

# FAQs

## 3D Guidance Trackers

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## **PRODUCTS OVERVIEW:**

### **Q. What trackers make up the new 3D Guidance product line?**

**A.** The 3D Guidance line includes three trackers:

- medSAFE
- driveBAY
- trakSTAR

### **Q. How do they differ from Ascension's earlier magnetic trackers?**

**A.** They represent a new generation of Ascension trackers, designed with the latest advancements in digital signal processing, passive sensing of DC magnetic fields, Kalman filtering, dynamic noise suppression, and micro miniaturization of sensor components. They enable you to track the instant position and orientation of miniaturized sensors at unprecedented high speed and high accuracy with minimal noise. Each product contains self-diagnostics and run-time monitoring for improved tracker reliability and safety.

**medSAFE** is the first Ascension tracker to meet the highest medical compliant standards. It is a Class 1, Type CF, Defib Proof tracker, which means its sensors can be used in cardiac applications once users meet FDA/CE and/or IRB requirements.

**driveBAY** and **trakSTAR** are the first Ascension trackers to fully meet RoHS and WEEE standards as well as all pertinent medical, electrical and safety standards.

### **Q. Aren't all magnetic trackers the same?**

**A.** No, there are several generations of trackers on the market. These range from 1st generation AC electromagnetic technology, first patented by Polhemus Inc. in the 1970s, and later enhanced by medical device companies, including Biosense, GE, Medtronic, MediGuide, NDI, and SuperDimension; 2nd generation trackers patented by Ascension in the 1990s that employ pulsed DC magnetic technology; and now 3rd generation DC magnetic technology, also patented by Ascension. 3D Guidance technology offers the latest improvements and innovations in magnetic tracking technology.

First generation trackers are notoriously susceptible to distorted measurements in the presence of common metals, such as carbon steel, aluminum, and even stainless steel.

Second generation DC trackers exhibit only 1/5 the sensitivity to non-magnetic conductive metal as their earlier counterparts. As a result their sensors can be attached to ultrasound scanheads, titanium instruments, and non-magnetic stainless steel objects without discernable loss of accuracy. However, their sensors contained fluxgates that limited sensor miniaturization to 5 mm in diameter, were subject to ferrous metal distortion, and were too complex to achieve truly low cost.

Third generation magnetic tracking represents the state-of-the-art in real-time tracking. It includes six degrees-of-freedom sensors as small as 0.94mm in diameter, low cost, disposable sensor pricing, special transmitters that block distortions emanating below the tracking volume, and advanced processing and calibration techniques for robust performance in all kinds of environments.

**Q. How do the new 3D Guidance trackers differ from one another?**

**A.** Here is a chart of key differences:

Features	medSAFE	trakSTAR	driveBAY
Number of Sensors <i>(When Using Mid and Short-Range Transmitters)</i>	8	4	4
Transmitter Options	<ul style="list-style-type: none"> <li>• Mid Range</li> <li>• Short Range</li> <li>• Flat</li> </ul>	<ul style="list-style-type: none"> <li>• Mid Range</li> <li>• Short Range</li> </ul>	<ul style="list-style-type: none"> <li>• Mid Range</li> <li>• Short Range</li> </ul>
Electronics Packaging	External Box with Built-in Power Supply <i>(No "brick")</i>	External Box with Built-in Power Supply <i>(No "brick")</i>	Module Fitting into PC Drive Bay; Uses PC's Power Supply
Immunity to Distortion from	Yes	Yes	Yes

Common Hospital Metals & Composites  (Stainless-Steel--300 Series, Titanium, Brass, and Aluminum)			
Ferrous Metal Immunity	Yes (Area Beneath Flat Transmitter Tablet)	No	No
Medical Compliance Level	Class 1, Type CF, Defib Proof	Class 1, Type B Applied Part	Class 1, Type B Applied Part
List Price  (Single 8mm Sensor with Mid-Range Transmitter)	\$7,895	\$3,790	\$3,640

**Q. What are the differences between earlier 3D Guidance/microBIRD trackers and medSAFE?**

**A.** Ascension's original 3D Guidance tracker -- with full medical compliance for navigation of miniaturized sensors -- was released in 2007. It succeeded microBIRD that had been released in 2005 as a laboratory tool for medical researchers. microBIRD enabled one to track miniaturized sensors, but it did not carry a medical certification for use in internal medical procedures.

**medSAFE** is a 2008 update of last year's 3D Guidance tracker. It tracks up to 8 six-degrees-of-freedom sensors simultaneously, and offers improved dynamic performance, hot swapping, time stamped records, on-board flash reprogramming, customizable settings, biocompatible sensors, and extensive self-test and run-time diagnostics for improved reliability and safety.

**medSAFE** also supports tracking of the world's smallest six degrees-of-freedom sensor: 0.94mm in diameter X 7.6mm in length. It is small enough to fit into the distal tip of a 19-gauge hollow needle.

**Q. Are 3D Guidance trackers compatible with legacy (older model) Ascension trackers?**

**A.** Yes, 3D Guidance trackers are drop-in replacements for many Ascension magnetic trackers that you once used.

**trakSTAR** is fully compatible with Ascension magnetic trackers that use RS-232 and USB interfaces. **trakSTAR** supports Flock of Birds, miniBIRD and all other Ascension magnetic tracker using the RS-232 Interface, running winBIRD, CBIRD, SBIRD and SOCKET programs, and employing Windows drivers.

3D Guidance (older model), microBIRD, and pciBIRD users can substitute new USB and DLL (drivers) and continue to use old applications. Note, however, 3D Guidance trackers do not presently support the extended range transmitter that is available with legacy products. If you need extended range tracking, you can still obtain it by buying a Flock or MotionStar tracker.

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## **HARDWARE:**

Q. What is the difference between a short-range transmitter with an air core versus a short-range transmitter with a ferrite core?

A. The biggest difference is range. Both transmitters enable six degrees-of-freedom sensor tracking, but the ferrite version produces a stronger signal than the air core version. At 17 inches of separation, the position and angular noise for a ferrite transmitter will be about one half that of the air core. For this reason, we recommend that the air core transmitter be used in very short-range applications, such as tracking a sensor referenced to a transmitter that is no greater than 8 -12 inches away.

Q. Is the new short-range transmitter light enough to mount on a person?

A. As long as the transmitter is mounted on a bracket (and therefore not in direct contact with a person), it can be used for body tracking. The “air core “ version weighs just 230 grams. As stated above, it is specifically designed for close range applications. For some medical applications, it can be mounted on a swing arm or insulated band attached to the patient for tracking miniaturized sensors within the body. In at least one new application, this new transmitter is attached to a headband for tracking sensors and instruments on and near the face. Sensor measurements can be referenced relatively to one another or absolutely from their geometric center to the center of the transmitter.

**Q. How close can we put two sensors?**

**A.** 8mm sensors should maintain a center-to-center separation distance of approximately 1.3 inches (33mm) for best performance.

Q. What does hot swapping of sensors mean?

A. Each sensor is individually calibrated and can be used with any electronics unit. Sensors can also be unplugged and re-plugged into the electronics unit and data reporting will resume as soon as a new connection is made.

Q. What do you mean by time stamping of records?

A. A temporal stamp is applied at the time of data acquisition with 100-microsecond resolution. The time stamp is provided in UTC format and is synchronized with your host computer's clock when initialized by our DLL.

Q. Do any of the trackers support a button mode?

A. Yes, trakSTAR allows you to append an external switch or button, to each data record. See below for additional information.

Q. How is button status reported in the data file?

A. Three data formats are provided in our API that include the button status as a member of the data format structure. (See: DOUBLE\_POSITION\_ANGLES\_

TIME\_Q\_BUTTON\_RECORD on pages 164 and 165 of the **trakSTAR** Operations Guide.)

With these formats, the state of the button is returned as a button value with each data record (regardless of state of button). When a switch/button 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 input is sampled by the electronics once per transmitter axis measurement (i.e. 3 times per system measurement cycle for a mid or short range transmitter).

Q. Is there any way to synchronize the trakSTAR with other data acquisition equipment in our lab? In other words, can the trakSTAR accept a TTL signal to either start the acquisition (with no delay) or to record this signal as a high-low signal synchronized with the recorded data?

A. Although we do not support use of an external sync to drive the acquisition, there are two ways to correlate time events with the sensor data records:

**Timestamps** – As noted above, several of our data formats include time stamped records. As the timestamp is synchronized to the host PC's time clock during initialization, any other device connected to the PC using the PC's timestamp can be matched up to a given sensor's data record.

**Button Mode** – We include a data format in the API that gives you the status of an external button/switch (simple contact closure - no TTL required) with each record. You can use this button input to represent an external event (i.e. from another device) and be reflected in the sensor's data stream.

Q. Can we plug in any device and use your button?

A. Any contact closure switch or button that meets the electrical requirements stated in the trakSTAR Operations Guide can be used. Note: your device must be wired to mate with the external BNC connector on the rear panel of the trakSTAR.

Q. Power-line noise once was a problem with DC magnetic trackers. How do 3D Guidance trackers handle this problem?

A. 3D Guidance trackers support a new and improved wide notch filter that dramatically reduces 60Hz noise without exacting a noticeable penalty in dynamic performance.

Q. What is the difference between measurement rate and update rate?

A. With previous generation trackers, there was no difference. Measurement rate was the update rate. With 3D Guidance trackers, however, a new tracking solution (full 6DOF output) is iteratively computed after each transmitter axis excitation. With a mid-range or short-range transmitter, this means that by the time each transmitter axis has been energized, three solutions have been derived and output to your host computer. If the measurement rate is set at 80HZ and you are using one of our dipole (cubic) transmitters, you will receive 80Hz X 3 or 240 solutions in each measurement cycle. Update rate is independent of the number of sensors tracked so the update will remain constant regardless of the number of sensors tracked.

Q. Can you explain how measurement and update rates are calculated?

A. The calculations differ in the speed in which new tracking solutions are available for your use:

*Measurement Rate* is the rate at which the tracker 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.

#### Legacy (Older) Ascension Trackers:

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.

$$UpdateRate = \frac{1}{a * t_A} Hz$$

Where:

*a* = Number of transmitter axes

$$t_A = Axis\ cycle\ time = \frac{1}{Measurement\ Rate * a} (sec)$$

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:

$$UpdateRate = \frac{1}{3 * 4.167mS} = 80Hz$$

#### 3D Guidance Trackers

Ascension's new generation of 3D Guidance trackers compute a new position and orientation solution at the end of *each* transmitter axis cycle (see Figure 1 below). Both dipole and flat transmitter-based systems use proprietary new algorithms to advance the solution in time so there is minimal skew of the data. This yields an update rate that is:

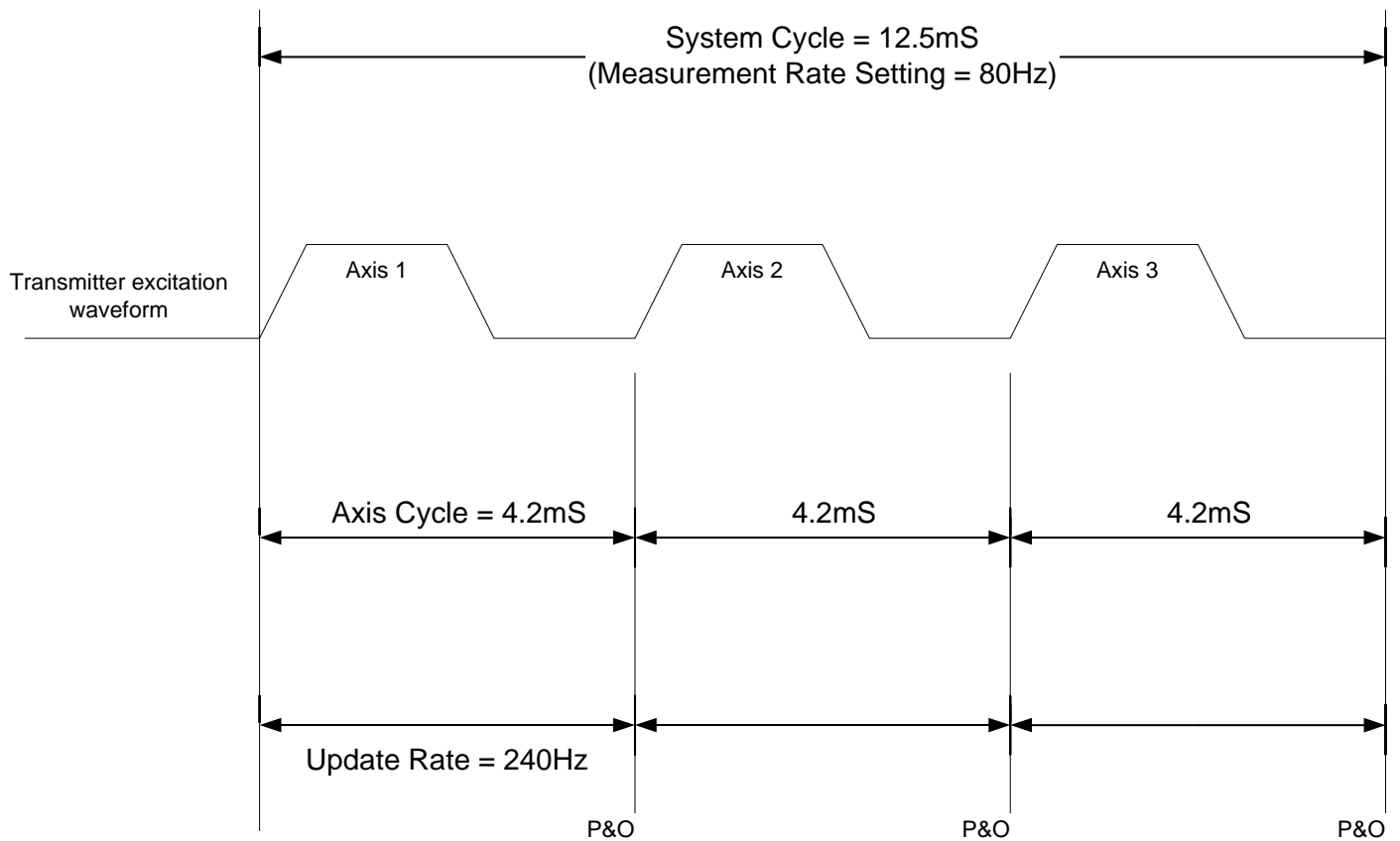
$$UpdateRate = \frac{1}{t_A} \\ = a * Measurement\ Rate$$

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 is:

$$\text{Update Rate} = 3 * 80\text{Hz} = 240\text{Hz}$$



**Figure 1:** Transmitter excitation waveform for a 3-axis transmitter running at a measurement rate of 80Hz. For 3DGuidance trackers, this yields an update rate of  $3 \times 80 = 240\text{Hz}$ .

**Q. How do 3D Guidance trackers interface to host computers?**

**A. medSAFE** and **trakSTAR** communicate via high speed USB or serial RS-232 ports.

**driveBAY** outputs are available over your computer's USB port.

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## **SOFTWARE / FIRMWARE:**

Q. What software is provided?

A. You will receive a Windows API, which is compatible with APIs available for legacy trackers (pciBIRD, microBIRD and 3D Guidance) configuration utility, sample programs, and a number of demo utilities. The Cubes utility is a graphically based demo program that lets you checkout the tracker's performance prior to incorporating it into your application. A virtual dice cube on your monitor mimics the motion of your sensor in free space. Cubes also present a numerical representation of the absolute position and orientation of each sensor as it moves. These programs are contained on a CD-ROM provided with your tracker for loading onto your computer.

Q. If I need a firmware upgrade, must I return my tracker or insert new proms in my tracker's electronics unit?

A. No, we can provide on-board flash reprogramming of your unit for most upgrades. In some cases, a hardware upgrade will be required to add new features to a medSAFE tracker.

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## **ACCURACY BEHAVIOR OF MAGNETIC FIELD TRACKERS:**

Q. Is accuracy the same throughout the tracker's motion box?

A. No. If, under static conditions, you move one sensor throughout the motion box (i.e., the volume in which a magnetic tracker meets its accuracy specifications) and measure its position and angular accuracy, you will observe accuracy changes as a function of its location in the motion box. Similarly, if you rigidly fix two sensors near one another in a mechanical assembly and then move and rotate it in the motion box, you will observe the range between the two sensors varies as a function of the assembly's location in the motion box.

Q. Are these variations in accuracy "normal behavior" or is there a hardware or software problem with the magnetic tracker?

A. You are observing normal behavior as long as the errors fall within the expected (specified range) of errors for a given tracker.

Q. What is the expected range of errors?

A. For an ideal magnetic tracker, there are no positional measuring errors. Wherever you move a sensor in the motion box, it measures position and orientation without error. That is to say errors do not vary throughout the motion box because each individual sensor perfectly measures its position coordinates.

In the real world, however, position and orientation errors vary in magnitude throughout the motion box. These errors are caused by the designer's inability to design a perfect measuring machine. Errors can also be produced by environment factors, such as metal in or near the motion box. Depending on the composition and size of this metal, it can distort the magnetic fields and cause varying errors in the motion box. These errors are static errors. In other words, if you move away from a location and return to it, the sensor will always measure the same error at this location. If you move to a different location, you will measure a different but still repeatable error. Errors do not jump from one value to another, but change smoothly as the sensor moves about.

Q. How can the accuracy be greater or less than the specified accuracy at different points in the motion box?

A. Ascension specifies the tracker's accuracy using the Root-Mean-Square (RMS) error statistic. It is computed by moving the sensor to hundreds of locations throughout the motion box and recording the error at each location. The RMS value is then computed using all the error data throughout the motion box.  $RMS = \text{square root of } (\text{sum of all errors squared} / \text{number of locations})$ . Statistically speaking, if the errors are normally distributed then 68% of all errors fall within the band of  $\pm RMS$  and 99.7% of the errors fall within the band of  $\pm 3 \times RMS$ .

For some Ascension trackers the RMS accuracy is specified as 0.07 inch or 1.8 mm. Other products are specified as 0.04 inches or 1.0 mm. A sensor placed at any one location in the motion box will read only the peak error only at that location, not the RMS error. As a result, some errors may be larger and some smaller than the specified

accuracy. For example, if the sensor were located at the peak positive error then you would measure an error of 0.12 inches (3 mm) when using the sensor with a 0.04-inch (1 mm) RMS spec. If you had two sensors and you were unlucky enough to place one sensor at the positive maximum error and another at the negative maximum error then you would record a total difference in positional error of at least 0.24 inches (6 mm).

If you are developing a new product or doing research with a magnetic tracker, it is important to take this discussion into account when determining if the tracker is performing as specified.

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## REGULATORY:

### Q. What regulatory standards do 3D Guidance trackers meet?

**A. medSAFE** is a *Class 1* medical device per *IEC 60601-1*. Its sensors are designed and tested to the *Type CF, Defib Proof Applied Part* designation. The system complies with electrical, safety, and electromagnetic compatibility requirements set forth in *IEC 60601-1* and *-2*.

**driveBAY** and **trakSTAR** are *Class 1* medical devices per *IEC 60601-1*. Their sensors meet *Type B Applied Part* standards. They also carry the CE mark and meet *IEC 60601-1-2, Class B Limits for EMC*.

## INSTANT HELP:

If you did not find the answer to your question here, please contact us at [support@ascension-tech.com](mailto:support@ascension-tech.com) for a direct response.

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