HIGH-PRECISION FIBER OPTICAL GYROSCOPE WITH LINEAR DIGITAL OUTPUT

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Abstract -- *The design and industrial production of closed loop fiber optical gyroscopes with linear digital output is considered. This gyro characterized by high accuracy can be applied in high-grade (space, aviation, marine, land) inertial navigation systems.*

The opportunity of commercial production of precision fiber–optic gyroscope (FOG) is directly determined by the level of technological base and its main components like polarization maintaining optical fibers and integrated optic components. We have created our own infrastructure to produce such components as multifunctional integrated optical chip (MIOC), polarization maintaining fibers (PANDA), fiber splitter, fiber depolarizer and fiber coil and electronic block. Some of the engineering solutions offered (related to fiber and integrated optical technologies and signal processing electronic devices) are protected by the patents and their efficiency is experimentally confirmed.

Main directions of technical release of the FOG were:

- use of single-mode fiber PANDA with high birefringence and small loss for fiber coil symmetrical wound with length more then 1000 meters and diameter 140 millimeter;
- development and application of multifunctional integral optical element, produced by the proton exchange method, which performs the functions of Y- splitter, polarizer and phase modulator;
- use of thermal stabilized semiconductor superluminescent diode as a light source with operating wavelength 830±30 nm. The light power at the output of pigtailed single-mode waveguide is not less 2 mW;
- development of special data processing serrodyne scheme with closed loop of feedback, which provides minimal errors in transformation and in linear digital output both rotation rate and rotation angle values;
- development of a non-welding technology of assembling of the optical block.

Present technology level of fiber manufacturing on the Optolink" Ltd. allows to produce fiber with following parameters:

- loss of optical light power, α 3÷4 dB/km; - polarization beat length, L_p ≤2,5 mm;
- coefficient of intermode polarization coupling, h ≤10^{-5} 1/m; - outer diameter, d ≤80 μm.

Directed splitters, produced by the method of curling – fusion extraction from isotropic single-mode fiber, have the following typical parameters:

- power division coefficient, % 50±1; - extra power loss, dB 0,1.

The technology of manufacturing of Lyot fiber depolarizer provides achievement of:

- optical power loss, dB < 0,5; - residual light polarization at the width of a spectral line 15 nm, % < 0,1.

Main parameters of OPTOLINK MIOC with operating wavelength 830±30 nm are following:

- optical power losses (at depolarized light) <7 dB;
- polarizer extinction ratio > 60 dB;
- splitting ratio - 0.5± 0.05;
- phase sensitivity of each of modulator >1 rad/V

FOG electronic components are carrying out the following functions:

- the emitter to the power source connection with synchronous simultaneous of light power and superluminescent diode crystal temperature; - signal transformation, amplification and synchronous demodulation from the optical block output; - voltage forming for auxiliary phase modulation of light waves; - voltage forming for compensative phase modulation of light wave; - output signal forming.

The fiber optical gyroscope is powered from an external source with direct voltage 18÷36 V through three galvanic independent DC/DC transformers with output voltage ±15 V, ±12 V and ±5 V.

Finally, FOG with following parameters is realized by Optolink Ltd.:

Bias repeatability (3σ) ≤ 0.1 °/h Random walk ≤ $0.005°/\sqrt{h}$
Scale factor repeatability ≤ 0.01 %.

This gyro characterized by high accuracy can be applied in high-grade (space, aviation, marine, land) inertial navigation systems.

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