FIBER OPTIC GYROSCOPES

VG091 SERIES

Information Guide

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<th>Model</th>
<th>Extension</th>
<th>Key Features</th>
<th>Fiber Length, m</th>
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<tr>
<td>Differential</td>
<td>VG091</td>
<td>A</td>
<td>Ø24 x 52 mm</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>VG091</td>
<td>A-4LN</td>
<td>North seeking capability</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>VG191</td>
<td>A</td>
<td>Ø24 x 40 mm</td>
<td>160</td>
</tr>
<tr>
<td>Digital</td>
<td>VG191</td>
<td>AD</td>
<td>Built-in ADC</td>
<td>160</td>
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1. Introduction

1.1. Scope

This guide describes fiber optic gyroscope main features. Suggestions on product use, handling and installation are given.

1.2. Product Description

The Fizoptika gyro is a complete gyro system which comprises a fiber optic sensing assembly and analog processing electronics. The sensing assembly (an open-loop minimum configuration) is fabricated from a single length of optical fiber by a fusion-tapering technique.

The series features thumb-sized design combined with instant start-up and low power consumption.

The basic model of the series is VG091A—the first smallest and lightest fiber optic gyro.

See product main parameters in Annex 1, pins assignment and axes definition in Annex 2.

With an exclusive technology of precise polarization control all the models acquire Minimum Magnetic Sensitivity about 3°/h/Gauss and may be used without heavy magnetic shielding for a lot of applications. The housing of some models is fabricated from µ-metal to get ultimate magnetic immunity (<0.1°/h/Gauss).

With the reinforced inner frame, the gyros acquire negligible vibration sensitivity.

1.3. Essential

The gyro housing is silicone sealed. Keep the product dry during its whole lifetime.

Do not drop. Excessive shock can damage the unit.

Use standard ESD practices when handling the unit.

2. Electrical Characteristics

2.1. Powering

The gyro requires a clean and stable 5Vdc (±5%) power supply. Voltages greater than 5.5V (or reversing polarity) can cause some components to heat and eventually fail. Smooth voltage transient at power-on is recommended.

See Electrical Diagrams in Annex 3.

2.2. Differential Output

The gyro has two output leads (OUT+, OUT-)

\[
U(+) = U0 + \frac{1}{2} SF \cdot \Omega \\
U(-) = U0 - \frac{1}{2} SF \cdot \Omega
\]

Each lead is an independent fully functional signal channel with own LPF (~1kHz) and output amplifier. See Output Circuit Diagram in Annex 3. Serial 1KOhm resistors are to protect the amplifiers from wrong load. Both outputs are biased at \(U0=1V\) to Common (GND). \(U0\) is in fact internal signal virtual ground.

The gyro "differential" output is defined as the voltage between outputs (OUT+ and OUT-)

\[
U(\Omega) = U(+) - U(-) = SF \cdot \Omega
\]

The output voltage range is ±2V.

Diagnostics. If gyro fails, \(U0 \neq 1V\).

The SF and bias are slightly sensitive to supply voltage. The sensitivity coefficients are individual for each unit. Values for reference: SF – 0.05%/V, bias – 0.1 mV/V.

2.3. Temperature Output

The gyro provides temperature data via TS lead:

\[
V(TS) = 0.5 + t \cdot ^\circ C / 100 \quad [V]
\]

Temperature output is single-ended.

2.4. Digital Output

The digital model incorporates an analog processing circuit and digital circuit integrated into a single PCB. It is equipped with precise 24-bit ADC and powerful processor. It can be factory programmed to provide real time compensated data. The digital signal (RS422, 921.6 kBd, 8 kHz rate) contains angular rate raw data and set of gyro parameters used for data compensation and built-in test. Read more in Fiber Optic Gyroscope Digital Output.
2.5. Effect of Environment

- **Temperature**
  - Bias ~ 0.1-1 μV / °C (temperature sensitivity of the components of analog processing circuit)
  - SF ~ 0.02 -0.04% / °C (SLD spectrum temperature effect)

- **Magnetic field** (minimized response, non-shielded)
  - Bias ~ 3°/h/Gauss (along X axis, non-adjustable response)
  - SF is not sensitive

- **Vibration**
  - Bias is not sensitive (VRE = 0)
  - Noise spectrum factor 1-20 μV/ g*Hz (direction dependent)
  - SF is not sensitive

3. Mounting Guidelines

The VG091 is extremely lightweight. There is no need for a strong joint to a mating frame (object). There is a variety of simple methods how to attach the gyro not deforming its housing. The adhesive mounting is most recommended as it does not deliver any stress to the gyro and is quite reliable. It also provides sufficiently high resonance of the joint with low Q-factor.

Clamping is another possible method. Using plastic tighteners, ties, adhesive tapes, etc. is proved to be practical.

3.1. Adhesive Mounting

- Apply silicon adhesive to the side surface of the gyro.
- Aim for an adhesive thickness of 0.2-0.4 mm.

3.2. Mating Frame

Resonances of the mating frame and the gyro to frame joints (adhesive or mechanical) should exceed vibration frequencies. Otherwise, an extra noise at the output is possible because the gyro may acquire much higher levels of vibration compared to the mating frame.

4. Analog output reading

The outputs are DC-coupled and can be used in either single-ended or differential mode. Differential mode offers the best performance since the common mode errors and noise are minimized. The positive and negative outputs of the unit should be connected to differential input amplifiers with an input impedance of at least 500kOhm referred to ground. The amplifier should also have a good common mode rejection and a suitable bandwidth for the application.
## Annex 1. Product Main Parameters

<table>
<thead>
<tr>
<th>PERFORMANCE</th>
<th>VG091A</th>
<th>VG091A-4LN</th>
<th>VG191A</th>
<th>VG191AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input range (°/s)</td>
<td>300</td>
<td>60</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Bias stability / Bias repeatability (RMS, °/h)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Angle random walk (°/vh)</td>
<td>0.04</td>
<td>0.01</td>
<td>0.015</td>
<td>0.012</td>
</tr>
<tr>
<td>Bandwidth (kHz)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SF stability / SF repeatability (RMS, %)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Magnetic response (°/h/Gauss)</td>
<td>3</td>
<td>0.03</td>
<td>4 / 0.1*</td>
<td>3 / 0.05*</td>
</tr>
</tbody>
</table>

## ELECTRICAL INTERFACE

| Start-up (s) | 0.03 | 0.03 | 0.03 | 0.03 |
| Powering (W) | 0.5  | 0.5  | 0.5  | 0.5  |
| Data rate (kHz) | -    | -    | -    | 8    |
| Baud rate (k8d) | -    | -    | -    | 921.6 |

## PHYSICAL PARAMETERS

| Dimensions (mm) | Ø24x52 | Ø24x52 | Ø24x40 | Ø24x48 |
| Weight (gram) | 30     | 50     | 30 / 40* | 30 / 45* |
| Volume (cl) | 2.4    | 2.4    | 1.8    | 2.2    |
| Housing material | Al alloy / µ-metal* | Al alloy / µ-metal* | Al alloy / µ-metal* |

## ENVIRONMENT

| Operating temperature (°C) | -40...+70 | -40...+70 | -40...+70 | -40...+70 |
| Endurance temperature (>2 h, °C) | -55...+85 | -55...+85 | -55...+85 | -55...+85 |
| Vibration (RMS, 0.02 - 2 kHz, g) | 18 | 18 | 18 | 18 |
| Shocks (g, 1 ms) | 750 | 350 | 750 | 750 |

## RELIABILITY

| MTBF / Lifetime (yrs)** | 15 | 15 | 15 | 15 |

* Magnetically shielded
** Humidity conditions applied
Annex 2. Pins assignment, axes definition

Analog Output

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TS</td>
</tr>
<tr>
<td>2</td>
<td>+5V</td>
</tr>
<tr>
<td>3</td>
<td>OUT-</td>
</tr>
<tr>
<td>4</td>
<td>OUT+</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
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</table>

Digital Output

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RS422TA</td>
</tr>
<tr>
<td>2</td>
<td>+5V</td>
</tr>
<tr>
<td>3</td>
<td>RS422 TB</td>
</tr>
<tr>
<td>4</td>
<td>D_GND</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td>B</td>
<td>factory use</td>
</tr>
<tr>
<td>A</td>
<td>factory use</td>
</tr>
</tbody>
</table>

Sensing axis (X) to the main cylinder axis (Z) =90°+/−0.5°, X to Y (contacts line) =90°+/−0.5°
Annex 3. Electrical Diagrams

The minimal configuration electronics drives the internal light diode (SLD) and phase modulator (PZT) for signal conditioning. It performs precise demodulation of the optical signal to form gyro raw output (no error compensation).
Annex 4. Test Data Samples

**Allan Variance Plot**

Power-on Transient (ms)
as gyro rotates 20 deg/s, time resolution 0.2ms

**VG091A. Bias vs Temperature**

**VG091A. SF vs Temperature**

**VG191AD. Bias vs Temperature**

**VG191AD. SF vs Temperature**
Vibro Test Report

SINE Vibration Response Normalized

Random Vibration test