBER**

The Tracker's main firmware version number is stored as a 2 digit revision number. It can be accessed by issuing the [GetBoardConfiguration](#) command for the specified board. Revisions of secondary firmware loads can be queried using the [GetBoardParameter](#) call and the [BOARD\\_SOFTWARE\\_REVISIONS](#) parameter type.

- **POST ERRORS**

Selecting the POST\_ERROR\_PCB board parameter type with the [GetBoardParameter](#) call immediately after power-up, will return the results of the Power ON Self Test (POST). See the parameter structure [POST\\_ERROR\\_PARAMETER](#) for details

- **VITAL PRODUCT DATA STORAGE**

User application data that is tied to a particular tracking board (electronics unit) can be stored in the Vital Product Data (VPD) storage area on the individual board. The Vital Product Data parameter provides a mechanism for reading or writing individual bytes to this storage area.. The VPD section comprises 112 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. See the Board Parameter type

[VITAL PRODUCT DATA\\_PCB](#)

- **MODEL STRING**

The board's model string can be obtained by calling [GetBoardParameter](#).

- **PART NUMBER**

The board's part number can be obtained by calling [GetBoardParameter](#).

## TRANSMITTER

The following operations apply only to transmitters.

- **NEXT TRANSMITTER**

This command allows us to turn on next transmitter or turn off the current transmitter in the 3DGuidance™ system. A full description of the operation is found at [SELECT TRANSMITTER](#).

[REFERENCE FRAME](#) and [XYZ REFERENCE FRAME](#) are both used to set up the transmitters reference frame for all sensors using that transmitter. The reference frame must be set up for each transmitter separately and may be set up differently for each one. Upon power up the Reference Frame is initialized to 0,0,0 and the XYZ Reference Frame is disabled. Note: No transmitter is selected at power up.

- **REFERENCE FRAME**

Defines new measurement reference frame. The new reference frame is provided as 3 angles describing the azimuth, elevation and roll angles. There is no offset component and the reference frame is still centered on the transmitter. This parameter is changed or examined by using the [SetTransmitterParameter](#) and [GetTransmitterParameter](#) function calls. See [REFERENCE FRAME](#) for full description and details.

- **XYZ REFERENCE FRAME**

When the transmitter REFERENCE\_FRAME is changed it will cause the azimuth, elevation and roll angles of all the sensors to change to a new reference frame but it will not cause the x, y and z position coordinates to change unless the XYZ Reference Frame flag is set. This flag is changed and examined with the [SetTransmitterParameter](#) and the [GetTransmitterParameter](#) function calls. See [XYZ REFERENCE FRAME](#) for full description and usage.

- **SERIAL NUMBER**

The transmitter's serial number can be obtained by using [GetTransmitterParameter](#)

- **VITAL PRODUCT DATA STORAGE**

User application data that is tied to a particular tracking transmitter can be stored in the Vital Product Data (VPD) storage area on the individual transmitter. The Vital Product Data parameter provides a mechanism for reading or writing individual bytes to this storage area. The VPD section comprises 112 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. See the Transmitter Parameter type [VITAL PRODUCT DATA TX](#)

- **MODEL STRING**

The transmitter's model string can be obtained by calling [GetTransmitterParameter](#).

- **PART NUMBER**

The transmitter's part number can be obtained by calling [GetTransmitterParameter](#).

## Pre-Initialization Setup

 **Note:**  
Changes to the  
ATC3DG.ini file  
via these  
commands may  
require, ADMIN  
(modify)  
privileges.

There are some specific operations that are available PRIOR to initializing the 3DGuidance tracking system. These operations utilize parameters passed with the [GetSystemParameter](#) and [SetSystem Parameter](#) calls, and provide API access to those items stored in the system configuration file (i.e. ATC3DG.ini). NOTE: If when using these 'Pre-Init' SetSystem parameters you receive the error 'BIRD\_ERROR\_UNABLE\_TO\_OPEN\_FILE', check to be sure current user has Windows modify privileges.

- **COMMUNICATIONS MEDIA**

This parameter is used to configure the communications media that will be used for sending and receiving data with the tracking device. Current supported media types are USB and RS232. See the parameter structure: [COMMUNICATIONS MEDIA PARAMETER](#) for additional details.

NOTE: This parameter can be used prior to a InitializeBIRDSystem() function call.  
The Media Type is set to USB by default.

- **LOGGING**

Setting the LOGGING parameter to TRUE (using the SetSystem Parameter) will enable logging of the communications traffic between the API and the tracking device. Useful for reporting and trouble-shooting errors with the Ascension tracking system.

NOTE: This parameter can be used prior to a InitBIRDSystem() function call. It is set to FALSE by default.

- **RESET**

This parameter is used to enable/disable the automatic reset of the tracking device that occurs with the InitializeBIRDSystem API call. Disabling reset will make the InitBIRDSystem function call perform much faster and may be useful in the development phase of a project, but this should be used with caution, as a reset places the tracking device in a known state and disabling this may cause undetermined side effects.

NOTE: This parameter can be used prior to a InitializeBIRDSystem() function call.  
It is set to TRUE by default.

- **AUTOCONFIG**

This parameter can be used to specify the number of sensors to configure for the tracking device. This parameter is needed with systems that support the use of multiple 5DOF sensors in lieu of a single 6DOF sensor. For Non-Dipole configurations, 4 and 12 are the valid values for this parameter. See the [AUTOCONFIG](#) section in Chapter 3 for additional details.

NOTE: This parameter can be used prior to a InitBIRDSystem() function call. It is set to 4 by default.

## System Initialization

With the exception of the ‘Pre-Init’ commands, the first operation that must be performed before the system can be used is initialization. This is performed by calling the function InitializeBIRDSystem(). The call takes no parameters and returns no information except for a completion code. The only acceptable code is BIRD\_ERROR\_SUCCESS. All other codes are fatal errors which either indicate a condition that has prevented the system from initializing or they indicate a prevailing condition that disallows the system from completing the initialization. For example, the error code:

BIRD\_ERROR\_COMMAND\_TIME\_OUT probably indicates a non-responding board. This is a hard failure. The error code BIRD\_ERROR\_INVALID\_DEVICE\_ID indicates that although the board is functional, initialization will not be allowed to proceed because the board is incompatible with the driver and API. The error codes are provided as a diagnostic and indicate a system condition that needs to be rectified before initialization can complete. Without a complete and successful initialization the system cannot be used.

Note: Initialization is an all-inclusive operation. Internally, the first task it performs is to enumerate the 3DG<sup>TM</sup> Guidance<sup>TM</sup> trackers connected to the system. Secondly, each board is queried concerning its status and functionality. An internal database is then constructed of the current state of the system. The synchronization hardware is initialized and enabled.

The initialization may be invoked as follows:

```
#include "ATC3DG.h"
.
.
.
int errorCode;
.

.

errorCode = InitializeBIRDSystem();

if(errorCode!=BIRD_ERROR_SUCCESS)
{
    // place error handler here
}
```

Note: An error handler should be called which will display or log the error reported. The application should terminate as no further progress is possible without successful initialization. Note that the error returned by a call when the system has not been initialized yet (BIRD\_ERROR\_SYSTEM\_UNINITIALIZED) can be decoded at any time using the GetErrorText() call.

## System Setup

The system setup involves setting the sensor measurement rate, selecting the AGC mode, power line frequency and maximum range, setting the Metric/English flag and turning on a transmitter. All of these operations are performed using the SetSystemParameter() call. All parameters have a default value associated with them so unless the default is unsuitable the parameter need not be changed.

The following code fragment shows how all the parameters may be changed to a new value:

```
#include "ATC3DG.h"                                // needed for enumerated types and calls

int errorCode;

double pl = 50.0;                                  // 50 Hz power line

AGC_MODE_TYPE agc = SENSOR_AGC_ONLY;               // tx power fixed at max
double rate = 86.1;                                // 86.1 Hz
double range = 72.0;                               // 72 inches
BOOL metric = true;                             // metric reporting enabled
short tx = 0;                                    // tx index number 0 selected

errorCode = SetSystemParameter(POWER_LINE_FREQUENCY, &pl, sizeof(pl));
if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

errorCode = SetSystemParameter(AGC_MODE, &agc, sizeof(agc));
if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

errorCode = SetSystemParameter(MEASUREMENT_RATE, &rate, sizeof(rate));
if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

errorCode = SetSystemParameter(MAXIMUM_RANGE, &range, sizeof(range));
if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

errorCode = SetSystemParameter(METRIC, &metric, sizeof(metric));
```

```

if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

errorCode = SetSystemParameter(SELECT_TRANSMITTER, &tx, sizeof(tx));
if(errorCode != BIRD_ERROR_SUCCESS)
{
    // error handler
}

```

Another way to initialize the system is to use the `RestoreSystemConfiguration()` call. This together with the `SaveSystemConfiguration()` call provide a convenient way for the user to save the current state of the total system to a configuration file (.ini) and then use that file at a later time to re-initialize the system to that exact state. These calls allow the user to save or restore all settable parameters used by the system, sensors and transmitter. The following code fragment illustrates the usage of the `RestoreSystemConfiguration()` call.

**Tip:** Most tracker power-up settings can also be pre-configured using the Configuration Utility. See [Power-Up Settings](#) for details.

```

//
// Initialize system from ini file
//
errorCode = RestoreSystemConfiguration("oldconfig.ini");
if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode);

```

The simplest way to create a system configuration file is to let the system do it for you by using the `SaveSystemConfiguration()` call. This call will create a file with the required format and including the current value for every system, sensor and transmitter parameter available. These files are saved as text files and can be edited using a text editor such as notepad.exe. See the section on configuration file format for details. The following code fragment shows how to save the current system configuration.

```

errorCode =
SaveSystemConfiguration("c:\trakSTAR\newconfig.ini");
if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode);

```

The `RestoreSystemConfiguration()` call is capable of setting every system, sensor and transmitter parameter available but it cannot and will not initialize the system. As with most other API calls the `InitializeBIRDSystem()` call must be made before `RestoreSystemConfiguration()` can be used.

## Sensor Setup

 **Note:** The ALL\_SENSORS Sensor ID can only be used in the GetXXRecord() calls.

The sensor setup involves selecting a data format, setting the filter and quality parameters, determining the sensor angle alignment and hemisphere of operation. All of these parameters have an associated default value. The parameter only needs to be changed if the default is inappropriate.

In most cases the default filter and quality parameters will be found to provide adequate performance for the intended application. Unless the sensor is going to be attached to something that would cause it to be tilted while in its reference position then the angle align parameters will not need to be changed. The hemisphere will need to be changed if the sensor is going to operate anywhere other than the forward hemisphere, which is the default. Typically the user will only have to set up the data format if something other than position/angles in double floating point is required. At a minimum nothing need be changed and the system will still operate successfully.

Note: It is necessary to set or change the parameter for each of the sensors individually as required. This allows each sensor to have its parameters set to different values.

The following code fragment gives an example of how to call the set parameter function in this case to set the data format to a double floating point value of position and matrix:

```
USHORT sensorID = 2;
int errorCode;
DATA_FORMAT_TYPE format = DOUBLE_POSITION_MATRIX;

errorCode = SetSensorParameter(
    sensorID,           // index number of target sensor
    DATA_FORMAT,        // command parameter type
    &format,            // address of data source buffer
    sizeof(format) // size of source buffer
);
if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode);
// user must provide an error handler
```

The following code fragment shows how all the parameters may be changed to a new value. First a macro is defined which handles the different types of parameters which may be passed to the basic SetSensorParameter() call.

```
#include "ATC3DG.h"

///////////////////////////////
/////////////////////////////
//
```

```

// SET_SENSOR_PARAMETER macro
//
#define      SET_SENSOR_PARAMETER(id, type, value) \
{ \
    type##_TYPE buf = value; \
    errorCode = SetSensorParameter(id, type, &buf, sizeof(buf)); \
    if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode); \
}

// In order for the above macro to compile without error it is
// necessary to provide typedefs for all the XXX_TYPES that are
// generated by "type##_TYPE"

// DATA_FORMAT_TYPE already defined as an enumerated type
typedef DOUBLEANGLES_RECORD           ANGLE_ALIGN_TYPE;
typedef DOUBLEANGLES_RECORD           REFERENCE_FRAME_TYPE;
typedef bool                          XYZ_REFERENCE_FRAME_TYPE;
// HEMISPHERE_TYPE already defined as an enumerated type
typedef bool                          FILTER_AC_WIDE_NOTCH_TYPE;
typedef bool                          FILTER_AC_NARROW_NOTCH_TYPE;
typedef double                        FILTER_DC_ADAPTIVE_TYPE;
typedef ADAPTIVE_PARAMETERS          FILTER_ALPHA_PARAMETERS_TYPE;
typedef bool                          FILTER_LARGE_CHANGE_TYPE;
typedef QUALITY_PARAMETERS           QUALITY_TYPE;

///////////////////////////////
/////////////////////////////
// Main program
//
int errorCode;
sensorID = 0;

SET_SENSOR_PARAMETER(sensorID, DATA_FORMAT,
DOUBLE_POSITIONANGLES_TIME_STAMP);

// initialize a structure of angles
DOUBLEANGLES_RECORD anglesRecord = {30, 45, 60};
SET_SENSOR_PARAMETER(sensorID, ANGLE_ALIGN, anglesRecord);

// initialize a structure of angles
DOUBLEANGLES_RECORD anglesRecord = {60, 45, 30};
SET_SENSOR_PARAMETER(sensorID, REFERENCE_FRAME, anglesRecord);
SET_SENSOR_PARAMETER(sensorID, XYZ_REFERENCE_FRAME, true);
SET_SENSOR_PARAMETER(sensorID, HEMISPHERE, TOP);
SET_SENSOR_PARAMETER(sensorID, FILTER_AC_WIDE_NOTCH, true);
SET_SENSOR_PARAMETER(sensorID, FILTER_AC_NARROW_NOTCH, false);
SET_SENSOR_PARAMETER(sensorID, FILTER_DC_ADAPTIVE, 1.0);

// initialize the alpha parameters
ADAPTIVE_PARAMETERS adaptiveRecord = {
    500, 500, 500, 500, 500, 500, 500,
    20000, 20000, 20000, 20000, 20000, 20000,
    2, 4, 8, 16, 32, 32, 32,
}

```

```
    true
SET_SENSOR_PARAMETER(sensorID, FILTER_ALPHA_PARAMETERS, adaptiveRecord);
SET_SENSOR_PARAMETER(sensorID, FILTER_LARGE_CHANGE, false);

// initialize the quality parameter structure
QUALITY_PARAMETERS qualityParameters = { 15, 20, 16, 5 };
SET_SENSOR_PARAMETER(sensorID, QUALITY, qualityParameters);
```

## Transmitter Setup

The transmitter setup consists solely of setting up the transmitter reference frame. The default reference frame is (0, 0, 0) using Euler angles. The transmitter reference frame can only be changed by rotation there is no position offset available. The parameters only need to be changed if the default is inappropriate.

Once set, the transmitter reference frame will apply to all sensors. The reference frame setup is usually used to compensate for a transmitter whose installation results in it being tilted relative to the desired angular reference frame.

The following code fragment illustrates how to use the SetTransmitterParameter() call to setup the transmitter reference frame.

```

USHORT transmitterID = 1;
int errorCode;
// e.g. a transmitter tilted at 45 degrees in elevation
DOUBLE_ANGLES_RECORD frame = {0, 45, 0};
errorCode = SetTransmitterParameter(
    transmitterID,           // index number of target transmitter
    REFERENCE_FRAME,         // command parameter type
    &frame,                 // address of data source buffer
    sizeof(frame)            // size of source buffer
);
if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode);
    // user must provide an error handler

// In this example we also want the sensor position to be
// corrected to compensate for the tilt in the transmitter
// So we set the XYZ_REFERENCE_FRAME parameter to "true"
// (Its default is "false")
BOOL xyz = true;
errorCode = SetTransmitterParameter(
    transmitterID,           // index number of target transmitter
    XYZ_REFERENCE_FRAME,      // command parameter type
    &xyz,                   // address of data source buffer
    sizeof(xyz)              // size of source buffer
);
if(errorCode!=BIRD_ERROR_SUCCESS) errorHandler(errorCode);
    // user must provide an error handler

```

## Acquiring Tracking Data

**Tip:** Setting the SensorID to ALL\_SENSORS will return data records from all sensors.

Data is acquired by making calls to [GetAsynchronousRecord\(\)](#) or [GetSynchronousRecord\(\)](#) for each sensor that data is required from. Before calling either function it is necessary to initialize the system, transmitters and sensors to their desired settings. It is possible to acquire data with every setting left in its default state with the exception of SELECT\_TRANSMITTER. The SYSTEM\_PARAMETER\_TYPE, SELECT\_TRANSMITTER is set to (-1) on initialization. This means that no transmitter has been selected. The minimum system setup required before data can be selected is to call SetSystemParameter() with the SELECT\_TRANSMITTER parameter and pass the id of the transmitter that is required to be turned on. The following code fragment illustrates a minimum requirement for acquiring data. It assumes that there is a transmitter attached to id = 0 and that there is a sensor attached to id = 0.

```
///////////
/////
// First initialize the system
//
int errorCode = InitializeBIRDSystem();
if(errorCode!=BIRD_ERROR_SUCCESS)
{
    errorHandler(errorCode); // user supplied error handler
}

///////////
/////
// Turn on the transmitter.
// We turn on the transmitter by selecting the
// transmitter using its ID
//
USHORT id = 0;
errorCode = SetSystemParameter(SELECT_TRANSMITTER, &id,
sizeof(id));
if(errorCode!=BIRD_ERROR_SUCCESS)
{
    errorHandler(errorCode);
}

///////////
/////
// Get a record from sensor #0.
```

```

// The default record type is DOUBLE_POSITION_ANGLES
//
USHORT sensorID = 0;
DOUBLE_POSITION_ANGLES_RECORD record;
errorCode = GetAsynchronousRecord(sensorID, &record,
sizeof(record));
if(errorCode!=BIRD_ERROR_SUCCESS)
{
    errorHandler(errorCode);
}

```

## Error Handling

Each call to the API will return either an error code or a status code depending on the command issued. Commands that return a status code are the GetSystemStatus(), GetBoardStatus(), GetSensorStatus() and GetTransmitterStatus() commands.

The only acceptable response to a command is BIRD\_ERROR\_SUCCESS. If any other response is received in response to sending a command, then the command failed to complete and the error code will inform the user of the reason why it failed. The function GetErrorText() can be used to generate a message string for output to a file or screen display describing in English the nature of the error code passed to this command. Note that GetErrorText() does not require the 3DGGuidance system to be initialized before it can be used.

It is possible for the software to recover from some error code conditions. For example if the system has not been initialized then the error code BIRD\_ERROR\_SYSTEM\_UNINITIALIZED will be returned. The software could recover by calling InitializeBIRDSystem() before doing anything else.

But this error is usually an indication of a software “bug”. Other errors like BIRD\_ERROR\_NO\_SENSOR\_ATTACHED can be recovered from by displaying a message to the user suggesting that they attach a sensor to the system.

 **Tip:** Call GetSensorStatus() after each data request to help validate the data returned from the sensor.

## Status Codes

The status code returned by the GetXXXStatus() commands gives a bit-mapped indication of abnormal conditions that have been detected by the tracker for the device selected. This status code can be utilized effectively by the host application to track down hardware errors and conditions, as well as to help validate the position and orientation data records that have been returned from the sensor. For example, calling the GetSensorStatus()

immediately after the GetSynchronousRecord() will allow the host application to determine if the ‘0’s received in the sensor data record were due to the sensor being saturated (DEVICE STATUS bit 2 set) or due to the position/orientation algorithm still initializing (DEVICE STATUS bit 13 set).

The use of the Get...Status() function call(s) has the advantage, from the host application stand point, that no additional tracking communications take place during the course of this API call. This makes the use of these calls very fast and efficient. Note that the status code is only updated with a call to either GetAsynchronous or GetSynchronousRecord( ). Therefore the status returned is always the status associated with the last data record requested.

If the status code returned = 0, then the device or component is fully operational. Any status other than 0 indicates an error/abnormal condition, which may prevent successful operation of the device or component. For example if a call is made to GetSensorStatus() for a sensor channel whose sensor is not attached then the returned status will be 0x00000003, indicating that the NOT\_ATTACHED and the GLOBAL\_ERROR bits are set. See the [DEVICE\\_STATUS](#) definition table for additional details.

# 3DGuidance API

The following elements define the API used with the 3DGuidance systems.

[3D Guidance API Functions](#)

[3D Guidance API Structures](#)

[3D Guidance API Enumeration Types](#)

[3D Guidance API Status/Error Bit Definitions](#)

[3D Guidance Initialization](#)

## 3D Guidance API Functions

The following functions are used with the 3DGuidance systems.

[InitializeBIRDSystem](#)

[GetBIRDSystemConfiguration](#)

[GetTransmitterConfiguration](#)

[GetSensorConfiguration](#)

[GetBoardConfiguration](#)

[GetSystemParameter](#)

[GetSensorParameter](#)

[GetTransmitterParameter](#)

[GetBoardParameter](#)

[SetSystemParameter](#)

[SetSensorParameter](#)

[SetTransmitterParameter](#)

[SetBoardParameter](#)

[GetAsynchronousRecord](#)

[GetSynchronousRecord](#)

[GetBIRDError](#)

[GetErrorText](#)

[GetSensorStatus](#)

[GetTransmitterStatus](#)

[GetBoardStatus](#)

[GetSystemStatus](#)

[SaveSystemConfiguration](#)

[RestoreSystemConfiguration](#)

[CloseBIRDSystem](#)

## InitializeBIRDSystem

The **InitializeBIRDSystem** function resets (when configured to do so) and initializes the 3DGuidance hardware and system.

```
int InitializeBIRDSystem();
```

### Parameters

This function takes no parameters

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Initialization completed successfully
BIRD_ERROR_INCORRECT_DRIVER_VERSION	The wrong version of the driver has been installed for this version of the API dll. Install or re-install the correct driver.
BIRD_ERROR_OPENING_DRIVER	Non-specific error opening driver. Make sure that the driver is properly installed.
BIRD_ERROR_NO_DEVICES_FOUND	No 3DGuidance Tracker hardware was found by the host system. Verify that hardware is installed and is of the correct type.
BIRD_ERROR_INVALID_DEVICE_ID	A 3DGuidance device has been found that is not supported by this API dll. Verify 3DGuidance model installed.
BIRD_ERROR_FAILED_LOCKING_DEVICE	Driver could not lock 3DGuidance resources. Check that there is not another application using the hardware.
BIRD_ERROR_INCORRECT_PLD	The PLD version on the 3DGuidance hardware is incompatible with this version of the API dll. Verify 3DGuidance model installed.
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. If this error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_INCORRECT_BOARD_DEFAULT	An unexpected response was received from the controller on the 3DGuidance hardware. The board is responding to commands but the data returned is corrupt. If the error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_PCB_HARDWARE_FAILURE	The 3DGuidance firmware initialization did not complete within 10 seconds. It is assumed the board is faulty or the firmware has hung up somewhere. If the error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_UNRECOGNIZED_MODEL_STRING	The firmware is reporting a model string that is unrecognized by the API dll. This could be due to a

	hardware failure causing the model string data to be corrupted or it may be caused by a corrupted board EEPROM or the board installed is of a type not recognized by the API dll. If the error is repeatable return to vendor.
BIRD_ERROR_INVALID_CONFIGURATION,	The system has detected an invalid Multi-Unit Sync (MUS) configuration. This may be caused by an invalid Unit ID setting or more than one transmitter connected to the system. See the MUS Installation Addendum for assistance with MUS configuration setup.

## Remarks

If the [RESET](#) system parameter is enabled, this function call will first reset all 3DGuidance units connected to the system. The function will then interrogate the boards and determine their status. Finally, it will build a database of *TRACKER* information containing number of sensors, transmitters etc. This function takes several seconds to complete because it has to wait for the boards to reset and initialize internally. With the exception of a few [pre-initialization](#) operations, this function must be called first, before other commands can be sent.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[CloseBIRDSystem](#), [RestoreSystemConfiguration](#)

## GetBIRDSystemConfiguration

The **GetBIRDSystemConfiguration** will return a structure containing the [SYSTEM\\_CONFIGURATION](#).

```
int GetBIRDSystemConfiguration(
    SYSTEM_CONFIGURATION* pSystemConfiguration
);
```

### Parameters

*pSystemConfiguration*

[out] Pointer to a [SYSTEM\\_CONFIGURATION](#) structure that receives the information about the system.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.

### Remarks

This function passes a single parameter that is a pointer to a structure, which will hold the system configuration on return from the call. The structure contains variables that give the number of sensors, transmitters and boards in the system. These numbers can then be used to allocate storage for arrays of structures to store the sensor and transmitter configurations. The board configurations may be used to monitor the hardware configuration of the system.

The structure also contains the current measurement rate, line frequency, maximum range and AGC mode of the system when the configuration was returned. These parameters effect operation in a system-wide manner.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetSystemParameter](#), [SetSystemParameter](#), [GetSystemStatus](#), [SaveSystemConfiguration](#)

## GetTransmitterConfiguration

The **GetTransmitterConfiguration** will return a structure containing a [TRANSMITTER\\_CONFIGURATION](#).

```
int GetTransmitterConfiguration(
    USHORT transmitterID,
    TRANSMITTER_CONFIGURATION* pTransmitterConfiguration
);
```

### Parameters

*transmitterID*

[in] The transmitterID is in the range 0..(n-1) where n is the number of possible transmitters in the system.

*pTransmitterConfiguration*

[out] Pointer to a [TRANSMITTER\\_CONFIGURATION](#) structure that receives the information about the transmitter.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INVALID_DEVICE_ID	The transmitterID passed was out of range for the system.

### Remarks

This function takes as its parameters an index to a specific transmitter and a pointer to a structure that is used to return the transmitter configuration information.

The index number is in the range 0..(n-1) where n is the number of possible transmitters in the system.

The transmitter configuration returned contains most importantly the serial number of any transmitter attached at the specified ID. This is the most reliable way to correlate an actual physical transmitter and its index number. The other information provided is the index number of the board where the transmitter is found, and the channel number within that board. The transmitter type is also provided. Note however that the DEVICE\_TYPES enumerated type returned with this call WILL NOT support future transmitters. The [MODEL\\_STRING](#) and [PART\\_NUMBER](#) parameter types have replaced this functionality.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetTransmitterParameter](#), [SetTransmitterParameter](#), [GetTransmitterParameter](#), [GetTransmitterStatus](#)

## GetSensorConfiguration

The **GetSensorConfiguration** will return a structure containing a [SENSOR\\_CONFIGURATION](#).

```
int GetSensorConfiguration(
    USHORT sensorID,
    SENSOR_CONFIGURATION* pTransmitterConfiguration n
);
```

### Parameters

*sensorID*

[in] The sensorID is in the range 0..(n-1) where n is the number of possible sensors in the system.

*pSensorConfiguration*

[out] Pointer to a [SENSOR\\_CONFIGURATION](#) structure that receives the information about the sensor.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INVALID_DEVICE_ID	The sensorID passed was out of range for the system.

### Remarks

This function takes as its parameters an index to a specific sensor and a pointer to a structure that is used to return the sensor configuration information.

The index number is in the range 0..(n-1) where n is the number of possible sensors in the system.

The sensor configuration returned contains most importantly the serial number of any sensor attached at the specified ID. This is the most reliable way to correlate an actual physical sensor and its index number. The other information provided is the index number of the board where the sensor is found, and the channel number within that board. The sensor type is also provided. Note however that the DEVICE\_TYPES enumerated type returned with this call WILL NOT support future transmitters. The [MODEL\\_STRING](#) and [PART\\_NUMBER](#) parameter types have replaced this functionality.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetSensorParameter](#), [SetSensorParameter](#), [GetSensorStatus](#)

## GetBoardConfiguration

The **GetBoardConfiguration** will return a structure containing a [BOARD\\_CONFIGURATION](#).

```
int GetBoardConfiguration(
    USHORT boardID,
    BOARD_CONFIGURATION* pBoardConfiguration
);
```

### Parameters

*boardID*

[in] The boardID is in the range 0..(n-1) where n is the number of possible boards in the system.

*pBoardConfiguration*

[out] Pointer to a [BOARD\\_CONFIGURATION](#) structure that receives the information about the board.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INVALID_DEVICE_ID	The boardID passed was out of range for the system.

### Remarks

This function takes as its parameters an index to a specific board and a pointer to a structure that is used to return the board configuration information.

The index number is in the range 0..(n-1) where n is the number of possible boards in the system.

This function returns a structure slightly different from the [SENSOR\\_CONFIGURATION](#) and [TRANSMITTER\\_CONFIGURATION](#) structures. The [BOARD\\_CONFIGURATION](#) returned with this call provides the number of sensor and transmitter connectors available on this board. It also provides the revision number of the firmware running on the board.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetBoardParameter](#), [SetBoardParameter](#), [GetBoardStatus](#), [GetSystemStatus](#)

## GetSystemParameter

The **GetSystemParameter** will return a buffer containing the selected parameter values(s).

```
int GetSystemParameter(
    SYSTEM_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *parameterType*

[in] Contains the parameter type to be returned in the buffer. Must be a valid enumerated constant of the type [SYSTEM\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[out] Points to a buffer to be used for returning the information about the [SYSTEM\\_PARAMETER\\_TYPE](#) being queried. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being returned or the function may overwrite user memory.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the returned parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">SYSTEM_PARAMETER_TYPE</a> used.

### Remarks

The [GetSystemParameter](#) and [SetSystemParameter](#) commands are designed to allow access to and manipulation of parameters that effect the computation cycle and algorithm. These include measurement rate, AGC mode, Power line frequency etc. Note that some of the parameters take as values other enumerated types.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[SetSystemParameter](#), [GetSystemStatus](#)

## GetSensorParameter

The **GetSensorParameter** function will return a buffer containing the selected parameter values(s).

```
int GetSensorParameter(
    USHORT sensorID
    SENSOR_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

*sensorID*

[in] Valid SensorIDs are in the range 0..(n-1) where n is the number of sensors in the system.

*parameterType*

[in] Contains the parameter type to be returned in the buffer. Must be a valid enumerated constant of the type [SENSOR\\_PARAMETER\\_TYPE](#).

*pBuffer*

[out] Points to a buffer to be used for returning the information about the [SENSOR\\_PARAMETER\\_TYPE](#) being queried. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being returned or the function may overwrite user memory.

*bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the returned parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">SENSOR_PARAMETER_TYPE</a> used.
BIRD_ERROR_INVALID_DEVICE_ID	The <i>sensorID</i> passed was out of range for the system.

### Remarks

The GetSensorParameter command is designed to allow the viewing of parameters that effect the computation cycle and algorithm for a single sensor. The command differs from the system command in that it requires a device ID to indicate which sensor is being referred to. See [SENSOR\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[SetSensorParameter](#), [GetSensorConfiguration](#), [GetSensorStatus](#)

## GetTransmitterParameter

The **GetTransmitterParameter** function will return a buffer containing the selected parameter values(s).

```
int GetTransmitterParameter(
    USHORT transmitterID,
    TRANSMITTER_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *transmitterID*

[in] Valid transmitterIDs are in the range 0..(n-1) where n is the number of transmitters in the system.

#### *parameterType*

[in] Contains the parameter type to be returned in the buffer. Must be a valid enumerated constant of the type [TRANSMITTER\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[out] Points to a buffer to be used for returning the information about the [TRANSMITTER\\_PARAMETER\\_TYPE](#) being queried. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being returned or the function may overwrite user memory.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the returned parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">TRANSMITTER_PARAMETER_TYPE</a> used.
BIRD_ERROR_INVALID_DEVICE_ID	The transmitterID passed was out of range for the system.

### Remarks

The GetTransmitterParameter command is designed to allow the viewing of parameters that effect the operation of a single transmitter. The command differs from the system command in that it requires a device ID to indicate which transmitter is being referred to. See [TRANSMITTER\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[SetTransmitterParameter](#), [GetTransmitterConfiguration](#), [GetTransmitterStatus](#)

## GetBoardParameter

The **GetBoardParameter** function will return a buffer containing the selected parameter values(s).

```
int GetBoardParameter(
    USHORT boardID
    BOARD_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *boardID*

[in] Valid boardIDs are in the range 0..(n-1) where n is the number of boards in the system.

#### *parameterType*

[in] Contains the parameter type to be returned in the buffer. Must be a valid enumerated constant of the type [BOARD\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[out] Points to a buffer to be used for returning the information about the [BOARD\\_PARAMETER\\_TYPE](#) being queried. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being returned or the function may overwrite user memory.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the returned parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DG guidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">BOARD_PARAMETER_TYPE</a> used.
BIRD_ERROR_INVALID_DEVICE_ID	The <i>boardID</i> passed was out of range for the system.

### Remarks

The GetBoardParameter command is designed to allow the viewing of parameters that effect the operation of a single board. The command differs from the system command in that it requires a board ID to indicate which board is being referred to. See [BOARD\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[SetBoardParameter](#), [GetBoardConfiguration](#), [GetBoardStatus](#)

## SetSystemParameter

The **SetSystemParameter** function allows an application to change basic 3DGuidance system parameters.

```
int SetSystemParameter(
    SYSTEM_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *parameterType*

[in] Contains the parameter type to be passed in the buffer. Must be a valid enumerated constant of the type [SYSTEM\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[in] Points to a buffer to be used for passing the information about the [SYSTEM\\_PARAMETER\\_TYPE](#) being changed. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being passed or the function will read beyond the end of the buffer into user memory with indeterminate results.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size exactly of the parameter being passed in the buffer.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">SYSTEM_PARAMETER_TYPE</a> used.
BIRD_ERROR_NO_TRANSMITTER_RUNNING	A request was made to turn off the current transmitter by passing the value -1 with the parameter SELECT_TRANSMITTER selected and there was no transmitter currently running.
BIRD_ERROR_NO_TRANSMITTER_ATTACHED	A request was made to do one of the following: 1) Turn off the currently running transmitter and there is no transmitter attached to the system 2) Turn on the transmitter with the selected ID and there is no transmitter attached at that ID.
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.

BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. If this error is repeatable there is an unrecoverable hardware failure.
---------------------	---

### Remarks

The GetSystemParameter and SetSystemParameter commands are designed to allow access to and manipulation of parameters that effect the computation cycle and algorithm. These include measurement rate, AGC mode, Power line frequency etc. Note that some of the parameters take as values other enumerated types. See [SYSTEM\\_PARAMETER\\_TYPE](#) for a description of the individual parameters

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetSystemParameter](#), [GetSystemStatus](#), [GetBIRDSystemConfiguration](#)

## SetSensorParameter

The **SetSensorParameter** function allows an application to select and change specific characteristics of individual sensors in a 3DGGuidance system.

```
int SetSensorParameter(
    USHORT sensorID
    SENSOR_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

*sensorID*

[in] Valid sensorIDs are in the range 0..(n-1) where n is the number of sensors in the system.

*parameterType*

[in] Contains the parameter type whose new value is being passed in the buffer. It must be a valid enumerated constant of the type [SENSOR\\_PARAMETER\\_TYPE](#).

*pBuffer*

[in] Points to a buffer to be used for passing the new parameter information of the [SENSOR\\_PARAMETER\\_TYPE](#) being changed. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being passed or the function will read beyond the end of the buffer into user memory with indeterminate results.

*bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the passed parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">SENSOR_PARAMETER_TYPE</a> used.
BIRD_ERROR_INVALID_DEVICE_ID	The <i>sensorID</i> passed was out of range for the system.
BIRD_ERROR_COMMAND_TIME_OUT	3DGGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DGGuidance internal watchdog timer has elapsed. If this error is repeatable there is an unrecoverable hardware failure.

## Remarks

The SetSensorParameter command is designed to allow the manipulation of parameters that effect the computation cycle and algorithm for a single sensor. The command differs from the system command in that it requires a device ID to indicate which sensor is being referred to. See [SENSOR\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetSensorParameter](#), [GetSensorConfiguration](#), [GetSensorStatus](#)

## SetTransmitterParameter

The **SetTransmitterParameter** function allows an application to change specific operational characteristics of individual transmitters.

```
int SetTransmitterParameter(
    USHORT transmitterID
    TRANSMITTER_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *transmitterID*

[in] Valid transmitterIDs are in the range 0..(n-1) where n is the number of transmitters in the system.

#### *parameterType*

[in] Contains the parameter type to be passed in the buffer. Must be a valid enumerated constant of the type [TRANSMITTER\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[in] Points to a buffer to be used for passing the information about the [TRANSMITTER\\_PARAMETER\\_TYPE](#) being changed. WARNING: The size of the buffer must be equal to or greater than the size of the parameter being passed or the function may read beyond the end of the buffer into user memory with indeterminate results.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the passed parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type TRANSMITTER_PARAMETER_TYPE used.
BIRD_ERROR_INVALID_DEVICE_ID	The transmitterID passed was out of range for the system.
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. If this error is repeatable there is an unrecoverable hardware failure.

## Remarks

The SetTransmitterParameter command is designed to allow the manipulation of parameters that effect the operation of a single transmitter. The command differs from the system command in that it requires a device ID to indicate which transmitter is being referred to. See [TRANSMITTER\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetTransmitterParameter](#), [GetTransmitterConfiguration](#), [GetTransmitterStatus](#)

## SetBoardParameter

The **SetBoardParameter** function takes as a parameter a pointer to a buffer containing the selected parameter values(s) to be changed.

```
int SetBoardParameter(
    USHORT boardID
    BOARD_PARAMETER_TYPE parameterType,
    void* pBuffer,
    int bufferSize
);
```

### Parameters

#### *boardID*

[in] Valid boardIDs are in the range 0..(n-1) where n is the number of boards in the system.

#### *parameterType*

[in] Contains the parameter type to be passed in the buffer. Must be a valid enumerated constant of the type [BOARD\\_PARAMETER\\_TYPE](#).

#### *pBuffer*

[out] Points to a buffer containing the information about the [BOARD\\_PARAMETER\\_TYPE](#) being changed.

WARNING: The size of the buffer must be equal to or greater than the size of the parameter being modified or the function may attempt to read from user memory.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*. Note the *bufferSize* value must match the size of the returned parameter exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the <i>bufferSize</i> parameter passed did not match the size of the parameter being returned.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type <a href="#">BOARD_PARAMETER_TYPE</a> used.
BIRD_ERROR_INVALID_DEVICE_ID	The boardID passed was out of range for the system.

### Remarks

The GetBoardParameter command is designed to allow the changing of parameters that effect the operation of a single board. The command differs from the system command in that it requires a board ID to indicate which board is being referred to. See [BOARD\\_PARAMETER\\_TYPE](#) for a description of the individual parameters.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[GetBoardParameter](#), [GetBoardConfiguration](#), [GetBoardStatus](#)

## GetAsynchronousRecord

The **GetAsynchronousRecord** function allows an application to acquire a position and orientation data record from an individual sensor or all possible sensors.

```
int GetAsynchronousRecord(
    USHORT sensorID
    void* pRecord,
    int recordSize
);
```

### Parameters

#### *sensorID*

[in] Valid sensorIDs for an individual sensor are in the range 0..(n-1) where n is the number of sensors in the system. A sensorID value of ALL\_SENSORS (-1), is used to request records from all possible sensors. Note that using the ALL\_SENSORS sensorID will result in data records in the specified buffer for both attached and not attached sensors (with IDs= 0 ..(n-1)).

#### *PRecord*

[out] Points to a buffer to be used for returning the data record. WARNING: The size of the buffer must be equal to or greater than the size of the data record requested or the function may overwrite user memory with indeterminate results. Note also that when requesting data from all sensors (ID=ALL\_SENSORS), the buffer size must account for size of the data record \* N, where N is the max number of sensors supported by the system.

#### *recordSize*

[in] Contains the size of the buffer whose address is passed in *pRecord*. Note the *recordSize* value must match the size of the currently selected DATA\_FORMAT\_TYPE exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_NO_SENSOR_ATTACHED	Request for data record from a sensor channel where no sensor is attached or the sensor has been removed.
BIRD_ERROR_NO_TRANSMITTER_RUNNING	Request for data record but there is no transmitter running. Either the application failed to turn a transmitter on or the currently running transmitter has a problem or has been removed. If a transmitter problem is suspected use the <a href="#">GetTransmitterStatus</a> function to determine the precise problem.
BIRD_ERROR_INCORRECT_RECORD_SIZE	The <i>recordSize</i> of the buffer passed to the function does not match the size of the data format currently selected.
BIRD_ERROR_SENSOR_SATURATED	The attached sensor which is otherwise OK has gone into saturation. This may occur if the sensor is too close to the transmitter or if the sensor is too close to metal

	or an external magnetic field.
BIRD_ERROR_CPU_TIMEOUT	3DGuidance on-board controller had insufficient time to execute the position and orientation algorithm. This frequently occurs because the 3DGuidance controller is being overwhelmed with user interface commands. Reduce the rate at which GetAsynchronousRecord is being called.
BIRD_ERROR_SENSOR_BAD	The attached sensor is not saturated but is exhibiting another unspecified problem which prevents it from operating normally. Use the <a href="#">GetSensorStatus</a> function to determine the precise problem.
BIRD_ERROR_INVALID_DEVICE_ID	The transmitterID passed was out of range for the system.
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. It is necessary to re-initialize the system to recover from this error. If this error is repeatable there is an unrecoverable hardware failure.

### Remarks

The GetAsynchronousRecord function is designed to immediately return the data record from the last computation cycle. If this function is called repeatedly and at a greater rate than the measurement cycle, there will be duplication of data records.

In order to call this function, it is necessary to have already set the data format of the sensor that the record is being obtained from using the [SetSensorParameter\(\)](#) function. Once that is done, it is necessary to pass the ID of the sensor and a pointer to a buffer where the data record(s) will be returned. It is also necessary to pass a parameter with the size of the buffer being passed. If there is a mismatch in the buffer sizes, the command is aborted and an error returned.

The enumerated data formats of type [DATA\\_FORMAT\\_TYPE](#) come in a number of general forms: integer, floating point, floating point with timestamp, floating point with timestamp and quality number, and all. For each form the user can select to have position only, angles only, attitude matrix only or quaternion only, or any of the previous combined with position returned.

See the [Status Code](#) reference section for recommendations on using the GetSensorStatus() call immediately after the GetXXXXRecord request. This can be an effective means of validating the position and orientation data records returned from the sensors.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetSynchronousRecord](#)

## GetSynchronousRecord

The **GetSynchronousRecord** function allows an application to acquire unique position and orientation data records for a given sensor (or from all possible sensors), only as they are computed by the tracker and become available – once per data acquisition cycle.

```
int GetSynchronousRecord(
    USHORT sensorID
    void* pRecord,
    int recordSize
);
```

### Parameters

#### *sensorID*

[in] Valid sensorIDs for an individual sensor are in the range 0..(n-1) where n is the number of sensors in the system. A sensorID value of ALL\_SENSORS (-1), is used to request records from all possible sensors. Note that using the ALL\_SENSORS sensorID will result in data records in the specified buffer for both attached and not attached sensors (with IDs= 0 ..(n-1)).

#### *pRecord*

[out] Points to a buffer to be used for returning the data record. WARNING: The size of the buffer must be equal to or greater than the size of the data record requested or the function may overwrite user memory with indeterminate results. Note also that when requesting data from all sensors (ID=ALL\_SENSORS), the buffer size must account for size of the data record \* N, where N is the max number of sensors supported by the system.

#### *recordSize*

[in] Contains the size of the buffer whose address is passed in *pRecord*. Note the *recordSize* value must match the size of the currently selected DATA\_FORMAT\_TYPE exactly.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_NO_SENSOR_ATTACHED	Request for data record from a sensor channel where no sensor is attached or the sensor has been removed.
BIRD_ERROR_NO_TRANSMITTER_RUNNING	Request for data record but there is no transmitter running. Either the application failed to turn a transmitter on or the currently running transmitter has a problem or has been removed. If a transmitter problem is suspected use the <a href="#">GetTransmitterStatus</a> function to determine the precise problem.
BIRD_ERROR_INCORRECT_RECORD_SIZE	The <i>recordSize</i> of the buffer passed to the function does not match the size of the data format currently selected.
BIRD_ERROR_SENSOR_SATURATED	The attached sensor which is otherwise OK has gone

	into saturation. This may occur if the sensor is too close to the transmitter or if the sensor is too close to metal or an external magnetic field.
BIRD_ERROR_CPU_TIMEOUT	3DGuidance on-board controller had insufficient time to execute the position and orientation algorithm. This frequently occurs because the 3DGuidance controller is being overwhelmed with user interface commands. Reduce the rate at which function is being called.
BIRD_ERROR_SENSOR_BAD	The attached sensor is not saturated but is exhibiting another unspecified problem which prevents it from operating normally. Use the <a href="#">GetSensorStatus</a> function to determine the precise problem.
BIRD_ERROR_INVALID_DEVICE_ID	The transmitterID passed was out of range for the system.
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. It is necessary to re-initialize the system to recover from this error. If this error is repeatable there is an unrecoverable hardware failure.

## Remarks

The GetSynchronousRecord function is designed to place the tracker in a data-reporting mode in which each and every computed data record is sent to the host. The result is a constant **STREAM** of data with timing that is independent of the arrival of the host data request during the measurement cycle. While this prevents the occurrence of duplicate records (as can occur when calling the GetAsynchronousRecord faster than the tracker update rate), it does not guarantee that records will not be overwritten. The buffer available to the system for each sensor is 8 records long. If the host application does not keep up with the constant stream of data being provided in this mode, this buffer will overflow and records will be lost.

Note that the rate at which records are transmitted when using the GetSynchronousRecord can be changed through use of the **Report Rate** divisor. This divisor reduces the number of records output during STREAM mode, to that determined by the setting. For example, at a system measurement rate of 80Hz and a Report Rate of 1, the trakSTAR will transmit  $80 * 3 = 240$  Updates/sec (1 record every 4mS) for each sensor. Changing the Report Rate setting to 4 will reduce the number of records to  $240/4 = 60$  Updates/sec (1 record every 17mS) for each sensor. The default Report Rate setting of 1 makes all outputs computed by the tracker available. See the [Report Rate](#) system parameter type, and the [Configurable Settings](#) section in Chapter 3 for details on changing the default setting.

Issuing commands (other than GetSynchronousRecord) that must query the unit for a response, will cause the unit to come out of **STREAM** mode (i.e GetXXXXConfiguration). Also note that hot-swapping sensors during STREAM mode operation will introduce delay in data for all sensor channels, as the unit must be taken out of this mode to detect and process info from the inserted sensor, then commanded to resume the STREAM mode operation.

As with the GetAsynchronous call, a record containing data from all sensors can be obtained by setting the sensor ID to ALL\_SENSORS. For legacy tracker users, this is the equivalent of Group Mode. Note also that when requesting data from all sensors (ID=ALL\_SENSORS), the buffer size must account for size of the data record \* N, where N is the max number of sensors supported by the system.

In order to call this function, it is necessary to have already set the data format of the sensor(s) that the record is being obtained from using the [SetSensorParameter\(\)](#) function. Once that is done, it is necessary to pass the ID of the sensor and a pointer to a buffer where the data record(s) will be returned. It is also necessary to pass a parameter with the size of the buffer being passed. If there is a mismatch in the buffer sizes, the command is aborted and an error returned.

The enumerated data formats of type [DATA\\_FORMAT\\_TYPE](#) come in a number of general forms: integer, floating point, floating point with timestamp, floating point with timestamp and quality number, and all. For each form the user can select to have position only, angles only, attitude matrix only or quaternion only, or any of the previous combined with position returned.

See the [Status Code](#) reference section for recommendations on using the GetSensorStatus() call immediately after the GetXXXXRecord request. This can be an effective means of validating the position and orientation data records returned from the sensors.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetAsynchronousRecord](#)

## GetBIRDError

The **GetBIRDError** function forces the system to interrogate the hardware and update all the device status records. These status records may then be inspected using the GetSensorStatus, GetTransmitterStatus and GetBoardStatus function calls.

```
int GetBIRDError();
```

### Parameters

This function takes no parameters

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_COMMAND_TIME_OUT	3DG guidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_WATCHDOG	3DG guidance internal watchdog timer has elapsed. It is necessary to re-initialize the system to recover from this error. If this error is repeatable there is an unrecoverable hardware failure.

### Remarks

The GetBIRDError function will cause the system to interrogate all boards and all sensor and transmitter channels on each board to determine the status of all attached and unattached devices. Consequently the execution of this command may take quite a long time and it is not recommended that it be called regularly. It should only be called after a period of inactivity to refresh the system's internal record of device status. Note: once the global status has been updated, specific device status will be regularly updated during calls to GetXXXRecord. For example: In a system with two boards there will exist eight sensor channels. Calling GetBIRDError will acquire the current status for all eight channels. If the application then starts to make calls to GetAsynchronousRecord for sensor number 2 then the status for that sensor will be updated as necessary during the data acquisition.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[GetErrorText](#)

## GetErrorText

The **GetErrorText** function returns a message string describing the nature of the error code passed to it.

```
int GetErrorText(
    int errorCode,
    char* pBuffer,
    int bufferSize,
    int type
);
```

### Parameters

#### *errorCode*

[in] Contains an *int* value representing the error code parameter whose message string will be returned from the call. Must be a valid enumerated constant of the type [BIRD\\_ERROR\\_CODES](#).

#### *pBuffer*

[out] Points to a buffer that will be used to hold the message string returned from the call. WARNING: The actual buffer size must be equal to or greater than the *bufferSize* value passed or the function may overwrite beyond the end of the buffer into user memory with indeterminate results. Note: If the buffer provided is shorter than the string returned, the string will be truncated to fit into the buffer.

#### *bufferSize*

[in] Contains the size of the buffer whose address is passed in *pBuffer*.

#### *type*

[in] Contains an *int* value of enumerated type MESSAGE\_TYPE which may have one of the following values:

Value	Meaning
SIMPLE_MESSAGE	A single line text string will be returned with a terse description of the error.
VERBOSE_MESSAGE	A more complete description of the error will be returned. The description may include possible causes of the error where appropriate and a description of the steps required to ameliorate the error condition.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid enumerated constant of type BIRD_ERROR_CODES was passed in parameter <i>errorCode</i> .

### Remarks

This is a helper function provided to simplify the error reporting process.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetBIRDError](#)

## GetSensorStatus

The **GetSensorStatus** will return the status of the selected sensor channel.

```
DEVICE_STATUS GetSensorStatus(
    USHORT sensorID,
);
```

### Parameters

*sensorID*

[in] The sensorID is in the range 0..(n-1) where n is the number of possible sensors in the system.

### Return Values

The function returns a value of type [DEVICE\\_STATUS](#). The returned value contains the status of the selected sensor channel. The bits in the status word have the following meanings:

Bit	Name	Meaning	S	B	R	T
0	GLOBAL_ERROR	Global error bit. If any other error status bits are set then this bit will be set.	x	x	x	x
1	NOT_ATTACHED	No physical device attached to this device channel.			x	x
2	SATURATED	Sensor currently saturated.			x	
3	BAD_EEPROM	PCB or attached device has a corrupt or unresponsive EEPROM		x	x	x
4	HARDWARE	Unspecified hardware fault condition is preventing normal operation of this device channel, board or the system.	x	x	x	x
5	NON_EXISTENT	The device ID used to obtain this status word is invalid. This device channel or board does not exist in the system.		x	x	x
6	UNINITIALIZED	The system has not been initialized yet. The system must be initialized at least once before any other commands can be issued. The system is initialized by calling <a href="#">InitializeBIRDSystem</a>	x	x	x	x
7	NO_TRANSMITTER_RUNNING	An attempt was made to call <a href="#">GetAsynchronousRecord</a> when no transmitter was running.	x	x	x	
8	BAD_12V	N/A for the 3DG systems				
9	CPU_TIMEOUT	N/A for the 3DG systems				
10	INVALID_DEVICE	The system has detected that the connected sensor does not match the port configuration (i.e. 5DOF sensor in 6DOF port).				
11	NO_TRANSMITTER_ATTACHED	A transmitter is not attached to the tracking system.	x	x	x	x
12	OUT_OF_MOTIONB_OX	The sensor has exceeded the maximum range and the position has been clamped to the maximum range			x	
13	ALGORITHM_INITIALIZING	The sensor has not acquired enough raw magnetic data to compute an accurate P&O solution. This is set in Non-Dipole configurations when the algorithm is lost.			x	
14 - 31	<reserved>	Always returns zero.	x	x	x	x

## Remarks

This function takes as its only parameter an index to a selected sensor. The function call returns a 32-bit status word.

No error codes are returned so it is not possible to determine if the call was successful through the standard process of inspecting the returned error code. But there are 2 possible runtime error conditions:

- 1) Calling the function before InitializeBIRDSSystem has been called
- 2) Calling the function with an invalid sensor ID.

Both these conditions have been taken care of by the addition of bits 5 and 6 in the status word.

- 1) If the function InitializeBIRDSSystem has not been called then the "UnInitialized" bit will be set.
- 2) If this function call was made with an invalid (out of range) sensor ID then the "Non-Existent" bit will be set.

The use of the Get...Status() function call(s) has the advantage, from the host application stand point, that no additional tracking communications take place during the course of this API call. This makes the use of these calls very fast and efficient, lending to use of the status value as an effective means for the host application to validate the position and orientation data records from the sensor.

Note that the status code is only updated with a call to either **GetAsynchronous()** or **GetSynchronousRecord()**. Therefore the status returned is always the status associated with the last data record requested. Determining if the sensor is operational can be done by simply testing to ensure that the status word = 0.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetSensorConfiguration](#), [GetSensorParameter](#), [SetSensorParameter](#)

## GetTransmitterStatus

The **GetTransmitterStatus** will return the status of the selected transmitter channel.

```
DEVICE_STATUS GetTransmitterStatus(
    USHORT transmitterID,
);
```

### Parameters

*transmitterID*

[in] The transmitterID is in the range 0..(n-1) where n is the number of possible transmitters in the system.

### Return Values

The function returns a value of type *DEVICE\_STATUS*. The returned value contains the status of the selected transmitter channel. The bits in the status word have the following meanings:

Bit	Name	Meaning	S	B	R	T
0	GLOBAL_ERROR	Global error bit. If any other error status bits are set then this bit will be set.	x	x	x	x
1	NOT_ATTACHED	No physical device attached to this device channel.			x	x
2	SATURATED	Sensor currently saturated.			x	
3	BAD_EEPROM	PCB or attached device has a corrupt or unresponsive EEPROM		x	x	x
4	HARDWARE	Unspecified hardware fault condition is preventing normal operation of this device channel, board or the system.	x	x	x	x
5	NON_EXISTENT	The device ID used to obtain this status word is invalid. This device channel or board does not exist in the system.		x	x	x
6	UNINITIALIZED	The system has not been initialized yet. The system must be initialized at least once before any other commands can be issued. The system is initialized by calling <a href="#">InitializeBIRDSystem</a>	x	x	x	x
7	NO_TRANSMITTER_RUNNING	An attempt was made to call <a href="#">GetAsynchronousRecord</a> when no transmitter was running.	x	x	x	
8	BAD_12V	N/A for the 3DG systems				
9	CPU_TIMEOUT	N/A for the 3DG systems				
10	INVALID_DEVICE	The system has detected that the connected sensor does not match the port configuration (i.e. 5DOF sensor in 6DOF port).				
11	NO_TRANSMITTER_ATTACHED	A transmitter is not attached to the tracking system.	x	x	x	x
12	OUT_OF_MOTIONBOARD	The sensor has exceeded the maximum range and the position has been clamped to the maximum range			x	
13	ALGORITHM_INITIALIZING	The sensor has not acquired enough raw magnetic data to compute an accurate P&O solution. This is set in Non-Dipole configurations when the algorithm is lost.			x	
14 - 31	<reserved>	Always returns zero.	x	x	x	x

## Remarks

This function takes as its only parameter an index to a selected transmitter. The function call returns a 32-bit status word.

No error codes are returned so it is not possible to determine if the call was successful through the standard process of inspecting the returned error code. But there are 2 possible runtime error conditions:

- 1) Calling the function before InitializeBIRDSystem has been called
- 2) Calling the function with an invalid transmitter ID.

Both these conditions have been taken care of by the addition of bits 5 and 6 in the status word.

- 1) If the function InitializeBIRDSystem has not been called then the "UnInitialized" bit will be set.
- 2) If this function call was made with an invalid (out of range) transmitter ID then the "Non-Existent" bit will be set.

Determining if the transmitter is operational can be done by simply testing to ensure that the status word = 0.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetTransmitterConfiguration](#), [GetTransmitterParameter](#), [SetTransmitterParameter](#)

## GetBoardStatus

The **GetBoardStatus** will return the status of the selected 3D guidance card.

```
DEVICE_STATUS GetBoardStatus(
    USHORT sensorID,
);
```

### Parameters

*boardID*

[in] The boardID is in the range 0..(n-1) where n is the number of units connected to the system.

### Return Values

The function returns a value of type *DEVICE\_STATUS*. The returned value contains the status of the selected 3Dguidance card. The bits in the status word have the following meanings:

Bit	Name	Meaning	S	B	R	T
0	GLOBAL_ERROR	Global error bit. If any other error status bits are set then this bit will be set.	x	x	x	x
1	NOT_ATTACHED	No physical device attached to this device channel.			x	x
2	SATURATED	Sensor currently saturated.			x	
3	BAD_EEPROM	PCB or attached device has a corrupt or unresponsive EEPROM		x	x	x
4	HARDWARE	Unspecified hardware fault condition is preventing normal operation of this device channel, board or the system.	x	x	x	x
5	NON_EXISTENT	The device ID used to obtain this status word is invalid. This device channel or board does not exist in the system.		x	x	x
6	UNINITIALIZED	The system has not been initialized yet. The system must be initialized at least once before any other commands can be issued. The system is initialized by calling <a href="#">InitializeBIRDSystem</a>	x	x	x	x
7	NO_TRANSMITTER_RUNNING	An attempt was made to call <a href="#">GetAsynchronousRecord</a> when no transmitter was running.	x	x	x	
8	BAD_12V	N/A for the 3DG systems				
9	CPU_TIMEOUT	N/A for the 3DG systems				
10	INVALID_DEVICE	The system has detected that the connected sensor does not match the port configuration (i.e. 5DOF sensor in 6DOF port).				
11	NO_TRANSMITTER_ATTACHED	A transmitter is not attached to the tracking system.	x	x	x	x
12	OUT_OF_MOTIONB_OX	The sensor has exceeded the maximum range and the position has been clamped to the maximum range			x	
13	ALGORITHM_INITIALIZING	The sensor has not acquired enough raw magnetic data to compute an accurate P&O solution. This set in Non-Dipole configurations when the algorithm is lost.			x	

14 - 31	<reserved>	Always returns zero.	x	x	x	x
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**Remarks**

This function takes as its only parameter an index to a selected 3Dguidance unit. The function call returns a 32-bit status word.

No error codes are returned so it is not possible to determine if the call was successful through the standard process of inspecting the returned error code. But there are 2 possible runtime error conditions:

- 1) Calling the function before InitializeBIRDSSystem has been called
- 2) Calling the function with an invalid board ID.

Both these conditions have been taken care of by the addition of bits 5 and 6 in the status word.

- 1) If the function InitializeBIRDSSystem has not been called then the "UnInitialized" bit will be set.
- 2) If this function call was made with an invalid (out of range) board ID then the "Non-Existent" bit will be set.

Determining if the board is operational can be done by simply testing to ensure that the status word = 0.

**Requirements**

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[GetBoardConfiguration](#), [GetBoardParameter](#), [SetBoardParameter](#)

## GetSystemStatus

The **GetSystemStatus** will return the status of the 3DG guidance system.

```
DEVICE_STATUS GetSystemStatus()
```

### Parameters

This function takes no parameters

### Return Values

The function returns a value of type *DEVICE\_STATUS*. The returned value contains the status of the 3DG guidance system. The bits in the status word have the following meanings:

Bit	Name	Meaning	S	B	R	T
0	GLOBAL_ERROR	Global error bit. If any other error status bits are set then this bit will be set.	x	x	x	x
1	NOT_ATTACHED	No physical device attached to this device channel.			x	x
2	SATURATED	Sensor currently saturated.			x	
3	BAD_EEPROM	PCB or attached device has a corrupt or unresponsive EEPROM		x	x	x
4	HARDWARE	Unspecified hardware fault condition is preventing normal operation of this device channel, board or the system.	x	x	x	x
5	NON_EXISTENT	The device ID used to obtain this status word is invalid. This device channel or board does not exist in the system.		x	x	x
6	UNINITIALIZED	The system has not been initialized yet. The system must be initialized at least once before any other commands can be issued. The system is initialized by calling <a href="#">InitializeBIRDSystem</a>	x	x	x	x
7	NO_TRANSMITTER_RUNNING	An attempt was made to call <a href="#">GetAsynchronousRecord</a> when no transmitter was running.	x	x	x	
8	BAD_12V	N/A for the 3DG systems				
9	CPU_TIMEOUT	N/A for the 3DG systems				
10	INVALID_DEVICE	The system has detected that the connected sensor does not match the port configuration (i.e. 5DOF sensor in 6DOF port).				
11	NO_TRANSMITTER_ATTACHED	A transmitter is not attached to the tracking system.	x	x	x	x
12	OUT_OF_MOTIONBOX	The sensor has exceeded the maximum range and the position has been clamped to the maximum range			x	
13	ALGORITHM_INITIALIZING	The sensor has not acquired enough raw magnetic data to compute an accurate P&O solution. This is set in Non-Dipole configurations when the algorithm is lost.			x	
14 - 31	<reserved>	Always returns zero.	x	x	x	x

## Remarks

No error codes are returned so it is not possible to determine if the call was successful through the standard process of inspecting the returned error code. But there is one possible runtime error condition, namely, calling the function before InitializeBIRDSSystem has been called. If the function InitializeBIRDSSystem has not been called then the "UnInitialized" bit will be set.

Determining if the system is operational can be done by simply testing the status word. The system is only operational when the status word = 0.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[GetBIRDSSystemConfiguration](#), [GetSystemParameter](#), [SetSystemParameter](#)

## SaveSystemConfiguration

The **SaveSystemConfiguration** will save the current setup of the system to a file.

```
int SaveSystemConfiguration(
    LPCTSTR lpFileName
);
```

### Parameters

*lpFileName*

[in] Pointer to a null-terminated string that specifies the name of the file to create.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_UNABLE_TO_CREATE_FILE	The call was unable to complete for some unspecified reason. Check the format of the file name string.
BIRD_ERROR_CONFIG_INTERNAL	Internal error in configuration file handler. Report to vendor.

### Remarks

The only parameter to this call is the null-terminated string containing the file name. Note: In order to include a backslash (\) as a separator in the file name string it is necessary to precede it with a second backslash. See the example below.

```
int error = SaveSystemConfiguration("C:\\Configurations\\MyConfiguration.ini");
```

NOTE: If the file name is given without a full pathname specification then the file will be saved into the current directory. For example in the following example if the application is executing from <C:\MyPrograms> then the following call

```
int error = SaveSystemConfiguration("MyConfiguration.ini");
```

will save the configuration file to <C:\MyPrograms\MyConfiguration.ini>. This default mode of operation differs from the [RestoreSystemConfiguration\(\)](#) call which uses the %windir%\inf directory as the default directory.

The configuration that is saved contains all of the parameters initialized using the [SetSystemParameter](#), [SetSensorParameter](#) and [SetTransmitterParameter](#) function calls. The parameters that can be initialized with each of these calls are listed in the enumerated types [SYSTEM\\_PARAMETER\\_TYPE](#), [SENSOR\\_PARAMETER\\_TYPE](#) and [TRANSMITTER\\_PARAMETER\\_TYPE](#). Any parameters that are uninitialized will be saved with their default values.

The file format is described in [3D Guidance Initialization File Format](#) section.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also** [RestoreSystemConfiguration](#)

## RestoreSystemConfiguration

The **RestoreSystemConfiguration** will restore the system configuration to a previous state that has been saved in a file.

```
int RestoreSystemConfiguration(
    LPCTSTR lpFileName
);
```

### Parameters

*lpFileName*

[in] Pointer to a null-terminated string that specifies the name of the file to open.

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_UNABLE_TO_OPEN_FILE	The call was unable to complete for some unspecified reason. Check the format of the file name string.
BIRD_ERROR_MISSING_CONFIGURATION_ITEM	A mandatory configuration item was missing from the initialization file. Review contents of initialization file or use SaveSystemConfiguration() to automatically save a correctly formatted initialization file.
BIRD_ERROR_MISMATCHED_DATA	Data item in the initialization file does not match a system parameter. For example the initialization file states the system has 3 boards (NumberOfBoards=3) but the system initialization routine – InitializeBIRDSystem() only detected two.
BIRD_ERROR_CONFIG_INTERNAL	Internal error in configuration file handler. Report to vendor.

### Remarks

The only parameter to this call is the null-terminated string containing the file name. Note: In order to include a backslash (\) as a separator in the file name string it is necessary to precede it with a second backslash. See the example below.

```
int error = RestoreSystemConfiguration("C:\\Configurations\\MyConfiguration.ini");
```

NOTE: if the full pathname specification is not provided then the default search path is in the working directory. If the file is not found there then a BIRD\_ERROR\_UNABLE\_TO\_OPEN\_FILE error is generated.

The configuration that is restored contains all of the parameters that can be alternatively initialized using the SetSystemParameter, SetSensorParameter and SetTransmitterParameter function calls. The parameters that can be initialized with each of these calls are listed in the enumerated types SYSTEM\_PARAMETER\_TYPE, SENSOR\_PARAMETER\_TYPE and TRANSMITTER\_PARAMETER\_TYPE.

The file format is described in [3DGuidance Initialization File Format](#).

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

**See Also**

[SaveSystemConfiguration](#)

## CloseBIRDSystem

The **CloseBIRDSystem** function closes the 3DGGuidance system down.

```
int CloseBIRDSystem();
```

### Parameters

This function takes no parameters

### Return Values

The function returns a value of type *int*. This value takes the form of an [ERRORCODE](#) indicating success or failure for the call. The enumerated error code field contained within the 32-bit [ERRORCODE](#) may have one of the following values for this function call:

Value	Meaning
BIRD_ERROR_SUCCESS	No errors occurred. Call completed successfully

### Remarks

The CloseBIRDSystem function will return the 3DGGuidance system to an uninitialized state and release all resources and handles that were being used. It is recommended that this be called prior to terminating an application that has been using the 3DGGuidance system in order to prevent memory and/or resource leaks.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[InitializeBIRDSystem](#)

# 3D Guidance API Structures

The following structures are used with the 3DGuidance system.

[SYSTEM CONFIGURATION](#)  
[SENSOR CONFIGURATION](#)  
[TRANSMITTER CONFIGURATION](#)  
[BOARD CONFIGURATION](#)  
[ADAPTIVE PARAMETERS](#)  
[QUALITY PARAMETERS](#)  
[VPD COMMAND PARAMETER](#)  
[POST ERROR PARAMETER](#)  
[DIAGNOSTIC TEST PARAMETER](#)  
[BOARD REVISIONS](#)

Data record structures:

[SHORT POSITION RECORD](#)  
[SHORT ANGLES RECORD](#)  
[SHORT MATRIX RECORD](#)  
[SHORT QUATERNIONS RECORD](#)  
[SHORT POSITION ANGLES RECORD](#)  
[SHORT POSITION MATRIX RECORD](#)  
[SHORT POSITION QUATERNION RECORD](#)  
[DOUBLE POSITION RECORD](#)  
[DOUBLE ANGLES RECORD](#)  
[DOUBLE MATRIX RECORD](#)  
[DOUBLE QUATERNIONS RECORD](#)  
[DOUBLE POSITION ANGLES RECORD](#)  
[DOUBLE POSITION MATRIX RECORD](#)  
[DOUBLE POSITION QUATERNION RECORD](#)  
[DOUBLE POSITION TIME STAMP RECORD](#)  
[DOUBLE ANGLES TIME STAMP RECORD](#)  
[DOUBLE MATRIX TIME STAMP RECORD](#)  
[DOUBLE QUATERNIONS TIME STAMP RECORD](#)  
[DOUBLE POSITION ANGLES TIME STAMP RECORD](#)  
[DOUBLE POSITION MATRIX TIME STAMP RECORD](#)  
[DOUBLE POSITION QUATERNION TIME STAMP RECORD](#)  
[DOUBLE POSITION TIME Q RECORD](#)  
[DOUBLE ANGLES TIME Q RECORD](#)  
[DOUBLE MATRIX TIME Q RECORD](#)  
[DOUBLE QUATERNIONS TIME Q RECORD](#)  
[DOUBLE POSITION ANGLES TIME Q RECORD](#)  
[DOUBLE POSITION MATRIX TIME Q RECORD](#)  
[DOUBLE POSITION QUATERNION TIME Q RECORD](#)  
[SHORT ALL RECORD](#)  
[DOUBLE ALL RECORD](#)  
[DOUBLE ALL TIME STAMP RECORD](#)  
[DOUBLE ALL TIME STAMP Q RECORD](#)  
[DOUBLE ALL TIME STAMP Q RAW RECORD](#)

## SYSTEM\_CONFIGURATION

The **SYSTEM\_CONFIGURATION** structure contains the system information.

```
typedef struct tagSYSTEM_CONFIGURATION{
    double      measurementRate;
    double      powerLineFrequency;
    double      maximumRange;
    AGC_MODE_TYPE agcMode;
    int         numberBoards;
    int         numberSensors;
    int         numberTransmitters;
    int         transmitterIDRunning;
    bool        metric;
} SYSTEM_CONFIGURATION, *PSYSTEM_CONFIGURATION;
```

### Members

#### **measurementRate**

Indicates the current measurement rate of the tracking system. Default is 80.0 Hz.

#### **powerLineFrequency**

Indicates current power line frequency being used to set filter coefficients; Default line frequency is 60 Hz.

#### **maximumRange**

Indicates scale factor used by the tracker to report position of sensor with respect to the transmitter. Valid value of 36, represents full-scale position output in inches.

#### **agcMode**

Enumerated constant of the type: AGC\_MODE\_TYPE. Setting the mode to SENSOR\_AGC\_ONLY disables the normal transmitter power level switching.

#### **numberBoards**

Indicates the number of 3DG guidance cards connected/installed.

#### **numberSensors**

Indicates the number of ports available to plug in sensors.

#### **numberTransmitters**

Indicates the number of ports available to plug in transmitters.

#### **transmitterIDRunning**

Indicates ID of the transmitter that is ON.

Default is -1 (Transmitter OFF).

#### **metric**

TRUE = data output in millimeters

FALSE = output in inches (default)

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## TRANSMITTER\_CONFIGURATION

The **TRANSMITTER\_CONFIGURATION** structure contains an individual transmitter's information.

```
Typedef struct tagTRANSMITTER_CONFIGURATION{
    ULONG         serialNumber;
    USHORT        boardNumber;
    USHORT        channelNumber;
    DEVICE_TYPES  type;
    bool          attached;
} TRANSMITTER_CONFIGURATION, *PTRANSMITTER_CONFIGURATION;
```

### Members

#### **serialNumber**

The serial number of the attached transmitter. If no transmitter is attached this value is zero

#### **boardNumber**

The id number of the board for this transmitter channel.

#### **channelNumber**

The number of the channel on the board where this transmitter is located. Note: Currently boards only support single transmitters so this value will always be 0.

#### **type**

Contains a value of enumerated type [DEVICE\\_TYPES](#). Note however that the DEVICE\_TYPES enumerated type WILL NOT support future transmitters. The MODEL\_STRING and PART\_NUMBER parameter types have replaced this functionality.

#### **attached**

Contains a value of type *bool* whose value will be *true* if there is a transmitter attached otherwise it will be *false* if there is no transmitter attached. This value may be *true* even if there is a problem with the transmitter. A call should be made to GetTransmitterStatus to determine the operational state of the transmitter.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## SENSOR\_CONFIGURATION

The **SENSOR\_CONFIGURATION** structure contains an individual sensor's information.

```
typedef struct tagSENSOR_CONFIGURATION{
    ULONG          serialNumber;
    USHORT         boardNumber;
    USHORT         channelNumber;
    DEVICE_TYPES   type;
    bool           attached;
} SENSOR_CONFIGURATION, *PSENSOR_CONFIGURATION;
```

### Members

#### **serialNumber**

The serial number of the attached sensor. If no sensor is attached this value is zero

#### **boardNumber**

The id number of the board for this sensor channel.

#### **channelNumber**

The number of the channel on the board where this sensor is located.

#### **type**

Contains a value of enumerated type [DEVICE\\_TYPES](#). Note however that the DEVICE\_TYPES enumerated type WILL NOT support future sensors. The MODEL\_STRING and PART\_NUMBER parameter types have replaced this functionality.

#### **attached**

Contains a value of type *bool* whose value will be *true* if there is a sensor attached otherwise it will be *false* if there is no sensor attached. This value may be *true* even if there is a problem with the sensor. A call should be made to GetSensorStatus to determine the operational state of the sensor.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## BOARD\_CONFIGURATION

The **BOARD\_CONFIGURATION** structure contains an individual board's information.

```
typedef struct tagBOARD_CONFIGURATION{
    ULONG             serialNumber;
    BOARD_TYPES       type;
    USHORT            revision;
    USHORT            numberTransmitters;
    USHORT            numberSensors;
    USHORT            firmwareNumber;
    USHORT            firmwareRevision;
    Char              modelString[10];
} BOARD_CONFIGURATION, *PBOARD_CONFIGURATION;
```

### Members

#### **serialNumber**

The serial number of the board.

#### **type**

The board type. The type is of the enumeration type [BOARD\\_TYPES](#). Note however that the BOARD\_TYPES enumerated type WILL NOT support future boards. The MODEL\_STRING and PART\_NUMBER parameter types have replaced this functionality.

#### **revision**

The board ECO revision number.

#### **numberTransmitters**

This value denotes the number of available transmitter channels supported by this board.

#### **numberSensors**

This value denotes the number of available sensor channels supported by this board.

#### **firmwareNumber**

The firmware version of the on-board firmware is a two part number usually denoted as a number and a fraction, e.g. 3.85. The integer number part is contained in the firmwareNumber.

#### **firmwareRevision**

The firmwareRevision contains the fractional part of the firmware version number.

#### **modelString[10]**

Each board has a configuration EEPROM. Contained in the EEPROM are the calibration values belonging to the board. Also contained in the EEPROM is a "model string" which is used to identify the board type. The modelString is a 10 character array which contains the "model string". The string is not null-terminated. For example the driveBAY/trakSTAR systems supporting 6DOF operation will have the string "6DBB4 ". The string is padded with space characters to the end of the buffer.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## ADAPTIVE\_PARAMETERS

The **ADAPTIVE\_PARAMETERS** structure contains the adaptive DC filter parameters for an individual sensor channel.

```
typedef struct tagADAPTIVE_PARAMETERS{
    USHORT          alphaMin[ 7 ];
    USHORT          alphaMax[ 7 ];
    USHORT          vm[ 7 ];
    bool            alphaOn;
} ADAPTIVE_PARAMETERS, *PADAPTIVE_PARAMETERS;
```

### Members

#### **alphaMin[7]**

The **alphaMin** values define the lower ends of the adaptive range that the filter constant alpha can assume in the DC filter, as a function of sensor to transmitter. NOTE: Each of the 7 array positions corresponds to a sensor gain setting with position 0 corresponding to the lowest gain setting when the sensor is closest to the transmitter.

#### **alphaMax[7]**

The **alphaMax** values define the upper ends of the adaptive range that the filter constant alpha can assume in the DC filter, as a function of sensor to transmitter. NOTE: Each of the 7 array positions corresponds to a sensor gain setting with position 0 corresponding to the lowest gain setting when the sensor is closest to the transmitter.

#### **vm[7]**

The 7 words that make up the **vm** array represent the expected noise that the DC filter will measure. By changing the table values, you can increase or decrease the DC filter's lag as a function of sensor range from the transmitter. NOTE: Each of the 7 array positions corresponds to a sensor gain setting with position 0 corresponding to the lowest gain setting when the sensor is closest to the transmitter.

#### **alphaOn**

This boolean value is used to enable or disable the adaptive DC filter.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## QUALITY\_PARAMETERS

The **QUALITY\_PARAMETERS** structure contains the parameters used to setup the distortion detection algorithm for an individual sensor channel.

```
typedef struct tagQUALITY_PARAMETERS{
    SHORT          error_slope;
    SHORT          error_offset;
    USHORT         error_sensitivity;
    USHORT         filter_alpha;
} QUALITY_PARAMETERS, *PQUALITY_PARAMETERS;
```

### Members

#### **error\_slope**

This value is the slope of the inherent system error. It will need to be adjusted depending on the type of hardware used. The final distortion error delivered to the application is the total system error – inherent system error. Valid values range between -127 and 127.

#### **error\_offset**

This value is the offset of the inherent system error. Valid values range between -127 and 127.

#### **error\_sensitivity**

This value is used to increase or decrease the sensitivity of the algorithm to distortion error. The distortion error is equal to the total system error – inherent system error. This value is then multiplied by the error\_sensitivity. Valid values range between 0 and 127.

#### **filter\_alpha**

The output error value has considerable noise in it. An alpha filter is used to filter the output value. The amount of filtering applied can be adjusted by setting the filter\_alpha value. Valid values range between 0 and 127.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## VPD\_COMMAND\_PARAMETER

The **VPD\_COMMAND\_PARAMETER** structure contains the parameters used during reading and writing to the Vital Product Data (VPD) storage area. The VPD is a 512-byte storage area located in EEPROM on the main electronic unit (EU). Using the **SetSystemParameter()** and **GetSystemParameter()** commands it is possible to read and write individual bytes within the VPD storage area.

```
typedef struct tagVPD_COMMAND_PARAMETER{
    USHORT      address;
    UCHAR       value;
} VPD_COMMAND_PARAMETER;
```

### Members

#### **address**

This value is the address of a byte location within the VPD that is the target for either a read or a write operation.

#### **value**

This parameter contains the actual value to be written to the VPD location specified by **address** during a write operation (**SetSystemParameter()**) or it is a location where the value read from the VPD will be placed during a read operation (**GetSystemParameter()**).

**NOTE:** The VITAL\_PRODUCT\_DATA\_PCB ([board parameter type](#)) has replaced this functionality.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## POST\_ERROR\_PARAMETER

The **POST\_ERROR\_PARAMETER** structure contains the parameters used to report errors generated during the POST (Power on Self-Test) sequence. Note that when used with Multi-Unit Synch configurations, passing this parameter with the `GetSystemParameter()` call will only access those POST errors generated on the first unit (Multi-Unit ID =0). The [POST\\_ERROR\\_PARAMETER](#) board parameter type should be used with the `GetBoardParameter()` call, for accessing these errors across multiple units.

```
typedef struct tag POST_ERROR_PARAMETER{
    USHORT      error;
    UCHAR       channel;
    UCHAR       fatal;
    UCHAR       moreErrors;

} POST_ERROR_PARAMETER;
```

### Members

#### **error**

Contains a 32-bit value representing the error code parameter that was reported from the POST sequence. This value takes the form of a standard [ERRORCODE](#), indicating success or failure. The enumerated error code field contained within the 32-bit [ERRORCODE](#) will be of the type [BIRD\\_ERROR\\_CODES](#). A message string describing the nature of the error code can be obtained by passing the error to the [GetErrorText](#) function.

#### **channel**

This value contains the ID number of the sensor channel in which the POST error was detected.

#### **fatal**

This value indicates whether or not the error detected and reported by the POST sequence is a fatal error or just a warning.

#### **moreErrors**

The moreErrors value is used to indicate if additional POST errors are in the Error buffer, waiting to be read.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DIAGNOSTIC\_TEST\_PARAMETERS

The **DIAGNOSTIC\_TEST\_PARAMETERS** structure contains the parameters needed to perform various diagnostic test functions. It is used by the GetSystemParameter() and the SetSystemParameter() function calls. Note however that when used with Multi-Unit Synch configurations, the Get/Setsystem parameter will only access those diagnostic tests on the first unit (Multi-Unit ID =0). The [DIAGNOSTIC\\_TEST\\_PCB](#) board parameter type should be used with the Get/SetBoardParameter() calls, for accessing these tests across multiple units.

The diagnostic tests provided by a system are divided into suites of tests, where each suite typically provides a group of related tests, for example, sensor tests. By passing this structure with the parameters appropriately set the user can select one, an entire suite or the entire set of tests to be executed.

**NOTE:** Error terminology used within this command: There are 2 basic types of error. The first type is an error in the command invocation, namely, use of incorrect parameter values and/or sizes. This is called a *Call Error*. The second type of error is the error reported back from the tracking system as a consequence of having performed and failed a diagnostic test. This is called a *Diagnostic Error*.

```
typedef struct tagDIAGNOSTIC_TEST_PARAMETERS{
    UCHAR          suite;
    UCHAR          test;
    UCHAR          suites;
    UCHAR          tests;
    PUCHAR        *pTestName;
    USHORT         testNameLen;
    USHORT         *diagError;
} DIAGNOSTIC_TEST_PARAMETERS, *PDIAGNOSTIC_TEST_PARAMETERS;
```

### Members

#### suite

This parameter determines which test suite is being referenced. The test suites are numbered using a base of 1. If the suite number is set greater than the maximum number of suites available then a Call Error message will be returned. If the suite number is set to zero then the entire diagnostic set is being referenced.

#### test

This parameter is used to select the individual test within a test suite to reference. The tests are numbered using a base of 1. If the test number provided exceeds the number of tests in the suite a Call Error will be returned. If the test number passed is zero then the entire set of tests in the selected suite is being referenced.

#### suites

This parameter is a “don’t care” when passed to the function. Upon return it can have a number of different meanings depending upon the situation where it was used. See Table 9.

#### tests

This parameter is a “don’t care” when passed to the function. Upon return it can have a number of different meanings depending upon the situation where it was used. See Table 9.

#### pTestName

This parameter is a pointer provided to a buffer, which should be large enough to hold a string containing the name of the last test to be referenced by the selected diagnostic(s). If the diagnostics all run to completion successfully this name will be the name of the last test. The user should provide a buffer 64 bytes long. This buffer is long enough to contain 2 names each 32 bytes long. The first name is the title of the Test Suite and the second name if present is the title of the individual Diagnostic Test referenced.

#### testNameLen

This parameter is an unsigned short whose value is the length of the TestName buffer provided by the user whose pointer is provided by pTestName. It is essential that the length parameter match the actual length of the buffer supplied otherwise buffer overruns may occur with unpredictable consequences.

#### diagError

This parameter is a USHORT where the call will return an error code if the diagnostic fails otherwise the contents will be zero.

GetSystemParameter() and SetSystemParameter() Diagnostic Test Usage							
Call	Action	Input Param.		Output Parameter			
		Suite	Test	Suites	Tests	TestName	DiagError
GetSystemParameter()	Get number of test suites available.	0	0 (Don't care)	Total number of suites available.  If no diagnostics are supported this value will be zero.	Don't care	Don't Care	Don't Care.
GetSystemParameter()	Get number of tests available in selected suite.	N	0	Suite number N is returned	Total number of tests available in the suite	32 character zero terminated string containing the <b>Suite Name</b>	Error* if N > Total number of available suites.
GetSystemParameter()	Get string name of individual test.	N	M	Suite number N is returned	Test number M is returned.	64 character zero terminated string containing the <b>Suite/Test Name</b> .	Error* if N > Total number of available suites.  Error if M > Total number of available tests within this suite.
SetSystemParameter()	Execute entire set of available diagnostic tests.	0	0 (Don't Care)	<b>If successful</b> returns the number of the final suite.  <b>If fails</b> stops at and returns the number of the suite	<b>If successful</b> returns the number of the final test.  <b>If fails</b> stops at and returns the number of the test	64 character zero terminated string containing the <b>Suite/Test Name</b> .	<b>If successful</b> returns an error code of zero  <b>If fails</b> returns an error code. *
SetSystemParameter()	Execute entire set of tests for the selected suite.	N	0	Suite number N is returned.	<b>If successful</b> returns the number of the final test.  <b>If fails</b> stops at and returns the number of the test	64 character zero terminated string containing the <b>Suite/Test name</b> .	<b>If successful</b> returns an error code of zero  <b>If fails</b> returns an error code. *
SetSystemParameter()	Execute an individual diagnostic test.	N	M	Suite number N is returned.	Test number M is returned.	64 character zero terminated string containing the <b>Suite/Test name</b> .	<b>If successful</b> returns an error code of zero  <b>If fails</b> returns an error code. *

Table 9 Diagnostic Test Usage

\* NOTE: A character string describing the error condition can be obtained by calling GetErrorText() and passing the error code.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in PCIBird3.h

**Library:** Use PCIBird3.lib

## See Also

## COMMUNICATIONS\_MEDIA\_PARAMETERS

The **COMMUNICATIONS\_MEDIA\_PARAMETERS** structure contains the parameters needed to configure the various communication protocols. It can be used by the GetSystemParameter() and the SetSystemParameter() function calls prior to initialization, and provides API access to those items stored in the system configuration file (i.e. ATC3DG.ini). NOTE: Users without Windows Modify privileges (i.e. Admin) may receive the error 'BIRD\_ERROR\_UNABLE\_TO\_OPEN\_FILE' when calling the SetSystemParameter() call with these 'pre-init' parameters.

```
typedef struct tagCOMMUNICATIONS_MEDIA_PARAMETERS
{
    COMMUNICATIONS_MEDIA_TYPE mediaType;
    union
    {
        struct
        {
            CHAR comport[64];
        } rs232;
        struct
        {
            USHORT port;
            CHAR ipaddr[64];
        } tcpip;
    };
} COMMUNICATIONS_MEDIA_PARAMETERS;
```

### Members

#### **mediaType**

This parameter defines the communications media to use for subsequent calls to InitBIRDSystem(). See [COMMUNICATIONS MEDIA TYPES](#) for valid values.

#### **rs232.comport**

This parameter is used only for the RS232 media type. This parameter defines the name of the RS232 communications port. Valid string format are "COMX" where X is the RS232 communications port number.

#### **tcpip.port**

This parameter is used only for the TCPIP media type. This parameter defines the port number to use for establishing a TCP/IP session with the tracking device.

#### **tcpip.ipaddr**

This parameter is used only for the TCPIP media type. This parameter defines IP address to use for establishing a TCP/IP session with the tracking device. This parameter is required to be in dotted decimal internet addressing format.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## BOARD\_REVISIONS

The **BOARD\_REVISIONS** structure contains the parameters used to return the revisions of the firmware in the 3DGuidance board.

```
typedef struct tagBOARD_REVISIONS{
    USHORT      boot_loader_sw_number;
    USHORT      boot_loader_sw_revision;
    USHORT      mdsp_sw_number;
    USHORT      mdsp_sw_revision;
    USHORT      nondipole_sw_number;
    USHORT      nondipole_sw_revision;
    USHORT      fivedof_sw_number;
    USHORT      fivedof_sw_revision;
    USHORT      sixdof_sw_number;
    USHORT      sixdof_sw_revision;
    USHORT      dipole_sw_number;
    USHORT      dipole_sw_revision;
} BOARD_REVISIONS;
```

### Members

#### **boot\_loader\_sw\_number**

Major revision number for the boot loader.

#### **boot\_loader\_sw\_revision**

Minor revision number for the boot loader.

#### **mdsp\_sw\_number**

Major revision number for the acquisition DSP.

#### **mdsp\_sw\_revision**

Minor revision number for the acquisition DSP.

#### **nondipole\_sw\_number**

Major revision number for the nondipole DSP.

#### **nondipole\_sw\_revision**

Minor revision number for the nondipole DSP.

#### **fivedof\_sw\_number**

Major revision number for the 5DOF DSP.

#### **fivedof\_sw\_revision**

Minor revision number for the 5DOF DSP.

#### **sixdof\_sw\_number**

Major revision number for the 6DOF DSP.

#### **sixdof\_sw\_revision**

Minor revision number for the 6DOF DSP.

#### **dipole\_sw\_number**

Major revision number for the dipole DSP.

#### **dipole\_sw\_revision**

Minor revision number for the dipole DSP.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## SHORT\_POSITION\_RECORD

The **SHORT\_POSITION\_RECORD** structure contains position information only in 16-bit signed integer format.

```
typedef struct tagSHORT_POSITION{
    short          x;
    short          y;
    short          z;
} SHORT_POSITION_RECORD, *PSHORT_POSITION_RECORD;
```

### Members

**x**

This is the x position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

**y**

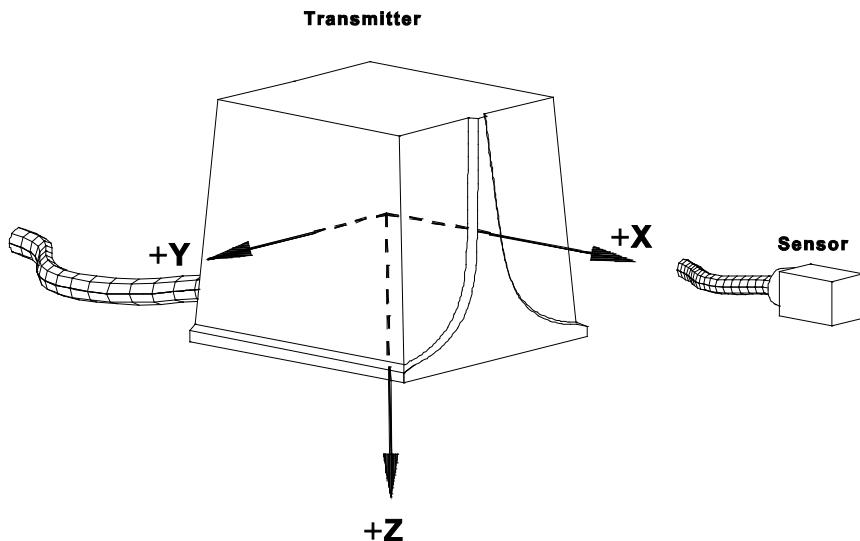
This is the y position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

**z**

This is the z position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

### Remarks

The X, Y and Z values vary between the binary equivalent of +/- maximum range. The positive X, Y and Z directions are shown below.



**Figure 49 : Measurement Reference Frame (Mid-Range Transmitter)**

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## SHORTANGLES\_RECORD

The **SHORTANGLES\_RECORD** structure contains Euler angle information only in 16-bit signed integer format.

```
typedef struct tagSHORTANGLES{
    short          a;
    short          e;
    short          r;
} SHORTANGLES_RECORD, *PSHORTANGLES_RECORD;
```

### Members

**a**

This value is the azimuth angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

**e**

This value is the elevation angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

**r**

This value is the roll angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

### Remarks

In the ANGLES mode, the Tracker outputs the orientation angles of the sensor with respect to the transmitter. The orientation angles are defined as rotations about the Z, Y, and X axes of the sensor. These angles are called Zang, Yang, and Xang or, in Euler angle nomenclature, Azimuth, Elevation, and Roll.

Zang (Azimuth) takes on values between the binary equivalent of +/- 180 degrees. Yang (Elevation) takes on values between +/- 90 degrees, and Xang (Roll) takes on values between +/- 180 degrees. As Yang (Elevation) approaches +/- 90 degrees, the Zang (Azimuth) and Xang (Roll) become very noisy and exhibit large errors. At 90 degrees the Zang (Azimuth) and Xang (Roll) become undefined. **This behavior is not a limitation of the Tracker - it is an inherent characteristic of these Euler angles.** If you need a stable representation of the sensor orientation at high Elevation angles, use the MATRIX output mode.

The scaling of all angles is full scale = 180 degrees. That is, +179.99 deg = 7FFF Hex, 0 deg = 0 Hex, -180.00 deg = 8000 Hex.

Angle information is 0 when sensor saturation occurs.

To convert the numbers received into angles in degrees, first multiply by 180 and finally divide the number by 32768 to get the angle. The equation should look something like:

$$\text{Angle} = (\text{signed int} * 180) / 32768;$$

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## SHORT\_MATRIX\_RECORD

The **SHORT\_MATRIX\_RECORD** structure contains only the 3x3 rotation matrix 'S' in 16-bit signed integer format.

```
typedef struct tagSHORT_MATRIX{
    short             s[3][3];
} SHORT_MATRIX_RECORD, *PSHORT_MATRIX_RECORD;
```

### Members

#### s[3][3]

This is a 3x3 array of values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

### Remarks

The MATRIX mode outputs the 9 elements of the rotation matrix that **define the orientation of the sensor's X, Y, and Z axes with respect to the transmitter's X, Y, and Z axes**.

Each row of the matrix describes the orientation of one of the sensor's axis in the transmitter's frame of reference. So if the first row of the matrix was [.75, .10, .66], it would mean that in the transmitter's coordinate frame, the sensor's x-axis is a vector in the direction <.75, .10, .66>. The second row is the sensor's y-axis, the third row is the z-axis. Each row (and column) will have a length of 1. Each row will be orthogonal (90 degree difference) to every other row (and every column will be orthogonal to every other column).

In graphics applications the rotation matrix is used to rotate the 3-D coordinates of the item being drawn. To do this, **the transpose of the Ascension matrix is used (the rows become the columns)**.

Say you want your 3D model to follow the orientation of the sensor. Multiply the transpose of the Ascension rotation matrix by the 3D position of each point in the model. newPt = M.transpose() \* pt. Where pt is a 3x1 vector containing the object's point.

The nine elements of the output matrix are defined generically by:

$$\begin{vmatrix} M(1,1) & M(1,2) & M(1,3) \\ M(2,1) & M(2,2) & M(2,3) \\ M(3,1) & M(3,2) & M(3,3) \end{vmatrix}$$

Or in terms of the rotation angles about each axis where **Z** = **Zang**, **Y** = **Yang** and **X** = **Xang**:

$\cos(Y) * \cos(Z)$	$\cos(Y) * \sin(Z)$	$-\sin(Y)$
$-(\cos(X) * \sin(Z))$ $+(\sin(X) * \sin(Y) * \cos(Z))$	$(\cos(X) * \cos(Z))$ $+(\sin(X) * \sin(Y) * \sin(Z))$	$\sin(X) * \cos(Y)$
$(\sin(X) * \sin(Z))$ $+(\cos(X) * \sin(Y) * \cos(Z))$	$-(\sin(X) * \cos(Z))$ $+(\cos(X) * \sin(Y) * \sin(Z))$	$\cos(X) * \cos(Y)$

Or in Euler angle notation, where R = Roll, E = Elevation, A = Azimuth:

$\cos(E) * \cos(A)$	$\cos(E) * \sin(A)$	$-\sin(E)$
$-(\cos(R) * \sin(A))$ $+(\sin(R) * \sin(E) * \cos(A))$	$(\cos(R) * \cos(A))$ $+(\sin(R) * \sin(E) * \sin(A))$	$\sin(R) * \cos(E)$
$(\sin(R) * \sin(A))$ $+(\cos(R) * \sin(E) * \cos(A))$	$-(\sin(R) * \cos(A))$ $+(\cos(R) * \sin(E) * \sin(A))$	$\cos(R) * \cos(E)$

The matrix elements take values between the binary equivalents of +.99996 and -1.0.

Element scaling is +.99996 = 7FFF Hex, 0 = 0 Hex, and -1.0 = 8000 Hex.

Matrix information is 0 when sensor saturation occurs.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## SHORT\_QUATERNIONS\_RECORD

The **SHORT\_QUATERNIONS\_RECORD** structure contains only the 4 quaternion values in 16-bit signed integer format.

```
typedef struct tagSHORT_QUATERNIONS{
    short             q[4];
} SHORT_QUATERNIONS_RECORD, *PSHORT_QUATERNIONS_RECORD;
```

### Members

#### **q[4]**

This is an array of 4 quaternion values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

### Remarks

In the QUATERNION mode, the Tracker outputs the four quaternion parameters that describe the orientation of the sensor with respect to the transmitter. The quaternions,  $q_0$ ,  $q_1$ ,  $q_2$ , and  $q_3$  where  $q_0$  is the scalar component, have been extracted from the MATRIX output using the algorithm described in "Quaternion from Rotation Matrix" by Stanley W. Shepperd, Journal of Guidance and Control, Vol. 1, May-June 1978, pp. 223-4.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## SHORT\_POSITION\_ANGLES\_RECORD

The **SHORT\_POSITION\_ANGLES\_RECORD** structure contains position and angles information in 16-bit signed integer format.

```
typedef struct tagSHORT_POSITION_ANGLES{
    short          x;
    short          y;
    short          z;
    short          a;
    short          e;
    short          r;
} SHORT_POSITION_ANGLES_RECORD, *PSHORT_POSITION_ANGLES_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### y

This is the y position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### z

This is the z position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### a

This value is the azimuth angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

#### e

This value is the elevation angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

#### r

This value is the roll angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[SHORT\\_POSITION\\_RECORD](#), [SHORT\\_POSITION\\_ANGLES\\_RECORD](#)

## SHORT\_POSITION\_MATRIX\_RECORD

The **SHORT\_POSITION\_MATRIX\_RECORD** structure contains position and matrix information in 16-bit signed integer format.

```
typedef struct tagSHORT_POSITION_MATRIX{
    short          x;
    short          y;
    short          z;
    short         s[3][3];
} SHORT_POSITION_MATRIX_RECORD, *PSHORT_POSITION_MATRIX_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### y

This is the y position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### z

This is the z position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### s[3][3]

This is a 3x3 array of values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[SHORT\\_POSITION\\_RECORD](#), [SHORT\\_MATRIX\\_RECORD](#)

## SHORT\_POSITION\_QUATERNION\_RECORD

The **SHORT\_POSITION\_QUATERNION\_RECORD** structure contains position and quaternion information in 16-bit signed integer format.

```
typedef struct tagSHORT_POSITION_QUATERNION{
    short          x;
    short          y;
    short          z;
    short         s[3][3];
} SHORT_POSITION_QUATERNION_RECORD, *PSHORT_POSITION_QUATERNION_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### y

This is the y position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### z

This is the z position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### q[4]

This is an array of 4 quaternion values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[SHORT\\_POSITION\\_RECORD](#), [SHORT\\_QUATERNIONS\\_RECORD](#)

## DOUBLE\_POSITION\_RECORD

The **DOUBLE\_POSITION\_RECORD** structure contains position information only in double floating point format.

```
typedef struct tagDOUBLE_POSITION{
    double          x;
    double          y;
    double          z;
} DOUBLE_POSITION_RECORD, *PDOUBLE_POSITION_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

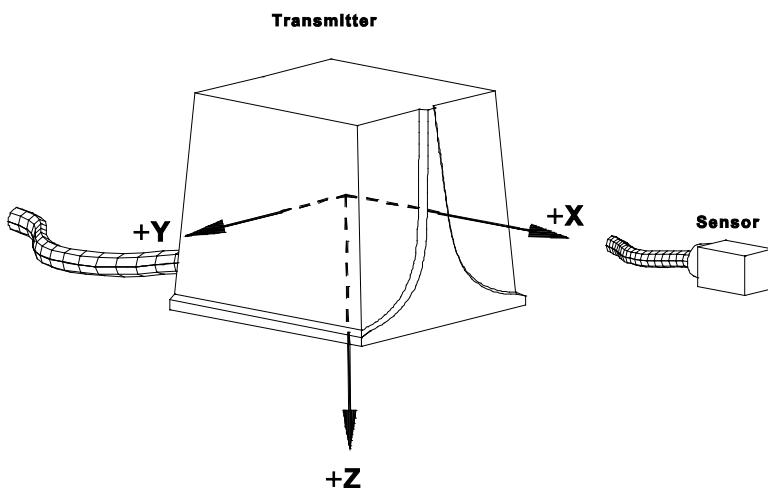
This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

### Remarks

The X, Y and Z values vary between the double precision floating point equivalent of +/- maximum range. The positive X, Y and Z directions are shown below.



**Figure 50 Measurement Reference Frame (Mid-Range Transmitter)**

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DOUBLEANGLES\_RECORD

The **DOUBLEANGLES\_RECORD** structure contains Euler angles information only in double floating point format.

```
typedef struct tagDOUBLEANGLES{
    double          a;
    double          e;
    double          r;
} DOUBLEANGLES_RECORD, *PDOUBLEANGLES_RECORD;
```

### Members

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

### Remarks

In the DOUBLE ANGLES mode, the Tracker outputs the orientation angles of the sensor with respect to the transmitter using double precision floating point format. The orientation angles are defined as rotations about the Z, Y, and X axes of the sensor. These angles are called Zang, Yang, and Xang or, in Euler angle nomenclature, Azimuth, Elevation, and Roll.

Zang (Azimuth) takes on values between the binary equivalent of +/- 180 degrees. Yang (Elevation) takes on values between +/- 90 degrees, and Xang (Roll) takes on values between +/- 180 degrees. As Yang (Elevation) approaches +/- 90 degrees, the Zang (Azimuth) and Xang (Roll) become very noisy and exhibit large errors. At 90 degrees the Zang (Azimuth) and Xang (Roll) become undefined. This behavior is not a limitation of the Tracker - it is an inherent characteristic of these Euler angles. If you need a stable representation of the sensor orientation at high Elevation angles, use the MATRIX output mode.

The scaling of all angles is full scale = 180 degrees. That is, +179.99 deg = 7FFF Hex, 0 deg = 0 Hex, -180.00 deg = 8000 Hex.

Angle information is 0 when sensor saturation occurs.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DOUBLE\_MATRIX\_RECORD

The **DOUBLE\_MATRIX\_RECORD** structure contains only a 3x3 rotation matrix in double floating point format.

```
typedef struct tagDOUBLE_MATRIX{
    double         s[3][3];
} DOUBLE_MATRIX_RECORD, *PDOUBLE_MATRIX_RECORD;
```

### Members

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

### Remarks

The MATRIX mode outputs the 9 elements of the rotation matrix that **define the orientation of the sensor's X, Y, and Z axes with respect to the transmitter's X, Y, and Z axes.**

Each row of the matrix describes the orientation of one of the sensor's axis in the transmitter's frame of reference. So if the first row of the matrix was [.75, .10, .66], it would mean that in the transmitter's coordinate frame, the sensor's x-axis is a vector in the direction <.75, .10, .66>. The second row is the sensor's y-axis, the third row is the z-axis. Each row (and column) will have a length of 1. Each row will be orthogonal (90 degree difference) to every other row (and every column will be orthogonal to every other column).

In graphics applications the rotation matrix is used to rotate the 3-D coordinates of the item being drawn. To do this, **the transpose of the Ascension matrix is used (the rows become the columns).**

Say you want your 3D model to follow the orientation of the sensor. Multiply the transpose of the Ascension rotation matrix by the 3D position of each point in the model. newPt = M.transpose() \* pt. Where pt is a 3x1 vector containing the object's point.

The nine elements of the output matrix are defined generically by:

M(1,1)	M(1,2)	M(1,3)
M(2,1)	M(2,2)	M(2,3)
M(3,1)	M(3,2)	M(3,3)

Or in terms of the rotation angles about each axis where **Z = Zang, Y = Yang and X = Xang:**

$\cos(Y) * \cos(Z)$	$\cos(Y) * \sin(Z)$	$-\sin(Y)$
$-(\cos(X) * \sin(Z))$ + $(\sin(X) * \sin(Y) * \cos(Z))$	$(\cos(X) * \cos(Z))$ + $(\sin(X) * \sin(Y) * \sin(Z))$	$\sin(X) * \cos(Y)$
$(\sin(X) * \sin(Z))$ + $(\cos(X) * \sin(Y) * \cos(Z))$	$-(\sin(X) * \cos(Z))$ + $(\cos(X) * \sin(Y) * \sin(Z))$	$\cos(X) * \cos(Y)$

Or in Euler angle notation, where **R = Roll**, **E = Elevation**, **A = Azimuth**:

$$\begin{matrix} \cos(E) * \cos(A) & \cos(E) * \sin(A) & -\sin(E) \\ -(\cos(R) * \sin(A)) & (\cos(R) * \cos(A)) & \sin(R) * \cos(E) \\ +(\sin(R) * \sin(E) * \cos(A)) & +(\sin(R) * \sin(E) * \sin(A)) & \sin(R) * \cos(E) \\ \\ (\sin(R) * \sin(A)) & -(\sin(R) * \cos(A)) & \cos(R) * \cos(E) \\ +(\cos(R) * \sin(E) * \cos(A)) & +(\cos(R) * \sin(E) * \sin(A)) & \end{matrix}$$

The matrix elements take values between the binary equivalents of +.99996 and -1.0. Element scaling is +.99996 = 7FFF Hex, 0 = 0 Hex, and -1.0 = 8000 Hex.

Matrix information is 0 when sensor saturation occurs.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## DOUBLE\_QUATERNIONS\_RECORD

The **DOUBLE\_QUATERNIONS\_RECORD** structure contains only an array of 4 quaternion values in double floating point format.

```
typedef struct tagDOUBLE_QUATERNIONS{
    double           q[ 4 ];
} DOUBLE_QUATERNIONS_RECORD, *PDOUBLE_QUATERNIONS_RECORD;
```

### Members

#### **q[4]**

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

### Remarks

In the QUATERNION mode, the Tracker outputs the four quaternion parameters that describe the orientation of the sensor with respect to the transmitter using double precision floating point format. The quaternions,  $q_0$ ,  $q_1$ ,  $q_2$ , and  $q_3$  where  $q_0$  is the scalar component, have been extracted from the MATRIX output using the algorithm described in "Quaternion from Rotation Matrix" by Stanley W. Sheppard, Journal of Guidance and Control, Vol. 1, May-June 1978, pp. 223-4.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DOUBLE\_POSITION\_ANGLES\_RECORD

The **DOUBLE\_POSITION\_ANGLES\_RECORD** structure contains position and Euler angle information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_ANGLES{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
} DOUBLE_POSITION_ANGLES_RECORD, *PDOUBLE_POSITION_ANGLES_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE ANGLES RECORD](#)

## DOUBLE\_POSITION\_MATRIX\_RECORD

The **DOUBLE\_POSITION\_MATRIX\_RECORD** structure contains position and matrix information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_MATRIX{
    double          x;
    double          y;
    double          z;
    double         s[3][3];
} DOUBLE_POSITION_MATRIX_RECORD, *PDOUBLE_POSITION_MATRIX_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE MATRIX RECORD](#)

## DOUBLE\_POSITION\_QUATERNION\_RECORD

The **DOUBLE\_POSITION\_QUATERNION\_RECORD** structure contains position and quaternion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_QUATERNION{
    double          x;
    double          y;
    double          z;
    double        q[4];
} DOUBLE_POSITION_QUATERNION_RECORD, *PDOUBLE_POSITION_QUATERNION_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE QUATERNIONS RECORD](#)

## DOUBLE\_POSITION\_TIME\_STAMP\_RECORD

The **DOUBLE\_POSITION\_TIME\_STAMP\_RECORD** structure contains position information only in double floating point format.

```
typedef struct tagDOUBLE_POSITION_TIME_STAMP{
    double          x;
    double          y;
    double          z;
    double          time;
} DOUBLE_POSITION_TIME_STAMP_RECORD, *PDOUBLE_POSITION_TIME_STAMP_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#)

## DOUBLE\_ANGLES\_TIME\_STAMP\_RECORD

The **DOUBLE\_ANGLES\_TIME\_STAMP\_RECORD** structure contains Euler angles information only in double floating point format.

```
typedef struct tagDOUBLE_ANGLES_TIME_STAMP{
    double          a;
    double          e;
    double          r;
    double          time;
} DOUBLE_ANGLES_TIME_STAMP_RECORD, *PDOUBLE_ANGLES_TIME_STAMP_RECORD;
```

### Members

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE ANGLES RECORD](#)

## DOUBLE\_MATRIX\_TIME\_STAMP\_RECORD

The **DOUBLE\_MATRIX\_TIME\_STAMP\_RECORD** structure contains only a 3x3 rotation matrix in double floating point format.

```
typedef struct tagDOUBLE_MATRIX_TIME_STAMP{
    double          s[3][3];
    double          time;
} DOUBLE_MATRIX_TIME_STAMP_RECORD, *PDOUBLE_MATRIX_TIME_STAMP_RECORD;
```

### Members

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE MATRIX RECORD](#)

## DOUBLE\_QUATERNIONS\_TIME\_STAMP\_RECORD

The **DOUBLE\_QUATERNIONS\_TIME\_STAMP\_RECORD** structure contains only an array of 4 quaternion values in double floating point format.

```
typedef struct tagDOUBLE_QUATERNIONS_TIME_STAMP {
    double           q[ 4 ];
    double           time;
} DOUBLE_QUATERNIONS_TIME_STAMP_RECORD, *PDOUBLE_QUATERNIONS_TIME_STAMP_RECORD;
```

### Members

#### **q[4]**

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### **time**

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_QUATERNIONS\\_RECORD](#)

## DOUBLE\_POSITION\_ANGLES\_TIME\_STAMP\_RECORD

The **DOUBLE\_POSITION\_ANGLES\_TIME\_STAMP\_RECORD** structure contains position and Euler angle information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_ANGLES_TIME_STAMP{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          time;
} DOUBLE_POSITION_ANGLES_TIME_STAMP_RECORD, *PDOUBLE_POSITION_ANGLES_TIME_STAMP_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE ANGLES RECORD](#)

## DOUBLE\_POSITION\_MATRIX\_TIME\_STAMP\_RECORD

The **DOUBLE\_POSITION\_MATRIX\_TIME\_STAMP\_RECORD** structure contains position and matrix information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_MATRIX_TIME_STAMP {
    double          x;
    double          y;
    double          z;
    double         s[3][3];
    double          time;
} DOUBLE_POSITION_MATRIX_TIME_STAMP_RECORD, *PDOUBLE_POSITION_MATRIX_TIME_STAMP_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE MATRIX RECORD](#)

## DOUBLE\_POSITION\_QUATERNION\_TIME\_STAMP\_RECORD

The **DOUBLE\_POSITION\_QUATERNION\_TIME\_STAMP\_RECORD** structure contains position and quaternion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_QUATERNION_TIME_STAMP {
    double          x;
    double          y;
    double          z;
    double          q[4];
    double          time;
} DOUBLE_POSITION_QUATERNION_TIME_STAMP_RECORD,
*PDOUBLE_POSITION_QUATERNION_TIME_STAMP_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE QUATERNIONS RECORD](#)

## DOUBLE\_POSITION\_TIME\_Q\_RECORD

The **DOUBLE\_POSITION\_TIME\_Q\_RECORD** structure contains position, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_TIME_Q{
    double          x;
    double          y;
    double          z;
    double          time;
    USHORT          quality;
} DOUBLE_POSITION_TIME_Q_RECORD, *PDOUBLE_POSITION_TIME_Q_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#)

## DOUBLEANGLES\_TIME\_Q\_RECORD

The **DOUBLEANGLES\_TIME\_Q\_RECORD** structure contains Euler angles, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLEANGLES_TIME_Q{
    double          a;
    double          e;
    double          r;
    double          time;
    USHORT          quality;
} DOUBLEANGLES_TIME_Q_RECORD, *PDOUBLEANGLES_TIME_Q_RECORD;
```

### Members

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLEANGLES\\_RECORD](#)

## DOUBLE\_MATRIX\_TIME\_Q\_RECORD

The **DOUBLE\_MATRIX\_TIME\_Q\_RECORD** structure contains a 3x3 rotation matrix, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_MATRIX_TIME_Q{
    double          s[3][3];
    double          time;
    USHORT          quality;
} DOUBLE_MATRIX_TIME_Q_RECORD, *PDOUBLE_MATRIX_TIME_Q_RECORD;
```

### Members

#### **s[3][3]**

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### **time**

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

#### **quality**

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE MATRIX RECORD](#)

## DOUBLE\_QUATERNIONS\_TIME\_Q\_RECORD

The **DOUBLE\_QUATERNIONS\_TIME\_Q\_RECORD** structure contains an array of 4 quaternion values, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_QUATERNIONS_TIME_Q{
    double          q[4];
    double          time;
    USHORT          quality;
} DOUBLE_QUATERNIONS_TIME_Q_RECORD, *PDOUBLE_QUATERNIONS_TIME_Q_RECORD;
```

### Members

#### **q[4]**

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### **time**

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a **time\_t** structure, it can be converted into a date and time string using **ctime()** for example. The fractional part of the time variable represents fractions of a second.

#### **quality**

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_QUATERNIONS\\_RECORD](#)

## DOUBLE\_POSITION\_ANGLES\_TIME\_Q\_RECORD

The **DOUBLE\_POSITION\_ANGLES\_TIME\_Q\_RECORD** structure contains position Euler angle, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_ANGLES_TIME_Q{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          time;
    USHORT          quality;
} DOUBLE_POSITION_ANGLES_TIME_Q_RECORD, *PDOUBLE_POSITION_ANGLES_TIME_Q_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

#### See Also

[DOUBLE\\_POSITION\\_RECORD](#), [DOUBLE\\_ANGLES\\_RECORD](#)

## DOUBLE\_POSITION\_MATRIX\_TIME\_Q\_RECORD

The **DOUBLE\_POSITION\_MATRIX\_TIME\_Q\_RECORD** structure contains position, matrix, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_MATRIX_TIME_Q{
    double          x;
    double          y;
    double          z;
    double          s[3][3];
    double          time;
    USHORT          quality;
} DOUBLE_POSITION_MATRIX_TIME_Q_RECORD, *PDOUBLE_POSITION_MATRIX_TIME_Q_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE MATRIX RECORD](#)

## DOUBLE\_POSITION\_QUATERNION\_TIME\_Q\_RECORD

The **DOUBLE\_POSITION\_QUATERNION\_TIME\_Q\_RECORD** structure contains position, quaternion, timestamp and distortion information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_QUATERNION_TIME_Q{
    double          x;
    double          y;
    double          z;
    double          q[4];
    double          time;
    USHORT          quality;
} DOUBLE_POSITION_QUATERNION_TIME_Q_RECORD, *PDOUBLE_POSITION_QUATERNION_TIME_Q_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_POSITION\\_RECORD](#), [DOUBLE\\_QUATERNIONS\\_RECORD](#)

## SHORT\_ALL\_RECORD

The **SHORT\_ALL\_RECORD** structure contains position, Euler angles, rotation matrix and quaternion information in 16-bit signed integer format.

```
typedef struct tagSHORT_ALL{
    short          x;
    short          y;
    short          z;
    short          a;
    short          e;
    short          r;
    short          s[3][3];
    short          q[4];
} SHORT_ALL_RECORD, *PSHORT_ALL_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### y

This is the y position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### z

This is the z position value of a 3-axis coordinate position system. The value is a short integer. In order to determine the true position it is necessary to divide by 32768 (8000 hex) and multiply by the maximum range.

#### a

This value is the azimuth angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

#### e

This value is the elevation angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

#### r

This value is the roll angle of the sensor. The value is a short integer. In order to determine the true angle it is necessary to divide by 32768 (8000 hex) and multiply by 180 degrees.

#### s[3][3]

This is a 3x3 array of values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

#### q[4]

This is an array of 4 quaternion values. Each value is delivered as a 16-bit signed integer. In order to convert each value to a number in the range +1 -> -1 it is necessary to divide each value by 32768 (8000 hex). The signed integer has a range of +32767 -> -32768 which when divided by 32768 will give a fractional number in the range 0.99997 -> -1.00000.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[SHORTANGLES\\_RECORD](#), [SHORTMATRIX\\_RECORD](#), [SHORTPOSITION\\_RECORD](#), [SHORTQUATERNIONS\\_RECORD](#)

## DOUBLE\_ALL\_RECORD

The **DOUBLE\_ALL\_RECORD** structure contains position, Euler angles, rotation matrix and quaternion information in double floating point format.

```
typedef struct tagDOUBLE_ALL{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          s[3][3];
    double          q[4];
} DOUBLE_ALL_RECORD, *PDOUBLE_ALL_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_ANGLES\\_RECORD](#), [DOUBLE\\_MATRIX\\_RECORD](#), [DOUBLE\\_POSITION\\_RECORD](#), [DOUBLE\\_QUATERNIONS\\_RECORD](#)

## DOUBLE\_ALL\_TIME\_STAMP\_RECORD

The **DOUBLE\_ALL\_TIME\_STAMP\_RECORD** structure contains position, Euler angles, rotation matrix, quaternion and timestamp information in double floating point format.

```
typedef struct tagDOUBLE_ALL_TIME_STAMP{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          s[3][3];
    double          q[4];
    double          time;
} DOUBLE_ALL_TIME_STAMP_RECORD, *PDOUBLE_ALL_TIME_STAMP_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_ANGLES\\_RECORD](#), [DOUBLE\\_MATRIX\\_RECORD](#), [DOUBLE\\_POSITION\\_RECORD](#), [DOUBLE\\_QUATERNIONS\\_RECORD](#)

## DOUBLE\_ALL\_TIME\_STAMP\_Q\_RECORD

The **DOUBLE\_ALL\_TIME\_STAMP\_Q\_RECORD** structure contains position, Euler angles, rotation matrix, quaternion, timestamp and quality information in double floating point format.

```
typedef struct tagDOUBLE_ALL_TIME_STAMP_Q{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          s[3][3];
    double          q[4];
    double          time;
    USHORT          quality;
} DOUBLE_ALL_TIME_STAMP_Q_RECORD, *PDOUBLE_ALL_TIME_STAMP_Q_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

#### See Also

[DOUBLE ANGLES RECORD](#), [DOUBLE MATRIX RECORD](#), [DOUBLE POSITION RECORD](#), [DOUBLE QUATERNIONS RECORD](#)

## DOUBLE\_ALL\_TIME\_STAMP\_Q\_RAW\_RECORD

The **DOUBLE\_ALL\_TIME\_STAMP\_Q\_RAW\_RECORD** structure contains position, Euler angles, rotation matrix, quaternion, timestamp, quality and raw matrix information in double floating point format.

```
typedef struct tagDOUBLE_ALL_TIME_STAMP_Q_RAW{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          s[3][3];
    double          q[4];
    double          time;
    USHORT          quality;
    Double          raw[3][3];
} DOUBLE_ALL_TIME_STAMP_Q_RAW_RECORD, *PDOUBLE_ALL_TIME_STAMP_Q_RAW_RECORD;
```

### Members

#### **x**

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### **y**

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### **z**

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### **a**

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### **e**

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### **r**

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### **s[3][3]**

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### **q[4]**

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### **time**

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### **quality**

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

#### **raw[3][3]**

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000. These values are the raw sensor values after they have been corrected for all known system error sources. This information is for factory use only.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

[DOUBLE ANGLES RECORD](#), [DOUBLE MATRIX RECORD](#), [DOUBLE POSITION RECORD](#), [DOUBLE QUATERNIONS RECORD](#)

## DOUBLE\_POSITION\_ANGLES\_TIME\_Q\_BUTTON\_RECORD

The **DOUBLE\_POSITION\_ANGLES\_TIME\_Q\_BUTTON\_RECORD** structure contains position Euler angle, timestamp, distortion and button information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_ANGLES_TIME_Q_BUTTON{
    double          x;
    double          y;
    double          z;
    double          a;
    double          e;
    double          r;
    double          time;
    USHORT          quality;
    USHORT          button;
}DOUBLE_POSITION_ANGLES_TIME_Q_BUTTON_RECORD, *PDOUBLE_POSITION_ANGLES_TIME_Q_BUTTON_RECORD
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### a

This value is the azimuth angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### e

This value is the elevation angle of the sensor. The value is reported in degrees with a range of +89.995 to -90.000 degrees.

#### r

This value is the roll angle of the sensor. The value is reported in degrees with a range of +179.995 to -180.000 degrees.

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

#### button

The button value is a 16-bit unsigned integer that represents the state of an external contact closure that the user has been connected to the tracker (where applicable - see [Rear Panel Connectors](#) for connector description). When a switch is connected, a 1 in the button value indicates the contact or switch is CLOSED, and a 0 indicates the contact is OPEN. The button line is sampled and available in this data record once per transmitter axis cycle - 3 times the system measurement rate for a mid or short-range transmitter.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

#### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE ANGLES RECORD](#)

## DOUBLE\_POSITION\_MATRIX\_TIME\_Q\_BUTTON\_RECORD

The **DOUBLE\_POSITION\_MATRIX\_TIME\_Q\_BUTTON\_RECORD** structure contains position, matrix, timestamp, distortion and button information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_MATRIX_TIME_Q_BUTTON{
    double          x;
    double          y;
    double          z;
    double         s[3][3];
    double          time;
    USHORT          quality;
    USHORT          button;
}DOUBLE_POSITION_MATRIX_TIME_Q_BUTTON_RECORD, *PDOUBLE_POSITION_MATRIX_TIME_Q_BUTTON_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### s[3][3]

This is a 3x3 array of values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

#### button

The button value is a 16-bit unsigned integer that represents the state of an external contact closure that the user has been connected to the tracker (where applicable - see [Rear Panel Connectors](#) for connector description). When a switch is connected, a 1 in the button value indicates the contact or switch is CLOSED, and a 0 indicates the contact is OPEN. The button line is sampled and available in this data record once per transmitter axis cycle - 3 times the system measurement rate for a mid or short-range transmitter.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE\\_POSITION\\_RECORD](#), [DOUBLE\\_MATRIX\\_RECORD](#)

## DOUBLE\_POSITION\_QUATERNION\_TIME\_Q\_BUTTON\_RECORD

The **DOUBLE\_POSITION\_QUATERNION\_TIME\_Q\_BUTTON\_RECORD** structure contains position, quaternion, timestamp, distortion and button information in double floating point format.

```
typedef struct tagDOUBLE_POSITION_QUATERNION_TIME_Q_BUTTON{
    double          x;
    double          y;
    double          z;
    double          q[4];
    double          time;
    USHORT          quality;
    USHORT          button;
}DOUBLE_POSITION_QUATERNION_TIME_Q_BUTTON_RECORD, *PDOUBLE_POSITION_QUATERNION_TIME_Q_BUTTON_RECORD;
```

### Members

#### x

This is the x position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### y

This is the y position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### z

This is the z position value of a 3-axis coordinate position system. The position will be reported in inches unless the SYSTEM\_PARAMETER\_TYPE, METRIC has been set to true in which case the position will be reported in millimeters.

#### q[4]

This is an array of 4 quaternion values. Each value is in the range +0.99997 to -1.00000

#### time

The time variable is the time stamp for the data record and is returned as a **double** value. The integer portion of the variable represents the number of elapsed seconds since midnight, Jan 1, 1970, UTC, and is the standard way of representing time and date. If this is cast as a time\_t structure, it can be converted into a date and time string using ctime() for example. The fractional part of the time variable represents fractions of a second.

#### quality

The quality value is a 16-bit unsigned integer. A very small quality number indicates no or minimal position and orientation errors due to distortion of the transmitter field depending on how sensitive you have set the error indicator. A large quality number indicates maximum error for the sensitivity level selected.

#### button

The button value is a 16-bit unsigned integer that represents the state of an external contact closure that the user has been connected to the tracker (see [Rear Panel Connectors](#) for connector description). When a switch is connected, a 1 in the button value indicates the contact or switch is CLOSED, and a 0 indicates the contact is OPEN. The button line is sampled and available in this data record once per transmitter axis cycle - 3 times the system measurement rate for a mid or short-range transmitter.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

[DOUBLE POSITION RECORD](#), [DOUBLE QUATERNIONS RECORD](#)

# 3D Guidance Enumeration Types

The following enumeration types are used with the 3DGuidance trackers

[BIRD\\_ERROR\\_CODES](#)

[MESSAGE\\_TYPE](#)

[TRANSMITTER\\_PARAMETER\\_TYPE](#)

[SENSOR\\_PARAMETER\\_TYPE](#)

[BOARD\\_PARAMETER\\_TYPE](#)

[SYSTEM\\_PARAMETER\\_TYPE](#)

[HEMISPHERE\\_TYPE](#)

[AGC\\_MODE\\_TYPE](#)

[DATA\\_FORMAT\\_TYPE](#)

[BOARD\\_TYPES](#)

[DEVICE\\_TYPES](#)

[COMMUNICATIONS\\_MEDIA\\_TYPES](#)

[PORT\\_CONFIGURATION](#)

[AUXILIARY\\_PORT\\_TYPE](#)

## BIRD\_ERROR\_CODES

The **BIRD\_ERROR\_CODES** enumeration type defines the values that the enumerated error code field of the ERRORCODE can be returned with from a function call.

```
enum BIRD_ERROR_CODES{
    BIRD_ERROR_SUCCESS=0,
    BIRD_ERROR_PCB_HARDWARE_FAILURE,
    BIRD_ERROR_TRANSMITTER_EEPROM_FAILURE,
    BIRD_ERROR_SENSOR_SATURATION_START,
    BIRD_ERROR_ATTACHED_DEVICE_FAILURE,
    BIRD_ERROR_CONFIGURATION_DATA_FAILURE,
    BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER,
    BIRD_ERROR_PARAMETER_OUT_OF_RANGE,
    BIRD_ERROR_NO_RESPONSE,
    BIRD_ERROR_COMMAND_TIME_OUT,
    BIRD_ERROR_INCORRECT_PARAMETER_SIZE,
    BIRD_ERROR_INVALID_VENDOR_ID,
    BIRD_ERROR_OPENING_DRIVER,
    BIRD_ERROR_INCORRECT_DRIVER_VERSION,
    BIRD_ERROR_NO_DEVICES_FOUND,
    BIRD_ERROR_ACCESSING_PCI_CONFIG,
    BIRD_ERROR_INVALID_DEVICE_ID,
    BIRD_ERROR_FAILED_LOCKING_DEVICE,
    BIRD_ERROR_BOARD_MISSING_ITEMS,
    BIRD_ERROR_NOTHING_ATTACHED,
    BIRD_ERROR_SYSTEM_PROBLEM,
    BIRD_ERROR_INVALID_SERIAL_NUMBER,
    BIRD_ERROR_DUPLICATE_SERIAL_NUMBER,
    BIRD_ERROR_FORMAT_NOT_SELECTED,
    BIRD_ERROR_COMMAND_NOT_IMPLEMENTED,
    BIRD_ERROR_INCORRECT_BOARD_DEFAULT,
    BIRD_ERROR_INCORRECT_RESPONSE,
    BIRD_ERROR_NO_TRANSMITTER_RUNNING,
    BIRD_ERROR_INCORRECT_RECORD_SIZE,
    BIRD_ERROR_TRANSMITTER_OVERCURRENT,
    BIRD_ERROR_TRANSMITTER_OPEN_CIRCUIT,
    BIRD_ERROR_SENSOR EEPROM_FAILURE,
    BIRD_ERROR_SENSOR_DISCONNECTED,
    BIRD_ERROR_SENSOR_REATTACHED,
    BIRD_ERROR_NEW_SENSOR_ATTACHED,
    BIRD_ERROR_UNDOCUMENTED,
    BIRD_ERROR_TRANSMITTER_REATTACHED,
    BIRD_ERROR_WATCHDOG,
    BIRD_ERROR_CPU_TIMEOUT_START,
    BIRD_ERROR_PCB_RAM_FAILURE,
    BIRD_ERROR_INTERFACE,
    BIRD_ERROR_PCB_EPROM_FAILURE,
    BIRD_ERROR_SYSTEM_STACK_OVERFLOW,
    BIRD_ERROR_QUEUE_OVERRUN,
    BIRD_ERROR_PCB EEPROM_FAILURE,
    BIRD_ERROR_SENSOR_SATURATION_END,
    BIRD_ERROR_NEW_TRANSMITTER_ATTACHED,
    BIRD_ERROR_SYSTEM_UNINITIALIZED,
    BIRD_ERROR_12V_SUPPLY_FAILURE,
    BIRD_ERROR_CPU_TIMEOUT_END,
    BIRD_ERROR_INCORRECT_PLD,
    BIRD_ERROR_NO_TRANSMITTER_ATTACHED,
    BIRD_ERROR_NO_SENSOR_ATTACHED,
    BIRD_ERROR_SENSOR_BAD,
    BIRD_ERROR_SENSOR_SATURATED,
```

```

BIRD_ERROR_CPU_TIMEOUT,
BIRD_ERROR_UNABLE_TO_CREATE_FILE,
BIRD_ERROR_UNABLE_TO_OPEN_FILE,
BIRD_ERROR_MISSING_CONFIGURATION_ITEM,
BIRD_ERROR_MISMATCHED_DATA,
BIRD_ERROR_CONFIG_INTERNAL,
BIRD_ERROR_UNRECOGNIZED_MODEL_STRING,
BIRD_ERROR_INCORRECT_SENSOR,
BIRD_ERROR_INCORRECT_TRANSMITTER,
BIRD_ERROR_ALGORITHM_INITIALIZATION,
BIRD_ERROR_LOST_CONNECTION,
BIRD_ERROR_INVALID_CONFIGURATION,
BIRD_ERROR_TRANSMITTER_RUNNING,
BIRD_ERROR_MAXIMUM_VALUE
);

```

Enumerator Value	Meaning
BIRD_ERROR_SUCCESS=0	No errors occurred. Call completed successfully
BIRD_ERROR_PCB_HARDWARE_FAILURE	The 3DGuidance firmware initialization did not complete within 10 seconds. It is assumed the board is faulty or the firmware has hung up somewhere. If the error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_TRANSMITTER_EEPROM_FAILURE	<handled internally>
BIRD_ERROR_SENSOR_SATURATION_START	<handled internally>
BIRD_ERROR_ATTACHED_DEVICE_FAILURE	<obsolete>
BIRD_ERROR_CONFIGURATION_DATA_FAILURE	<obsolete>
BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER	Invalid constant of the selected enumerated type has been used.
BIRD_ERROR_PARAMETER_OUT_OF_RANGE	The parameter value passed to the function call was not within the legal range for the parameter selected.
BIRD_ERROR_NO_RESPONSE	<obsolete>
BIRD_ERROR_COMMAND_TIME_OUT	3DGuidance on-board controller has failed to respond to a command issued to it. If error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_INCORRECT_PARAMETER_SIZE	The value of the parameter size passed did not match the expected size of the parameter either being passed or returned with this call.
BIRD_ERROR_INVALID_VENDOR_ID	<obsolete>
BIRD_ERROR_OPENING_DRIVER	Non-specific error opening driver. Make sure that the driver is properly installed.
BIRD_ERROR_INCORRECT_DRIVER_VERSION	The wrong version of the driver has been installed for this version of the API dll. Install or re-install the correct driver.
BIRD_ERROR_NO_DEVICES_FOUND	No 3DGuidance hardware was not found by the host system. Verify that hardware is installed and is of the correct type.
BIRD_ERROR_ACCESSING_PCI_CONFIG	The error occurred in the PCIBird PCI interface. There is a problem with the PCI configuration registers. If error is

	repeatable there is an unrecoverable hardware failure. *pciBIRD error only
BIRD_ERROR_INVALID_DEVICE_ID	The device ID passed was out of range for the system.
BIRD_ERROR_FAILED_LOCKING_DEVICE	Driver could not lock 3DGuidance resources. Check that there is not another application using the hardware.
BIRD_ERROR_BOARD_MISSING_ITEMS	The required resources were not found defined in the PCI configuration registers. Possible corrupt configuration. If error is repeatable there is an unrecoverable hardware failure. *pciBIRD error only
BIRD_ERROR_NOTHING_ATTACHED	<obsolete>
BIRD_ERROR_SYSTEM_PROBLEM	<obsolete>
BIRD_ERROR_INVALID_SERIAL_NUMBER	<obsolete>
BIRD_ERROR_DUPLICATE_SERIAL_NUMBER	<obsolete>
BIRD_ERROR_FORMAT_NOT_SELECTED	<obsolete>
BIRD_ERROR_COMMAND_NOT_IMPLEMENTED	This function has not been implemented yet.
BIRD_ERROR_INCORRECT_BOARD_DEFAULT	An unexpected response was received from the controller on the 3DGuidance hardware. The board is responding to commands but the data returned is corrupt. If the error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_INCORRECT_RESPONSE	<obsolete>
BIRD_ERROR_NO_TRANSMITTER_RUNNING	A request was made to turn off the current transmitter by passing the value -1 with the parameter SELECT_TRANSMITTER selected and there was no transmitter currently running.
BIRD_ERROR_INCORRECT_RECORD_SIZE	The record size of the buffer passed to the function does not match the size of the data format currently selected.
BIRD_ERROR_TRANSMITTER_OVERCURRENT	<handled internally>
BIRD_ERROR_TRANSMITTER_OPEN_CIRCUIT	<handled internally>
BIRD_ERROR_SENSOR_EEPROM_FAILURE	<handled internally>
BIRD_ERROR_SENSOR_DISCONNECTED	<handled internally>
BIRD_ERROR_SENSOR_REATTACHED	<handled internally>
BIRD_ERROR_NEW_SENSOR_ATTACHED	<obsolete>
BIRD_ERROR_UNDOCUMENTED	<handled internally>
BIRD_ERROR_TRANSMITTER_REATTACHED	<handled internally>
BIRD_ERROR_WATCHDOG	3DGuidance internal watchdog timer has elapsed. If this error is repeatable there is an unrecoverable hardware failure.
BIRD_ERROR_CPU_TIMEOUT_START	<handled internally>
BIRD_ERROR_PCB_RAM_FAILURE	<handled internally>
BIRD_ERROR_INTERFACE	<handled internally>
BIRD_ERROR_PCB_EPROM_FAILURE	<handled internally>

BIRD_ERROR_SYSTEM_STACK_OVERFLOW	<handled internally>
BIRD_ERROR_QUEUE_OVERRUN	<handled internally>
BIRD_ERROR_PCB_EEPROM_FAILURE	<handled internally>
BIRD_ERROR_SENSOR_SATURATION_END	<handled internally>
BIRD_ERROR_NEW_TRANSMITTER_ATTACHED	<obsolete>
BIRD_ERROR_SYSTEM_UNINITIALIZED	The 3DGuidance hardware and system has not been initialized yet. The <a href="#">InitializeBIRDSystem</a> function must be called first.
BIRD_ERROR_12V_SUPPLY_FAILURE	<handled internally>
BIRD_ERROR_CPU_TIMEOUT_END	<handled internally>
BIRD_ERROR_INCORRECT_PLD	The PLD version on the 3DGuidance hardware is incompatible with this version of the API dll. Verify 3DGuidance model installed.
BIRD_ERROR_NO_TRANSMITTER_ATTACHED	A request was made to do one of the following: 1) Turn off the currently running transmitter and there is no transmitter attached to the system 2) Turn on the transmitter with the selected ID and there is no transmitter attached at that ID.
BIRD_ERROR_NO_SENSOR_ATTACHED	Request for data record from a sensor channel where no sensor is attached or the sensor has been removed.
BIRD_ERROR_SENSOR_BAD	The attached sensor is not saturated but is exhibiting another unspecified problem which prevents it from operating normally. Use the GetSensorStatus function to determine the precise problem.
BIRD_ERROR_SENSOR_SATURATED	The attached sensor which is otherwise OK is currently saturated. This may occur if the sensor is too close to the transmitter or if the sensor is too close to metal or an external magnetic field.
BIRD_ERROR_CPU_TIMEOUT	3DGuidance on-board controller had insufficient time to execute the position and orientation algorithm. This frequently occurs because the 3DGuidance controller is being overwhelmed with user interface commands. Reduce the rate at which GetAsynchronousRecord is being called.
BIRD_ERROR_UNABLE_TO_CREATE_FILE	The call was unable to complete for some unspecified reason. Check the format of the file name string.
BIRD_ERROR_UNABLE_TO_OPEN_FILE	The call was unable to complete for some unspecified reason. Check the format of the file name string.
BIRD_ERROR_MISSING_CONFIGURATION_ITEM	A mandatory configuration item was missing from the initialization file. Review contents of initialization file or use SaveSystemConfiguration() to automatically save a correctly formatted initialization file.
BIRD_ERROR_MISMATCHED_DATA	Data item in the initialization file does not match a system parameter. For example the initialization file states the system has 3 boards (NumberOfBoards=3) but the system initialization routine – InitializeBIRDSystem() only detected two.
BIRD_ERROR_CONFIG_INTERNAL	Internal error in configuration file handler. Report to

	vendor.
BIRD_ERROR_UNRECOGNIZED_MODEL_STRING	The firmware is reporting a model string which is unrecognized by the API dll. This could be due to a hardware failure causing the model string data to be corrupted or it may be caused by a corrupted board EEPROM or the board installed is of a type not recognized by the API dll. If the error is repeatable return to vendor.
BIRD_ERROR_INCORRECT_SENSOR	An invalid sensor type has been attached to this card.
BIRD_ERROR_INCORRECT_TRANSMITTER	An invalid transmitter type has been attached to this card.
BIRD_ERROR_ALGORITHM_INITIALIZATION	The position and orientation algorithm used for the non-dipole transmitters has not correctly initialized.
BIRD_ERROR_LOST_CONNECTION	USB connection to the tracker has been lost. This may be due to usb cable removal, or removal of power to the electronics unit.
BIRD_ERROR_INVALID_CONFIGURATION	The system has queried the Multi-Unit ID settings for each of the attached electronics units, and found that the current configuration is not supported. Valid MUS configurations include: 0,1 (8 sensors), 0,1,2 (12 sensors), 0,1,2,3 (16 sensors). Further details can be found in the MUS Installation Guide Addendum.
BIRD_ERROR_TRANSMITTER_RUNNING	A request to read or write to the VPD component memory storage area was made while the transmitter was still running. De-select (turn off) the transmitter prior to a read/write to VPD memory.
BIRD_ERROR_MAXIMUM_VALUE	Final error code place holder

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

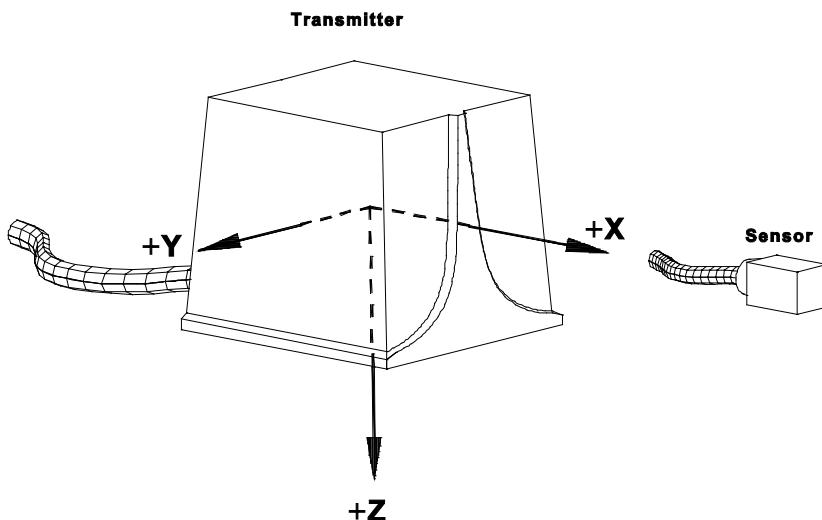
## SENSOR\_PARAMETER\_TYPE

The **SENSOR\_PARAMETER\_TYPE** enumeration type defines values that are used with the GetSensorParameter and SetSensorParameter functions to specify the operational characteristics of an individual sensor.

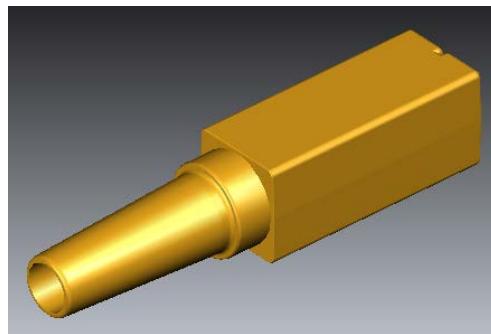
```
enum SENSOR_PARAMETER_TYPE{
    DATA_FORMAT,
    ANGLE_ALIGN,
    HEMISPHERE,
    FILTER_AC_WIDE_NOTCH,
    FILTER_AC_NARROW_NOTCH,
    FILTER_DC_ADAPTIVE,
    FILTER_ALPHA_PARAMETERS,
    FILTER_LARGE_CHANGE,
    QUALITY,
    SERIAL_NUMBER_RX,
    SENSOR_OFFSET,
    VITAL_PRODUCT_DATA_RX,
    VITAL_PRODUCT_DATA_PREAMP,
    MODEL_STRING_RX,
    PART_NUMBER_RX,
    MODEL_STRING_PREAMP,
    PART_NUMBER_PREAMP,
    PORT_CONFIGURATION
};
```

Enumerator Value	Meaning
DATA_FORMAT	See the Data Format Structures section for details
ANGLE_ALIGN	<p>By default, the angle outputs from the Tracker are measured in the coordinate frame defined by the transmitter's X, Y and Z axes, as shown in <a href="#">Figure 51</a> and are measured with respect to rotations about the physical X, Y and Z axes of the sensor <a href="#">Figure 52</a>. The ANGLE_ALIGN parameter allows you to mathematically change the sensor's X, Y and Z axes to an orientation which differs from that of the actual sensor.</p> <p>For example: Suppose that during installation you find it necessary, due to physical requirements, to rotate the sensor, resulting in its angle outputs reading Azim = 5 deg, Elev = 10 and Roll = 15 when it is in its normal "resting" position. To compensate, use the ANGLE_ALIGN parameter, passing as values 5, 10 and 15 degrees. After this sequence is sent, the sensor outputs will be zero, and orientations will be computed as if the sensor were not misaligned.</p> <p>ANGLE_ALIGN parameters are not meaningful for 5DOF sensors. ANGLE_ALIGN parameters applied to a 5DOF sensor will be ignored.</p>

ANGLE\_ALIGN,  
continued



**Figure 51 Measurement Reference Frame**



**Figure 52 Receiver Zero Orientation (8mm Sensor)**

**HEMISPHERE**

The shape of the magnetic field transmitted by the Tracker is symmetrical about each of the axes of the transmitter. This symmetry leads to an ambiguity in determining the sensor's X, Y, Z position. The amplitudes will always be correct, but the signs ( $\pm$ ) may all be wrong, depending upon the hemisphere of operation. In many applications, this will not be relevant, but if you desire an unambiguous measure of position, operation must be either confined to a defined hemisphere or your host computer must 'track' the location of the sensor.

There is no ambiguity in the sensor's orientation angles as output in the ANGLES data formats, or in the rotation matrix as output in the MATRIX formats.

The HEMISPHERE parameter is used to tell the Tracker in which hemisphere, centered about the transmitter, the sensor will be operating. There are six hemispheres from which you may choose: the FRONT (forward), BACK (rear), TOP (upper), BOTTOM (lower), LEFT, and the RIGHT. If no HEMISPHERE parameter is specified, the FRONT is used by default.

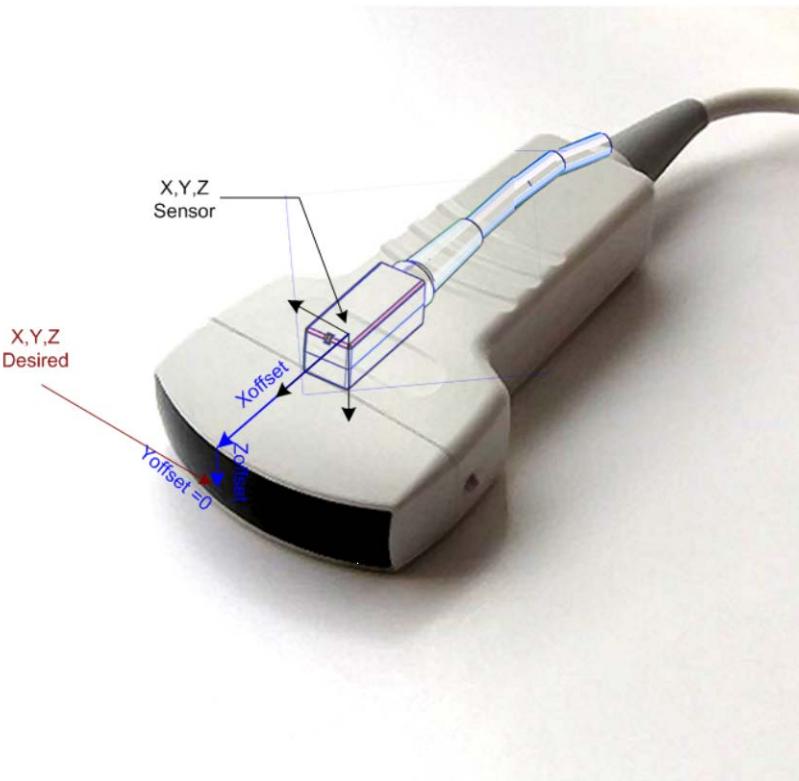
The ambiguity in position determination can be eliminated if your host computer's software continuously 'tracks' the sensor location. In order to implement tracking, you must understand the behavior of the signs ( $\pm$ ) of the X, Y, and Z position outputs when the sensor crosses a hemisphere boundary. When you select a given

	<p>hemisphere of operation, the sign on the position axes that defines the hemisphere direction is forced to positive, even when the sensor moves into another hemisphere. For example, the power-up default hemisphere is the front hemisphere. This forces X position outputs to always be positive. The signs on Y and Z will vary between plus and minus depending on where you are within this hemisphere. If you had selected the bottom hemisphere, the sign of Z would always be positive and the signs on X and Y will vary between plus and minus. If you had selected the left hemisphere, the sign of Y would always be negative, etc.</p> <p>Regarding the default front hemisphere, if the sensor moved into the back hemisphere, the signs on Y and Z would instantaneously change to opposite polarities while the sign on X remained positive. To 'track' the sensor, your host software, on detecting this sign change, would reverse the signs on The Tracker's X, Y, and Z outputs. In order to 'track' correctly: You must start 'tracking' in the selected hemisphere so that the signs on the outputs are initially correct, and you must guard against the case where the sensor legally crossed the <math>Y = 0</math>, <math>Z = 0</math> axes simultaneously without having crossed the <math>X = 0</math> axes into the other hemisphere.</p>
FILTER_AC_WIDE_NO_TCH	The AC WIDE notch filter refers to a eight tap FIR notch filter that is applied to the sensor data to eliminate sinusoidal signals with a frequency between 30 and 72 hertz. If your application requires minimum transport delay between measurement of the sensor's position/orientation and the output of these measurements, you may want to evaluate the effect on your application with this filter shut off and the AC NARROW notch filter on.
FILTER_AC_NARROW_NOTCH	The AC NARROW notch filter refers to a two tap finite impulse response (FIR) notch filter that is applied to signals measured by the Tracker's sensor to eliminate a narrow band of noise with sinusoidal characteristics. Use this filter in place of the AC WIDE notch filter when you want to minimize the transport delay between Tracker measurement of the sensor's position/orientation and the output of these measurements. The transport delay of the AC NARROW notch filter is approximately one third the delay of the AC WIDE notch filter.

FILTER_DC_ADAPTIVE	<p>The DC filter refers to an adaptive, infinite impulse response (IIR) low pass filter applied to the sensor data to eliminate high frequency noise. Generally, this filter is always required in the system unless your application can work with noisy outputs. When the DC filter is enabled, you can modify its noise/lag characteristics by changing alphaMin and Vm.</p> <p>To use the default filter settings, just set the FILTER_DC_ADAPTIVE value to 1.0. To disable the filter set the value to 0.0</p>
FILTER_ALPHA_PARAMETERS	<p>To modify the filter characteristics, configure the elements of the structure <a href="#">ADAPTIVE PARAMETERS</a>.</p> <p>The alphaMin and alphaMax values define the lower and upper ends of the adaptive range that the filter constant alpha can assume in the DC filter, as a function of sensor to transmitter separation. When alphaMin = 0 Hex, the DC filter will provide an infinite amount of filtering (the outputs will never change even if you move the sensor). When alphaMin = 0.99996 = 7FFF Hex, the DC filter will provide no filtering of the data. At the shorter ranges you may want to increase alphaMin to obtain less lag while at longer ranges you may want to decrease alphaMin to provide more filtering (less noise/more lag). Note that alphaMin must always be less than alphaMax.</p> <p>When there is a fast motion of the sensor, the adaptive filter reduces the amount of filtering by increasing the ALPHA used in the filter. It will increase ALPHA only up to the limiting alphaMax value. By doing this, the lag in the filter is reduced during fast movements. When alphaMax = 0.99996 = 7FFF Hex, the DC filter will provide no filtering of the data during fast movements. Some users may want to decrease alphaMax to increase the amount of filtering if the Tracker's outputs are</p>

	<p>too noisy during rapid sensor movement.</p> <p>The 7 words that make up the Vm table values represent the expected noise that the DC filter will measure. By changing the table values, you can increase or decrease the DC filter's lag as a function of sensor range from the transmitter.</p> <p>The DC filter is adaptive in that it tries to reduce the amount of low pass filtering in the Tracker as it detects translation or rotation rates in the Tracker's sensor. Reducing the amount of filtering results in less filter lag.</p> <p>Unfortunately, electrical noise in the environment—when measured by the sensor—also makes it look like the sensor is undergoing a translation and rotation. As the sensor moves farther and farther away from the transmitter, the amount of noise measured by the sensor appears to increase because the measured transmitted signal level is decreasing and the sensor amplifier gain is increasing. In order to decide if the amount of filtering should be reduced, the Tracker has to know if the measured rate is a real sensor rate due to movement or a false rate due to noise. The Tracker gets this knowledge by the user specifying what the expected noise levels are in the operating environment as a function of distance from the transmitter. These noise levels are the 7 words that form the Vm table. The Vm values can range from 1 for almost no noise to 32767 for a lot of noise.</p>
FILTER_LARGE_CHANGE	When the LARGE_CHANGE filter is selected, the position and orientation outputs are not allowed to change if the system detects a sudden large change in the outputs. Large undesirable changes may occur at large separation distances between the transmitter and sensor when the sensor undergoes a fast rotation or translation. If the LARGE_CHANGE value is TRUE the outputs will not be updated if a large change is detected. If value is FALSE, the outputs will change.
QUALITY QUALITY –cont	<p>This data structure is used to adjust the output characteristics of the Quality number. Also referred to as the METAL error or Distortion number, this value is returned with certain data formats and gives the user an indication of the degree to which the position and angle measurements are in error. This error may be due to 'bad' metals located near the transmitter and sensor, or due to TRACKER 'system' errors. 'Bad' metals are metals with high electrical conductivity such as aluminum, or high magnetic permeability such as steel. 'Good' metals have low conductivity and low permeability such as 300 series stainless steel, or titanium. The QUALITYError number also reflects TRACKER 'system' errors resulting from accuracy degradations in the transmitter, sensor, or other electronic components. It will represent a level of accuracy degradation resulting from either movement of the sensor or environmental noise. A very small QUALITYError number indicates no or minimal position and angle errors depending on how sensitive you have set the error indicator. A large QUALITYError number indicates maximum error for the sensitivity level selected.</p> <p>Users of the QUALITYError number will find that as a metal detector, it is sensitive to the introduction of metals in an environment where no metals were initially present. This metal detector can fool you, however, if there are some metals initially present and you introduce new metals. It is possible for the new metal to cause a distortion in the magnetic field that reduces the existing distortion at the sensor. When this occurs you'll see the Error value initially decrease, indicating less error, and then finally start increasing again as the new metal causes more distortion. <b>User beware. You need to evaluate your application for suitability of this metal detector.</b></p> <p>Because the TRACKER is used in many different applications and environments, the QUALITYError indicator needs to be sensitive to this broad range of environments. Some users may want the error indicator to be sensitive to very small amounts of metal in the environment while other applications may only want the error indicator sensitive to large amounts of metal. To accommodate this range of detection sensitivity, the <a href="#">SetSensorParameter()</a> allows the user to set a QUALITY Sensitivity setting that is appropriate to their application.</p> <p>The QUALITYError number will always show there is some error in the system</p>

QUALITY –cont	<p>even when there are no metals present. This error indication usually increases as the distance between the transmitter and sensor increases, and is due to the fact that TRACKER components cannot be made or calibrated perfectly. To minimize the amount of this inherent error in the Error value, a linear curve fit, defined by a <b>slope</b> and <b>offset</b>, is made to this inherent error and stored in each individual sensor's memory since the error depends primarily on the size of the sensor being used (25mm, 8mm, or 5 mm). The <a href="#">Quality Parameters</a> Structure (manipulated through the <a href="#">SetSensorParameter()</a> command) allows the user to eliminate or change these values. For example, maybe the user's standard environment has large errors and he or she wants to look at variations from this standard environment. To do this he or she would adjust the Slope and Offset settings to minimize the QUALITYError values.</p> <p>The QUALITYError number that is output is computed from the following equation:</p> $\text{QUALITYError} = \text{Sensitivity} \times (\text{ErrorSYSTEM} - (\text{Offset} + \text{Slope} \times \text{Range}))$ <p>Where Range is the distance between the transmitter and sensor.</p> <p><b>Sensitivity</b></p> <p>The user supplies a Sensitivity value based on how little or how much he or she wants the QUALITYError value to reflect errors.</p> <p><b>Offset</b></p> <p>If you are trying to minimize the base errors in the system by adjusting the Offset you could set the Sensitivity =1, and the Slope=0 and read the Offset directly as the QUALITYError number.</p> <p><b>Slope</b></p> <p>You can determine the slope by setting the Sensitivity=1 and looking at the change in QUALITYError as you translate the sensor from range=0 to range max for the system (ie 36" ). Since its difficult to go from range =0 to max., you might just translate over say half the distance and double the error value change you measure.</p> <p><b>Alpha</b></p> <p>The QUALITYError value is filtered before output to the user to minimize noise jitter. The Alpha value determines how much filtering is applied to the error value. Range is FFFF -&gt; 0 Users should think of it as a signed fractional value with a range of 0.9999 -&gt; 0 (negative numbers not allowed). A zero value is an infinite amount of filtering, whereas a 0.9999 value is no filtering. As Alpha gets smaller the time lag between the insertion of metal in the environment and it being reported in the QUALITYError value increases.</p>
---------------	--

SERIAL_NUMBER_RX	Returns the serial number of the attached sensor.
SENSOR_OFFSETS	<p>Normally the position outputs from the 3DGuidance™ represent the x, y, z position of the center of the sensor with respect to the origin of the Transmitter. The SENSOR_OFFSETS command allows the user to specify a location that is offset from the center of the sensor.</p> <p>The x, y, z offset distances you supply in a DOUBLE_POSITION_RECORD with this command are measured in the sensor reference frame and are measured from the sensor center to the desired position on the tracked object. NOTE these values must be supplied in inches.</p> 

VITAL_PRODUCT_DATA_RX	Used to read or write to individual bytes in the Vital Product Data (VPD) storage area on the sensor. The VPD section comprises 128 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. The parameter passed with these commands is a structure <a href="#">VPD_COMMAND_PARAMETERS</a> which contains the address of the target byte and, in the case of the write command ( <a href="#">SetSensorParameter</a> ) the value of the byte to be written. In the case of the read command ( <a href="#">GetSensorParameter</a> ), the value of the byte read from the VPD is placed in the value location in the structure.  Note: Reading or writing VPD is not allowed when the transmitter is running.
VITAL_PRODUCT_DATA_PREAMP	Used to read or write to individual bytes in the Vital Product Data (VPD) storage area on the preamp. The VPD section comprises 128 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. The parameter passed with these commands is a structure <a href="#">VPD_COMMAND_PARAMETERS</a> which contains the address of the target byte and, in the case of the write command ( <a href="#">SetSensorParameter</a> ), the value of the byte to be written. In the case of the read command ( <a href="#">GetSensorParameter</a> ), the value of the byte read from the VPD is placed in the value location in the structure.  Note: Reading or writing VPD is not allowed when the transmitter is running.
MODEL_STRING_RX	Returns the model string of the sensor in an 11 byte NULL terminated character string.
PART_NUMBER_RX	Returns the part number of the sensor in an 16 byte NULL terminated character string.
MODEL_STRING_PREAMP	Returns the model string of the preamp in an 11 byte NULL terminated character string. (driveBAY and trakSTAR units do not have preamps, therefore this is an invalid parameter for those systems)
PART_NUMBER_PREAMP	Returns the part number of the preamp in an 16 byte NULL terminated character string. (driveBAY and trakSTAR units do not have preamps, therefore this is an invalid parameter for those systems)
PORT_CONFIGURATION	Returns a value of <a href="#">PORT_CONFIGURATION_TYPE</a> containing the current configuration of this sensor port. DOF_6_XYZ_AER and DOF_5_XYZ_AE indicate 6DOF and 5DOF ports, respectively. DOF_NOT_ACTIVE indicates that the port is not logically active because the physical port has been configured for 6DOF operation.  For example, if Sensor Port 1 on the unit is configured for '6DOF', and the PORT_CONFIGURATION of Sensor 5 (ID=4) or 9 (ID=8) is requested, the return value will be 'DOF_NOT_ACTIVE'.  PORT_CONFIGURATION is currently determined at startup only. Calling SetSensorParameter with the PORT_CONFIGURATION parameter will return BIRD_ERROR_ILLEGAL_COMMAND_PARAMETER.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## MESSAGE\_TYPE

The **MESSAGE\_TYPE** enumeration type defines a value used with the GetErrorText function to define the type of message string returned from the call.

```
enum MESSAGE_TYPE{
    SIMPLE_MESSAGE,
    VERBOSE_MESSAGE
};
```

Enumerator Value	Meaning
SIMPLE_MESSAGE	The call GetErrorText will return a short terse message string describing the meaning of the error code passed.
VERBOSE_MESSAGE	The call GetErrorText will return a message string containing a full and comprehensive description of the problem and possible resolutions where appropriate.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## TRANSMITTER\_PARAMETER\_TYPE

The **TRANSMITTER\_PARAMETER\_TYPE** enumeration type defines values that are used with the GetTransmitterParameter and SetTransmitterParameter functions to specify the operational characteristics of an individual transmitter.

```
enum TRANSMITTER_PARAMETER_TYPE{
    SERIAL_NUMBER_TX,
    REFERENCE_FRAME,
    XYZ_REFERENCE_FRAME,
    VITAL_PRODUCT_DATA_TX,
    MODEL_STRING_TX,
    PART_NUMBER_TX
};
```

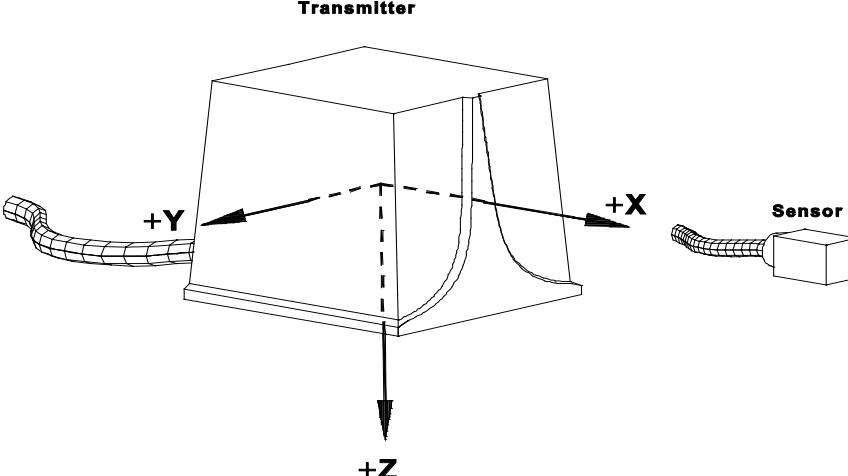
Enumerator Value	Meaning
SERIAL_NUMBER_TX	This returns the serial number of the attached physical device
REFERENCE_FRAME	<p>By default, the Tracker's reference frame is defined by the transmitter's physical X, Y, and Z axes. In some applications, it may be desirable to have the orientation measured with respect to another reference frame. The REFERENCE FRAME parameter permits you to define a new reference frame by inputting the angles required to align the physical axes of the transmitter to the X, Y, and Z axes of the new reference frame. The alignment angles are defined as rotations about the Z, Y, and X axes of the transmitter. These angles are called the, Azimuth, Elevation, and Roll angles.</p> <p>Although a change to the REFERENCE FRAME parameter values will cause the Tracker's output angles to change, it has no effect on the position outputs. If you want The Tracker's XYZ position reference frame to also change with this parameter, then you must enable this mode using the XYZREFERENCE FRAME parameter.</p>  <p>The diagram illustrates a transmitter and a sensor. The transmitter is represented by a rectangular cube with a coiled cable labeled '+Y' extending from its left side. A vertical dashed line extends downwards from the center of the transmitter. A horizontal dashed line extends to the right from the center, labeled '+X'. A solid arrow points downwards from the center, labeled '+Z'. To the right of the transmitter, a separate rectangular cube labeled 'Sensor' is connected by a coiled cable. The text 'Transmitter' is centered above the transmitter cube, and 'Sensor' is to its right.</p>

Figure 53 Measurement Reference Frame (Standard Transmitter)

	<b>Figure 54 Receiver Zero Orientation (8mm Sensor)</b>
XYZ_REFERENCE_FRAME	When the boolean value XYZ_REFERENCE FRAME is TRUE, the Tracker's XYZ measurement frame will also correspond to the new reference frame defined by the REFERENCE FRAME parameter values. When the Boolean value is FALSE, the XYZ measurement frame reverts to the orientation of the transmitter's physical XYZ axes.
VITAL_PRODUCT_DATA_TX	Used to read or write to individual bytes in the Vital Product Data (VPD) storage area on the transmitter. The VPD section comprises 128 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. The parameter passed with these commands is a structure <a href="#">VPD_COMMAND_PARAMETERS</a> which contains the address of the target byte and, in the case of the write command ( <a href="#">SetTransmitterParameter</a> ) the value of the byte to be written. In the case of the read command ( <a href="#">GetTransmitterParameter</a> ) the value of the byte read from the VPD is placed in the value location in the structure. Note: Reading or writing VPD is not allowed when the transmitter is running.
MODEL_STRING_TX	Returns the model string of the transmitter in an 11 byte NULL terminated character string.
PART_NUMBER_TX	Returns the part number of the transmitter in an 16 byte NULL terminated character string.

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## BOARD\_PARAMETER\_TYPE

The **BOARD\_PARAMETER\_TYPE** enumeration type defines parameters that can be changed and/or inspected with the GetBoardParameter and SetBoardParameter functions. These parameters control the operational characteristics of the board. One of these enumerated values is passed as a parameter to the call to indicate the type and size of the actual parameter passed. The table below describes the actual type and size and purpose of the parameters passed for each of these types.

```
enum BOARD_PARAMETER_TYPE{
    SERIAL_NUMBER_PCB,
    BOARD_SOFTWARE_REVISIONS,
    POST_ERROR_PCB,
    DIAGNOSTIC_TEST_PCB,
    VITAL_PRODUCT_DATA_PCB,
    MODEL_STRING_PCB,
    PART_NUMBER_PCB
};
```

Enumerator Value	Meaning
SERIAL_NUMBER_PCB	Returns the serial number of the 3DGuidance™ board.
BOARD_SOFTWARE_REVISIONS	Returns the board software revisions in a <a href="#">BOARD REVISIONS</a> structure.
POST_ERROR_PCB	Used to examine results of the POST (Power ON Self Test). See Parameter Structure <a href="#">POST_ERROR_PARAMETER</a>
DIAGNOSTIC_TEST_PCB	Used to execute diagnostic tests. May also be used to acquire information on available diagnostic tests. See Parameter structure: <a href="#">DIAGNOSTIC_TEST_PARAMETERS</a>
VITAL_PRODUCT_DATA_PCB	Used to read or write to individual bytes in the Vital Product Data (VPD) storage area on the electronics unit. The VPD section comprises 112 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. The parameter passed with these commands is a structure <a href="#">VPD_COMMAND_PARAMETERS</a> which contains the address of the target byte and, in the case of the write command ( <a href="#">SetBoardParameter</a> ) the value of the byte to be written. In the case of the read command ( <a href="#">GetBoardParameter</a> ), the value of the byte read from the VPD is placed in the value location in the structure. Note: Reading or writing VPD is not allowed when the transmitter is running.
MODEL_STRING_PCB	Returns the model string of the board in an 11 byte NULL terminated character string.
PART_NUMBER_PCB	Returns the part number of the board in an 16 byte NULL terminated character string.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## SYSTEM\_PARAMETER\_TYPE

The **SYSTEM\_PARAMETER\_TYPE** enumeration type defines parameters that can be changed and/or inspected with the GetSystemParameter and SetSystemParameter functions. These parameters control the operational characteristics of the system. One of these enumerated values is passed as a parameter to the call to indicate the type and size of the actual parameter passed. The table below describes the actual type and size and purpose of the parameters passed for each of these types.

```
enum SYSTEM_PARAMETER_TYPE{
    SELECT_TRANSMITTER,
    POWER_LINE_FREQUENCY,
    AGC_MODE,
    MEASUREMENT_RATE,
    MAXIMUM_RANGE,
    METRIC,
    VITAL_PRODUCT_DATA,
    POST_ERROR,
    DIAGNOSTIC_TEST,
    REPORT_RATE,
    COMMUNICATIONS_MEDIA,
    LOGGING,
    RESET,
    AUTOCONFIG,
    AUXILIARY_PORT,
    COMMUTATION_MODE,
    END_OF_LIST
};
```

Enumerator Value	Meaning
SELECT_TRANSMITTER	Either select and turn on a specific transmitter or turn off the current transmitter. The parameter passed is a short int which contains the id of the transmitter selected to be turned on. If the current transmitter needs to be turned off this value should be set to -1.
POWER_LINE_FREQUENCY	Informs the hardware of the frequency of the AC power source. The parameter passed is a double value describing the frequency in Hz. There are only two valid values: either 50.0 or 60.0 Hz.
AGC_MODE	Select the automatic gain control (AGC) mode. The parameter passed is one of the enumerated type AGC_MODE_TYPE.
MEASUREMENT_RATE	Set the measurement rate. The parameter passed is a double value and represents the measurement rate in Hz. The valid range of values is 20.0 < rate < 255.0
MAXIMUM_RANGE	Sets the system maximum range. The parameter passed is a double value representing the maximum range in any of the 3 axes in inches. There are three valid ranges, 36.0 inches, 72.0 inches and 144.0 inches.
METRIC	Enables/disables metric position reporting. The parameter passed is a bool. If the value is true then metric reporting is selected otherwise if the value is false then metric reporting is turned off. Metric data is reported in millimeters. Non-metric data is reported in inches.
VITAL_PRODUCT_DATA*	Used to read or write to individual bytes in the Vital Product Data (VPD) storage area on the main board. The VPD contains 512 bytes of user modifiable data storage. It is the user's responsibility to define the contents and structure and to maintain that structure. The parameter passed with these commands is a structure <a href="#">VPD COMMAND PARAMETER</a> which contains

	the address of the target byte and in the case of the write command (SetSystemParameter) the value of the byte to be written. In the case of the read command (GetSystemParameter), the value of the byte read from the VPD is placed in the value location in the structure.
POST_ERROR*	Used to examine results of the POST (Power ON Self Test). See Parameter Structure <a href="#">POST_ERROR_PARAMETER</a>
DIAGNOSTIC_TEST*	Used to execute diagnostic tests. May also be used to acquire information on available diagnostic tests. See Parameter structure: <a href="#">DIAGNOSTIC_TEST_PARAMETERS</a>
REPORT_RATE	Used to set the decimation rate for streaming data records. The report rate is a single byte value 1 to 127, 0 is not valid.
COMMUNICATIONS_MEDIA	Used to configure the communications media for interaction with the tracking device. See Parameter structure: <a href="#">COMMUNICATIONS MEDIA PARAMETER</a> NOTE: This parameter can be used prior to a InitBIRDSystem() function call.
LOGGING	Used to enable/disable logging of the communications traffic between the API and the tracking device. Useful for reporting and trouble-shooting errors with the Ascension tracking system. NOTE: This parameter can be used prior to a InitBIRDSystem() function call.
RESET	Used to enable/disable the automatic tracking device reset on a InitBIRDSystem API call. Disabling reset will make the InitBIRDSystem function call perform much faster and may be useful in the development phase of a project, but this should be used with caution, as a reset places the tracking device in a known state and disabling it may cause undetermined side effects. NOTE: This parameter can be used prior to a InitBIRDSystem() function call.
AUTOCONFIG	Used to specify the number of sensors to configure the tracking device. This parameter is needed with systems that support the use of multiple 5DOF sensors in lieu of a single 6DOF sensor. For Non-Dipole configurations, 4 and 12 are the valid values for this parameter. See the <a href="#">AUTOCONFIG</a> section in Chapter 3 for additional details.
AUXILIARY_PORT	Used to select between front panel and auxiliary ports on equipped trackers. The parameter is a pointer to the first element of a 4-element array of type <a href="#">AUXILIARY_PORT_TYPE</a> .
COMMUTATION_MODE	Used to enable/disable the alternate data acquisition mode required when running integrated sensor modules (i.e. M1525). NOTE: This parameter should only be enabled when sensors of this type are connected, as the system's sensitivity to conductive metal will increase slightly when this mode is being used.
END_OF_LIST	Final system parameter type place holder

\* - **NOTE:** Use of the VITAL\_PRODUCT\_DATA, POST\_ERROR, and DIAGNOSTIC\_TEST system parameters with Multi-Unit System (MUS) configurations will only yield information from the first unit (MUS ID=0). For accessing this information/functionality across all units, see the [Board Parameters](#).

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## HEMISPHERE\_TYPE

The **HEMISPHERE\_TYPE** enumeration type defines values that are used when setting the HEMISPHERE with the SetSensorParameter call. The default HEMISPHERE\_TYPE is FRONT.

```
enum HEMISPHERE_TYPE{
    FRONT,
    BACK,
    TOP,
    BOTTOM,
    LEFT,
    RIGHT
};
```

Enumerator Value	Meaning
FRONT	The FRONT is the forward hemisphere in front of the transmitter. The front of the transmitter is the side with the Ascension logo molded into the case. It is the side opposite the side with the 2 positioning holes. This is the default.
BACK	The BACK is the opposite hemisphere to the FRONT hemisphere.
TOP	The TOP hemisphere is the upper hemisphere. When the transmitter is sitting on a flat surface with the locating holes on the surface the TOP hemisphere is above the transmitter.
BOTTOM	The BOTTOM hemisphere is the opposite hemisphere to the TOP hemisphere.
LEFT	The LEFT hemisphere is the hemisphere to the left of the observer when looking at the transmitter from the back.
RIGHT	The RIGHT hemisphere is the opposite hemisphere to the LEFT hemisphere. The LEFT hemisphere is on the left side of the observer when looking at the transmitter from the back.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## AGC\_MODE\_TYPE

The **AGC\_MODE\_TYPE** enumeration type defines values that are used when setting the AGC\_MODE with the SetSensorParameter call. The default is TRANSMITTER\_AND\_SENSOR\_AGC.

```
enum AGC_MODE_TYPE{
    TRANSMITTER_AND_SENSOR_AGC,
    SENSOR_AGC_ONLY
};
```

 **Note:** Transmitter AGC not active in 3DGGuidance Systems.

Enumerator Value	Meaning
TRANSMITTER_AND_SENSOR_AGC	Select both transmitter power switching and sensor gain control for the AGC implementation. This is the default. NOTE: As the sensor moves away from the transmitter the signal decreases so it is necessary to increase the gain of the sensor amplifier. As the sensor approaches the transmitter the signal increases so the sensor amp gain needs to be reduced. But, there comes a point where the sensor is so close to the transmitter that the signal saturates the sensor and at that point it becomes necessary to reduce the power of the transmitter. Doing this allows the sensor to be used close to the transmitter. All transmitter power switching and sensor amp gain control is handled automatically for the user.
SENSOR_AGC_ONLY	Disable transmitter power switching and use only sensor gain control for the AGC implementation. NOTE: When the power switching is disabled the transmitter will run at full power all the time. This means that there comes a point at which the sensor as it is approaching the transmitter will saturate. Since the transmitter will not reduce power this is the minimum limiting range for this mode of operation.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DATA\_FORMAT\_TYPE

The DATA\_FORMAT\_TYPE enumeration type

```
enum DATA_FORMAT_TYPE{
    NO_FORMAT_SELECTED=0,
    SHORT_POSITION,
    SHORT_ANGLES,
    SHORT_MATRIX,
    SHORT_QUATERNIONS,
    SHORT_POSITION_ANGLES,
    SHORT_POSITION_MATRIX,
    SHORT_POSITION_QUATERNION,
    DOUBLE_POSITION,
    DOUBLE_ANGLES,
    DOUBLE_MATRIX,
    DOUBLE_QUATERNIONS,
    DOUBLE_POSITION_ANGLES,
    DOUBLE_POSITION_MATRIX,
    DOUBLE_POSITION_QUATERNION,
    DOUBLE_POSITION_TIME_STAMP,
    DOUBLE_ANGLES_TIME_STAMP,
    DOUBLE_MATRIX_TIME_STAMP,
    DOUBLE_QUATERNIONS_TIME_STAMP,
    DOUBLE_POSITION_ANGLES_TIME_STAMP,
    DOUBLE_POSITION_MATRIX_TIME_STAMP,
    DOUBLE_POSITION_QUATERNION_TIME_STAMP,
    DOUBLE_POSITION_TIME_Q,
    DOUBLE_ANGLES_TIME_Q,
    DOUBLE_MATRIX_TIME_Q,
    DOUBLE_QUATERNIONS_TIME_Q,
    DOUBLE_POSITION_ANGLES_TIME_Q,
    DOUBLE_POSITION_MATRIX_TIME_Q,
    DOUBLE_POSITION_QUATERNION_TIME_Q,
    SHORT_ALL,
    DOUBLE_ALL,
    DOUBLE_ALL_TIME_STAMP,
    DOUBLE_ALL_TIME_STAMP_Q,
    DOUBLE_ALL_TIME_STAMP_Q_RAW,
    DOUBLE_POSITION_ANGLES_TIME_Q_BUTTON,
    DOUBLE_POSITION_MATRIX_TIME_Q_BUTTON,
    DOUBLE_POSITION_QUATERNION_TIME_Q_BUTTON,
    MAXIMUM_FORMAT_CODE
};
```

Enumerator Value	Selects Data Record of Structure Type:
NO_FORMAT_SELECTED=0,	No data format selected.
SHORT_POSITION,	<a href="#">SHORT POSITION RECORD</a>
SHORT_ANGLES,	<a href="#">SHORT ANGLES RECORD</a>
SHORT_MATRIX,	<a href="#">SHORT MATRIX RECORD</a>
SHORT_QUATERNIONS,	<a href="#">SHORT QUATERNIONS RECORD</a>
SHORT_POSITION_ANGLES,	<a href="#">SHORT POSITION ANGLES RECORD</a>
SHORT_POSITION_MATRIX,	<a href="#">SHORT POSITION MATRIX RECORD</a>
SHORT_POSITION_QUATERNION,	<a href="#">SHORT POSITION QUATERNION RECORD</a>

DOUBLE_POSITION,	<a href="#">DOUBLE POSITION RECORD</a>
DOUBLE_ANGLES,	<a href="#">DOUBLE ANGLES RECORD</a>
DOUBLE_MATRIX,	<a href="#">DOUBLE MATRIX RECORD</a>
DOUBLE_QUATERNIONS,	<a href="#">DOUBLE QUATERNIONS RECORD</a>
DOUBLE_POSITION_ANGLES,	<a href="#">DOUBLE POSITION ANGLES RECORD</a>
DOUBLE_POSITION_MATRIX,	<a href="#">DOUBLE POSITION MATRIX RECORD</a>
DOUBLE_POSITION_QUATERNION,	<a href="#">DOUBLE POSITION QUATERNION RECORD</a>
DOUBLE_POSITION_TIME_STAMP,	<a href="#">DOUBLE POSITION TIME STAMP RECORD</a>
DOUBLE_ANGLES_TIME_STAMP,	<a href="#">DOUBLE ANGLES TIME STAMP RECORD</a>
DOUBLE_MATRIX_TIME_STAMP,	<a href="#">DOUBLE MATRIX TIME STAMP RECORD</a>
DOUBLE_QUATERNIONS_TIME_STAMP,	<a href="#">DOUBLE QUATERNIONS TIME STAMP RECORD</a>
DOUBLE_POSITION_ANGLES_TIME_STAMP,	<a href="#">DOUBLE POSITION ANGLES TIME STAMP RECORD</a>
DOUBLE_POSITION_MATRIX_TIME_STAMP,	<a href="#">DOUBLE POSITION MATRIX TIME STAMP RECORD</a>
DOUBLE_POSITION_QUATERNION_TIME_STAMP,	<a href="#">DOUBLE POSITION QUATERNION TIME STAMP RECORD</a>
DOUBLE_POSITION_TIME_Q,	<a href="#">DOUBLE POSITION TIME Q RECORD</a>
DOUBLE_ANGLES_TIME_Q,	<a href="#">DOUBLE ANGLES TIME Q RECORD</a>
DOUBLE_MATRIX_TIME_Q,	<a href="#">DOUBLE MATRIX TIME Q RECORD</a>
DOUBLE_QUATERNIONS_TIME_Q,	<a href="#">DOUBLE QUATERNIONS TIME Q RECORD</a>
DOUBLE_POSITION_ANGLES_TIME_Q,	<a href="#">DOUBLE POSITION ANGLES TIME Q RECORD</a>
DOUBLE_POSITION_MATRIX_TIME_Q,	<a href="#">DOUBLE POSITION MATRIX TIME Q RECORD</a>
DOUBLE_POSITION_QUATERNION_TIME_Q,	<a href="#">DOUBLE POSITION QUATERNION TIME Q RECORD</a>
SHORT_ALL,	<a href="#">SHORT ALL RECORD</a>
DOUBLE_ALL,	<a href="#">DOUBLE ALL RECORD</a>
DOUBLE_ALL_TIME_STAMP,	<a href="#">DOUBLE ALL TIME STAMP RECORD</a>
DOUBLE_ALL_TIME_STAMP_Q,	<a href="#">DOUBLE ALL TIME STAMP Q RECORD</a>
DOUBLE_ALL_TIME_STAMP_Q_RAW,	<a href="#">DOUBLE ALL TIME STAMP Q RAW RECORD</a>
DOUBLE_POSITION_ANGLES_TIME_Q_BUTTON	<a href="#">DOUBLE POSITION ANGLES TIME Q BUTTON RECORD</a>
DOUBLE_POSITION_MATRIX_TIME_Q_BUTTON	<a href="#">DOUBLE POSITION MATRIX TIME Q BUTTON</a>
DOUBLE_POSITION_QUATERNION_TIME_Q_BUTTON	<a href="#">DOUBLE POSITION QUATERNION TIME Q BUTTON</a>
MAXIMUM_FORMAT_CODE	End of table place holder

## Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## See Also

## BOARD\_TYPES

A value of the **BOARD\_TYPES** enumeration type is returned from a call to GetBoardConfiguration in the *type* parameter location of the structure **BOARD\_CONFIGURATION**.

**NOTE:** The **BOARD\_TYPES** enumerated type WILL NOT support future boards. The [MODEL\\_STRING](#) and [PART\\_NUMBER](#) parameter types have replaced this functionality.

```
enum BOARD_TYPES{
    ATC3DG_MEDSAFE
    PCIBIRD_STD1
    PCIBIRD_STD2
    PCIBIRD_8mm1
    PCIBIRD_8mm2
    PCIBIRD_2mm1
    PCIBIRD_2mm2
    PCIBIRD_FLAT
    PCIBIRD_FLAT_MICRO1
    PCIBIRD_FLAT_MICRO2
    PCIBIRD_DSP4
    PCIBIRD_UNKNOWN
    ATC3DG_BB
};
```

Enumerator Value	Meaning
ATC3DG_MEDSAFE	medSAFE
PCIBIRD_STD1	Synchronized PCIBird – Single Standard Sensor
PCIBIRD_STD2	Synchronized PCIBird – Dual Standard Sensor
PCIBIRD_8mm1	Synchronized PCIBird – Single 8mm Sensor
PCIBIRD_8mm2	Synchronized PCIBird – Dual 8mm Sensor
PCIBIRD_2mm1	Single 2mm sensor - microsensor
PCIBIRD_2mm2	Dual 2mm sensor -microsensor
PCIBIRD_FLAT	Flat transmitter, 8mm
PCIBIRD_FLAT_MICRO1	Flat transmitter, single TEM sensor (all types)
PCIBIRD_FLAT_MICRO2	Flat transmitter, dual TEM sensor (all types)
PCIBIRD_DSP4	Standalone, DSP, 4 sensor
PCIBIRD_UNKNOWN	Default
ATC3DG_BB	DriveBAY/trakSTAR (formerly bayBIRD)

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## DEVICE\_TYPES

A value of the **DEVICE\_TYPES** enumeration type is returned in the *type* parameter location of either the SENSOR\_CONFIGURATION or the TRANSMITTER\_CONFIGURATION structures which are returned from a call to either GetSensorConfiguration or GetTransmitterConfiguration.

**NOTE:** The **DEVICE\_TYPES** enumerated type **WILL NOT support future transmitters and sensors. The MODEL\_STRING and PART\_NUMBER parameter types have replaced this functionality.**

```
enum DEVICE_TYPES{
    STANDARD_SENSOR,
    TYPE_800_SENSOR,
    STANDARD_TRANSMITTER,
    MINIBIRD_TRANSMITTER,
    SMALL_TRANSMITTER,
    TYPE_500_SENSOR,
    TYPE_180_SENSOR,
    TYPE_130_SENSOR,
    TYPE_TEM_SENSOR,
    UNKNOWN_SENSOR,
    UNKNOWN_TRANSMITTER,
    TYPE_800_BB_SENSOR,
    TYPE_800_BB_STD_TRANSMITTER,
    TYPE_800_BB_SMALL_TRANSMITTER,
    TYPE_090_BB_SENSOR
};
```

Enumerator Value	Meaning
STANDARD_SENSOR	Standard Flock sensor with miniDIN connector
TYPE_800_SENSOR	8mm sensor with miniDIN connector (miniBIRDII sensor)
STANDARD_TRANSMITTER	Standard Flock transmitter
MINIBIRD_TRANSMITTER	Standard MiniBird transmitter
SMALL_TRANSMITTER	Compact transmitter
TYPE_500_SENSOR	5mm sensor with miniDIN connector
TYPE_180_SENSOR	1.8mm microsensor
TYPE_130_SENSOR	1.3mm microsensor
TYPE_TEM_SENSOR	1.8mm, 1.3mm, 0.Xmm microsensors
UNKNOWN_SENSOR	default
UNKNOWN_TRANSMITTER	default
TYPE_800_BB_SENSOR	DriveBAY/trakSTAR sensor (bayBIRD)
TYPE_800_BB_STD_TRANSMITTER	DriveBAY/trakSTAR mid-range TX
TYPE_800_BB_SMALL_TRANSMITTER	DriveBYA/trakSTAR short-range TX
TYPE_090_BB_SENSOR	DriveBAY/trakSTAR sensor (bayBIRD)

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

## COMMUNICATIONS\_MEDIA\_TYPES

A value of the **COMMUNICATIONS\_MEDIA\_TYPES** enumeration type is set or returned in the *mediaType* field of the [COMMUNICATIONS MEDIA PARAMETER](#) structure, which is used with a call to either GetSystemParameter or SetSystemParameter.

NOTE: Once communication over a given media type has been initiated after power-up, the tracker will continue to expect communication over this media regardless of the setting of this enumerated type. The tracker will remain in this communication state until power to the unit has been reset, at which time the media type parameter may once again be utilized.

```
enum COMMUNICATIONS_MEDIA_TYPES{
    USB,
    RS232,
    TCPIP
};
```

Enumerator Value	Meaning
USB	Selects the USB device driver that was selected during installation.
RS232	Uses the Window's COM port interface. IMPORTANT: There are some limitations on the use of this interface, the GetSynchronous API is not supported with this interface and GetAsynchronous API cannot be used with the ALL_SENSORS parameter.
TCPIP	Uses TCP/IP

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## POR T\_CONFIGURATION\_TYPE

The **POR T\_CONFIGURATION\_TYPE** enumeration type defines values that are used when getting the PORT\_CONFIGURATION with a GetSensorParameter call.

```
enum PORT_CONFIGURATION_TYPE {
    DOF_NOT_ACTIVE,
    DOF_6_XYZ_AER,
    DOF_5_XYZ_AE,
};
```

Enumerator Value	Meaning
DOF_NOT_ACTIVE	This sensor does not logically exist in the current configuration.
DOF_6_XYZ_AER	The sensor is a 6DOF sensor.
DOF_5_XYZ_AE	The sensor is a 5DOF sensor.

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## AUXILIARY\_PORT\_TYPE

The **AUXILIARY\_PORT\_TYPE** enumeration type defines values that are used when getting or setting the AUXILIARY\_PORT with a GetSystemParameter or SetSystemParameter call.

```
enum AUXILIARY_PORT_TYPE
{
    AUX_PORT_NOT_SUPPORTED,
    AUX_PORT_NOT_SELECTED,
    AUX_PORT_SELECTED,
};
```

Enumerator Value	Meaning
AUX_PORT_NOT_SUPPORTED	There is no auxiliary port associated with this sensor port.
AUX_PORT_NOT_SELECTED	The auxiliary port is not selected.
AUX_PORT_SELECTED	The auxiliary port is selected..

### Requirements

**Windows NT/2000:** Requires Windows 2000 or later.

**Header:** Declared in ATC3DG.h

**Library:** Use ATC3DG.lib

### See Also

## 3D Guidance API Status/Error Bit Definitions

The following bit definitions are used with the 3DGuidance tracker

[ERRORCODE](#)

[DEVICE\\_STATUS](#)

## ERRORCODE

The **ERRORCODE** *int* has the following format:

Bit	Meaning
0-15	Enumerated error code of type <a href="#">BIRD_ERROR_CODES</a>
16-19	Address ID of device reporting error.
20-25	Reserved (Unused)
26	If bit = 1 there are more error messages pending <obsolete>
27 - 29	Error source code: 000 = System error 001 = 3DGuidance board error 010 = Sensor error 100 = Transmitter error Note: All other source codes are invalid
30 - 31	Bits 30 and 31 provide the following advisory error level code Note: It is recommended that all error messages be resolved before proceeding. 00 = Warning 01 = Warning 10 = Fatal Error

## DEVICE\_STATUS

The **DEVICE\_STATUS** is a *typedef* for an *unsigned long* (32 bits) and has the following error bit definitions:

Bit	Name	Meaning	S	B	R	T
0	GLOBAL_ERROR	Global error bit. If any other error status bits are set then this bit will be set.	x	x	x	x
1	NOT_ATTACHED	No physical device attached to this device channel.			x	x
2	SATURATED	Sensor currently saturated.			x	
3	BAD_EEPROM	PCB or attached device has a corrupt or unresponsive EEPROM		x	x	x
4	HARDWARE	Unspecified hardware fault condition is preventing normal operation of this device channel, board or the system.	x	x	x	x
5	NON_EXISTENT	The device ID used to obtain this status word is invalid. This device channel or board does not exist in the system.		x	x	x
6	UNINITIALIZED	The system has not been initialized yet. The system must be initialized at least once before any other commands can be issued. The system is initialized by calling <a href="#">InitializeBIRDSystem</a>	x	x	x	x
7	NO_TRANSMITTER_RUNNING	An attempt was made to call <a href="#">GetAsynchronousRecord</a> when no transmitter was running.	x	x	x	
8	BAD_12V	N/A for the 3DG systems				
9	CPU_TIMEOUT	N/A for the 3DG systems				
10	INVALID_DEVICE	The system has detected that the connected sensor does not match the port configuration (i.e. 5DOF sensor in 6DOF port).				
11	NO_TRANSMITTER_ATTACHED	A transmitter is not attached to the tracking system.	x	x	x	x
12	OUT_OF_MOTIONBOARD_OX	The sensor has exceeded the maximum range and the position has been clamped to the maximum range			x	
13	ALGORITHM_INITIALIZING	The sensor has not acquired enough raw magnetic data to compute an accurate P&O solution. This is set in Non-Dipole configurations when the algorithm is lost.			x	
14 - 31	<reserved>	Always returns zero.	x	x	x	x

The 4 columns with the headings S, B, R and T indicate whether or not the bits are applicable depending on which device status is being acquired. S = system, B = board, R = sensor and T = transmitter.

# 3D Guidance Initialization Files

The Initialization File is used to set a 3DGGuidance tracker to a predetermined state.

## 3D Guidance Initialization File Format Reference

The following sections describe the syntax and meaning of the items used in each type of initialization file section. Initialization files must follow these general rules:

- ❖ Sections begin with the section name enclosed in brackets.
- ❖ A **System** section must be included in any initialization file used with the 3DGGuidance hardware. The **System** section contains mandatory items that must be present for the file to be valid. These items are used to verify the applicability of this file to the system being initialized.

The following initialization sections are used to initialize the 3DGGuidance system:

### [\[System\]](#)

[\[ErrorHandling\]](#) (Reserved for future enhancements)

[\[Sensorx\]](#) (Where *x* is replaced with a decimal number representing the *id* of the sensor.)

[\[Transmitterx\]](#) (Where *x* is replaced with a decimal number representing the *id* of the transmitter.)

## [System]

The **System** section must be included in all initialization files formatted for use with the 3DGuidance tracker hardware.

```
[System]
NumberOfBoards=number-boards
TransmitterIDRunning=Tx-ID
MeasurementRate=sample-rate
Metric=metric-switch
PowerLineFrequency=power
AGCMode=mode
MaximumRange=range
```

### *number-boards*

This parameter is a decimal number and represents the number of 3DGuidance units connected to the PC. This number must match the current number of units for the file to be accepted. This item is mandatory.

### *Tx-ID*

This parameter is a decimal number and represents the index number of the transmitter selected to run after initialization. It assumes that a transmitter is attached at that index location. If no transmitter is attached a bad status will be generated for the sensors. If this value is set to -1 then no transmitter will be selected and all transmitters (if any are attached) will be turned off.

### *sample-rate*

This parameter selects the system measurement rate. It will determine how fast the transmitters are driven and the rate at which a new data sample will be produced. The parameter is an unsigned floating point value describing the measurement rate in Hz.

### *metric-switch*

This parameter is a Boolean switch which may have either one of two values. The valid settings are YES or NO. When the value YES is selected the position data will be output with millimeter dimensions. If the value is set to NO the output will be in inches.

### *power*

This parameter is a floating point value representing the AC power line frequency in Hz. Currently only two values are valid. These are 50 and 60 Hz.

### *mode*

This parameter is a string describing the AGC mode to be used for the system.

### *range*

This parameter is a floating point value representing the maximum range that the system will report in inches. The only valid values are 36 and 72 (inches).

The following example shows a typical **System** section:

```
[System]
NumberOfBoards=1
TransmitterIDRunning=0
MeasurementRate=103.3
Metric=YES
PowerLineFrequency=60
AGCMode=SENSOR_AGC_ONLY
MaximumRange=36
```

## [Sensorx]

The **Sensor** section is optional.

```
[Sensorx]
Format=format-type
Hemisphere=hemisphere-type
AC_Narrow_Filter=narrow-flag
AC_Wide_Filter=wide-flag
DC_Filter=dc-flag
Alpha_Min=min-params
Alpha_Max=max-params
Vm=vm-params
Angle_Align=align-angles
Filter_Large_Change=change-flag
Distortion=distortion-params
```

### *Format-type*

This parameter takes the form of the DATA\_FORMAT\_TYPE enumerated constant listed in the ATC3DG.h file. Use the exact spelling and case as found in the header file.

### *Hemisphere-type*

This parameter takes the form of the HEMISPHERE\_TYPE enumerated constant listed in the ATC3DG.h file. Use the exact spelling and case as found in the header file.

### *Narrow-flag*

This parameter is a Boolean and is selected by entering either yes or no.

### *Wide-flag*

This parameter is a Boolean and is selected by entering either yes or no.

### *dc-flag*

This parameter is a Boolean and is selected by entering either yes or no.

### *Min-params*

These parameters are entered as a sequence of 6 comma separated floating point numbers in the range 0 to +1.0.

Note: A Min\_param cannot exceed its equivalent Max\_param in value.

### *max-params*

These parameters are entered in the same format as the Min\_params. Note a Max\_param may never have a value lower than its equivalent Min\_param.

### *vm-params*

These parameters are entered as 6 comma-separated integers. The valid range for the integers is from a minimum of 1 to a maximum of 32767.

### *Align-angles*

These parameters are entered as 3 comma-separated floating point values. The parameters represent azimuth, elevation and roll. The azimuth and roll values must lie with the range -180 to +180 degrees and the elevation value must lie within the range -90 to +90 degrees.

### *Change-flag*

This parameter is a Boolean and is selected by entering either yes or no.

### *Distortion-params*

These parameters are entered as 4 comma-separated integers. The 4 values are defined as follows: error-slope, error-offset, error-sensitivity and filter-alpha. The slope should have a value between -127 and +127. (Default is 0) The offset should have a value between -127 and +127. (The default is 0) The sensitivity should have a value between 0 and +127 (Default is 2) and the alpha should have a value between 0 and 127. (The default is 12)

The following example shows a typical **Sensor** section from a configuration file:

```
[Sensor2]
Format=SHORT_POSITION_ANGLES
Hemisphere=FRONT
AC_Narrow_Filter=no
AC_Wide_Filter=yes
DC_Filter=yes
Alpha_Min=0.02,0.02,0.02,0.02,0.02,0.02
Alpha_Max=0.09,0.09,0.09,0.09,0.09,0.09
Vm=2,4,8,32,64,256,512
Angle_Align=0,0,0
Filter_Large_Change=NO
Distortion=164,0,32,327
```

## [Transmitterx]

The **Transmitter** section is optional.

```
[Transmitterx]
XYZ_Reference=reference-flag
XYZ_Reference_Angles=reference-angles
```

### *Reference-flag*

This parameter is a Boolean and should be entered as yes or no. If yes is selected a new sensor position will be calculated for the new reference frame defined by the reference frame angles.

### *Reference-angles*

These parameters take the form a sequence of 3 comma-separated floating point values which represent the azimuth, elevation and roll of the new transmitter reference frame. The azimuth and roll must have values in the range -180 to +180 degrees. The elevation value must be in the range -90 to +90 degrees.

The following example shows a typical **Transmitter** section from a configuration file:

```
[Transmitter1]
XYZ_Reference=no
XYZ_Reference_Angles=0,45,0
```

# Ascension RS232 Interface Reference

*This chapter details the method for communicating with the trakSTAR 2 directly using the RS232 interface protocol and command set.*

## RS232 Signal Description

A pinout and signal description of the RS-232C interface is found below. Note that trakSTAR 2 requires connections only to pins 2, 3 and 5 of the 9-pin interface connector.

Table 10 TrakSTAR 2 9-pin RS-232C connector pinout

PIN	RS232 Signal	Direction	Description
2	Receive Data	Tracker to Host	Serial data output from The Tracker to the host
3	Transmit Data	Host to Tracker	Serial data output from the host to The Tracker
5	Signal Ground	Tracker to Host	Tracker to host Signal reference
7	Request to Sent	Host to Tracker	Holds The Tracker in RESET when high

Note: These are the Electronic Industries Association (EIA) RS232 signals names. The Tracker is configured as Data Communication equipment (DCE) and therefore Transmit Data is an input and Receive Data is an output.

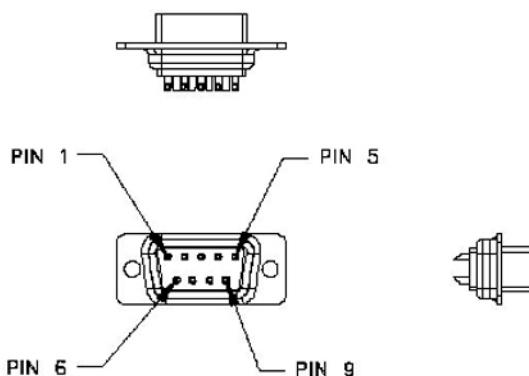


Figure 55 Rear View: 9-Pin D-Sub Connector

## Using the 'reset on CTS' feature

The **trakSTAR 2** can be configured to perform a system reset when pin 7, its CTS line (RTS on HOST side) is held high. This provides a method of reinitializing the system if the state of the firmware is unknown. This feature is enabled only through placement of an internal jumper on the main PCB. Please contact technical support for details.

**NOTE:** Users running applications in a Windows® environment who would like to enable this feature, should take steps to ensure that command of this line (and of the serial port) is clearly asserted.

## RS232 Commands

Each RS232 command consists of a single **command byte** followed by **N command data bytes**, where N depends upon the command. A command is an 8-bit value, which the host transmits to the Tracker.

The RS232 **command format** is as follows:

MS BIT									LS BIT
Stop	7	6	5	4	3	2	1	0	Start

### RS232

Command	1	BC7	BC6	BC5	BC4	BC3	BC2	BC1	BC0	0
---------	---	-----	-----	-----	-----	-----	-----	-----	-----	---

- where BC7-BC0 is the 8-bit command value (see RS232 Command Reference)
- and the MS BIT (Stop = 1) and LS BIT (Start = 0) refers to the bit values that the UART in your computer's RS232 port automatically inserts into the serial data stream.

The RS232 **command data format** is as follows:

MS BIT									LS BIT
Stop	7	6	5	4	3	2	1	0	Start

### RS232

Data	1	BD7	BD6	BD5	BD4	BD3	BD6	BD1	BD0	0
------	---	-----	-----	-----	-----	-----	-----	-----	-----	---

- where BD7-BD0 is the 8-bit data value associated with a given command.

## Command Summary

The following summarizes the action of each RS232 command. The details of command usage are presented later in this chapter in the section entitled [RS232 Command Reference](#).

 **Tip:** For a listing of valid system parameters to use with the CHANGE or EXAMINE VALUE commands, see CHANGE VALUE in the 'Command Reference' section.

Table 11 RS232 Command Summary

Command	Description
ANGLES	Data record contains 3 rotation angles
ANGLE ALIGN	Aligns sensor to reference direction
BORESIGHT (See Note)	Aligns sensor to the reference frame
BORESIGHT REMOVE (See Note)	Remove the sensor BORESIGHT
BUTTON MODE	Send to append the button (contact closure/switch) information to the data record
BUTTON READ	Send to read the state of the Button when Button mode is not enabled.
CHANGE VALUE	Changes the value of a selected Tracker system parameter.
EXAMINE VALUE	Reads and examines a selected Tracker system parameter.
MATRIX	Data record contains 9-element rotation matrix.
OFFSET	Configures positional outputs from the Tracker to specify a location that is offset from the center of the Sensor.
POINT	One data record is output from the trakSTAR unit for each B command issued.
POSITION	Data record contains X, Y, Z position of sensor
POSITION/ANGLES	Data record contains POSITION and ANGLES
POSITION/MATRIX	Data record contains POSITION and MATRIX
POSITION/QUATERNION	Data record contains POSITION and QUATERNION

Command	Description
QUATERNION	Data record contains QUATERNIONS
REFERENCE FRAME	Defines new measurement reference frame
REPORT RATE	Measurement rate divisor command. Reduces the number of records output during STREAM mode
RESET	Performs a system reset
RUN	Turns Transmitter ON and starts running after SLEEP
SLEEP	Turns Transmitter OFF and suspends system operation
STREAM	Data records are transmitted continuously from the selected sensor. If GROUP mode is enabled then data records are output continuously from all sensors connected to the tracker.
STREAM STOP	Stops any data output that was started with the STREAM

**Note: Commands not implemented at time of manual writing**

## Command Utilization

The host may tell the tracker what type of data to send when a data request is issued. The desired type of data is indicated by sending one of the following data record commands: ANGLES, MATRIX, POSITION, QUATERNION, POSITION/ANGLES, POSITION/MATRIX or POSITION/QUATERNION. These commands do not cause tracker to transmit data to the host. For the host to receive data, it must issue a data request. Use the POINT data request each time you want one data record or use the STREAM data request to initiate a continuous flow of data records from the tracker. If you want to reduce the rate at which data STREAMs from tracker, use the REPORT RATE command. All commands can be issued in any order and at any time to change trakSTAR's output characteristics.

The following is a hypothetical command sequence, issued after power-up, which illustrates the use of some of the commands.

**Table 12 Hypothetical Command Sequence**

Command	Description
RUN	Turn on the transmitter (needed if system configured to sleep on reset)
ANGLES	Output records will contain angles only

Command	Description
POINT	Tracker outputs ANGLES data record.
STREAM	ANGLE data records start streaming from tracker and will not stop until the mode is changed to POINT or the STREAM STOP command is issued.
POINT	An ANGLE data record is output and the streaming is stopped

## Response Format

Two types of binary data are returned from **trakSTAR 2**:

- 3. Position/Orientation data
- 4. CHANGE/EXAMINE VALUE data

**Position/orientation** data are the data returned from the Tracker in the ANGLES, POSITION, MATRIX, POSITION/ANGLES, POSITION/MATRIX, POSITION/QUATERNION and QUATERNION formats. This data is returned in one or more 8-bit data bytes, using a special format described below.

All other types of data that the tracker returns are in the **CHANGE/EXAMINE VALUE** data format. This data is also returned in one or more 8 bit data bytes, using the response format described with each Change/Examine value command. (see the 'Command Reference' section for details). The Change/Examine value data is not shifted and does not contain the 'phasing' bits found in the Position/Orientation data.

## Position/Orientation Data Format

The Position/Orientation information generated by the tracker is sent in a form called a data record. The number of bytes in each record is dependent on the output format selected by the user. Each 2-byte word is in a binary format dependent on the word type (i.e. Position, Angles, etc.). The binary formats consist of the 14 most significant bits (bits B15 - B2) of the sixteen bits (bits B15 - B0) that define each word. The two least significant bits (bits B1 and B0) are not used by the tracker. The first bit of the first byte transmitted is always a one (1) while the first bit of all other transmitted bytes in the record is always a zero (0). These "phasing" bits are required for the host computer to identify the start of a record when the data is streaming from the tracker without individual record requests. In general, the output data will appear as follows:

MS BIT								LS BIT								WORD #
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	
1	B8	B7	B6	B5	B4	B3	B2	1	LSbyte	1	C8	C7	C6	C5	C4	#1 LSbyte
0	B15	B14	B13	B12	B11	B10	B9	0	MSbyte	0	C15	C14	C13	C12	C11	#1 MSbyte
0	C15	C14	C13	C12	C11	C10	C9	0	LSbyte	0	C8	C7	C6	C5	C4	#2 LSbyte
0	MSbyte	0	C15	C14	C13	C12	C11	0	MSbyte	0	C15	C14	C13	C12	C11	#2 MSbyte

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0	.	.	.	.	.	.	.	.	.
0	.	.	.	.	.	.	.	.	.
0	.	.	.	.	.	.	.	.	.
0	N8	N7	N6	N5	N4	N5	N2		#N LSbyte
0	N15	N14	N13	N12	N11	N10	N9		#N MSbyte

The MS (most significant) bits are the phasing bits, and are not part of the data.

For example, the tracker is about to send a data record consisting of these three data words:

Word#	Decimal	Hex	Binary (2 bytes)	
			MSbyte	LSbyte
#1	4386	1122	0010001	00100010
#2	13124	3344	00110011	01000100
#3	21862	5566	01010101	01100110

The conversion to the binary data format by the tracker is as follows:

### Tracker

- 1) Shifts each data word right      2) Breaks each word into MSByte

one bit		LSByte pairs	
MS	LS	10010001	LS
00001000	10010001	00001000	MS
00011001	10100010	10100010	LS
00101010	10110011	00011001	MS
		10110011	LS
		00101010	MS

- 3) Shifts each LSByte right one more bit (Marks with "1" if first byte)      4) Transmits all bytes in stream

MS	BIT								WORD #
	7	6	5	4	3	2	1	0	
1	1	0	0	1	0	0	0	0	#1 LSByte
0	0	0	0	1	0	0	0	0	#1 MSByte
0	1	0	1	0	0	0	1		#2 LSByte
0	0	0	1	1	0	0	1		#2 MSByte
0	1	0	1	1	0	0	1		#3 LSByte
0	0	1	0	1	0	1	0		#3 MSByte

The user's computer can identify the beginning of the data record by catching the leading "1", and converting subsequent data bytes back to their proper binary values.

## HOST:

- 1) Receives data bytes in stream after  
catching first marked "1" (Changes  
that "1" back to a "0")

01001000	LS	10010000	LS
00001000	MS	00001000	MS
01010001	LS	10100010	LS
00011001	MS	00011001	MS
01011001	LS	10110010	LS
00101010	MS	00101010	MS

- 3) Combines each MSByte/LSByte pair  
left one more  
into data words  
correct original
- 4) Shifts each word  
bit, giving the  
binary value

MS	LS	MS	LS
00001000	10010000	00010001	00100000
00011001	10100010	00110011	01000100
00101010	10110010	01010101	01100100

You don't need to worry about the fact that the two least significant bits are different because the data words do not use these bits.

**RS232 Command Reference**

All commands are listed alphabetically in the following section. Each command description contains the command codes required to initiate the commands, as well as the format and scaling of the data records that the **trakSTAR** will output to the host computer.

## ANGLES

	ASCII	HEX	DECIMAL	BINARY
Command Byte	W	57	87	01010111

In the ANGLES mode, The Tracker outputs the orientation angles of the sensor with respect to the Transmitter. The orientation angles are defined as rotations about the Z, Y, and X axes of the sensor. These angles are called Zang, Yang, and Xang or, in Euler angle nomenclature, Azimuth, Elevation, and Roll. The output record is in the following format for the six transmitted bytes:

MSB								LSB	
7	6	5	4	3	2	1	0	BYTE #	
1	Z8	Z7	Z6	Z5	Z4	Z3	Z2	#1	LSbyte Zang
0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	#2	MSbyte Zang
0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	#3	LSbyte Yang
0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	#4	MSbyte Yang
0	X8	X7	X6	X5	X4	X3	X2	#5	LSbyte Xang
0	X15	X14	X13	X12	X11	X10	X9	#6	MSbyte Xang

Zang (Azimuth) takes on values between the binary equivalent of +/- 180 degrees. Yang (Elevation) takes on values between +/- 90 degrees, and Xang (Roll) takes on values between +/- 180 degrees. As Yang (Elevation) approaches +/- 90 degrees, the Zang (Azimuth) and Xang (Roll) become very noisy and exhibit large errors. At 90 degrees the Zang (Azimuth) and Xang (Roll) become undefined. This behavior is not a limitation of The Tracker - it is an inherent characteristic of these Euler angles. If you need a stable representation of the sensor orientation at high Elevation angles, use the MATRIX output mode.

The scaling of all angles is full scale = 180 degrees. That is, +179.99 deg = 7FFF Hex, 0 deg = 0 Hex, -180.00 deg = 8000 Hex.

**To convert the numbers into angles (degrees)** first cast it into a signed integer. This will give you a number from +/- 32767. Second multiply by 180 and finally divide the number by 32768 to get the angle. The equation should look something like this:

$$(\text{signed int(Hex #)} * 180) / 32768$$

## ANGLE ALIGN

	ASCII	HEX	DECIMAL	BINARY
Command Byte	q	71	113	01110001
Command Data	A, E, R			

By default, the angle outputs from each sensor are measured in the coordinate frame defined by the Transmitter's X, Y and Z axes, as shown in [Figure 26: Default Transmitter/Sensor Coordinate Frames](#) and are measured with respect to rotations about the physical X, Y and Z axes of the sensor. The ANGLE ALIGN1 command allows you to mathematically change each sensor's X, Y and Z axes to an orientation that differs from that of the actual sensor.



**Note:** The ANGLE ALIGN command only affects the computation of orientation - it has no effect on position.

For example, suppose that during installation you find it necessary, due to physical requirements, to cock the sensor, resulting in its angle outputs reading Azim = 5 deg, Elev = 10 and Roll = 15 when it is in its normal "resting" position. To compensate, use the ANGLE ALIGN command, passing as Command Data the angles of 5, 10 and 15 degrees. After this sequence is sent, the sensor outputs will be zero, and orientations will be computed as if the sensor were not misaligned.



**Note:** The ANGLE ALIGN command is ignored for 5DOF sensors.

The host computer must send the *Command Data* immediately following the *Command Byte*. Command data consists of the angles. The Command Byte and Command Data must be transmitted to The Tracker in the following seven-byte format:

MSB								LSB	
7	6	5	4	3	2	1	0		BYTE #
0	1	1	1	0	0	1	0		#1 Command Byte
B7	B6	B5	B4	B3	B2	B1	B0		#2 LSbyte A
B15	B14	B13	B12	B11	B10	B9	B8		#3 MSbyte A
B7	B6	B5	B4	B3	B2	B1	B0		#4 LSbyte E
B15	B14	B13	B12	B11	B10	B9	B8		#5 MSbyte E
B7	B6	B5	B4	B3	B2	B1	B0		#6 LSbyte R
B15	B14	B13	B12	B11	B10	B9	B8		#7 MSbyte R

See the ANGLES command for the format and scaling of the angle values sent

## BORESIGHT

	ASCII	HEX	DECIMAL	BINARY
Command Byte	u	75	117	01110101



**Note:** Command not implemented at time of manual writing.

Sending the single byte BORESIGHT command to the 3DGuidance causes the sensor to be aligned to the Tracker's REFERENCE FRAME. In other words, when you send the command, the sensor's orientation outputs will go to zero, making it appear as if it was physically aligned with the Tracker's REFERENCE FRAME. All orientation outputs thereafter are with respect to this BORESIGHTed orientation. This command is equivalent to taking the angle outputs from the Tracker and using them in the ANGLE ALIGN commands but without the need to supply any angles with the command. This command does not change any angles you may have set using the ANGLE ALIGN command. However, if you use the ANGLE ALIGN command after you send the BORESIGHT command, these new ANGLE ALIGNs will remove the effect of the BORESIGHT command and replace them with the ANGLE ALIGN angles.

Use the BORESIGHT REMOVE command to revert to the sensor outputs as measured by the orientation of the sensor

## BORESIGHT REMOVE

	ASCII	HEX	DECIMAL	BINARY
Command Byte	v	76	118	01110110

Sending the single byte BORESIGHT REMOVE command to the tracker causes the sensor's orientation outputs to revert to their values before you sent the BORESIGHT command. That is, if there were no ANGLE ALIGN values present, the sensor's orientation outputs will now be with respect to the sensor's physical orientation. If there were ANGLE ALIGN values present before the BORESIGHT command was given, then after the BORESIGHT REMOVE command is given, the sensor's orientation outputs will be with respect to this mathematically defined ANGLE ALIGNed sensor orientation.



**Note:** Command not implemented at time of manual writing.

## BUTTON MODE

	ASCII	HEX	DECIMAL	BINARY
Command Byte	M	4D	77	01001101
Command Data	MODE			

The BUTTON MODE command is used to set how the state of a rear panel external button will be reported to the host computer (see [Table 4](#)). The BUTTON MODE Command Byte must be followed by a single Command Data byte, which specifies the desired report format. The button state is reported to the host via a single Button Value byte. This byte can be sent by the Tracker after the last data record element is transmitted, or can be read at any time using the BUTTON READ command. If you set the Command Data byte equal to 0 Hex, the Button Value byte is not appended to the data record, and you must use the BUTTON READ command to examine the status of the button. If you set the Command Data byte equal to 1, the Button Value byte will be appended to the end of each transmitted data record unless the Metal indicator byte is output also, in which case the Metal indicator byte will be the last byte and the Button value byte will be next to last. For example, you had selected the POSITION/ANGLE mode, the output sequence would now be: x, y, z, az, el, rl, button, for a total of 13 bytes instead of the normal 12 bytes.

The BUTTON MODE command must be issued to the Tracker in the following 2-byte sequence:

MSB								LSB		BYTE #
7	6	5	4	3	2	1	0			
0	1	0	0	1	1	0	1	#1	Command Byte	
0	0	0	0	0	0	0	D0	#2	Command Data	

Where D0 = “0” or “1.”

For a description of the values that may be returned in the Button Value byte, see the BUTTON READ command.

## BUTTON READ

	ASCII	HEX	DECIMAL	BINARY
Command Byte	N	4E	78	01001110

The BUTTON READ command allows you to determine at any time the state of an external button (contact closure/switch) that the user has connected to the rear panel of the tracker (see [Table 4](#)). This command is especially useful when you want to read the buttons but do not have BUTTON MODE set to 1 (which would append the Button Value byte to every transmitted record).

Immediately after you send the BUTTON READ Command Byte, the Tracker will return a single byte containing the button value. The Button Value byte can assume the following Hex values:

- 0 Hex = 0: No button pressed.
- 1 Hex = 1: Button pressed



**Note:** The Button Value byte does not contain the phasing bits normally included in the Bird's transmitted data records. The above values are the ones actually sent to the host.

The Tracker updates its button reading every transmitter axis cycle (3 times per measurement cycle for mid and short-range transmitters), whether you request the value or not. Thus, the system does not store previous button presses, and indicates only whether the button has been pressed within the last transmitter axis cycle.

## CHANGE VALUE

	ASCII	HEX	DECIMAL	BINARY
CHANGE VALUE				
Command Byte	P	50	80	01010000

CHANGE VALUE		
Command Byte	PARAMETERnumber	PARAMETERvalue

The CHANGE VALUE command allows you to change the value of The Tracker system parameter defined by the PARAMETERnumber byte and the PARAMETERvalue byte(s) sent with the command.

## EXAMINE VALUE

	ASCII	HEX	DECIMAL	BINARY
EXAMINE VALUE				
Command Byte	O	4F	79	01001111

EXAMINE VALUE		
Command Byte	PARAMETERnumber	

The EXAMINE VALUE command allows you to read the value of the Tracker system parameter defined by the PARAMETERnumber sent with the command. Immediately after The Tracker receives the command and command data, it will return the parameter value as a multi-byte response.

Valid CHANGE VALUE and EXAMINE VALUE PARAMETER numbers are listed in the table below. *Note: not all PARAMETERnumbers are CHANGEable, but ALL are EXAMINEable.*

**Table 13 List of Examine Value Valid Parameters**

Parameter		CHANGEable	CHANGE	EXAMINE		Description	
			Bytes Send	Bytes			
				Send	Receive		
Dec	Hex						
0	0	No	0	2	2	Tracker status	
1	1	No	0	2	2	Software revision number	
2	2	No	0	2	2	Tracker computer crystal speed	
3	3	Yes	4	2	2	Position scaling	
4	4	Yes	4	2	2	Filter on/off status	
5	5	Yes	16	2	14	DC Filter constant table ALPHA_MIN	
8	8	Yes	3	2	1	Data ready output character	
9	9	Yes	3	2	1	Changes data ready character	
10	A	No	0	2	1	Tracker outputs an error code	
12	C	Yes	16	2	14	DC filter constant table Vm	
13	D	Yes	16	2	14	DC filter constant table ALPHA_MAX	
14	E	Yes	3	2	1	Sudden output change elimination	
15	F	No	0	2	10	System Model Identification	
17	11	Yes	3	2	1	XYZ Reference Frame	
20	14	Yes	3	2	1	Filter line frequency	
22	16	Yes	4	2	2	Change/Examine Hemisphere	
23	17	Yes	8	2	6	Change/Examine Angle Align2	

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Parameter		CHANGEable	CHANGE	EXAMINE		Description	
				Bytes			
				Send	Receive		
24	18	Yes	8	2	6	Change/Examine Reference Frame2	
25	19	No	0	2	2	Tracker (Electronics) Serial Number	
26	1A	No	0	2	2	Sensor Serial Number	
27	1B	No	0	2	2	Xmtr Serial Number	
28	1C	Yes	12	2	10	Metal Detection	
29	1D	Yes	1	2	1	Report Rate	
35	23	Yes	3	2	1	Group Mode	
36	24	No	0	2	14	System Status	
50	32	Yes	3	2	5	AutoConfig	
71	47	Yes	8	2	6	Sensor Offsets	
130	82	No	0	2	2	Boot Loader Firmware Revision	
131	83	No	0	2	2	MDSP Firmware Revision	
133	85	No	0	2	2	NonDipole POServer Firmware Revision	
135	87	No	0	2	2	5DOF Firmware Revision	
136	88	No	0	2	2	6DOF Firmware Revision	
137	89	No	0	2	2	Dipole POServer Firmware Revision	

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The **CHANGE VALUE** command must be issued to The Tracker in the following N-byte sequence:

MSB								LSB	
7	6	5	4	3	2	1	0	BYTE #	
0	1	0	1	0	0	0	0	#1 Command Byte, 'P'	
N7	N6	N5	N4	N3	N2	N1	N0	#2 PARAMETERnumber	
B7	B6	B5	B4	B3	B2	B1	B0	#3 PARAMETERdata	
<b>LSbyte</b>									
B7	B6	B5	B4	B3	B2	B1	B0	#4 PARAMETERdata	
<b>MSbyte</b>									
B7	B6	B5	B4	B3	B2	B1	B0	#N PARAMETERdata	

Where N7-N0 represent a PARAMETERnumber (i.e. 00000011 or 00000100), and B7-B0 represent N-bytes of PARAMETERdata. If the PARAMETERdata is a word then the Least Significant byte (LSbyte) is transmitted before the Most Significant byte (MSbyte). If the PARAMETERdata is numeric, it must be in 2's complement format. You do not shift and add 'phasing' bits to the data.

The EXAMINE VALUE command must be issued to The Tracker in the following 2-byte sequence:

MSB								LSB	
7	6	5	4	3	2	1	0	BYTE #	
0	1	0	0	1	1	1	1	#1 Command Byte	
N7	N6	N5	N4	N3	N2	N1	N0	#2 PARAMETERnumber	

Where N7-N0 represent a PARAMETERnumber, i.e. 00000000 or 00000001, etc.

If the PARAMETERdata returned is a word then the Least Significant byte (LSbyte) is received before the Most Significant byte (MSbyte). If the PARAMETERdata is numeric, it is in 2's complement format. The PARAMETERdata received does not contain 'phasing' bits. The PARAMETERdata value, content and scaling depend on the particular parameter requested. See the following discussion of each parameter.

## TRACKER STATUS

When PARAMETERnumber = 0 during EXAMINE, The Tracker returns a status word to tell the user in what mode the unit is operating. The bit assignments for the two-byte response are:



**Tip:** To retrieve the error code(s) indicated by this 'flag' (B13), send '10' as the parameter (see [ERROR CODE](#)).

Table 14 Tracker Status Bits

Bit #	Description
B15	1 – If Tracker is “Master” Tracker 0 – If Tracker is “Slave” Tracker
B14	1 – If Tracker has been initialized following Auto Config 0 – If Tracker has not been initialized
B13	1 – If errors exist in the SYSTEM ERROR register (error(s) detected) 0 – If no errors exist in the register (no errors detected)
B12	1 – If Tracker is RUNNING 0 – IF Tracker is not RUNNING
B6-B11	Not currently used by trakSTAR
B5	1 – If the Tracker is in SLEEP mode (Opposite of B12) 0 – If the Tracker is in RUN Mode
B4-B1	0001 If POSITION outputs selected 0010 If ANGLE outputs selected 0011 If MATRIX outputs selected 0100 If POSITION/ANGLE outputs selected 0101 If POSITION/MATRIX outputs selected 0110 Factory use only 0111 If QUANTERNION outputs selected 1000 If POSITION/QANTERNION outputs selected
B0	0 – If POINT mode selected 1 If STREAM mode selected
<b>Note: In STREAM mode, you cannot examine status</b>	

## SOFTWARE REVISION NUMBER

When PARAMETERnumber = 1 during EXAMINE, The Tracker returns the two byte revision number of the software located in The Tracker's Flash memory. The revision number in base 10 is expressed as INT.FRA where INT is the integer part of the revision number and FRA is the fractional part. For example, if the revision number is 2.13 then INT = 2 and FRA = 13. The value of the most significant byte returned is FRA. The value of the least significant byte returned is INT. Thus, in the above example the value returned in the most significant byte would have been 0D Hex and the value of the least significant byte would have been 02 Hex. If the revision number were 3.1 then the bytes would be 01 and 03 Hex.

## TRACKER COMPUTER CRYSTAL SPEED

When PARAMETERnumber = 2 during EXAMINE, the Tracker returns the speed of its computer's crystal in megahertz (MHz). The most significant byte of the speed word is equal to zero, and the base 10 value of the least significant byte represents the speed of the crystal. For example, if the least significant byte = 19 Hex, the crystal speed is 25 MHz. The 3DGGuidance™ always reports 325MHz.

## POSITION SCALING

When PARAMETERnumber = 3 during EXAMINE, the Tracker returns a code that describes the scale factor used to compute the position of the sensor with respect to the transmitter. If the separation exceeds this scale factor, The Tracker's position outputs will not change to reflect this increased distance, rendering the measurements useless. The most significant byte of the parameter word returned is always zero. If the least significant byte = 0, the scale factor is 36 inches for a full-scale position output. If the least significant byte is = 1, the full-scale output is 72 inches

To CHANGE the scale factor send the Tracker two bytes of PARAMETERdata with the most significant byte set to zero and the least significant set to zero or one.

**Note: Changing the scale factor from the default 36 inches to 72 inches reduces by half the resolution of the output X, Y, Z coordinates.**

## FILTER ON/OFF STATUS

When PARAMETERnumber = 4 during EXAMINE, the Tracker returns a code that tells you what software filters are turned on or off in the unit. The average user of the Tracker should not have to change the filters, but it is possible to do so. The most significant byte returned is always zero. The bits in the least significant byte are coded per the following table:

**Table 15 Filter On/Off Status Bit Assignments**

<b>Bit #</b>	<b>Description</b>
B7-B3	0
B2	1 – If the AC NARROW notch filter is ON (default) 0 – If the AC NARROW notch filter is OFF
B1	1 – If the AC WIDE notch filer is ON (default) 0 – If \the AC WIDE notch filter is OFF
B0	1 – If the DC (Adaptive) filter is ON (default) 0 – If the DC filter is OFF
B6-B11	Not currently used by trakSTAR

The **AC NARROW** notch filter refers to a two tap finite impulse response (FIR) notch filter that is applied to signals measured by the Tracker's sensor to eliminate a narrow band of noise with sinusoidal characteristics. Use this filter in place of the AC WIDE notch filter when you want to minimize the transport delay between Tracker measurement of the sensor's position/orientation and the output of these measurements. The transport delay of the AC NARROW notch filter is approximately one third the delay of the AC WIDE notch filter.

The **AC WIDE** notch filter refers to an eight tap FIR notch filter that is applied to the sensor data to eliminate sinusoidal signals with a frequency between 30 and 72 hertz. If your application requires minimum transport delay between measurement of the sensor's position/orientation and the output of these measurements, you may want to evaluate the effect on your application with this filter shut off and the AC NARROW notch filter on. If you are running the Tracker synchronized to a CRT, you can usually shut this filter off without experiencing an increase in noise.

The **DC** filter refers to an adaptive, low pass filter applied to the sensor data to eliminate high frequency noise. When the DC filter is turned on, you can modify its noise/lag characteristics by changing ALPHA\_MIN and Vm.

To CHANGE the FILTER ON/OFF STATUS send The Tracker two bytes of PARAMETER data with the most significant byte set to zero and the least significant set to the code in the table above.

## DC FILTER CONSTANT TABLE ALPHA\_MIN

When PARAMETER number = 5 during EXAMINE, The Tracker returns 7 words (14 bytes) which define the lower end of the adaptive range that filter constant ALPHA\_MIN can assume in the DC filter. When ALPHA\_MIN = 0 Hex, the DC filter will provide an infinite amount of filtering (the outputs will never change even if you move the sensor). When ALPHA\_MIN = 0.99996 = 7FFF Hex, the DC filter will provide no filtering of the data.

**Table 16 DC Filter Constant Table Default Values (Std Range Transmitter)**

Range (Inches)	ALPHA MIN (Decimal)
0-17	0.02 = 028F (HEX)
17-22	0.02
22-27	0.02
27-34	0.02
34-42	0.02
42-54	0.02
54+	0.02

To CHANGE ALPHA\_MIN, send The Tracker seven words of PARAMETER data corresponding to the ALPHA\_MIN table defined above. Increase ALPHA\_MIN to obtain less; decrease ALPHA\_MIN to provide more filtering (less noise/more lag). ALPHA\_MIN must always be less than ALPHA\_MAX.

## DISABLE/ENABLE DATA READY OUTPUT

Enabling the DATA READY character provides a method for notifying you as soon as the newest position and orientation data has been computed. Typically, you would issue a POINT data request as soon as you receive the DATA READY command. If you are running in STREAM mode you should not use the DATA READY character since the position and orientation is sent to you automatically as soon as it is ready.

When PARAMETERnumber = 8 during EXAMINE, The Tracker outputs one byte of data, equal to 1 if Data Ready Output is enable or a 0 if disabled.

To CHANGE DATA READY, send The Tracker one byte of PARAMETERdata = 1 if The Tracker is to output the Data Ready Character every measurement cycle as soon as a new measurement is ready for output. The default Data Ready Character is a comma (2C Hex, 44 Dec).

## SET DATA READY CHARACTER

When PARAMETERnumber = 9 during EXAMINE, The Tracker returns one byte, the current ASCII value of the Data Ready Character.

To CHANGE the DATA READY CHARACTER, send The Tracker one byte of PARAMETERdata equal to the character value that The Tracker should use as the Data Ready Character.

## ERROR CODE

When PARAMETERnumber = 10 during EXAMINE, The Tracker will output a one byte Error code, indicating a particular system condition was detected. The byte returned represents the earliest error code sent to the SYSTEM ERROR register. See the *Error Reporting* section below, for details.

## DC FILTER TABLE Vm

When PARAMETERnumber = 12 during EXAMINE, The Tracker returns a 7 word (14 byte) table, or during CHANGE, the user sends to The Tracker a 14 byte table representing the expected noise that the DC filter will measure. By changing the table values the user can increase or decrease the DC filter's lag as a function of sensor distance from the Transmitter.

The DC filter is adaptive in that it tries to reduce the amount of low pass filtering in The Tracker as it detects translation or rotation rates in The Tracker's sensor. Reducing the amount of filtering results in less filter lag. Unfortunately electrical noise in the environment, when measured by the transmitter, may also make it look like the sensor is undergoing a translation and rotation. The Tracker has to know if the measured events are real due to movement or false due to noise. The Tracker gets this knowledge by the user specifying what the expected noise levels are in the operating environment. These noise levels are the 7 words that form the Vm table. The Vm values can range from 1 for almost no noise to 32767 for a lot of noise.

**Table 17 DC Filter Table Default Values (Dipole Transmitters)**

Range (Inches)	VM (Integer)
0-17	2
17-22	4
22-27	4
27-34	4
34-42	4
42-54	4
54+	4

As Vm increases so does the amount of filter lag. To reduce the amount of lag, reduce the larger Vm values until the noise in The Tracker's output is too large for your application.

### DC FILTER CONSTANT TABLE ALPHA\_MAX

When PARAMETERnumber = 13 during EXAMINE, the Tracker returns 7 words (14 bytes) that define the upper end of the adaptive range that filter constant ALPHA\_MAX can assume in the DC filter as a function of sensor to Transmitter separation. When there is a fast motion of the sensor, the adaptive filter reduces the amount of filtering by increasing the ALPHA used in the filter. It will increase ALPHA only up to the limiting ALPHA\_MAX value. By doing this, the lag in the filter is reduced during fast movements. When ALPHA\_MAX = 0.99996 = 7FFF Hex, the DC filter will provide no filtering of the data during fast movements.

**Table 18 DC Filter Constant Table Default Values (Dipole Transmitters)**

Range (Inches)	ALPHA MAX ((Integer))
0-17	0.9
17-22	0.9
22-27	0.9
27-34	0.9
34-42	0.9
42-54	0.9
54+	0.9

To CHANGE ALPHA\_MAX send The Tracker seven words of PARAMETERdata corresponding to ALPHA\_MAX. During CHANGE, you may want to decrease ALPHA\_MAX to increase the amount of filtering if The Tracker's outputs are too noisy during rapid sensor movement. ALPHA\_MAX must always be greater than ALPHA\_MIN.

### SUDDEN OUTPUT CHANGE LOCK

When PARAMETERnumber = 14, during EXAMINE, the Tracker returns a byte which indicates if the position and orientation outputs will be allowed to change if the system detects a sudden large change in the outputs. Large undesirable changes may occur at large separation distances between the transmitter and sensor when the sensor undergoes a fast rotation or translation. The byte returned will = 1 to indicate that the outputs will not be updated if a large change is detected. If the byte returned is zero, the outputs will change.

To change SUDDEN OUTPUT CHANGE LOCK send the Tracker one byte of PARAMETERdata = 0 to unlock the outputs or send one byte = 1 to lock the outputs.

## SYSTEM MODEL IDENTIFICATION

When PARAMETERnumber = 15 during EXAMINE, The Tracker returns 10 bytes which will represent the device that was found.

**Table 19 System Model Identification**

Device Description String	Device
“6DFOB “	Stand alone (SRT)
“6DERC “	Extended Range Controller
“6DBOF “	MotionStar (old name)
“6DBB4”	3DGuidance driveBAY/trakSTAR/driveBAY 2 / trakSTAR 2 Systems supporting 6DOF transmitters
“5DBB4”	3DGuidance driveBAY 2 / trakSTAR 2 Systems supporting 5DOF /6DOF transmitters
“6DMC180-4”	3D Guidance (4 sensor 3DGuidance medSAFE™)
“PCBIRD “	pcBIRD
“SPACEPAD “	SpacePad
“MOTIONSTAR”	MotionStar (new name)
“WIRELESS “	MotionStar Wireless
“LASERBIRD2”	LASERBIRD 2
“PHASORBIRD”	PHASORBIRD

## XYZ REFERENCE FRAME

By default, the XYZ measurement frame is the reference frame defined by the physical orientation of the transmitter's XYZ axes even when the REFERENCE FRAME command has been used to specify a new reference frame for measuring orientation angles. When PARAMETERnumber = 17, during CHANGE, if the one byte of PARAMETER DATA sent to the Tracker is = 1, the XYZ measurement frame will also correspond to the new reference frame defined by the REFERENCE FRAME command. When the PARAMETER DATA sent is a zero, the XYZ measurement frame reverts to the orientation of the transmitter's physical XYZ axes.

During EXAMINE, the Tracker returns a byte value of 0 or 1 to indicate that the XYZ measurement frame is either the transmitter's physical axes or the frame specified by the REFERENCE FRAME command.

## FILTER LINE FREQUENCY

When PARAMETERnumber = 20, during EXAMINE, the Tracker returns a byte whose value is the Line Frequency which is being used to determine the Wide Notch Filter coefficients. The default Line Frequency is 60 Hz.

To CHANGE the Line Frequency send 1 byte of PARAMETERdata corresponding to the desired Line Frequency. The range of Line Frequencies available are 1 -> 255.

Example: To change the Line Frequency to 50Hz you would first send a Change Value command (50 Hex), followed by a Filter Line Frequency command (14 Hex), followed by the line frequency for 50 Hz (32 Hex).

## HEMISPHERE

When PARAMETERnumber = 22, during EXAMINE, the Tracker will return 2 bytes of data defining the current Hemisphere. These are as follows:

Table 20 List of Hemisphere Definitions

<b>Hemisphere</b>	<b>HEMI AXIS</b>		<b>HEMI SIGN</b>	
	<b>ASCII</b>	<b>HEX</b>	<b>ASCII</b>	<b>HEX</b>
Forward	nul	00	nul	00
Aft (Rear)	nul	00	soh	01
Lower	ff	0C	nul	00
Upper	ff	0C	soh	01
Right	ack	06	nul	00
Left	ack	06	soh	01

**Notes:**

- 1) Please note that these are the same PARAMETERdata values as are used by the HEMISPHERE command 'L' (4C Hex). To CHANGE the Hemisphere, send 2 PARAMETERdata bytes as described above.
- 2) This command operates in exactly the same way as the HEMISPHERE command. The command is now included in the CHANGE/EXAMINE command set in order to allow users to examine the values which were previously inaccessible.
- 3) The values can only be EXAMINED with this command if they were previously CHANGED by this command.

## ANGLE ALIGN

When PARAMETERnumber = 23 during EXAMINE, The Tracker will return 3 words (6 bytes) of data corresponding to the Azimuth, Elevation, and Roll angles used in the ANGLE ALIGN command. This command differs from the ANGLE ALIGN command only in that it allows both reading and writing of the angles. See ANGLE ALIGN for a full explanation of its use.

To CHANGE the angles send 6 bytes of PARAMETERdata after the 2 command bytes.

## REFERENCE FRAME

When PARAMETERnumber = 24 during EXAMINE, The Tracker will return 3 words (6 bytes) of data corresponding to the Azimuth, Elevation and Roll angles used in the REFERENCE FRAME command.

See REFERENCE FRAME2 command for an explanation.

To CHANGE the angles send 6 bytes of PARAMETERdata after the 2 command bytes.

## TRACKER SERIAL NUMBER

When PARAMETERnumber = 25 during EXAMINE, The Tracker will return a 1 word (2 byte) value corresponding to the Serial Number of the Tracker Electronics Unit.

**Note: This number cannot be changed.**

## SENSOR SERIAL NUMBER

When PARAMETERnumber = 26, during EXAMINE, the Tracker will return a 1 word (2 byte) value corresponding to the Serial Number of the Tracker's sensor. This number cannot be changed.

## TRANSMITTER SERIAL NUMBER

When PARAMETERnumber = 27, during EXAMINE, the Tracker will return a 1 word (2 byte) value corresponding to the Serial Number of the Tracker's transmitter. You can not swap transmitters while the Tracker is switched ON. If you do you will get the Serial Number of the transmitter that was attached to the Tracker when it was first turned on. This number cannot be changed.

## METAL

When PARAMETERnumber=28, during EXAMINE, the Tracker that this command is sent to, returns 5 words (10 bytes) of data that define the metal detection parameters. The order of the returned words is:

**METALflag**  
**METALsensitivity**  
**METALoffset**  
**METALSlope**  
**METALalpha**

The least significant byte of each parameter, which is sent first, contains the parameter value. The most significant byte is always zero.

On CHANGE, the user sends to the target Tracker sensor, 5 words of metal detection parameter data as defined above in the EXAMINE command.

If you only want to change one metal parameter at a time, refer to the METAL command.

## REPORT RATE

When PARAMETERnumber = 29 during EXAMINE, The Tracker will return a single byte of data that defines how often the Tracker outputs data to your host computer when in STREAM mode. This change parameter value is similar to the REPORT RATE command except the user is not limited to a report rate of every first, second, eighth, or thirty-second cycles.

During CHANGE, the user supplies one byte with this command with any value between 1 and 127 that defines how many measurement cycles occur before position and orientation data are output when the Tracker is in STREAM mode.

## GROUP MODE

The GROUP MODE command is used if you have multiple sensors and you want to get data from all the sensors by issuing a single request.

When PARAMETERnumber = 35, during EXAMINE VALUE, the Tracker will respond with one byte of data indicating if the Tracker is in GROUP MODE. If the data is a 1, the Tracker is in GROUP MODE and if the data is 0 The Tracker is not in GROUP MODE. When in GROUP MODE, in response to the POINT or STREAM commands, the Tracker will send data records from all sensors attached to the system. Information is output from the sensor with the smallest address first. The last byte of the data record from each sensor contains the address of that sensor. This address byte contains no phasing bits. Each sensor can be in a different data output format if desired. For example, if 3 sensors are in the system, and the first is configured to output POSITION data only (6 data bytes plus 1 address byte) and the other two are configured to output POSITION/ANGLES data (12 data bytes plus 1 address byte), the system will respond with 33 bytes when a data request is made.

During a CHANGE VALUE command, the host must send one data byte equal to a 1 to enable GROUP MODE or a 0 to disable GROUP MODE.

## SYSTEM STATUS

When PARAMETERnumber = 36, during EXAMINE, the Tracker returns to the host computer 14 bytes defining the physical configuration of each sensor attached to the unit. This command can be sent to the tracker either before or after the unit is running. The response has the following format, where one byte is returned for each possible sensor address:

BYTE 1	- address 1 configuration
BYTE 2	- address 2 configuration

BYTE 14 - address 14 configuration

Each byte has the following format:

**Table 21 System Status Bit Descriptions**

Bit #	Description
B7	If 1, device is accessible. If 0, device is not accessible. A device is accessible when it is attached and powered on. It may or may not be running.
B6	If 1, the device is running. If 0, device is not running. A device is running when the power switch to the unit is on, it has been AUTO-CONFIGed and it is AWAKE (in RUN mode). A device is not running when the power switch is on and it has not been AUTO-CONFIGed or it has been AUTO-CONFIGed and it is ASLEEP (transmitter OFF).
B5	If 1, then there is a valid sensor at this address. If 0, then no sensor at this address was found.
B4	If 1, then the transmitter is an ERT/WRT. If 0, transmitter is standard range.
B3	If 1, ERT/WRT #3 is present. If 0, not present.
B2	If 1, ERT/WRT #2 is present. If 0, not present.
B1	If 1, ERT/WRT #1 is present. If 0, not present.
B0	If 1, ERT/WRT #0 or standard range transmitter is present. If 0, not present.

## AUTOCONFIG

The AUTO-CONFIGURATION command is used to start running multiple Trackers, i.e., multiple sensors/tracked-objects. In the case of the 3D Guidance trakSTAR, there are four Tracked sensors.

When PARAMETERnumber = 50 (0x32h), during an CHANGE VALUE command, the Tracker will perform all the necessary configurations for a one transmitter/multiple sensor configuration. The tracker expects one byte of data corresponding to the number of Tracker sensors that should be used in the 1 transmitter/multiple sensor mode. The command sequence to AutoConfig for 4 sensors would be:

**0x50 - Examine/Change**

**0x32 –autoconfig- 1 transmitter/n sensors**

**0x04. – 4 sensors**

When PARAMETERnumber = 50, during an EXAMINE VALUE command, the Tracker returns 5 bytes of configuration information. Three pieces of information are passed, FBB CONFIGURATION MODE, FBB DEVICES, and FBB DEPENDENTS.

FBB CONFIGURATION MODE: indicates the current Tracker configuration as either **Standalone** (treats unit as 1 sensor system) or **One Transmitter/Multiple Sensors** mode.

FBB DEVICES is used to tell which Trackers/Sensors on the FBB are running.

FBB DEPENDENTS is not used by the 3DG guidance systems

**Table 22 AUTOCONFIG Bit Definitions**

Byte	Description	
1	FBB Configuration Mode: 0 - STANDALONE 1 - ONE TRANSMITTER/MULTIPLE SENSORS	
2,3	FBB Devices:	
Bit	Definition	
15	0	
14	If 1, device at address 14 is running If 0, device at address 14 is not running  A Tracker is RUNNING when the power switch is on, it has been AUTO-CONFIGURED and it is AWAKE. A device is not running when the LED is blinking green and it has not been AUTO-CONFIGURED or it has been AUTO-CONFIGURED and it is ASLEEP.	
13	If 1, device at address 13 is running If 0, device at address 13 is not running	
1	If 1, device at address 1 is running If 0, device at address 1 is not running	

## SENSOR OFFSET

When PARAMETERnumber = 71 during EXAMINE, The Tracker will return 3 words (6 bytes) of data corresponding to the X, Y and Z offsets used in the OFFSET command.

See OFFSET command for an explanation.

To CHANGE the offsets send 6 bytes of PARAMETERdata after the 2 command bytes.

### **BOOT LOADER FIRMWARE REVISION**

When PARAMETERnumber = 130 during EXAMINE, the system will return 2 bytes indicating the revision number of the Boot Loader firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

### **MDSP FIRMWARE REVISION**

When PARAMETERnumber = 131 during EXAMINE, the system will return 2 bytes indicating the revision number of the MDSP firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

### **NONDIPOLE POSERVER FIRMWARE REVISION**

When PARAMETERnumber = 133 during EXAMINE, the system will return 2 bytes indicating the revision number of the NonDipole POServer firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

### **FIVEDOF FIRMWARE REVISION**

When PARAMETERnumber = 135 during EXAMINE, the system will return 2 bytes indicating the revision number of the 5DOF firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

### **SIXDOF FIRMWARE REVISION**

When PARAMETERnumber = 136 during EXAMINE, the system will return 2 bytes indicating the revision number of the 6DOF firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

### **DIPOLE POSERVER FIRMWARE REVISION**

When PARAMETERnumber = 137 during EXAMINE, the system will return 2 bytes indicating the revision number of the Dipole POServer firmware. E.g., if the first byte returned is 1 and the second byte is 2, the firmware revision number is 1.2.

## HEMISPHERE

	ASCII	HEX	DECIMAL	BINARY
Command Byte	L	4C	76	01001100

Command Data	HEMI_AXIS	HEMI_SIGN
--------------	-----------	-----------

The shape of the magnetic field transmitted by the Tracker is symmetrical about each of the axes of the transmitter. This symmetry leads to an ambiguity in determining the sensor's X, Y, Z position. The amplitudes will always be correct, but the signs ( $\pm$ ) may all be wrong, depending upon the hemisphere of operation. In many applications, this will not be relevant, but if you desire an unambiguous measure of position, operation must be either confined to a defined hemisphere or your host computer must 'track' the location of the sensor.

There is no ambiguity in the sensor's orientation angles as output by the ANGLES command, or in the rotation matrix as output by the MATRIX command.

The HEMISPHERE command is used to tell the Tracker in which hemisphere, centered about the transmitter, the sensor will be operating. There are six hemispheres from which you may choose: the forward, aft (rear), upper, lower, left, and the right. If no HEMISPHERE command is issued, the forward is used by default.

The two Command Data bytes, sent immediately after the HEMISPHERE command, are to be selected from these:

Hemisphere ASCII HEX	HEMI_AXIS ASCII HEX	HEMI_SIGN ASCII HEX
Forward	nul 00	nul 00
Aft (Rear)	nul 00	soh 01
Upper	ff 0C	soh 01
Lower	ff 0C	nul 00
Left	ack 06	soh 01
Right	ack 06	nul 00

The ambiguity in position determination can be eliminated if your host computer's software continuously 'tracks' the sensor location. In order to implement tracking, you must understand the behavior of the signs ( $\pm$ ) of the X, Y, and Z position outputs when the sensor crosses a hemisphere boundary. When you select a given hemisphere of operation, the sign on the position axes that defines the hemisphere direction is forced to be positive, even when the sensor moves into another hemisphere. For example, the power-up default hemisphere is the forward hemisphere. This forces X position outputs to always be positive. The signs on Y and Z will vary between plus and minus depending on where you are within this hemisphere. If you had selected the lower hemisphere, the sign of Z would always be positive and the signs on X and Y will vary between plus and minus. If you had selected the left hemisphere, the sign of Y would always be negative, etc.

Regarding the default forward hemisphere, if the sensor moved into the aft hemisphere, the signs on Y and Z would instantaneously change to opposite polarities while the sign on X remained positive. To 'track' the sensor, your host software, on detecting this sign change, would reverse the signs on The Tracker's X, Y, and Z outputs. In order to 'track' correctly: You must start 'tracking' in the selected hemisphere so that the signs on the outputs are initially correct, and you must guard against the case where the sensor legally crossed the  $Y = 0$ ,  $Z = 0$  axes simultaneously without having crossed the  $X = 0$  axes into the other hemisphere.

## MATRIX

	ASCII	HEX	DECIMAL	BINARY
Command Byte	X	58	88	01011000

The MATRIX mode outputs the 9 elements of the rotation matrix that define the orientation of the sensor's X, Y, and Z axes with respect to the Transmitter's X, Y, and Z axes. If you want a three-dimensional image to follow the rotation of the sensor, you must multiply your image coordinates by this output matrix.

The nine elements of the output matrix are defined generically by:

$$\begin{matrix} . & M(1,1) & M(1,2) & M(1,3) \\ .. & M(2,1) & M(2,2) & M(2,3) \\ .. & M(3,1) & M(3,2) & M(3,3) \\ . & & & \end{matrix}$$

Or in terms of the rotation angles about each axis (where Z = Zang, Y = Yang and X = Xang):

$$\begin{matrix} . & & & \\ . & & & \\ . & \cos(Y)*\cos(Z) & \cos(Y)*\sin(Z) & -\sin(Y) \\ . & -\cos(X)*\sin(Z) & \cos(X)*\cos(Z) & . \\ . & +\sin(X)*\sin(Y)*\cos(Z) & +\sin(X)*\sin(Y)*\sin(Z) & \sin(X)*\cos(Y) \\ . & \sin(X)*\sin(Z) & -\sin(X)*\cos(Z) & . \\ . & +\cos(X)*\sin(Y)*\cos(Z) & +\cos(X)*\sin(Y)*\sin(Z) & \cos(X)*\cos(Y) \\ . & & & \end{matrix}$$

Or in Euler angle notation, where R = Roll, E = Elevation, A = Azimuth:

$$\begin{matrix} . & & & \\ . & & & \\ . & \cos(E)*\cos(A) & \cos(E)*\sin(A) & -\sin(E) \\ . & -\cos(R)*\sin(A) & \cos(R)*\cos(A) & . \\ . & +\sin(R)*\sin(E)*\cos(A) & +\sin(R)*\sin(E)*\sin(A) & \sin(R)*\cos(E) \\ . & \sin(R)*\sin(A) & -\sin(R)*\cos(A) & . \\ . & +\cos(R)*\sin(E)*\cos(A) & +\cos(R)*\sin(E)*\sin(A) & \cos(R)*\cos(E) \\ . & & & \end{matrix}$$

The output record is in the following format for the eighteen transmitted bytes:

MSB								LSB		
7	6	5	4	3	2	1	0	BYTE #		
1	M8	M7	M6	M5	M4	M3	M2	#1	LSbyte M(1,1)	
0	M15	M14	M13	M12	M11	M10	M9	#2	MSbyte M(1,1)	
0	M8	M7	M6	M5	M4	M3	M2	#3	LSbyte M(2,1)	
0	M15	M14	M13	M12	M11	M10	M9	#4	MSbyte M(2,1)	
0	M8	M7	M6	M5	M4	M3	M2	#5	LSbyte M(3,1)	
0	M15	M14	M13	M12	M11	M10	M9	#6	MSbyte M(3,1)	
0	M8	M7	M6	M5	M4	M3	M2	#7	LSbyte M(1,2)	
0	M15	M14	M13	M12	M11	M10	M9	#8	MSbyte M(1,2)	
0	M8	M7	M6	M5	M4	M3	M2	#9	LSbyte M(2,2)	
0	M15	M14	M13	M12	M11	M10	M9	#10	MSbyte M(2,2)	
0	M8	M7	M6	M5	M4	M3	M2	#11	LSbyte M(3,2)	
0	M15	M14	M13	M12	M11	M10	M9	#12	MSbyte M(3,2)	
0	M8	M7	M6	M5	M4	M3	M2	#13	LSbyte M(1,3)	
0	M15	M14	M13	M12	M11	M10	M9	#14	MSbyte M(1,3)	
0	M8	M7	M6	M5	M4	M3	M2	#15	LSbyte M(2,3)	
0	M15	M14	M13	M12	M11	M10	M9	#16	MSbyte M(2,3)	
0	M8	M7	M6	M5	M4	M3	M2	#17	LSbyte M(3,3)	
0	M15	M14	M13	M12	M11	M10	M9	#18	MSbyte M(3,3)	

The matrix elements take values between the binary equivalents of +.99996 and -1.0.

Element scaling is +.99996 = 7FFF Hex, 0 = 0 Hex, and -1.0 = 8000 Hex.

## METAL

	ASCII	HEX	DECIMAL	BINARY
Command Byte	s	73	115	01110011
Command Data	METALflag		METALdata	

When the METAL mode command is given, all subsequent Tracker data requests will have a METAL error byte added to the end of the data stream. If the BUTTON byte is also being output, the BUTTON byte precedes the METAL byte. The METAL error byte is a number between 0 and 127 base 10 that indicates the degree to which the position and angle measurements are in error due to ‘bad’ metals located near the transmitter and sensor or due to Tracker ‘system’ errors. ‘Bad’ metals are metals with high electrical conductivity such as aluminum, or high magnetic permeability such as steel. ‘Good’ metals have low conductivity and low permeability such as 300 series stainless steel, or titanium. The METAL error byte also reflects Tracker ‘system’ errors resulting from accuracy degradations in the transmitter, sensor, or other electronic components. The METAL error byte also responds to accuracy degradation resulting from movement of the sensor or environmental noise. A METAL error byte = 0 indicates no or minimal position and angle errors depending on how sensitive you have set the error indicator. A METAL error byte = 127 indicates maximum error for the sensitivity level selected.

The metal detector is sensitive to the introduction of metals in an environment where no metals were initially present. This metal detector can fool you, however, if there are some metals initially present and you introduce new metals. It is possible for the new metal to cause a distortion in the magnetic field that reduces the existing distortion at the sensor. When this occurs you’ll see the METALerror value initially decrease, indicating less error, and then finally start increasing again as the new metal causes more distortion

**WARNING:** You need to evaluate your application for suitability of this metal detector.

Because the Tracker is used in many different applications and environments, the METAL error indicator needs to be sensitive to this broad range of environments. Some users may want the METAL error indicator to be sensitive to very small amounts of metal in the environment while other applications may only want the error indicator sensitive to large amounts of metal. To accommodate this range of detection sensitivity, the METAL command allows the user to set a Sensitivity that is appropriate to their application.

The METAL error byte will always show there is some error in the system even when there are no metals present. This error indication usually increases as the distance between the transmitter and sensor increases and is due to the fact that Tracker components cannot be made or calibrated perfectly. To minimize the amount of this inherent error in the METAL error value, a linear curve fit, defined by a slope and offset, is made to this inherent error and stored in each individual sensor's memory since the error depends primarily on the size of the sensor being used (25mm, 8mm, or 5 mm). The METAL command allows the user to eliminate or change these values. For example, maybe the user's standard environment has large errors and he or she wants to look at variations from this standard environment. To do this he or she would adjust the slope and offset to minimize the METAL error values.

On power up initialization of the system or whenever the user wants to change the METAL values the user must send to the TRACKER the following three byte sequence:

Command Byte    METALflag    METALdata

Where the Command Byte is the equivalent of an ASCII s (lower case) and the METALflag and METAL data are:

METALflag    METALdata

0	0	Turn off metal detection.
1	0	Turn on metal detection using system default METALdata
2	Sensitivity	Turn on metal detection and change the Sensitivity
3	Offset	Turn on metal detection and change the Offset
4	Slope	Turn on metal detection and change the Slope
5	Alpha	Turn on metal detection and change the filter's alpha

METALflag =0. This is the default power up configuration. No METAL error byte is output at the end of the Tracker's data stream. A zero value, zero decimal or zero hex or zero binary must be sent as the METALdata if you are turning off METAL detection.

METALflag=1. Turns on METAL detection using the system default sensitivity, offset, slope and alpha values. When METAL detection is turned on an additional byte is output at the end of the Tracker's output data. If you have BUTTON MODE enabled then the METAL error value will be output after the BUTTON value byte is output.

METALflag=2. Turns on METAL detection and changes the Sensitivity of the measurement to metals. The Offset, Slope and Alpha values are unchanged from their previous setting. The METALerror value that is output is computed from:

METALerror = Sensitivity x ( METALerrorSYSTEM - (Offset + Slope x Range)). Where range is the distance between the transmitter and sensor. The user supplies a Sensitivity byte as an integer between

0 and 127 depending on how little or how much he or she wants METALerror to reflect errors. The default value is 32.

METALflag=3. Turns on METAL detection and changes the Offset value defined in the equation above. The Offset byte value must be an integer value between plus or minus 127. If you are trying to minimize the base errors in the system by adjusting the Offset you could set the Sensitivity =1, and the Slope=0 and read the Offset directly as the METALerror value.

METALflag=4. Turns on METAL detection and changes the Slope value defined in the equation above. The Slope byte value must be an integer between plus or minus 127. You can determine the slope by setting the Sensitivity=1 and looking at the change in the METALerror value as you translate the sensor from range=0 to range max for the system, i.e. 36" for a flock. Since its difficult to go from range =0 to max., you might just translate over say half the distance and double the METALerror value change you measure.

METALflag=5. Turns on METAL detection and changes the filter's Alpha value. The METALerror value is filtered before output to the user to minimize noise jitter. The Alpha value determines how much filtering is applied to METALerror. Alpha varies from 0 to 127. A zero value is an infinite amount of filtering, whereas a 127 value is no filtering. The system default is 12. As Alpha gets smaller the time lag between the insertion of metal in the environment and it being reported in the METALerror value increases.

## OFFSET

	ASCII	HEX	DECIMAL	BINARY
Command Byte	K	4B	75	01001011
Command Data	X, Y, Z OFFSET DISTANCES FROM SENSOR			

Normally the position outputs from the **trakSTAR** represent the x, y, z position of the center of the sensor with respect to the origin of the Transmitter. The OFFSET command allows the user to specify a location that is offset from the center of the sensor. Figure 43 shows an application of the offset command where the desired positional outputs from the Tracker differ from the normal x, y, z sensor outputs.

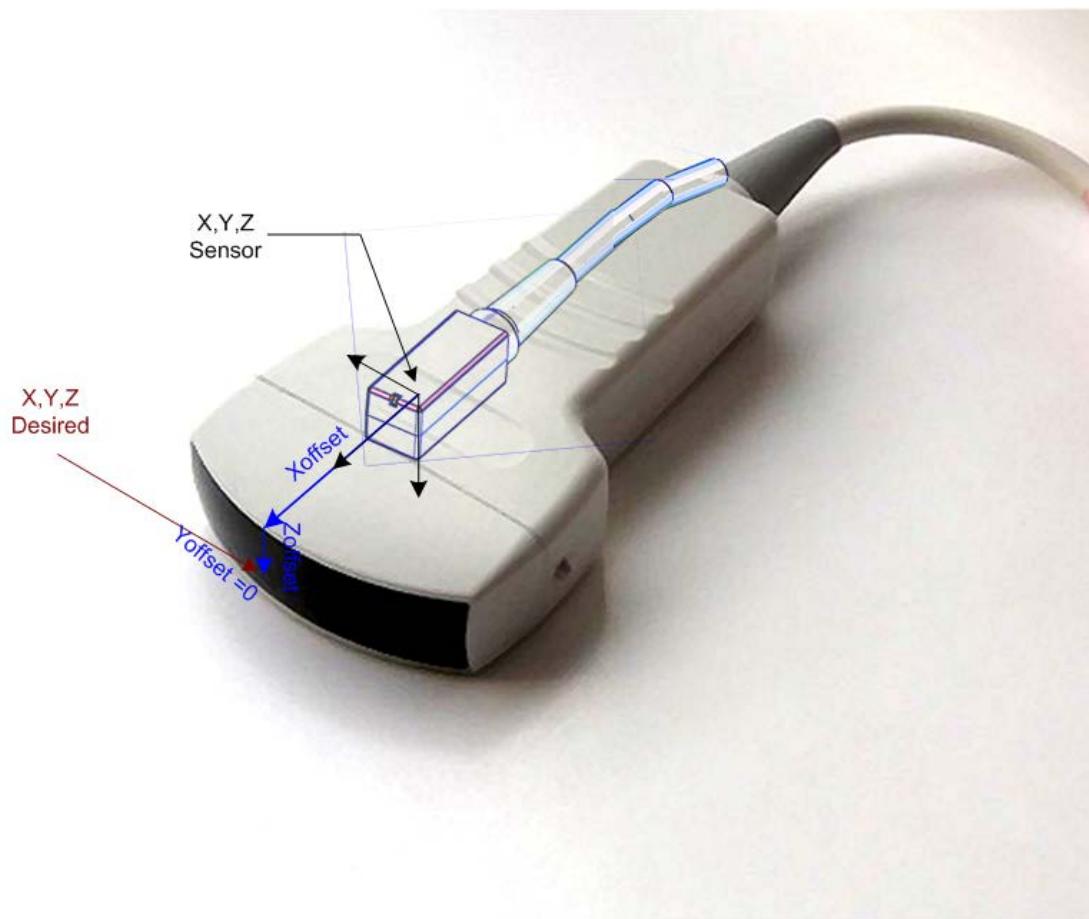
Referring to Figure 43, the x, y, z offset distances you supply with this command are measured in the reference frame attached to the sensor and are measured from the sensor center to the desired position (in inches). After the command is executed, all subsequent positional outputs from the Tracker will be x, y, z desired.

With the command you send to the Tracker three words of data, the Xoffset, Yoffset, and Zoffset coordinates. The scaling of these coordinates is the same as the POSITION command coordinates. For example, assume you were using a Tracker in its default maximum range mode of 36 inches full scale. Also assume the Xoffset, Yoffset, and Zoffset values where 5.4 inches, - 2.1 inches, and 1.3 inches. You would then output three integer or their hex equivalents to the Tracker equal to:

$$\text{Xoffset} = 4915 = 5.4 * 32768 / 36.$$

$$\text{Yoffset} = 63625 = 65536 - 1911$$

$$\text{Zoffset} = 1183$$



**Figure 56 Using the OFFSET command**

## POINT

	ASCII	HEX	DECIMAL	BINARY
Command Byte	B	42	66	01000010

In the POINT mode, The Tracker sends one data record each time it receives the B Command Byte

## POSITION

	ASCII	HEX	DECIMAL	BINARY
Command Byte	V	56	86	01010110

In the POSITION mode, The Tracker outputs the X, Y, and Z positional coordinates of the sensor with respect to the Transmitter. The output record is in the following format for the six transmitted bytes:

	MSB	7	6	5	4	3	2	1	0	LSB	BYTE #
1	X8	X7	X6	X5	X4	X3	X2			#1 LSbyte X	
0	X15	X14	X13	X12	X11	X10	X9			#2 MSbyte X	
0	Y8	Y7	Y6	Y5	Y4	Y3	Y2			#3 LSbyte Y	
0	Y15	Y14	Y13	Y12	Y11	Y10	Y9			#4 MSbyte Y	
0	Z8	Z7	Z6	Z5	Z4	Z3	Z2			#5 LSbyte Z	
0	Z15	Z14	Z13	Z12	Z11	Z10	Z9			#6 MSbyte Z	

The X, Y, and Z values vary between the binary equivalent of  $\pm$  MAX inches. Where MAX = 36" or 72". The default positive X, Y, and Z directions are shown in Figure 26 [Default Reference Frame](#)

Scaling of each position coordinate is full scale = MAX inches. That is, +MAX = 7FFF Hex, 0 = 0 Hex, -MAX = 8000 Hex. Since the maximum range (Range = square root(X\*\*2+Y\*\*2+Z\*\*2)) from the Transmitter to the sensor is limited to MAX inches, only one of the X, Y, or Z coordinates may reach its full scale value. Once a full scale value is reached, the positional coordinates no longer reflect the correct position of the sensor.

To convert the numbers into inches first cast it into a signed integer. This will give you a number from +/- 32767. Second multiply by 36 or 72. Finally divide the number by 32768 to get the position in inches. The equation should look something like this:

$$(\text{signed int(Hex \#)} * 36) / 32768$$

Or:  $(\text{signed int(Hex \#)} * 72) / 32768$

## POSITION/ANGLES

	ASCII	HEX	DECIMAL	BINARY
Command Byte	Y	59	89	01011001

In the POSITION/ANGLES mode, the outputs from the POSITION and ANGLES modes are combined into one record containing the following twelve bytes:

MSB								LSB		
7	6	5	4	3	2	1	0	BYTE #		
1	X8	X7	X6	X5	X4	X3	X2	#1	LSbyte X	
0	X15	X14	X13	X12	X11	X10	X9	#2	MSbyte X	
0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	#3	LSbyte Y	
0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	#4	MSbyte Y	
0	Z8	Z7	Z6	Z5	Z4	Z3	Z2	#5	LSbyte Z	
0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	#6	MSbyte Z	
0	Z8	Z7	Z6	Z5	Z4	Z3	Z2	#7	LSbyte Zang	
0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	#8	MSbyte Zang	
0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	#9	LSbyte Yang	
0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	#10	MSbyte Yang	
0	X8	X7	X6	X5	X4	X3	X2	#11	LSbyte Xang	
0	X15	X14	X13	X12	X11	X10	X9	#12	MSbyte Xang	

See POSITION mode and ANGLE mode for number ranges and scaling.

## POSITION/MATRIX

	ASCII	HEX	DECIMAL	BINARY
Command Byte	Z	5A	90	01011010

In the POSITION/MATRIX mode, the outputs from the POSITION and MATRIX modes are combined into one record containing the following twenty four bytes:

MSB								LSB	
7	6	5	4	3	2	1	0	BYTE #	
1	X8	X7	X6	X5	X4	X3	X2	#1	LSbyte X
0	X15	X14	X13	X12	X11	X10	X9	#2	MSbyte X
0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	#3	LSbyte Y
0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	#4	MSbyte Y
0	Z8	Z7	Z6	Z5	Z4	Z3	Z2	#5	LSbyte Z
0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	#6	MSbyte Z
0	M8	M7	M6	M5	M4	M3	M2	#7	LSbyte M(1,1)
0	M15	M14	M13	M12	M11	M10	M9	#8	MSbyte M(1,1)
0	M8	M7	M6	M5	M4	M3	M2	#9	LSbyte M(2,1)
0	M15	M14	M13	M12	M11	M10	M9	#10	MSbyte M(2,1)
0	M8	M7	M6	M5	M4	M3	M2	#11	LSbyte M(3,1)
0	M15	M14	M13	M12	M11	M10	M9	#12	MSbyte M(3,1)
0	M8	M7	M6	M5	M4	M3	M2	#13	LSbyte M(1,2)
0	M15	M14	M13	M12	M11	M10	M9	#14	MSbyte M(1,2)
0	M8	M7	M6	M5	M4	M3	M2	#15	LSbyte M(2,2)
0	M15	M14	M13	M12	M11	M10	M9	#16	MSbyte M(2,2)
0	M8	M7	M6	M5	M4	M3	M2	#17	LSbyte M(3,2)
0	M15	M14	M13	M12	M11	M10	M9	#18	MSbyte M(3,2)
0	M8	M7	M6	M5	M4	M3	M2	#19	LSbyte M(1,3)
0	M15	M14	M13	M12	M11	M10	M9	#20	MSbyte M(1,3)
0	M8	M7	M6	M5	M4	M3	M2	#21	LSbyte M(2,3)
0	M15	M14	M13	M12	M11	M10	M9	#22	MSbyte M(2,3)
0	M8	M7	M6	M5	M4	M3	M2	#23	LSbyte M(3,3)
0	M15	M14	M13	M12	M11	M10	M9	#24	MSbyte M(3,3)

See POSITION mode and MATRIX mode for number ranges and scaling.

## POSITION/QUATERNION

	ASCII	HEX	DECIMAL	BINARY
Command Byte	]	5D	93	01011101

In the POSITION/QUATERNION mode, The Tracker outputs the X, Y, and Z position and the four quaternion parameters, q0, q1, q2, and q3 that describe the orientation of the sensor with respect to the Transmitter. The output record is in the following format for the fourteen transmitted bytes:

MSB	7	6	5	4	3	2	1	LSB 0	BYTE #	
	1	X8	X7	X6	X5	X4	X3	X2	#1	LSbyte X
	0	X15	X14	X13	X12	X11	X10	X9	#2	MSbyte X
	0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	#3	LSbyte Y
	0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	#4	MSbyte Y
	0	Z8	Z7	Z6	Z5	Z4	Z3	Z2	#5	LSbyte Z
	0	Z15	Z14	Z13	Z12	Z11	Z10	Z9	#6	MSbyte Z
	0	B8	B7	B6	B5	B4	B3	B2	#7	LSbyte q0
	0	B15	B14	B13	B12	B11	B10	B9	#8	MSbyte q0
	0	B8	B7	B6	B5	B4	B3	B2	#9	LSbyte q1
	0	B15	B14	B13	B12	B11	B10	B9	#10	MSbyte q1
	0	B8	B7	B6	B5	B4	B3	B2	#11	LSbyte q2
	0	B15	B14	B13	B12	B11	B10	B9	#12	MSbyte q2
	0	B8	B7	B6	B5	B4	B3	B2	#13	LSbyte q3
	0	B15	B14	B13	B12	B11	B10	B9	#14	MSbyte q3

See POSITION mode and QUATERNION mode for number ranges and scaling.

## QUATERNION

	ASCII	HEX	DECIMAL	BINARY
Command Byte	\	5C	92	01011100

In the QUATERNION mode, The Tracker outputs the four quaternion parameters that describe the orientation of the sensor with respect to the Transmitter. The quaternions,  $q_0$ ,  $q_1$ ,  $q_2$ , and  $q_3$  where  $q_0$  is the scalar component, have been extracted from the MATRIX output using the algorithm described in "Quaternion from Rotation Matrix" by Stanley W. Shepperd, Journal of Guidance and Control, Vol. 1, May-June 1978, pp. 223-4. The output record is in the following format for the eight transmitted bytes:

MSB								LSB	
7	6	5	4	3	2	1	0	BYTE #	
1	B8	B7	B6	B5	B4	B3	B2	#1	LSbyte $q_0$
0	B15	B14	B13	B12	B11	B10	B9	#2	MSbyte $q_0$
0	B8	B7	B6	B5	B4	B3	B2	#3	LSbyte $q_1$
0	B15	B14	B13	B12	B11	B10	B9	#4	MSbyte $q_1$
0	B8	B7	B6	B5	B4	B3	B2	#5	LSbyte $q_2$
0	B15	B14	B13	B12	B11	B10	B9	#6	MSbyte $q_2$
0	B8	B7	B6	B5	B4	B3	B2	#7	LSbyte $q_3$
0	B15	B14	B13	B12	B11	B10	B9	#8	MSbyte $q_3$

Scaling of the quaternions is full scale = +.99996 = 7FFF Hex, 0 = 0 Hex, and -1.0 = 8000 Hex.

## REFERENCE FRAME

	ASCII	HEX	DECIMAL	BINARY
Command Byte	r	72	114	01110010

Command Data	A, E, R
--------------	---------

By default, The Tracker's reference frame is defined by the Transmitter's physical X, Y, and Z axes.(see [Figure 26](#)) In some applications, it may be desirable to have the orientation measured with respect to another reference frame. The REFERENCE FRAME command permits you to define a new reference frame by inputting the angles required to align the physical axes of the Transmitter to the X, Y, and Z axes of the new reference frame. The alignment angles are defined as rotations about the Z, Y, and X axes of the Transmitter. These angles are called the, Azimuth, Elevation, and Roll angles.

The command sequence consists of a Command Byte and 6 Command Data bytes. The Command Data consists of the alignment angles Azimuth (A), Elevation (E), and Roll (R).

If you immediately follow the REFERENCE FRAME command with a POINT or STREAM mode data request you may not see the effect of this command in the data returned. It may take one measurement period before you see the effect of the command.

The Command Byte and Command Data must be transmitted to The Tracker in the following seven-byte format:

MSB								LSB	
7	6	5	4	3	2	1	0		BYTE #
0	1	1	1	0	0	1	0		#1 Command Byte
B7	B6	B5	B4	B3	B2	B1	B0		#2 LSbyte A
B15	B14	B13	B12	B11	B10	B9	B8		#3 MSbyte A
B7	B6	B5	B4	B3	B2	B1	B0		#4 LSbyte E
B15	B14	B13	B12	B11	B10	B9	B8		#5 MSbyte E
B7	B6	B5	B4	B3	B2	B1	B0		#6 LSbyte R
B15	B14	B13	B12	B11	B10	B9	B8		#7 MSbyte R

See the ANGLES command for the format and scaling of the angle values sent.

## REPORT RATE



**Note:** For alternate Report Rate settings, use the CHANGE/ EXAMINE command for this function. See [REPORT RATE PARAMETERnumber=29](#).

Measurement Rate Divisor Command	ASCII	HEX	DECIMAL	BINARY
1	Q	51	81	01010001
2	R	52	82	01010010
8	S	53	83	01010011
32	T	54	84	01010100

If you do not want a Tracker data record output to your host computer every Tracker measurement cycle when in STREAM mode then use the REPORT RATE command to change the output rate to every other cycle (R), every eight cycles (S) or every thirty-two cycles (T). If no REPORT RATE command is issued, transmission proceeds at the default measurement rate.

## RESET

	ASCII	HEX	DECIMAL	BINARY
Command Byte	b	62	98	01100010

The RESET command is issued to the standalone Tracker to restart the entire system. RESET does reinitialize the system from the flash memory, so any configuration or alignment data entered before the system was reset, will revert back to power-up settings stored in the Flash.

## RS232 TO FBB

	ASCII	HEX	DECIMAL	BINARY	
Command Byte (SENSOR) ADDR		≡ F0	240	11110000	+ FBB

The RS232 TO FBB pass through command is a command that was developed for first generation single sensor products, to allow the host computer to communicate with any specified trackers via a single RS232 interface. However, this command is equally relevant for the 3DGuidance systems, which support multiple sensors. The pass through command permits selection and configuration of sensors beyond the first sensor.



**Note: For legacy users: The 3D Guidance systems only support Normal Addressing Mode.**

The command is a preface to each of the RS232 commands. This command is 1 Byte long:

Command Byte = 0xF0 + destination sensor address (in Hex)

Sensor address 1 (0x1 hex) would be: 0xF1

Sensor address 4 (0x4 hex) would be: 0xF4

Example 1: There are two Tracked sensors connected to the system. One at Address 1 and the other at Address 2. (By default the Tracked sensor connected to the first port is at Address 1 and the Tracked sensor connected to the second port is at Address 2)



**Note: No jumpers or FBB cables required for multi-sensor operation in the 3D Guidance systems.**

To get Position/Angle data **from Sensor 1**, the host would either send:

A 2 byte command consisting of:

The RS232 TO FBB command, (0xF1 hex)

Followed by the POINT command (0x42 hex)

Or the 1 byte:

POINT command (0x42hex)

To get Position/Angle data **from Sensor 2**, the host would send:

A 2 byte command consisting of:

The RS232 TO FBB command, (0xF2 hex)

Followed by the POINT command (0x42 hex)

**Note: To use STREAM mode with multiple sensors, first send the GROUP MODE commands, followed by STREAM command.**

## RUN

	ASCII	HEX	DECIMAL	BINARY
Command Byte	F	46	70	01000110

The RUN command is issued to the standalone Tracker to restart normal system operation after the Tracker has been put to sleep with the SLEEP command. RUN does not reinitialize the system RAM memory, so any configuration or alignment data entered before the system went to SLEEP will be retained.

## SLEEP

	ASCII	HEX	DECIMAL	BINARY
Command Byte	G	47	71	01000111

The SLEEP command turns the transmitter off, and halts the system. While asleep, The Tracker will respond to data requests and mode changes but the data output will not change. To resume normal system operation, issue the RUN command.



**Tip:** To maximize the life of your system, issue the SLEEP command when you are not using the tracker, or configure the Sleep on Reset setting in Default Configuration (see [Table 1](#)).

## STREAM

	ASCII	HEX	DECIMAL	BINARY
Command Byte	@	40	64	01000000

In the STREAM mode, The Tracker starts sending continuous data records to the host computer as soon as new data is available - at selected measurement rate. Data records will continue to be sent until the host sends the STREAM STOP command or the POINT command, or any format command such as POSITION to stop the stream.

Some computers and/or high-level software languages may not be able to keep up with the constant STREAM of data in this mode. Bytes received by your RS232 port may overrun one another or your input buffer may overflow if Tracker data is not retrieved fast enough. This condition will cause lost bytes, hence if your high-level application software requests say 12 bytes from the RS232 input buffer, it may hang because one or more bytes were lost. To eliminate this possibility, read one byte at a time looking for the phasing bit that marks the first byte of the data record.

See [REPORT RATE](#) to change the rate at which records are transmitted during STREAM.

## STREAM STOP

	ASCII	HEX	DECIMAL	BINARY
Command Byte	?	3F	63	00111111

STREAM STOP turns STREAM mode off, stopping any data that was STREAMing from the Tracker. This is an alternative to stopping the stream using a POINT command. NOTE: The record in progress when the 3DGuidance receives the command will still be output in its entirety to the host computer. To ensure that you have cleared your input port before executing any new commands, send STREAM STOP, delay and then discard any data in your serial port buffer.

## Error Reporting

The Tracker continuously monitors tracker activities and reports particular conditions through error codes. These codes may be generated as a result of the power-up diagnostics, or from regular error detection during normal operation. All error codes are reported to an internal SYSTEM ERROR buffer. This buffer holds up to 32 error codes.

Note that there are two Examine commands that are used together to retrieve error codes from the tracker.

- Examine Parameter 10 – retrieves single byte error code and removes it from the SYSTEM ERROR buffer.
- Examine Parameter 16 - retrieves a two byte error code and does not remove it from the SYSTEM ERROR buffer.
  - Bit 16 - unused
  - Bit 15 - flag for a diagnostic error
  - Bit 14 – unused
  - Bit 13 – Fatal error
  - Bits 9-12 – Bird Address (Sensor address; 0 if not sensor related)
  - Bits 1-8 – Error Code

## Diagnostic Errors

Note that errors reported by the tracker immediately after power-up may be diagnostic messages that are reported by the tracker for use by the USB based API (ATC3DG). To confirm and/or see what information these messages contain, you can run and observe the ‘Communication Init’ window in the tracker’s Configuration Utility. Diagnostic messages are indicated by setting bit 15 in the 2-byte error code (returned with Examine Parameter 16).

```
diagError = (birdError >> 14) & 0x01; // Diag error in 15th bit
```

These diagnostic messages may be safely ignored, without affecting tracker operation. For a full detailed listing of these diagnostic codes, please contact Ascension.

**Table 23 Error Notification Options**

Error Notification	Description
<i>Error Flag</i>	<p>Monitor the ERROR bit (B13) in the two byte BIRD STATUS register.</p> <p>5. Send EXAMINE VALUE command with PARAMETERnumber = 0</p> <p>When an error is detected this bit is set to a '1', and the generated error code is sent to the SYSTEM ERROR buffer.</p> <p>To retrieve the code after the flag has been set:</p> <p>6. Send the EXAMINE VALUE command with PARAMETERnumber = 10</p> <p>This returns the earliest Error sent to the buffer and clears it.</p> <p><b>Note:</b> If there is only one error in the buffer, reading the ERROR bit (B13) in the BIRD STATUS word, will reset the bit to '0' indicating all errors have been read and cleared from the buffer. If the bit remains a '1', then additional errors remain and should be read.</p>
<i>SYSTEM ERROR</i>	<p>Alternatively, the user can query the SYSTEM ERROR buffer directly.</p> <p>7. Send the EXAMINE VALUE command with PARAMETERnumber = 10</p> <p>This returns the earliest Error sent to the buffer. and clears it.</p> <p>8. Additional queries will return and clear the next Error code in the buffer, until the buffer. is empty. When the buffer is empty, the query will return '0'.</p> <p><b>Note:</b> If the query returns '45', then the 16-byte(16 error codes) buffer has overflowed, and the newest codes generated will be lost.</p>

## Error Code Listing

<b>Code</b>	<b>Error Description</b>
<b>0</b>	No Error
	Cause: SYSTEM ERROR register empty
<b>3</b>	Electronic Unit Configuration Data Corrupt
	Cause: The system was not able to read the Electronics unit's configuration data
	Action: Reset the system
<b>5</b>	Component Configuration Data Corrupt
	Cause: The system was not able to read the component EEPROM configuration data, or the components are not plugged in.
	Action: Insure that the components are present, calibrate the components
<b>6</b>	Invalid RS232 Command
	Cause: The system has received an invalid RS232 command, which can occur if the user sends down a command character that is not defined or if the data for a command does not make sense (i.e., change value commands with an unknown parameter number).
	Action: Only send valid RS232 commands to The Tracker.
<b>11</b>	RS232 Receive Overrun or Framing Error
	Cause: An overrun or framing error has been detected by the serial channel UART as it received characters from the user's host computer on the RS232 interface.
	Action: If an overrun error, the baud rate of the user's host computer and The Tracker differ. This may be due to incorrect baud selection, inaccuracy of the baud rate generator, or the RS232 cable is too long for the selected baud rate. If a framing error, the host software may be sending characters to its own UART before the UART finishes outputting the previous character.
<b>18</b>	Illegal Baud Rate Error

<b>Code</b>	<b>Error Description</b>
	Cause: If the baud rate setting is in an 'invalid' baud rate setting then this error will occur.  Action: Set up baud rate with a valid setting.
37	DSP POST error  Cause: Can't download code to the acquisition DSP(s).  Action: Contact Ascension
44	Algorithm Overflow  Cause: Computational error, possibly due to noise in the environment  Action: Check environment, and sensor data using utility
45	Error Buffer Overflow  Cause: Too many errors detected and sent to the SYSTEM ERROR register. Not all errors will be reported  Action: Read register to clear errors
46	Flash Checksum error  Cause: Section of the Electronics Unit's Flash memory corrupted.  Action: Reload the Flash using the utility, but not more than 5000 times.

# Troubleshooting, Maintenance, and Repair

*Taking care of your trakSTAR 2 is easy. For best results over time, please treat all tracker components like delicate scientific instruments. Sensors, the transmitter, and their cables are typically handled most and are subject to the most wear and tear. Handle them with care and they will operate as specified for many years to come.*

## User Maintenance

trakSTAR 2 requires minimal maintenance. Here are a few things that you can do to maximize good performance:

### Maintenance Prior to Each Use

1. Periodically check the transmitter and sensor cables for nicks and cuts in the insulation.
2. Inspect both the component connectors and receptacles for bent or damaged pins.
3. Inspect the transmitter for cracks and exterior damage. If transmitter is cracked or interior of the transmitter is exposed in some way, the component should be replaced after proper disposal.

### Periodic Maintenance (As needed)

1. Inspect USB and serial port connections. Tighten as necessary to ensure positive contact.
2. Check that transmitter, sensor, and electronics unit mounting provisions are secure, and are as recommended in the [Mounting the Hardware](#) section of this Guide.

## Proper Handling of Sensor and Cable

Since sensors and cables move through space and are often attached to flexible tools and instruments, they are subject to frequent and continuing stress. Here are a few things you can do to minimize problems:

- Don't over flex or twist the sensor cable.
- Prevent any part of the sensor from being crushed. The connectors can become warped if stepped on; the internal wires in the sensor cable may break or become weakened if pinched; and the sensor head may be damaged if trapped under something heavy.
- Don't drop or whack the sensor head against a hard surface. This will cause accuracy errors.
- If the sensor head is mounted on a tool, implement a strain relief where the sensor cable exits the tool to distribute forces over a region of the cable.

## Cleaning and Disinfecting

To clean the equipment (electronics unit, transmitter, sensor, and cables) wipe with a cloth dampened with a cleaning solution such as mild soap and water, isopropyl alcohol or a similar solution according to your organization's standards. After each use, thoroughly clean equipment. In environments where the equipment may come in contact with biological fluid or tissue, be sure to follow your organization's procedures for proper cleaning and disinfection. The electronics unit, transmitters and sensors cannot be subject to autoclaving or gamma radiation. Sensors will withstand ETO. Do not immerse the electronics unit, transmitter, sensor, or cables in liquids, as they are not waterproof.



**Note:** The electronics unit, transmitters and sensors cannot be subject to autoclaving or gamma radiation. Sensors will withstand ETO processing. Do not immerse the electronics unit, transmitter, sensor, or cables in liquids, as they are not waterproof.

## Firmware Updates

As new features or updates become available for trakSTAR 2, you may find it necessary to update the firmware stored in the Electronic Unit's memory. The driveBAY2 Utility included on your CD-ROM allows you to do this without opening the Electronics Unit or returning it to Ascension. See [Appendix I, driveBAY 2 Utility](#).

## Disposal

The European Union has issued a directive, known as the WEEE (Waste Electrical and Electronic Equipment) Directive, to protect the quality of our environment by reducing the amount of electrical equipment waste buried in landfills. WEEE focuses on the recycling and reuse of “equipment that depends on an electronic current or an electromagnetic field to operate and as equipment for the generation, transfer and measurement of such currents and fields.” Although none of the **trakSTAR 2**’s components are hazardous materials, proper disposal is important, especially, in the European Union where these components cannot be consigned to a landfill. Wherever available, tracker components should be brought to centralized recycling and collection points. Please contact Ascension Technical Support for further instructions on the correct disposal procedures in your country. If you have biologically contaminated components, please refer to your organization’s standard operating procedures for proper disposal.

## Troubleshooting

Most installation and tracking problems are easy to fix. Consult the troubleshooting table for common problems and their solutions. If you continue to experience problems, contact Ascension for technical support.

**Table 24 Troubleshooting Symptoms, Possible Causes, and Solutions**

Symptom	Possible Causes	Solution
No front panel LED illumination	No Power Fuse(s) blown	Check AC connections to power supply Reset hardware by cycling AC power Check fuse drawer for blown fuse. Replace with same rating/type (see <a href="#">Fuses</a> ).
Front panel LED blinking red/yellow.	No valid transmitter attached.	Attach transmitter Reseat transmitter connector See <a href="#">Table 23</a> for LED state definitions
Front panel LED slow blinking green/orange.	Electronics not yet 'programmed' for the attached Transmitter	Let the unit continue reading and programming the calibration information from the transmitter. When the programming is complete, the LED will switch to slow blink green.
Demo Utility doesn't run	No serial communication Software Installation unsuccessful	Check the suggestions outlined in 'Not able to communicate' below Re-initialize the HOST PC and run the installation again
Cubes Demo says 'Invalid Device'	Sensor port of the electronics unit not configured to run the attached sensor type.	Run the driveBAY2 Utility and check the Sensor port configuration. Follow the steps outlined in <a href="#">Configuring for 5DOF Operation</a> .
Cubes Demo says 'Lost'	Position Algorithm for NonDipole transmitter has not converged on a solution Sensor is outside the calibrated volume of the Non-Dipole transmitter	Check the <a href="#">Performance Motion Box</a> for the sensor/transmitter combination you are running, and ensure that the sensor is within this volume. Rotate the sensor and move it toward the transmitter surface. Consider changing to a Manual Starting Pose in power-up default settings. See <a href="#">Appendix III</a> for details.
Power-up defaults did not change after configuring with the utility	Configuration download interrupted Tracker did not reset(restart) after burning the Flash settings	Re-start the <b>trakSTAR 2</b> and the utility and set the defaults again. Be sure to click <b>APPLY</b> to send the settings to the Electronics Cycle power to the <b>trakSTAR 2</b> , and re-check the settings

Symptom	Possible Causes	Solution
Not able to communicate with the system using USB	Re-initialize USB  Driver not installed	-Unplug and replug USB cable on tracker.  -Cycle power on the tracker  -Check installation/status of driveBAY 2 USB driver in Windows Device Manager. Re-install if necessary
Not able to communicate with the system using RS-232	Baud rate incorrect  COM port incorrect  RS232 cable disconnected	Only supported Baud Rate for the <b>trakSTAR 2</b> system is 115200.  Specify to your HOST PC the COM port that the tracker is connected to.  Check that the serial connections at both ends of the cable are fully seated.
No Data	Sensor is saturated  Transmitter is OFF or disconnected  Component connections faulty	Check the error codes for a sensor a saturation condition. Move the sensor farther away from the Transmitter.  Check status of the Transmitter. Turn ON using <a href="#"><u>SELECT TRANSMITTER</u></a> parameter or <a href="#"><u>RUN</u></a> command (ATCRS232 protocol).  Check that Sensor/Transmitter connectors are correctly installed. Inspect pins for wear or damage.  Contact Ascension for assistance
Data is too noisy	Filters OFF  Low Signal  External noise in environment  Changing Hemisphere  Line frequency value set incorrectly.	Check FILTER STATUS for present state of filter configuration.  Decrease distance from sensor to Transmitter.  Be sure that the sensor is not located near the Tracker's power supply or other electronic devices or cables. See section on <a href="#"><u>Reducing Noise</u></a> in Chapter 3  If the signs of the X, Y or Z position outputs suddenly change you may have crossed a hemisphere boundary. Use the HEMISPHERE command to rectify.  Determine correct frequency (50 Hz in Europe, 60 Hz in North America) and set to correct value.

Symptom	Possible Causes	Solution
Poor accuracy	Metal in tracking environment. Damaged equipment. Sensor or transmitter connector not properly inserted. A software application error.	Check all around the transmitter to the furthest distance from the center of the transmitter to the maximum distance the sensor is used. Move or replace metal, or reposition trakSTAR 2 system. Check for damage. Correct by unplugging and plugging the components back into the board. Verify formulas and scale factors.

## Error Codes

Chapter 5 : 3DGuidance API Reference provides an explanation and listing of all [ERRORCODE](#) via the USB interface.

Chapter 6: Ascension RS232 Interface Reference provides a complete [Error Code Listing](#) for the RS232 protocol.

## LED Definitions

Table 25 LED Definitions

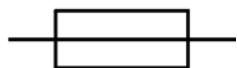
LED State	Description of Board Status	Possible Error Conditions resulting in LED state:
<b>OFF</b>	Power applied to board.	PLD un-programmed PLD error LED faulty Board error Board un-powered.
<b>SOLID RED</b>	PLD loaded and configured.	Flash memory un-programmed POSERVER DSP error Board error
<b>SOLID ORANGE</b>	POSERVER DSP - boot loader successfully loaded and running. All preliminary tests completed.	Multi-Boot Loader test failed POSERVER main application not found Code corrupt? DSP error Board error
<b>SLOW BLINKING RED (&lt; 1Hz)</b>	POSERVER DSP - application loaded, running and Command Handler executing	MDSP application not found in Flash Communications failure Failed starting MDSP
<b>FAST BLINKING RED (&gt; 2Hz)</b>	MDSP DSP - code downloaded by POSERVER	MDSP failed to respond to messages MDSP code corrupt MDSP error Board error
<b>SLOW BLINKING ORANGE (&lt; 1Hz)</b>	POSERVER successfully communicated with MDSP	System EEPROM error PLD version error MDSP fails to respond after tests MDSP test failed

LED State	Description of Board Status	Possible Error Conditions resulting in LED state:
<b>FAST BLINKING ORANGE (&gt; 2Hz)</b>	All of POSERVER initialization and power on test is complete	Transmitter not present Transmitter EEPROM error Transmitter hardware failure
<b>SLOW BLINKING GREEN/ORANGE (&lt; 1Hz)</b>	Unit is re-programming internal memory for the attached Non-Dipole transmitter.	Normal – no user action necessary. When a NonDipole (Flat or MAGnet) transmitter and electronics unit are ‘paired’ together for the first time, the electronics unit must update internal memory with the new transmitter’s calibration information. When the unit completes the transfer of information from the transmitter’s memory (up to 2 minutes), it will turn the LED to the Ready state (slow blinking or solid green).  Note that this re-programming occurs whenever the non-dipole transmitter has changed from that which was previously connected. If on power-up the unit detects that the same transmitter is still attached, no re-programming is necessary and the standard boot time (~12sec) will be observed.
<b>SLOW BLINKING GREEN (&lt; 1Hz)</b>	System is fully functional. The transmitter <u>is not</u> being energized during acquisition. (ASLEEP)	System ASLEEP – normal If auto-config issued then abnormal
<b>SOLID GREEN</b>	System is fully functional. The transmitter <u>is</u> being energized during the acquisition. (AWAKE)	System AWAKE – normal If SLEEP command issued then abnormal.
<b>FAST BLINKING RED/ORANGE (&gt; 2Hz)</b>	Run-time Diagnostic Error	One of the run-time diagnostics has failed.  Primary suspect is a removed transmitter. (This shows up as a TX Temp Sense error.)  Secondary suspects might be TX Temp. Sense or EU Temp Sense (over-heating problem)

# Contacting Ascension Technology Corporation for Repair

## Fuses

A fuse drawer is located on the rear panel, next to the AC power inlet. Both power entry conductors are protected by size 5 x 20 mm fuses:



**T1AL250V : 1.0 A ; 250V; T (Time Lag /SLO-BLO)**

## Other

There are no user serviceable parts inside the trakSTAR 2 Electronics, Transmitters, or Sensors. In addition to this Guide, we can provide personal support by contacting us at any of the following ways:

**World Wide Web:** <http://www.ascension-tech.com/support/>

**E-mail:** [support@ascension-tech.com](mailto:support@ascension-tech.com)

**Telephone:** Call (802) 893-6657 9 a.m.-- 5 p.m. U.S. Eastern Standard Time, Monday through Friday.

**Fax:** (802) 893-6659

## Warranty

Ascension warrants that its products are free from defects in material and workmanship for a period of one (1) year from date of delivery, providing the products are not subject to misuse, neglect, accident, incorrect installation, or improper care. If any Ascension products fail due to no fault of the buyer, Ascension will (at its option) either repair the defective product and restore it to normal operation without charge for parts and labor or provide a replacement in exchange for the defective product. Repair work shall be warranted for the remainder of the unexpired warranty period or for a period of 60 days, whichever is longer. This warranty is the exclusive warranty given in lieu of any other express or implied warranty. Ascension disclaims any implied warranties of merchantability and fitness to a particular purpose. Warranties are voided if the buyer utilizes a power supply that does not strictly adhere to Ascension's electrical power requirements, changes the configuration of a tracker, (such as, adding extensions to cables or modifying boards), or mishandles Sensors or cables. To avoid warranty issues, customers should carefully adhere to all product advisories. Transmitter, Sensors, cables and connectors are sensitive electronic components and should be treated with care. Do not drop, pull, twist, or mishandle cables.

## Accessories List

### 6DOF Transmitter Options

600214-O	<b>3DG Short-Range Transmitter (SRT) for driveBAY 2/trakSTAR 2</b>
	■ Cable Length: 10.9 ft. (3.3 m)
600222-K	<b>3DG Mid-Range Transmitter (MRT) for driveBAY 2/trakSTAR 2</b>
	■ Cable Length: 10.9 ft. (3.3 m)

### 5DOF/6DOF Transmitter Options

600805-9C	<b>3DG Flat Transmitter for driveBAY 2/trakSTAR 2</b>
	■ Cable Length: 10.9 ft. (3.3 m)
600806	<b>3DG MAGnet Transmitter for driveBAY 2/trakSTAR 2</b>
	■ Cable Length: 10.9 ft. (3.3 m)

600808	<b>3DG miniMAG Transmitter for driveBAY 2/trakSTAR 2</b>
	■ Cable Length: 10.9 ft. (3.3 m)

### 6DOF Sensor Options

600865-GEN	<b>3DG Model 55 6DOF Sensor for driveBAY/trakSTAR</b>	
	■ Sensor OD = 0.56 mm	■ Cable OD = 3.8 mm
	■ Sensor Length = 80-210 mm	■ Cable Length = <8.2 ft. [2.5 m]
600855	<b>3DG Model 90 6DOF Sensor for driveBAY/trakSTAR</b>	
	■ Sensor OD = 0.9 mm	■ Cable OD = 0.6 mm
	■ Sensor Length = 7.25 mm	■ Cable Length = 10.9 ft. [3.3 m]
600798-PT-3.3	<b>3DG Model 130 6DOF Sensor for driveBAY/trakSTAR</b>	
	■ Sensor OD = 1.5 mm	■ Cable OD = 1.2 mm
	■ Sensor Length = 7.7 mm	■ Cable Length = 10.9 ft. [3.3 m]
600799-PT-3.3	<b>3DG Model 180 6DOF Sensor for driveBAY/trakSTAR</b>	
	■ Sensor OD = 2 mm	■ Cable OD = 1.2 mm
	■ Sensor Length = 9.9 mm	■ Cable Length = 10.9 ft. [3.3 m]
600786	<b>3DG Model 800 6DOF Sensor for driveBAY/trakSTAR</b>	
	■ Sensor = 8 x 8 x 20 mm	■ Cable OD = 3.8 mm
		■ Cable Length = 10.9 ft. [3.3 m]

### 5 Degrees-of-Freedom (5DOF) Sensor Options

600920	<b>3DG Model 55 5DOF Sensor for driveBAY2 /trakSTAR2</b>	
	■ Sensor OD = 0.56 mm	■ Cable OD = 1.2 mm
	■ Sensor Length = 100 mm	■ Cable Length = 6.2 ft. [1.9 m]
600925	<b>3DG Model 90 5DOF Sensor for driveBAY2 / trakSTAR2</b>	
	■ Sensor OD = 0.9 mm	■ Cable OD = 1.2 mm
	■ Sensor Length = 100 mm	■ Cable Length = 6.2 ft. [1.9 m]
600930	<b>3DG Model 130 5DOF Sensor for driveBAY2 / trakSTAR2</b>	
	■ Sensor OD = 1.6 mm	■ Cable OD = 1.2 mm
	■ Sensor Length = 8.0 mm	■ Cable Length = 6.6 ft. [2.0 m]

### 5 Degrees-of-Freedom (5DOF) Junction Box

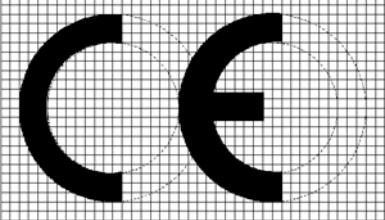
601139	<b>3DG 5DOF Junction Box for driveBAY2 /trakSTAR2</b>
	■ Cable OD = 3.8 mm
	■ Cable Length = 8.0 ft (2.4m)

### Cables

103992	<b>Cable, USB-A Male to USB-B Male</b>
103985	<b>Cable, Medical Grade AC Power, USA</b>
103615-A	<b>Cable, AC Power for US/Japan</b>
103985-EU	<b>Cable, Medical Grade AC Power, Continental Europe</b>

# Regulatory Information and Specifications

## Mid-Range, Short Range, Flat, MAGnet, and miniMAG Transmitter Configurations:

	<p>In accordance with EN60601-1 (Medical electrical equipment – general requirements for safety), this equipment is classified as follows:</p> <p>Class I</p> <p>Type B Applied Part</p> <p>Not AP/APG</p>
--	--

Class I: Non-invasive electric/electronic equipment without a monitoring function, which has a reliable ground and thus provides the type of protection against electric shock as defined by EN60601-1.



**Type B Applied Part:** An applied part (sensors) complying with the specified requirements of EN 60601-1 to provide protection against electric shock, particularly regarding allowable leakage current. Type B specifies the degree of electric shock protection provided by the unit.

**Not AP/APG** means unsuitable for use in the presence of flammable gases.

**Modification or use of the equipment in any way that is not specified by Ascension Technology Corporation may impair the protection and accuracy provided by the equipment.**



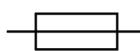
The lightning flash arrow symbol within an equilateral triangle is intended to alert the user to the presence of uninsulated dangerous voltage within the product's enclosure. That voltage may constitute a risk of electric shock to persons.



The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the appliance literature.



Waste Electrical and Electronic Equipment compatible. European Union – do not place in landfill.



This unit contains fuses. If replacing one, be sure to replace with the same type and rating. See [Fuses](#) section in Chapter 7



**Warning: This tracker does not have approval from the FDA for patient contact applications.** The tracker alone is not a stand-alone medical device, and thus must be tested as part of the larger host system.

## EC Declaration of Conformity

### EC Declaration of Conformity

Issued by

Ascension Technology Corporation  
PO Box 527  
Burlington, VT 05402 USA  
802-893-6657

**Equipment Description:** 3D Guidance trakSTAR 2<sup>TM</sup> Tracking System  
(w/Mid-Range, Short-Range, Flat, MAGnet, and miniMAG  
Transmitters)  
100-240VAC 50/60Hz; 70VA

**Applicable Directive:** 93/42/EEC, Medical Devices

**Applicable Standards:** IEC 60601-1 Ed. 3 2005  
Medical Electrical Equipment: Part 1: General  
Requirements for Safety

IEC 60601-1-2 Ed. 3 2007  
Medical Electrical Equipment: Part 1: General Requirements  
for Safety –2. Collateral Standard: Electromagnetic Compatibility-  
Requirements and Test

## FCC Compliance Statement

### Radio and television interference

Warning: Changes or modifications to this unit 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 and 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.

#### Declaration of Conformity

**Model Number:** 3D Guidance **trakSTAR 2™**  
**Trade Name:** Ascension  
**Responsible Party:** Ascension Technology Corporation  
**Address:** P.O. Box 527  
Burlington, Vermont 05402  
**Telephone Number:** (802) 893-6657

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.

# Product Specifications

## Performance

<b>Degrees of freedom:</b>	Six (position and orientation)
<b>Translation range:</b>	
<b>Short Range Transmitter:</b>	±45 cm in any direction
<b>Mid Range Transmitter:</b>	±76 cm in any direction
<b>Angular range:</b>	All attitude: ±180 deg azimuth and roll, ±90 deg elevation
<b>Static accuracy:</b>	Mid-Range, Short-Range, Flat, MAGnet, and miniMAG Transmitters: (see note below) 1.4 mm RMS position 0.5 degree RMS orientation
<b>Update rate:</b>	Mid and Short Range transmitters up to 600 updates/second.  Flat – 378 updates/sec (System Measurement Rate: 42Hz)  MAGnet and miniMAG – 504 updates/sec (System Measurement Rate: 42Hz)
<b>Position:</b>	Because of symmetries in the transmitted field for short and mid-range transmitters, operation of the sensor with these transmitters shall be confined to one of six hemispheres of operation. Operation within a given hemisphere requires that position sign of the axis of rotation for that hemisphere does not change sign. In order to meet accuracy specifications, the <b>system must operate in the forward (positive X) hemisphere.</b>  In order to meet accuracy specifications, sensors must operate in the <a href="#">Performance Motion Box</a> defined for the sensor/transmitter combination.
<b>Outputs:</b>	X, Y, Z positional coordinates, orientation angles, orientation matrix and quaternion.
<b>Interface</b>	USB 2.0 or RS232

## Physical

	<p>Mid-Range Transmitter: 3.75" (9.6cm) cube with 10' (3.05m) cable</p> <p>Short-Range Transmitter: 2.09"(5.3cm) x 2.09"(5.3cm) x 2.71"(6.9cm)</p> <p>Wide Range Trasmitter: 12" (30.5cm) cube with 20' (6.15m) cable</p> <p>Flat Transmitter: D: 22"(56cm) x22"(56cm) x1.1" (3cm) W: 23 lbs.</p> <p>MAGnet Transmitter: D: 8.1"(20.6cm) x8.1"(20.6cm) x 1.8" (4.6cm) W: 7 lbs.</p> <p>miniMAG Transmitter: D: 4.2"(10.7cm) x4.2"(10.7cm) x 2.1" (5.3cm) W: 2.5 lbs.</p> <p>Model 800 Sensor: Sensor: 8 mm x 8 mm x 20 mm (0.31 inch x 0.31 inch x 0.78 inch) Cable O.D.: 3.8mm Cable Length Options: 3.3m (10.8ft) 9.1 m (30 ft) cable</p> <p>Model 180 Sensor: Sensor Housing: Outside Diameter: 2 mm (0.07 inch)</p>
--	---

	<p>Length: 9.7 mm (0.38 inch) Sensor Cable: 3.3 m (10.8 ft)</p> <p>Model 130 Sensor: Sensor Housing: Outside Diameter: 1.5 mm (0.05 inch) Length: 7.7 mm (0.30 inch) Sensor Cable: 3.3 m (10.8 ft)</p> <p>Model 90 Sensor: Sensor Housing: Outside Diameter: 0.9 mm (0.035 inch) Length: 8.8 mm (0.35 inch) Sensor Cable: 3.3 m (10.8 ft)</p> <p>Model 55 Sensor: Sensor Housing: Outside Diameter: 0.55 mm –0/+0.01mm ( inch) Length: X.X mm (0.XX inch) Sensor Cable: X.X m (XX.X ft)</p> <p>Electronics Unit Dimensions (L x W x H): 18.4 cm x 29.2cm x 6.4 cm Weight: 1.43 Kg</p>
<b>Power:</b>	The unit's internal supplies will operate from 100 to 240V, at 50/60 Hz. Power consumption is 70 VA.
<b>Operating temperature:</b>	41°F to 104°F (5°C to 40°C), 90% non-condensing humidity.
<b>Warm up:</b>	System shall meet accuracy specifications after 5 mins
<b>Note on static accuracy:</b>	Accuracy is defined as the RMS position error of the magnetic center of a single sensor with respect to the magnetic center of a single transmitter over the <a href="#">Performance Motion Box</a> . Accuracy will be degraded if there are interfering electromagnetic noise sources or metal in the operating environment.

# Appendix I: driveBAY 2 Utility

## Running the driveBAY 2 Utility

### Setup

Before changing settings or beginning an upgrade, setup the tracker with either the RS232 or USB interface.



**Note:** This Utility can be run with either the driveBAY 2 or trakSTAR 2 systems.

1. Connect the RS232 or USB cable and the Power cable to the rear panel of the tracker.

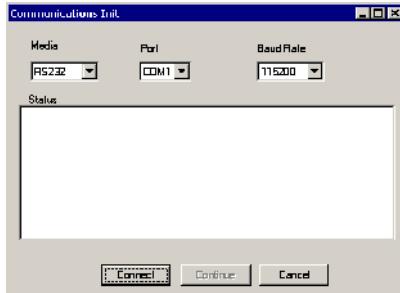


**Note:** The Utility can be run using either the RS232 (COM port capable of 115.2Kbaud) or USB interfaces.

2. Connect the other end of the RS232 or USB cable to an open COM port or USB port on the host PC (PC that will run the utility)
3. Power on the Tracker.

### Run the Utility

1. Start the utility by running the ‘driveBAY 2 Utility.exe’ file located on the CD-ROM. This opens the interface configuration window of the Utility.



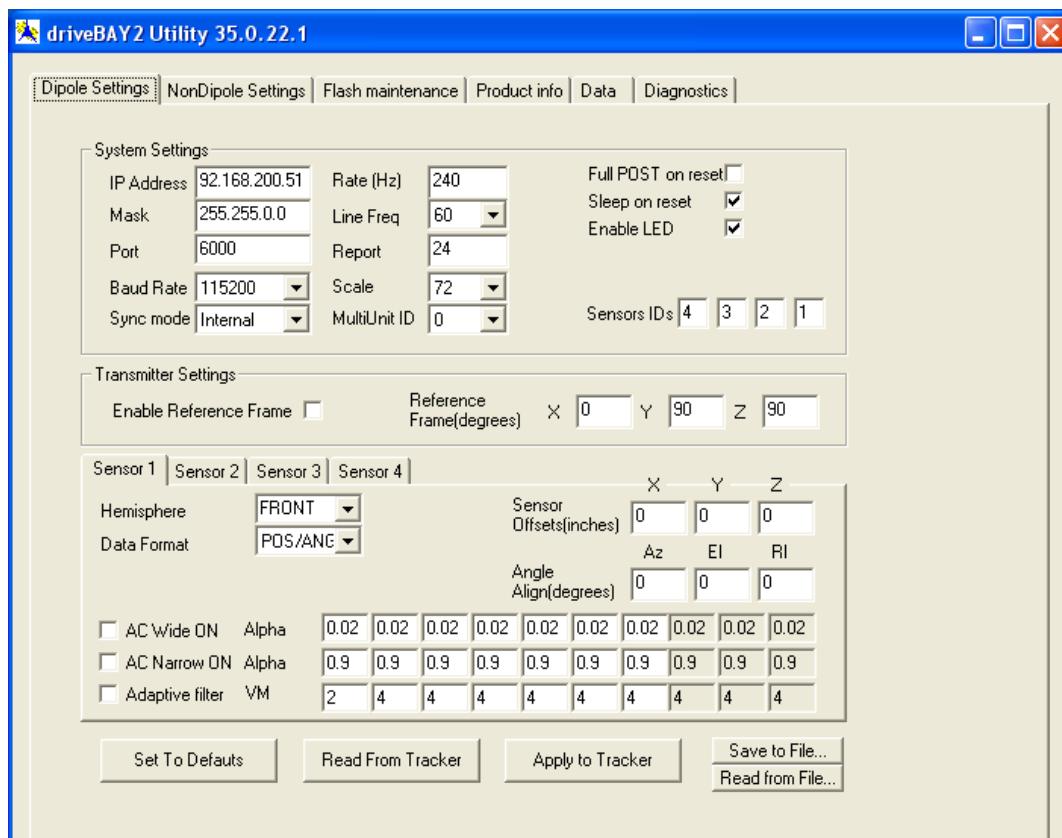
**Figure 57 driveBAY 2 Utility Communication Initialize Window**

2. If using the RS232 interface, select the COM port from the pull down menu, and click Connect.



**Note:** Current operation supports 115200 baud only.

3. If using the USB interface, select **USB** from the **Media** pull down menu and click **Connect** to establish communication with the tracker and initiate reading the current configuration. Progression of the reading is shown in the Status window.
4. When the reading has completed, select **Continue** to open the **Utility** default **Dipole Settings** tab. Changing settings on this tab will affect power-up behaviors of the tracker when a Dipole transmitter (i.e. MRT,SRT) is attached. See [Configurable Power-Up Settings](#) for a description of these settings.



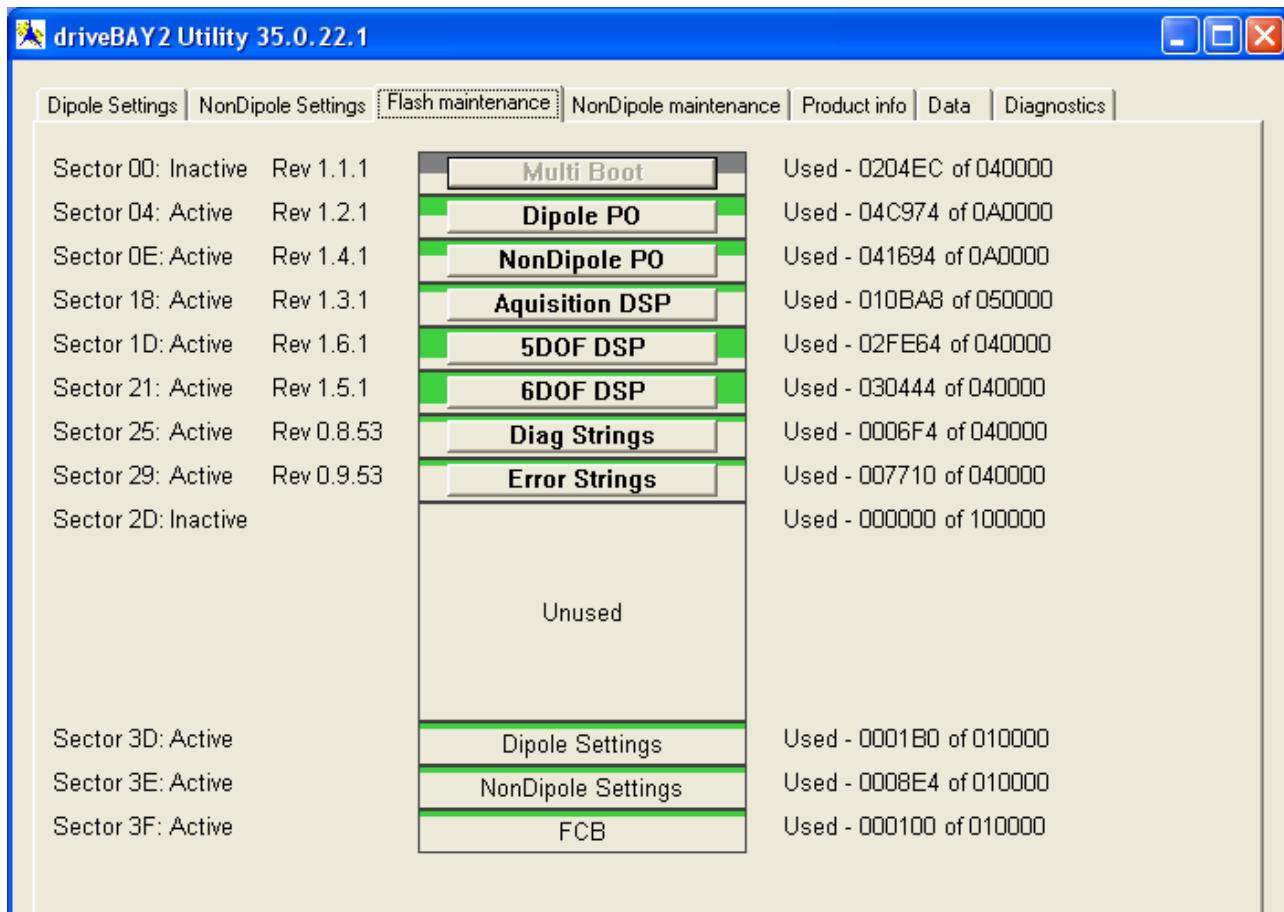
**Figure 58 driveBAY 2 Utility Window (Dipole Default Settings Tab Displayed)**

5. Select the **NonDipole Settings** tab to alter power-up behaviors of the tracker when a Non Dipole transmitter (i.e. Flat9, MAGnet,miniMAG) is attached. See [Configurable Power-Up Settings](#) for a description of these settings.



**Note:** If you change settings on either tab, you must click 'Apply to Tracker' (on any tab changed) and then re-boot the tracker for the new settings to take affect.

- To upgrade Flash Sectors, click the ‘Flash Maintenance’ tab to show the contents of the flash memory device.



**Figure 59 driveBAY 2 Utility Flash Maintenance**

- Click the flash sector to be upgraded. Select the new loader file and click ‘Open’. This will begin the upgrade of the flash sector. A progress bar will indicate status. When the upgrade of the sector is complete, the new contents of the Flash will be displayed in the ‘Rev’ field next to each sector
- Close the Utility (‘X’ in title bar) and cycle the power on the tracker.

## Appendix II: Application Notes

### Computing Stylus Tip Coordinates

In many applications that require a sensor mounted on a tool or pointing device, the position of the tip is required. This type of pointing device is generically referred to as a stylus.

The sensor position and orientation values are presented with respect to the center of the sensor. The corresponding X, Y, Z coordinates at the tip of the stylus may be easily calculated knowing the tip offset from the sensor center.

The stylus coordinates can be computed from the following:

$$\begin{aligned} X_S &= X_B + X_O * M(1,1) + Y_O * M(2,1) + Z_O * M(3,1) \\ Y_S &= Y_B + X_O * M(1,2) + Y_O * M(2,2) + Z_O * M(3,2) \\ Z_S &= Z_B + X_O * M(1,3) + Y_O * M(2,3) + Z_O * M(3,3) \end{aligned}$$

Where:

**X<sub>B</sub>, Y<sub>B</sub>, Z<sub>B</sub>** are the X, Y, Z position outputs from the 3DGGuidance<sup>TM</sup> sensor with respect to the transmitter's center.

**X<sub>O</sub>, Y<sub>O</sub>, Z<sub>O</sub>** are the offset distances from the sensor's center to the tip of the stylus.

**X<sub>S</sub>, Y<sub>S</sub>, Z<sub>S</sub>** are the coordinates of the stylus's tip with respect to the transmitter's center.

**M(i, j)** are the elements of the rotation matrix.

Often the values of X<sub>O</sub>, Y<sub>O</sub>, Z<sub>O</sub> are not known ahead of time and must be calculated. This may be done by placing the tip of the stylus at a set location, collecting data of the stylus being repositioned with the tip fixed, and solving for X<sub>O</sub>, Y<sub>O</sub>, Z<sub>O</sub>. Since the tip location (X<sub>S</sub>, Y<sub>S</sub>, Z<sub>S</sub>) is fixed, and the 3DGGuidance<sup>TM</sup> sensor position (X<sub>B</sub>, Y<sub>B</sub>, Z<sub>B</sub>) and orientation (M(i, j)) are reported by the system, solving for X<sub>O</sub>, Y<sub>O</sub>, Z<sub>O</sub> may be solved.

Collect many measurement points over a large range of angles and rotations for maximum accuracy.

## Explaining Measurement Rate vs. Update Rate

**Measurement Rate** is the rate at which the tracking system acquires a complete measurement set from all available axes in the transmitter.

**Update Rate** is the rate at which a new (unique) position and orientation solution for the sensor is computed by the tracker and available to the user.

### Older Systems:

In previous generation ATC trackers, a position and orientation solution would only be available after *all* transmitter axes had been energized. Thus the Update rate was equal to the system Measurement rate.

$$\text{UpdateRate} = \frac{1}{a * t_A} \text{ Hz}$$

Where:

$a$  = Number of transmitter axes

$$t_A = \text{Axis cycle time} = \frac{1}{\text{Measurement Rate} * a} \text{ (sec)}$$

For example, for an older tracker configured to run at a Measurement rate of 80Hz with a standard mid-range transmitter (3-axis transmitter), the Update rate would be computed as:

$$\text{UpdateRate} = \frac{1}{3 * 4.167mS} = 80\text{Hz}$$

## 3DGuidance Systems

Next generation systems have the capability to compute a new position and orientation solution at the end of each transmitter axis cycle (see Fig 1 below). Both [dipole](#) and [non-dipole](#) transmitter based systems use proprietary algorithms for advancing the solution in time so that there is very little skew of the data. This yields an Update rate that is:

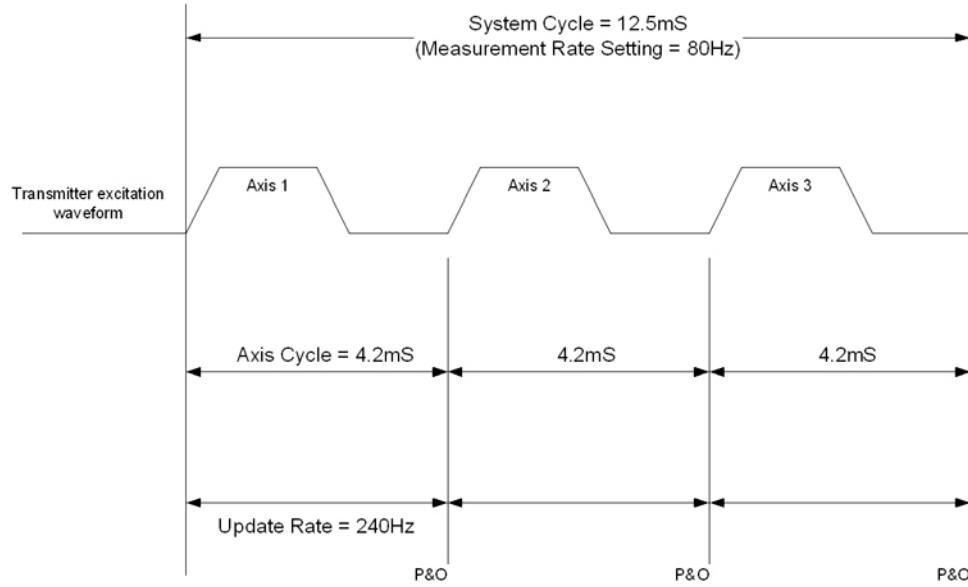
$$\begin{aligned} \text{UpdateRate} &= \frac{1}{t_A} \\ &= a * \text{Measurement Rate} \end{aligned}$$

Where again:

$a$  = Number of transmitter axes

Using the same example of a system running at a Measurement Rate of 80Hz with a standard mid-range transmitter (3-axis), the Update Rate would be:

$$\text{Update Rate} = 3 * 80\text{Hz} = 240\text{Hz}$$



**Figure 60 Transmitter Excitation Waveform**

# Appendix III: 3DGuidance Manual Starting Position for NonDipole Transmitters

## Scope

This document covers setting the manual starting position for 3DGuidance driveBAY2/traksTAR2 and medSAFE trackers when running NonDipole transmitters. NonDipole transmitters include the MAGnet transmitter, the miniMAG transmitter, and Flat transmitters. This document does not apply to Short-Range, Mid-Range or Wide-Range Dipole transmitters.

## Overview

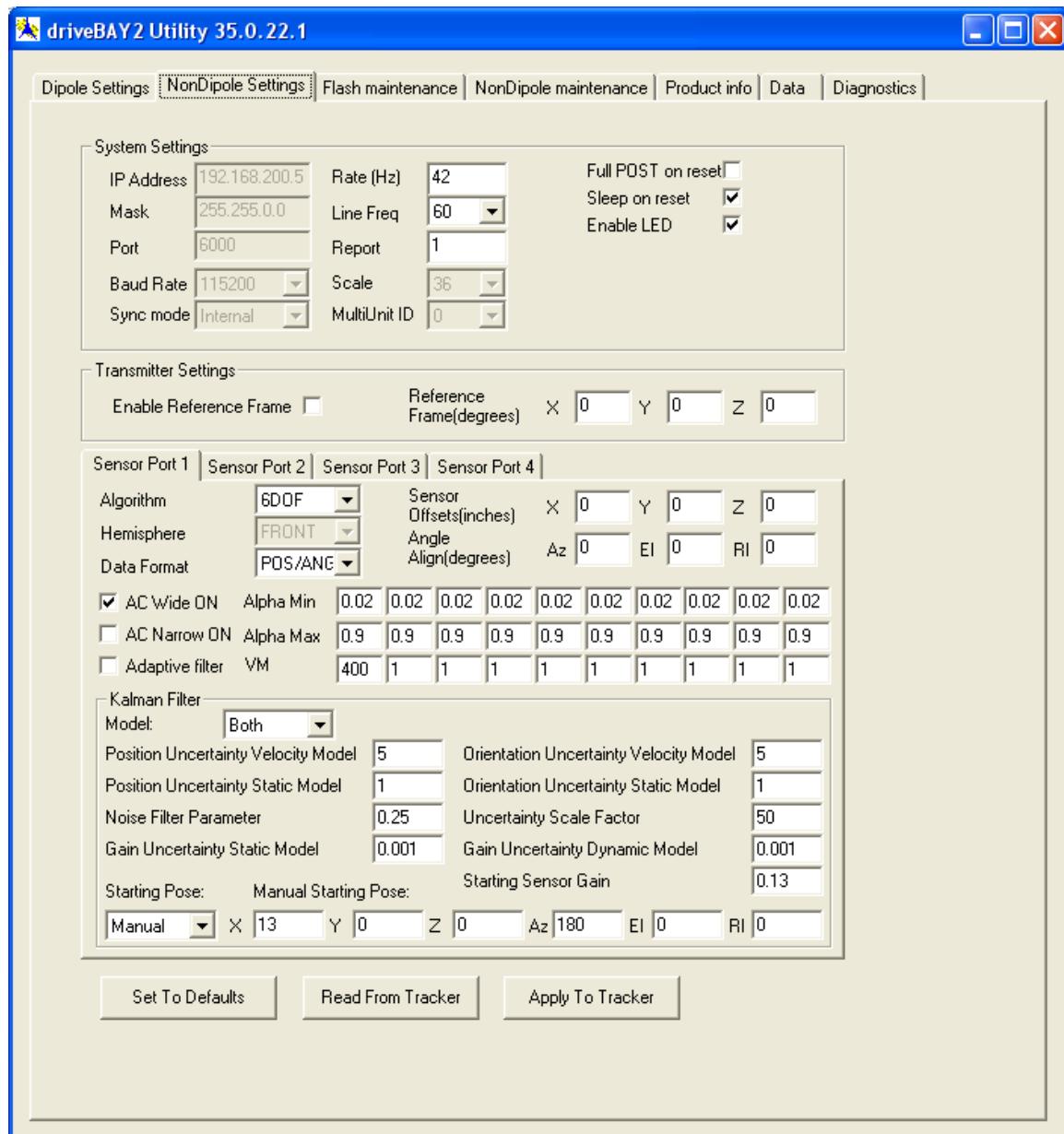
When tracking with NonDipole transmitters, 3DGuidance trackers use an iterative algorithm that is seeded with a starting pose (position and orientation). From that starting point, the algorithm converges on the true tracking solution.

Whenever tracking is interrupted and restarted, the starting pose is used. This includes power-up, sensor hot-swapping, running the transmitter after sleep, and re-entering the tracking volume.

The factory default setting (Auto) uses the center of the tracking volume for the position start and an orientation start of 0 degrees Azimuth, 0 degrees Elevation, 0 degrees Roll. In some cases, however, the algorithm may struggle to converge on the correct tracking solution, as evidenced by extremely noisy data with large quality/distortion values. In these situations, the sensor can be set to use a Manual starting pose selected by the user. By selecting a Manual starting pose close to the true position, algorithm convergence can be greatly improved.

## Setting the Manual Starting Pose with the driveBAY2 Utility

Currently the Manual starting pose can be set at power-up using the NonDipole Settings tab in the driveBAY2 Utility (see screenshot below). The **Starting Pose** pulldown menu allows selection of **Auto** or **Manual** modes and the adjacent text boxes specify the **Manual Starting Pose**. After entering the desired settings, click **Apply To Tracker** to save the settings to non-volatile memory in the tracker. These new settings will take effect after powering down and restarting the tracker.



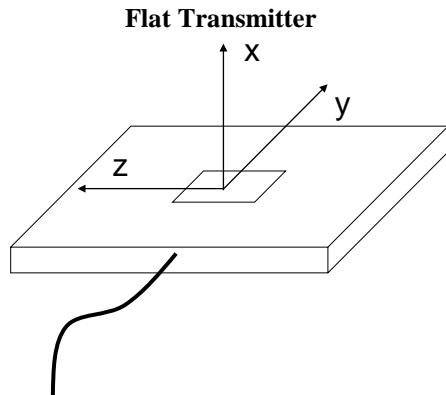
## Setting the Manual Starting Pose at Runtime

The 3DGGuidance API does not currently support this functionality.

## Determining the Appropriate Starting Position

The most straightforward way to choose the Manual starting pose is to place a sensor in a typical pose, record the tracking solution (e.g., with Cubes) and enter that position and orientation for the Manual Starting Pose. The following requirements must be observed:

1. The Manual Starting Pose must be expressed in inches and degrees.
2. For MAGnet and miniMAG transmitters, the Manual Starting Pose must be expressed in the factory default transmitter reference frame, i.e., with the Reference Frame set to (0, 0, 0) and the XYZ Reference Frame turned off.
3. For Flat transmitters, the Manual Starting Pose must be expressed in the reference frame shown below, which corresponds to setting the Reference Frame to (0, 90, 90).



The Cubes screenshots below show the Reference Frame and XYZ Reference Frame settings to apply in the Xmtr tab for cases 2 and 3 above.

**MAGnet and miniMAG**

System   Sensor 1   Sensor 2   Sensor 3   Sensor 4   Xmtr 1   Error Log   Save	
Attached Selected, off	
Alignment Reference Frame <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="checkbox"/> XYZ Reference Frame <input type="button" value="Apply"/>	

**Flat Transmitter**

System   Sensor 1   Sensor 2   Sensor 3   Sensor 4   Xmtr 1   Error Log   Save	
Attached Selected, off	
Alignment Reference Frame <input type="text" value="0"/> <input type="text" value="90"/> <input type="text" value="90"/> <input checked="" type="checkbox"/> XYZ Reference Frame <input type="button" value="Apply"/>	

Note that these reference frames are only required for determining the correct Manual Starting Pose settings. During tracking, the user is still free to apply any reference frame desired.