# SX Series
# GPS-Aided Inertial Navigation System (INS/GPS)
# Technical User Guide

- LMRK005 INS/GPS
- LMRK60 INS/GPS

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# 3 SAFETY AND HANDLING INFORMATION

- Always use caution when using the Gladiator ISN/GPS!
- **Please refer to your specific product datasheet to determine which appropriate input voltage to use.**
- **INS/GPS devices/units are sensitive scientific instruments containing shock and vibration sensitive sensors. Excessive shock and/or vibration can damage these sensors and can adversely affect sensor performance and unit output.**
- Avoid exposure to electrostatic discharge (ESD). Observe proper grounding whenever handling the INS/GPS.
- Properly attach the connector and ensure that it has been wired correctly before applying power to the INS/GPS.
- Units are shipped from factory in the following default settings, unless otherwise required for customer application:
    - 100 Hz FULL Mode
    - 921,000 Baud Rate
    - 1 Stop Bit

# 4 GETTING STARTED

This section contains directions and references for a quick start to using the INS/GPS.

For additional support, please contact the distributor representing your location. If there isn't a local representative for your location, please contact our Headquarters for assistance and someone from our Sales Team will assist you.

The INS/GPS Software Development Kit (SDK) is an optional product to assist first time users of a Gladiator INS/GPS. This kit provides the user everything they need to facilitate a rapid setup and test of the unit. The SDK includes display software with user-defined options including the following components and is seen in Figure 1:

- Turn-Key Solution for INS/GPS on User PC (all cabling/connectors/software included)
- Easy Integration of Direct INS/GPS RS-422/485 to PC USB Port (example hardware)
- Includes PC Display Software for INS/GPS
- Data Recording Capability
- Multiple User-Selected Field Options for Programming and Initializing the Unit
- Self-Test Button
- Power, Program/Run mode switches
- Antenna


*Figure 1 Example SDK box with SDK to PC USB cabling, GPS antenna, and CD-ROM*

If multiple units are purchased, the respective test data for each unit is placed on this CD for reference.

## 4.1 *RS-422/485 to USB Power Supply and Converter Cable*

Contained in the Software Development Kit is a complete RS-422/485 to USB Converter cable, including power supply and Self-Test button (Figure 2). The power supply uses USB power.

An RS-422/485 to USB converter (requires additional drivers that are included in a CD-ROM) is also included.

The SDK enables the user to quickly connect the INS/GPS to their PC to ease integration and testing. Connect the RS485 (9 or 15-pin) cable to the unit and the USB cable to the PC. The user should not turn on the power switch until all the software is installed.

*Figure 2 Typical INS/GPS connectors include: 9-pin (L) or 15-pin (R) Glenair connector*

## 4.2 *Hardware Application Note*

Please note that any unused RS-485 lines should be terminated by a 3 kΩ resistor with a shielded cable.

## 4.3 *Glamr Installation*

### 4.3.1 *Introduction*

The LINX SDM-USB-QS-S module requires that device drivers be installed on the host PC before they can interact. The drivers tell the PC how to talk to the module. These drivers are for Windows 7, 8, and 10. The set for Windows are the direct drivers, which offer program functions that allow a custom application to directly control the module through the USB port.


*Figure 3 SDK Installation CD-ROM*

To install the Glamr SDK application, run the Glamr setup executable found on the CD-ROM sent with your INS/GPS (*Figure 4*).

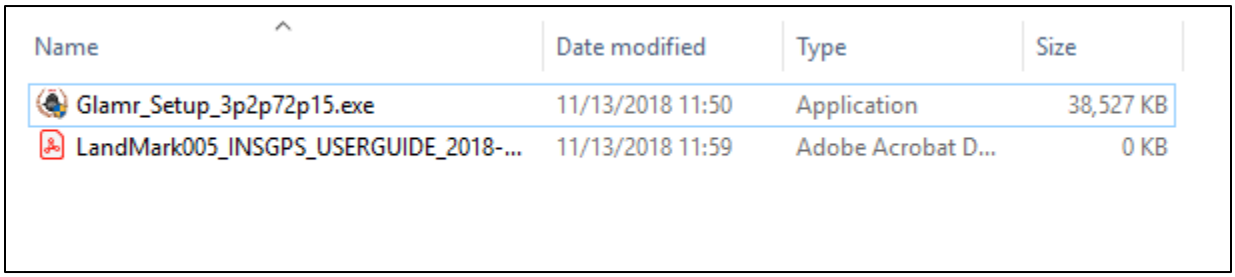



*Figure 4 Glamr setup location on SDK CD-ROM*

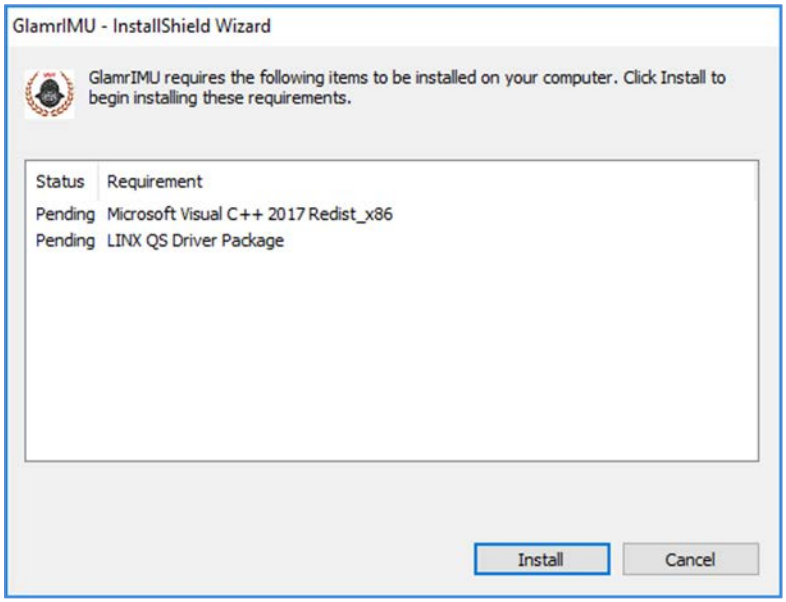



*Figure 5 Glamr prerequisite installations*

**ATTENTION:** Do **NOT** use the FTDI device driver that Windows 10 provides. It does not work with the LINX product even though they are using the FTDI parts. The PID was changed so it is unique.

Installing Glamr will place a shortcut to the application on the desktop and in the Start Menu.

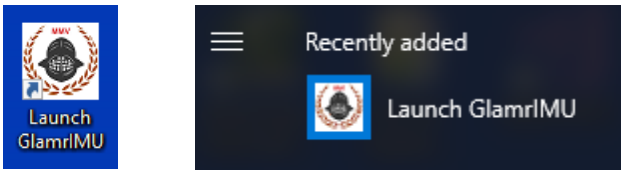



*Figure 6 Glamr shortcut locations*

The default Glamr installation directory is:

**C:\Program Files (x86)\Gladiator Technologies**

In addition to these shortcuts, the installation will also place a Glamr.ini file into:

***C:\Users\"username"\AppData\Roaming\Gladiator Technologies***

**NOTE**: Plug the connector cable into the USB port before you turn the device power on to avoid Windows loading as a mouse driver.

With Glamr successfully installed, open the program and a window will appear as in Figure 7.

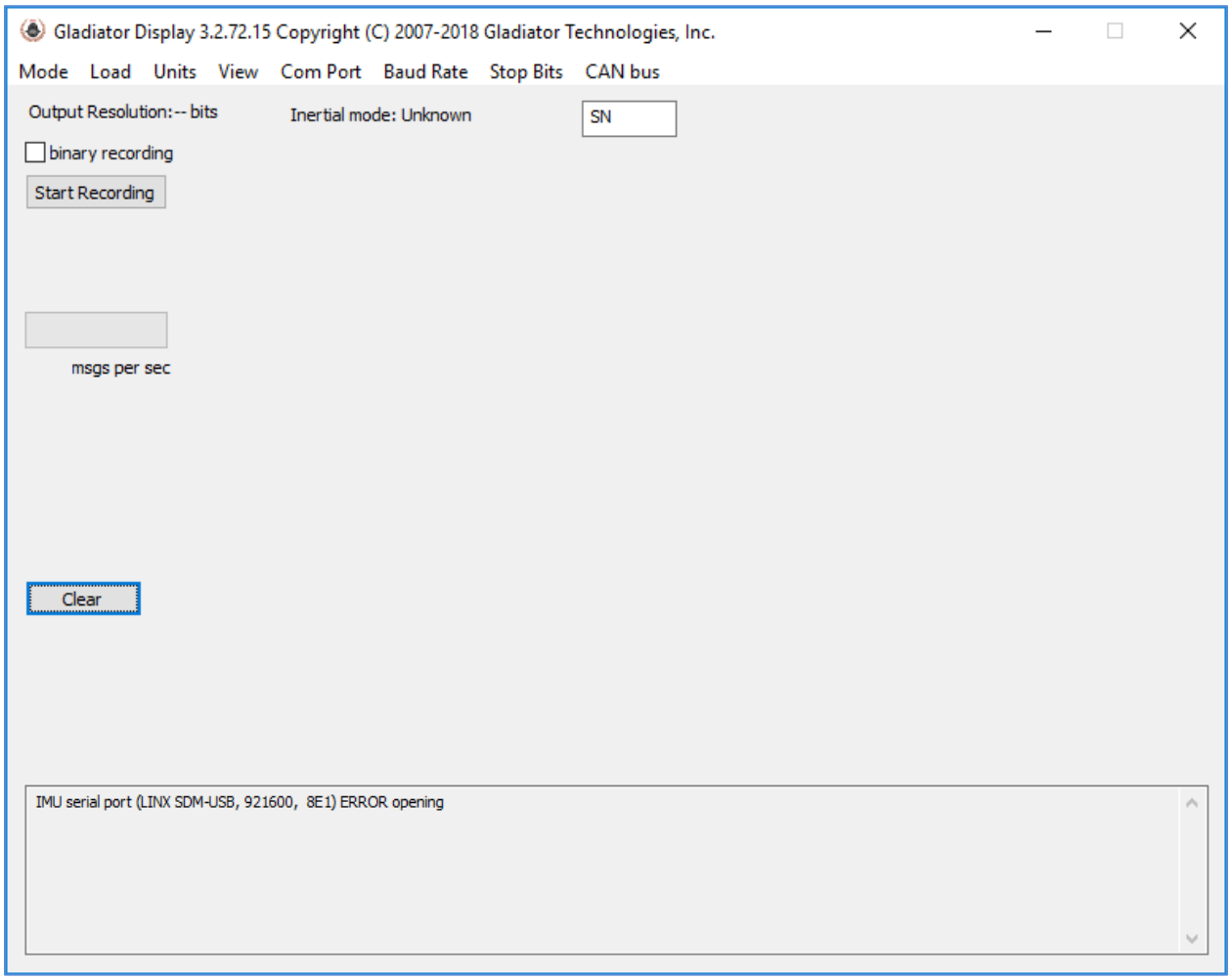



*Figure 7 Glamr screen before selecting correct COM port settings.*

The bottom of the Gladiator INS/GPS Display may read "IMU serial port (LINX SDM-USB, 115200, 8E1) ERROR opening." The installer defaults the baud rate to 921600 Mbps, so check the Baud Rate menu to ensure this is the case.

Only one copy of Glamr can be open at a given time. Always make sure there is not another copy open on the task bar. If there are multiple copies of Glamr open, a COM port error will appear when the user tries to interact with the unit.

Now reconnect the USB plug to the SDK. The “LINX” port should have a checkmark next to it. The bottom of the window should now read “IMU serial port (LINX SDM-USB, 115200, 8E1) success.” If Glamr is open and no unit is detected, Glamr will attempt to find it by cycling through different baud rates.

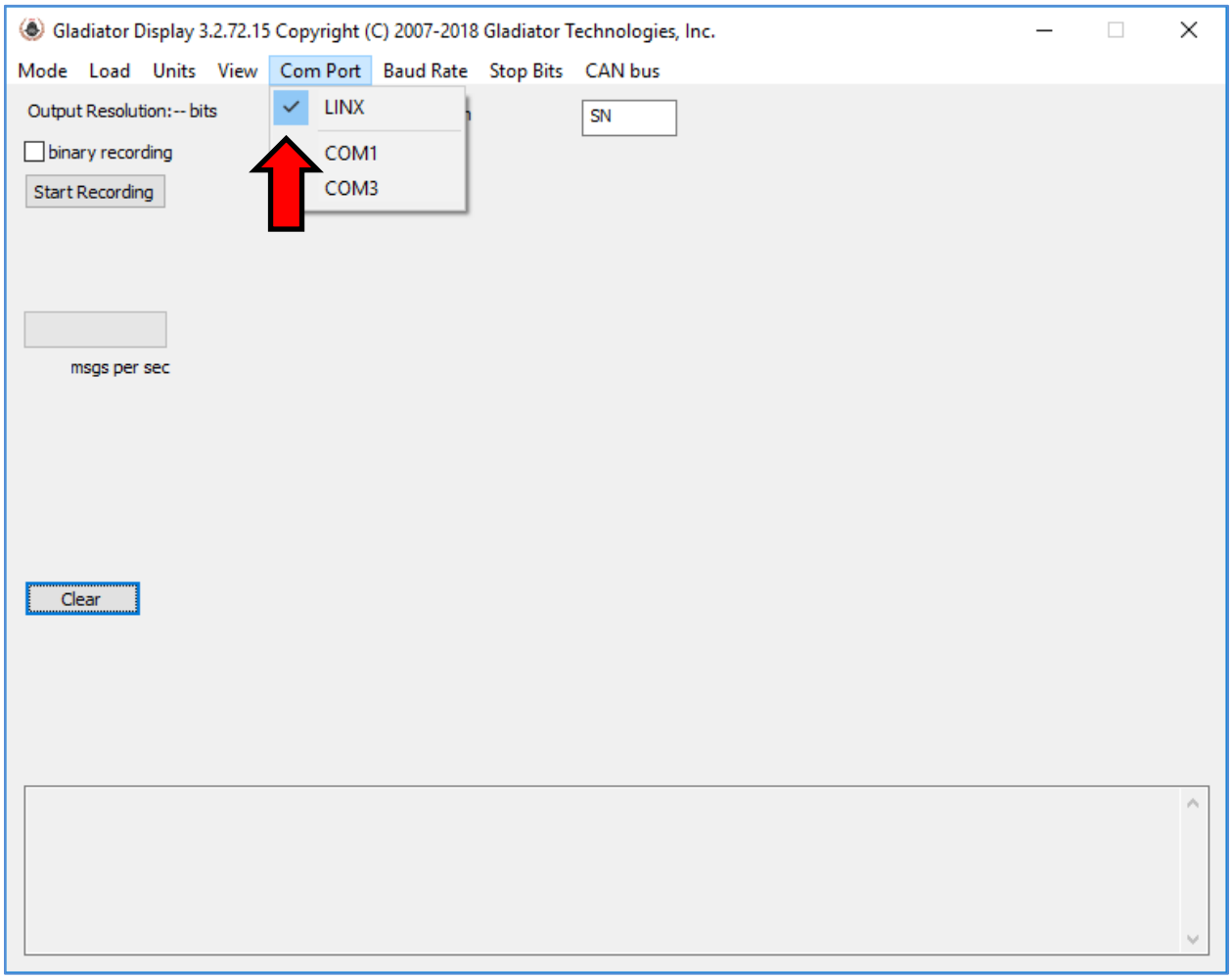



*Figure 8 Confirmed correct LINX port with message "success."*

Next, open the Windows Device Manager and expand the *Ports (COM & LPT)* section. Right-click on the device labeled “LINX SDM-USB-QS-S” and select “Properties.” Open the “Port Settings” tab and then click the “Advanced” button.

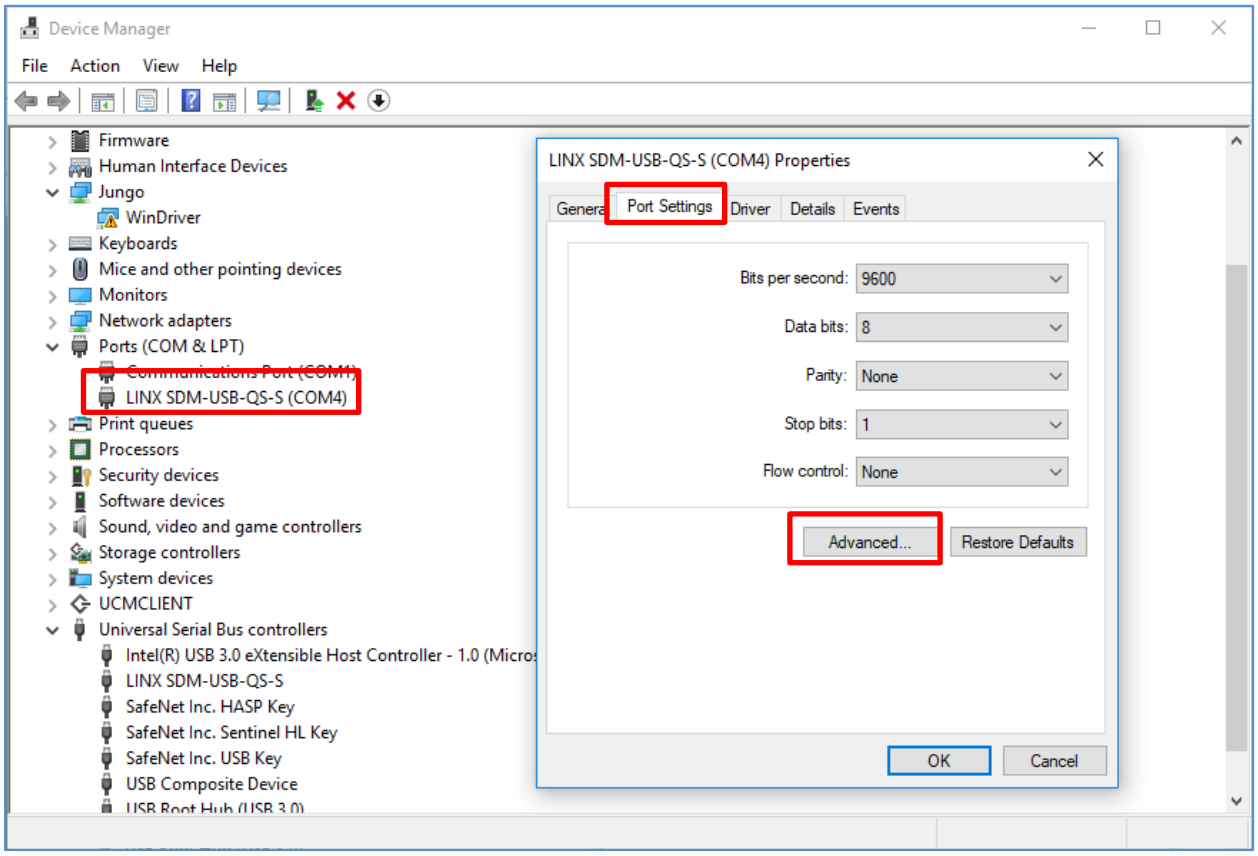



*Figure 9 Device Manager LINX-SDM-USB-QS-S port Properties*

Now change the Latency Timer drop-down setting to 1 msec (from the default 16 msec). Select OK and apply all changes. This setting is necessary for the Windows PC to receive INS/GPS message data at higher message rates without errors.

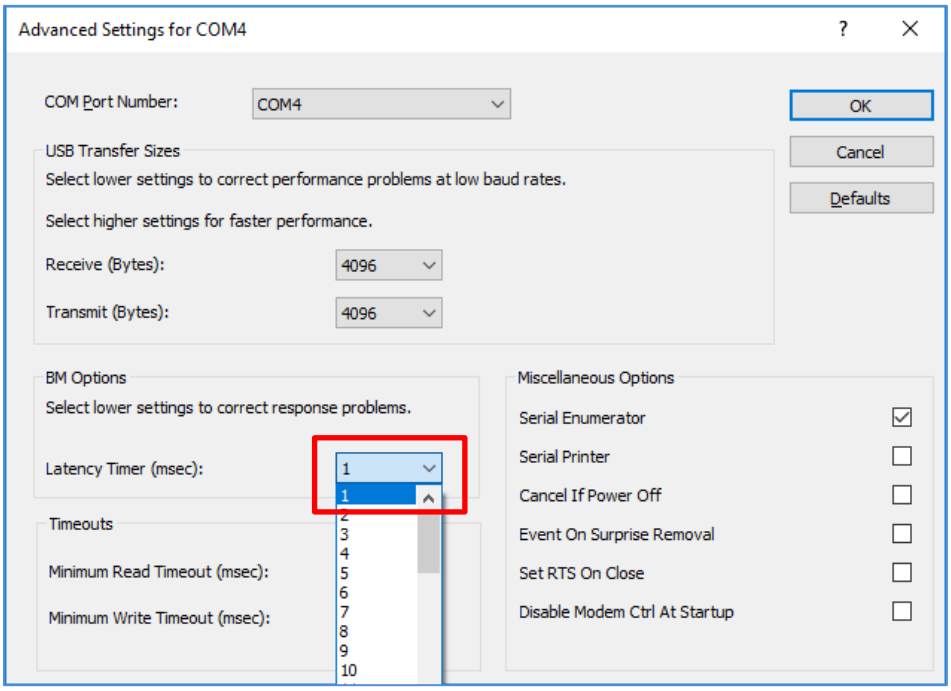



*Figure 10 Advanced Settings for COM port Latency Timer*

Turn on the power switch on the unit power supply and you should see data appear in the window as shown in Figure 12. You should be able to move the INS/GPS with your hand and see changes in rate, acceleration, and Euler angles for each axis located on-screen. To see rapid change, the record function will capture real-time data without the filter effect of the Glamr display.

## 4.4 *Select Applicable Baud Rate*

The baud rate needs to be at least 20% higher than the message rate times the number of bits per message so that INS/GPS may receive commands from the PC. Note that the serial port is half-duplex, so communication between device and host can only go one way. Here is a guide of the relationship between baud rates and message rates:

| | | | **Baud Rate Setting →** | |
|---|---|---|---|---|
| **Message Data Rate ↓** | | RS-485 Bits/s | 115200 | 921600 |
| | 100 Hz | 19800 | Yes | Yes |
| | 200 Hz | 39600 | Yes | Yes |
| | 600 Hz | 118800 | No | Yes |

**Note that 600 Hz Data Mode requires 921600 baud. By default, units are set to 921600 baud and Glamr defaults to communicating at 921600 baud.**

After power cycling the INS/GPS, the unit will resume normal functionality.

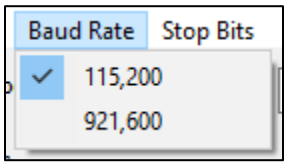



*Figure 11 Baud Rate menu*

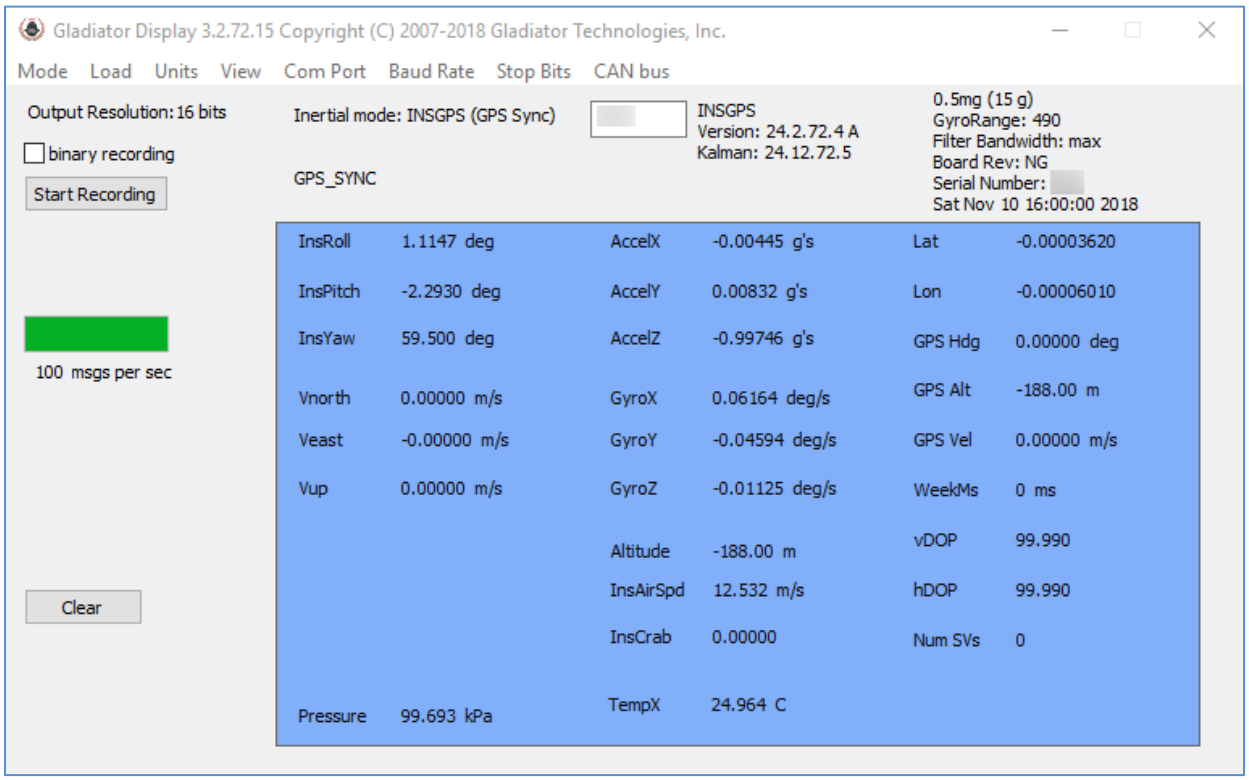



*Figure 12 INS/GPS data in Run Mode at 100 Hz data rate (unit stationary)*

The message “Msg out-of-sequence: exp XX, act YY” indicates that the program saw a skip in the message count, where XX and YY can be any integer value. This case can happen at start-up and can be ignored.

## 4.5 *Program Mode & Run Mode*

The SDK converter box provides a switch to select either “RUN” mode, or “PROGRAM” mode (Figure 13). These modes indicate which RS-485 serial pair you are communicating with (see datasheet for pinout details).

In RUN mode, the host is expected to only be receiving data from the INS/GPS.

In PROGRAM mode, the host can both send and receive data to/from the INS/GPS. This mode should be used to change communication parameters, as well as for loading/changing coefficient parameters.

## 4.6 *Self-Test in Glamr*

Glamr includes a self-test function. The user can initiate the Self-Test by the button (Figure 13), found on the switch box that is included in the INS/GPS SDK.

Press the button to activate a self-test of the sensors. The Glamr display will now show "Self-Test" is activated while also showing the data outputs. This message is located just above the data rate status bar. User should see a delta change in the X, Y, and Z sensor outputs per the data sheet (Figure 14) when Self-Test is initiated.

Note: If the simulated GPS 'outage' time is specified as *'-1'* then the self-test button will function as a cutout for the GPS signal when pressed, and will no longer affect the sensor outputs.

Refer to the INS/GPS datasheet to see typical activated sensor values.


*Figure 13 Self-Test, Power, and Run/Program*

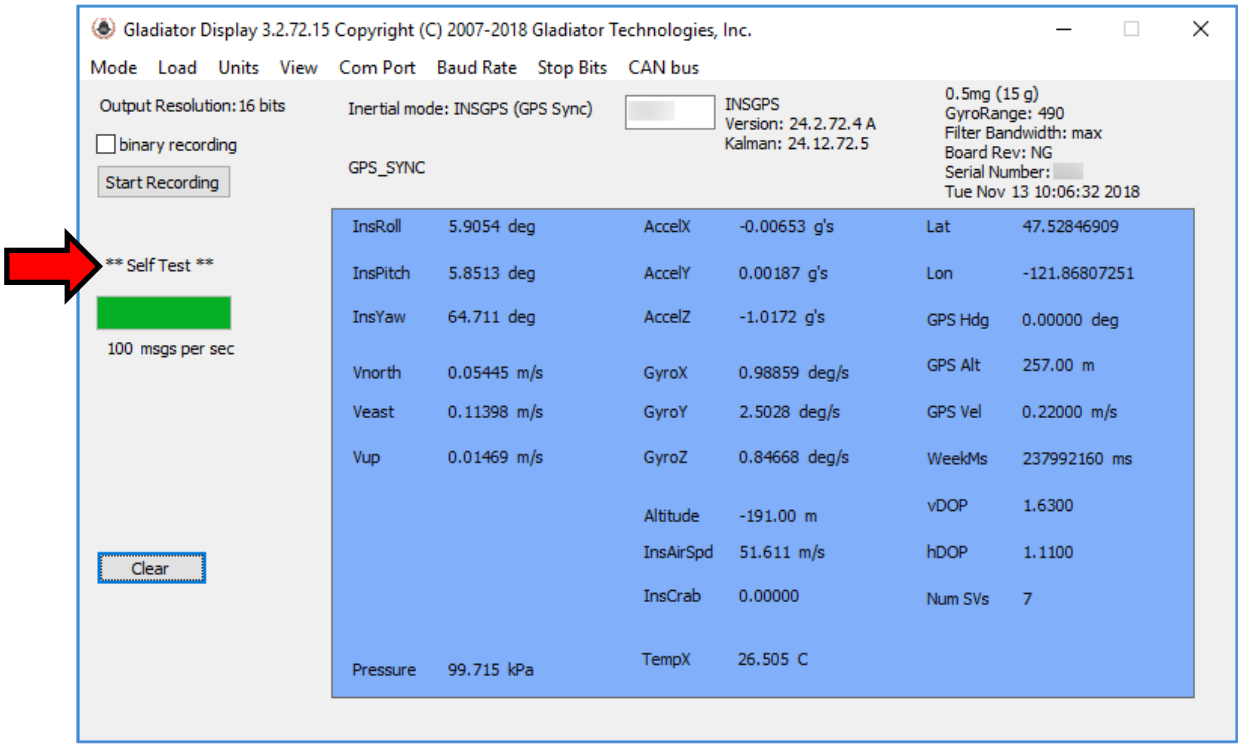



*Figure 14 Self-Test display when activated*

## 4.7 *Setting the Data Rate*

*The SDK must be set to "PROGRAM" mode to enable changing this field.* Glamr enables the user to quickly adjust the data rate. This feature is found in the Mode menu as shown in Figure 15. Raising or lowering the data rate determines how frequently data is sent from the unit to the host. Lower rates will benefit from additional sample averaging.

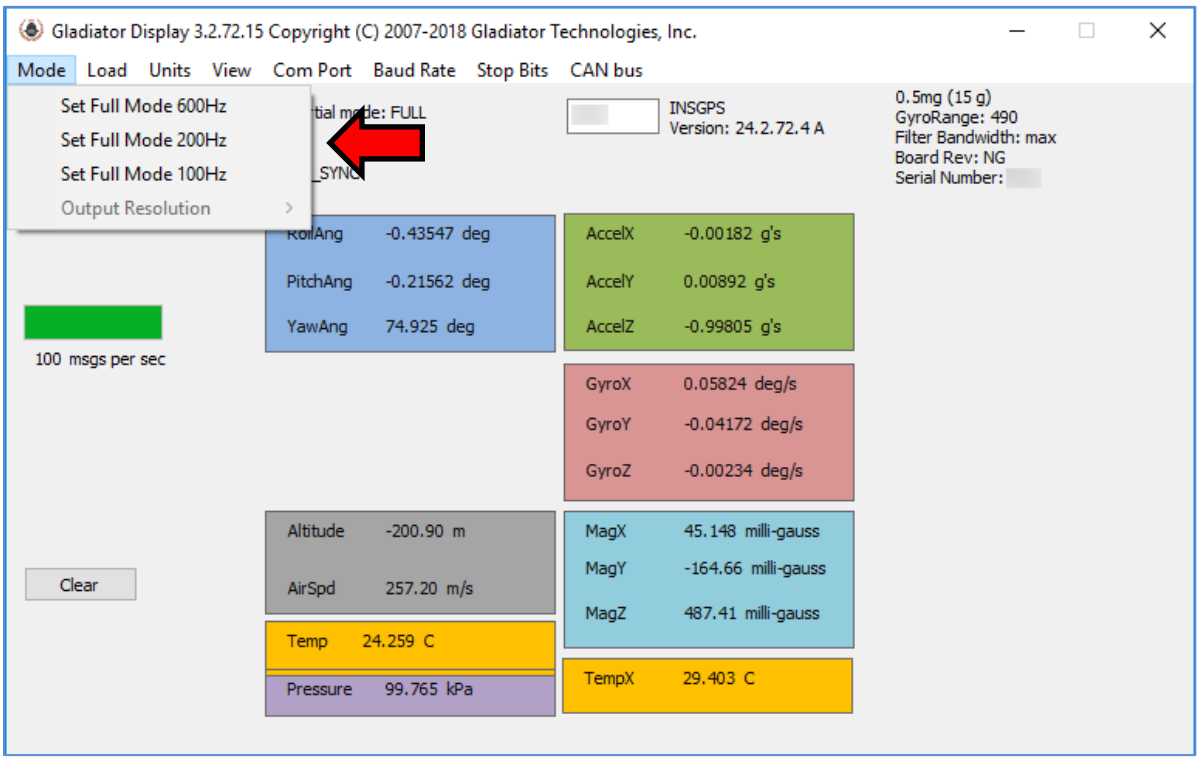



*Figure 15 Mode selection/data rate in "PROGRAM" mode*

## 4.8 *Select Applicable Stop Bits*

*The SDK must be set to "PROGRAM" mode to enable changing this field.* When using the INS/GPS, the number of stop bits is one or two as selected by the user. This can be chosen in the Stop Bits drop-down menu and selecting either 1 or 2 per Figure 16. The SX series default is a single Stop Bit.

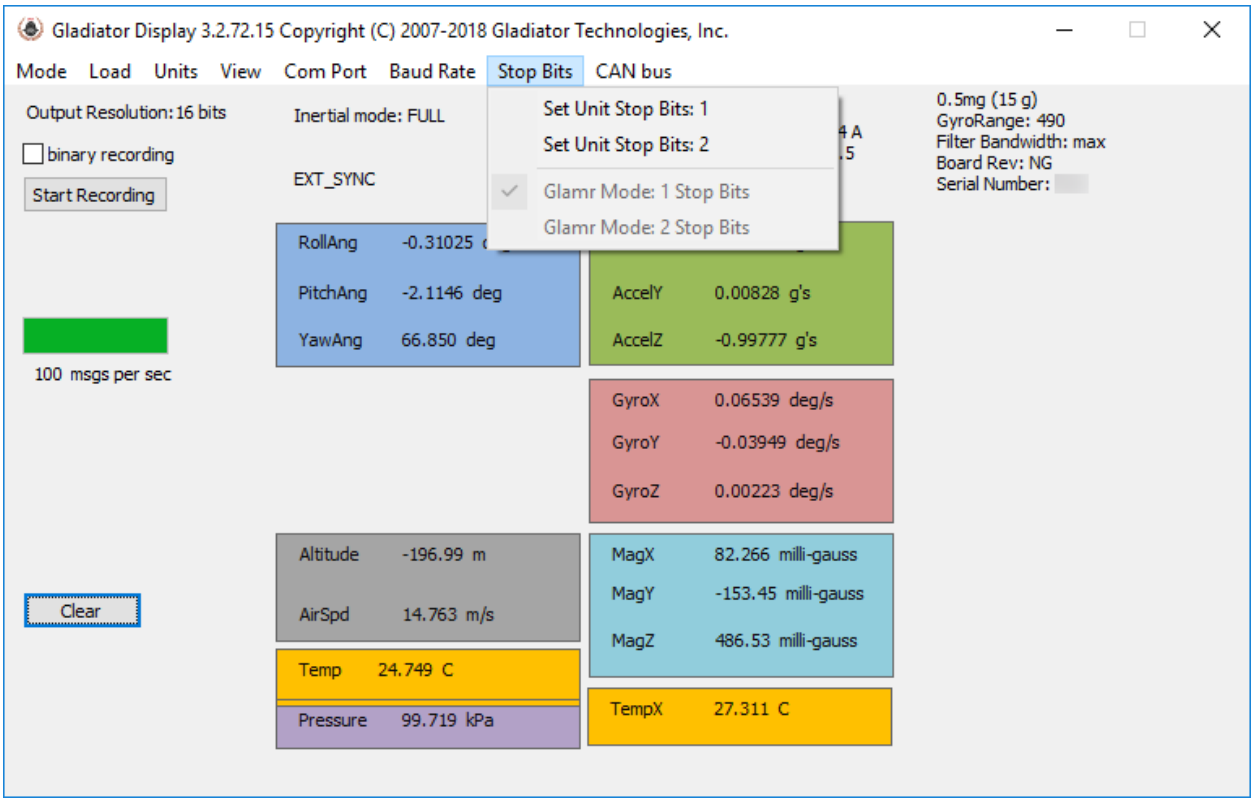



*Figure 16 Stop bit selection in "PROGRAM" mode*

## 4.9 *Sensor Display Options*

The SDK software can also set the dimensional units of the display. This is selected under Units, as seen in Figure 17-Figure 18.

**Note: This is only a cosmetic feature. The dimensional units from the device cannot change.**

### 4.9.1 *Gyroscope Unit Selection*

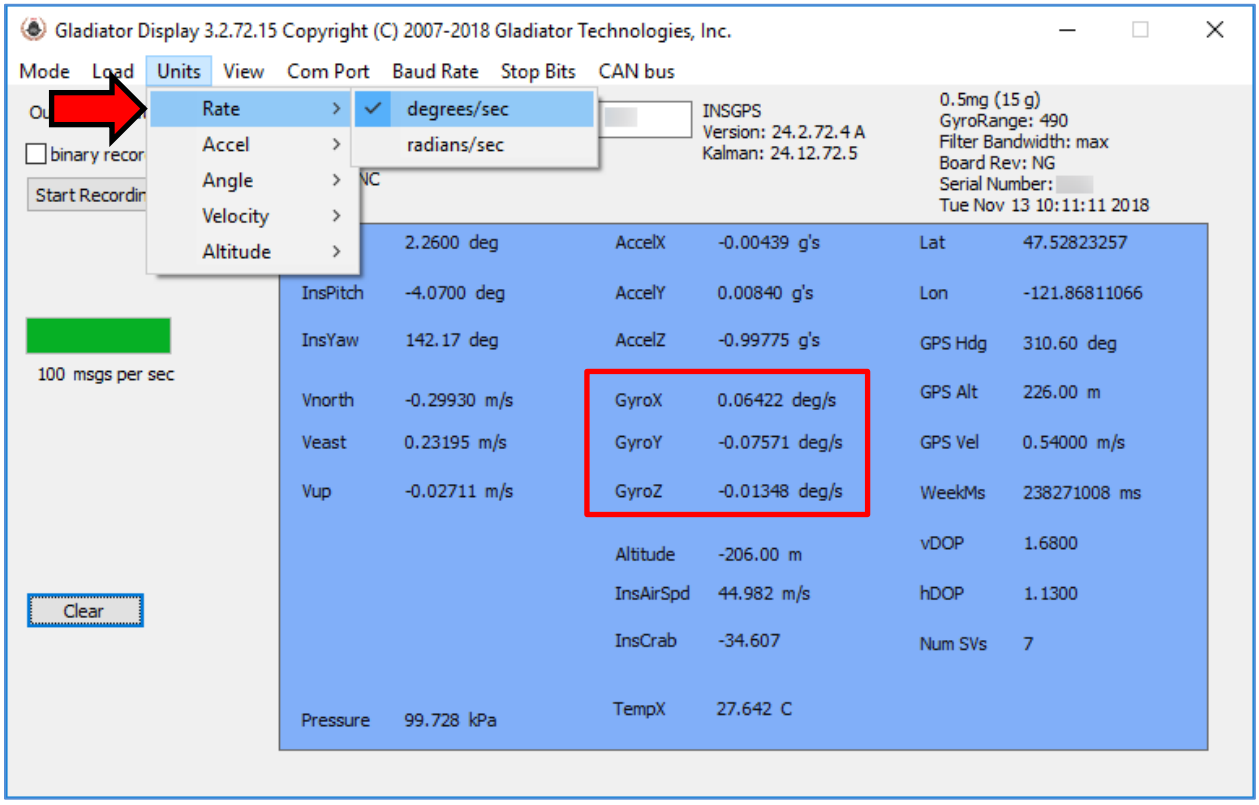



*Figure 17 Gyroscope units of measure selection options*

## 4.9.2 *Accelerometer Unit Selection*

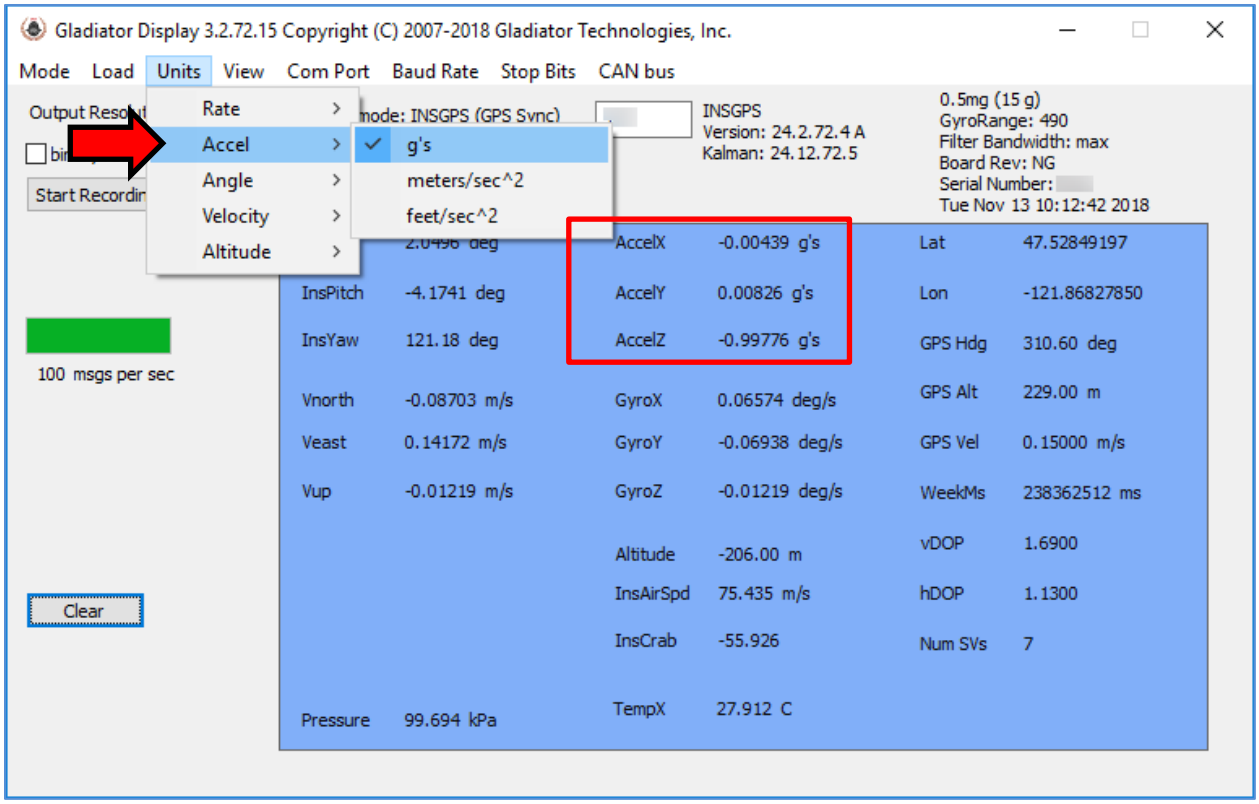



*Figure 18 Accelerometer units of measure selection options*

## 4.10 *Programming Coefficients*

*The SDK must be set to "PROGRAM" mode to enable changing this field.* The SDK software provides users with a display of certain coefficients stored in flash. These coefficients are used internally to modify various aspects of the INS/GPS performance. Modifying these parameters can have a dramatic impact on the output of the device.

**A password will be required to access some of these parameters.**

**Please consult Gladiator Support before changing the locked parameters.**

**Please refer to the Software Reference Manual for more detail about the individual parameters.**

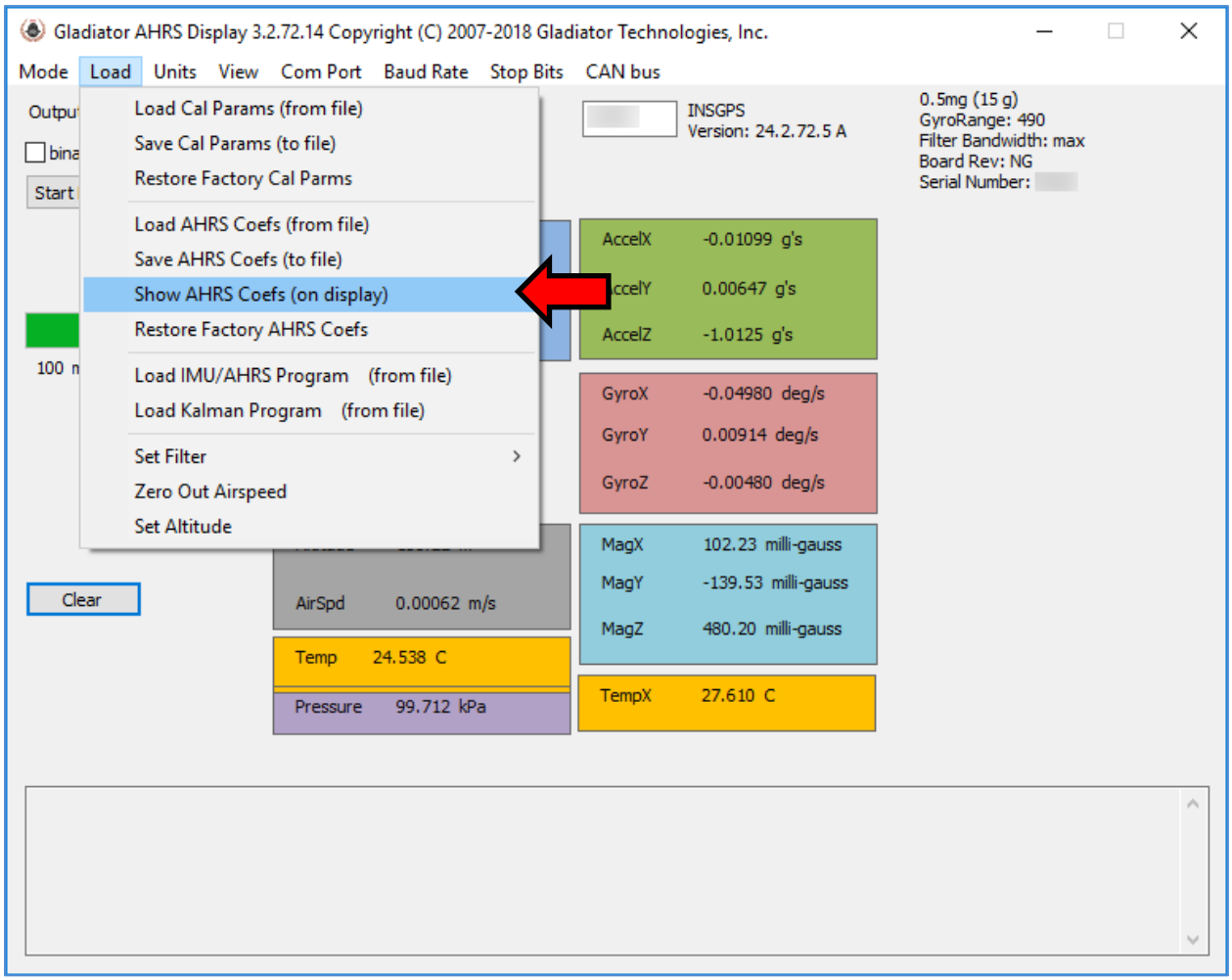



*Figure 19 Accessing the coefficient dialog in "PROGRAM" mode*

### 4.10.1*AHRS Parameters*

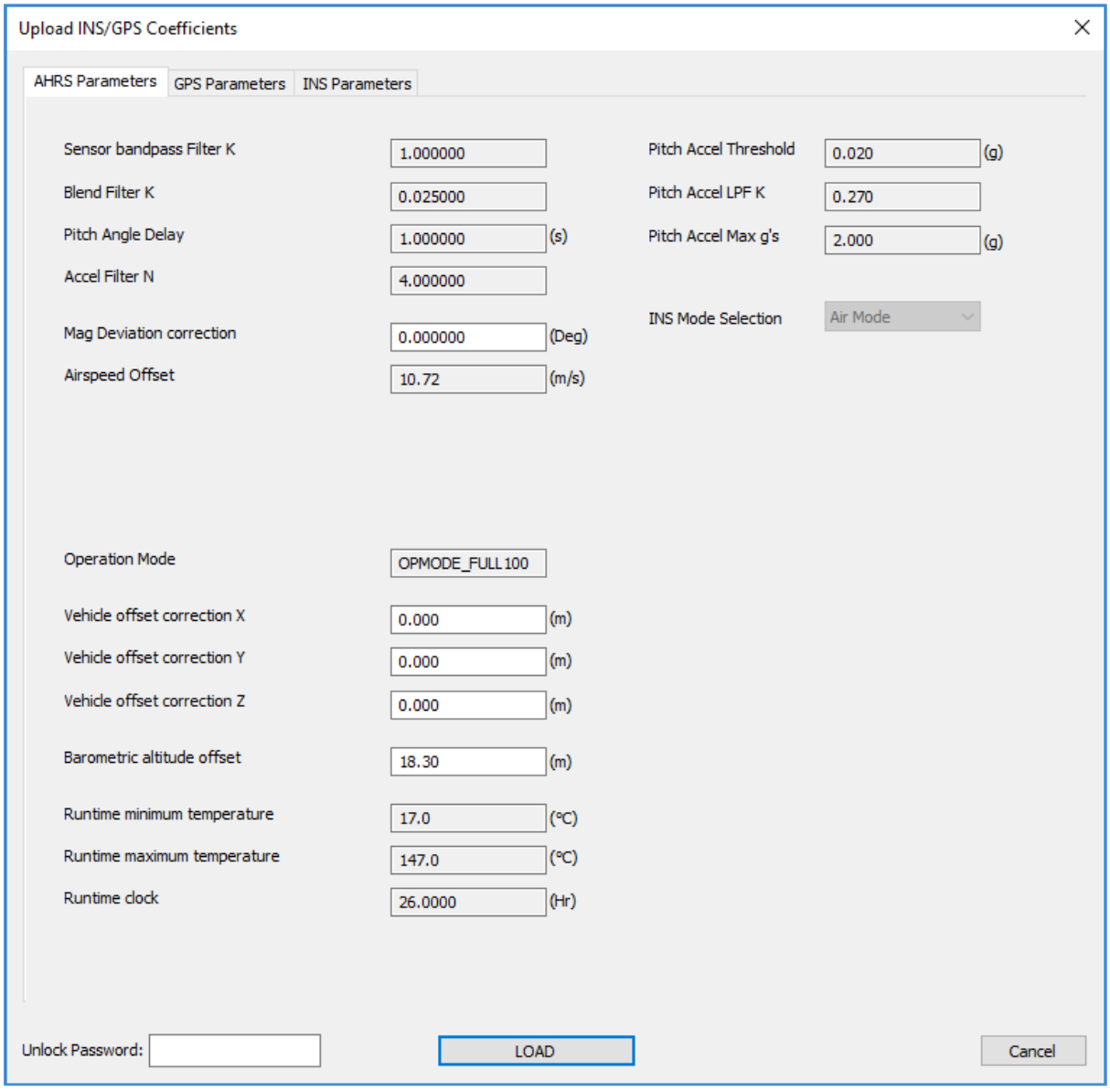



*Figure 20 AHRS coefficient parameters*

The most common AHRS parameters to change for proper operation are the *vehicle offset correction* values, and *barometric altitude offset.*

## 4.10.2*GPS Parameters*

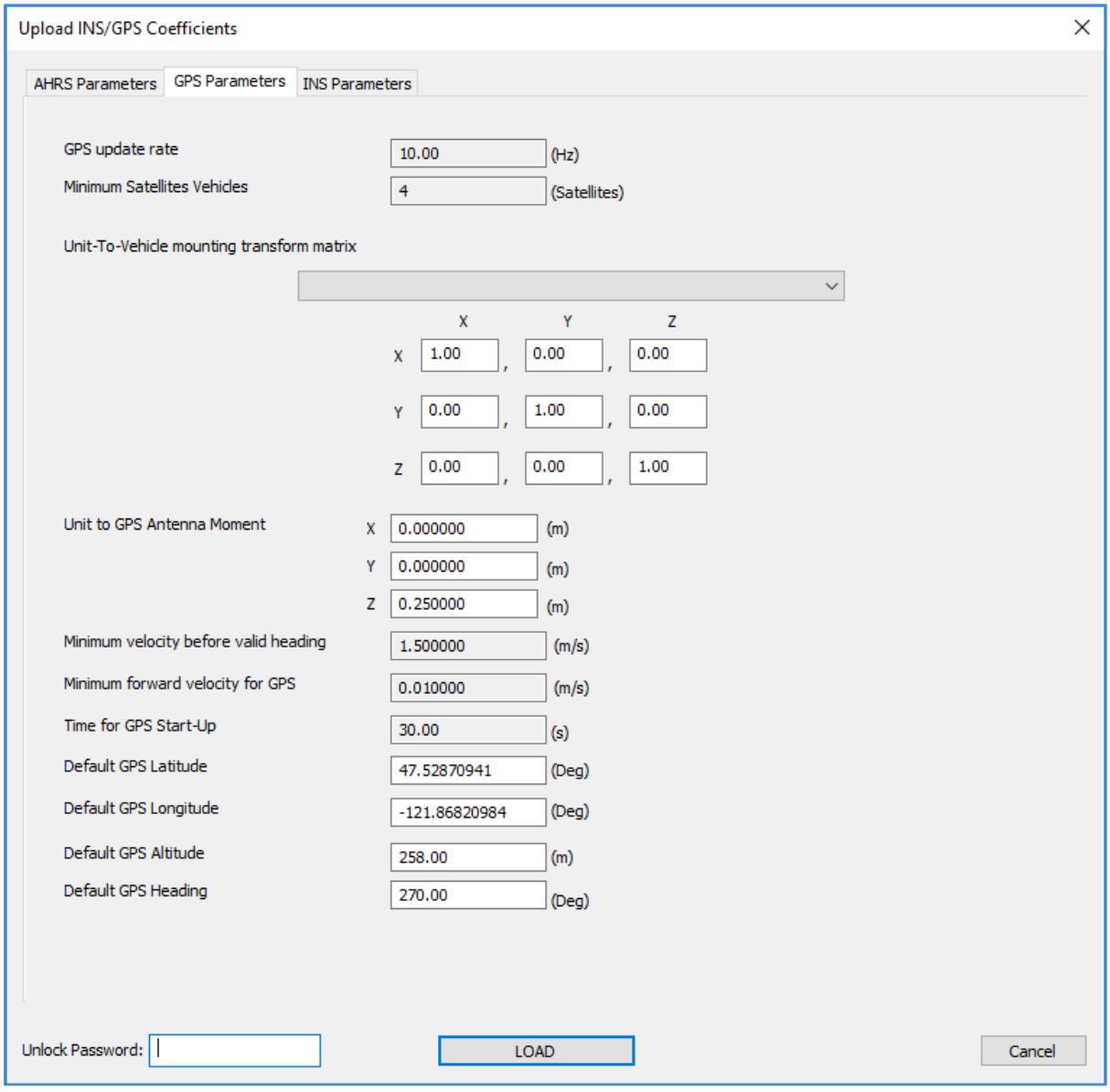



*Figure 21 GPS coefficient parameters*

The most common GPS parameters to change for proper operation the *unit to GPS antenna moment* values, and the *default GPS* values.

### 4.10.3*INS Parameters*

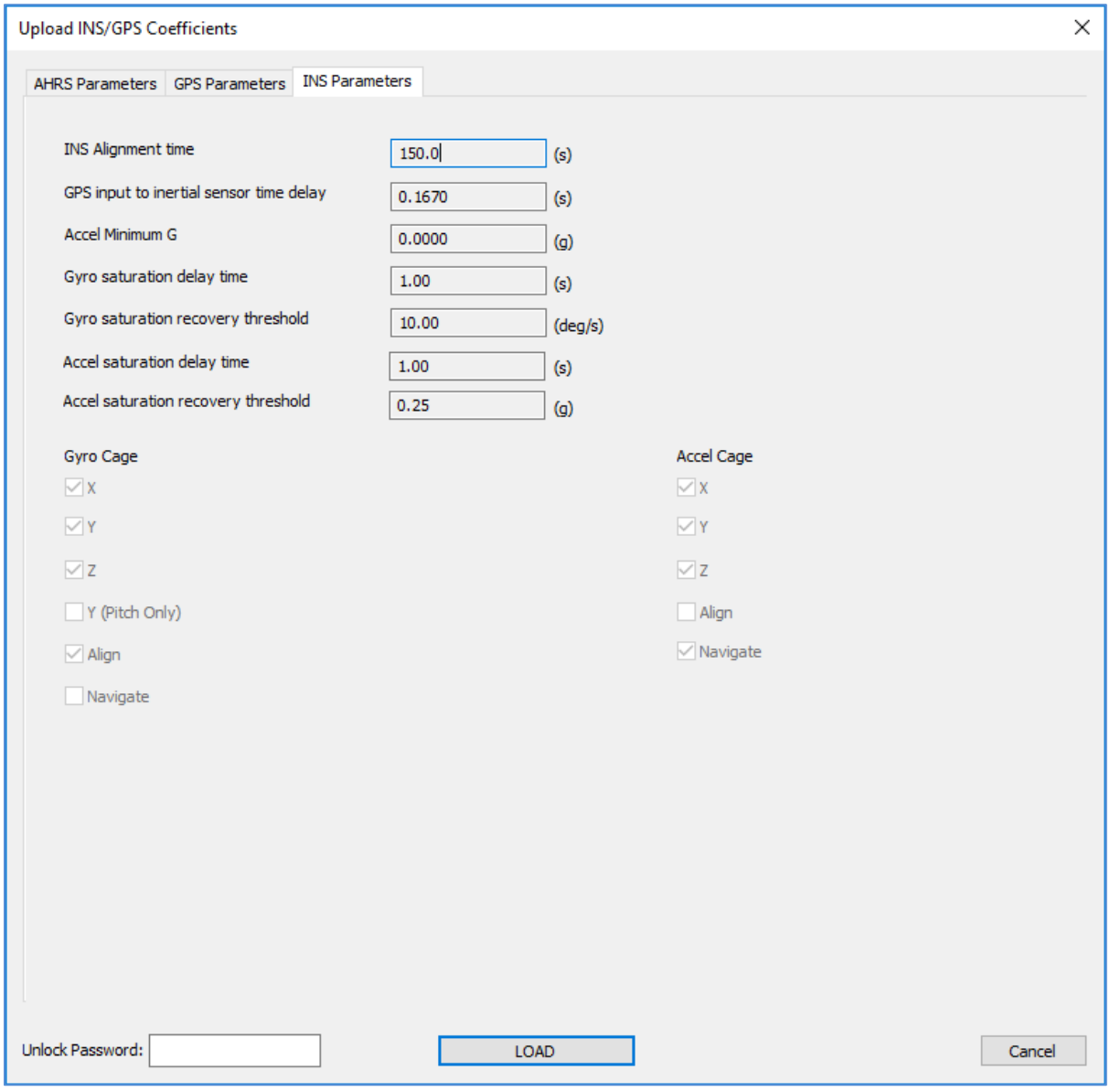



*Figure 22 INS coefficient parameters*

The INS parameters should not need modification for proper operation. Especially without consulting Gladiator Technologies Support.

## 4.11 *Data Record Feature*

The SDK software also has a data record feature that captures data outputting from the INS/GPS and puts it into .csv format. This enables the user to easily convert these data files to Excel or database format. The user should click the Start Recording button (Figure *23*) to initiate the data record function.

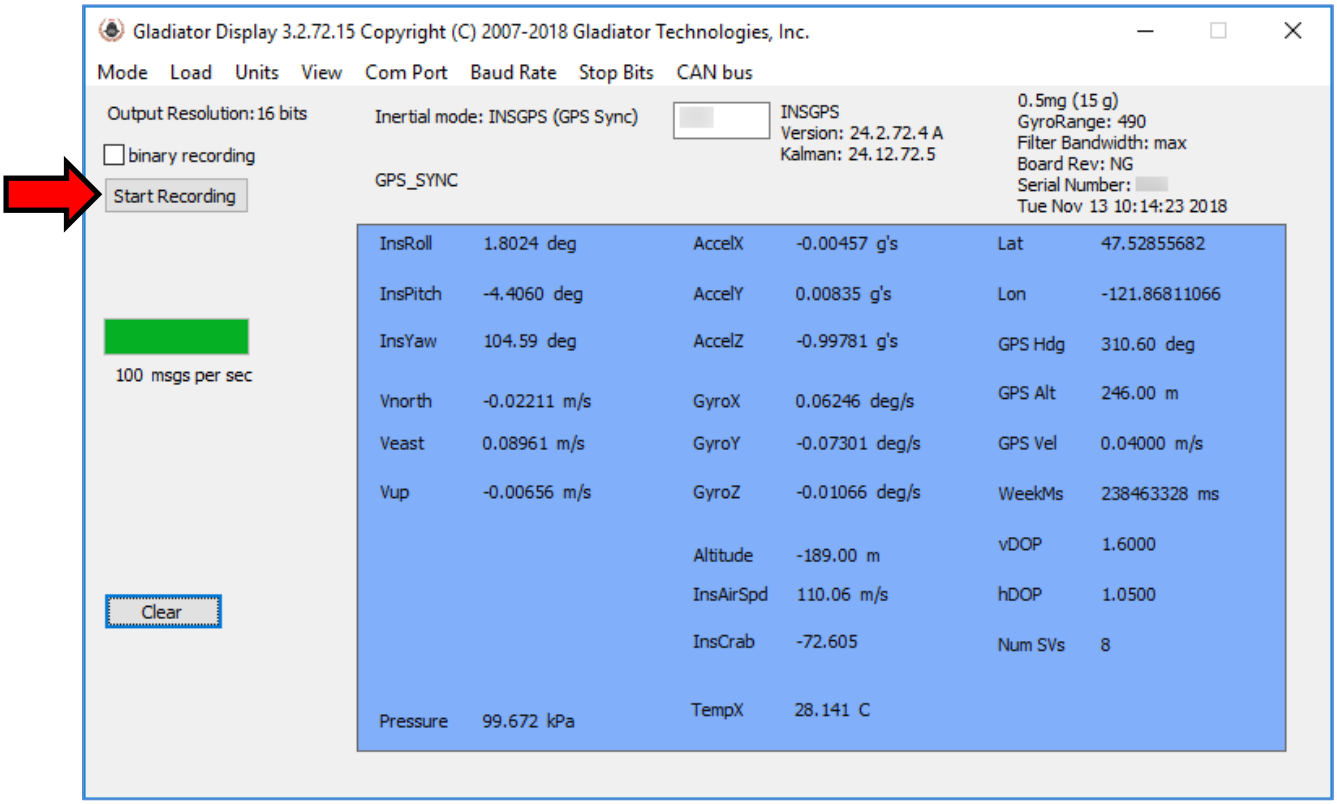



*Figure* 23 *Data Recording button*

After selecting "Start Recording," Glamr will prompt the user to designate a filename and location before the beginning the recording. Note that writing to pre-existing filename will **not** append the data and instead overwrite it with the new recording. At this prompt, click Open as shown in Figure 24. After the filename and location are selected, click the desired length of time to record then click OK.

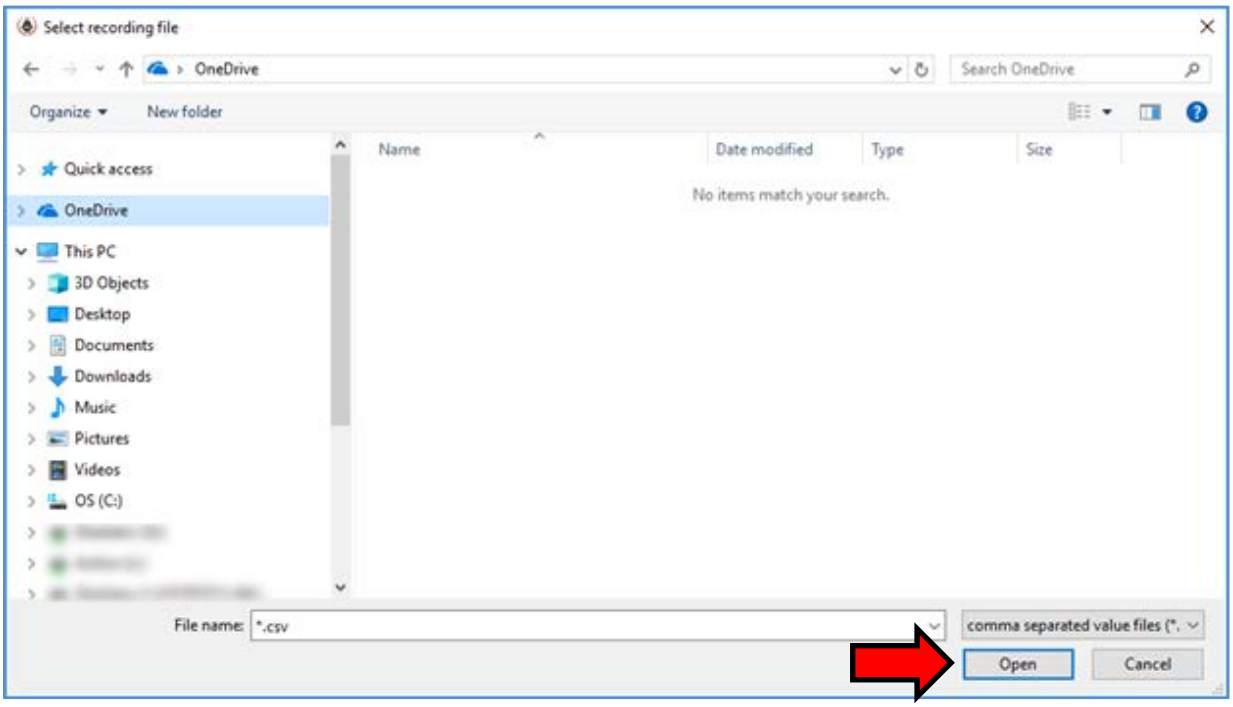



*Figure 24 Saving recorded data files*

If a recording time was specified by the user, the time remaining will appear below the Start Record button. To stop recording, simply click the “Stop Recording” button.

## 4.12 *Troubleshooting with Messages*

If you are experiencing difficulties interfacing the INS/GPS to your system, Glamr can be commanded to display messages to and from the unit in the message window. This is done via the View menu per Figure 25.

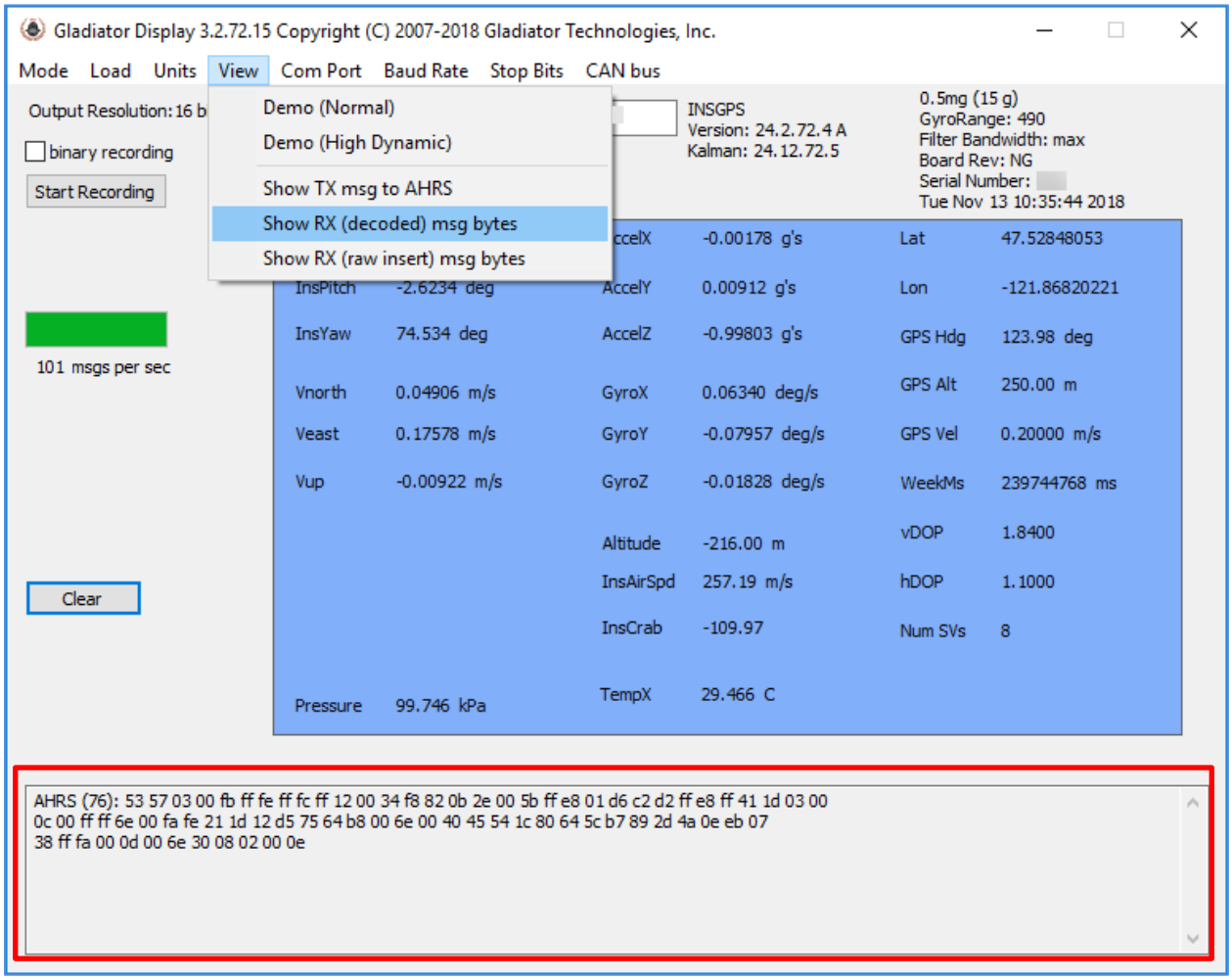
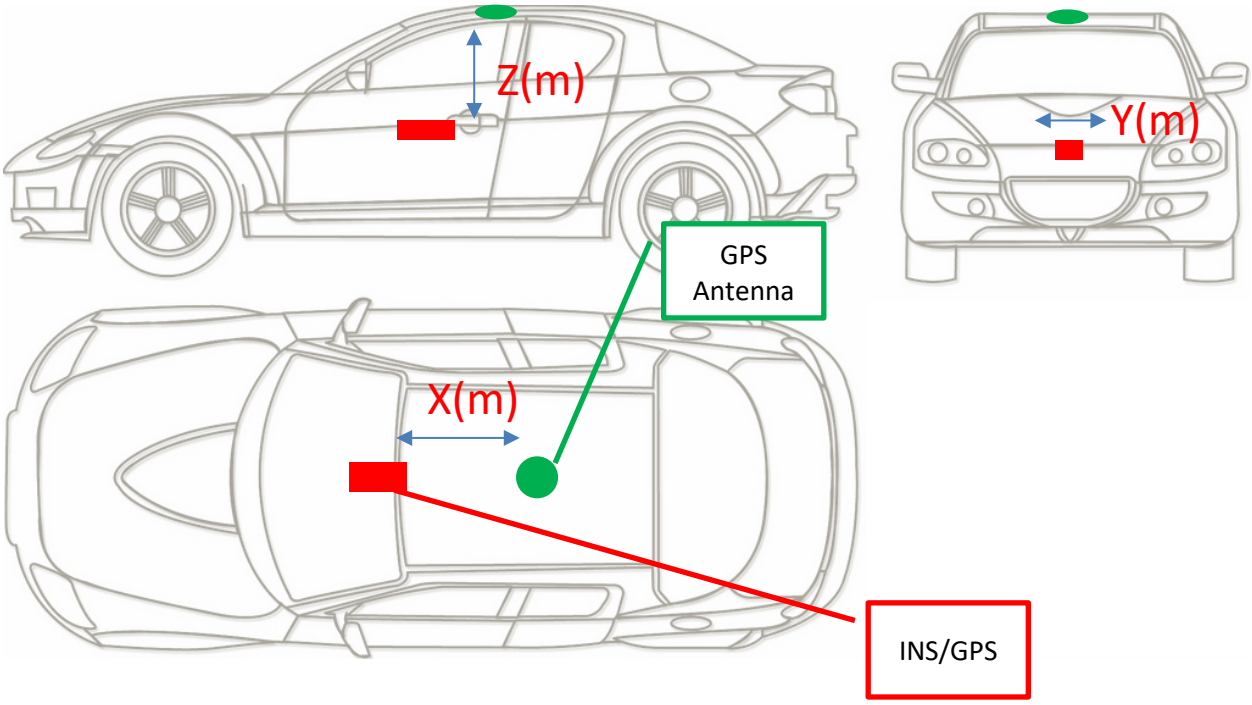



*Figure 25 Message options for troubleshooting (View menu)*

## 4.13 *Setting Up INS/GPS For Evaluation*

Prior to testing the INS/GPS, the user should identify the mounting position and orientation of the unit and the GPS antenna. Take note of the parameters (X, Y, Z) shown below:




Set the unit to PROGRAM mode.
Set the AHRS coefficients to match appropriately (4.10). Mainly the unit to GPS antenna moment values. If the unit is placed away from the vehicle center of rotation, then the vehicle offset correction values should also be set.

Before starting testing, set the default latitude, longitude, altitude, and heading (4.10.2). Set the current altitude with Glamr, or set the barometric altitude offset such that the displayed barometric altitude represents the current altitude.

Switch the unit to RUN mode, and cycle unit power to start the INS/GPS alignment process.

## 4.14 *Alignment Initialization of the INS/GPS*

Before powering the unit ON, follow these steps:

- Make sure the unit is on a stable surface and will not be moved during initialization
- Ensure the SDK is switched to “RUN” mode

Open Glamr and power the unit ON. Glamr will display that it is beginning an alignment process. The unit must not be moved during the INS initialization as during this period the INS Coordinate frame is being established. Moving the unit during this two-minute initialization period will result in permanent angle output errors until the user cycles power and re-initializes the unit. You also open the Attitude Indicator on initial application open to observe the stability of the unit during this period by going to “View” > “Demo”.

After approximately two-minutes (user-configurable) Glamr will indicate that alignment has completed. In addition, the attitude indicator should be flat and indicate no roll or pitch error if on a flat stable surface.


*Figure 26 INS Alignment initialization output with AHRS attitude demo display*

**Note: The INS/GPS can be externally commanded to restart the alignment initialization process while in PROGRAM mode. More details about this command can be found in the Software Reference Manual.**

## 4.15 *RTK-Enabled Devices*

Gladiator Technologies' INS systems that have RTK capability enabled can leverage the additional information to provide a more precise GPS solution. RTK input can be supplied to these INS systems via a differential serial input with the following protocol specifications:

- RS-485 Differential input
- 115200 baud, 8 data bits, 1 stop bit, no parity
- RTCM3 format

When a valid RTK signal is detected and an RTK update is delivered to the system, the INS will flag this in the status byte. This can also be observed with Glamr to confirm a valid RTK input.

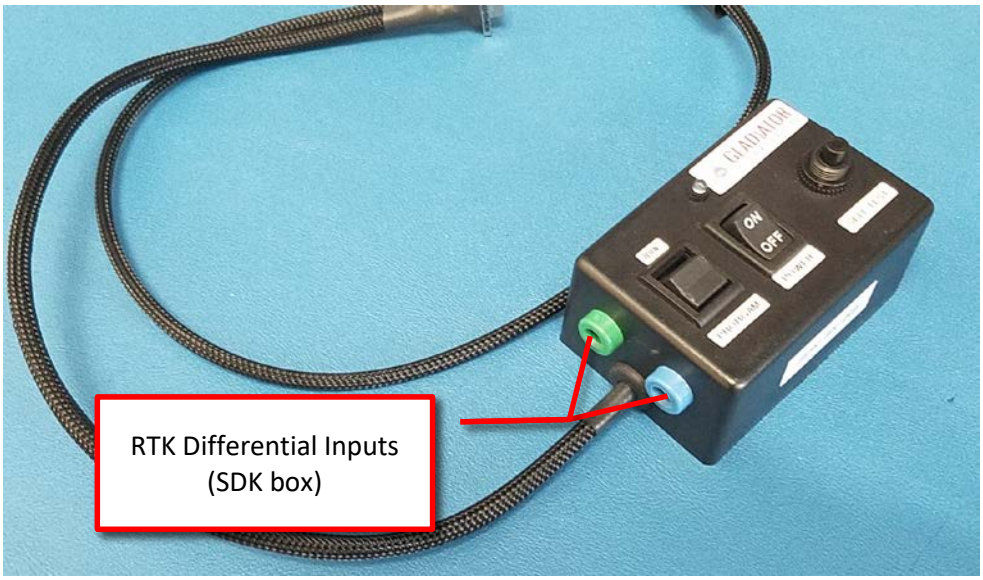



*Figure 27 Differential RTK inputs on SDK box*

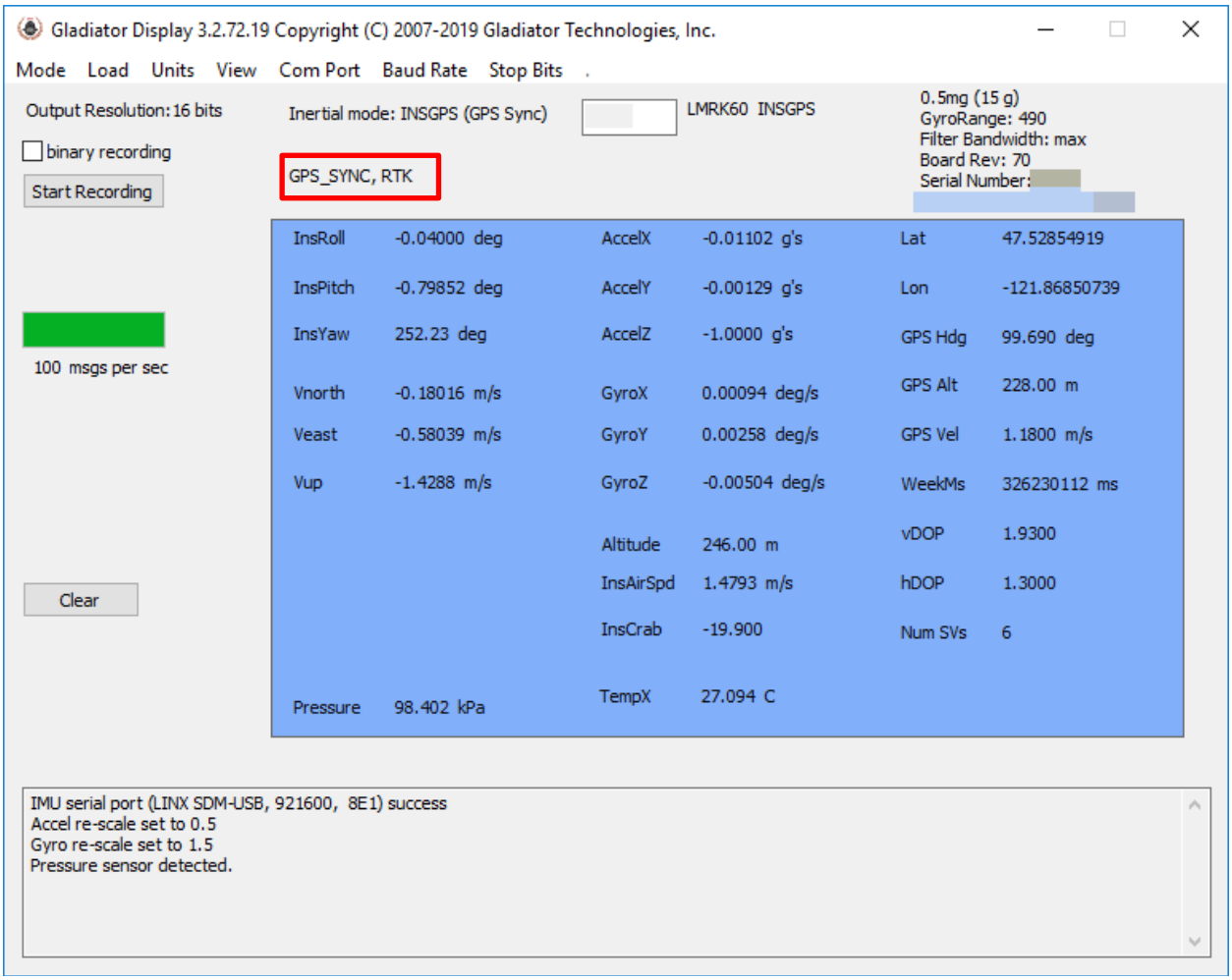



*Figure 28 Glamr displaying a valid RTK input has been detected.*

## 4.16 *Trouble-shooting Common Setup Errors*

**Do NOT move the unit during INS alignment initialization!**

The most common setup error is moving the unit or significantly bumping the unit during INS Alignment Initialization. If the unit is rotated it will corrupt the INS Coordinate Frame and as a result give you a permanent angle error even after INS Navigate has been confirmed.

If a problem is detected during alignment initialization the unit will report an "alignment error" in the status byte. see the Software Reference Manual for more details. Glamr will also display an alignment error message if this is reported in the status byte.

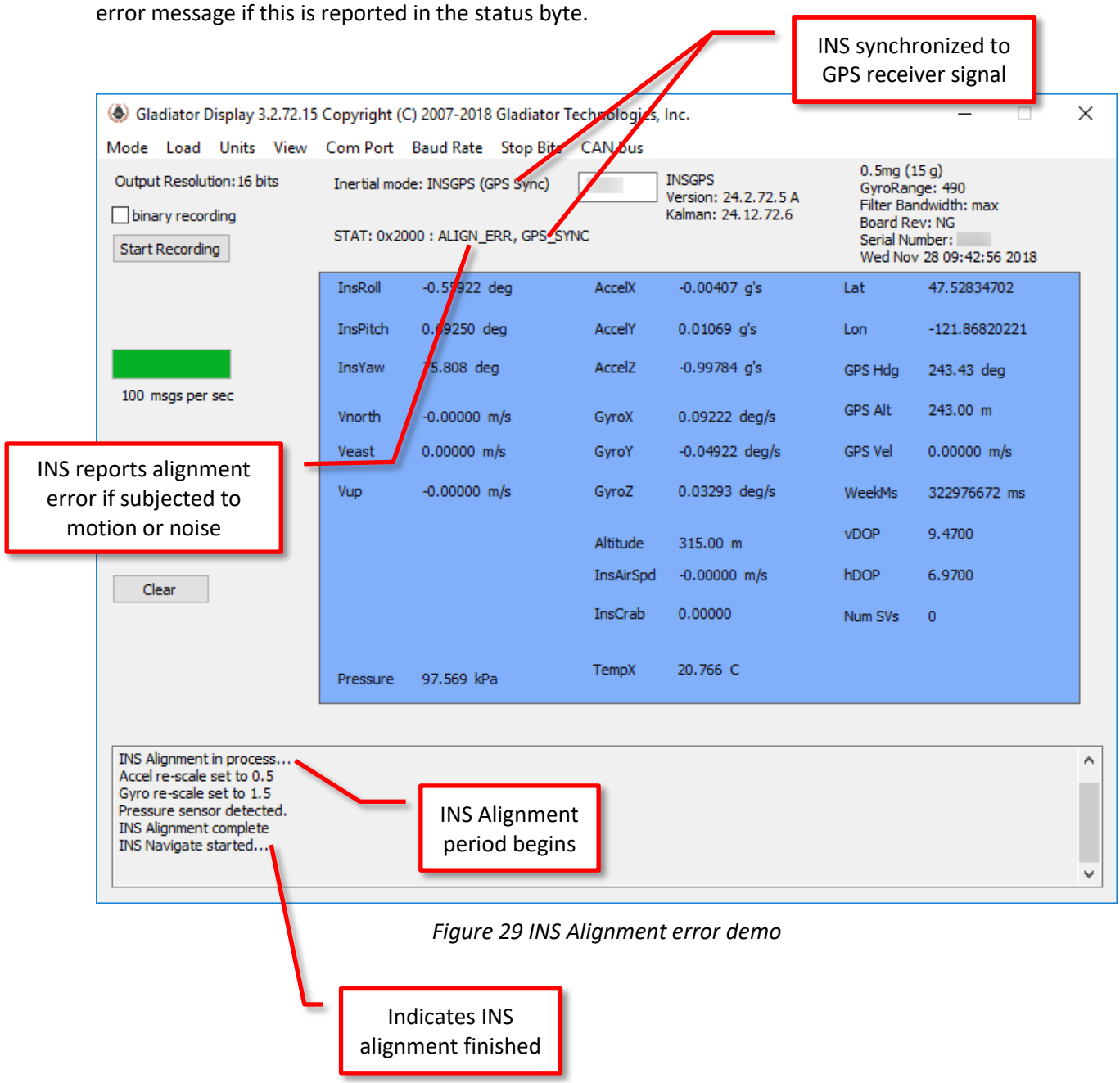



*Figure 29 INS Alignment error demo*

# 5 PATENT AND TRADEMARK INFORMATION

All Gladiator Technologies SX Series INS/GPS devices are newly developed units containing significant intellectual property and are expected to be protected by United States of America (USA) and other foreign patents pending. LandMark™ is an official and registered Trademark that identifies Gladiator Technologies brand name for our digital inertial and integrated GPS systems products.

# 6 APPLICABLE EXPORT CONTROLS

LandMark INS/GPS have been self-classified by Gladiator Technologies with pending Commodity Classification by the U.S. Department of Commerce under the Export Administration Regulations (EAR), as ECCN7A994 and as such may be exported without a license using symbol NLR (No License Required) to destinations other than those identified in country group E of supplement 1 to Part 740 (commonly referred to as the T-5 countries) of the Export Administration Regulations. Items otherwise eligible for export under NLR may require a license if the exporter knows or is informed that the items will be used in prohibited chemical, biological, or nuclear weapons or missile activities as defined in Part 774 of the EAR. Copies of official U.S. Department of Commerce Commodity Classifications are available upon request.

# 7 USER LICENSE

Gladiator Technologies grants purchasers and/or consignees of Gladiator INS/GPS a no-cost, royalty-free license for use of the following software code for use with Gladiator INS/GPS. Companies or persons not meeting the criteria as a purchaser or consignee are strictly prohibited from use of this code. Users in this category wanting to use the code may contact the factory for other user licensing options.

# 8 STANDARD LIMITED WARRANTY

Gladiator Technologies offers a standard one-year limited warranty with the factory's option to either repair or replace any units found to be defective during the warranty period. Opening the case, mishandling or damaging the unit will void the warranty. Please see Gladiator Technologies' Terms & Conditions of sale regarding specific warranty information.

# 9 QUALITY MANAGEMENT SYSTEM

Gladiator Technologies' Quality Management System is third party certified to AS9100 Requirements for Aviation, Space and Defense (latest revision). To view our current certificate please go to www.gladiatortechnologies.com or www.lkdaerospace.com.

# 10 THEORY OF OPERATION

Currently, Gladiator INS/GPS devices support:

- Digital 6 DOF MEMS INS/GPS that outputs x-, y-, and z-axis angular rates, x-, y-, and z-axis linear acceleration data, temperature, x-, y-, and z-axis magnetometer data, barometric pressure, AHRS roll, pitch, and yaw angles, GPS VDOP & HDOP, North/East/vertical velocities, INS roll, pitch, and yaw angles, INS crab angle, INS airspeed, Latitude, Longitude, GPS time, baro altitude, GPS altitude, GPS velocity, GPS heading, and number of satellites vehicles (SV).

- Utilizing Gladiator's proprietary thermal modeling process, these INS/GPS units are fully temperature compensated, with temperature-corrected biases and scale factors, plus corrected misalignment and g-sensitivity.

**INS/GPS Features:**

- The RS-422/485 serial digital interface provides serial data outputs enabling the user to monitor the outputs during use. Internal sampling is done at 4.8 kHz. Over-sampling is done on the INS/GPS inertial sensors at 2X when set at 100 Hz and then averaged to improve the noise of the MEMS sensors. The nominal output rate in the INS/GPS is 100 Hz ±5%. An RS-422/485 to USB converter is available in Gladiator's INS/GPS Software Development Kit (SDK) to enable a quick INS/GPS to PC integration.

- Three MEMS gyro signals with active filtering and over sampling when set at 100 Hz with a 16-bit A/D converter. Gladiator INS/GPS units are available in the following standard gyroscope ranges:
    - ±490°/sec

- Three MEMS accel signals with digital filtering and oversampling when set at 100 Hz with a 16-bit A/D converter. Gladiator INS/GPS units are available in the following standard accelerometer ranges:
    - 15g

- The internal temperature sensors outputs are over sampled when set at 100 Hz with a 16-bit converter. These temperature measurements are co-located with the x-, y-, and z-axis INS/GPS to enable accurate temperature compensation of the INS/GPS outputs. The x gyro (XGYR) temperature is reported to the user.

- The calibration process measures temperature at a minimum of five set points from -50°C to +85°C and a nine-point correction table is generated that identifies temperature-based offsets for each of the INS/GPS data sets.

- Though a precision orthogonal mounting block is used in testing LandMark™ INS/GPS units, misalignment error correction is also essential in enabling high performance navigation from a MEMS inertial sensor assembly. The calibration process also corrects and compensates for internal misalignment errors for all sensors in all three axes.

- G-sensitivity errors associated with the INS/GPS devices are also modeled and calibrated to correct these performance errors associated with acceleration inputs in all three INS/GPS axes.

- All calibration data is loaded into an internal memory EEPROM enabling a look-up table for thermal modeling correction of the outputs during use.

LandMark INS/GPS datasheets are available via download on our website. The latest version of all documentation can be found on the Gladiator Technologies website at www.gladiatortechnologies.com. Copies of the User's Guides are available upon request at support@gladiatortechnologies.com.

The LandMark INS/GPS SDK software design enables updates to the INS/GPS interface. As these software enhancements and upgrades become available, Gladiator will make these available to our INS/GPS customers.

# 11 LandMark INS/GPS PRODUCT DESCRIPTION

Designed for commercial stabilization and aircraft applications, the LandMark INS/GPS is ideal for commercial applications requiring high inertial performance approaching "small RLG or open loop FOG-Class," yet available at a much lower cost. Other key advantages include low power consumption, small size, light weight, and no inherent wear out modes for long life. The signature features of the LandMark INS/GPS are the exceptionally low noise and bias performance.

The unit is environmentally sealed in a rugged enclosure and has a MIL-SPEC connector to withstand environmental vibration and shock typically associated with commercial aircraft requirements. LandMark INS/GPS units are well suited for demanding commercial applications including: rail track telemetry, navigation, flight control, precision imaging, platform and antenna stabilization, flight testing, and laboratory use.

For the exact specifications of your INS/GPS, please refer to the datasheet on the website.

## 11.1 *Outline and 3D Solid Models*

Please visit the product page of your INS/GPS on the Gladiator website at http://www.gladiatortechnologies.com/gps-aided/. Here you can download the 3D Solid Model, 2D outline drawing, and other product information.

## 11.2 *Center of Gravity*

Some applications need to know the center of gravity (CG) of the package. Please refer to the mechanical drawing for details.

## 11.3 *Sensor Bandwidth*

The bandwidth of a typical Gladiator sensor can be seen in Figures 30-31. The maximum bandwidth of our gyroscopes is 250 Hz (Figure 29) and the maximum bandwidth of our accelerometers is 1100 Hz (product dependent). To verify these values, we collect one minute of data at 2500 Hz, then perform a Fast Fourier Transform and plot the result.

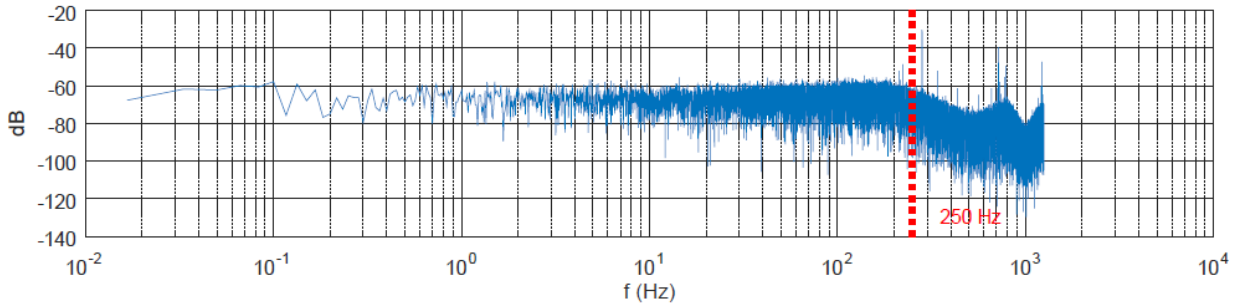



*Figure 30 Typical gyroscope bandwidth (250 Hz) of LMRK005 INS/GPS*

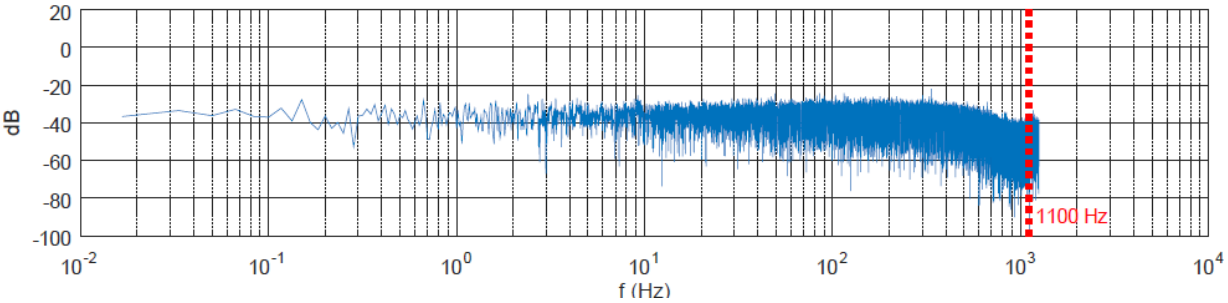



*Figure 31 Typical accelerometer bandwidth (1100 Hz) LMRK005 INS/GPS*

## 11.4 *INS/GPS Block Diagram*

Gladiator INS/GPS units have internal functionality which can be represented with a block diagram. Figure 31 is a high-level representation of the INS/GPS.

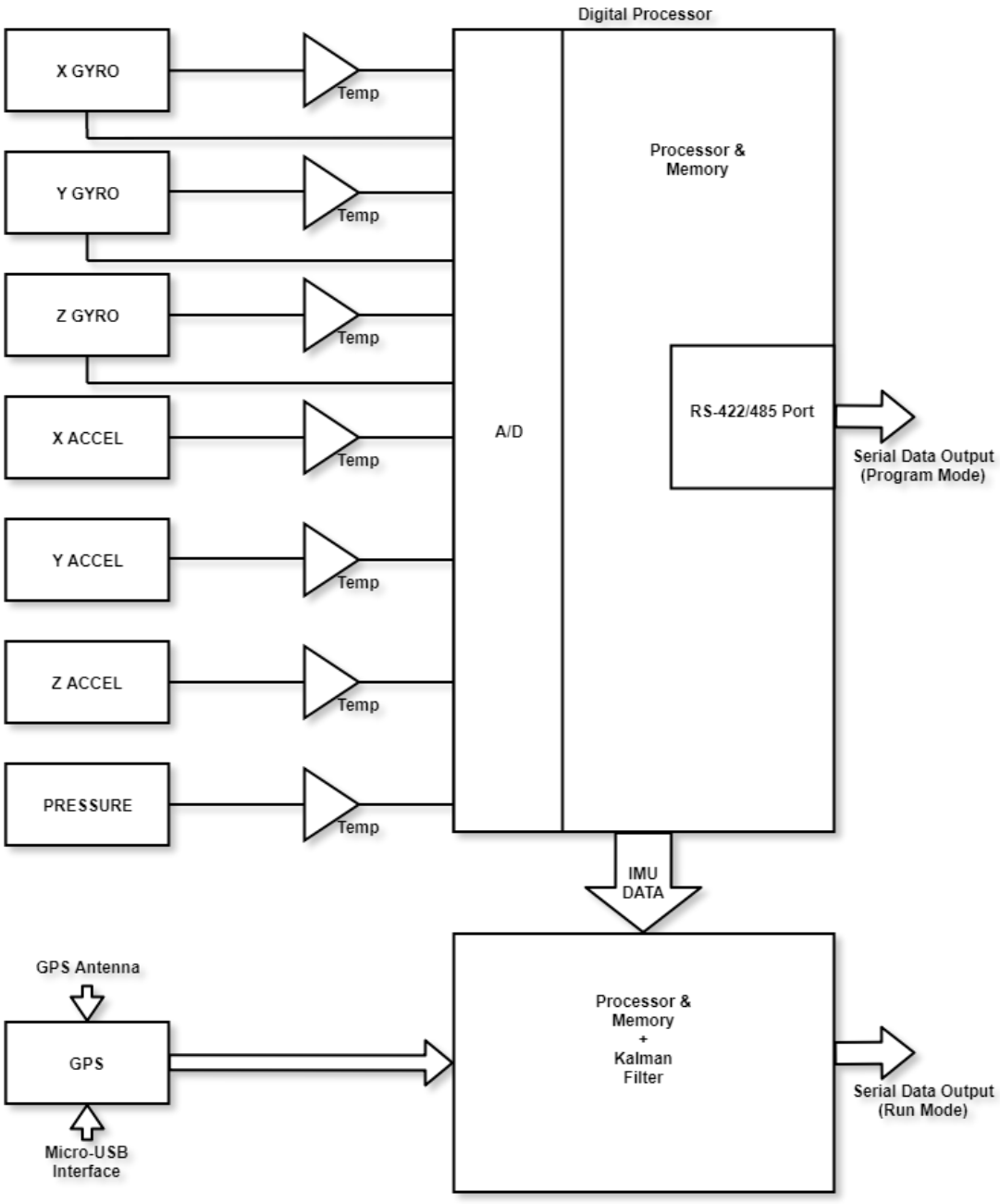



*Figure 32 INS/GPS block diagram*

# 12 INS/GPS MESSAGE PROTOCOL

## 12.1 *Serial Communication Settings*

INS/GPS units are shipped to the customer in a standard configuration of 921,600 baud (in 100 Hz FULL Mode) and 1 Stop bit.

| Parameter | Value |
|---|---|
| Bits/second: | 115200, 921600 |
| Start bits: | 1 |
| Data bits: | 8 |
| Parity: | E |
| Stop bits: | 1 or 2 (Selectable) |

*Figure 33 Serial communication settings values*

## 12.2 *INS/GPS Message Packet Format*

At power-up, the INS/GPS enters operational mode using the last commanded mode setting. **Please refer to the Gladiator Technologies Software Reference for additional information**.

## 12.3 *Sample Data Format*

Figure 33 provides a sample INS/GPS data format output in Excel.

| MSGCOUN | GYRX (°/s) | GYRY (°/s) | GYRZ (°/s) | ACCX (mg | ACCY (mg | ACCZ (mg | TEMPX (C | MAGX (m | MAGY (m | MAGZ (m | PRESSURE | ROLL (deg | PITCH (de | HEADING | GPS_VDO | GPS_HDO | INS_VNor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 1.53 | 0.19 | 1.03 | -77.5 | 72.5 | -1027.5 | 24.21 | 123 | -186 | 386 | 102.1 | 0.63 | -0.23 | 63.42 | 1.37 | 0.9 | 18.9 |
| 46 | -3.08 | 1.05 | 0.04 | 37 | -35 | -940 | 24.21 | 120 | -191 | 390 | 102.1 | 0.61 | -0.21 | 63.4 | 1.37 | 0.9 | 18.91 |
| 47 | 2.57 | -3.81 | 0.93 | -68.5 | 75 | -1065 | 24.21 | 114 | -194 | 392 | 102.1 | 0.63 | -0.25 | 63.4 | 1.37 | 0.9 | 18.86 |
| 48 | -2.71 | 1.1 | 0.18 | 37.5 | -84 | -966 | 24.21 | 110 | -190 | 387 | 102.1 | 0.6 | -0.23 | 63.39 | 1.37 | 0.9 | 18.91 |
| 49 | 2.22 | -1.11 | 0.75 | -65 | 74.5 | -1081 | 24.21 | 115 | -192 | 391 | 102.11 | 0.61 | -0.24 | 63.38 | 1.37 | 0.9 | 18.89 |
| 50 | -2.5 | 1.3 | 0.49 | 69.5 | -44.5 | -947.5 | 24.21 | 118 | -187 | 387 | 102.11 | 0.59 | -0.22 | 63.37 | 1.37 | 0.9 | 18.92 |
| 51 | 0.6 | -4.88 | 0.6 | -83 | 128 | -1110 | 24.21 | 118 | -184 | 383 | 102.11 | 0.58 | -0.27 | 63.35 | 1.37 | 0.9 | 18.86 |
| 52 | -0.36 | 3.9 | 0.3 | 7 | -114 | -917 | 24.21 | 120 | -186 | 383 | 102.11 | 0.57 | -0.23 | 63.34 | 1.37 | 0.9 | 18.95 |
| 53 | -2.53 | -3.45 | 0.6 | -69.5 | 99.5 | -1069.5 | 24.21 | 120 | -191 | 383 | 102.11 | 0.54 | -0.28 | 63.32 | 1.37 | 0.9 | 18.82 |
| 54 | 0.49 | 2.26 | -0.1 | 33 | -105 | -931 | 24.21 | 115 | -190 | 387 | 102.12 | 0.54 | -0.25 | 63.31 | 1.37 | 0.9 | 18.88 |
| 55 | -0.96 | -2.46 | 0.93 | -76.5 | 90 | -1073 | 24.21 | 120 | -193 | 389 | 102.12 | 0.52 | -0.29 | 63.3 | 1.37 | 0.9 | 18.83 |
| 56 | -2.61 | 3.45 | 0.13 | 33.5 | -42 | -916 | 24.2 | 121 | -191 | 390 | 102.12 | 0.51 | -0.25 | 63.28 | 1.37 | 0.9 | 18.89 |
| 57 | 0.24 | -4.18 | 0.45 | -41.5 | 109 | -1089 | 24.2 | 119 | -187 | 384 | 102.12 | 0.51 | -0.3 | 63.27 | 1.37 | 0.9 | 18.81 |
| 58 | 1.13 | 2.52 | 0.72 | 1.5 | -63.5 | -945.5 | 24.21 | 124 | -191 | 383 | 102.12 | 0.52 | -0.26 | 63.25 | 1.37 | 0.9 | 18.89 |
| 59 | -3.38 | -3.04 | 0.1 | -37 | 69 | -1083 | 24.21 | 122 | -193 | 387 | 102.12 | 0.48 | -0.3 | 63.24 | 1.37 | 0.9 | 18.83 |
| 60 | 1.51 | 2.55 | 0.48 | -6 | -71.5 | -937.5 | 24.21 | 118 | -193 | 384 | 102.12 | 0.49 | -0.26 | 63.23 | 1.37 | 0.9 | 18.89 |
| 61 | -0.6 | -4.39 | 0.25 | -57 | 39.5 | -1086.5 | 24.22 | 120 | -196 | 390 | 102.12 | 0.48 | -0.31 | 63.21 | 1.37 | 0.9 | 18.82 |
| 62 | -2.84 | 4.88 | 0.57 | 3.5 | -25 | -947.5 | 24.22 | 122 | -192 | 386 | 102.12 | 0.47 | -0.24 | 63.2 | 1.37 | 0.9 | 18.92 |
| 63 | -1.49 | -4.41 | 0.15 | 9 | 62 | -1078 | 24.22 | 124 | -190 | 385 | 102.12 | 0.46 | -0.28 | 63.18 | 1.37 | 0.9 | 18.84 |

| INS_VEast | INS_VUp ( | INS_ROLL | INS_PITCH | INS_HEAD | INS_CRAB | INS_AIRSF | INS_LATIT | INS_LONG | INS_TIME | BARO_ALT | GPS_ALTI | GPS_VELC | GPS_HEAI | GPS_SVS ( | K_STATUS | A_STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -25.28 | -0.35 | 1.25 | -0.64 | 306.78 | 93.36 | 31.63 | 47.58539 | -122.226 | 5.11E+08 | 20 | 20 | 31.56 | 306.8 | 11 | 0 | 2 |
| -25.29 | -0.35 | 1.22 | -0.63 | 306.78 | 93.39 | 31.86 | 47.58539 | -122.226 | 5.11E+08 | 19 | 20 | 31.58 | 306.8 | 11 | 0 | 81 |
| -25.22 | -0.37 | 1.24 | -0.67 | 306.79 | 93.39 | 31.7 | 47.58539 | -122.226 | 5.11E+08 | 20 | 20 | 31.49 | 306.8 | 11 | 0 | 2 |
| -25.29 | -0.36 | 1.21 | -0.66 | 306.79 | 93.41 | 31.87 | 47.5854 | -122.226 | 5.11E+08 | 20 | 20 | 31.58 | 306.8 | 11 | 0 | 81 |
| -25.25 | -0.37 | 1.24 | -0.67 | 306.8 | 93.42 | 31.66 | 47.5854 | -122.226 | 5.11E+08 | 19 | 20 | 31.54 | 306.8 | 11 | 0 | 2 |
| -25.29 | -0.36 | 1.21 | -0.66 | 306.81 | 93.44 | 31.88 | 47.5854 | -122.226 | 5.11E+08 | 19 | 20 | 31.58 | 306.8 | 11 | 0 | 81 |
| -25.2 | -0.39 | 1.22 | -0.7 | 306.81 | 93.46 | 31.73 | 47.5854 | -122.226 | 5.11E+08 | 19 | 20 | 31.47 | 306.8 | 11 | 0 | 2 |
| -25.32 | -0.37 | 1.21 | -0.66 | 306.81 | 93.48 | 31.83 | 47.5854 | -122.226 | 5.11E+08 | 19 | 20 | 31.63 | 306.8 | 11 | 0 | 81 |
| -25.14 | -0.38 | 1.19 | -0.7 | 306.82 | 93.5 | 31.64 | 47.5854 | -122.226 | 5.11E+08 | 19 | 20 | 31.41 | 306.68 | 11 | 1 | 2 |
| -25.23 | -0.37 | 1.19 | -0.68 | 306.81 | 93.52 | 31.84 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.51 | 306.68 | 11 | 0 | 81 |
| -25.16 | -0.38 | 1.18 | -0.7 | 306.81 | 93.51 | 31.61 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.43 | 306.68 | 11 | 0 | 2 |
| -25.24 | -0.37 | 1.16 | -0.67 | 306.82 | 93.54 | 31.83 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.53 | 306.68 | 11 | 0 | 81 |
| -25.13 | -0.39 | 1.16 | -0.71 | 306.82 | 93.55 | 31.65 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.4 | 306.68 | 11 | 0 | 2 |
| -25.22 | -0.38 | 1.17 | -0.68 | 306.83 | 93.58 | 31.85 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.51 | 306.68 | 11 | 0 | 81 |
| -25.14 | -0.39 | 1.13 | -0.71 | 306.83 | 93.6 | 31.63 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.42 | 306.68 | 11 | 0 | 2 |
| -25.22 | -0.38 | 1.15 | -0.69 | 306.83 | 93.61 | 31.84 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.51 | 306.68 | 11 | 0 | 81 |
| -25.12 | -0.4 | 1.14 | -0.73 | 306.84 | 93.63 | 31.66 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.39 | 306.68 | 11 | 0 | 2 |
| -25.25 | -0.38 | 1.11 | -0.68 | 306.84 | 93.64 | 31.8 | 47.58541 | -122.226 | 5.11E+08 | 18 | 20 | 31.55 | 306.68 | 11 | 0 | 81 |
| -25.15 | -0.4 | 1.1 | -0.73 | 306.84 | 93.67 | 31.67 | 47.58542 | -122.226 | 5.11E+08 | 18 | 20 | 31.42 | 306.75 | 11 | 1 | 2 |

*Figure 34 Sample INS/GPS data*

Please note that when a customer uses the Glamr interface the program automatically rescales the INS/GPS outputs. This is displayed in Figure 33.

### 12.3.1 *Interfacing without Glamr*

If you are not using the Glamr interface be aware that the outputs require a divide by function. Additionally, you should use the LSB's noted per your INS/GPS datasheet. For example, for a 490 °/s rate range INS/GPS the 16-bit LSB is 0.015 °/s:

$$LSB = \frac{(Sensor\ Range)}{2^{Bit\ Resolution-1}} = \frac{490\ °/s}{2^{15}} = 0.015\ °/s$$

The calculations for higher bit resolutions are as follows:

$$\frac{490\ °/s}{2^{23}} = 0.00006\ °/s$$

$$\frac{490\ °/s}{2^{31}} = 0.00000023\ °/s$$

For a 2000 °/s gyro at 16-bit:

$$\frac{2000\ °/s}{2^{15}} = 0.061\ °/s$$

For temperature, $0.01\ °C$ should be used. Note that in the exponent, one bit is subtracted from the total bit resolution to account for both positive and negative values (effectively dividing it by two).

# 13 Mounting

Mounting for the INS/GPS accommodates both metric and U.S. mounting screws. Mount the unit to a flat surface with 4ea M2 metric stainless-steel screws (or 2-56). The minimum torque requirement is 32 in/oz. Be sure that the surface that you are mounting to is as clean and as level as possible to eliminate potential alignment errors. Adequate mounting to a surface should fall within a flatness of +/- 0.001" or +/- 0.025 mm.

Failing to mount the unit in this fashion can result in unaccounted stress in the sensors and therefore may affect data output. Gladiator Technologies strongly encourages the user to mount the unit correctly in the described manner to ensure proper functioning.

# 14 Operation and Troubleshooting

## 14.1 *Technical Assistance*

Please contact the factory or your local Gladiator Technologies sales representative's office for technical assistance.

| Technical Support - USA |
| --- |
| **Gladiator Technologies** |
| **Attn:** Technical Support |
| 8020 Bracken Place SE |
| Snoqualmie, WA 98065 USA |
| **Tel:** 425-396-0829 x241 |
| **Fax:** 425-396-1129 |
| **Email:** support@gladiatortechnologies.com |
| **Web:** www.gladiatortechnologies.com |

## 14.2 *Authorized Distributors and Technical Sales Representatives*

If you need additional assistance, please contact your local distributor and/or the factory for further technical support:

http://www.gladiatortechnologies.com/international-customers/

## Revision History

| Rev | Date | Description | Page Number(s) |
|---|---|---|---|
| C | 6/26/2019 | Added section 4.15 | 33 |
| B | 5/9/2019 | Added Hardware note Section 4.2 | 8 |
| A | 1/9/2019 | Initial document creation | - |