OPTICALLY ENHANCED ATTITUDE AND HEADING REFERENCE SYSTEM

OptoAHRS

Interface Control Document

Revision 1.0

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1. INTRODUCTION

Inertial Labs™ optically-enhanced attitude and heading reference system (OptoAHRS) (see fig.1.1) is designed for measuring carrier's Euler orientation angles (heading, pitch and roll), as well as azimuth and elevation angles of the tube-type object it is fixed to in static and dynamic environment. It combines technologies of inertial sensors with optical image tracking resulting in a robust and reliable 3DOF orientation module capable of operation in virtually any environment.

With the addition of optical image tracking the system is now able to mount directly to a device under measure, and with one known reference direction, can be turned on and operated immediately without any magnetic calibration whatsoever. During operation, device's magnetometer calibrations are able to be derived on-the-fly allowing in time for the device to operate with both optical and magnetic heading determination.

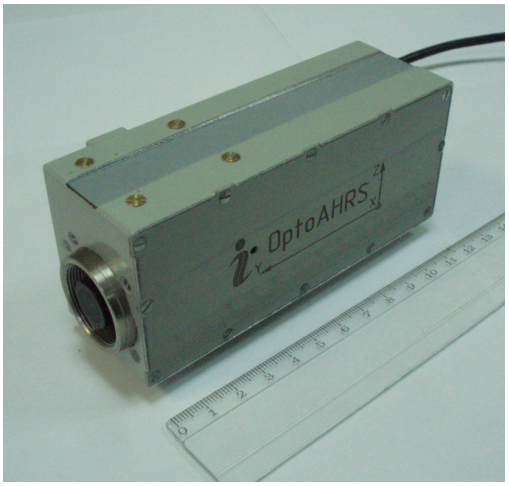

Fig. 1.1: Inertial Labs™ OptoAHRS

Fig. 1.2 shows the OptoAHRS own coordinate system OXYZ. This coordinate system is body-fixed and defined as the calibrated sensor coordinate system. The misalignments of the axes of the body-fixed coordinate system OXYZ are about 0.01°.

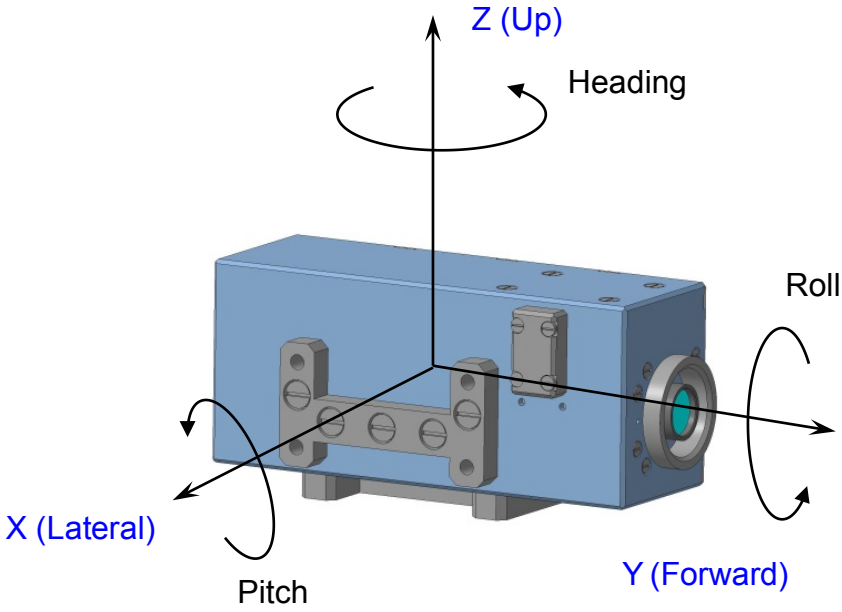

Fig. 1.2: Coordinate System of the Inertial Labs™ OptoAHRS

The device's output data are the Euler angles of rotation from the Earth-level frame (East-North-Up) to the body frame, heading first, then pitch, and then roll (see Fig. 1.2 above). The device also outputs azimuth and elevation of the tube-type object it is fixed to:

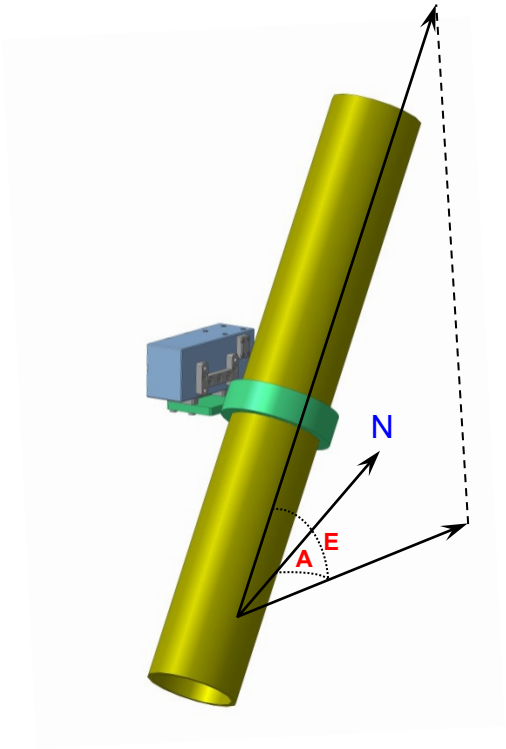

Fig. 1.3: Azimuth (A) and Elevation (E) of a Tube

Important Note: To enable the device to output accurate tube's azimuth and elevation, the appropriate bore-sighting procedure must be performed upon installation of the device onto the tube (see the Inertial Labs™ OptoAHRS Demo Program user's manual).

2. SCOPE AND APPLICABILITY

This Interface Control Document (ICD) provides details on mechanically mounting, electrical connections, powering and software interface between the Inertial Labs™ OptoAHRS and a PC or another host computer.
This document is intended for all parties requiring such information, including engineers and researchers responsible for implementing the interface.

3. SPECIFICATIONS

Parameter	Units	
Output signals		Heading, Pitch, Roll; Azimuth and Elevation
Update rate	Hz	100
Start-up time (1)	sec	10
Full accuracy data (Warm-up Time) (2)	sec	30
Heading		
Range	deg	0 to 360
Angular resolution	deg	0.05
Accuracy (0 to 360 deg, relative to the 1st reference) (3)	deg	0.2
Noise (at 100 Hz output)	deg RMS	0.02
Attitude		
Range: Pitch, Roll (autonomous)	deg	0 to 360
Range: Pitch, Roll (optical)	deg	±22.5
Angular resolution	deg	0.05
Static accuracy in whole temperature range	deg	0.1
Noise (@100 Hz)	deg RMS	0.02
Angular Rate		
Gyroscopes measurement range	deg/s	±300
In-run bias stability at constant temperature	deg/s RMS	0.02
Bias stability in whole temperature range	deg/s RMS	0.2
Scale factor accuracy	%	0.1
Gyroscopes noise	deg/sec√Hz	0.035
Axis misalignment	mrad	0.15
Resolution	deg/sec	0.01
Bandwidth	Hz	50
Linear Acceleration		
Accelerometers measurement range	g	±2
In-run bias stability at constant temperature	mg RMS	0.05
Bias stability in whole temperature range	mg RMS	1
Bias turn-on, turn-on repeatability	mg RMS	0.1
Scale factor accuracy	%	0.1
Accelerometers noise	mg√Hz	0.04
Axis misalignment	mrad	0.15
Resolution	mg	0.1
Bandwidth	Hz	50
Environment		
Operating temperature	deg C	-30 to +70
Non-operating vibration (4)	g, Hz	10-50Hz, 0.15mm/55-500Hz 2.0g
Non-operating shock (5)	g, ms	50g, 11ms, half sine wave
MTBF	hours	55500
Electrical		
Supply voltage	V DC	12 to 36
Power consumption	W	3.5
Interface		
Standard	-	USB
Rate	Mbit/sec	480
Physical		
Size	mm	129 × 48 × 48
Weight	gram	400 (w/o camera cap, splitter box, and cable); 600 (full set)

(1) it may be reduced on request
(2) including the time of initial alignment
(3) upon loop closure (see the corresponding section of the OptoAHRS Demo Program user's manual)
(4) MIL-STD 810F. Method 514.5. Procedure I
(5) MIL-STD 810F. Method 516.5. Procedure I

4. MECHANICAL INTERFACE

Fig. 3.1 shows the outline drawings of the Inertial Labs™ OptoAHRS. All dimensions are in millimeters.

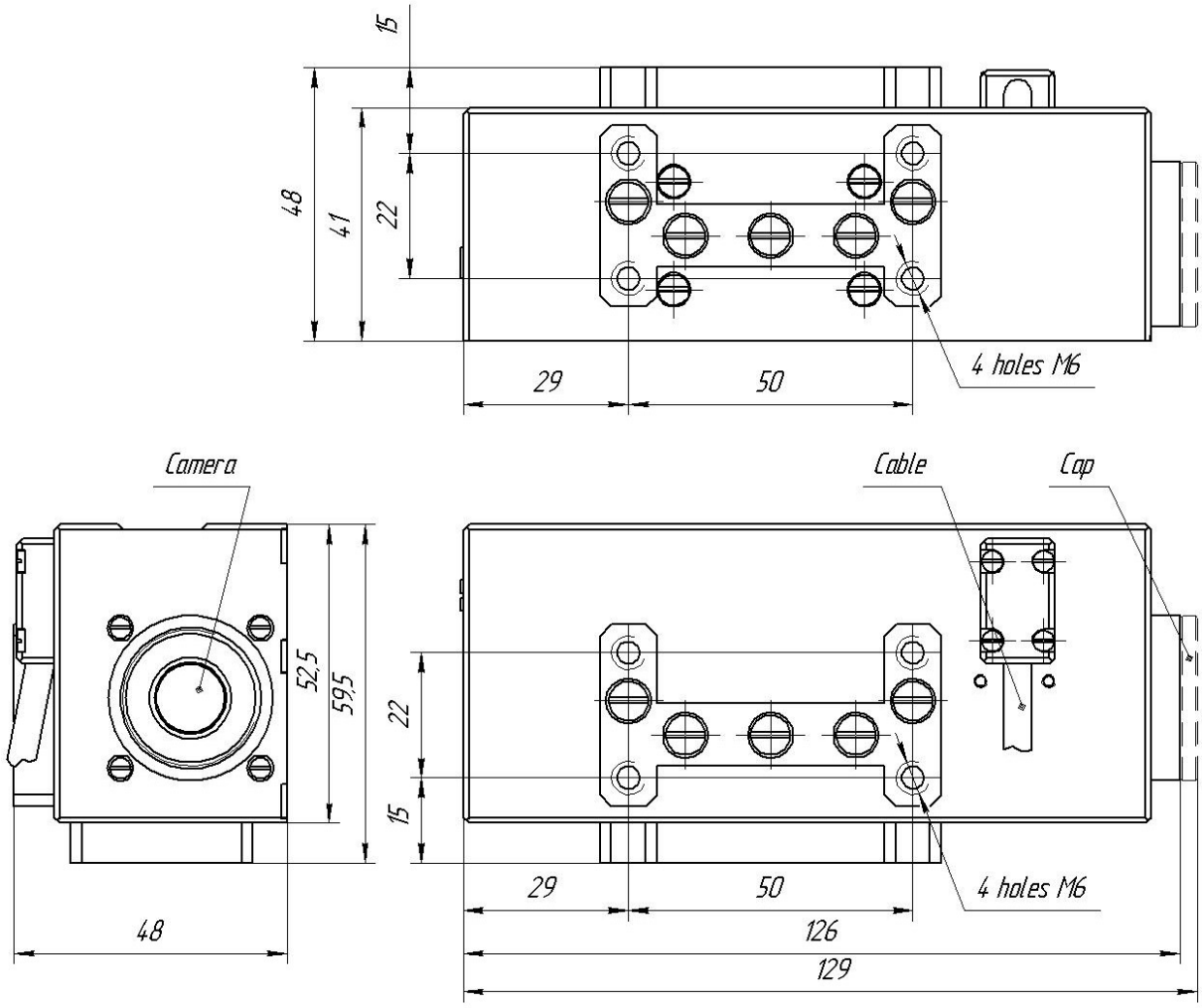

Fig. 3.1: Inertial Labs™ OptoAHRS Outline Drawing

The Inertial Labs™ OptoAHRS shall be fixed to its carrier with the use of either mounting holes 1 to 4 or 5 to 8 (see Fig. 3.2 below). All the above mounting holes are threaded M6x7mm holes (see Fig. 3.1 above).

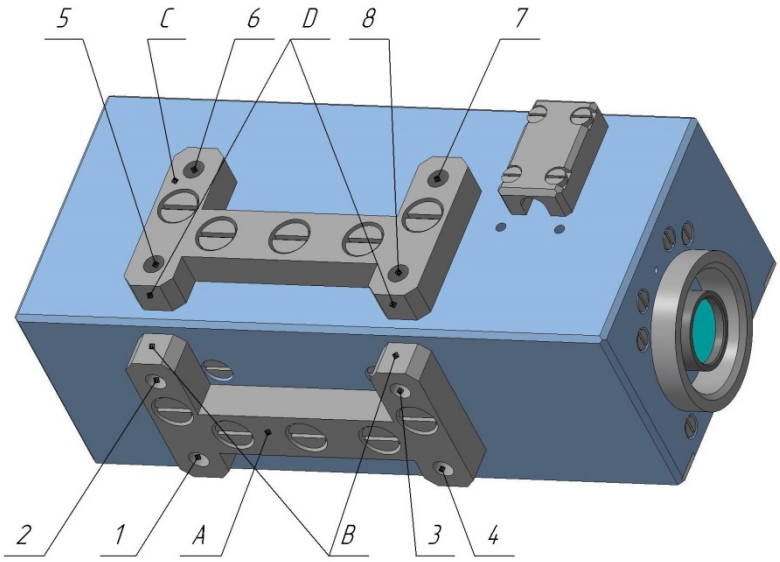

Fig. 3.2: Inertial Labs™ OptoAHRS Mounting Holes 1 to 4 and 5 to 8 and Aligning Surfaces A (Pitch and Roll) and B (Heading)

To secure accurate heading, pitch, roll output, the device must be aligned relative to the carrier axes with the use of aligning surfaces A (pitch and roll) and B (heading) (see Fig. 3.2). Surfaces C and D shall not be used for this purpose.

Important Note: If the device is supposed to be used for measuring azimuth and elevation of a tube, the above accurate alignment with the use of surfaces A and B is not needed, since such alignment may be achieved by performing the bore-sighting procedure (see the Inertial Labs™ OptoAHRS Demo Program user's manual).

In the case of installation of the device on a tube (for measuring its elevation and azimuth), the device must be installed in such a way that it is approximately level in the tube average position (i.e. at the middle of tube's elevation angle operation range) (see Fig. 3.3 below). This provides the best conditions for device's camera operation.

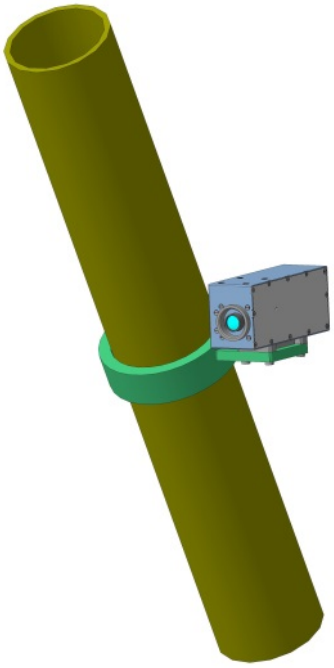

Fig. 3.3: Installation of the Inertial Labs™ OptoAHRS onto a Tube

When optic orientation is not available for one reason or another (blocked camera view, pure lightness conditions, etc.), the Inertial Labs™ OptoAHRS relies on magnetometer data for heading updates. Because of this, it shall be installed onto its carrier as far as possible from large ferromagnetic masses and powerful sources of magnetic, electrical and electro-magnetic fields. It is highly recommended to make its mount fixture (for mounting it to the carrier) from non-magnetic materials.

5. ELECTRICAL INTERFACE

The Inertial Labs™ OptoAHRS is equipped with a USB Cable with a USB Standard Type A plug to connect it to a PC. The USB port of a PC shall meet the requirements of Universal Serial Bus Specification Revision 2.0 (USB 2.0).

To connect it to power, the device is equipped with a male DC PC-GP2.1 power plug. The "+" outlet of a power source shall be connected to the inner contact of the device power plug.

The device shall be powered with DC power in the range of 12…36V. The device power consumption is below 3.5W.
An AC/DC power adapter for the OptoAHRS is provided by the Inertial Labs and is included into the device delivery set.

6. SOFTWARE INTERFACE

The output data of the Inertial Labs™ OptoAHRS may be obtained and it may be started and controlled through calling the procedures and functions of the Inertial Labs™ OptoAHRS SDK (see Inertial Labs™ OptoAHRS SDK user's manual).

Calibration of the Inertial Labs™ OptoAHRS magnetometers on hard and soft iron (3D, 2D, 2D/2T, and zone 3D) may be also performed through calling the procedures and functions of the Inertial Labs™ OptoAHRS SDK (see Inertial Labs™ OptoAHRS SDK user's manual). The descriptions of the corresponding procedures are given in the Inertial Labs™ OptoAHRS Demo Program user's manual.

The source code of the OptoAHRS Demo program (provided by Inertial Labs™) may be used as a sample source code of how the above procedures and functions shall be called.