Intelligent Fibre-Optic Gyro (iFG)

Operating Manual

0707-SOM-00001, Issue 04

Tritech

CONTENTS

TECHNICAL SUPPORT

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An out of hours emergency number is available by ringing the above telephone number

If you have cause to use our Technical Support service, please ensure that you have the following details at hand prior to calling:

- iFG Assembly Part No.
- iFG Serial No.
- Operating mode settings (if known)
- Firmware version (if known)
- Details of other equipment used in the iFG system (e.g. iGC, iIF etc.)
- Fault Description
- Details of remedial action or fault finding already implemented

It is worthwhile keeping a copy of this manual to hand, together with any system drawings showing how the iFG connects to your system prior to making a call to the help-line. This will ensure that we can diagnose the problem as quickly as possible.

1. SAFETY NOTES

1.1 GENERAL

All installation, operation, maintenance and repair works must be carried out by competent personnel. The installation of the iFG and associated components is fully the responsibility of the user.

The iFG shall be installed, commissioned, operated and maintained in accordance with this instruction manual, including staying within the maximum operating conditions given in Section 1 (iFG Supply Specification). Failure to do so may lead to safety hazards or equipment failure.

Before starting installation, commissioning, operation or maintenance of the iFG, personnel should read and understand all relevant sections of this manual.

Any queries, comments or suggestions regarding the content of this manual or the safe installation, operation or maintenance of the iFG should be referred to Tritech.

1.2 ELECTRICAL SYSTEMS

Any electrical supply or connection should be regarded as dangerous until proven otherwise by disconnection and isolation or by measurement. This applies as much to external power supply circuitry as to the iFG equipment described in this manual.

Before doing any work on or inside the iFG, the electrical power supply to the iFG should be isolated and the power connector unplugged. This includes electrical fault-finding so as to avoid inadvertent contact between the housing and exposed connections on any of the electrical components or circuit boards during removal / installation of components.

1.3 USER SERVICEABILITY

The iFG does not have any user serviceable components, other than the mode selection switches and configuration jumpers. No attempt should be made to disassemble or open the iFG sensor assembly (other than the procedures as described in this manual).

2. INTRODUCTION

The iFG is a solid-state single-axis fibre-optic gyro (FOG) sensor system that measures rate of turn to a high degree of accuracy, and with very low drift-rate.

The iFG can be used as a stand alone unit to provide a single axis angular rate or heading sensor. To provide optimised drift rate and integrated angular output the iFG should be combined with a sensor that provides a long term heading reference such as the Tritech intelligent Gyrocompass (iGC).

When combined with an iGC, an iFG will provide a magnetic-north referenced fibre-optic stabilised gyro system with a drift rate of better than 20º heading per hour. The combination of iFG and iGC greatly reduces the effects of extraneous magnetic fields by means of slowly slaving the iFG output to the magnetic heading obtained from the iGC and can therefore be used to replace traditional spinning mass gyrocompasses with a more reliable solid-state solution with significantly better drift-rate performance.

In addition, an iFG/iGC combination can be used to compliment the use of a North-seeking survey grade gyrocompass. The iFG is configured to allow the temporary fitment of a North-seeking gyro and will act as an automatic backup in the event of failure of the survey compass.

The iFG contains all the necessary internal electronics, firmware and software to interface with varying system configurations and provide data output in a number of industry standard formats. Data is transmitted as a serial data stream, in RS232 hardware format, and in a user selectable format (baud-rate and data packet construction). An optional RS485 interface can be configured as a factory installed option.

Power requirement for the iFG is nominally 24V dc at 250mA maximum, but a power supply in the range 10V to 32V with a 5W output is acceptable. The supply voltage must be a good quality regulated and smoothed DC.

The iFG is intended to be mounted inside a 1-atmosphere pressure vessel on the host ROV (or vehicle), and this pressure vessel is normally an existing vehicle pod. The unit should be mounted on a flat horizontal surface inside the pod. Electrical connections from the iFG to the host vehicle electronics and the iGC sensor are via two 9-way D-type connectors on the iFG front panel. The enclosure of the iFG chassis is connected internally to the 0V DC supply voltage, so if isolation between the mounting chassis and the 0V DC supply to the iFG from the host ROV / Vehicle is a requirement, the iFG must be mounted on a isolation plate. Refer to the Installation section below for further details.

2.1 INTELLIGENT GYROCOMPASS (IGC):

The iFG is normally integrated with a Tritech iGC unit. The iGC is based around a set of sensors which measure acceleration, magnetic field direction, and rate of turn on three orthogonal axes. Data from these sensors is processed to give outputs of heading, pitch, roll and heave acceleration. Optionally, the unit can also provide surge and sway accelerations.

As standard, the iGC is supplied with a PC software application that gives a clear animated display of heading, pitch, roll, turns counter, heave acceleration and iGC status. This PC programme is normally used when the user does not have an effective heading display, for diagnostics / additional data control or in applications where an additional display is useful to complement the existing heading display system.

The iGC communicates with the 'host' system either directly when used on its own or through the iFG where enhanced drift and magnetic performance is required.

As standard the iGC is supplied in a 1-atmosphere pressure housing suitable for use down to 4000 metres depth, but is available in a 6000 metre version or in a 'surface' housing (i.e. suitable for use inside an existing pressure vessel or at the surface) as an option.

Please refer to the iGC Operators Manual for full details of the iGC.

2.2 INTELLIGENT INTERFACE PCB (IIF):

For systems where an RS232 (or optional RS485) sensor output is not compatible with the existing heading sensor interface, Tritech have developed a number of interface PCBs that can be used to convert the digital telemetry signals from the iGC (and optionally the iFG) into a compatible format. These PCBs are installed in the host system in place of the existing heading sensor interface PCB, and emulate the original sensor outputs (e.g. synchro, analogue, digital etc.) but use the iGC / iFG as the data source.

These PCBs offer a simple 'hardware' upgrade to existing systems, without the requirement to rewrite control system software or redesign hardware. They also offer additional capabilities over existing systems, such as the ability to receive data from a North-seeking gyro and convert to the host format, output of pitch and roll signals in the host system's correct format, automatic selection of the 'best' heading source and improved autoheading / turns counter interfaces.

At the time of writing this manual, the following iIF PCBs are available:

- Ametek Straza / Perry Tritech Scorpio ROV
- Perry Tritech Super Scorpio ROV
- Hydrovision Diablo
- Subsea 7 (Subsea Offshore) Pioneer ROV

Tritech are continually expanding the range of supported systems, so please contact Tritech if you have requirements that are not covered by the list above.

Refer to the 'Typical Applications' drawings in the following section for details of some of the possible configurations that the iGC/iFG product family can be used in.

Note:

Because the iFG is normally used in conjunction with one or both of the above products, the manuals for these items should be available for reference when installing and setting up an iFG as part of a heading reference and motion sensing system.

3. PRINCIPLE OF OPERATION

3.1 FOG BASICS:

The iFG is a Fibre Optic Gyroscope (FOG) based sensor, which uses a long length of optical fibre (approximately 3km) wound into a small coil. Light is launched into both ends of the fibre coil simultaneously and when this light has travelled along the fibre, it is then split from the fibre into a detector. The two 'paths' of the light that have travelled around the fibre coil (in opposite directions) are compared, and any difference in the time taken for each beam to travel around the coil is measured by interference techniques.

If during the passage of the light around the coil, the sensor assembly is rotated, the light travelling in one direction will have to go further than the light travelling in the opposite direction. This will cause a very small difference in the time of the received light beams, but this can be detected and translated into a measurement of how far the sensor has turned. The sketch below shows this principle:
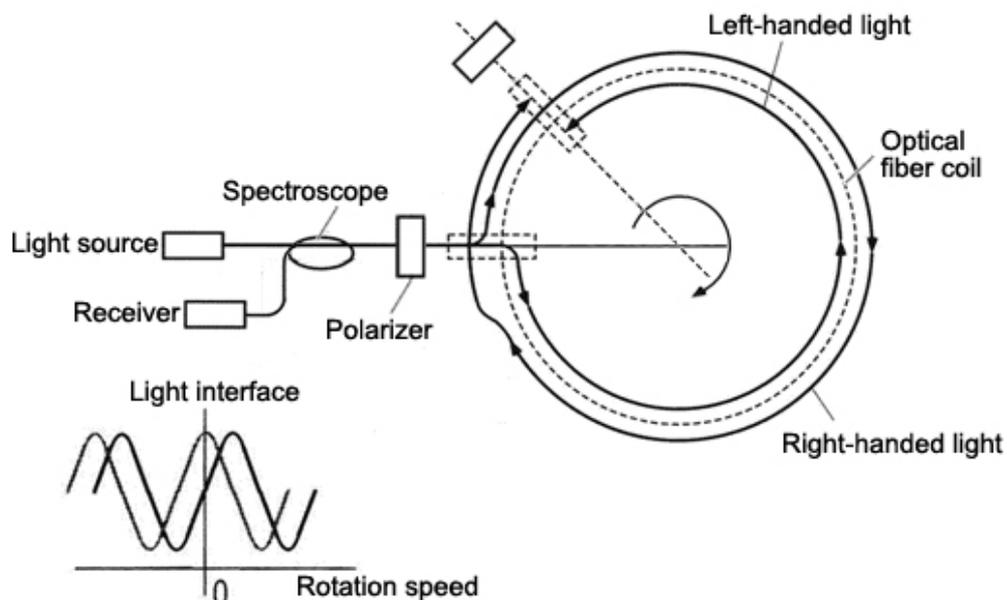
Electronics inside the iFG calculates this timing difference and translates this into a change of angle of the sensor. As the sensor is fixed to the host vehicle / ROV, the sensor measures the relative heading of the vehicle.

By connecting a magnetic heading reference to the iFG (such as the iGC unit), the iFG can be provided with an initial 'correct' heading that is 'locked' into its memory. Relative angular movements from this initial heading are then computed into an actual vehicle heading value by the internal software.

Additional processing and interface electronics allow the heading value to be provided to the host system in a useable format that matches the vehicle control system requirements.

3.2 ROV GYRO SYSTEMS:

The principle of operation of the iFG/iGC combination is identical to that of aircraft type fluxgate gyrocompasses which have been fitted to ROVs for over thirty years, and the iFG/iGC combination is designed to replace this type of equipment but with greater accuracy and much improved reliability.

In order to aid understanding this section describes how the old mechanical, spinning mass, gyrocompasses worked.

It may be helpful for the reader to have access to the Tritech display software, so that the displays and commands described in this document (along with many others that aren't) can be seen and experimented with.

History & Background:

For centuries the most common method of obtaining a heading has been to use a magnetic compass, where a magnetised needle aligns itself with the Earth's magnetic field and points in the local direction of North. Three potential problems with this are geographical variations in the local direction of magnetic North, deviation from local magnetic disturbances and dynamic effects.

Variation is caused by the fact that magnetic North is not in the same place on the Earth's surface as true North, it wanders around over time and can vary from place to place. Navigators are used to this: Charts are drawn with respect to true North and show temporal as well as local geographical changes in variation. If he wants to work with true headings, the navigator simply adds or subtracts the published variation to or from his magnetic heading to arrive at the "true" value.

Magnetic North also reverses polarity, but as this only occurs very rarely (the last reversal was about 780,000 years ago) it needn't concern us here!

Deviation occurs when magnetically active materials such as other magnets, ferrous metals or current carrying cables interfere with the local direction of the Earth's magnetic field causing the compass to point in some direction other than North. Traditionally mariners overcame this by placing their compass as far away from such disturbances as possible, compensating for as much of the deviation as possible using movable iron spheres and recording any remaining deviation (measured during a swing of the compass) which could be added or subtracted from the measured magnetic heading to arrive at the correct figure.

Dynamic effects occur when the compass is accelerated during motion. The inertia of the compass components means that the needle can't keep up with fast changes in vehicle direction or orientation.

A fourth possible source of inaccuracy is misalignment. If the compass is not aligned with the centreline of the vessel it will always be in error by the magnitude of the misalignment. This can be completely avoided by mounting the compass correctly.

In simple terms, a gimbal mounted Gyroscope tends to stay pointing in the same direction despite movement of the host platform (or the earth) and was used as a compass, initially to reduce dynamic inaccuracies rather than overcome magnetic inaccuracy. Indeed, if the gyroscope were perfect there would be no need for a magnetic sensor at all because once set up it would always point North. Unfortunately this is not the case and the gyro tends to drift away from its original alignment, due to friction in its support bearings or other disturbing forces including precession due to the rotation of the earth. So a means must be provided to preserve the original, known, alignment. Mechanical, spinning mass gyros can be made to reference to true north (north seeking), by using the phenomenon of precession to find the earth's axis of rotation, but they are complex, large, heavy and expensive. For aircraft systems the size and weight of these systems was generally unacceptable so another means to provide long term alignment was required and this was provided by means of a magnetic sensor (usually called a fluxgate) to keep track of magnetic North.

A typical aircraft gyrocompass system is shown below and consists of a fluxgate (to be mounted in a magnetically undisturbed location), a gyro and electronics package, a display and a control switch panel.

The control panel allows the pilot to decide whether to use a combined (gyro & fluxgate) output or a single (gyro or fluxgate) in the event of a fault. It also allows, on start up, the gyro to be aligned with a known heading using the precess (CW/CCW) switch

The basic method of operation is as follows, and in all cases the output from the gyro is taken as the primary heading indication:

Imagine that the vehicle is on a steady Northerly course, with the output from the gyro and the fluxgate shown diagrammatically below:

Fluxgate Output   **Gyro Output**
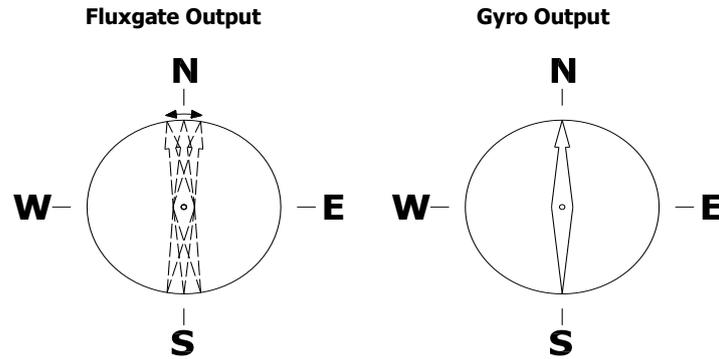
In this case the fluxgate output is moving probably due to either magnetic disturbance or dynamic movement (due to heave or sway), but it can be seen that the gyro output remains steady. It should also be noted that the fluxgate tends to "dither" around the correct heading, which would be the case if deviations have been properly calibrated out of the system.

Fluxgate Output   Gyro Output
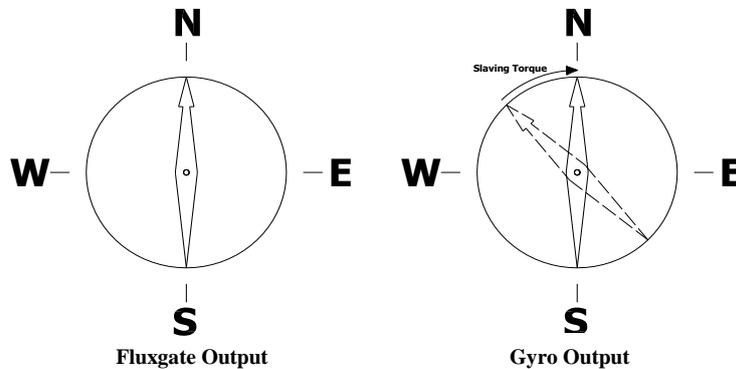
The second diagram shows what happens when the gyro heading drifts away from North (shown by the dotted needle. It can be seen that the fluxgate is still pointing at magnetic North, but the gyro output has drifted. Here the system measures the difference in heading between the fluxgate and gyro outputs (the error) and applies a slaving (correcting) torque to bring the gyro heading back into alignment with the fluxgate.

The trick here is matching the slave rate to the drift rate so that short term variations in fluxgate headings are damped out. For example a typical Bendix King aircraft gyrocompass has a gyro drift rate of 20-30° per hour and applies a slave rate of 60° per hour to keep the gyro in alignment with the fluxgate. The effect of this is to damp any fluctuations in fluxgate output that are faster than 60° per hour whilst still keeping the two outputs in long term alignment.

As stated previously, the primary reason for using this method was to damp out dynamic errors, but it has the added advantage of damping out magnetic disturbances as well, and it is for this reason as well as weight and size restrictions that has made this type of equipment popular for use in ROVs.

3.3 IFG & IGC OPERATING PRINCIPLES:

Functionally the principle of operation of an iFG/iGC combination is identical to that of aircraft type fluxgate gyrocompass systems which have been described above but the iGC/iFG combination provides this functionality with greater accuracy and much improved reliability. In this instance the iFG mimics the performance of the mechanical gyro and the iGC provides the magnetic reference previously provided by a fluxgate.

The iFG provides a stable heading that is free from magnetic influences, but suffers from gradual drift that degrades heading accuracy over time, whilst the iGC provides a heading that is continually referenced to the direction of local magnetic North. This means that if the iGC is placed next to a magnetically active object its

heading reading will be immediately distorted. In the ROV these magnetically induced distortions are avoided by regarding the iFG as the primary heading output, and effectively ignoring the iGC output. The function of the iGC heading is to counteract long-term drift in the iFG and to provide a backup indication should the iFG fail for some reason.

Drift correction for the iFG is achieved as follows: If the drift of the iFG is 15° per hour, for example, we can expect iFG heading data to lose accuracy at the same rate. However, over this period, despite transient magnetic anomalies, on average we can expect the iGC to give a good indication of where magnetic North is. The system therefore "slaves" the output of the iFG towards the iGC at a rate just faster than its natural drift (say 20° per hour). Therefore the iFG output is corrected for natural drift but it acts to damp out the magnetic deviations that are seen by the iGC.

This approach depends upon magnetic disturbances being transient rather than permanent and therefore the iGC should be mounted as far away from equipment on the ROV that might provide a magnetic disturbance as is possible. These influences include, components that contain ferrous metals or their own magnetic fields such as hydraulic pumps, motors and valves, electric motors, solenoids, transformers and so on.

When a magnetic disturbance is present for a long period, for example when tracking a pipe, then the heading output will gradually drift so that every few minutes the vehicle's auto-heading might have to be reset by a few degrees. Unfortunately, this is inherent in the design of the equipment and because the iFG is constantly slaving itself towards the iFG, when there is a constant magnetic offset we should expect the heading to change at the same rate as the system slaving rate i.e. 20° per hour. So every three minutes or so heading will change by 1°. The only way around this is to fit a North-seeking gyro at much greater cost.

However, free/slave and precess commands are available in the standard Tritech command set that allow the iFG heading to be freed from its slavery to the iGC (which might be being affected by the steel pipe) and may reduce the rate of change of heading. Alternatively, the precess command can be used to adjust the heading without having to disengage and then re-engage auto-heading.

The two main sources of drift in the iFG are earth drift and sensor drift. Earth drift occurs because the iFG measures earth rotation as the world spins beneath it, as shown in the picture below:
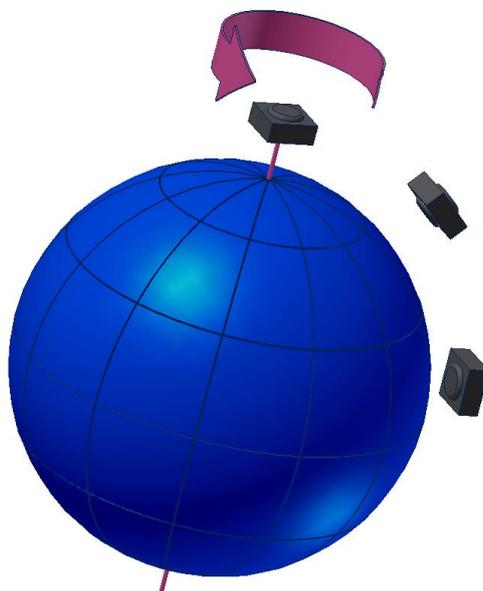
The iFG is a single axis device and therefore only measures rotations about its vertical axis. If the iFG where at the true North pole; the earth's axis of rotation and the iFG's measurement axis would be coincidental so the iFG will measure full earth rotation of 15° per hour (360° per day). If the iFG is used at the equator then the earth's axis of rotation will be at right angles to the measurement axis of the iFG, which consequently will not register any angular movement due to earth rotation. For any point in between the pole and the equator the earth drift rate will be the earth's rotation rate (15° per hour) multiplied by the sine of the latitude of the iFG's location.

So for Aberdeen Scotland, whose latitude is approximately 57°N, the earth drift as measured by the iFG will be 15° x sin(57°) = 12.6° per hour. Where the iFG is moved from one side of the equator to the other the same rule applies but the sense of rotation changes so for latitude 57°S the earth drift will be -12.6° per hour.

Sensor drift, on the other hand, is the inherent inaccuracy (or 'bias') of the sensor and varies from sensor to sensor. This value is measured accurately during sensor calibration in the factory and is pre-programmed as a 'static' correction into the iFG at the end of the factory calibration process. Once calibrated, this correction is automatically applied continuously by the internal software to reduce the apparent sensor drift, thus improving the overall sensor accuracy.

Any remaining inaccuracies in the sensor drift-rate can only be taken into account by means of slow slaving to a known direction (magnetic North). This is automatically implemented when the iFG is connected to the iGC.

The iFG to iGC slave rate can be set by the user and can be made sufficiently large to counteract both sources of drift and keep the heading referenced to magnetic North in the long term. The advantage of this is that the operator does not have to change a system latitude setting or sensor bias but it does mean that the heading may be less accurate than is theoretically possible under certain circumstances; in particular when the iFG is run in un-slaved mode. Latitude correction will only make an appreciable difference if the vehicle's work location moves through several degrees of latitude, for example from the North Sea to Brazil. Anything less than 5° (300 nautical miles) is probably not worth bothering about but incorporation of latitude correction would slightly reduce the frequency at which auto-heading may have to be adjusted in the presence of a persistent magnetic disturbance, (when running un-slaved) from perhaps once every 3 or 4 minutes to once every 5-6 minutes.

To achieve optimum performance the user can input corrections for latitude and sensor bias which then allows a much smaller slave rate to be set in the software.

For normal ROV navigation operations however, a 20° per hour slaving rate provides a significant improvement over older mechanical aircraft gyros (three times or more better) and is more than sufficient to provide consistent and accurate heading data.

The precess command also allows the heading to aligned even when the system is switched on in a magnetically disturbed area such as the deck of a ship. Just before launch, the vehicle's heading should be checked against the ship's heading and the displayed heading can be slewed, using the precess command to agree with it. As long as the time interval between this action and launch is small, a good heading will be preserved until the vehicle is free from magnetic disturbance and the iGC is getting a reliable earth's magnetic heading reading. Alternatively the system can be run un-slaved between alignment and when the magnetic disturbance has been cleared.

If using the system (ROV / vehicle) in a highly magnetic environment such as adjacent to a BOP or subsea structure, the magnetic heading from the iGC will likely be highly inaccurate. In such cases, it is recommended to periodically move the ROV away from the magnetic influence, allow the iGC to acquire a good magnetic North heading reading and then manually 'slave' the iFG to this correct heading. This manual process is implemented by a function in the system software (described in the software section below).

3.4 OPERATIONAL PERFORMANCE IN EXTREME LATITUDES

The magnetic sensors in the iGC measure the magnetic field strength in three dimensions and the iGC computes the magnetic dip angle, the horizontal and vertical components and the horizontal angle to the major component of the magnetic field, which should be local magnetic north.
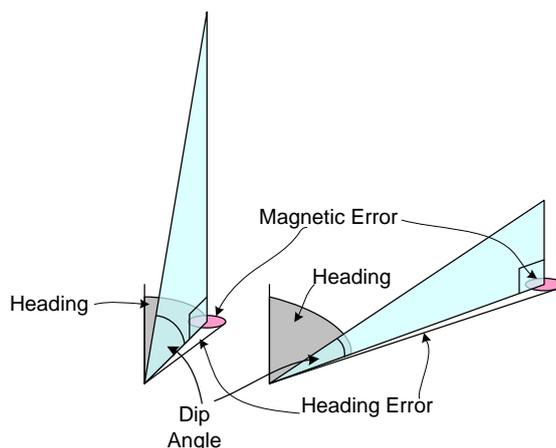
If the iGC is taken to extreme latitudes then the dip angle becomes more severe and the system will become more sensitive to variations of horizontal intensity.

This means that any items on the vehicle that have their own magnetic field will have an increasingly dominant effect on the ability of the system to resolve north as latitude increases.

If the local conditions prevent the fluxgate from providing a stable output then the system will trend towards the fluctuating heading at the system slaving rate, nominally 20° per hour.

If the system is run in free mode where the heading produced by the fluxgate is ignored then the system will drift at the system error rate which depends on the system calibration accuracy.

The factors affecting the error rate, in order of importance, are:

- Sensor factory bias calibration
- Latitude setting to counteract earth drift
- Sensor thermal stability
- Pitch and roll stability
- Sensor dynamic linearity

The last three factors will account for the bulk of the errors and will provide the limits of performance for the systems.

3.5 PITCH AND ROLL STABILITY EFFECTS

Since the fibre optic sensor unit in the iFG is only a single axis device, then to achieve the highest accuracy all the rotation must take place in the same plane as is being measured.

If the system is pitched 5 degrees down and the vehicle is rotated by 90 degrees then the pitch corrected and the vehicle rotated back following error will creep in, as illustrated in the example below:

COS of pitch change * heading change = .996 * 90 = 89.65 degrees

This means that a heading error of 0.34 degrees would have occurred due to the pitch change, and at a 20° degrees per hour slaving rate this error would take about 1 minute to be automatically corrected.

It is the nature of ROVs to wobble as they move and but normally the vehicle motion is symmetric and ROVs do not make repeated clockwise turns without turning back due to umbilical constraints. ROVs also do not normally operate with extreme pitch or roll offsets. For these reasons, the use of a single-axis FOG is well suited to the ROV application.

When operating in any location where the iGC sensor is inoperable then the system heading accuracy will hold to a reasonable degree of accuracy for a few hours but will ultimately degrade at a rate that depends on the factors listed above.

4. TYPICAL APPLICATIONS

There are various methods of integrating the iFG with existing ROV / vehicles control systems, the following sketches showing typical applications:

⚠	**Caution** The iFG has a higher voltage range than the iGC. The iGC voltage range is 12-26VDC whereas the iFG voltage range is 10-32VDC. Connecting an iGC to an iFG running above 26VDC will damage the iGC.

4.1 IFG AND IGC PAIR WITH SERIAL CONNECTION

The most common application of the iFG is in combination with a Tritech iGC magnetic heading / pitch / roll sensor. In this configuration, all data and commands (for both units) are directed through the iFG port 1 connector and all external interfaces are made via the iFG port 2 connector. In this mode, the iFG is used as a heading 'stabiliser' to provide a vehicle heading that is less susceptible to local magnetic interference.

iGC and iFG pair - with serial interface to Host control system
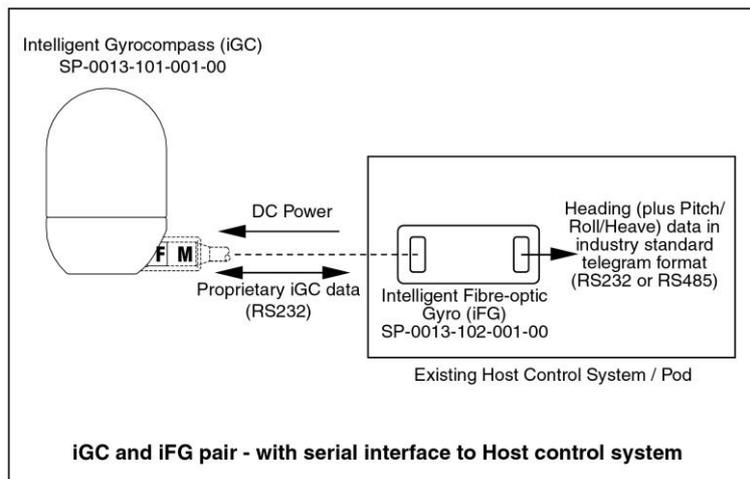
4.2 IFG AND IGC PAIR WITH IIF FOR HOST SYSTEM INTERFACE

The iFG and iGC can also be integrated in systems where the primary heading is made via a bespoke interface PCB rather than via a serial data connection. In these cases, an iIF interface PCB is used to translate the iGC and iFG combined data to an electrical format supported by the system specific interface PCB:

iGC and iFG interfaced to existing Host using iIF PCB
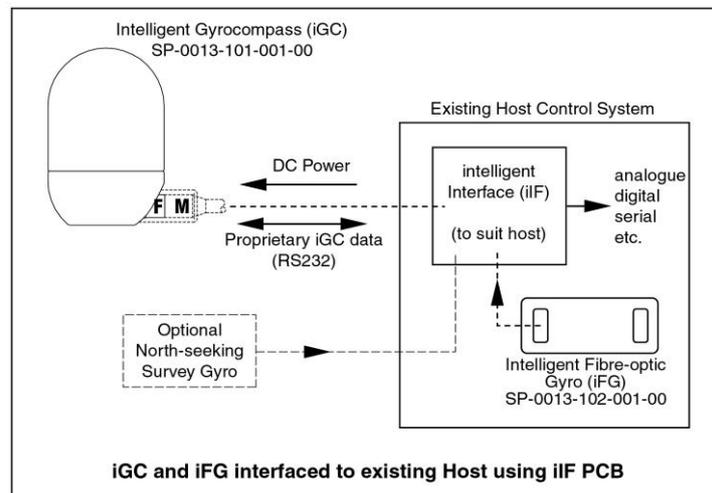
4.3 STAND-ALONE IFG

An iFG can be connected to a host's telemetry system using a serial data link, and can be used to provide a relative heading output. This type of system can provide short-term heading readings that can be manually or automatically corrected from an external known heading reference. This type of system can be used for example for deployment of systems or structures from a vessel with known heading to the seabed - and is of particular value when the structure being deployed is highly magnetic.

**Stand-alone iFG with dedicated navigation display
& Heading input from external source**
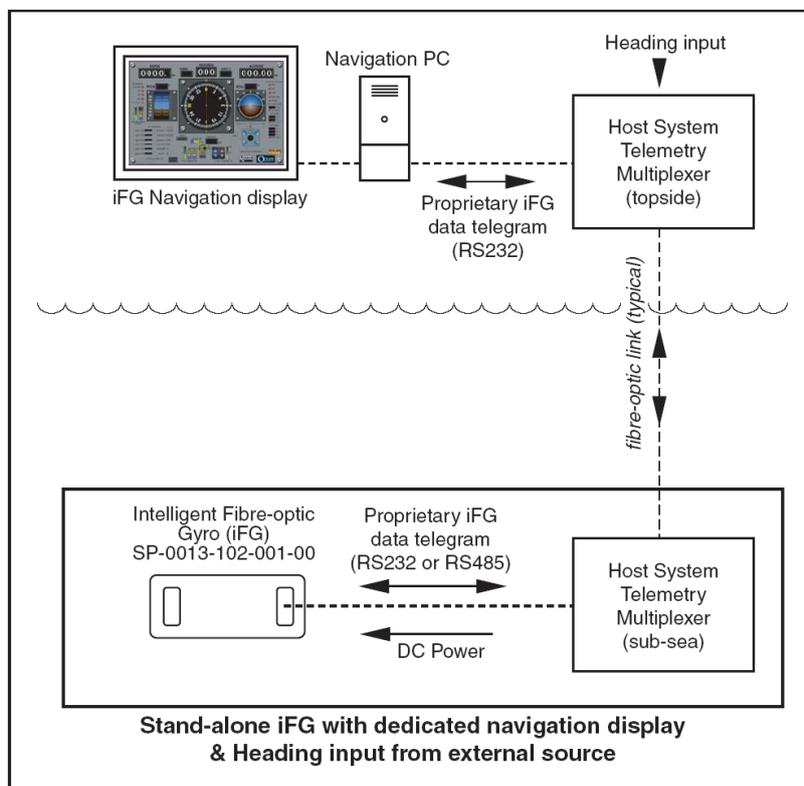
In addition to the sketches shown, there are numerous alternative options for interconnection of the iFG and iGC product family to existing or bespoke control systems.

If your desired application is not shown, please contact Tritech for advice on the best method of achieving the interface that you require.

5. INTERFACING DETAILS

There are two electrical connectors on the front panel of the iFG. These connectors are 9-pin D-type (D-Sub) male connectors, and are labelled 'PORT 1' and 'PORT 2'.

The iFG operates from a smooth regulated DC power supply, and this is connected to the iFG through either of the two D-type connectors. The input voltage specifications are as follows:

24V DC nominal (10V to 32V range) @ 5W typical power consumption.

There are three serial communications ports available on the iFG, the function of which depends on the selected operating mode.

The electrical connections to the device are described below.

5.1 PORT 1 CONNECTOR:

Port 1 is the Left-hand connector, and its pinouts are as follows:

Pin 1 – nDIRECT
When this pin is connected to RS232 GND (pin 5), the ASCII direct output telegram data from the FOG sensor is transmitted on RS232 serial port 1 (pin 3 of PORT 1 connector). Data can also be transmitted to the FOG sensor on RS232 serial port (pin 2 of PORT 1 connector) when in this mode. This mode is normally only used during maintenance by service engineers.

Pin 2 – RS232 RX1
This is RS232 serial port 1 receive data pin. This serial port is normally used for the serial connection to the Tritech navigation software PC. This pin is the downlink data input to the iFG, and should be connected to the downlink transmit output from the ROV serial multiplexer. This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors.

Pin 3 – RS232 TX1
This is serial port 1 transmit data pin. This serial port is normally used for the serial connection to the Tritech navigation software PC. This pin is the uplink data output from the iFG, and should be connected to the uplink receive input on the ROV serial multiplexer. This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors.

Pin 4 – n/c
No connection. Do not connect anything to this pin.

Pin 5 – RS232 GND
This is serial port 1 & serial port 3 0V DC Ground connection. This is the 0V reference for the serial port signals, and should be connected to the 0V of the serial devices / interfaces that are connected to the iFG serial ports 1 and 3. This signal is isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors.

Pin 6 – RS232 RX3
This is serial port 3 receive data pin. This serial port is normally used for the serial connection to the iGC unit. This pin is the data input to the iFG (from the iGC output), and should be connected to the transmit output from the iGC (pin 3 of the iGC Subconn connector). iGC sensor data is sent on this pin. This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors. This serial port can be operated in RS485 mode rather than RS232 signalling levels, if this option has been installed at time of manufacture. In this case, the pins 6 & 7 on the PORT2 connector

are used (see below). To enable RS232 mode (rather than RS485 mode), internal jumper links inside the iFG must be set accordingly.

Pin 7 – RS232 TX3

This is serial port 3 transmit data pin. This serial port is normally used for the serial connection to the iGC unit. This pin is the data output form the iFG (connected to the iGC serial data input), and should be connected to the receive input on the iGC (pin 4 of the iGC Subconn connector). Downlink commands to the iGC are sent via this pin. This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors. This serial port can be operated in RS485 mode rather than RS232 signalling levels, if this option has been installed at time of manufacture. In this case, the pins 6 & 7 on the PORT2 connector are used (see below). To enable RS232 mode (rather than RS485 mode), internal jumper links inside the iFG must be set accordingly.

Pin 8 – 0V POWER

This is the 0V DC power supply connection to the iFG. Alternatively, pin 8 on PORT 2 connector can be used for 0V Power input to the iFG. This is internally isolated form other PORT1 and PORT2 pins.

Pin 9 – +10 to +30V POWER INPUT

This is the +10 to +32V DC power supply connection to the iFG. Alternatively, pin 9 on PORT 2 connector can be used for +ve DC Power input to the iFG. This is internally isolated form other PORT1 and PORT2 pins.

The mating connector for PORT 1 is a 9-pin female D-Sub connector. This connector should be retained with locking / jackscrews (No.4 UNC-40TPI). A shielded backshell for the mating connector is recommended.

5.2 PORT 2 CONNECTOR:

Port 2 is the Right-hand connector, and its pinouts are as follows:

Pin 1 – n/c

No connection. Do not connect anything to this pin.

Pin 2 – RS232 RX2

This is serial port 2 receive data pin. This serial port is normally used for the serial connection to the local host ROV / Vehicle control system. This pin is the Host's input data to the iFG, and should be connected to the transmit output from the Host ROV control system. This pin is optional, and is only required when commands from the host ROV control system are to be sent to the iFG (application specific). This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors.

Pin 3 – RS232 TX2

This is serial port 2 transmit data pin. This serial port is normally used for the serial connection to the local host ROV / Vehicle control system. This pin is the data output from the iFG, and should be connected to the receive input on the Host ROV control system. Data is transmitted from this pin in the format selected by the operating Mode switches. This serial port operates at standard RS232C signalling levels. Signals are isolated from power supply 0V, but use the same 0V Ground reference as all other signals on both PORT1 and PORT2 connectors.

Pin 4 – nPROG

When this pin is connected to RS232 GND (pin 5), the iFG is placed into programming mode. The internal system firmware can be updated / loaded via the PORT2 Serial Port 2. This mode is normally only used during maintenance by service engineers.

Pin 5 – RS232 GND

This is serial port 2 0V DC Ground connection. This is the 0V reference for the serial port signals, and should be connected to the 0V of the serial devices / interfaces that are connected to the iFG serial port 2.

Pin 6 – RS485 A

This is serial port 3 RS485-A pin. This serial port is normally used for the serial connection to the iGC unit. This pin allows serial port 3 to operate in RS485 mode (and this port is shared with the port 3 RS232 pins on the PORT1 connector). To enable RS485 mode (rather than RS232 mode), internal jumper links inside the iFG must be set accordingly. RS485 mode is only available if this option has been installed at time of manufacture.

Pin 7 – RS232 TX3

This is serial port 3 RS485-B pin. This serial port is normally used for the serial connection to the iGC unit. This pin allows serial port 3 to operate in RS485 mode (and this port is shared with the port 3 RS232 pins on the PORT1 connector). To enable RS485 mode (rather than RS232 mode), internal jumper links inside the iFG must be set accordingly. RS485 mode is only available if this option has been installed at time of manufacture.

Pin 8 – 0V POWER

This is the 0V DC power supply connection to the iFG. Alternatively, pin 8 on PORT 1 connector can be used for 0V Power input to the iFG.

Pin 9 – +10 to +30V POWER INPUT

This is the +10 to +32V DC power supply connection to the iFG. Alternatively, pin 9 on PORT 1 connector can be used for +ve DC Power input to the iFG.

The mating connector for PORT 2 is a 9-pin female D-Sub connector. This connector should be retained with locking / jackscrews (No.4 UNC-40TPI). A shielded backshell for the mating connector is recommended.

5.3 MODE SELECTION SWITCHES:

There are two Mode selection switches on the iFG to allow different operating modes to be set. These are often preset by Tritech before the iFG is delivered (assuming that the desired operating mode is known). The User can however set the operating modes to a different value to suit his operational requirements.


The Primary Mode switch is a rotary switch on the front panel. This switch sets the main operating mode for the sensor, and is adjusted using a small screwdriver. Changes to the switch setting cause the iFG to reset and re-boot the internal firmware. Details of the supported operating modes and corresponding switch settings are given in the table below:

BCD Mode Switch	Function
0	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 No ASCII telegram output.
1	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 19k2 baud Format taken from Submode switch ASCII Table 1
2	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 9600 baud Format taken from Submode switch ASCII Table 1
3	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 4800 baud Format taken from Submode switch ASCII Table 1
4	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 19k2 baud Format taken from Submode switch ASCII Table 2
5	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 9600 baud Format taken from Submode switch ASCII Table 2
6	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 4800 baud Format taken from Submode switch ASCII Table 2
7	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 2 TX2 & RX2 ASCII Telegram RS485 output from Port2 A/B at 19k2 baud Format taken from Submode switch ASCII Table 1
8	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 2 TX2 & RX2 ASCII Telegram RS485 output from Port2 A/B at 19k2 baud Format taken from Submode switch ASCII Table 2
9	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 Special Mode taken from Internal Submode switch.

There is a second Sub-mode selection switch inside the iFG. This switch allows different output telegram formats to be selected for the serial port 2 interface to the host ROV control system. The supported modes are selected from two 'tables' (Table 1 and Table 2) according to the Primary mode switch setting (above). The two tables of output telegram formats are listed in the Appendix.

To set the Sub-Mode switch, the iFG must be opened up and the switch settings carefully adjusted. The following procedure should be used:

1. Remove iFG from the host ROV / Vehicle pod and take to static-safe workshop bench.
2. Remove the four Pozi-head screws at the four corners of the FRONT cover plate (the plate with the D-type connectors).
3. Carefully remove the plate, being careful to not pull on the internal wiring loom.
4. Identify the Sub-mode switch, and adjust to the desired setting using a small jeweller's screwdriver or similar.
5. Carefully re-fit the plate to the iFG housing, taking care to not trap the wiring loom during re-installation.
6. Replace the four cover screws, ensuring that these are not over-tightened.
7. RE-fit the iFG to the host ROV pod and test.

SUB-MODE SWITCH
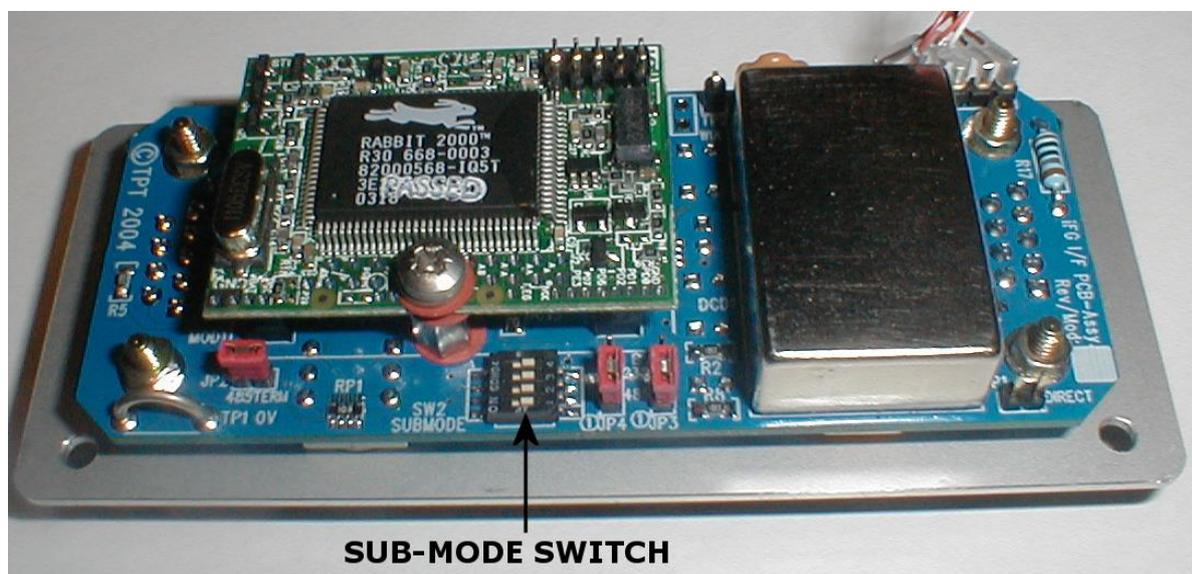
Note that the position of the switch is determined by the printed 'ON' marking on the top surface of the switch.

5.4 RS485 PORT SELECTION JUMPERS:

If serial port 3 is to be operated in RS485 mode (factory installed option), the internal jumper links must be set accordingly. These are accessed by the same method as described above for the Sub-mode switch adjustment. The jumpers (JP3 and JP4) are next to the Sub-mode switch, and are set as follows:

        Both jumpers in Position 1-2 = RS232 mode
        Both jumpers in Position 2-3 = RS485 mode

When operating in RS485 mode, a 120-ohm terminating resistor can be selected by using jumper JP2. If this jumper is fitted, the 120-ohm resistor is in circuit. The typical RS485 operating mode would have this jumper fitted.

5.5 FRONT PANEL LEDS:

There are six status LEDs on the front panel of the iFG. These LEDs are useful during system commissioning and fault-finding. Their function is as follows:

DC Power LED:
Illuminates whenever the DC power is applied.

system LED:
Illuminates when the system is functioning correctly and the internal processor is running.

FOG data LED:
Illuminates when data is being received from the internal FOG sensor.

host data LED:
Illuminates when data is being sent / received from the Host connection port(s).

direct LED:
Illuminated only when the direct FOG sensor output is selected (either by an internal jumper setting or pulling PORT1-pin 1 low.

fault LED:
Illuminates when there is a system fault (such as the iFG not receiving the iGC data or not being correctly slaved to the iGC).

The fault LED will pulse on and off during the initialisation stage of the iGC and iFG. The LED will stop pulsing once the iFG/iGC slaved status is achieved.
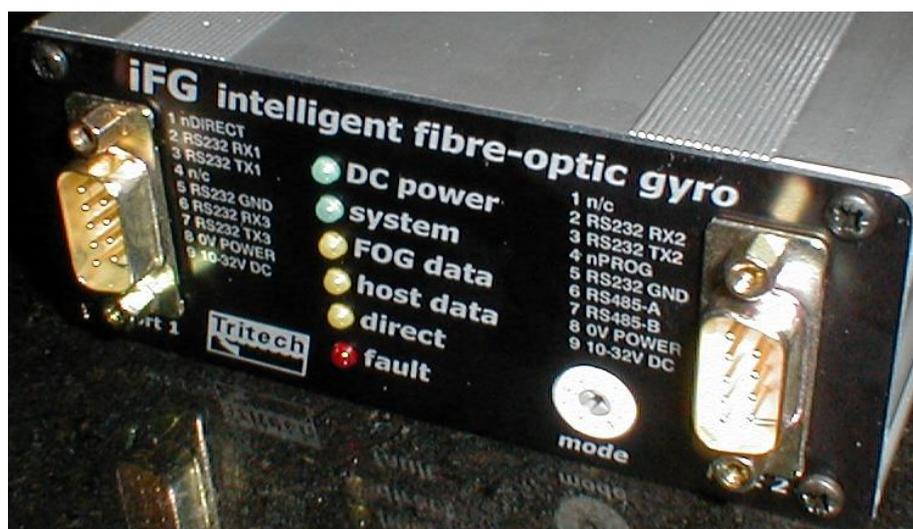
Whilst the front panel LEDs are a useful guide, the Tritech iGC/iFG software provides much more comprehensive diagnostic data, and should be used where possible for faultfinding etc.

6. INSTALLAION

6.1 SAFETY

Before commencing installation of the iFG:

- Refer to Section 6 – 'Safety Notes' in this manual.
- All relevant parts of this section of the manual should be read and understood.

6.2 IFG MECHANICAL INSTALLATION

When deciding where to mount the iFG, consideration should be given to:

- Electrical connections to the host ROV / vehicle system and the external iGC;
- Availability and rating / specification of the DC power supply;
- Physical alignment with the axes of the host system (particularly to ensure the unit is installed horizontally to the vehicle;
- Stiffness of the mounting arrangement;
- Physical protection of the sensor;
- Proximity to electrical or magnetic sources of interference;
- The ambient temperature inside the pod where the iFG will be located;
- Electrical earthing and possible 0V isolation requirements.

6.3 ELECTRICAL CONNECTIONS

The iFG must connect to the host vehicle control system via an RS232 link, or in some cases to the iIF PCB mounted in the host vehicle pod. Locating the iFG in the same pod or area of the vehicle will simplify these connections.

6.3.1 Power Supply

A fused (or otherwise protected) DC power supply is required to operate the iFG. Consideration of the availability of this supply in the desired installation location should be given. It can be an advantage to be able to switch the power supply ON and OFF remotely from the vehicle surface control console.

	Caution
⚠️	The iFG has a higher voltage range than the iGC. The iGC voltage range is 12-26VDC whereas the iFG voltage range is 10-32VDC. Connecting an iGC to an iFG running above 26VDC will damage the iGC.

6.3.2 Physical Alignment

Alignment of the iFG (i.e. which direction it is facing with respect to the front of the host vehicles) is not critical because it does not measure heading directly. Instead it measures relative heading information and relies upon initial direction information from the iGC on power-up. It then uses iGC direction to keep long term correspondence with magnetic North.

More important is that the iGC is correctly aligned with the desired reference axes on the host vehicle (refer to the iGC manual for further details on iGC mounting and installation).

6.3.3 Mounting Stiffness

The iFG should be rigidly mounted so that flexibility and / or system vibration does not affect the outputs.

6.3.4 Physical protection of the sensor

The iFG is a reasonably robust unit, but it should be handled carefully and installed in an area that is unlikely to cause mechanical damage to the sensor during maintenance operations etc. The electrical connectors should be secured with their locking screws.

6.3.5 Electrical or Magnetic Interference

The iFG should be mounted in a location away from local magnetic or electrical sources of interference. Such interfering devices are electric motors, power supplies, inverter drives, phase-angle lamp dimmers etc.

6.3.6 Ambient Temperature

The accuracy of the iFG and its bias / drift-rate performance is directly related to the temperature (or more importantly – any changes in temperature). The iFG should be located in an area of the vehicle control pod away from direct heat sources such as power supply regulators etc. Once the ROV is operational however, the control pod internal temperatures generally stabilise to a constant value.

6.3.7 Electrical Earthing and Isolation

If the host vehicle chassis is to be kept isolated form the 0V DC Ground Reference used for the iFG serial ports, the iFG must be installed on an insulating mounting plate. Fasteners that secure the iFG must also provide electrical isolation by means of insulating washers etc. The 0V DC Serial Port GND reference pins on the iFG are electrically connected to the iFG case. This provides the best noise-immunity and screening for the device, but can cause problems with ground-fault detection and CP systems if not respected.

6.3.8 Installation Drawing

The following drawing shows installation dimensions and fastener details for the installation of the iFG. **Note the warning regarding mounting screw length**.
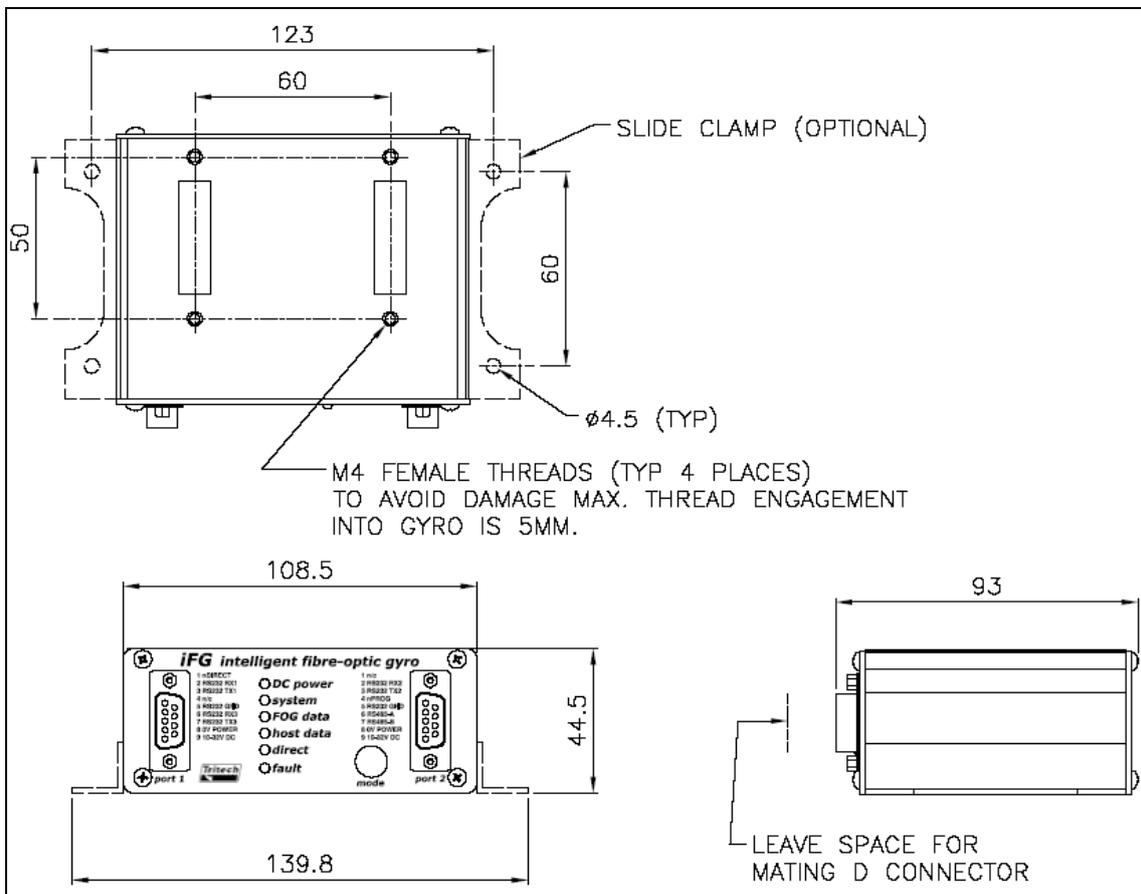
6.4 IFG ELECTRICAL INSTALLATION

6.4.1 Installation Planning

The electrical installation of the iFG should be carefully planned, to ensure that the following points are covered:

- A suitable DC power supply is provided, and that this can be switched remotely if possible;

- The electrical interfacing to the iGC unit is designed and implemented correctly;

- The electrical interfacing to the host ROV / vehicle control system is correctly designed and documented;

- The electrical interfacing to the iIF PCB (if used) is correctly implemented;

- The correct mode selections have been made to provide output data in the desired format;

- The link to the Tritech surface control software is implemented (even if not used for primary heading operations – but for diagnostics and set-up);

- The correct device settings are set using the control software (e.g. bias corrections, operational latitude etc.).

Typical installation wiring diagrams for various installation configurations are given in the Appendix, and these should be used for reference when designing a particular installation method for the host ROV / vehicle.

Prior to installation, a plan should be made of the interface method to be used for the iFG. This will involve the following steps:

1. Identify the DC power supply to be used on the host system. Ensure that the voltage is in the specified range and that the supply is suitably fused / protected. (The iFG is fused with an automatic self-resetting 250mA fuse internally, but the interconnecting cable should be protected with a suitable fuse / circuit breaker at the host end - e.g. a 1A antisurge type). It is advisable to use a switched supply to allow the iFG to be powered down in isolation from other circuits.

2. Decide which operating mode that will be used for the iFG - the complete list of operating modes is given in section 10 above (Primary Modes) and in the Appendix (Sub-modes).

3. Decide which hardware interface protocol is to be used (RS232 or RS485) for Serial Port 3.

4. Make a drawing of the required interface cable(s) (refer to the typical interface cable details in the Appendix).

5. Check compatibility of the host control system for the chosen operating mode (Hardware protocol, baud-rate, telegram format, update rate etc.). This should be checked by referring to the host vehicle control system documentation together with the Sub-mode tables listed in the Appendix.

6. Plan how the Tritech topside PC software is to be implemented. The connection from the iFG to a PC running the Tritech software is important as it allows the iFG to be set-up and its performance monitored whilst in use – even when the host ROV control system provides an independent heading display. Having a connection to the Tritech software (usually via a spare RS232 ROV multiplexer channel) allows the user to adjust iFG settings (such as latitude) without accessing the unit inside the pod. The PC running the software at the topside can be used for other purposes when not adjusting or monitoring iFG settings or data.

If the operating mode that the iFG is to be used in differs from the mode settings as the unit was supplied (refer to Section 1 - iFG Supply Specification), the iFG mode switch settings (on the front panel and possibly internally) will have to be adjusted. This is covered in section 10 above.

6.4.2 Installation Procedure

The following procedure should be followed to complete the Electrical Installation of the iFG:

1. Make any necessary wiring and modifications to the Host control system to provide the appropriate power supply and telemetry circuits.

2. Using a digital multimeter, insert probes into sockets 8 and 9 of the appropriate D connector on the interconnecting cable (prior to connecting to the iFG).

3. Carefully power-up the Host supply (or the iFG supply circuit if switchable). Confirm that the output voltage is the correct value and polarity.

    Caution!
    Do not connect the cable to the iFG until provision of correct voltage to the correct pins on the iFG connector has been checked (see commissioning section).

    Note:
    The iFG input power connections are protected against reverse polarity of the supply connections. If power is inadvertently connected in reverse polarity, the iFG will not power up, but will not be damaged.

4. With the power to the Host control system isolated, attach the interconnecting cable(s) to the iFG and secure with jackscrews.

5. When the correct iFG supply voltage has been confirmed, isolate the iFG supply and check that there is no power present on the connector sockets (pins 8 & 9).

6. Connect the female connector(s) to the iFG.

7. Carefully power-up the Host supply (or the iFG circuit if switchable).

8. Check correct operation of the iFG according to the Commissioning Section below.

7. COMMISSIONING

7.1 GENERAL

Before starting commissioning of the iFG:

- Refer to the Section 6 – 'Safety Notes' above.

- All relevant parts of this section of the manual should be read and understood.

- All electrical power and data connections must be complete and tested.

7.2 OVERVIEW

The iFG is a rate sensor device which measures rate of rotation. If it is nominally held stationary it will still output a measurement of rotation made up of two components:

1. The rotation of the earth spinning upon its axis.

2. The natural drift rate of the sensor.

Fortunately, the natural drift rate of the sensor remains constant for a particular sensor, although it does vary slightly until the sensor reaches an equilibrium running temperature.

The output due to earth rotation varies with latitude. If the sensing axis is held parallel to the ground at the North Pole it will output a value of angular rotation of 15° per hour (360° per day). If the sensing axis is held parallel to the ground at the equator the sensor will give zero output.

During power up, the iFG's initialisation routines recall the stored Latitude setting from the internal EEPROM memory. This setting is converted to an 'Earth bias correction' value that is continually applied to the sensor output. The stored calibration 'drift bias correction' figure is also recalled and this is also applied continuously to the sensor output data together with the Earth bias correction.

If the Electrical Installation procedures in the Section above have been followed correctly, the iFG should function correctly when it is powered-up for the first time.

On application of DC power, the iFG reads the Mode selection switches and calculates the required internal settings to match the required output format. A short ASCII data packet is transmitted from the serial port 1 (in 19,600, N, 8, 1 format) that can be used to check the current configuration.

After 5 seconds, the iFG enters its output mode selected and begins to function according to the rules of the mode settings.

The reason for transmitting the configuration packet is that it allows users to check the correct operating mode and settings using a simple terminal programme (e.g. HyperTerminal) for faultfinding. Under most circumstances, the Host data interface should ignore or discard this data and begin responding to or processing the normal output telegram packets once they start. If the configuration packet causes problems for the Host interface software, it can be disabled as a factory or field-installable firmware option.

After power-up, and assuming that the operating mode selected uses an iGC as the magnetic sensor reference, the following sequence of events occurs:

1. The iFG carries out internal start-up functions and configurations;
2. The iGC starts up (assuming power is applied to the iGC at the same time as the iFG);
3. The iFG receives the iGC heading, pitch and roll data which it monitors;
4. The iFG heading output data sent to the host system at this time is the 'raw' iGC heading value as received form the iGC;

5. The iFG monitors the iGC heading value, and waits until the iGC heading 'settles' to a steady value. This may take some time (a minute or more) depending on the time it takes the iGC to stabilise – and whether the system is moving (e.g. on a ship where the heading is changing).
6. Once the steady iGC heading is received, this heading is 'locked' into the iFG as the initial heading reference. The output heading data from the iFG is now taken from the iFG FOG sensor heading output.
7. The iFG continually corrects the output heading data for Earth drift and Sensor Bias drift.
8. The iFG continually 'slaves' its output to the iGC magnetic heading value at a rate of 20° per hour.

An understanding of this process will allow the engineer commissioning the system to follow the sequence using the diagnostic software.

7.3 POWERING UP FOR THE FIRST TIME

Ideally when the iFG is powered up for the first time, this should be done with the iFG (and iGC) rigidly mounted and stationary. The heading, particularly, should be kept constant during initial power up. This allows the iFG to acquire the iGC reference heading quickly.

With the host control system powered up and ready, apply power to the iFG / iGC. Check that the correct data appears 5 seconds or so after application of power (either on the Tritech Navigation display if used or the Host ROV control system heading display). If the data is detected and appears to be correct, the data check procedures below should be followed.

If no data appears, check that the iFG connections and interfaces are all correct. A very common commissioning problem that can occur with RS232 or RS485 signals is that the TX and RX lines (for RS232), A+ and B- lines (for RS485) are accidentally swapped the wrong-way around. With these lines swapped, no damage should occur but the system will not function - it is therefore safe to try swapping the telemetry connections.

If problems persist, it may be necessary to examine the data signals with an oscilloscope or by monitoring the LED indicators on the front panel.

If the iFG data is still not received correctly, the output and mode settings of the iFG should be checked with the system setup programme or by using a terminal programme as described below:

7.3.1 Checking configuration settings using HyperTerminal

The output data from the iFG RS232 port 1 should be connected to a PC or Laptop with an RS232 serial port using a suitable test cable. This will probably be via the hors ROV multiplexer if the serial port 1 is connected to the surface for purposes of running the Tritech navigation software.

Boot the test PC and run up a terminal emulator programme (e.g. HyperTerminal, Procomm, Telix etc.).

Select the correct COM port that the iFG serial port 1 is attached to in the terminal software. Note that PCs that are using a USB to Serial converter often assign a COM port above COM3. Check under Device Manager (or equivalent) if in doubt.

Set the terminal programme's port settings to 19,200 baud No parity, 8 data bits and 1 stop bit. Enable the terminal programme into 'connected state' if applicable.

Power up the iFG and observe the terminal output window. The configuration data message should be seen on the terminal screen - a typical output is shown below (note that this is a screenshot from an iGC configuration page, which is almost identical to the iFG version):
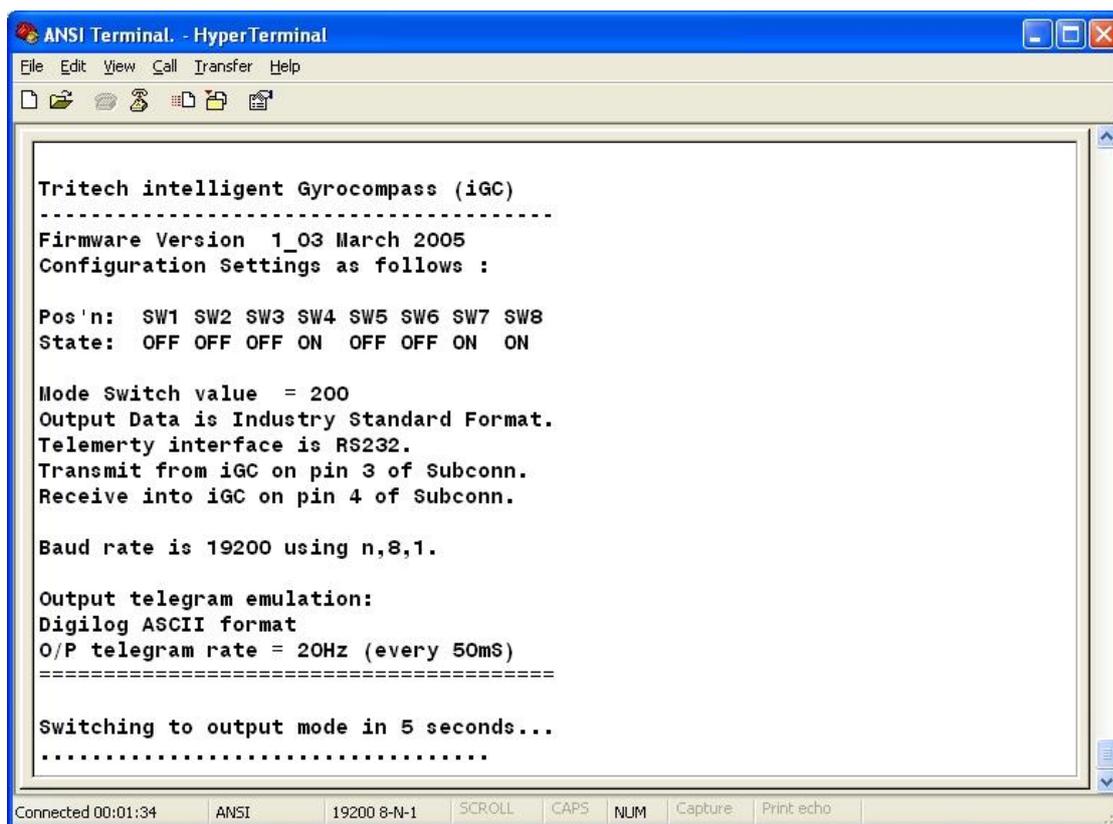
If the configuration screen is not seen, check the cabling and power supply to the iFG, check the terminal programme with a known good data source (or looped back from itself by connecting pins 2 & 3 of the PC com port and typing on the keyboard). Check that if using a programming cable that the programming switch is NOT in programming position.

Investigate the problem until a satisfactory configuration message is received.

In exceptional circumstances, it may be necessary to check the status LEDs on the iFG's front panel.

Once the configuration message is correctly received, it is likely that the 'live' iFG data will be received that will connect to the Tritech Navigation software. At this time, shut down the terminal software and start up the Tritech Navigation software to allow monitoring and configuration of the iFG's performance.

7.3.2 Checking Operation with iFG Software

Once the serial link to the iFG serial port 1 has been proven, the Tritech Navigation software should be used to check for correct iFG operation. Details of this software are given in the section below.

The Tritech software can be used to also check configuration settings for the host ROV interface on iFG serial port 2 (the mode selection switch values can be examined).

7.3.3 Checking Host ROV Data

In most cases where the iFG is used as an integrated sensor with a host ROV control system, the data from the iFG will be sent to the host ROV via iFG serial port 2. The protocol used is selected from the Mode switches as describes earlier in this manual.

After powering up the iFG / iGC system, and confirming correct operation of the Tritech Navigation PC software with the iFG / iGC, the data interface with the host ROV should be checked.

This procedure involves checking that the data (e.g. heading, pitch, roll) is being correctly received by the host ROV control system. A check of the ROV compass display etc. should confirm this.

When the output data from the iFG to the ROV has been checked and tested OK, the ability of the ROV to send commands to the iFG should also be checked. Not all ROV host systems support the sending of commands to the iFG, so please refer to the ROV control system documentation for details.

If you are involved with designing the interface between the iFG and a host ROV system, we recommend that several important commands are supported in the ROV control system software / driver. A suggested command set is given below. Please contact Tritech for engineering assistance when implementing these commands:

CALIBRATE_DRIFT	FORCE_MODE_NOSLAVE
PRECESS_CW_S	FORCE_MODE_NORMAL
PRECESS_CCW_S	SET_FREQ_20
PRECESS_CW_L	SET_FREQ_10
PRECESS_CCW_L	SET_FREQ_5
SET_FOG_TO_MAG	SET_FREQ_4
DRIFT_CORRECT_CW_S	SET_FREQ_2
DRIFT_CORRECT_CCW_S	SET_FREQ_1
DRIFT_CORRECT_CW_M	RESET_IFG
DRIFT_CORRECT_CCW_M	RESET_IGC
DRIFT_CORRECT_CW_L	ZERO_QUALITY_FLAG
DRIFT_CORRECT_CCW_L	INCREASE_ESLAVING_RATE
FORCE_MODE_MAG	DECREASE_ESLAVING_RATE

7.4 SYSTEM PERFORMANCE TESTING

After the hardware installation and data interfaces have been correctly commissioned, the iGC / iFG gyro system should be checked for correct operation with the host ROV control system.

The following steps should be followed:

1. Set up the correct operational latitude that the system is working at (using Tritech Navigation software – or host ROV telemetry interface if supported).
2. Power up the system and check correct heading, pitch and roll data.
3. Check that the earth and bias corrections are being applied (by examining the Data page on the Tritech software).
4. Check that the iFG is 'slaved' to the iGC correctly, and that the slaving rate is set to 20°/hour.
5. Rotate the host vehicle (either underwater or by using a crane etc) to confirm correct operation of the gyro as the vehicle heading changes.
6. Make several complete turns in both directions to check correct operation, and also to check turns counter function.
7. Check that the iFG can be manually re-slaved to the iGC heading output.
8. Check for reasonable correlation between the iGC and iFG heading values as the system is rotated. Note that correlation may not be particularly good if the system is being operated in close proximity to magnetic interference (such as in a steel test-tank or next to a crane or container etc).
9. Check for accuracy of the heading reference by setting the host vehicle to point in a known heading direction. This will confirm that the iGC has been installed correctly aligned with the front / forward direction on the host ROV.

These checks should be carried out whenever the system has been maintained or removed / re-fitted etc.

Important Note:

As the iFG sensor is normally located inside the ROV 1-atmosphere control pod, it is very important that the iFG is installed horizontally. Some control pods allow the rotation of the internal chassis by turning the pod end-cap. Care should be taken to mark the '12-o-clock' position of the pod end cap to ensure that the internal chassis is horizontal after the pod is closed up.

7.5 CALIBRATION

There should be no requirement for the User to calibrate the iFG system. As delivered from Tritech the system should be correctly calibrated and its bias correction rates set.

If these settings are accidentally changed – and the correct values lost, Tritech can provide details of the correct bias settings for each iFG.

7.6 AUTO-HEADING CHECKS

Where the iFG / iGC is used as the heading input to a host ROV auto-heading controller, the performance of this should be checked. Refer to the host ROV documentation for details of this function.

8. OPERATIONAL ISSUES

8.1 GENERAL

When in use, the iFG / iGC system should provide reliable and accurate heading, pitch and roll data to the host system.

In order to get the best performance from the system, the User / Operator must be aware of certain operational issues or considerations that will ensure the best performance.

8.2 PRE-DIVE CHECKS

Prior to diving the ROV, the iFG and iGC system should be powered up (if not continuously powered when the ROV instruments are powered). The system should be checked for correct heading output and correct slaving of the iFG to iGC. Ideally these checks should be made using the Tritech Navigation software and the host ROV control system.

Important Note:

When the ROV system is on deck on its host vessel, the magnetic interference to the iGC will be significant. This will come from the vessel superstructure, the A-frame, the TMS and other steel structures near the ROV. This magnetic influence will almost certainly cause an error in the iGC heading.

After a period of time, the iFG will be 'slaved' to this incorrect iGC heading (at a rate of 20° per hour). If the ROV has been on deck for some time, the iGC (and therefore iFG) heading will be inaccurate.

There are two techniques that can be used to resolve this problem:

1. Immediately prior to launching the ROV, the vessel heading should be acquired by the ROV operator (form the ship's compass etc). The heading of the ROV on deck should then be calculated (depending on how the launch system is oriented with respect to vessel heading). This correct heading should then be sent to the iFG (by means of the 'precess' commands in the system software). The ROV can now be launched with a known good heading in the iFG. When the ROV is underwater and away from the ship's magnetic influence, the system will operate correctly.

2. The ROV can be launched with an incorrect heading, and when underwater and away from magnetic influence, the iGC heading can be monitored to ensure that it is stable. When a stable iGC heading is being read, this should be transferred into the iFG heading using the software commands.

Either of these techniques will ensure that the heading at the start of the dive is as good as possible. If this procedure is not followed, the incorrect initial heading will take some time to be corrected to the true heading (this can take several hours at a slaving rate of 20°/hour).

8.3 CORRECTIONS DURING THE DIVE

During the dive and particularly when the system is being used in an area where there is significant magnetic influence (such as near a subsea structure, pipeline, BOP etc), there will be the possibility that the iGC will have been generating an incorrect magnetic heading for some time. This incorrect heading will 'push' the iFG heading around to the inaccurate value at the slaving rate of 20°/hour.

In cases such as this, the recommendation is to move the ROV away from the interfering structure, and if possible sit the ROV on the seabed for a minute or two. After this time, the iGC heading should have restored to the correct value and the iFG can be manually precessed (or set directly) to the iGC heading.

The frequency of this process depends on the magnitude of the magnetic error and the criticality of the ROV heading for the operations being carried out.

8.4 LATITUDE CHANGES

When the system is used, it is the responsibility of the ROV operator to ensure that the correct latitude is entered into the iFG to provide the Earth bias corrections. The latitude should be available from the vessel surveyor / bridge. This value should be entered whenever there has been a significant change in location.

Latitude is set using the Tritech software (or via the host ROV interface if the appropriate command is supported).

9. USING IFG / IGC NAVIGATION SOFTWARE

9.1 OVERVIEW

The iFG / iGC PC software is a stand-alone application that provides the user with a real-time display of Heading, Pitch, Roll, turns counter, heave and system status.

Normally this software is used where the iFG / iGC is not integrated to a complete host control system, but it can be used in parallel with an existing host control system for the purposes of extended diagnostics and control, providing certain interface criteria are met.

The software operates under the Windows® operating system, and provides a clear graphical display of iFG / iGC data. There are various options selectable by the User in the software that allows integration with different iFG / iGC configurations. It is also a useful tool for faultfinding, commissioning and setting up iFG / iGC applications.

The minimum requirements of the host PC are as follows:

- 1GHz Pentium 4 (or better);
- Windows NT, Windows 2000, Windows XP, Windows Vista, Windows 7;
- 512MB RAM;
- 200MB Free disk space;
- 1 x RS232 serial port (or USB port for USB to RS232 converter);
- 1024 x 768 display;
- CD ROM drive (or USB port for memory stick loading)

9.2 MAIN NAVIGATION DISPLAY

The Main Navigation Display presents the following information

Display Item	Description
Analogue Heading	Animated rotating compass card - this shows instantaneous output of the active heading sensor output. The red 'H' invalid flag is present if the heading is invalid. The blue 'F' flag is present if the iFG is Free (not slaved to iGC).
Digital Heading	Numeric display of the active heading sensor output to 1 decimal place. The colour of the digits represent the heading source (white is iFG, yellow is iGC, green is NSG, red is Relative)
Digital Reciprocal	Numeric display of the active heading sensor reciprocal heading output to 1 decimal place.
Analogue Pitch	Animated artificial horizon display of iGC pitch sensor. +/-30° range.
Digital Pitch	Numeric display of the iGC pitch sensor output to 1 decimal place. +/-90° range.
Analogue Roll	Animated artificial horizon display of iGC pitch sensor. +/-90° range.
Display Item	Description
Digital Roll	Numeric display of the iGC roll sensor output to 1 decimal place. +/-90° range.

Analogue Heave	Animated heave acceleration sensor display. +30 to -40 ms^{-2} range.
Digital Heave	Digital heave acceleration sensor display to 1 decimal place. +/- 99ms^{-2} range.
Turns Counter	Digital display of number of turns made by iGC system since power-up or last reset. Range +/- 9.9 turns to 1 decimal place.
IGC Temperature	Digital display of iGC internal temperature. -9.9°C to +70°C range to 1 decimal place.
IGC Heading	Shows the raw output from the iGC when the iFG is being using to provide the primary heading output. Gives any indication of the varying magnetic disturbance acting upon the system.
System Time	Digital display of PC system time in format hh:mm:ss
Telemetry status	LED indicator showing telemetry status of iGC, iFG, iIF, North-Seeking Gyro (survey gyro / NSG) and Seanet SCU. LED colours as follows: Red comms failed / absent. Green comms good. Grey no comms expected (not enabled). Yellow comms failed / absent.
Sensor status box	Text description of each sensor's status.
Heading source	Indicators to show the source of the current displayed heading. This can be one of the following: *iGC* - This is the iGC heading output alone. *iFG relative* - This is the iFG relative heading output prior to a valid iGC heading having been received. i*FG unslaved* - This is the iFG heading after having been slaved to the iGC, but the iGC data stream has been lost (or the slaving function has been switched off). i*FG/iGC slaved* - This is the ideal output mode where the iFG is providing stabilised heading output with magnetic slaved corrections from the iGC. *Survey Gyro* - Where a survey gyro or North- seeking Gyro is used with the system, this shows when the NSG is providing the active displayed heading data.
Display Item	**Description**
System Alarm	Illuminates Red when any system alarm is detected (e.g. telemetry failure, water ingress etc.).
CCW - CW	If the system has been disturbed by a magnetic influence and the current vehicle heading is accurately known, the heading output can be manually adjusted to this known heading by using these CCW (counter clockwise) and CA (clockwise buttons).

| Turns counter 'Reset' button | Resets the turns counter to 0.0 turns. |
'Show Data' button	Shows the iGC / iFG / iIF Data display screen.
'Setup' button	Accesses the set-up and configuration screen(s).
'Turn Slaving OFF/ON' button	Allows the iGC slaving correction to be turned ON and OFF.
'Exit' button	Quits the application.

Typical main software display:

9.3 DATA DISPLAY

The data display screen presents the following information:

Display Item	Description
IGC Heading	Shows iGC heading output in raw and engineering (degrees) formats.
IGC Pitch Angle	Shows iGC pitch output in raw and engineering (degrees) formats.
IGC Roll Angle	Shows iGC roll output in raw and engineering (degrees) formats.

IGC Heave Acc.	Shows iGC heave acceleration output in raw and engineering (m/s^2) formats.
IGC Temperature	Shows iGC temperature output in raw and engineering (°C) formats.
IGC Flags	Shows (via simulated LEDs) iGC sensor data and water ingress status.
Extended Data	Shows the iGC serial number, mode of operation, rateskip and firmware issue,
Data Packet Received	Shows the source of the data received by the host (this will depend upon the system configuration and set up.
IFG Heading	Shows iFG heading output in raw and engineering (degrees) formats. The Mag / iFG LEDs show whether the iGC or the iFG output is being used for the navigation display.
IFG State Machine	Shows the status of the internal state machine variable that tracks iFG operating mode (made up of individual data flag bits as shown on the 8 LED indicators).
Extended Data	Shows the iFG serial number, mode of operation, rateskip and firmware issue,
NSG Heading	Shows NSG (North seeking Gyro) heading output in raw and engineering (degrees) formats, if one is fitted
Raw FOG Output	Shows the raw output from the iFG before drift or slave correction.
Drift Correction	Shows the magnitude of the drift correction being applied to the iFG, derived during start up or from memory (if stable magnetic heading cannot be maintained during start up).
Delta MAG - FOG	Difference between the iFG output and the magnetic heading derived from the iGC.
Slaving Push	Magnitude of the slaving correction applied to the iFG in response to the difference between its heading and the magnetic heading derived from the iGC.
Drift Lock	Shows whether the iFG is successfully locked to the iGC output during start up.
Slave Seq.	Slave sequence shows the sequence of events during start up as the iFG is locked on to the iGC magnetic output.

Typical Data software display:
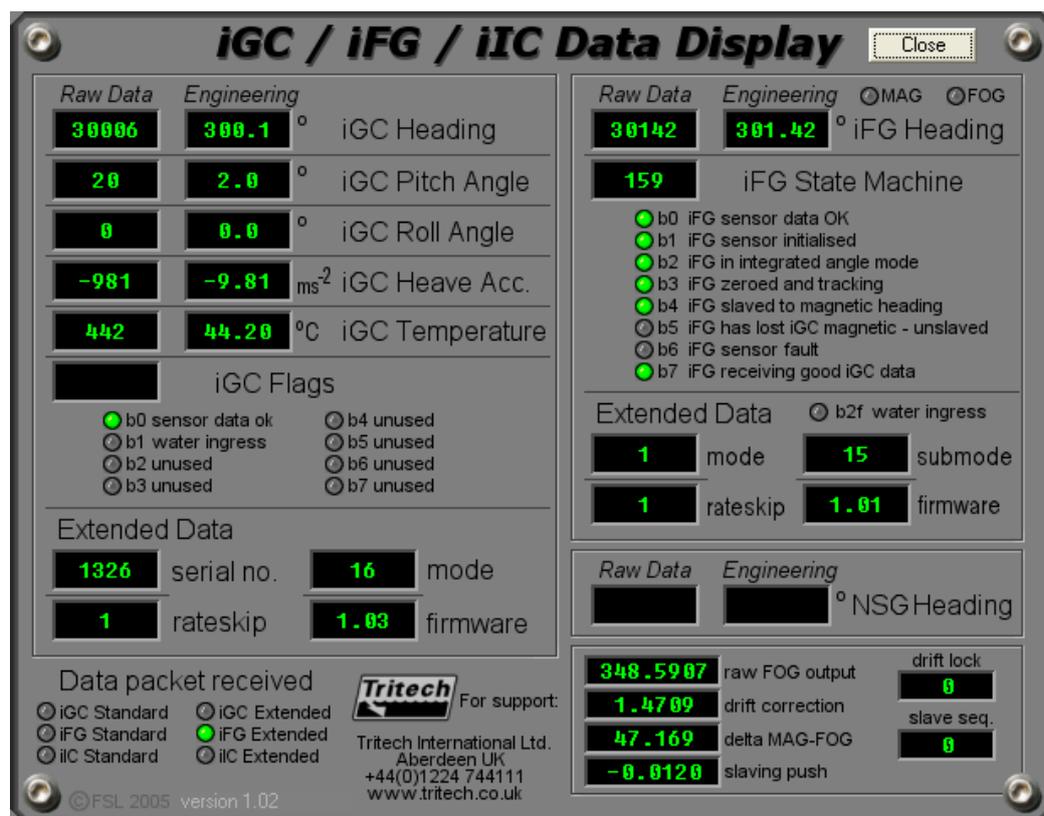
9.4 SYSTEM SETUP DISPLAY

The software and attached iFG / iGC are configured via the System Setup display screen. The various areas of the control screen are described below:

Binary Host Serial Setup:
This is the configuration of the serial port used to communicate with the iFG. This is normally set to 19,200 baud and to the serial port in use.

Navigation Display Configuration:
Selects the behaviour of the displayed heading on the Navigation Software screen.

Sensor Offsets:
These are sensor offset values. These are only applied at the surface and relate only to the Tritech Navigation display (and third-party outputs), so the data sent to the host ROV control system inside the ROV pod are NOT affected by these settings. To adjust the offsets to the host ROV data, this should be set via the iFG sensor offsets button.

iFG and iCC Commands:
This tab control provides various control buttons for the configuration of the iFG. These are detailed in the following section.

Displayed Units:
Allows the units for temperature and heave acceleration to be changed.

System Alarms:
Provides status alarms and configuration from the attached sensors.

Data Logging To Disk:

Allows data from the iGC /iFG to be logged to a text file on the PC hard disk. This can be useful for diagnostics and performance monitoring. The values to record are configurable, as is the destination file and the logging rate.

Third Party Output:

This allows the gyro data to be sent to a 'third-party' via a separate serial port on the PC. The data sent can be used for input to a survey system, video overlay etc. Various data formats are supported, and additional formats can be provided on request.
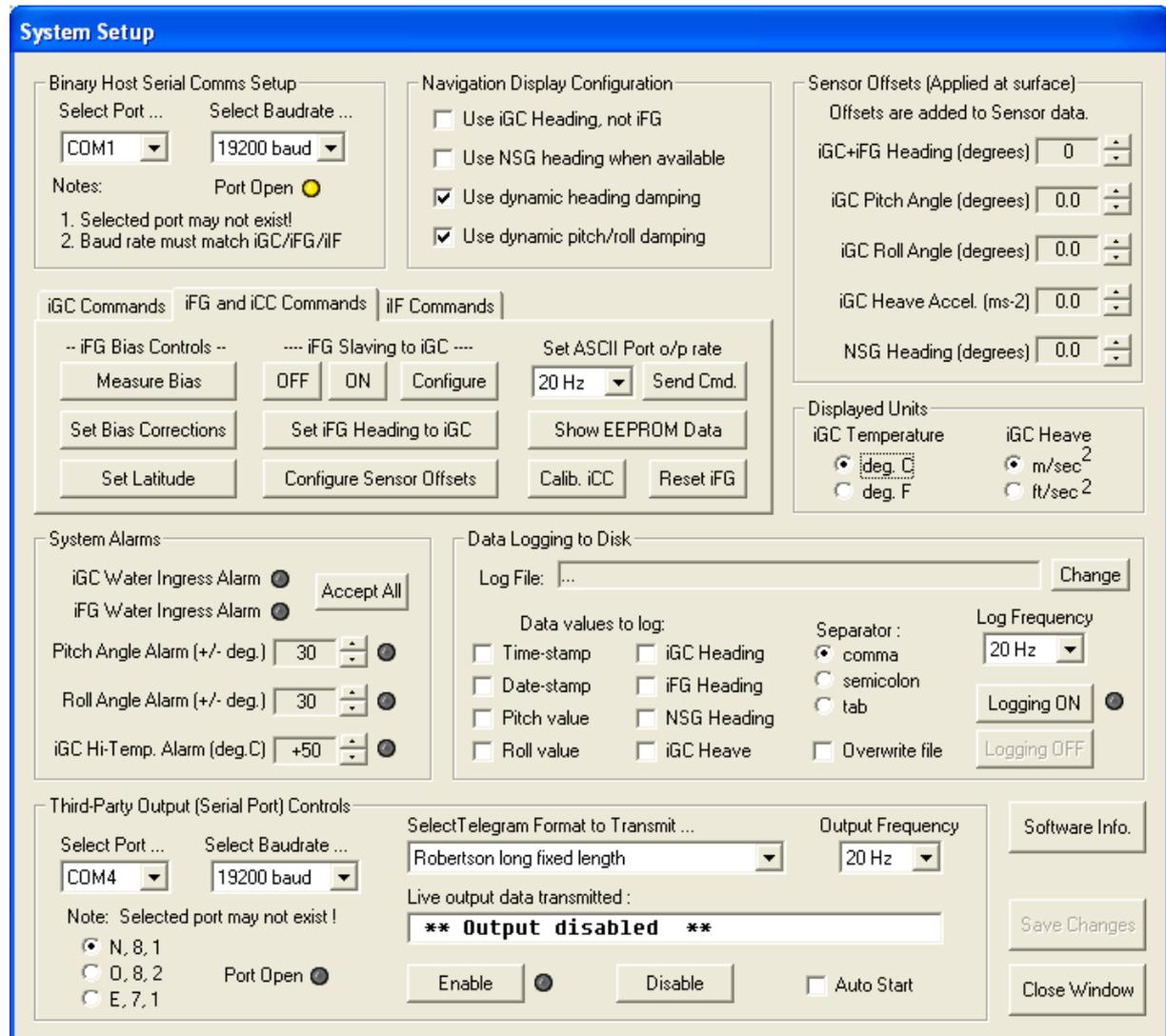
9.5 IFG CONFIGURATION CONTROLS

The software allows configuration of various iFG settings and access to iFG data. These controls are grouped under the **iFG and iCC Commands** tab.

9.5.1 Setting Latitude

Clicking the Set Latitude button pops up the following screen. This is used to send an updated latitude value to the iFG. The current latitude setting is shown.
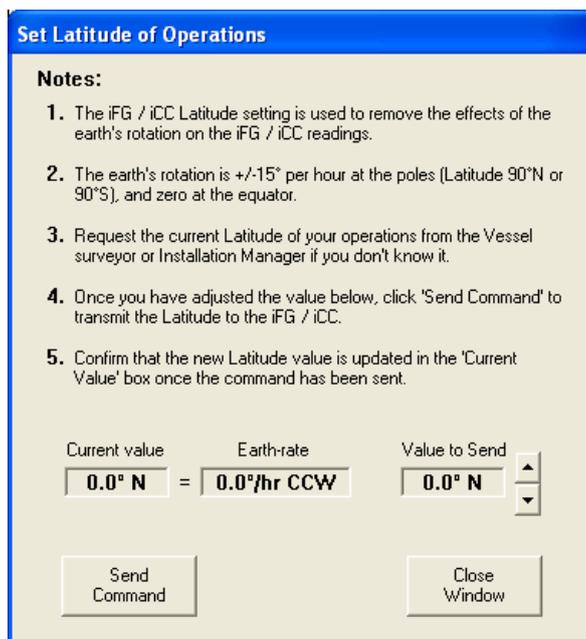
9.5.2 Setting Slaving Behaviour

The slaving of the iFG to the iGC can be turned ON and OFF via the two buttons on the Setup tab page. The slaving rate can be adjusted with the 'Configure' button.
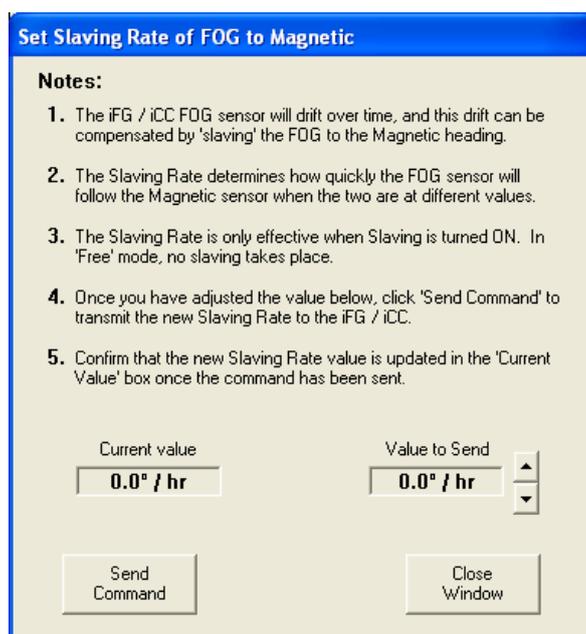
9.5.3 Setting Bias Correction Values

Clicking the Set Bias Corrections button pops up the following screen. This is used to send a configuration to the iFG changing the Bias corrections:
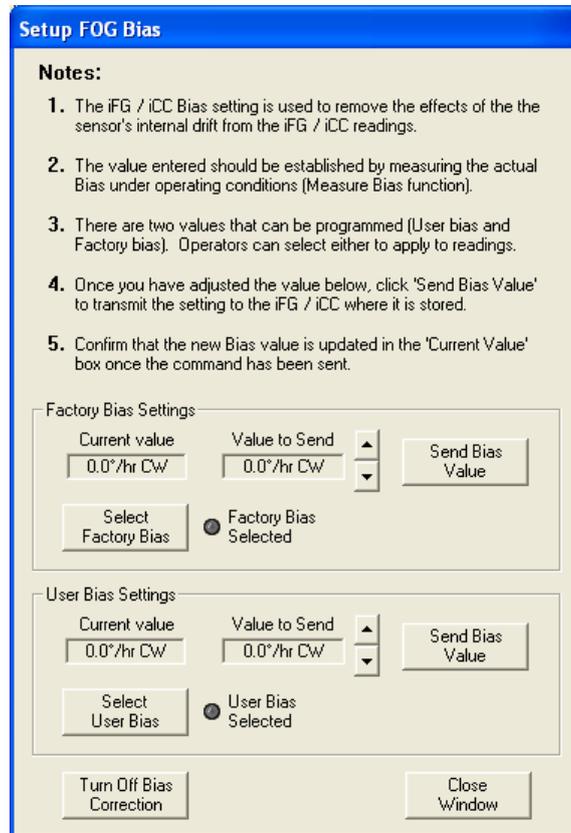
9.5.4 Measuring Bias Drift Rate

The sensor free bias can be measured by clicking the 'Measure Bias' button. When a measurement is started, the Live Bias Measurement window opens:

9.5.5   Setting iFG Offsets in EEPROM

The iFG sensor offsets in EEPROM can be set via the 'Configure Sensor Offsets' button. These should only be required if the mounting of the iFG / iGC on the host system is not perfect.

9.5.6   Viewing the iFG EEPROM Data:

The stored EEPROM data can be viewed. This data includes the history of any previous sensor bias measurements and a history of previous power up/down cycles. To provide current data, the three 'Request' buttons must be clicked to request the data from the iFG:

9.5.7 Resetting the iFG remotely:

The iFG sensor can be reset with the Reset iFG button. This has the same effect as power-cycling the iFG.

9.5.8 Setting the iFG heading to the current iGC heading:

The iFG sensor's stored heading can be quickly aligned with the iGC output heading by clicking the 'Set iFG Heading to iGC' button. This allows the iFG to be reset after a magnetic offset has caused divergence between iFG and iGC. The same result can be achieved by manually precessing the iFG around to the current iGC heading (using the main screen precess buttons).

10. MAINTENANCE

10.1 OVERVIEW

Before starting any maintenance of the iFG:

- Refer to the Section 6 - Safety Notes at the beginning of this manual.

- All relevant parts of this section of the manual should be read and understood.

10.2 GENERAL

The iFG is designed for low maintenance operation, and generally speaking does not require any preventative maintenance.

In addition there are no user serviceable parts inside the iFG. The procedures given in section 10.3 (Mode Switch settings) are the only reason that the iFG should be opened.

If the iFG is taken out of service, it should be stored in dry, climate controlled conditions.

10.3 PERFORMANCE CHECKS

Periodically the correct performance of the iFG system should be checked. This can follow the procedures set out in the Commissioning section above.

11. APPENDICES

iFG Front Panel Mode Switch Settings

BCD Mode Switch	Function
0	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 No ASCII telegram output.
1	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 19k2 baud Format taken from Submode switch ASCII Table 1
2	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 9600 baud Format taken from Submode switch ASCII Table 1
3	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 4800 baud Format taken from Submode switch ASCII Table 1
4	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 19k2 baud Format taken from Submode switch ASCII Table 2

BCD Mode Switch	Function
5	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 9600 baud Format taken from Submode switch ASCII Table 2
6	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 ASCII Telegram RS232 output Port2 TX2 at 4800 baud Format taken from Submode switch ASCII Table 2
7	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 2 TX2 & RX2 ASCII Telegram RS485 output from Port2 A/B at 19k2 baud Format taken from Submode switch ASCII Table 1
8	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 2 TX2 & RX2 ASCII Telegram RS485 output from Port2 A/B at 19k2 baud Format taken from Submode switch ASCII Table 2
9	Proprietary iFG Extended binary telegram on Port 1 TX1 & RX1 iGC Extended binary telegram received on Port 1 TX3 & RX3 Special Mode taken from Internal Submode switch.

Telegram Code	Submode Switch				Telegram Description	Notes	Implemented at firmware version
	SW 1	SW 2	SW 3	SW 4	ASCII telegram type (16 possible selections)		
0	off	off	off	off	Robertson SKR80/SKR82 Streaming data output. 20Hz repetition rate.	Streaming output - see 'rate' column for output telegram frequency 4 bytes sent in sequence (no delimiter) hundreds pattern (0)(0)00hhhh tens pattern (0)(0)01tttt units pattern (0)(0)10uuuu decimals pattern (0)(0)11uuuu	*1.01 & later*
1	on	off	off	off	Robertson SKR80/SKR82 Streaming data output. 20Hz repetition rate.	Streaming output - see 'rate' column for output telegram frequency 4 bytes sent in sequence (no delimiter) hundreds pattern (0)(0)00hhhh tens pattern (0)(0)01tttt units pattern (0)(0)10uuuu decimals pattern (0)(0)11uuuu	
2	off	on	off	off	Robertson ASCII short (no leading zeroes) Streaming data output. 20Hz repetition rate.	Streaming output - see 'rate' column for output telegram frequency Variable length (11, 12 or 13 chars) ASCII telegram in format: $HHH.H,N,SS<cr><lf> where: $ is a '$' character HHH.H is ASCII heading, no leading zero(es), decimal place always sent N is Normal - always sent as 'N' SS is status, ASCII '00' (two zero chars) is OK 80' is 'not ready', '10' is water ingress.	*1.01 & later*
3	on	on	off	off	Robertson ASCII short (with leading zeroes) Streaming data output. 20Hz repetition rate.	Streaming output - see 'rate' column for output telegram frequency Fixed length (13 chars) ASCII telegram in format: $HHH.H,N,SS<cr><lf> where: $ is a '$' character HHH.H is ASCII heading, packed with leading zero(es) N is Normal - always sent as 'N' SS is status, ASCII '00' (two zero chars) is OK 80' is 'not ready', '10' is water ingress.	*1.01 & later*
4	off	off	on	off	Robertson ASCII long (no leading zeroes) Streaming data output. 20Hz repetition rate at 19,200 Baud. 10Hz repetition rate at 9,600 and 4,800 Baud	Streaming output - see 'rate' column for output telegram frequency Variable length (26 to 30 chars) ASCII telegram in format: $HHH.H,N,SS,+LL,QQ,+RR.R,+PP.P<cr><lf> where: $ is a '$' character, HHH.H is ASCII heading, no leading zero(es) N is Normal - always sent as 'N', SS is status (as Robertson Short) +LL is latitude, always sent as '+0' QQ is speed, always sent as '0' +RR.R is roll degrees in -30 to +30 range, decimal always sent +PP.P is pitch degrees in -30 to +30 range, decimal always sent	*1.01 & later*

Telegram Code	Submode Switch SW 1	SW 2	SW 3	SW 4	Telegram Description	Notes	Implemented at firmware version
	ASCII telegram type (16 possible selections)						
5	on	off	on	off	Robertson ASCII long (with leading zeroes) Streaming data output. 20Hz repetition rate at 19,200 Baud. 10Hz repetition rate at 9,600 and 4,800 Baud	Streaming output - see 'rate' column for output telegram frequency Fixed length (30 chars) ASCII telegram in format: $HHH.H,N,SS,+LL,QQ,+RR.R,+PP.P<cr><lf> where: $ is a '$' character, HHH.H is ASCII heading, packed leading zero(es) N is Normal - always sent as 'N', SS is status (as Robertson Short) +LL is latitude, always sent as '+0' QQ is speed, always sent as '0 +RR.R is roll degrees in -30 to +30 range, leading zero & decimal sent +PP.P is pitch degrees in -30 to +30 range, leading zero & decimal sent	1.01 & later
6	off	on	on	off	SG Brown ASCII (fixed length) Streaming data output. 20Hz repetition rate.	Streaming output - see 'rate' column for output telegram frequency Fixed length (6 chars) ASCII telegram in format: HHHH<cr><lf> where: HHHH is ASCII heading in degrees x 10 leading zeroes always sent e.g. 0461 is heading 46.1 degrees.	1.01 & later
7	on	on	on	off	NMEA 0183 $HEHDT (north seekng gyro) ASCII Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Variable length (17-19 chars) ASCII telegram (no leading zeroes) in format $HEHDT,hhh.h,T*kk<cr><lf> where: $HEHDT signifies north seeking gyro, true heading hhh.h is heading without leading zeroes T signifies relative to True North * is a '*' character kk is XOR checksum of all chars between $ and * exclusive.	1.01 & later
8	off	off	off	on	NMEA 0183 $HCHDM (mag. compass) ASCII Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Variable length (17-19 chars) ASCII telegram (no leading zeroes) in format $HCHDM,hhh.h,M*kk<cr><lf> where: $HCHDM signifies magnetic compass, magnetic heading hhh.h is heading without leading zeroes M signifies relative to Magnetic North * is a '*' character kk is XOR checksum of all chars between $ and * exclusive.	1.01 & later

iFG Mode Listing (ASCII Table 1 - Outputs from Port 2 TX2 for RS232 or Port2 RS485)
Baudrate & RS232 / RS485 Selection based on Mode Switch on front panel

Telegram Code	Submode Switch SW 1	SW 2	SW 3	SW 4	ASCII telegram type (16 possible selections) / Telegram Description	Notes	Implemented at firmware version
9	on	off	off	on	Digilog ASCII (fixed length with leading zeroes) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Fixed length (20 chars) ASCII telegram in format: HhhhhPspppRsrrrrf\<cr>\<lf> where: H is a 'H' character hhhh is ASCII heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 f is flag where 'E' is OK, 'N' is invalid heading, 'S' is settling, 'W' is water ingress *	1.01 & later
10	off	on	off	on	OceanTools ASCII (fixed length, leading zeroes) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Fixed length (20 chars) ASCII telegram in format: HhhhhPspppRsrrrrf\<cr>\<lf> where: H is a 'H' character hhhh is ASCII heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 f is flag : 'E' is OK, 'N' is invalid heading, 'M' is settling (aligning), 'W' is water ingress *	1.01 & later
11	on	on	off	on	Anschutz Binary (modified to add Pitch & Roll) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Fixed length (18 chars) binary telegram in format: \<stx> b1…b16 \<etx> where \<stx> is binary 0x02, \<etx> is binary 0x03 b1 & b2 is 12-bit heading, b3 is incremental heading, b4 & b5 is pitch b6 & b7 is roll, b8 to b10 is rate of turn, b11 & b12 is status b13 to b15 is compass data b16 is checksum ** see manual for full details of bit positions / functions **	
12	off	off	on	on	Octans 'Gyrocompass 1' format (NMEA) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Three Alternate NMEA 0183 var. length messages Heading / Pitch Roll / Status $HEHDT,hhh.h,T*kk\<cr>\<lf> (as NMEA format above - 17-19 chars) $PHTRO,x.xx,a,y.yy,b*kk\<cr>\<lf> where x.xx is pitch in degrees, a is 'M' fo bow up, 'P' for bow down, y.yy is roll in degres b is 'B' for port down, 'T' for port up checksum etc as standard NMEA. (25 - 29 chars variable). $PHINF,hhhhhhhh*kk\<cr>\<lf> where hhhhhhhh is status hex chars 00000000 for healthy good data, 00000007 for invalid data. (20 chars	1.01 & later
13	on	off	on	on	Octans 'Gyrocompass 2' format (NMEA) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Three Alternate NMEA 0183 messages Heading / Pitch Roll Heave / Status $HEHDT,hhh.h,T*kk\<cr>\<lf> (as NMEA format above 17-19 chars) $PHTRH,x.xx,a,y.yy,b,z.zz,c*kk\<cr>\<lf> (38chv) where x.xx is pitch in degrees a is 'M' for bow up, 'P' for bow down, y.yy is roll in degres b is 'B' for port down, T' for port up, z.zz is heave acceleration in ms-2, c is 'U' if going up, 'O' if going down $PHINF,hhhhhhhh*kk\<cr>\<lf> where hhhhhhhh is status hex chars 00000000 for healthy good data, 00000007 for invalid data	1.01 & later

iFG Mode Listing (ASCII Table 1 - Outputs from Port 2 TX2 for RS232 or Port2 RS485)
Baudrate & RS232 / RS485 Selection based on Mode Switch on front panel

Telegram Code	Submode Switch SW 1	SW 2	SW 3	SW 4	ASCII telegram type (16 possible selections) Telegram Description	Notes	Implemented at firmware version
14	off	on	on	on	Tokimec PTVG Format (NMEA) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency NMEA 0183 message containing Pitch, Roll and Heading (30 chars) $PTVG,abbbbPaccccR,ddd.dT*kk<cr><lf> where: abbbb is pitch bb(degrees)bb(minutes) a is '-' for bow down, space for bow up acccc is roll cc(degrees)cc(minutes) a is '-' for port up, space for port down. ddd.d is heading in degrees checksum etc as standard NMEA.	1.01 & later
15	on	on	on	on	Standard iGC ASCII output - Streaming @ 20Hz Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Standard ASCII output packet in iGC ASCII format - streamed ouput. Contents Fixed length (27 chars) ASCII telegram in format: HhhhhPsppppRsrrrrZsaaaafw<cr><lf> where: H is a 'H' character hhhh is ASCII heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 Z is an 'Z' character, s is + or - sign, aaaa is heave accel. in ms-2 * 100 (-0981 at rest f is flag 'E' is OK, 'N' is invalid data; w is WIA status 'D' for dry, 'W' for wet.	1.01 & later

Baudrate & RS232 / RS485 Selection based on Mode Switch on front panel

Telegram Code	Submode Switch SW 1	SW 2	SW 3	SW 4	ASCII telegram type (16 possible selections) Telegram Description	Notes	Implemented at firmware version
0	off	off	off	off			
1	on	off	off	off	Watson AHRS-E304 Type 1 (Perry) format	I HHH.H +rr.r +pp.p +hh.h +RR.R +PP.P +TT<cr> 42 chars pitch + is bow up	
2	off	on	off	off	Watson AHRS-E304 Type 2 (Perry) format	I HHH.H +rr.r +pp.p +hh.h +RR.R +PP.P +TT<cr> 42 chars pitch + is bow down	
3	on	on	off	off			
4	off	off	on	off			
5	on	off	on	off			
6	off	on	on	off			
7	on	on	on	off			
8	off	off	off	on			

Baudrate & RS232 / RS485 Selection based on Mode Switch on front panel

Telegram Code	ASCII telegram type (16 possible selections)				Telegram Description	Notes	Implemented at firmware version
	Submode Switch						
	SW 1	SW 2	SW 3	SW 4			
9	on	off	off	on			
10	off	on	off	on			
11	on	on	off	on			
12	off	off	on	on	Sub atlantic TCM2 Format Streaming data output. 10Hz repetition rate at 9,600 Baud.	$Cxxx.xPxx.xRxx.x*6C<CR><LF>	*3.07a & later*
13	on	off	on	on	OceanTools ASCII Message 8 (fixed length, leading zeroes) Streaming data output. 20Hz repetition rate at 19,200 & 9,600 Baud 10Hz repetition rate at 4,800 Baud.	Streaming output - see 'rate' column for output telegram frequency Fixed length (38 chars) ASCII telegram in format: HhhhhPsppppRsrrrrX+0000Y+0000Z+0000f<cr><lf> where: H is a 'H' character hhhh is ASCII heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 f is flag : 'E' is OK, 'N' is invalid heading, 'M' is settling (aligning), 'W' is water ingress Rotation rate values X, Y & Z are sent all as zero (+0000)	*3.05a & later*

iFG Mode Listing (ASCII Table 2 - Outputs from Port 2 TX2 for RS232 or Port2 RS485)

Baudrate & RS232 / RS485 Selection based on Mode Switch on front panel

Telegram Code	Submode Switch SW 1	SW 2	SW 3	SW 4	ASCII telegram type (16 possible selections) Telegram Description	Notes	Implemented at firmware version
14	off	on	on	on	SMD ASCII output - Streaming @ 20Hz Streaming data output. Supports ASCII downlink commands Supports NMEA NSG heading input Operates in pure relative mode when no iGC telegram received or timed ou (To allow relative only ops with no Mag input) Future - may support P & R correction of heading drift.	SMD ASCII output packet format - streamed ouput. Contents Fixed length (36 chars) ASCII telegram in format: HhhhhCccccPspppRsrrrrZsaaaaMmmmfw<cr><lf> where: H is a 'H' character, hhhh is ASCII iFG heading in degrees * 10, packed with leading zero(es C is a 'C' character, cccc is ASCII iGC heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 Z is an 'Z' character, s is + or - sign, aaaa is heave accel. in ms-2 * 100 (-0981 at rest) M is a 'M' character, mmm is the current operating mode 000 to 999 - see table decode f is iFG quality flag where 1 is good thu 9 bad, N is no FOG available, E is ideal, X is recal drif w is water ingress status in iGC - 'D' for dry, 'W' for wet.	*1.06a & later*
15	on	on	on	on	SMD ASCII output - Streaming @ 20Hz Streaming data output. Supports ASCII downlink commands	SMD ASCII output packet format - streamed ouput. Contents Fixed length (36 chars) ASCII telegram in format: HhhhhCccccPspppRsrrrrZsaaaaMmmmfw<cr><lf> where: H is a 'H' character, hhhh is ASCII iFG heading in degrees * 10, packed with leading zero(es C is a 'C' character, cccc is ASCII iGC heading in degrees * 10, packed with leading zero(es P is a 'P' character, s is + or - sign, pppp is pitch angle in degrees * 10 R is an 'R' character, s is + or - sign, rrrr is roll angle in degrees * 10 Z is an 'Z' character, s is + or - sign, aaaa is heave accel. in ms-2 * 100 (-0981 at rest) M is a 'M' character, mmm is the current operating mode 000 to 999 - see table decode f is iFG quality flag where 1 is good thu 9 bad, N is no FOG available, E is ideal, X is recal drif w is water ingress status in iGC - 'D' for dry, 'W' for wet.	*1.03 & later*