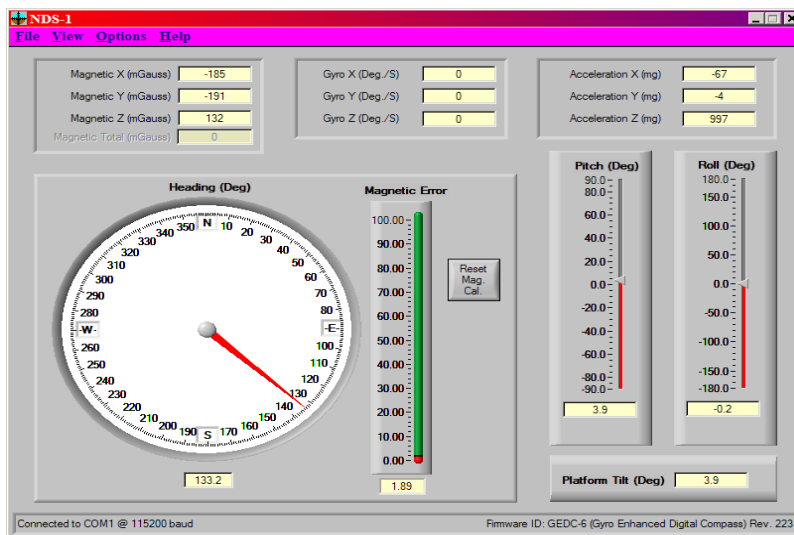


NDS-1 Navigation Development System

USERS MANUAL



SPARTON NAVIGATION SENSOR PRODUCT FAMILY:

DC-4 GEDC-6 AHRS-8

Developed By: SPARTON
Date: 9/18/2012
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www.spartonnavex.com

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Revision History

REV	CHANGE NO.	DATE OF CHANGE	DESCRIPTION OF CHANGE	INITIALS AND DATE
1.0	N/A	9/30/11	• ORIGINAL RELEASE FOR NDS-1	JT 9/30/11
2.0	N/A	9/18/12	• ADDS AHRS-8 ATTITUDE HEADING REFERENCE SYSTEM	JT 9/18/12

Navigation Development System (NDS-1) Users Manual

Overview

Welcome to the Sparton Navigation Development System (NDS-1). The NDS-1 provides a simple way to set up and evaluate Sparton's line of navigation sensor modules, including:

- **DC-4: Navigation Sensor**
- **GEDC-6: Gyro-Enhanced Navigation Sensor**
- **AHRS-8: Attitude Heading Reference System**

To run the NDS-1 Navigation Development System, the following is required:

- The NDS-1 Adapter Board with power adapter cord
- A Sparton DC-4, GEDC-6 or AHRS-8 navigation sensor module (purchased separately)
- CD ROM disk containing the NDS-1 Host Application Software and documentation
- A serial or USB cable for connection to a Windows based PC



The NDS-1 Adapter Board and the DC-4/GEDC-6/AHRS-8 are static sensitive devices. Please use proper Electrostatic Discharge (ESD) protection procedures when handling.

The NDS-1 Adapter Board is shown in Figure 1 with the navigation sensor module installed.

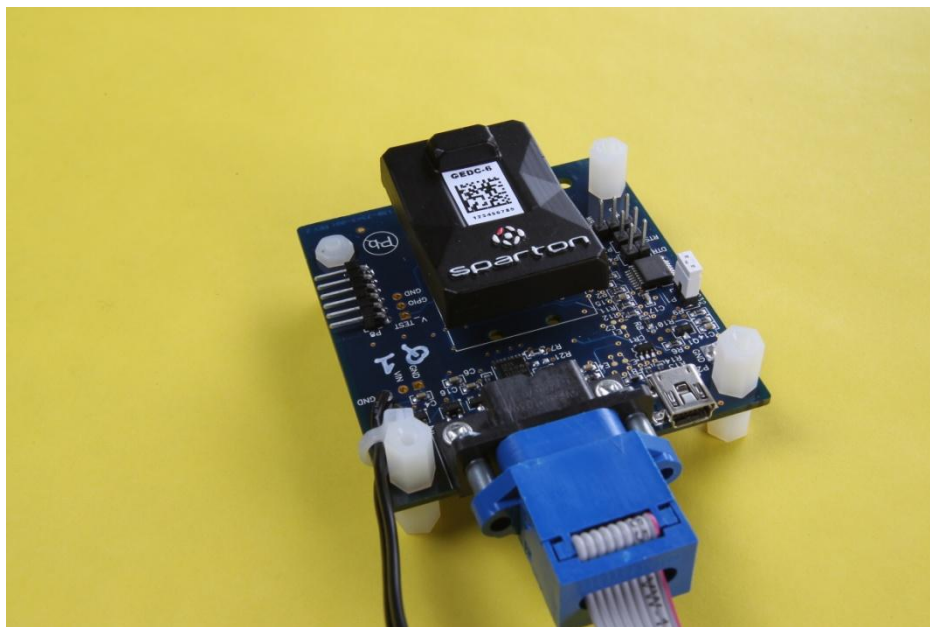


FIGURE 1: NDS-1 ADAPTER BOARD



NDS-1 Navigation Development System Contents

- NDS-1 Adapter Board with power adapter (DC-4/GEDC-6/AHRS-8 purchased separately)
- Non-magnetic Serial Cable
- USB Cable
- NDS-1 Host Application Software
- CD containing application software and documentation

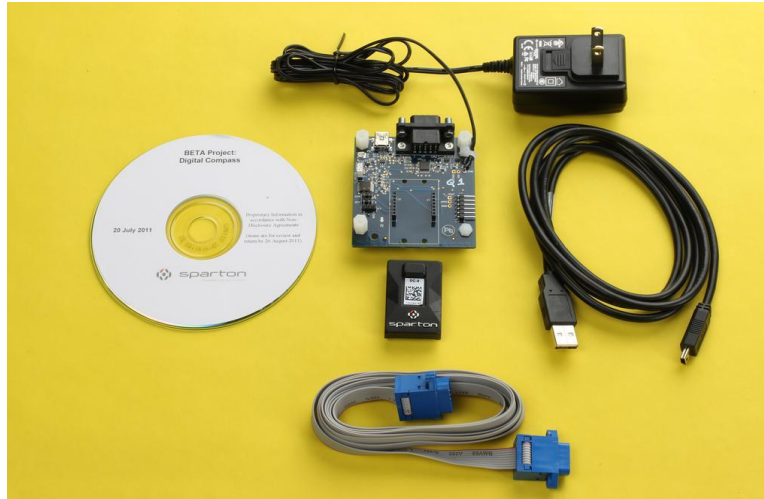


FIGURE 2: NDS-1 HARDWARE

NDS-1 System Set Up

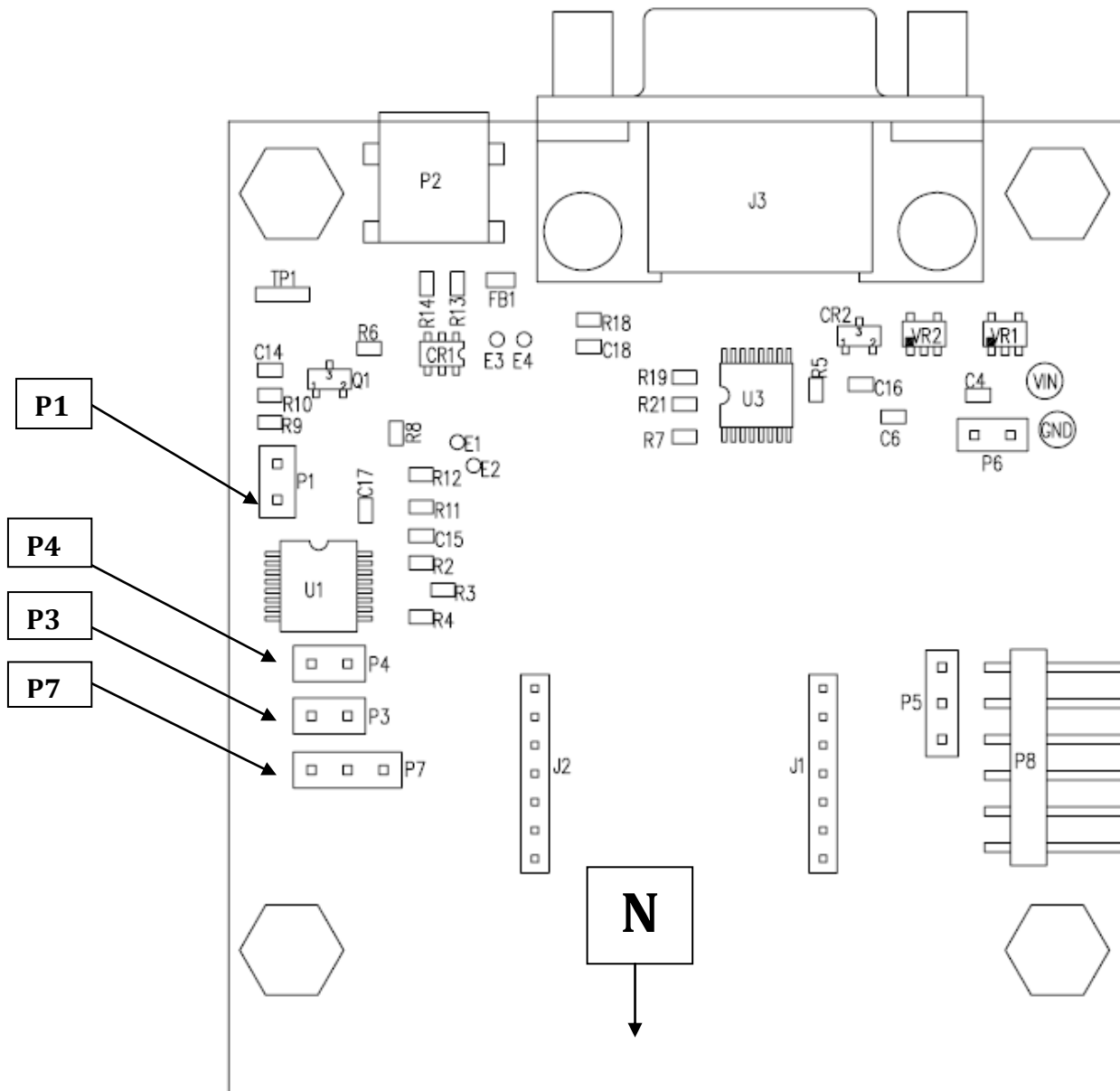
Please follow these instructions to get the NDS-1 system up and running:

- 1) Insert the NDS-1 Host Application CD-ROM disc into the PC (Note: PC Windows XP/Vista/7 only, no MAC or Linux Support).
- 2) From 'My Computer' or Windows Explorer select and run setup.exe.
- 3) Follow the on-screen setup instructions.
- 4) The newly installed program can be found in the Windows 'Start' menu after installation. Typically: "Start/All Programs/Navigation Development System/NDS-1".

Warning: Make sure the navigation sensor is mated correctly to the interface board. Misalignment of the pins can cause serious electrical damage to the navigation sensor. Sparton's warranty does not cover faulty user hardware setup.

- 5) Install the Sparton navigation sensor module (DC-4, GEDC-6, AHRS-8) into the NDS-1 Adapter Board connector (the connector is keyed) per Figure 1.
- 6) Connect the NDS-1 Adapter Board to the PC using one of the provided cables. (Note: It is preferential, although not required, to use the serial cable due to its non-magnetic properties).

- 7) The NDS-1 Adapter Board has several jumper blocks (Figure 1) as noted by Adapter Boards silkscreen as P1, P3, P4 and P7. These connectors are further described in the NDS-1 Navigation Development System Users Guide. Follow the applicable instructions below depending upon whether USB or RS232 cable connectivity is chosen.



PRIMARY SIDE

FIGURE 3: THE NDS-1 ADAPTER BOARD LAYOUT

If you have chosen to connect to a PC via a RS232 port:

- Short pins 1 and 2 of jumper P1 with provided jumper plug
- Leave pins of jumpers P3, P4 and P7 open (factory default)
- Plug the attached power adaptor into an AC outlet
- Connect serial cable to DB9 connector J3. (Note: Use the provided non-magnetic serial cable to avoid interference with navigation sensor operations.)

If you have chosen to connect to the PC via a USB port:

- Leave pins of jumper P1 open (factory default)
- Leave pins of jumpers P3, P4 and P7 open (factory default)
- There are two ways to apply power, either plug in the AC adapter or run the system using USB power (+5V). It is permissible to leave the AC adapter unplugged. The AC adapter is designed to provide clean power in electrically noisy environments.
- Connect USB cable to Mini-B USB connector P2 on the NDS-1 Adapter Board.

Note 1: The USB cable has magnetic properties. An in-field calibration of the navigation sensors must be performed to compensate for this.

Note 2: The NDS-1 Adapter Board uses the FTDI USB to serial UART converter chip FT232R. The target PC needs to have a USB driver for the FT232R chip installed. If not resident on the PC, the driver and the applicable instructions can be downloaded from FTDI website: <http://www.ftdichip.com/FTDrivers.htm>

- 8) Start the NDS-1 Host Application by double clicking on the NDS-1 icon as found on the 'Start' menu bar.

The software will search for the correct COM port and baud rate (factory default is 115.2K baud, COM1). This may take a few minutes. Alternatively, the Setup Menu can be used to manually set the COM port and baud rate.

Note 3: The NDS-1 GUI is different from that used for the Sparton SP300xD series digital compasses, and is required for use with the DC-4, GEDC-6 and AHRS-8 products. The NDS-1 GUI is labeled as such in the upper left hand corner of the GUI.

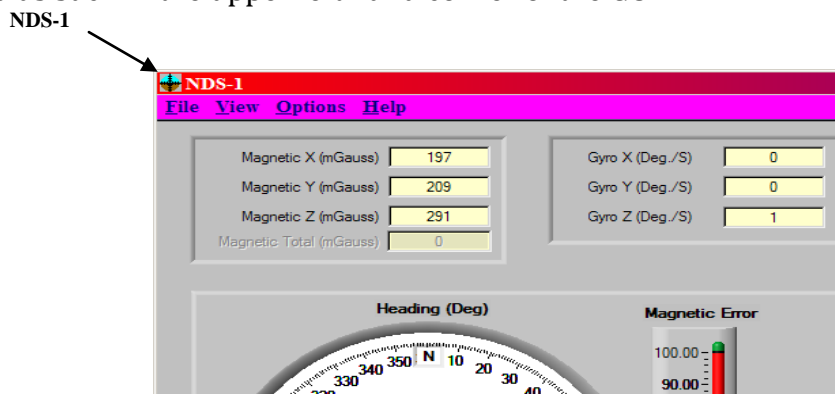


FIGURE 4: THE NDS-1 HOST APPLICATION

Guided Tour of the NDS-1 Host Application

Boot up screen:

When the program is started, a dialog box will be displayed as the system searches for the NDS-1 adapter board and DC-4/GEDC-6/AHRS-8 navigation sensor module. The status is displayed in the lower left hand corner as the system scans available COM ports. Once the system connects, the COM port and baud rate are displayed. Cancelling auto-search will bring up the dialog box for manual settings.

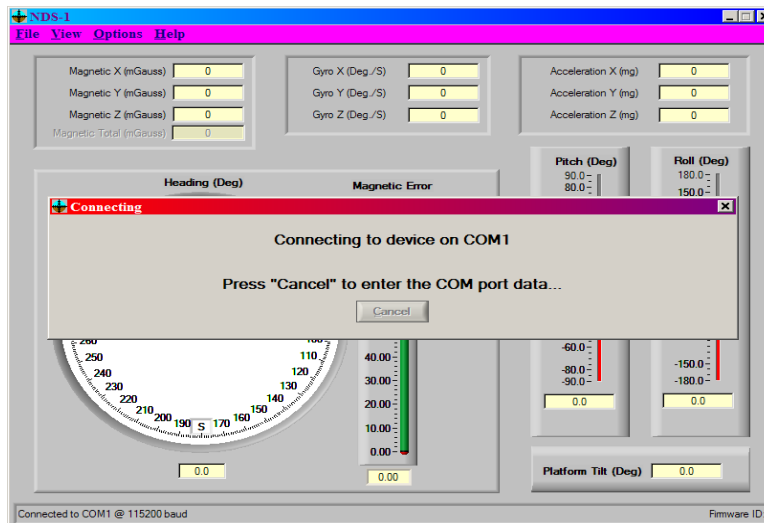


FIGURE 5: AUTODETECT AT BOOT UP

Manually Setting the COM port:

If auto-search is cancelled, a dialog box will be displayed (Figure 6) to allow manual entry of the COM port and baud rate. Enter a COM port and baud rate, or choose auto detect to restart the auto detection process. Choose cancel to exit the dialog box.

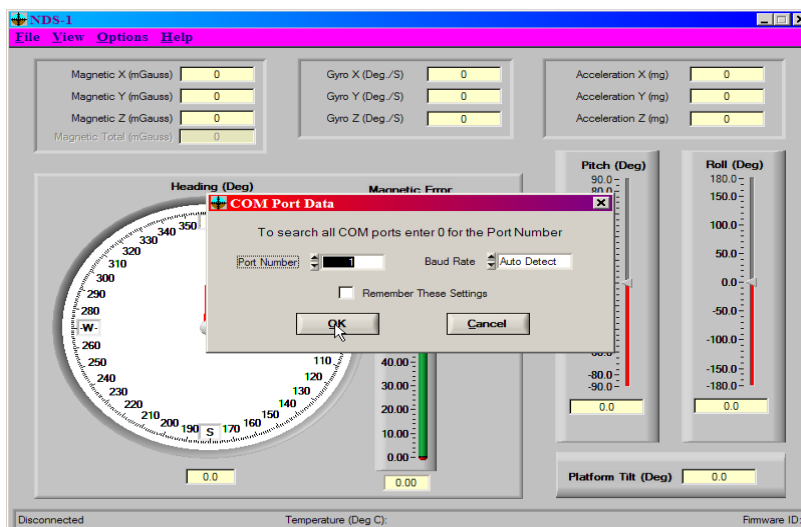


FIGURE 6: COM PORT DIALOG BOX

Home Screen:

After successfully connecting to the NDS-1 adapter board, the NDS-1 Host Application dashboard will be displayed. The home screen dashboard includes meters to display the navigation sensor heading, pitch, roll and magnetic error. In addition, the raw data from the magnetometer, gyro (if applicable), accelerometer and heading are displayed. Tilt is displayed in the lower right hand corner.

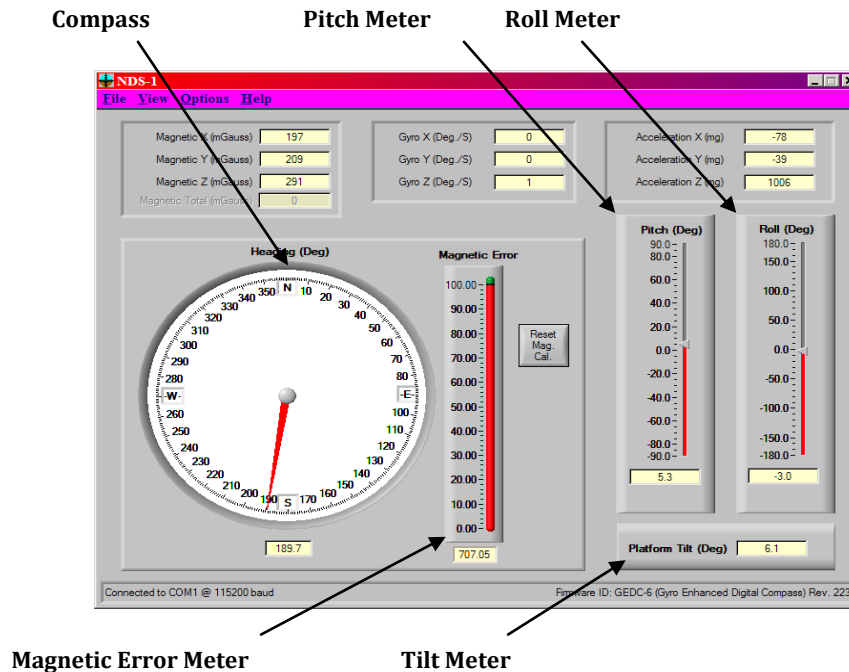


FIGURE 7: HOME SCREEN DISPLAY

The dashboard has four pull down menus: File, View, Options and Help. The File menu allows the user to enable the log file for data collection, download a new magnetic model to the device and exit the program.

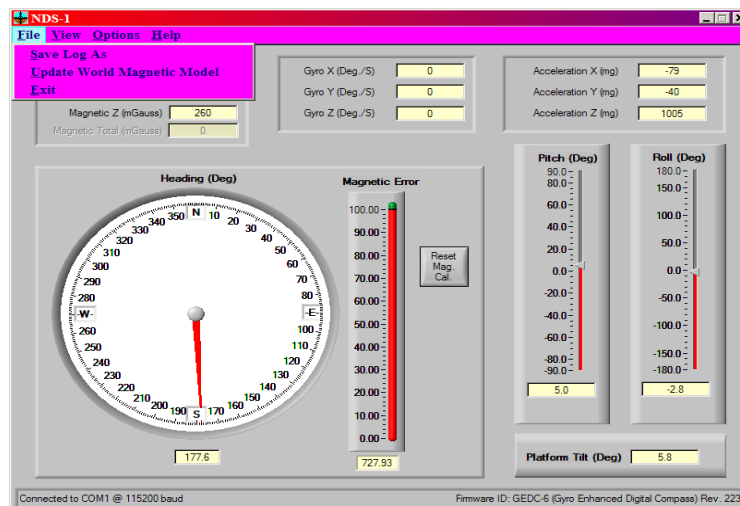


FIGURE 8: FILE MENU

The View menu provides access to the strip chart recorder, cockpit display and device variables.

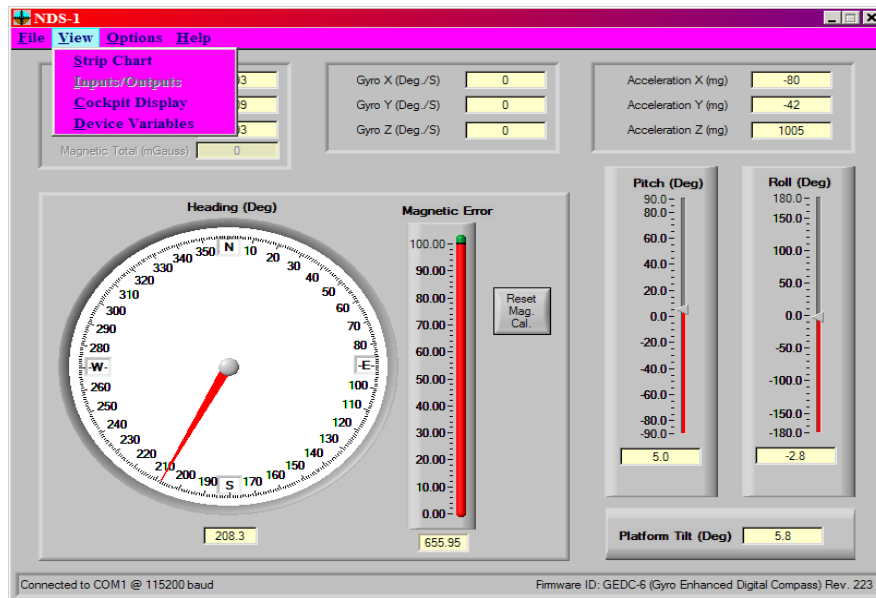


FIGURE 9: VIEW MENU

The cockpit view is shown in Figure 10. It is designed to emulate the view within an airplane's cockpit. The attitude indicator (also known as an artificial horizon) shows the aircraft's attitude relative to the horizon. From this the pilot can tell whether the wings are level and if the aircraft nose is pointing above or below the horizon. The navigation sensor shows the imaginary aircraft's heading relative to magnetic north. The three digital meters, roll, pitch and yaw display each reading in degrees, to a tenth of a degree.

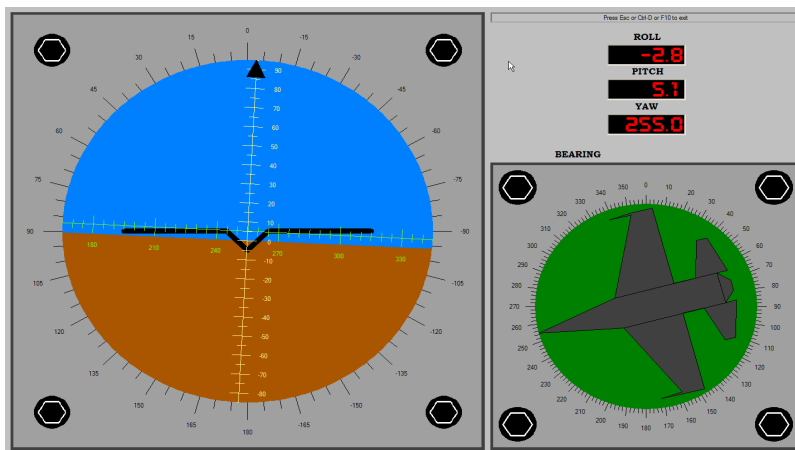


FIGURE 10: COCKPIT VIEW

The strip chart recorder displays data from all nine sensors, magnetometers in milligauss, accelerometers in mili-g, and gyro data in degrees per second.

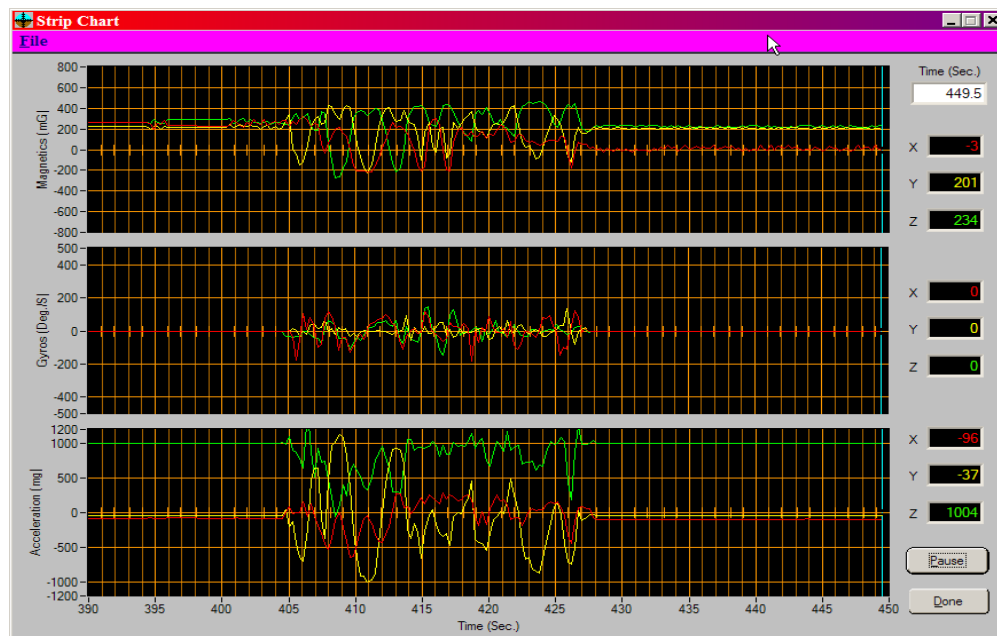


FIGURE 11: STRIP CHART VIEW

Selecting the File menu (

Figure 12) reveals the Save Log As menu. Selecting this option will save strip chart data to a log file. The log file is a .csv file and can be imported into a spreadsheet for analysis.

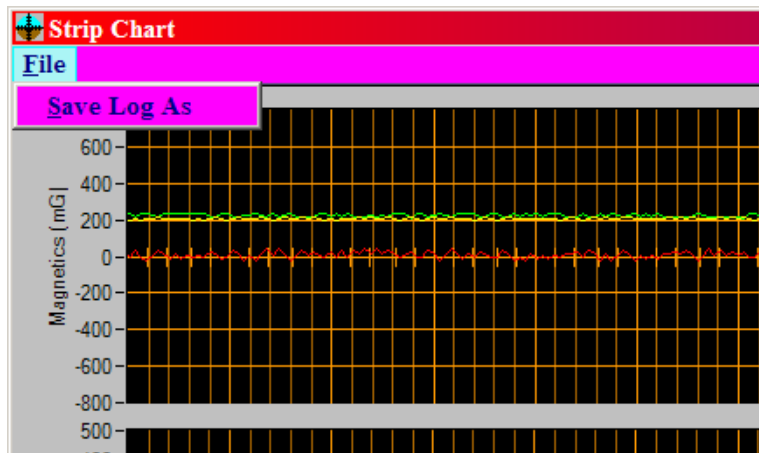


FIGURE 12: ENABLING THE LOG FILE FROM THE STRIP CHART RECORDER

The Options menu provides access to the following commands: Settings, Auto Variance, Calibration, Orientation, Baud Rate, Accelerometer Range, Terminal Emulator, Reconnect and Test Commands.

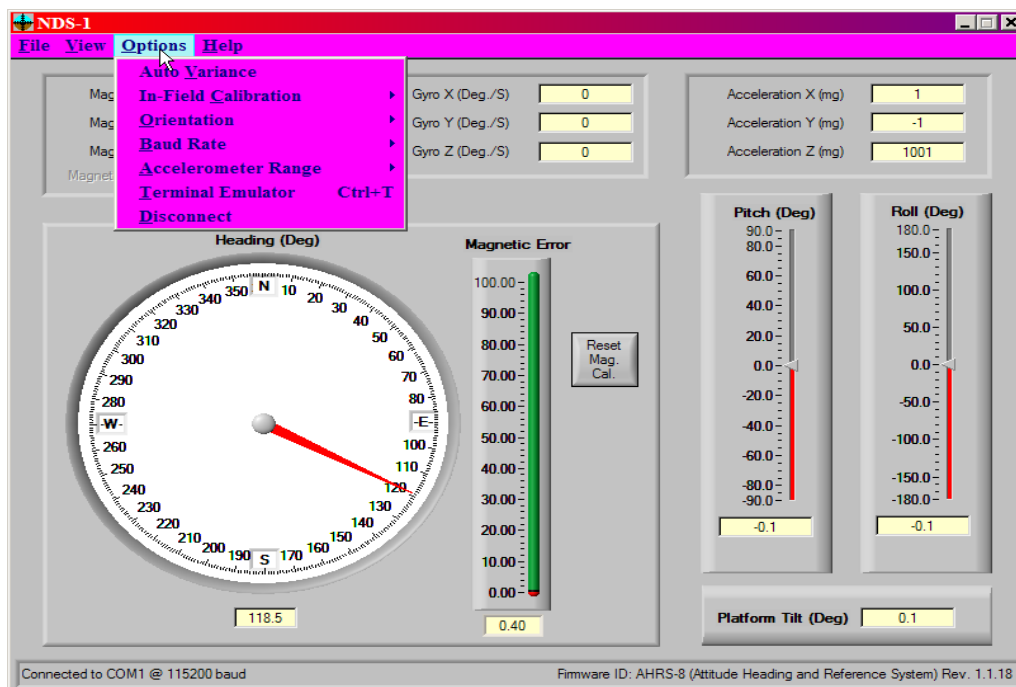


FIGURE 13: OPTIONS MENU

Auto Variance:

Entering latitude, longitude, altitude and the day into the auto variance calculator will compute the magnetic variance value. The magnetic variance is computed within the navigation sensor module and is used to provide a true north heading output.

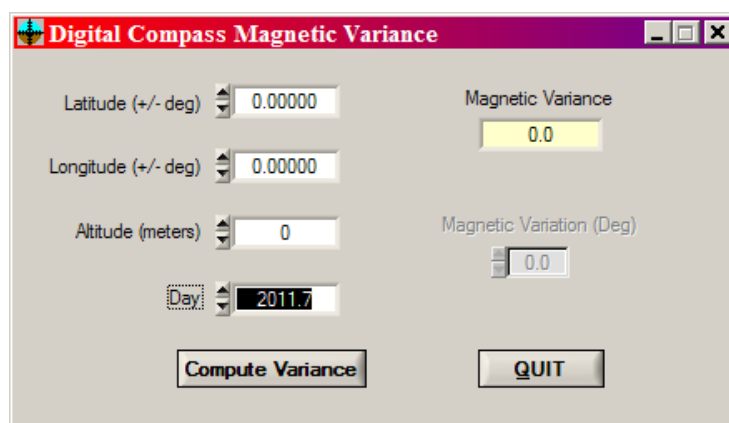


FIGURE 14: AUTO VARIANCE

In-Field Calibration:

This menu option provides the options for 2D or 3D in-field calibration to compensate for any hard or soft iron that may be present in the mounting platform.

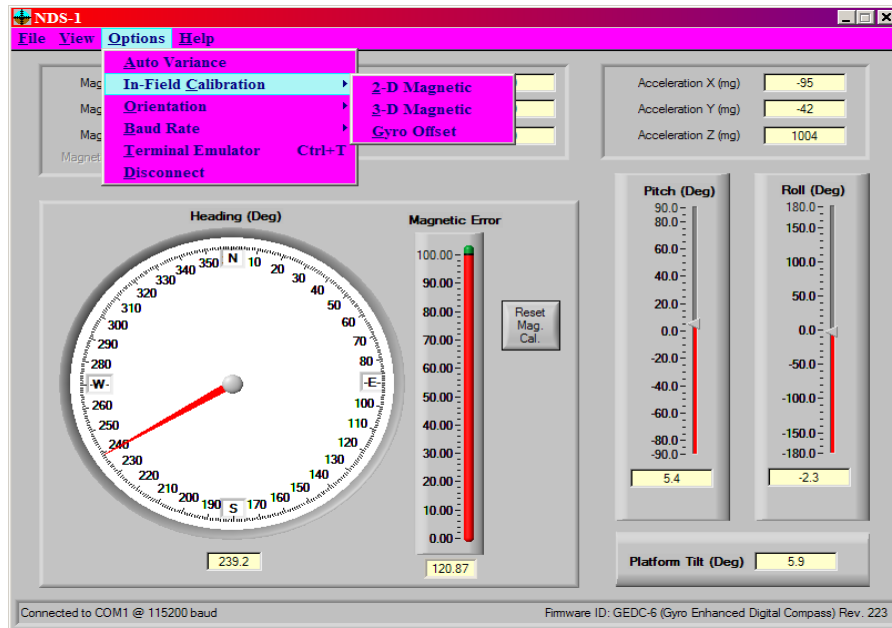


FIGURE15: IN-FIELD CALIBRATION

Orientation:

This drop down provides the options for mounting the DC-4, GEDC-6 or AHRS-8 navigation sensor in the mounting platform. There are five choices (Horizontal, Vertical, Left Edge, Right Edge or Inverted). For more information and graphical representations of these orientations please reference the Sparton Navigation Sensor Product Guide.

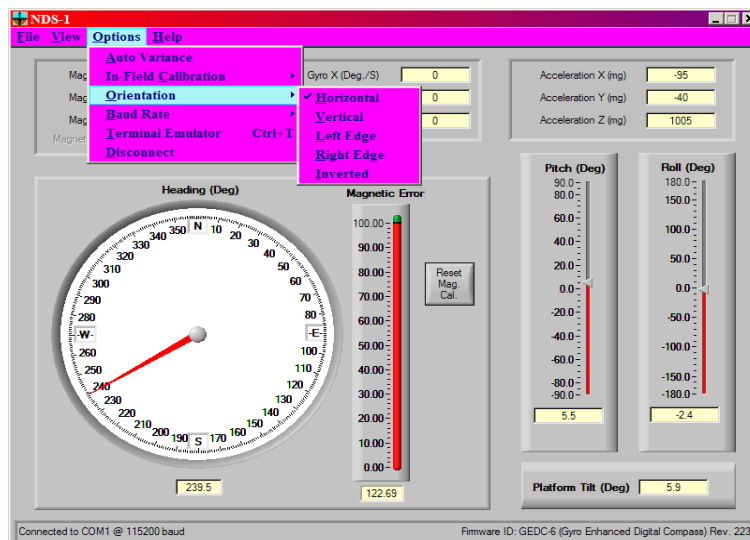


FIGURE16: ORIENTATION

Baud Rate:

The Baud Rate menu allows manual selection of the Baud rate for communicating with the NDS-1 adapter board. Due to the large amount of data required to update the GUI display, baud rates below 9600 are not allowed when using the NDS-1 GUI software. *Note: Jumper P3 and P4 must not be present for proper operation.*

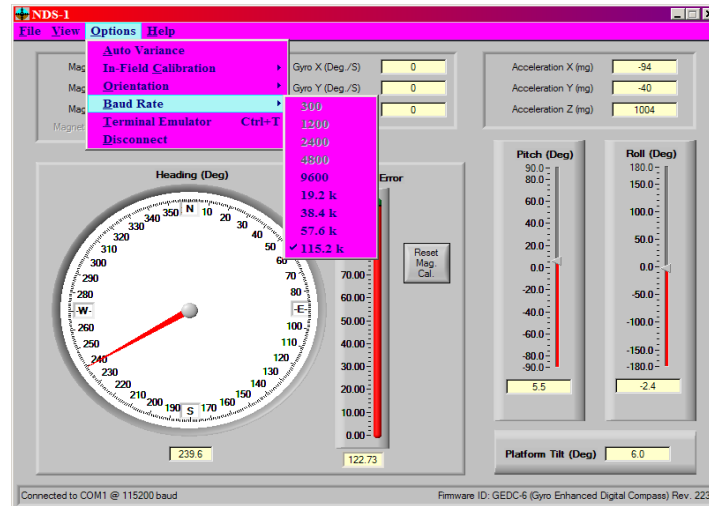


FIGURE17: BAUD RATE

Accelerometer Range

The AHRS-8 offers user selectable accelerometer dynamic ranges via the menu, either 4g or 8g. The 8g range is a trade-off with less resolution. A reset or power cycle must be performed for this change to take effect in the accelerometer, and thusly cannot be changed 'on the fly' as such. Please reference the Software Users Interface Manual for additional information.

Note: User selectable dynamic ranges not applicable to DC-4 or GEDC-6.

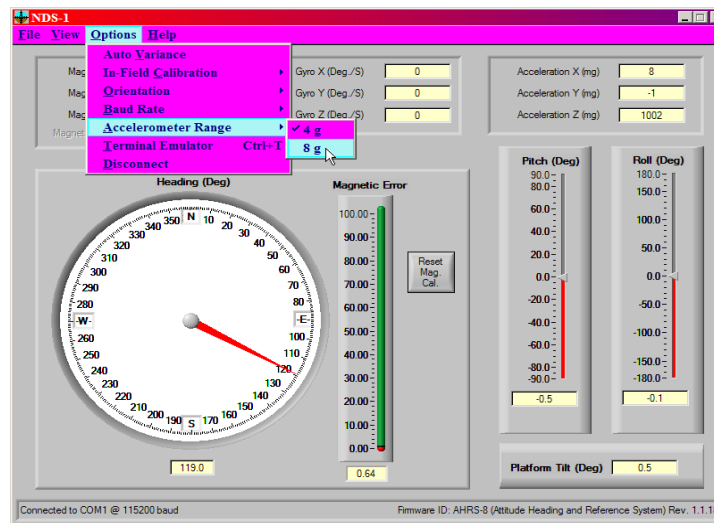


FIGURE17: ACCELEROMETER DYNAMIC RANGE SELECTION

Terminal Emulator:

The terminal emulator provides access to the command line interface (CLI) for the attached device (DC-4, GEDC-6 or AHRS-8).

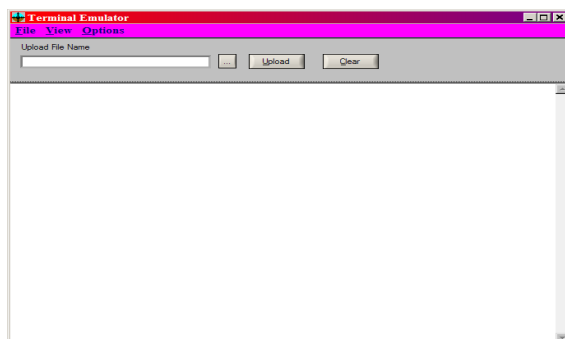


FIGURE18: TERMINAL EMULATOR

Power User Tip: A third party terminal emulator may be used in place of the NDS-1 terminal emulator.

Disconnect/Reconnect:

The Disconnect command stops communication with the NDS-1 Adapter Board, to allow for Adapter Board replacement. The menu will toggle when selected; selecting Options/Reconnect will restart communications.

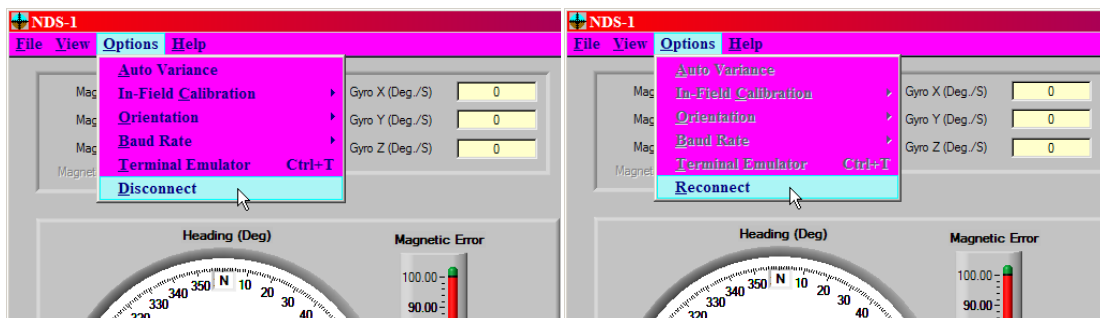


FIGURE19: DISCONNECT

FIGURE 20: RECONNECT

Help:

The Help menu provides information about the NDS-1 as well as links to the Sparton Navigation and Exploration web site and customer support.

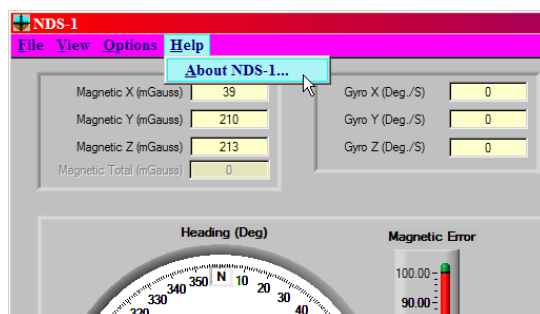


FIGURE 21: HELP

NDS-1 Hardware Reference Guide

The following section includes useful hardware information and a more detailed overview of the NDS-1 hardware interfaces and their functions.

(Please reference the Sparton Navigation Sensor Product Guide and the respective data sheets for the DC-4, GEDC-6 or AHRS-8 for additional details)

NDS-1 Features and Interconnections

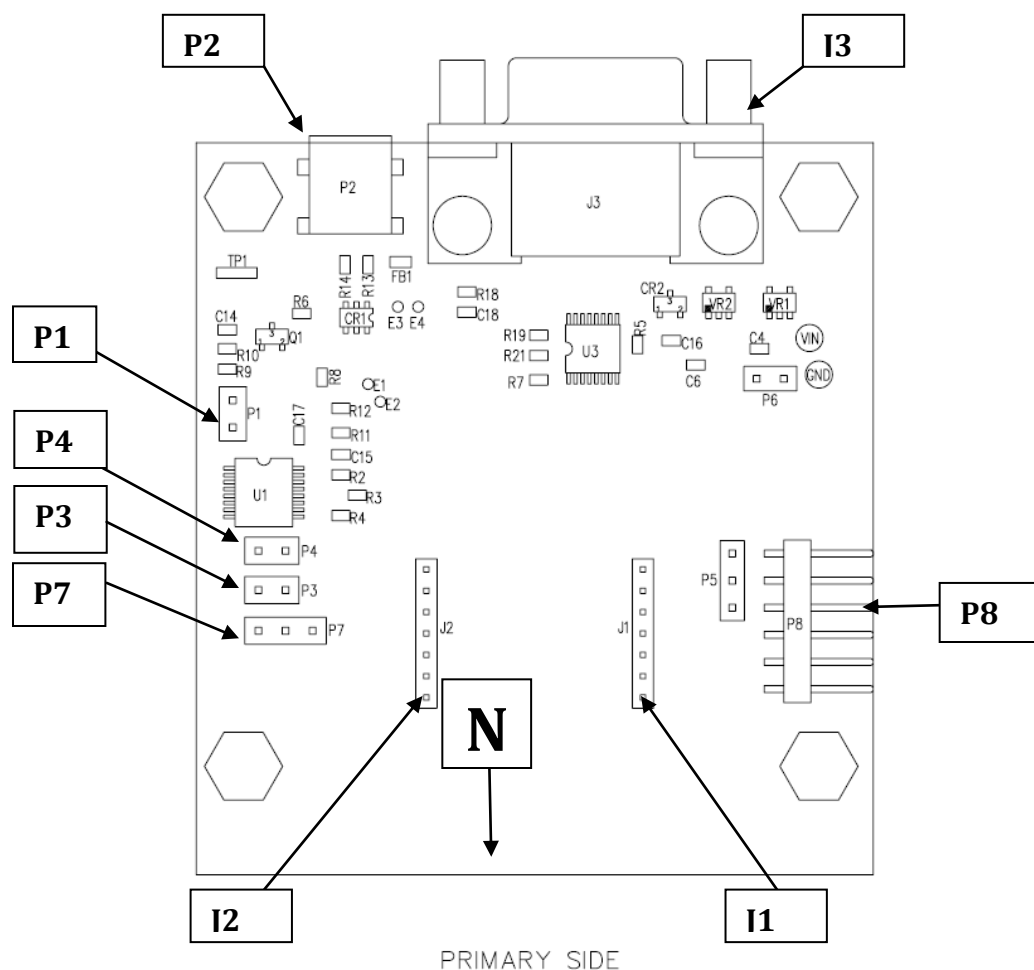


FIGURE 22: THE NDS-1 ADAPTER BOARD LAYOUT

NDS-1 Adapter Board Connectors and Pin Out Connections

NDS-1 Adapter Board Connectors

NDS-1 Adapter Board Connectors	Function
J1 and J2	These are the two single row connectors that mates with the navigation sensor.
J3	This is a standard 9 pin D-style RS232 connector used to communicate with the navigation sensor from a PC Serial Port.
P1	Selects the communication channel. Leave it unpopulated to use the USB virtual com port or install a jumper to use RS232 communication via the J3 connector.
P2	This is a standard mini-USB connector used to communicate/power the navigation sensor from a PC virtual COM port
P3 and P4	Install jumpers on these connectors to pass the DTR and RTS RS232 connectors to the navigation sensor. These are needed to download new firmware to the navigation sensor.
P8	Provides a debug port for troubleshooting.

Navigation Sensor Sockets J1 and J2:

Connector - Pin Number	Pin Name	I/O	Function
J1-1	V_TEST	I	3.3V regulator output for test purposes (factory use only)
J1-2	DEBUG_RXD	O	3.3V logic RXD output to Navigation Sensor Debug Port (factory use only)
J1-3	DEBUG_TXD	I	3.3V logic TXD input from Navigation Sensor Debug Port (factory use only)
J1-4		N/A	Pin blocked for keying
J1-5	#WP_EEPROM	O	3.3V logic, active-low EEPROM write protect
J1-6	GPIO	I/O	Do not connect (factory use only)
J1-7	GND	N/A	System Ground
J2-1	V+	O	+5V power supply output.
J2-2	USER_RXD	O	3.3V logic RXD output to Navigation Sensor User Com Port
J2-3	USER_TXD	I	3.3V logic TXD input from Navigation Sensor User Com Port
J2-4	#RESET	O	3.3V logic, active-low reset output. Used with Navigation Sensor programming.
J2-5	#EINT0	O	3.3V logic, active-low interrupt output. Used with Navigation Sensor programming.
J2-6	GND	N/A	System Ground
J2-7	GND	N/A	System Ground

User USB Port Connector P2:

Connector - Pin Number	Pin Name	I/O	Function
P2-1	VCC	I	+5V power supply input (from USB Host. Max load = 80mA)
P2-2	D-	I/O	USB Data -
P2-3	D+	I/O	USB Data +
P2-4	GND	N/A	System Ground
P2-5	GND	N/A	System Ground
P2-Shell	GND	N/A	System Ground

User Com Port Connector J3:

Connector - Pin Number	Pin Name	I/O	Function
J3-1		N/A	No connection
J3-2	RS232_TXD	O	RS232 TXD output from User Com Port
J3-3	RS232_RXD	I	RS232 RXD Input to User Com Port
J3-4	RS232_DTR	I	RS232 DTR Input to User Com Port (used for programming)
J3-5	GND	N/A	System Ground
J3-6		N/A	No connection
J3-7	RS232_RTS	I	RS232 RTS Input to User Com Port (used for programming)
J3-8		N/A	No connection
J3-9		N/A	No connection

Debug Port Connector P8:

Connector - Pin Number	Pin Name	I/O	Function
P8-1	GND	N/A	System Ground
P8-2		N/A	No connection
P8-3	USB_PWR	I	+5V power supply input (from USB/RS232 converter cable. Max load = 80mA)
P8-4	RS232_RXD	I	3.3V logic RXD Input to Debug Port (factory use only)
P8-5	RS232_TXD	O	3.3V logic TXD Output to Debug Port (factory use only)
P8-6		N/A	No connection

NDS-1 Host Application Reference Guide**Universal Asynchronous Receiver Transmitter (UART)**

The UART communicates with the navigation sensor using 3.3V logic-level signaling.

DC-4, GEDC-6 and AHRS-8: 115.2K Baud (factory default), selectable from 300 to 115.2K Baud, 8 data bits, 1 stop bit, no parity.

The UART provides full duplex communication. See the definitions section in the Software Interface Users Manual for description of valid UART commands.

NDS-1 System Software Operation

This section of the manual provides navigation sensor setup and operation within the Navigation Development System platform. The connecting message will appear on the GUI upon system start up.

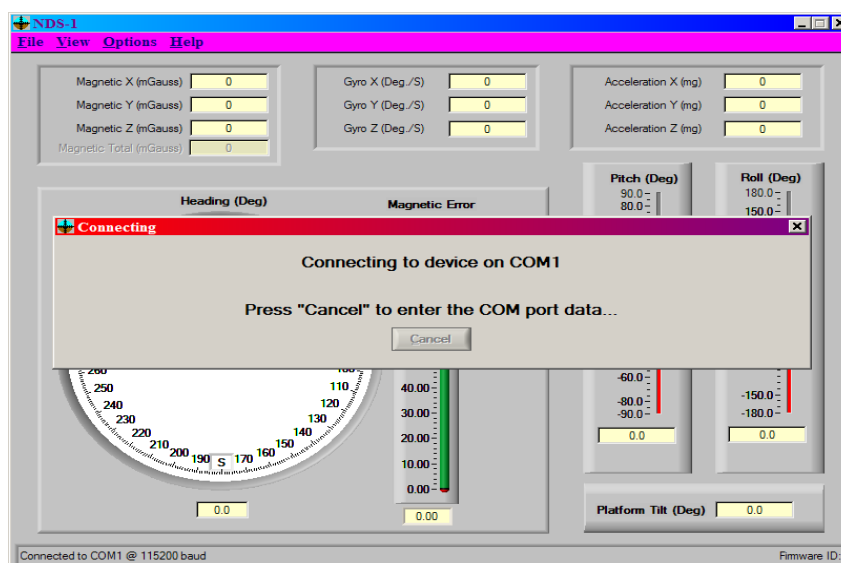


FIGURE 23: CONNECTING MESSAGE

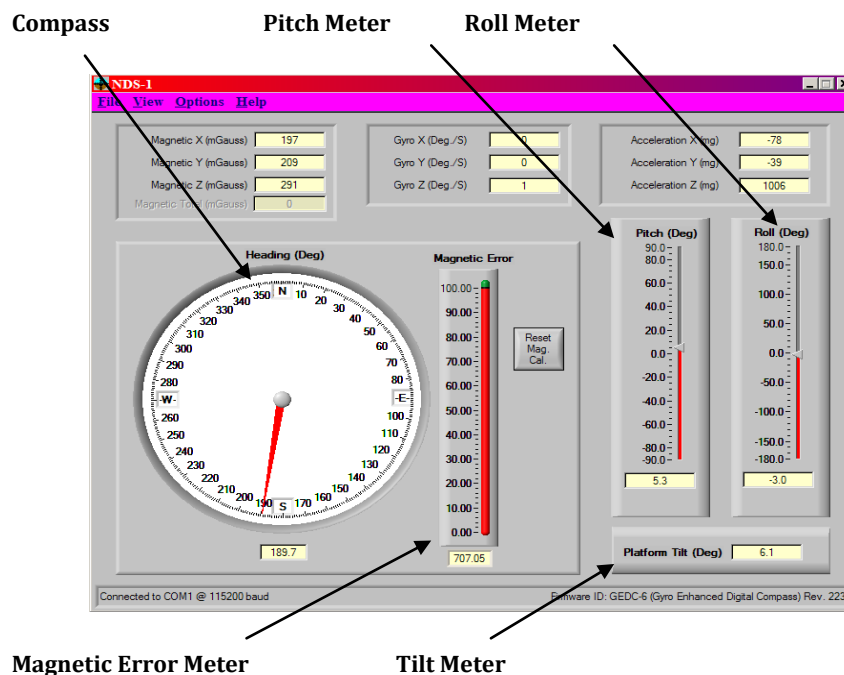


FIGURE 24: NDS-1 COMPASS VIEW

The development kit software will attempt to establish a communication link with the navigation sensor. After establishing a communication link with the navigation sensor the development kit software will continually update the display with information (See Figure 24).

NDS-1 Navigation Sensor Measurement Display Elements

Magnetic measurements are displayed in milli-gauss. These measurements consist of the true X, Y, and Z components of the magnetic field as seen by the navigation sensor. The magnetic measurements are relative to the navigation sensor platform orientation and do not include any pitch and roll compensation. Magnetic heading is shown graphically on a compass dial as well as numerically below the dial and indicates the direction in which the navigation sensor platform is pointing.

Acceleration measurements are displayed in milli-g (where $g = 9.8 \text{ meters/sec}^2$). These measurements consist of the true X, Y, and Z components of the acceleration as seen by the navigation sensor. It is important to note that these measurements will include acceleration due to motion of the navigation sensor platform as well as the acceleration due to gravity.

Gyro measurements are displayed in degrees per second. These measurements consist of the true X, Y, and Z components of the rotation rate as seen by the navigation sensor.

Pitch and Roll information is provided both graphically and numerically to indicate the current orientation of the platform. The overall tilt of the platform is calculated by the software development kit using the pitch and roll information. The overall platform tilt is direction independent and indicates the tilt of the platform from vertical expressed in degrees. Platform tilt values greater than 90 degrees indicate the platform is inverted.

Setting the Navigation Sensor Mounting Orientation

The navigation sensor mounting orientation within the application platform is selected by the “Options/Orientation” menu item. Available choices are horizontal, vertical, left edge, right edge and inverted orientations. These are displayed pictorially and described in greater detail within the Sparton Navigation Sensor Product Guide.

True North Heading Option and Magnetic Variance

The magnetic heading can be adjusted to indicate true North by setting the magnetic variance angle. The magnetic variance angle depends on geographical location, the navigation sensor can calculate the variance angle based on latitude, longitude, altitude, and time information obtained from an external GPS source. To compute the magnetic variation angle, select the “Options/Auto Variance” menu item.

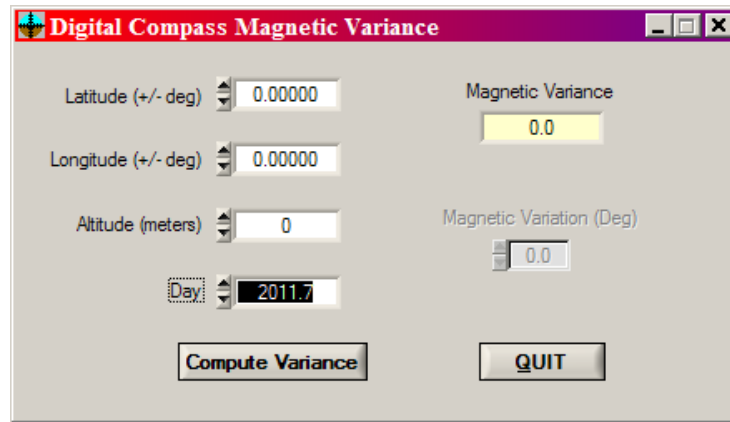


FIGURE 25: AUTOMATIC MAGNETIC VARIANCE

Enter the current geographical location (geodetic coordinate system referenced to the WGS 84 ellipsoid). Latitude and longitude are entered in degrees with + being north and east respectively. Altitude is entered in meters above sea level. The day is entered as a fractional year based on the current day of the year (i.e. February 15 is the 46th day of 2008. In fractional terms, this would be $46/365 = 0.126$. The Day value for February 15, 2008 would then be entered as 2008.1 (resolution beyond a tenth causes negligible change in variance). Once the location and time values have been entered, select "Compute Variance" to send the data to the navigation sensor. The "Compute Variance" button will turn red while the navigation sensor computes the magnetic variance. Once the computation is complete, the magnetic variance will be updated in the navigation sensor.

Note: To Retain Magnetic Variance Accuracy, The Magnetic Model Must Be Updated Every Five Years. This Only Affects The Calculation Of True Heading And Does Not Affect Magnetic Heading Accuracy.

Data Logging

The development kit software can log navigation sensor data as it is received. To begin logging data, select the "File/Save Log As" menu item then select the file name to save the data in. The data are logged in comma separated file (.csv) in the following format:

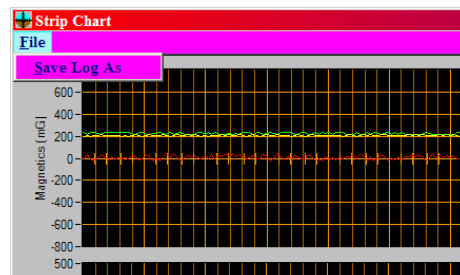


FIGURE 26: DATA LOGGING OPTION

Column 1: Date/Time
 Column 2: Magnetic X
 Column 3: Magnetic Y
 Column 4: Magnetic Z
 Column 5: Magnetic Total
 Column 6: Gyro X
 Column 7: Gyro Y
 Column 8: Gyro Z
 Column 9: Acceleration X
 Column 10: Acceleration Y
 Column 11: Acceleration Z
 Column 12: Magnetic Heading
 Column 13: Magnetic Error
 Column 14: Pitch
 Column 15: Roll
 Column 16: Platform Tilt

Select the “File/Save Log As” menu item again to stop logging data.

Updating the World Magnetic Model

The navigation sensor uses a spherical harmonic model to calculate the magnetic variance. This variance is then used to adjust the magnetic heading to indicate a true north heading. In order to retain accuracy, the magnetic model must be updated every five years. This only affects the calculation of true heading and does not affect the magnetic heading accuracy. To update the world magnetic model select the “File/Download World Magnetic Model” menu item. Browse to the coefficient file if downloaded from the Sparton website or go to the Sparton Update folder to select “WMM.dat” for default coefficients (used to model 2010.0 to 2015.0 date range). Once the file is selected, press the “Select” button (See Figure 27).

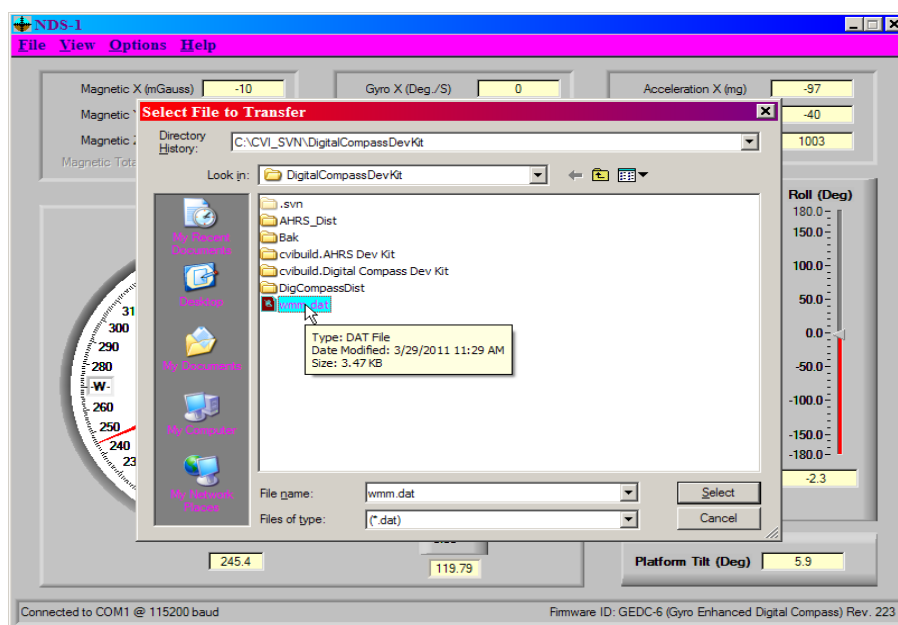


FIGURE 2: COEFFICIENT FILE SELECTION

A progress bar is displayed to show the status of the download (see Figure 28). When the progress bar reaches 100%, the download is complete.

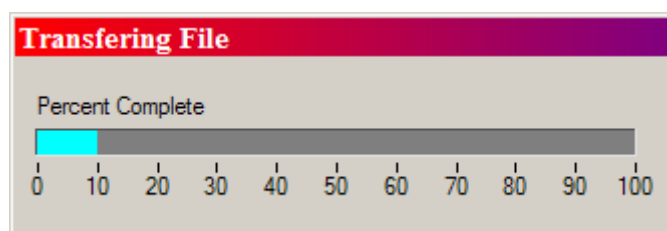


FIGURE 28: UPDATE PROGRESS BAR

Strip Chart Display

The development kit software can display the magnetic, gyro and accelerometer data in a strip chart format (See figure 29). To view the strip chart display select the “View/Strip Chart” menu item.

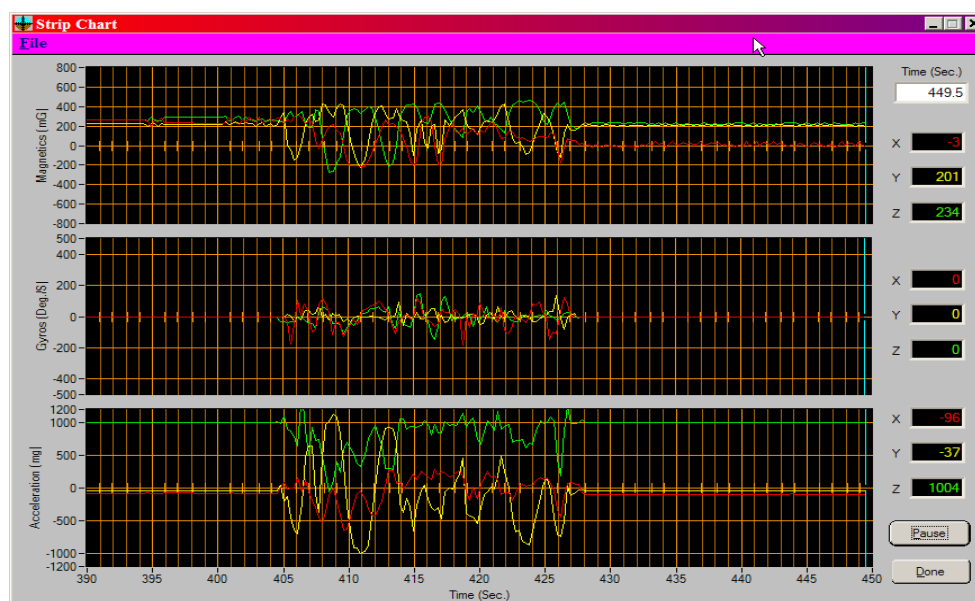


FIGURE 29: STRIP CHART DISPLAY

The strip chart will continue to collect data as long as Windows is not in a tracking loop. If Windows is in a tracking loop then no data will be collected during that time, causing gaps in the time record. To avoid gaps in the time record do not select menu items, move windows around, or move the strip chart cursors with the mouse. Press the “Pause” button to pause the strip chart. While the strip chart is paused individual data points can be read on the right hand indicators by moving the strip chart cursors with the mouse or the keyboard left or right arrow keys. The left and right arrow keys will move the strip chart cursors in large intervals. To move the strip chart cursors one data point at a time hold the “Shift” key down while pressing the left and right arrow keys.

Press the “Done” button to close the strip chart display.

Cockpit Display Mode

The development kit software has a display mode that simulates an aircraft cockpit. To enter the cockpit display mode, select the “View/Cockpit Display” menu item.

The display will show an artificial horizon gauge, a compass gauge, a roll indicator, a pitch indicator and a yaw indicator as depicted in Figure 31. The artificial horizon gauge roll axis is black and encircles the gauge. It is read via the black triangular pointer. The artificial horizon gauge pitch axis is yellow and is read at the center of the gauge. The artificial horizon gauge yaw axis is green and is also read at the center of the gauge. The following table lists the user commands that are available in cockpit display mode:

KEYBOARD COMMANDS

Command	Action
CTRL-H	Toggle the artificial horizon gauge display mode to “heads up” and back.
CTRL-S	This is a standard 9 pin D RS232 connector used to communicate/power the navigation sensor from a PC Serial Port.
ESC or CTRL-D or F10	Return to the default development kit software display mode.

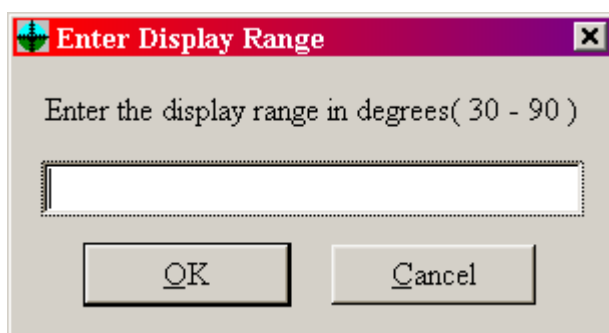


FIGURE 30: DISPLAY RANGE ENTRY DIALOGUE BOX

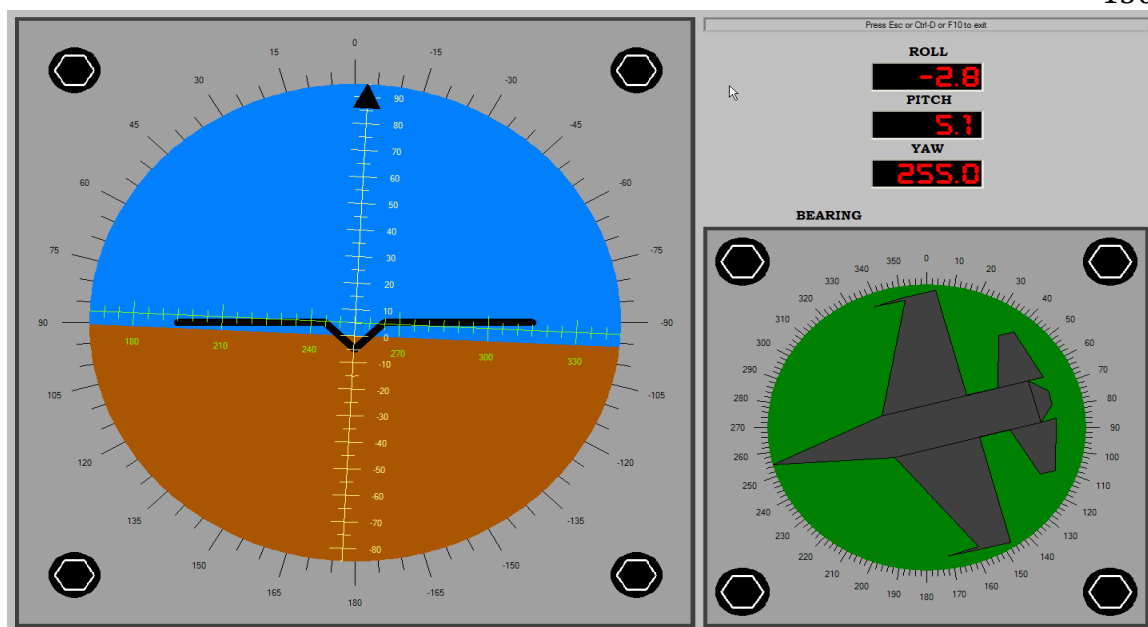


FIGURE 3: COCKPIT DISPLAY

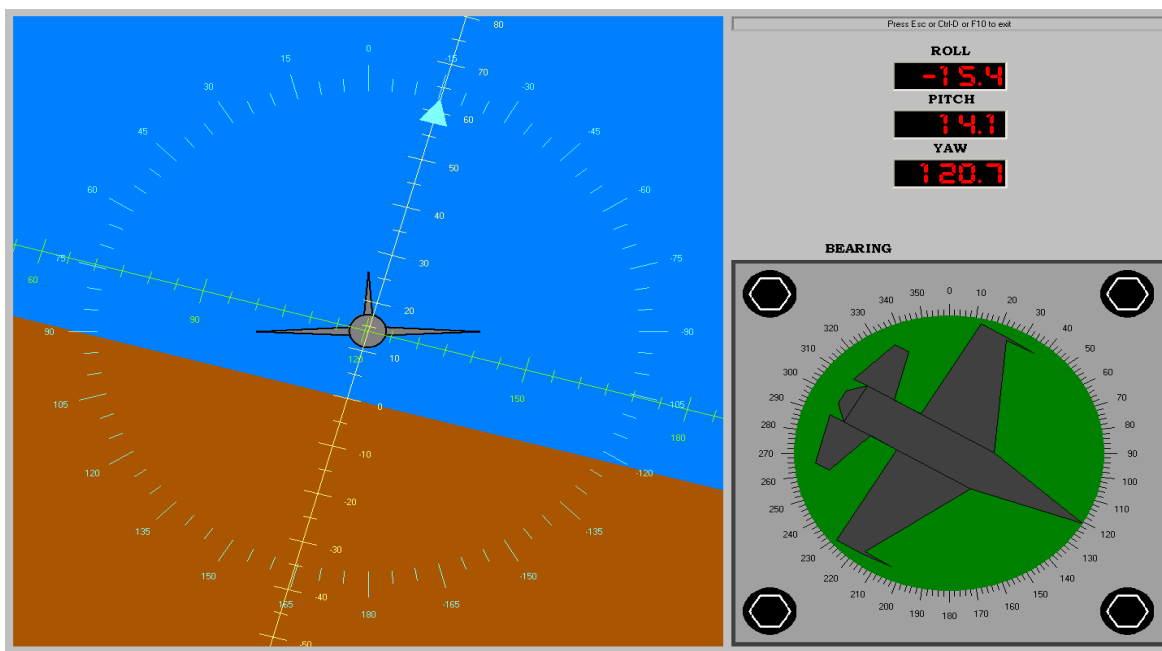


FIGURE 32: HEADS UP COCKPIT DISPLAY

Displaying and Editing Database Variables

The navigation sensor maintains an internal database of certain software variables. The development kit software can display and edit those variables by selecting the “View/Device Variables” menu item. When the menu item is selected the “Device Variables” window will appear (see Figure 33).

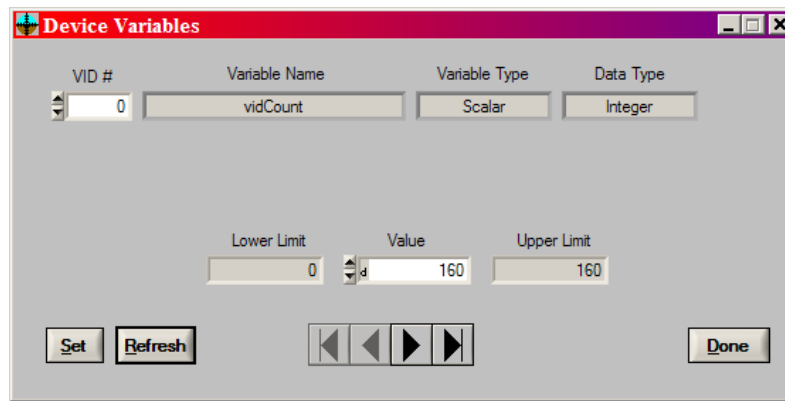


FIGURE 33: DEVICE VARIABLE WINDOW

The “VID #” control displays the zero indexed present variable ID. VID # 0 is always the “vidCount” variable which is the number of variables available to view and edit. Following the “VID #” control are the “Variable Name”, “Variable Type” and “Data Type” indicators (see the Sparton Remote Function Select (RFS) Protocol Interface Design Description document for standard VID numbers, supported variable types, supported data types and the serial protocol definition). The variable data are displayed below the above controls and indicators. The variable data will change depending on the variable type and data type.

To edit the value of a variable enter the new value into the “Value” control then press the “Set” button. If the variable is writeable then the new value will remain in the “Value” control. Otherwise the control will return to its former value if it’s a read only variable or another value if it happens to be a variable that is constantly updated internally (sensor data, for example). Use caution when editing variables (some can have profound effects on navigation sensor operation).

Some variable are constantly updated internally. Press the “Refresh” button to view the latest value of those variables.

To the right of the “Refresh” button are some standard navigation button to browse the variable database.

Some variables (RFS “Bit map” variable type) are constructed of fields that contain other variables. If the value in the “VID #” control corresponds to an RFS “Bit map” variable type then the “Device Variables” window will contain a second line of variable information that identifies the variables contained in the individual fields of the bit map variable (see figure 34). The extra line also has a zero indexed “Field” control to select the desired bit field and a “Fields” indicator to display the total number of fields. To change the variables contained in the bit map press the “Build” button.

The **Device Variables** dialog box displays configuration for a variable with VID # 28. The variable name is "position", its type is "Bit map", and its data type is "Integer" with 8 fields. Below this, a sub-table shows field configuration for Field 0: the variable name is "pitch", its type is "Scalar", and its data type is "Float32". The "Value" field is set to 5.436, with a lower limit of -180.0 and an upper limit of 180.0. At the bottom are buttons for "Set", "Refresh", navigation arrows, "Build", and "Done".

VID #	Variable Name	Variable Type	Data Type	Fields
28	position	Bit map	Integer	8

Field	Variable Name	Variable Type	Data Type
0	pitch	Scalar	Float32

Lower Limit	Value	Upper Limit
-180.0	5.436	180.0

FIGURE 34: BIT MAP VARIABLE

When the “Build” button is pressed the “Build Bit Map VID” window will appear (see figure 35). The “Build Bit Map VID” window contains a list box containing a list of all the allowable bit map variable fields. Select the desired bit map variable fields (or not) then press the “OK” or “Cancel” button.

The **Build Bit Map VID** dialog box features a list box with the following fields: quiet, orientation, baud, pitch, roll, yaw, yawt, quaternion, lat, lonG, alt, day, restorefactorycal, usertofactorycal, set_wmm, magvar, magr, magp, accelr, accelp, gyror, and gyrop. On the right side, there are buttons for "OK", "Cancel", "Select All", and "Clear All". Below these buttons is a label: "Select the Bit Map fields (16 max)".

FIGURE 35: BUILD BIT MAP VID WINDOW

If the “OK” button is pressed then the “Bit Map Info” window will appear displaying the fields that were selected, their VID numbers and their starting bit positions in the bit field (see Figure 36). You may want to save that information if you will be accessing the variable via the serial RFS protocol (see the Sparton Remote Function Select (RFS) Protocol Interface Design Description document for more information on the serial RFS protocol).

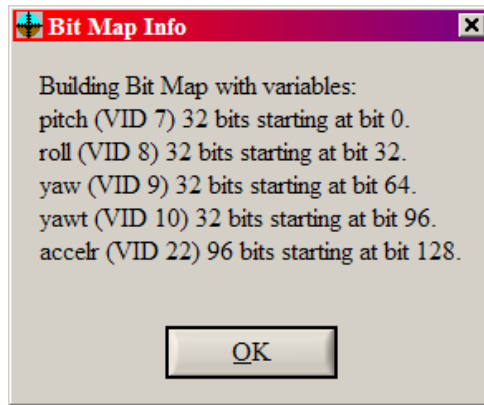


FIGURE 36: BIT MAP INFO WINDOW

Press the “Done” button to close the “Device Variables” window.

Terminal Emulator Mode

The development kit software has a terminal emulator mode that simulates an ASCII data terminal. The terminal emulator can be used to manually send and receive NMEA commands. Select the “Options/Terminal Emulator” menu item to enter the terminal emulator mode. The “Terminal Emulator” window will appear (see Figure 37). Data in the terminal emulator window can be viewed in hexadecimal by selecting the “View/Hexadecimal” menu item. Select the “View/Hexadecimal” menu item again to return to ASCII display mode. The terminal emulator can operate in either half duplex or full duplex by selecting the “Options/Duplex” menu item. The characters that are sent when the “Enter” key is pressed can be set with the Options/Termination String” menu item. The terminal emulator display can be cleared by pressing the “Clear” button.

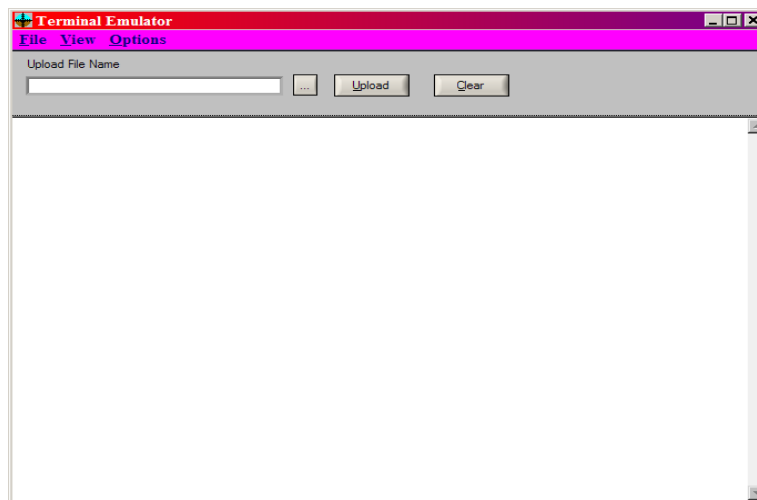


FIGURE 37: TERMINAL EMULATOR WINDOW

The terminal emulator can send a file to the remote device. Press the “...” button to browse for the file name to send or manually enter it in the “File Name” control. The selected file name will

appear in the “File Name” control. Press the “Send File” button to transmit the file to the remote device. The “Send File” button will change to the “Stop” button while the file is being transmitted. Press the “Stop” button to stop sending the file.

Select the “File/Exit” menu item or press the F10 key to close the “Terminal Emulator” window.

Using the Terminal Emulator

The interface is a command line interpreter that uses the Forth programming language syntax, programming model and execution paradigm. For further information on the command syntax *see the Sparton Navigation Modules Software Interface User's Manual on the CD, or at spartonnavex.com.*

Using NDS-1 to Calibrate the Sparton Navigation Sensor

In-Field Magnetic Calibration

In-field magnetic calibration algorithms enable Sparton's navigation products to maintain heading accuracy. When the navigation sensor is mounted in the user's application, any magnetic material (screws, brackets, components, etc) will affect the navigation sensor accuracy if not compensated. In-field calibration is required to remove many of these interferences. Sparton's navigation sensor products use an adaptive algorithm to optimize the magnetic parameters to account for any distortions surrounding the navigation sensor. Depending on the movement allowed by the application, two in-field magnetic calibration modes exist: 2-D and 3-D.

2-D In-Field Magnetic Calibration

The 2-D in-field magnetic calibration mode exists for applications that move in a plane such as a ground vehicle. Applications like this are usually constrained to rotation on a single axis. Sparton's navigation products are capable of being calibrated in any one of three planes defined by XY, YZ, or XZ relative to the navigation sensor. When performing a 2-D calibration, the navigation sensor will determine the plane automatically based on the data collected. Calibrations like this will inherently be less accurate than a 3-D calibration due to the inability of the navigation sensor to calibrate the axis of rotation.

The 2-D calibration can be enhanced by providing your location information such as latitude and longitude. Given your location, the navigation sensor can estimate the magnetic field and use this information to improve the 2-D calibration process. The basic steps for 2-D in-field magnetic calibration are outlined below:

- 1) If your location is known, use Auto Variance to compute your local magnetic parameters
- 2) Invoke the in-field 2D magnetic calibration under Options -> Calibration. Note the NDS-1 software provides instructions to guide the calibration process
- 3) Start the calibration by taking a magnetic measurement at the current orientation by pressing the ‘Cal Point’ button on the GUI.

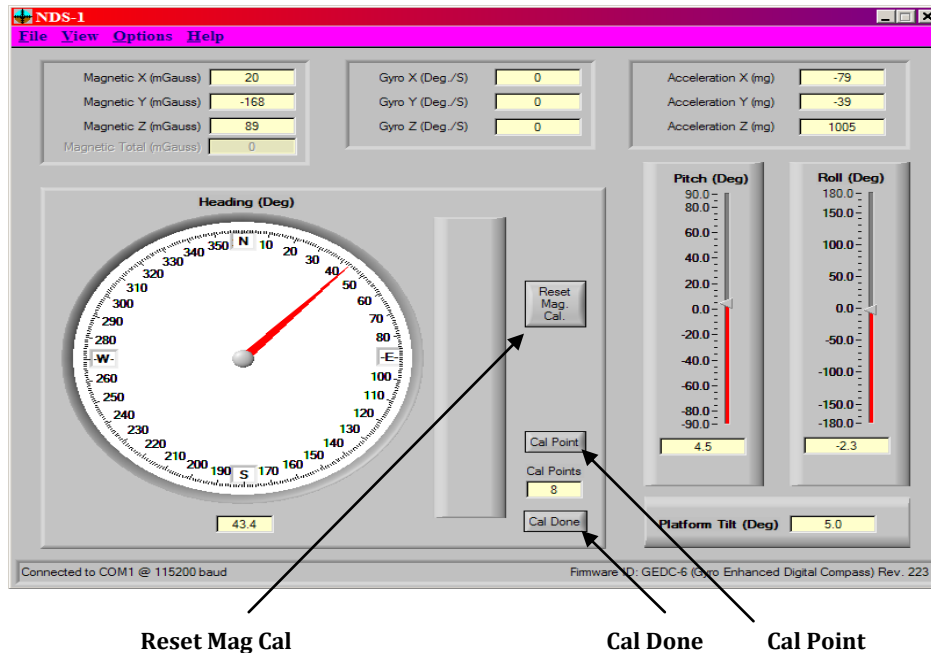


FIGURE 38: CALIBRATION

- 4) Rotate the navigation sensor to a new position and sample another point.
- 5) Repeat step 5 for a minimum of 4 points to a maximum of 12 points. Since this is a 2-D calibration, all rotations should be around a single axis.
- 6) Sampling more points will typically improve the calibration. It is also desirable to spread out the samples so they are not clustered in one direction. Spreading out the samples will improve the speed and accuracy of the final calibration.
- 7) Turn off point capture by pressing 'Cal Done'
- 8) The adaptive algorithm will now process the collected magnetic points to compute the optimal magnetic parameters for the navigation sensor. As the adaptive algorithm converges, the magnetic error will decrease in value.
- 9) When no further improvements to the magnetic error are observed, press 'Cal Done' to complete the calibration process and save the new parameters to non-volatile memory (parameters are saved automatically by the application).

3-D In-Field Magnetic Calibration

The 3-D in-field magnetic calibration mode exists for applications that can be rotated on more than one axis during operation. Applications like this usually have significant mobility in pitch, roll, and yaw. Since the navigation sensor has the opportunity to observe the earth's magnetic field in full 3-dimensions, this calibration provides the most accurate navigation sensor performance. The basic steps for 3-D in-field magnetic calibration are outlined below:

- 1) Invoke the in-field 3D magnetic calibration under Options -> Calibration. Note the NDS-1 software provides instructions to guide the calibration process

- 2) Start the calibration by taking a magnetic measurement at the current orientation by pressing the 'Cal Point' button on the GUI.
- 3) Rotate the navigation sensor to a new position and sample another point.
- 4) Repeat step 4 for a minimum of 4 points to a maximum of 12 points. Since this is a 3-D calibration, there should be a combination of pitch, roll, and yaw movements.
- 5) Sampling more points will typically improve the calibration. It is also desirable to spread out the samples so they are not clustered in one direction. Spreading out the samples will improve the speed and accuracy of the final calibration.
- 6) Turn off point capture by pressing 'Cal Done'
- 7) The adaptive algorithm will now process the collected magnetic points to compute the optimal magnetic parameters for the navigation sensor. As the adaptive algorithm converges, the magnetic error will decrease in value.
- 8) When no further improvements to the magnetic error are observed, press 'Cal Done' to complete the calibration process and save the new parameters to non-volatile memory (parameters are saved automatically by the application).

During the adaption process, the algorithm estimates the error in the magnetic calibration. This error is captured, scaled, and displayed graphically on a vertical bar to indicate the overall performance of the adaptive calibration process. When significant magnetic field distortions are detected, the indicator bar will become mostly red. Over time the distortions will be canceled out and the indicator bar will become mostly green.

The 'Reset Mag Cal' button clears the In-Field calibration values and restores the navigation sensor to the original factory calibration values.

For additional information on design considerations for incorporating navigation sensors, please reference the Sparton Navigation Sensor Product Guide.

Gyro Offset In-Field Calibration Instructions:

The GEDC-6 and AHRS-8 uses an advanced algorithm to continuously track the gyro offsets during normal use. Therefore, calibration of the gyro offsets should not be necessary. If offsets exist in the gyros when the GEDC-6 is stationary, the user would encounter a slow, constant change in orientation (i.e. drifting) over time. The following steps describe how to successfully execute an in-field calibration of the gyros:

- 1) Insure that the GEDC-6/AHRS-8 is stationary. Orientation of the navigation sensor does not matter.
- 2) Invoke the Gyro Offset Calibration option through either the GUI pull-down menu or by sending the proper command.
- 3) Once activated, keep the GEDC-6/AHRS-8 stationary for 30 seconds to insure that the offsets measurements are complete.
- 4) The gyro calibration will end automatically and return to normal gyro offset tracking after about 20 seconds. The new gyro offset will be saved to internal non-volatile memory.
- 5) After 30 seconds from the start of calibration, the GEDC-6/AHRS-8 can be used.

Note: Gyro offset calibration is not applicable to the Sparton DC-4 Navigation Sensor.



Troubleshooting

NDS-1 GUI Can't Connect

If you are trying to get the navigation sensor to work with the NDS-1 adaptor board and it can't connect:

- Verify that the USB/RS232 port selection jumper (P1) is set correctly
- Make sure you don't have something else using that port (you may need to disconnect the GUI to use a terminal emulator and vice versa)
- Verify that the GUI is labelled "NDS-1" in the upper left hand corner to ensure you are not using the legacy GUI
- Check that the RS232 or USB cable is plugged in and seated (both ends)
- Ensure that you don't have the user port outputting repeat data (check with terminal emulator)
- Verify the navigation sensor is seated properly
- Verify the navigation sensor has power (AC adaptor or USB)
- Make sure that the programming jumpers (P3 and P4) are not installed
- Check that your baud rate matches the baud rate setting on the navigation sensor, note that the NDS-1 GUI has an option to try all baud rates if the baud rate is unknown (reference Software Interface User's Manual for terminal emulator commands)
- Validate that your other serial interface properties are 8 bit, no parity, 1 stop bit, no flow control (reference Software Interface User's Manual)

Navigation Sensor Heading is Inaccurate

- Check for magnetic interference in the area, electric motors, chairs, door, cables, cell phone
- Make sure the navigation sensor has its original factory calibration data loaded. This can be accomplished via the 'restorefactorycal' command (reference Software Interface User's Manual)
- The in-field calibration may need to be reset or rerun (eliminates interference of items that are fixed in location relative to the navigation sensor)
- The gyro calibration may need to be rerun
- If you have changed any settings, make sure navigation sensor settings for mount, orientation or boresight matrix are as expected (reference Software Interface User's Manual)
- If you have changed any configuration or calibration data, invoke the "restorefactorycal" command (reference Software Interface User's Manual)

Your Application Cannot Connect

If you are trying to get the navigation sensor to work with your application and get no response:

- Check that you have a 3.3V logic level connection to navigation sensor pins USER_RXD (P2-2) and USER_TXD (P2-3) (reference CONNECTIONS table)
- Verify that the navigation sensor is seated properly (we recommend that you key it by blocking the socket for P1-4) (reference MECHANICAL INTERFACE section of the Sparton Navigation Sensor Product Guide)

- Ensure that the navigation sensor has power on P2-1 (+4V – +10V DC) and ground on P1-7, P2-6, P2-7 (reference DC-4, GEDC-6 or AHRS-8 Data Sheet)
- Make sure the programming pins (P2-4 and P2-5) are high (reference CONNECTIONS table)
- Verify that your baud rate matches the baud rate setting on the navigation sensor (reference Software Interface User's Manual for terminal emulator commands)
- Verify that your other serial interface properties are 8 bit, no parity, 1 stop bit, no flow control (reference Software Interface User's Manual)

This NDS-1 Navigational Development Systems Users Manual is intended to provide an overview of the NDS-1 Navigation Development System hardware and graphic user interface environments. For further information, specifications and software commands on the DC-4, GEDC-6 and AHRS-8 navigation sensors, please reference the Navigation Sensor Product Guide and the associated Software Interface Manual. These documents are provided on the NDS-1 CD for your reference.



For support and a listing of frequently asked questions please visit our website at www.spartonnavex.com