# Fiber Optic Gyroscope

## VG103S Series

**Information Guide**

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<th>Output</th>
<th>Model</th>
<th>Key Features</th>
<th>Fiber length, m</th>
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<tr>
<td>differential</td>
<td>VG103S</td>
<td>1200 g</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>VG103SE</td>
<td>Economy design</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>VG2103S</td>
<td>Al case, 4 flanges</td>
<td>100</td>
</tr>
<tr>
<td>digital</td>
<td>VG103SD</td>
<td>Built-in ADC</td>
<td>100</td>
</tr>
<tr>
<td></td>
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<td>Built-in ADC</td>
<td>200</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 ultra-compact fully plastic structure (apart from VG2103S model).

The basic model VG103S offers optimal combination of high performance and superb shock/vibration endurance. See product main parameters in Annex 1, outline dimensions, pins assignment, axes definition in Annex 2.

With an exclusive technology of precise polarization control the models acquire Minimum Magnetic Sensitivity about 1°/h/Gauss and can be used without heavy magnetic shielding for a lot of applications.

To suppress the gyro’s residual magnetic response an external μ-shield is available (Annex 3).

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 the electrical diagrams in Annex 4.

2.2. Differential Output

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

\[ U(+) = U_0 + \frac{1}{2} SF \cdot \Omega \]
\[ U(-) = U_0 - \frac{1}{2} SF \cdot \Omega \]

Each lead is an independent fully functional signal channel with own LPF (~1kHz) and output amplifier. See Output Circuit Diagram in Annex 4. Serial 1KOhm resistors are to protect the amplifiers from wrong load. Both outputs are biased at \( U_0=1V \) to Common (GND). \( U_0 \) 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, \( U_0 \neq 1V \).

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:

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

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 \( \sim 0.1-1 \mu V / ^\circ C \) (temperature sensitivity of the components of analog processing circuit)
  - SF \( \sim 0.02-0.04\% / ^\circ C \) (SLD spectrum temperature effect)

- Magnetic field (minimized response, non-shielded)
  - Bias \( \sim 1^\circ/ h/\text{Gauss (along X axis, nonadjustable response)} \)
  - SF is not sensitive

- Vibration
  - Bias is not sensitive (VRE = 0)
  - Noise spectrum factor 1-20 \( \mu V/ g^\ast/\text{Hz} \) (direction dependent)
  - SF is not sensitive

Test data samples are in Annex 5.

3. Mounting Guidelines

The VG103S models are 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 bottom of the gyro.
- The mating surface should be flat and clean.
- Aim for an adhesive thickness of 0.2-0.4 mm.

3.2. Screw Mounting (VG2103S)
- The mounting surface should be clean, smooth and flat.
- Plastic washers are preferable to avoid temperature induced stress.
- Torque screws M3 max to 30 Ncm limits. Use a manual torque wrench.

3.3. 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.

3.4. Cable Routing
Use flexible cables with a low weight per length. Make sure that cable bending does not result in contacts’ stress.

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>VG103S</th>
<th>VG103SE</th>
<th>VG2103S</th>
<th>VG103SD</th>
<th>VG103S-2LND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input range (°/s)</td>
<td>400</td>
<td>400</td>
<td>350</td>
<td>400</td>
<td>200</td>
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<tr>
<td>Bias stability / Bias repeatability (RMS, °/h)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Angle random walk (°/√h)</td>
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<td>0.02</td>
<td>0.02</td>
<td>0.015</td>
<td>0.007</td>
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<td>Bandwidth (kHz)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>SF stability / SF repeatability (RMS, %)</td>
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<td>0.02</td>
<td>0.02</td>
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<td>Magnetic response (°/h/Gauss)</td>
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<tr>
<td>Data rate (kHz)</td>
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<td>8</td>
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<tr>
<td>Baud rate (kBd)</td>
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<td>-</td>
<td>921.6</td>
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<tbody>
<tr>
<td>Dimensions (mm)</td>
<td>Ø55 x 17</td>
<td>Ø55 x 17</td>
<td>60 x 60 x 17</td>
<td>Ø55 x 17</td>
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<tr>
<td>Weight (gram)</td>
<td>40</td>
<td>40</td>
<td>80</td>
<td>40</td>
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<td>Volume (cl)</td>
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<td>4</td>
<td>4.5</td>
<td>4</td>
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<td>Housing material</td>
<td>plastic</td>
<td>plastic</td>
<td>Al alloy</td>
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<tbody>
<tr>
<td>Operating temperature (°C)</td>
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<td>-40...+70</td>
<td>-40...+70</td>
<td>-40...+70</td>
<td>-40...+70</td>
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<td>Endurance temperature (&gt;2 h, °C)</td>
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<td>-55...+85</td>
<td>-55...+85</td>
<td>-55...+85</td>
<td>-55...+85</td>
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<td>Vibration (RMS, 0.02 - 2 kHz, g)</td>
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<td>18</td>
<td>18</td>
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<td>Shocks (g, 1 ms)</td>
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<td>750</td>
<td>1200</td>
<td>350</td>
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<tbody>
<tr>
<td>MTBF (20°C) / Lifetime (yrs)*</td>
<td>15</td>
<td>10</td>
<td>15</td>
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</table>

* Humidity conditions applied
Annex 2. Outline Drawing, Axes Definition, Pin Assignment

VG103S, VG103SE

VG2103S
X(Ω) – sensing axis (±10°)

VG103SD, VG103S-2LND

Annex 3. Magnetic Shield*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (mm)</td>
<td>Ø56.5 x 21</td>
</tr>
<tr>
<td>Weight (gram)</td>
<td>50</td>
</tr>
<tr>
<td>Shielding factor</td>
<td>30-100</td>
</tr>
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</table>

*Except for VG2103S
Annex 4. 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.

Output Circuit Diagram
VG103SD, VG103S-2LND
Annex 5. Test Data Samples

VG103S. Allan Variance Plot

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

VG103S. Bias vs Temperature

VG103S. SF vs Temperature

VG103S. Output Component (AC) vs SINE Vibration
(2 g normalized)

VG103S. Shock Test Record (Z Direction)
(1200g, 0.7 ms)
Magnetic Report

SN: 072991

<table>
<thead>
<tr>
<th>Axis</th>
<th>Gx, mV/G</th>
<th>Gy, mV/G</th>
<th>Gz, mV/G</th>
<th>Current, mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.60</td>
<td>-0.89</td>
<td>-0.84</td>
<td>74.9</td>
</tr>
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</table>

VG103S. Output Voltage vs Angular Rate

VG103S-2LND.

VG103S-2LND. Output Voltage vs Angular Rate