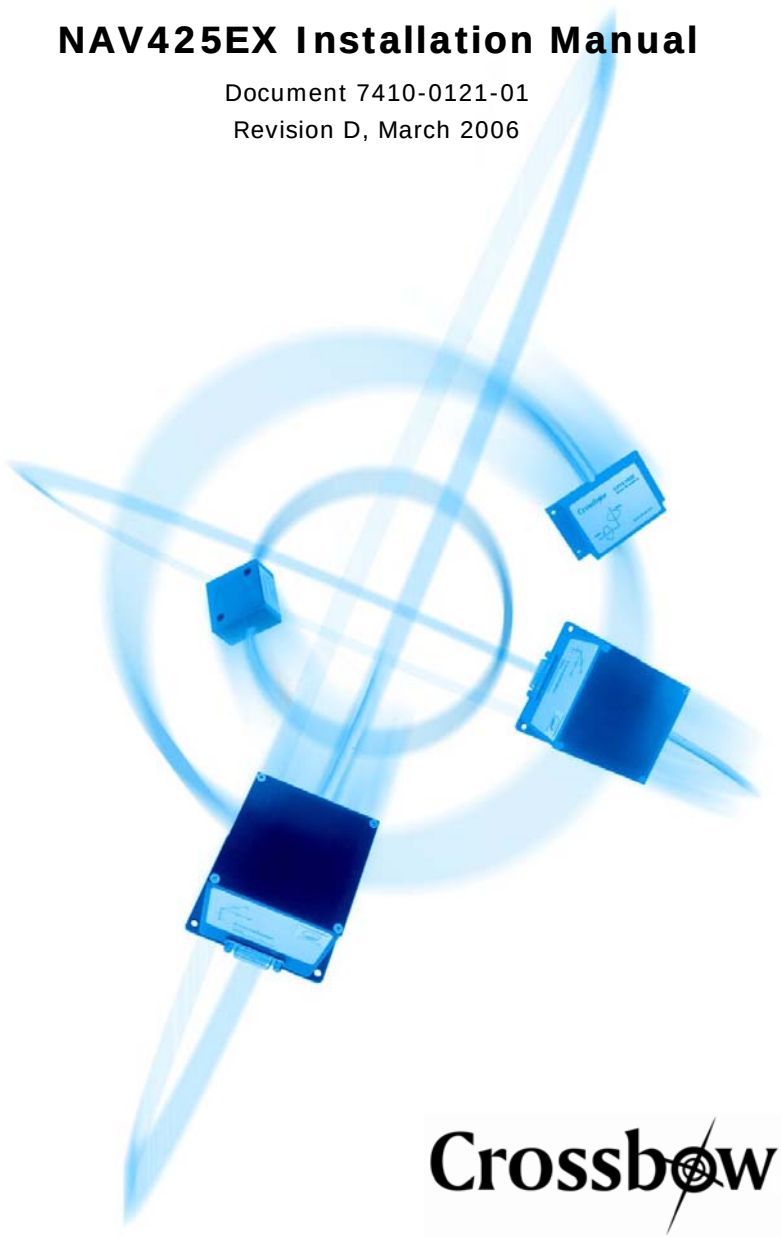
NAV425EX Installation Manual

Document 7410-0121-01
Revision D, March 2006



Crossbow

Crossbow Technology, Inc., 4145 N. First Street, San Jose, CA 95134
Tel: 408-965-3300, Fax: 408-324-4840
email: info@xbow.com, website: www.xbow.com

Table of Contents

About this Manual

The following annotations have been used to provide additional information.

NOTE

Note provides additional information about the topic.

☑ EXAMPLE

Examples are given throughout the manual to help the reader understand the terminology.

IMPORTANT

This symbol defines items that have significant meaning to the user

WARNING

The user should pay particular attention to this symbol. It means there is a chance that physical harm could happen to either the person or the equipment.

The following paragraph heading formatting is used in this manual:

1 Heading 1

1.1 Heading 2

1.1.1 Heading 3

Normal

1 Introduction

1.1 Purpose

This manual describes installation of the NAV425EX, a combined Navigation and Attitude Heading Reference System. The NAV425EX is intended for use in uncertified and experimental aircraft. This manual will discuss installation, calibration, and checkout procedures to help get you flying successfully with the NAV425EX.

1.2 The NAV425EX System Description

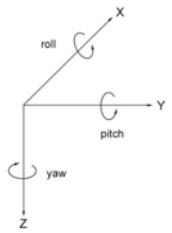
The Crossbow NAV425EX uses a 3-axis accelerometer and a 3-axis rate sensor to make a complete measurement of the dynamics of the aircraft. The addition of a 3-axis magnetometer inside the NAV425EX allows it to make a true measurement of magnetic heading without an external flux valve. With the addition of a Global Positioning System (GPS) receiver this system becomes a low-cost INS that can output location, velocity and acceleration in addition to attitude. The Crossbow NAV425EX is a solid-state equivalent of a vertical gyro/artificial horizon display combined with a directional gyro, flux valve and GPS.

The NAV425EX employs onboard digital processing to compensate for deterministic error sources within the unit and to compute attitude information. The NAV425EX accomplishes these tasks with high performance analog to digital converters and Digital Signal Processors (DSP). The NAV425EX products utilize a sophisticated Kalman filter algorithm to allow the unit to track orientation accurately through dynamic maneuvers. The Kalman filter will automatically adjust for changing dynamic conditions without any external user input. No user intervention or configuration is required at power-up.

The NAV425EX units are light-weight, low power, fast turn-on, reliable and accurate. This product contains precision sensors and should be handled with care. Do not expose the NAV425EX to large magnetic fields. This could permanently magnetize internal components and degrade its magnetic heading accuracy.

1.3 The NAV425EX Coordinate System

The NAV425EX has a coordinate system as shown in Figure 1. With the connector facing you, and the mounting plate down, the axes are defined as:



X-axis – from face with connector through the NAV425EX

Y-axis – along the face with connector from left to right

Z-axis – along the face with the connector from top to bottom

Figure 1 NAV425EX Coordinate System

The axes form an orthogonal right-handed coordinate system. An acceleration is positive when it is oriented towards the negative side of the coordinate axis. For example, with the NAV425EX sitting on a level table, it will measure zero g along the x- and y-axes and +1 g along the z-axis. Gravitational acceleration is directed downward, and thus will be defined as positive for the NAV425EX z-axis.

The angular rate sensors are aligned with these same axes. The rate sensors measure angular rotation rate around a given axis. The rate measurements are labeled by the appropriate axis. The direction of a positive rotation is defined by the right-hand rule. With the thumb of your right hand pointing along the axis in a positive direction, your fingers curl around in the positive rotation direction. For example, if the NAV425EX is sitting on a level surface and you rotate it clockwise on that surface, this will be a positive rotation around the z-axis. The x- and y-axis rate sensors would measure zero angular rates, and the z-axis sensor would measure a positive angular rate.

The magnetic sensors are aligned with the same axes definitions and sign as the linear accelerometers.

Pitch is defined positive for a positive rotation around the y-axis (pitch up). Roll is defined as positive for a positive rotation around the x-axis (roll right). Yaw is defined as positive for a positive rotation around the z-axis (turn right).

The angles are defined as standard Euler angles using a 3-2-1 system. To rotate from the body frame to an earth-level frame, roll first, then pitch, and then yaw.

IMPORTANT

The NAV425EX should be mounted in the aircraft with its baseplace down and connectors aft.

1.4 Connections

The NAV425EX has a male DB-15 connector. The signals are as shown in Table 1.

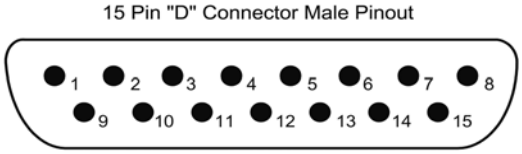


Table 1 Connector Pin Assignments

Pin	Signal
1	RS-232 Transmit Data
2	RS-232 Receive Data
3	Positive Power Input (+Vcc)
4	Power Ground
5	Chassis Ground
6	NC – Factory use only
7	NC – Factory use only
8	NC – Factory use only
9	Signal Ground
10	NC – Factory use only
11	NC – factory use only
12	NC – factory use only
13	BIT Status
14	NC – factory use only
15	NC – factory use only

1.5 Data Interface

The NAV425EX serial interface is standard RS-232, 9600 baud, 8 data bits, 1 start bit, 1 stop bit, no parity, and no flow control, and will output data packets at 25 Hz.

1.6 Magnetic Heading

Magnetic north is the direction toward the magnetic north pole; true north is the direction towards the true North Pole. The NAV425EX yaw angle output is referenced to magnetic north. The direction of true north will vary from magnetic north depending on your position on the earth. The difference between true and magnetic north is called declination or

magnetic variance. You will need to know your declination if you want to translate the NAV425EX magnetic heading into a heading referenced to true north.

1.7 Package Contents

You should have received:

- **1 NAV425EX Product**
- **1 NAV425EX Installation Manual**

  This manual is also available on the included software CD.
- **1 CD with NAV-VIEW software**

  NAV-VIEW software will allow you to view data and calibrate the magnetometers on the NAV425EX on a PC running Microsoft® Windows XP™. You can also download this software from Crossbow's web site at http://www.xbow.com.
- **1 Digital Signal Calibration/Maintenance Cable**

  The cable links the NAV425EX directly to a serial port on a PC running Microsoft Windows for installation and maintenance functions. Power is provided by the aircraft wiring harness but the serial output data stream from the NAV425EX is directed to the maintenance PC.

1.8 Unpacking the Equipment

Carefully unpack the equipment and verify all the major system components have been received. Visually inspect the package contents for any evidence of shipping damage. Retain the shipping container and packaging material in case reshipment is necessary.

IMPORTANT

The NAV425EX should not be dropped or exposed to large magnetic fields. This could permanently magnetize internal components of the NAV425EX and degrade its magnetic heading accuracy.

2 Quick Start

2.1 NAV-VIEW Software

Crossbow includes NAV-VIEW software to allow you to use the NAV425EX right out of the box and the evaluation is straightforward. Install the NAV-VIEW software, connect the NAV425EX to your serial port, apply power to your unit and start taking measurements.

2.1.1 NAV-VIEW Computer Requirements

The following are minimum capabilities that your computer should have to run NAV-VIEW successfully:

- CPU: Pentium-class
- RAM Memory: 64MB minimum, 128MB recommended
- Hard Drive Free Memory: 17MB
- Operating System: Windows 98, NT4, 2000, XP

2.1.2 Install NAV-VIEW

To install NAV-VIEW in your computer:

1. Insert the CD in the CD-ROM drive.
2. Find the NAV-VIEW folder. Double click on the setup file.
3. Follow the setup wizard instructions. You will install NAV-VIEW and a LabVIEW Runtime Engine. You will need both these applications.

If you have any problems or questions, you may contact Crossbow directly.

2.2 Connections

The NAV425EX is shipped with an installation and calibration cable to connect the unit to a PC communications port.

1. Connect the 15-pin female end of the calibration cable to the port on the NAV425EX.
2. Connect the 15-pin male end of the calibration cable to the aircraft cable connector which supplies power.
3. Start the computer before connecting the 9-pin end of the cable to the serial port of the computer. Later versions of Windows, especially Windows 2000 and Windows XP, interpret a connection to the serial port at boot time as a serial mouse. The operating system will load the mouse driver and interpret the data from the

NAV425EX as mouse commands if the NAV425EX is connected before the computer is started and booted.

4. Connect the 9-pin end of the cable to the serial port of your computer.
5. Apply power and let the NAV425EX initialize for 60 seconds.
6. With the NAV425EX connected to your PC serial port and powered, run the NAV-VIEW software.

2.3 Setting up NAV-VIEW

With the NAV425EX connected to your PC serial port and powered, open the NAV-VIEW software.

1. NAV-VIEW should automatically detect the NAV425EX and display the serial number and firmware version if it is connected.
2. If NAV-VIEW does not connect, check that you have the correct COM port selected. You find this under the "DMU" menu.
3. Select the type of display you want under the menu item "Windows". Graph displays a real time graph of all the NAV425EX data; FFT displays a Fast-Fourier transform of the data; Navigation shows an artificial horizon display.
4. You can log data to a file by entering a data file name. You can select the rate at which data is saved to disk.
5. If the status indicator says, "Connected", you're ready to go. If the status indicator doesn't say connected, check the connections between the NAV425EX and the computer; check the power; check the serial COM port assignment on your computer.

2.4 Take Measurements

Once you have configured NAV-VIEW to work with your NAV425EX, pick what kind of measurement you wish to see. "Graph" will show you the output you choose as a strip-chart type graph of value vs. time. "FFT" will show you a real-time Fast-Fourier transform of the output you choose. "Navigation" will show an artificial horizon and the stabilized roll, pitch and heading output of the NAV425EX.

Let the NAV425EX warm up for 60 seconds each time when first turned on. This allows the Kalman filter to estimate the rate sensor biases. ***The NAV425EX needs to be held still (motionless) during this period.*** Now you're ready to use the NAV425EX!

3 Limitations

3.1 Large Magnetic Field Exposure

The NAV425EX should not be exposed to large magnetic fields. This could permanently magnetize internal components of the NAV425EX and degrade its magnetic heading accuracy.

WARNING

Do not stick a magnet to the NAV425EX.

3.2 Mechanical and Vibration

The NAV425EX must be installed in a location that is rigid to alleviate potential vibration errors induced from normal airframe vibration sources.

The mounting plate must be stiff enough to rigidly follow the aircraft motions without inducing low frequency motions relative to the aircraft.

3.3 Magnetic Environment

The NAV425EX uses a set of sensitive magnetometers inside its housing to measure Earth's weak magnetic field to determine heading. As a result, small amounts of moving magnetic material near the NAV425EX can have large effects on the heading measurement.

The NAV425EX should be isolated from magnetic material as much as possible. Magnetic material will distort the magnetic field near the NAV425EX, which can affect its accuracy as a heading sensor.

Materials to avoid include anything that will stick to a magnet: iron, carbon steel, some stainless steels, nickel and cobalt. Use a magnet to test materials that will be near the NAV425EX. The NAV425EX can correct for the effect of these magnetic fields by using hard and soft iron calibration routine as long as the material is stationary.

Materials that will not affect the magnetic heading performance include aluminum, brass, plastic, titanium, wood, and some stainless steels. Again, if in doubt, try to stick a magnet on the material. If the magnet doesn't stick, you are working with a material that will not affect the heading.

Stationary ferrous objects will be compensated for by the calibration procedure. Moving ferrous objects within 24 inches cannot be compensated for by the calibration. The NAV425EX must not be located within 24 inches of any large moving ferrous metal objects such as landing gear components, electric motors, control linkages, etc. Ferrous metal objects that may change position during flight operations, such as landing gear, flap

actuators, and control linkages must not be within 24 inches of the NAV425EX.

The NAV425EX should not be located close to high current DC power cables or 400 cycle AC power cables and their associated magnetic fields.

3.4 Hard and Soft Iron Calibration

The NAV425EX must successfully complete a hard iron and soft iron calibration to reach full accuracy. Refer to Section 6.2 of this manual for detailed instructions.

3.5 Range Limitations

The internal sensors in the NAV425EX are limited to maneuvers of less than 200 deg/sec and less than 4 Gs acceleration in bank, pitch, and heading. Overrange of a sensor will induce attitude errors that will be corrected over time depending on the severity of the overrange. The NAV425EX, like all magnetometer and magnetic compass-based systems, will not perform properly at the magnetic North and South Poles.

3.6 GPS Antenna Connection

A GPS receiver needs to receive signals from as many satellites as possible. Good sky visibility is therefore a prerequisite. Even the best receiver can't make up for signal loss due to a poor cable or antenna, in-band jamming from nearby RF sources, or poor sky view.

An external active antenna (not provided) must be connected properly to the SMA connector on the NAV425EX. The antenna cable should be at least 2 ft long and not longer than required to reach from the NAV425EX to the antenna. Coiling, looping, or running the antenna cable next to RF sources should be avoided. If using a GPS antenna with a magnetic base, do not place the antenna on or next to the NAV425EX.

3.7 GPS Antenna Selection

An aviation grade active L1 GPS antenna is required for adequate heading, attitude, and position performance. We recommend an antenna and RF cable from AntCom Corporation (www.antcom.com) in Torrance, CA. Please contact them directly for purchasing an antenna and RF cable that suits your needs. We recommend antenna P/N: 2G15A-XS-1. The NAV425EX GPS RF connector is an SMA type.

IMPORTANT

Place the antenna with good sky visibility and use a ground plane if required by the antenna.

4 NAV425EX Pre-Installation Check out

This section describes the procedures to be used before final installation of the NAV425EX. These procedures describe the installation location selection for the NAV425EX. Please review section on limitations before you proceed.

4.1 Pre-Mod Avionics Test

Perform a pre-modification avionics systems test to verify that the systems that will be connected to the NAV425EX are working properly in accordance with their appropriate maintenance manuals.

4.2 Mating Connector Crimp Tools

A crimp tool recommended by the mating tool manufacturer should be used to ensure consistent and reliable crimp contact connections for the mating connector.

4.3 Pre-Mod Load Review

Complete an electrical load analysis on the aircraft prior to installing the NAV425EX to ensure the aircraft has the electrical load capacity to carry the new load. The NAV425EX will consume less than 5 Watts of power.

4.4 Installation Location Selection

4.4.1 Introduction

Selecting the location for the NAV425EX is a two-step process.

- The first step is to find a “proposed” location based on the criteria in this section.
- The second step is using the NAV425EX and the NAV-VIEW software to survey the proposed location for magnetic interference from other aircraft systems.

4.4.2 Location and proximity to IDU (Integrated Display Unit)

The NAV425EX can be mounted inside or outside of the pressure vessel. Most aircraft can accommodate the NAV425EX behind the aft cabin bulkhead.

4.4.3 Mounting Structure

The NAV425EX must be installed in a location that is rigid to alleviate potential vibration errors induced from normal airframe vibration sources.

The mounting plate must be stiff enough to rigidly follow the aircraft motions without inducing low frequency motions relative to the aircraft. If you have any doubt concerning the NAV425EX location suitability, please contact your Crossbow technical representative by phone at (408) 965-3300, or visit our website at http://www.xbow.com

4.4.4 Magnetic Environment Considerations

The NAV425EX uses sensitive magnetometers to detect heading and for roll/pitch corrections. As a result the unit must be placed in a magnetically clean environment away from moving metal parts and wires with pulsating current.

WARNING

For the NAV425EX to function properly in a tubular steel fuselage aircraft, you must completely degauss the airframe prior to NAV425EX installation. It may be necessary to degauss flight control cables near the NAV425EX location to prevent magnetic interference.

4.4.4.1 Distance from moving ferrous (iron and steel) metallic objects

The NAV425EX must not be located within 24 inches of any large, moving, ferrous metal objects such as landing gear components, motors, steel control cables or linkage. Avoid any metallic objects that may change position between ground operations and flight operations, such as landing gear, flap actuators, and control linkages.

4.4.4.2 Distance from electrical wires

The NAV425EX should not be located close to high current DC power cables or 400 cycle AC power cables and their associated magnetic fields. Wires carrying high currents, alternate currents, or intermittent currents can cause magnetic variations that will affect the NAV425EX. Keep wires with these characteristics at least 24 inches away from the NAV425EX. These wires can include:

- Battery wires
- Strobe wires
- Autopilot control wires
- Position light wires
- De-ice boot wires

Air conditioning power wires

HF control wires

4.4.5 NAV425EX Alignment with the aircraft

The NAV425EX will measure rotations around the axes of its sensors. The NAV425EX sensors are aligned with the baseplate. The baseplate references are noted in the mechanical drawing and are used as reference surfaces for aligning the NAV425EX sensor axes with the aircraft. The NAV425EX should be aligned as closely as possible with the axes you define in your system. Errors in alignment will contribute directly to errors in measured acceleration and rotation relative to your system axes. The ideal location of the NAV425EX is as close to the pitch and roll axes as possible. When faced with a decision between the two, it is better for the NAV425EX to be near or on the roll axis.

4.4.5.1 CG Alignment

The NAV425EX should be mounted as close to the center of gravity (CG) of your system as possible. This will minimize any possible "lever effect." If it is not mounted at the center of gravity, then rotations about the center of gravity may cause the NAV425EX accelerometers to measure acceleration proportional to the product of the angular rate squared and the distance between the NAV425EX and the aircraft CG

4.4.5.2 Attitude Leveling

The NAV425EX must be level on the yaw and roll planes of rotation when the aircraft is in straight and level flight. The pitch axis must be level to the aircraft when aircraft is leveled for weight and balance measurements.

4.4.5.3 Longitudinal Alignment

The NAV425EX connector must face aft of the aircraft.

It is important that the NAV425EX is properly aligned with the longitudinal axis of the aircraft and NOT with the fuselage skin. The alignment of the NAV425EX baseplate and the longitudinal axis must be within 0.5 degree for proper operation. The NAV425EX includes alignment holes on the base which may be used as a means for centering the unit on the aircraft. Please refer to the Appendix for the exact locations of the alignment pins.

WARNING

The NAV425EX must be aligned with the centerline of the aircraft. Failure to align the NAV425EX with the aircraft centerline will cause errors in heading that cannot be corrected.

4.4.6 Survey the Location for Magnetic Interference

The NAV425EX may be used to survey the proposed location for magnetic interference by other aircraft systems. The procedure uses the NAV425EX, located in the proposed location, and a laptop computer to survey the magnetic environment.

Temporarily mount/locate the NAV425EX in the proposed location.

Connect the NAV425EX using the calibration maintenance cable

Use the NAV-VIEW software to assess heading changes while operating the aircraft subsystems with the aircraft facing one of the ordinal directions N, S, E, or W. Repeat with the aircraft rotated 90 degrees to another ordinal direction. Use the NAV-VIEW software to determine the best location of the NAV425EX by selecting the Navigation Window and viewing the heading deviations as systems around the NAV425EX are activated, deactivated, and operated throughout their functions. A good location will not display more than a 4° heading change when all systems are operated. Systems should include operation of flaps, landing gears, and engines.

Step 1: Temporarily mount the NAV425EX in the proposed location.

Step 2: Install the NAV-VIEW Software on a portable computer

Step 3: Calibration Cable Connections

Step 4: NAV-VIEW Initialization

Upon opening the NAV-VIEW software, the software runs automatically. The following screen appears and stays on for 3 seconds. Please observe the disclaimer, which is shown on the screen:

Step 5: Magnetic Environment Survey Process

The survey process will assess the affect of aircraft subsystems on the NAV425EX heading performance. The heading display in the NAV-VIEW software will be used to observe changes in heading as the aircraft subsystems are actuated.

Point the aircraft to an ordinal heading

If possible, align the aircraft along an ordinal heading of North, South, East or West. Precision alignment is not necessary. Make sure the NAV425EX has completed the 60 second initialization period. Observe the heading reading on the NAV-VIEW software. ***Cycle mechanical subsystems and electrical subsystems that might interfere with the NAV425EX heading while checking for* heading errors**. Errors in heading will accumulate

gradually and can take up to two minutes to build to unacceptable levels. Be sure to observe trends in heading while you perform these checks and allow error to build to fully account for its severity if you suspect a system might be interfering with the magnetometers. Move all control cables to their full extents and operate all equipment to ensure that there are no adverse affects to the NAV425EX heading. An adverse affect would be a heading change of more than 4° at any time. A good location will not display more than a 4° heading change when all systems are operated. Systems can include operation of flaps, landing gears, and engines.

Rotate the Aircraft through approximately 90 degrees

Rotate the aircraft along an ordinal heading of North, South, East or West that is 90 degrees from the previous position. Precision alignment is not necessary. Make sure the NAV425EX has completed the 60 second initialization period. Observe the heading reading on the NAV-VIEW software. ***Cycle mechanical subsystems and electrical subsystems that might interfere with the NAV425EX heading while checking for heading errors.*** A good location will not display more than a 4° heading change when all systems are operated. Systems can include operation of flaps, landing gears, and engines. Repeat this for all the 4 ordinal heading directions (North, South, East and West) and ensure that satisfactory heading is obtained.

If the heading performance is not satisfactory, find a new location and repeat the test.

5 NAV425EX Installation Procedure

5.1 Secure the NAV425EX Wiring

The NAV425EX must be mounted clear of any wiring bundles, strobe lines, antennas, or anything that may cause magnetic or electrical interference. Secure the wiring allowing access and movement of the NAV425EX unit. Prepare, install, route, and terminate the connecting aircraft cable for the NAV425EX. Ensure the system wiring is routed separately from 400 cycle AC and high current DC power cables.

5.2 Degauss Control Cables and Hardware

Degauss all control cables, attachment hardware, and other equipment located within a 24 inch area of the NAV425EX unit using a hand-held degausser. Most audio and video degaussing units can be used.

5.3 Permanently Mount the NAV425EX

Find or manufacture a rigid mounting location of at least 0.040 inches (min) thick aluminum with sufficient stiffeners to alleviate potential vibration errors induced from normal airframe vibration (engine, control surfaces, etc.). Prepare a mounting plate in accordance with the NAV425EX Installation drawing and in accordance with good practice and procedures for mounting to the aircraft structure Secure the NAV425EX Unit to the airframe being careful to install all of the shims that were required to level on the yaw and roll planes of rotation when the aircraft is in a straight and level flight attitude. Use non-ferrous hardware where possible to reduce magnetic interference with the NAV425EX.

6 NAV425EX Post Installation Procedures

6.1 Hard/Soft Iron Calibration Introduction

The NAV425EX will need to be calibrated for hard and soft iron compensation before use with the aircraft. The NAV425EX series use magnetic sensors to compute heading. Ideally, the magnetic sensors would be measuring only earth's magnetic field to compute the heading angle. In the real world, however, residual magnetism in the NAV425EX itself and in your system will add to the magnetic field measured by the NAV425EX.

The extra magnetic field can create errors in the heading measurement if they are not compensated. These extra magnetic fields are called hard iron magnetic fields. In addition, magnetic material can change the direction of the magnetic field as a function of the input magnetic field. This dependence of the local magnetic field on input direction is called the soft iron effect. The NAV425EX measures any extra constant magnetic field that is associated with the NAV425EX or your aircraft and corrects for it during the calibration procedure. The NAV425EX can also make a correction for some soft iron effects. The process of measuring these non-ideal effects and correcting for them is called hard iron and soft iron calibration. Calibration will help correct for magnetic fields that are fixed with respect to the NAV425EX. It cannot compensate for time varying fields, or fields created by parts that move with respect to the NAV425EX.

The NAV425EX accounts for the extra magnetic field by making a series of measurements. The NAV425EX uses these measurements to model the hard iron and soft iron environment in your aircraft.

6.2 NAV425EX Hard and Soft Iron Calibration Procedure

The hard and soft iron calibration procedure is performed in place on the aircraft using the calibration/maintenance cable, a portable PC running Windows, and NAV-VIEW software provided by Crossbow Technology, Inc. The aircraft will then need to be rotated through a complete circle(s) while using the NAV-VIEW software. The calibration software will notify the user through the Message Box when the circle has been completed and report the calibration parameters calculated. A few rotations of the aircraft will be required to verify consistency in the calculated calibration parameters.

It is required that you do the calibration process with the NAV425EX installed in your system. If you do the calibration process with the NAV425EX by itself, you will only correct for the magnetism internal to the NAV425EX. If you then install the NAV425EX in an aircraft and the

magnetic environment is different, you will still see errors arising from the magnetism of the aircraft environment.

6.2.1 Equipment Needed

The following equipment and software is needed to perform the hard and soft iron calibration:

- **1 CD with NAV-VIEW Software**

  The NAV-VIEW graphically displays the NAV425EX output and provides step-by-step calibration instructions on a PC running Microsoft® Windows™. You can also download this software from Crossbow's web site at http://www.xbow.com.

- **1 Digital Signal Calibration/Maintenance Cable.**

  This links the NAV425EX directly to a serial port on a PC running Microsoft Windows for installation and maintenance functions. The cable provides aircraft power to the NAV425EX and redirects the serial data to the maintenance PC.

- **1 Portable computer**

  The computer should be a portable "laptop" style if possible with a serial port and Windows® type operating system. The following are minimum capabilities that your computer should have to run NAV-VIEW successfully:

  CPU: Pentium-class

  RAM Memory: 64MB minimum, 128MB recommended

  Hard Drive Free Memory: 17MB

  Operating System: Windows 98, NT4, 2000, XP

  Freely available RS-232 compatible Serial Port

  National Instruments Driver: LabVIEW RunTime Engine 6.1, which comes with NAV-VIEW software.

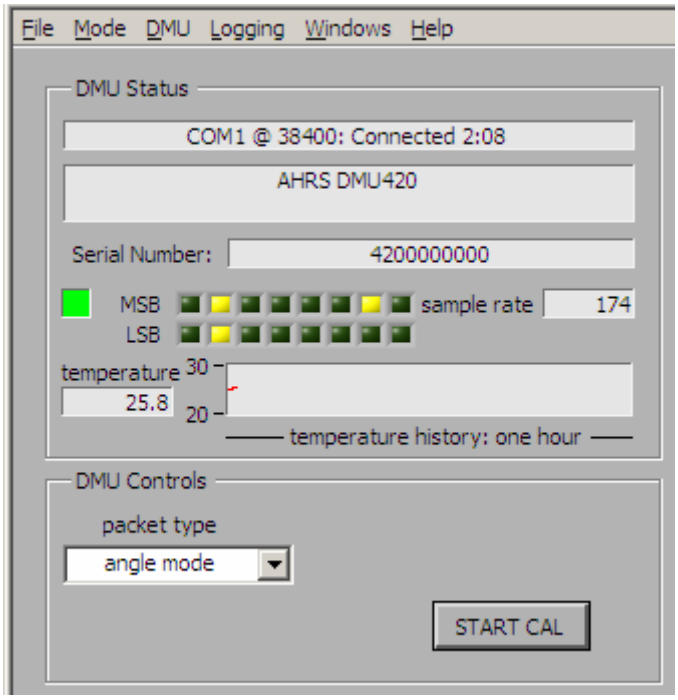
After finishing the steps aforementioned in Section 4.4.6, the program is ready to perform the calibration.

6.2.2 Calibration Process Overview

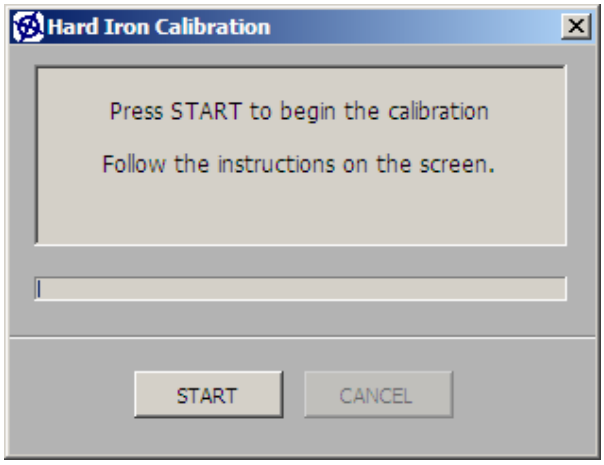
There are several steps to the calibration process that are repeated until the NAV425EX has collected enough data to compute a hard and soft iron compensation that meets the performance requirements. The calibration steps are:

1. Apply power to the NAV425EX.
2. Start NAV-VIEW software and make sure communication is established.

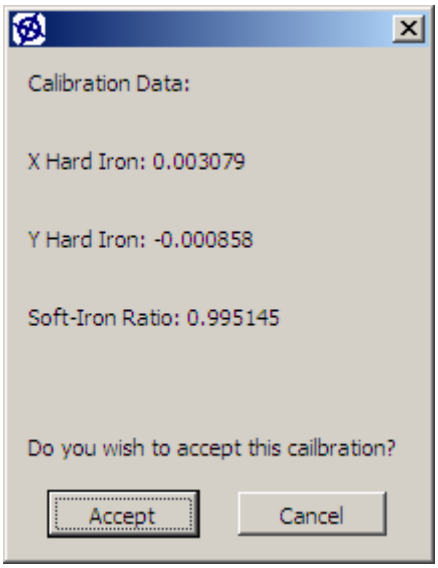
3. Wait 60 seconds for initialization to complete.
4. Click “PRESS CAL” button on the NAV-VIEW control panel.



5. The following message will appear, click Start to begin the calibration.



6. Slowly rotate the aircraft through a 380 degree turn (10-20 degrees per second is ideal) until the following message appears.
7. Stop the turn and write down the three calibration parameters displayed. These numbers represent the magnetic environment around the NAV425EX.



8. Click “Accept” to store the calibration or “Cancel” to ignore the calibration.
9. Disconnect power from the NAV425EX.
10. Wait 10 seconds.
11. Repeat this calibration procedure to verify consistency in the calibration parameters. Each parameter should not deviate more than 0.01 between calibrations.

6.3 Testing the NAV425EX Calibration

6.3.1 Heading Calibration

The heading calibration can be tested by comparing the heading output of the NAV425EX on the primary flight display against a known reference such as a compass, compass rose, or runway with known heading.

Align the aircraft along an ordinal heading of North, South, East or West. Make sure the NAV425EX has completed the 60 second static initialization period. Observe the heading reading on the NAV-VIEW software. Make sure heading reading agrees within 4^0 of the reference. Rotate the aircraft

along an ordinal heading of North, South, East or West that is 90 degrees from the previous position. Observe the heading reading on the NAV-VIEW software and make sure that this agrees within 4° from the reference. A good calibration will not display more than a 4° heading change once the turning is stopped. Repeat this test for all the four ordinal heading directions.

Significant errors in the NAV425EX heading calibration indicate improper calibration or improper operation of the NAV425EX. If the heading errors are greater than 4°, go back to section 6.2.2 and repeat the NAV-VIEW procedure until a satisfactory heading performance is obtained.

6.3.2 Attitude Calibration

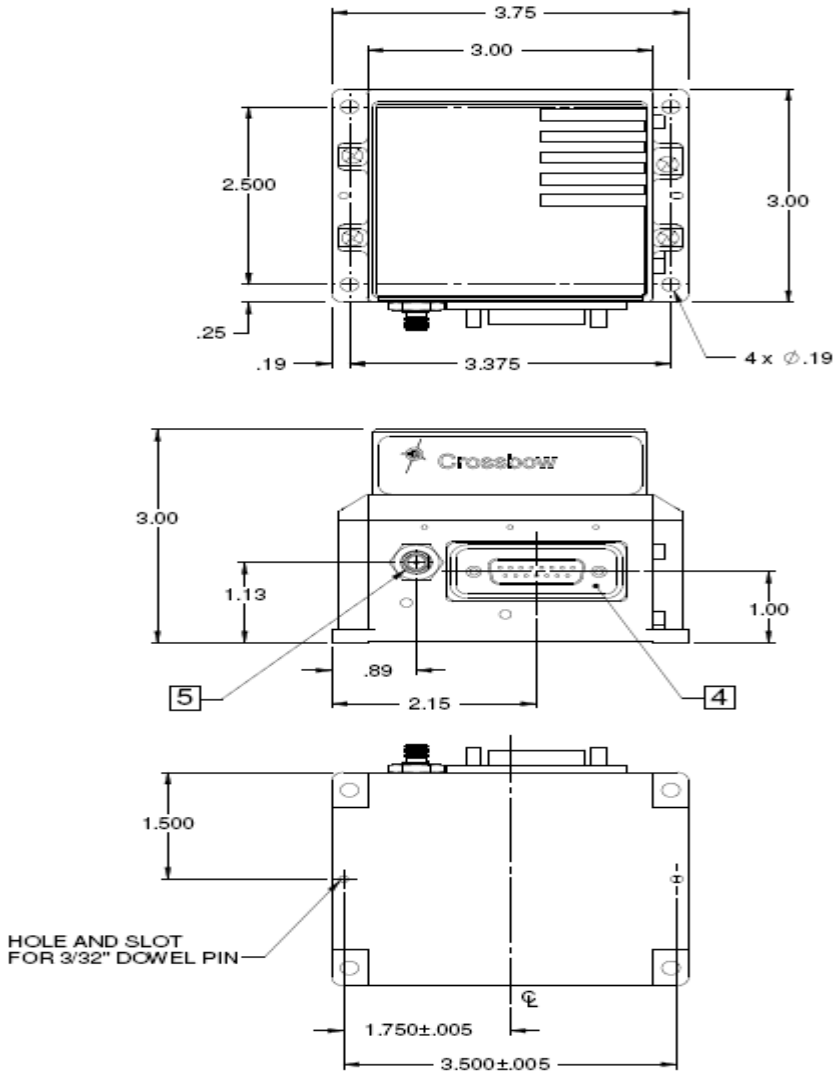
After installation is complete and while flight testing the aircraft, note the displayed attitude from the PFD while in level flight. If the display horizon line is shown too high, the NAV425EX must be tilted "nose up" a corresponding amount to bring the horizon line to the center of the screen. If the display horizon line is shown too low, the NAV425EX must be tilted "nose down" a corresponding amount to bring the horizon line to the center of the screen.

Likewise, if the PFD page shows a slight bank when the aircraft is in level flight, shimming may be required. Typically, the horizon line of the PFD should be near the center of the display when the aircraft is loaded with its typical payload. Once set, a discernible difference in aircraft attitude will be noticed throughout the range of airspeed, weight, and angle of attack combinations.

Carefully shim the NAV425EX with non-ferrous washers as needed. Repeat the magnetic hard and soft iron calibration process after a change in attitude calibration.

7 Appendix A. Mechanical Specifications

7.1 NAV425EX Mechanical Drawing



8 Support Information

8.1 Customer Service

As a Crossbow Technology customer you have access to product support services, which include:

- Single-point return service
- Web-based support service
- Same day troubleshooting assistance
- Worldwide Crossbow representation
- Onsite and factory training available
- Preventative maintenance and repair programs
- Installation assistance available

8.2 Contact Directory

United States: Phone: 1-408-965-3300 (8 AM to 5 PM PST)
Fax:1-408-324-4840 (24 hours)
Email: techsupport@xbow.com

Non-U.S.: Refer to website www.xbow.com

8.3 Return Procedure

8.3.1 Authorization

Before returning any equipment, please contact Crossbow to obtain a Returned Material Authorization number (RMA).

Be ready to provide the following information when requesting a RMA:

- Name
- Address
- Telephone, Fax, Email
- Equipment Model Number
- Equipment Serial Number
- Installation Date
- Failure Date
- Fault Description

8.3.2 Identification and Protection

If the equipment is to be shipped to Crossbow for service or repair, please attach a tag TO THE EQUIPMENT, as well as the shipping container(s), identifying the owner. Also indicate the service or repair required, the problems encountered, and other information considered valuable to the service facility such as the list of information provided to request the RMA number.

Place the equipment in the original shipping container(s), making sure there is adequate packing around all sides of the equipment. If the original shipping containers were discarded, use heavy boxes with adequate padding and protection.

8.3.3 Sealing the Container

Seal the shipping container(s) with heavy tape or metal bands strong enough to handle the weight of the equipment and the container.

8.3.4 Marking

Please write the words, "***FRAGILE, DELICATE INSTRUMENT***" in several places on the outside of the shipping container(s). In all correspondence, please refer to the equipment by the model number, the serial number, and the RMA number.

8.3.5 Return Shipping Address

Use the following address for all returned products:

Crossbow Technology, Inc.
4145 N. First Street
San Jose, CA 95134
Attn: RMA Number (XXXXXX)

Crossbow Technology, Inc.
4145 N. First Street
San Jose, CA 95134
Phone: 408.965.3300
Fax: 408.324.4840
Email: info@xbow.com
Website: www.xbow.com