

**microEFIS**

**BACKUP ELECTRONIC ATTITUDE  
REFERENCE SYSTEM**

**Inertial Measurement Unit (IMU) Model no. EFIS-AIGYRO6X**

**Software Model no. EFIS-AISW3**

**User's Guide**

Version 2.7b

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## **Caution**

The microEFIS Backup Electronic Attitude Reference system is not an FAA approved aircraft instrument. It is intended solely for use as an auxiliary attitude display for use in VFR flight conditions and should never be used as an IFR flight instrument. Any single attitude display device can fail, be misused and/or misinterpreted, and therefor become unsafe. Use the attitude reference system at your own risk. To reduce the risk carefully review and understand all aspects of this user manual and always use external visual horizon contact for flight attitude control. The electronic attitude reference system is not intended to be used as the primary flight attitude indicator and must never be used as such. Never rely on any single attitude display instrument for attitude control of any aircraft. Violation of this principle virtually ensures that aircraft control will eventually be lost and that an accident will occur.

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This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio or television reception, which can be determined by turning the device off and on. You are encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between this equipment and the receiver.

- Connect the equipment to a power source on a different power bus than that of the receiver.

- Consult the dealer or an experienced radio/TV technician for help.

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## **Introduction**

The attitude reference system uses precision inertial navigation system (INS) technology similar to that used in the newest commercial airliners and many spacecraft. The system uses a technique called strapdown inertial navigation (strapdown INS). This implies that the sensing system is “strapped down” to the airframe and is then able to sense the accelerations and rotations of the airframe to determine the aircraft attitude. The attitude reference system consists of an inertial measurement unit (IMU) module, and an attitude processing/display computer. The technology used for the attitude sensor module (IMU) is the same as that used in attitude heading reference sensor(AHRS) devices. In order for the system to work properly it is imperative that the IMU module be properly installed in the aircraft.

Until the 1990's most aircraft attitude systems utilized mechanical gimbaled gyroscopes. During the 1990's commercial airliners and corporate jet aircraft began using “strap down” INS systems which utilized solid-state fiber-optic or solid-state piezoelectric gyroscopes in conjunction with accelerometers and micro-computers to perform the required attitude derivation calculations. These strap down INS systems typically cost over \$100,000. The recent advent of micro-electromechanical system (MEMS) devices has enabled the development of miniature solid-state accelerometers and solid-state gyroscopes. These new MEMS components can be used in conjunction with personal computer technology to provide strap-down INS systems at a cost of well under \$10,000.

The ICARUS INSTRUMENTS microEFIS System consists of a strapdown INS sensor module (the IMU) and a software package for use with handheld computers, such as the Compaq iPaq 3600/3700,3800 series (typically called Personal Data Assistants – or PDA's). The ICARUS INSTRUMENTS IMU uses electronic piezoelectric gyroscopes. These are solid state devices, which use a quartz-crystal like vibrating element and utilize the Coriolis effect to determine angular acceleration rates. The ICARUS INSTRUMENTS IMU uses MEMS accelerometers to detect the acceleration on the aircraft and also to assist in the determination of the aircraft attitude. The ICARUS INSTRUMENTS IMU contains three of these solid-state electronic gyroscopes, solid-state accelerometers, and a micro-controller system. The gyroscopes sense the rate of rotation of the aircraft around the roll, pitch, and yaw axis. The accelerometers sense the acceleration of the aircraft around the roll, pitch and yaw axis and also sense the aircraft orientation relative to the earth.

Three gyroscopes are required to accurately determine aircraft attitude in a strap-down INS. This is required because the aircraft attitude determination requires yaw angular sensing whenever the aircraft is not in a straight and level attitude. Accurate aircraft attitude determination requires that roll, pitch and yaw all be measured. This requires a dedicated gyroscope for each of the roll, pitch and yaw axis. The micro-controller system converts the gyroscope and accelerometer signals into digital signals. These digital signals are then processed using digital signal processing algorithms. The processed data is then sent over a serial communication cable to the PDA. The software package in the PDA then further processes the sensor data and converts it into a data display format. The data is then displayed as an attitude/horizon gyro display in the same format as the Electronic Flight Information Systems (EFIS) used in commercial airliners.

The recommended pocket computer is the Compaq iPaq H3600/3700 series computer such as the model H3650 or H3635 (they are equivalent PDA's). The best source of iPaqs is directly from the Compaq website at [www.compaq.com](http://www.compaq.com) . A custom serial adapter cable is provided by Icarus Instruments to connect the iPaq to the gyro module. This cable sends both attitude data and power to the iPAQ. A power supply in the IMU supplies enough power to both run and charge the iPAQ's internal battery. The new 3800 series may also be used, but requires a different serial cable to connect to the IMU. This 3800 cable is available from Icarus for \$50.00. Order ME-1000-38C



## **Inertial Measurement Unit (IMU) Module Installation**

The IMU module must be securely mounted in the aircraft. The optimum location of the IMU module is near the aircraft center of rotation. The recommended mounting location for low wing aircraft is on the floor of the cabin area near the center of the main wing spar. For high wing aircraft the best location is as close as possible to the fuselage centerline. Any other location within about 6 feet of the main wing spar will work acceptably. The PDA display computer can be located at any convenient location. The PDA is not sensitive to any vibrations or movements during flight. The IMU module performs all motion sensing.

The IMU module senses the accelerations and roll rates of the aircraft yaw, pitch and roll axis. To ensure good accuracy, it is imperative that the IMU module be mounted so that it does not vibrate or move from its mounted location during flight. The IMU module works by detecting the aircraft roll rates and accelerations. If the IMU module vibrates, or is not mounted securely, the vibrations and movements will be interpreted as false acceleration and roll inputs by the IMU system. This will cause errors in the calculated and displayed attitudes. The errors will be a direct function of the level of vibration and movement of the IMU mounting.

Velcro strips are attached to the bottom of the IMU's base. This mounting technique was developed by numerous hours of testing in various aircraft conditions. This mounting technique has been used successfully even in aircraft such as Piper Cubs, which have high levels of airframe vibration and interior noise levels.

The preferred mounting technique is to use the supplied Velcro strips. Four 1" by 1" squares can be cut from the supplied velcro pieces and attached to the aircraft to mate with the corner areas of the velcro on the gyro module. It is not necessary to use the full Velcro mounting surface. The Velcro strips have an adhesive backing that allows them to be attached to a clean aircraft surface. The supplied Velcro is a type of Velcro which can attach to itself, that is, both mating pieces of Velcro are of the same type, instead of the older style of Velcro which used a plastic hook piece in conjunction with a fabric piece. For installation on a carpeted surface, it may be desirable to firmly attach the Velcro fasteners to the carpet by hand stitching with heavy sewing thread, in addition to the adhesive. Small bungee cords or elastic straps can also be used to mount the unit to the aircraft.

The most important factors for the mounting of the IMU module are:

1. Module must not vibrate.
2. Module must not move on the mount.
3. Module must be aligned with axis of flight.
4. Module should be as close as possible to center of aircraft rotation.

Vibration and mounting movement of the IMU module will cause inaccurate attitude displays. Actual location in the aircraft is not critical.

The IMU module should be connected to the computer display unit using the supplied. serial interface/power cable. (RS232 serial cable) Extension cables can also be used to enable the PDA to be located up to 20 feet from the IMU module. Any standard 9-pin serial extension cable may be used.

A fresh 9-Volt alkaline battery has been installed in the IMU. The IMU can also be powered using an external power source (8 to 32 volts DC) using the supplied cigarette lighter power adapter. Be sure that this adapter is plugged all the way into the IMU to insure a good contact. There is no power switch on the IMU, since it senses when the iPAQ computer is on and the microEFIS software is running.

A 9-Volt alkaline battery should be kept in the IMU even with an external power supply. The IMU will not drain the battery when connected to an external power supply. The IMU is designed to automatically switch to the internal battery in the event of a failure of the external power source. The voltage source that is running the IMU is displayed on the upper left-hand corner of the PDA. If this shows as 9 volts or less, the internal battery is powering the IMU; if this is approximately 14 or 28, then the aircraft power is supplying power to the IMU.

One of the most common problems encountered is the inability to accurately mount the unit in a level position. We originally designed the attitude calculations to be very accurate in all pitch and roll attitudes. This required that the unit be mounted to better than two degrees of true level when the aircraft was in straight and level flight. Because of our desire to make the unit truly portable, it became necessary to modify the software to work well even if the unit is not accurately mounted (allow as much as 10 degrees of mounting error). To meet this requirement we have optimized the software to accurately display when the aircraft is in a level attitude.

The trade-off is that the actual bank angles in turns are no longer as accurate as they were previously, but straight and level is now very precise. We believe this is the appropriate compromise. A primary goal of the current product is to perform as an emergency horizon in the event the primary flight display of the aircraft fails. To accomplish this goal we have optimized the pitch and roll display algorithm to be accurate when the aircraft is in a near level attitude with a tradeoff of less accuracy when the aircraft is in a steep bank configuration.

## Hardware Installation

Your iPAQ must be connected to the IMU (gyro module) using one of three methods. The basic ME-1000 comes with a serial cable that plugs into the bottom of the iPAQ and to the PDA connector on the gyro module. If you purchased the iPAQ cradle (ME-1000C), it comes with an integral cable that connects to the PDA port on the gyro. If you purchased the ME-1000SP, second serial port, a cable is supplied that connects directly between the short cable on the CF card serial port and the PDA port on the gyro.

All GPS sources connect to the lower port on the gyro. Icarus offers a Garmin compatible cable for the 195 and another cable for the 89, 90, 92, 295, and GPS Pilot III. The Smart Cable for panel mounted GPS's also feeds into the lower port. Any GPS that feeds this port must have waypoint information available. At the end of this manual, the pinout of the GPS connector is defined. Ship's power is also available at the gyro to power a GPS.

See following diagrams for details on the cable connections. The ME-1000C is not pictured as the connection is the same as the basic serial cable.

## Software Installation

The display software module is named microEFIS.EXE (with version numbers). This software must be installed onto a hand held computer (personal data assistant - PDA). The handheld computer must contain either a Microsoft PocketPC or Microsoft CE 2.11 operating system or higher. Windows CE 2002 is compatible with the microEFIS application.

The microEFIS software is provided on a 3.5 inch floppy diskette. This software must be installed onto the iPAQ PDA using a personal computer running some form of Windows. The PDA manufacturer supplies an interface, which enables software to be loaded onto the PDA from a personal computer. The most widely used software for the PC to PDA interface is Microsoft ActiveSync. Microsoft ActiveSync provides the capability to "drag" the microEFIS program from the floppy disk on the PC into the proper file directory on the PDA.

The iPAQ PocketPC microEFIS software is contained on the 3.5" floppy diskette. You must first install the ActiveSync software that came with your iPAQ on your PC by following the instructions in your iPAQ documentation.

To install the microEFIS software onto your iPAQ, perform the following procedure.

1. Place the microEFIS software diskette into the PC.

2. Plug in the iPAQ cradle to the PC.
3. Place iPAQ in cradle and turn it on using the power button. This will start ActiveSync.
4. Click on the "NO" button when you are asked to make a partnership with your iPAQ. Click "Next".
5. When the PDA is "connected" to the PC via ActiveSync, click on the "EXPLORE" feature of the ActiveSync program. Click on the down arrow to the right end of the "Address" bar and select the 3.5" diskette drive. Drag the microEFIS (looks like an attitude indicator) icon to the bottom of the screen, outside of the large box on the screen. Click on the "Back" button. Double click on "My Pocket PC". Double click on the "Windows" folder. Drag the microEFIS icon into the "Start Menu" folder. Ignore the error message at this point by clicking OK. This completes the microEFIS.EXE installation procedure.

New software updates are placed on the [www.icarusinstruments](http://www.icarusinstruments) web site. The newest software should always be used.

**Caution: The iPAQ's internal program memory for user installed programs is kept alive by the iPAQ's battery. If this battery is not charged on a regular basis, the programs will be lost. If this happens, you will have to re-load the microEFIS and any other information on your iPAQ.**

The iPAQ's battery will keep the program memory alive for about two weeks. Unless you keep the iPAQ charged between flights at home or in your hangar, you will lose the microEFIS program if it is left in the airplane for extended periods of time. The iPAQ is continuously charged when you are flying and the system is on. The little yellow light at the top of the iPAQ shows that the battery is charged (steady) or being charged (flashing).

Another approach is to have a Compact Flash Sleeve and a 16M flash card with the microEFIS program on it. This arrangement allows for an immediate re-load of the program by sliding the iPAQ into the sleeve. Contact Icarus for more details on this option.

## System Operation

To run the microEFIS software do the following:

1. Ensure the IMU module is securely connected to the serial port of the PDA with the serial interface cable. Serial communication errors will occur if the serial cable connection is not secure. When these errors occur an error message will be displayed on the PDA and the system operation will be halted until the serial data cable is properly secured.
  2. Verify that the IMU module is firmly attached to the airframe
  3. Turn the PDA on and run the microEFIS software by touching the top tool bar and then select microEFIS from the Start Menu. When the software starts, it will perform a calibration procedure, which will take approximately 10 seconds to complete.
  4. Keep the aircraft straight and level until the software completes the calibration phase. The aircraft should ideally be in a level position on the ground and not moving when the software is started. This is easy to do with tricycle gear aircraft. With tailwheel aircraft it may be necessary to realign the system while in straight and level flight. This is done by selecting the ALIGN button on the microEFIS software display. When performing the alignment in the air, it is necessary to hold the aircraft straight and level during the alignment period. (approximately 10 seconds)
- 2 The attitude/horizon should now be displayed on the PDA and the system is ready to use.
- 3 If, during the flight, the microEFIS software is stopped by exiting the program, the system must be realigned when you re-start. Keep the aircraft straight and level when you re-start the program and hold that attitude until the microEFIS AI screen reappears.

Note: YOU CANNOT PERFORM AN ALIGNMENT UNLESS YOU KNOW THE AIRCRAFT IS STRAIGHT AND LEVEL. YOU CANNOT EASILY PERFORM AN ALIGNMENT WHILE FLYING PARTIAL PANEL IF YOUR MAIN ATTITUDE GYRO IS NOT PRESENTING ACCURATE INFORMATION. WHILE IN IFR CONDITIONS, ALWAYS KEEP THE microEFIS SYSTEM RUNNING.

## **Running MicroEFIS with other software (no re-alignment required when re-starting microEFIS)**

The microEFIS software starting with version 2.7a and above, can run in the background while other applications are running on the screen. This means that the microEFIS software continues to calculate the aircraft's attitude, while other applications are using the rest of the PDA and the screen. No alignment is required when microEFIS is re-started when it has been running in the background.

For example, you may want to run the Control Vision AnyWhere Map on the screen while the microEFIS software is running in the background. However, in order for the microEFIS software to get its data from the gyro at the same time the map program is getting GPS data, your iPAQ must have TWO serial ports. One port is built-in on the bottom of the iPAQ and the second port is implemented using a Compact Flash Card sleeve and a plug-in CF card serial port. Contact Icarus about purchasing the required extra hardware to implement the second serial port.

For optimum performance when used with Anywhere Map, configure Anywhere Map for "Slow Updates" This will not affect the Anywhere Map's operation and will insure that the microEFIS software will be able to calculate the aircraft's attitude accurately.

To allow easy toggling between two applications such as the microEFIS and Anywhere Map, you must assign these applications to the buttons on the front of the iPAQ. This is easily done by the following process:

Select "Settings" from the main menu. Then select "Buttons". Now select which of the four buttons you want to use for microEFIS. Then select the arrow on the box below the button selection. Select Start Menu and then microEFIS. Finish by touching the OK at the top right of the screen. Now the selected button will start the microEFIS application. Repeat this process for Anywhere Map or any other application that you want to toggle with microEFIS. You will have to locate this application where it now resides on your iPAQ after selecting the button which will activate it.

Start microEFIS using its new application button. Align the gyro as described above and then activate the map program of your choice. The map program will take over the screen. To re-activate microEFIS, press its button. When in actual IFR conditions, it is recommended that you keep the microEFIS display running on your iPAQ.

## **System Functional Description**

The microEFIS software performs two major functions, which include digital signal processing of the IMU data, and the processing required to graphically display the attitude/artificial horizon data.

The microEFIS software performs approximately one half of the digital signal processing of the IMU sensor data. This allows the signal processing algorithms to be easily enhanced in the future, by simply installing an updated microEFIS.EXE program onto the PDA. INS (Inertial Navigation Systems) signal processing techniques are rapidly evolving and new techniques are continuously being developed. Allowing the PDA to perform a portion of the digital signal processing allows these new techniques to be implemented in the future, without the need to update the IMU module. This prevents the IMU module from becoming obsolete as new signal processing techniques become available.

The microEFIS software performs all of the graphical display capability of the system. This allows new display techniques to be added in the future by installing an updated microEFIS.EXE program onto the PDA. This further allows the system to remain “state-of-the-art” through software upgrades.

New microEFIS display capabilities are continuously being developed. At the current time the microEFIS contains several different types of data displays, all of which are simultaneously displayed.

The primary display is the Attitude/Artificial Horizon display. This display is an EFIS attitude display and looks much like a conventional attitude/artificial horizon gyro display. Pitch is denoted with a scale, which has a minor divisions at  $\pm 5$  degrees of pitch and major divisions at  $\pm 10$  degrees of pitch. A roll display scale is also provided which has minor divisions at  $\pm 10$  and  $\pm 20$  degrees of roll and major divisions at  $\pm 30$  and  $\pm 60$  degrees of roll. A roll angle pointer is located at the top of the attitude display. This roll angle pointer is an inverted white triangle. The roll angle pointer is called the “triangle reference pointer” The roll angle can be read from the scale marking directly below this roll angle pointer.

The display also simultaneously shows a slip/skid indicator. This ball, located in the bottom portion of the display, depicts slip and skid information in exactly the same manner as the classical ball slip/skid indicator.

Just above the centered skid ball is a turn rate indicator. This is a small horizontal line that shows your turn rate, just like a turn and bank and turn coordinator. It does go the right way! Because you never have had an AI and TC display on the same instrument, you may think one of these is backwards. Just look at your existing instruments to expel any doubts.

The PDA will also display a power supply voltage level indicator in the top left-hand corner of the display. It shows the voltage of the power source supplying power to the IMU. If your aircraft alternator fails, this voltage will drop immediately to the battery voltage.

Below this voltage display is a number representing the percentage of power left in the iPAQ. This will always be 100% when the iPAQ is fully charged and running off the power supply in the IMU.

When the power supply/battery reaches 7 volts the IMU will no longer operate properly so the system will automatically stop functioning and display a low battery voltage error display. The 9-volt battery must be replaced, or the IMU must be connected to a power source having a voltage of 8 to 32 volts to continue operation. After this is done the align function must be run to ensure that the system is properly calibrated



## AHRS GPS Interface Option

The AHRS (Attitude Heading Reference System) option consists of an additional connector on the IMU, additional internal hardware, and software, which enables the IMU to be connected to any standard GPS serial output (NMEA 4800 baud). The GPS receiver must have an aviation database such as any Garmin aviation type, Apollo Precedus, Lowrance 100/300, etc. Virtually all handheld aviation GPS receivers are compatible with the GPS requirements of the microEFIS. A Garmin 35 GPS receiver is not compatible since it lacks a database and a user interface to select a waypoint.

Some panel mount receivers also have the NMEA output, which can be brought to a panel mounted jack for connection to the microEFIS. Icarus also offers a smart cable that converts the serial output from any panel mounted GPS that does not have the NMEA format to the required format. Order this cable as part number ME-1000-SC.

The purpose of placing GPS navigation data onto the microEFIS screen is to provide a single source of both attitude and navigation data. In the event of an actual vacuum system or gyro failure (with possible simultaneous loss of the autopilot), it is desirable to minimize pilot workload. By providing both aircraft attitude and navigation information on one screen, the scan is simplified.

To take advantage of this “one screen” concept, you must use the GPS receiver that is connected to the microEFIS system to navigate to your desired waypoint. Whether a panel mount or portable GPS, the desired waypoint must be selected and then the “Go To” function must be activated.

When the GPS is connected, and at least 4 satellites are received, the system will automatically display the additional waypoint data. The data will not appear if there is no valid GPS data being received. When valid GPS data is available the AHRS option provides the following additional information onto the EFIS display at the bottom of the screen in two lines:

Waypoint Name  
Bearing to Waypoint  
Distance to Waypoint  
Time to Waypoint  
GPS altitude (if available from GPS)  
Ground Track  
Track Angle Error with turn arrow (degrees to turn to make track error zero)  
Ground Speed

At the top center of the screen in large numbers is your stabilized heading. When you are straight and level, this number is slaved to GPS ground track.

When you begin a turn, it will update at your actual turn rate, just like your DG or HSI would. This heading display backs up your DG or HSI, which are often also vacuum instruments.

When you level out, this display will revert to GPS ground track. GPS ground track is a very useful number, since it is what you want to be flying when on an airway or flying an approach. The only time that ground track is not exactly what you want is when you are given a heading to fly by a controller. While the controller may actually want you to follow a ground track, he/she means for you to fly a magnetic heading, ignoring any wind effects. However, the reality is that after a vacuum/gyro failure, you probably should declare an emergency and the difference between a mag heading and a ground track will be irrelevant for all practical purposes.

The iPAQ should be connected to the connector labeled "PDA" (top connector) using the supplied serial interface cable. The serial cable from the GPS (NMEA compatible) should be connected to the connector labeled "GPS" (bottom).

### **Cable Options to connect GPS receivers**

**ME-1000-G** Cable for Garmin receivers with 4 pin round connector (III Pilot, 295, and others) This cable connects the GPS to IMU for both GPS power and data. It eliminates need to use cigarette lighter power cable for GPS. GPS must be configured for NMEA output. Garmin 295 receivers do not come with NMEA as the default. Follow instructions on page 88 of the 295's manual to enable the NMEA format.

**ME-1000-195** Cable for Garmin 195. Connects GPS to IMU for both GPS power and data. Eliminates need to use cigarette lighter power cable for GPS.

**ME-1000-SC** Smart Cable for panel mounted GPS receivers. Converts aviation format to NMEA format using a microprocessor located inside the cable connector. Allows any Garmin, King, UPS, or Trimble panel mounted GPS receiver to drive the heading and GPS features of the microEFIS. Requires that a jack be mounted on the instrument panel and connected to your GPS's serial output. This jack and the mating plug are not supplied. Red wire goes to GPS receiver output and black and shield are grounded at the jack.

## Troubleshooting

This section discusses some solutions to the problems you may encounter when operating the attitude display system.

It is recommended that you become familiar with the system, and initially use the system, before trying to use it in an aircraft. The system can be operated sitting on a table and moved by hand. All you need to do is power up the system per the procedures while the IMU is setting on a flat surface. Keep in mind that when the IMU is moved by hand, you can easily exceed the 60 degree per second maximum angular rate limit. This will not damage the unit, but will cause loss of calibration and the unit will then temporarily display an incorrect attitude. Setting the unit on a flat surface will allow the unit to automatically recalibrate after a period of a couple of minutes. The unit will also automatically recalibrate while the aircraft is maintained in straight and level flight over a period of a few minutes. You can also realign the unit by pressing the Align button on the display, while the unit is setting on a flat surface, or while the aircraft is in straight and level flight. The unit will continue to operate though an inverted position (and even rolls), although it is not intended to be used for aerobatic type maneuvers.

### **If attitude display does not appear on the PDA display:**

This problem is most likely caused because the PDA is not receiving data from the IMU. Upon initial startup of the software a calibration procedure is automatically performed before the attitude display appears. This calibration procedure can take up to 30 seconds. If the attitude display does not appear within about 30 seconds then this indicates that the PDA is not receiving data from the IMU. Ensure a fresh battery and/or good power source is connected to the IMU. Ensure the IMU is turned on. Ensure that the serial cable is securely connected between the IMU and PDA. Ensure that the PDA is not running some other software. It is especially important to ensure that the PDA is not running software, which also uses the serial port (such as a GPS software moving map). Some software packages, which use the serial port, do not properly close the serial port. This can cause the serial port to become inoperative until the PDA is reset. A reset of the PDA will generally cause the serial port to start working again and should allow the attitude display software to be able to access the serial port properly. It is also important to ensure that the microEFIS.EXE application is stopped by selecting the "exit" menu item, before turning the PDA off. Failure to follow this precaution can cause the PDA serial port to stop operating properly until the PDA is reset.

In almost all cases, replacing the battery in the Gyro module and pressing the PDA reset button will resolve a problem where the attitude display does not appear. The PDA reset button is on the bottom of the iPAQ and can be pressed using the stylus.

**If attitude display becomes blank:**

The attitude display software will automatically blank the display in the event that the power supply/battery voltage drops below 7 volts. The attitude display software will also automatically blank the display if the serial communications with the IMU becomes marginal. If the attitude display becomes blank, ensure that the IMU power supply/battery is adequate, ensure that the serial cable is firmly connected, and ensure that the IMU has not been inadvertently turned off. If the attitude display becomes blank, it is recommended that the align procedure be performed prior to again using the attitude display information.

**If attitude display is not accurate:**

The most probable cause of this problem is the following:

IMU is not mounted in a level position.

Align procedure was not performed with IMU in level position.

IMU is vibrating.

IMU is moving on its mount.

60 degree/second angular rate has been exceeded.

After confirming that all of the above problems are addressed, you should perform the Align function while holding the aircraft in a straight and level flight attitude.

**If PDA display turns off:**

The PDA batteries/power source has become inadequate. Restore the power supply with recharged batteries or reconnect the power source if this occurs. You will then have to run the Align procedure.

The PDA is configured into some “power save” mode and has powered itself off. In this event you must reconfigure the PDA to disable all “power save” modes. Turn the PDA back on and run the Align procedure.

**If the PDA loses the program:**

The PDA requires the internal batteries to contain charge in order to retain internal programs. Do not allow the PDA internal batteries to become discharged. The PDA should always be kept on the charger whenever not being used for more than two weeks. Failure to keep the batteries charged will cause the PDA to lose the program. If this occurs recharge the PDA and reload the software into the PDA, then ensure the PDA is kept on the charger when not in use.

**If the PDA Display is slow or sluggish:**

The microEFIS software requires the full processing power of the PDA. If the PDA screen is slow to update then this indicates that other programs or tasks are running on the PDA. It is possible to have many “hidden” programs running on the PDA which can’t be viewed by any of the “status” software programs. The only way to ensure that no programs are running is to use the PDA reset button. In the Compaq iPaq this button is located behind a small hole on the bottom right side of the iPaq. The button must be pressed by inserting the tip of the Stylus through this hole and ensuring that the button is pressed. The PDA will then indicate that it has been reset and will start up. You can then run the microEFIS software.

Note that pressing this reset button will not cause you to lose any programs that have been loaded onto the iPaq. The reset button will only ensure that no programs are actively running in memory. This is the only method, which can be reliably used to make sure no programs are running in active memory. It is recommended that the reset button be pressed prior to each use of the microEFIS program.

In most cases we have noticed that even brand new iPaqs have some background programs running in active memory. This causes the microEFIS program to update the display very slowly. To eliminate this problem always press the iPaq reset button prior to the first time you run the microEFIS program.

## **EFIS-AIGYRO6X IMU Module Specifications**

### **Physical Enclosure**

#### Dimensions

6.75" x 4.75" x 2.5"

#### Weight

16 oz.

### **Power Supply**

#### Battery

Standard 9 Volt Battery

External Power (if battery is not used)

8 to 32 Volts @ less than 50 ma. (more current if PDA and GPS are also powered from the IMU)

### **External Interface**

RS232 DB9 Male Connector

#### Pinouts for Upper connector (to PDA)

1. No Connection
2. RX Data (from PDA)
3. TX Data (to PDA)
4. +5 volts out to PDA
5. Ground
6. CTS Input (from PDA)
7. No connection
8. RTS (From PDA)
9. RX Data from GPS connector (mirrors pin 2 of lower connector)

#### Pinouts of Lower connector (to GPS source)

1. 3.3 vdc out to power GPS
2. RX Data from GPS
3. No connection
4. +5 volt out to power GPS
5. Ground
6. No connection
7. No Connection
8. No Connection
9. Aircraft power out (to power portable GPS receivers) Is connected to the DC input jack

### **Method of Attachment to Airframe**

#### Velcro

Must be aligned parallel to the aircraft longitudinal axis

## Data Output

RS232 Serial

115.2 Kbaud

Data update rate

greater than 50 per second

## Sensor Specifications

Startup time

Less than 1 minute

Max roll and pitch rate

60 degrees per second

Drift (maximum average drift over 8 hours)

Pitch and Roll +/- 5 deg

(in level attitude)

## Environmental

Operating Temp Range

-30 to +75 C

Storage Temp

-40 to +90 C

MTBF

50,000 hours

## EFIS-AISW3 Software Specifications

### Compatible PocketPC computers/serial cables

Compaq iPaq H3600/3700 series handheld computer (PDA) with either 32 MB or 64 MB. H3800 series can also be used with special serial cable from Icarus.

## Display

Artificial Horizon Display

Simultaneous display of pitch and roll attitude with 5 degree pitch bars and roll tick marks

Turn rate indicator

Slip/Skid Indicator

Power Supply Voltage (aircraft bus voltage or gyro battery voltage)

Battery condition of iPAQ (percentage)  
Processing tick indicator  
Refresh Rate approx. 10 times/sec

**GPS option adds:**

Stabilized Heading/Ground Track (DG backup)  
Course Deviation Indicator (CDI) 1.0 nm Full Scale  
GPS Altitude MSL (if altitude is available from GPS)  
Waypoint ID  
Distance to waypoint  
Bearing to Waypoint (requires  
Ground Speed  
Ground Track  
Time to Waypoint  
Track Error with turn arrow

## User Controls

Align Button  
    Performs “caging” calibration function to reset display to level  
Exit  
    Exits microEFIS program

## Software media

Provided on 3.5” floppy  
Updates available by download from [www.icarusinstruments.com](http://www.icarusinstruments.com)  
**All specifications subject to change without prior notice.**

## Serial Interface Protocol

The following describes the serial interface protocol used for the standard product. This format can be changed with no prior notice to enable the addition of new product features.

Baud Rate



115.2 Kbaud

Message frame rate  
> 50 Hz

#### Data Frame Byte Sequence

Byte No.	Description
0	Synch Char value = 0x01
1	Synch Char value = 0x00
2	Roll Rate LSB
3	Roll Rate MSB
4	Pitch Rate LSB
5	Pitch Rate MSB
6	Yaw Rate LSB
7	Yaw Rate MSB
8	Accelerometer Reference LSB
9	Accelerometer Reference MSB
10	Longitudinal Acceleration LSB
11	Longitudinal Acceleration MSB
12	Lateral Acceleration LSB
13	Lateral Acceleration MSB
14	Yaw Axis Acceleration LSB
15	Yaw Axis Acceleration MSB
16	Power Supply Voltage
17	Checksum