Electrostatically Levitated Rotational Gyro

The Electric Vacuum Gyro

H.W. Knoebel : "*The Electric Vacuum Gyro*", Control Engng, 11, 2, p 70, (Feb. 1964).

The Electric Vacuum Gyro Is a high precision 2-axis gyro for inertia navigation systems. A metal spherical rotor is levitated by high electric field in high vacuum (10^{-8} – 10^{-9} mmHg) and rotated. The friction by mechanical supports are eliminated and hence high precision and low drift are achieved. This method was invented by Prof. A.Nordsieck in University of Illinois during his research on the inertia navigation systems for Polaris submarine.

Pinpoint for Polaris Launching

0.0001 deg per hr

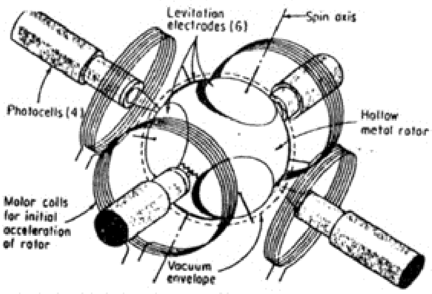


FIG. 1. Basic elements of the electric vacuum gyro include hollow rotor and levitation electrodes.

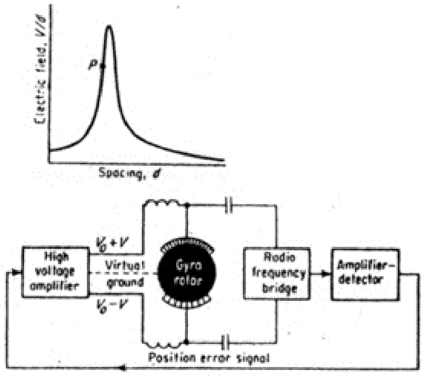
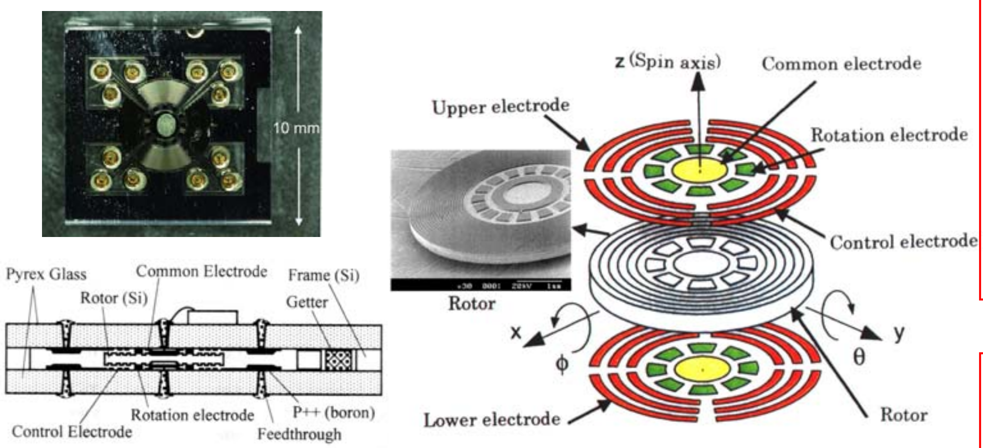
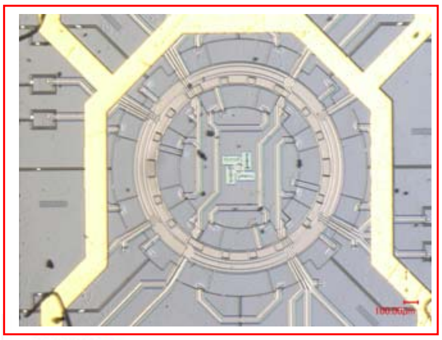


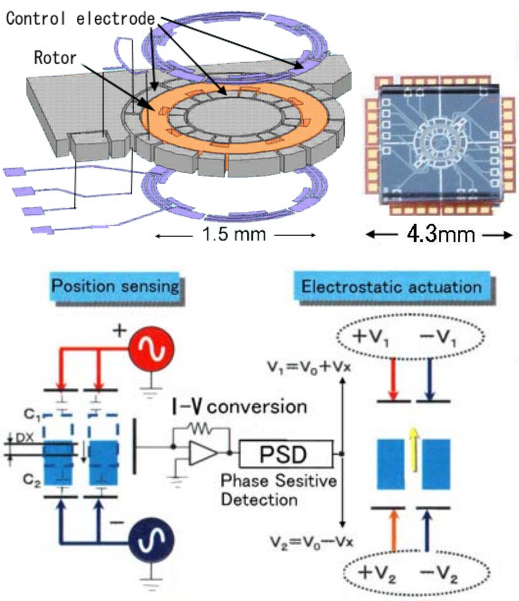
FIG. 6. Electronic levitation servo can be used to support rotor centrally in gap between electrodes (single axis).



Electrostatically levitated disk rotor type rotational gyro
(Tohoku University – Tokimec (at present Tokyo Keiki))



Reference : K.Fukatsu, T.Murakoshi and M.Esashi, Electrostatically Levitated Micro Motor for Inertia Measurement System, Technical Digest of the Transducers' 99 (1999) pp.1558-1561



TOKYO KEIKI

MULTI-AXIS MICRO INERTIAL SENSOR

MESAG-100

DESCRIPTION

The MESAG-100 is the first rotating type micro inertial sensor in the world based on MEMS technology. This sensor detects both 2-axis angular rate and 3-axis acceleration at a time by electrostatically suspending and rotating at a high speed a 1.5 mm diameter rotor in the shape of a ring made from silicon.

*MESAG (Registered Trademark)
Abbreviation of Micro Electrostatically Suspended Accelerometer and Gyro

FEATURES

- Multi-axis output of 2-axis angular rate and 3-axis acceleration.
- Small size, high performance, and low cost.
- High accuracy with a non-contact type rotor.
- It can easily be applied to attitude measuring systems

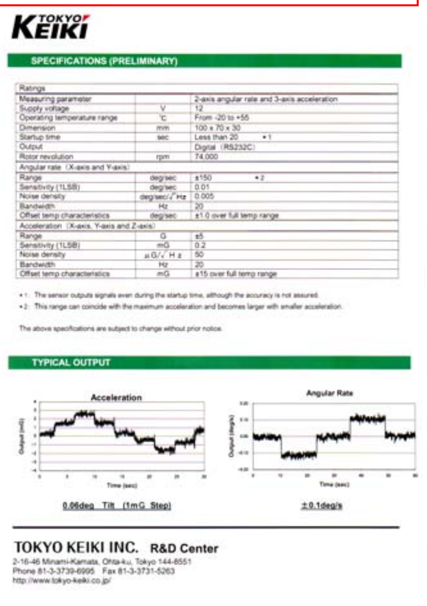
APPLICATION

- Automotive applications such as telematics, navigation, antiskid control, and rollover detection
- Antenna stabilization and control systems for trains, ships, earthmoving and construction machines, etc.
- Attitude measuring systems for games, robotics, personal digital assistance, welfare equipment, etc.

MESAG-100 (100×70×30mm)

SENSOR TIP (4.3×4.3×1 mm)

TYPICAL PACKAGING (14×14×3 mm)



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SPECIFICATIONS (PRELIMINARY)

Ratings		
Measuring parameter		2-axis angular rate and 3-axis acceleration
Supply voltage	V	12
Operating temperature range	℃	From -20 to +55
Dimension	mm	100 x 70 x 30
Startup time	sec	Less than 20 *1
Output		Digital (RS232C)
Rotor revolution	rpm	74,000
Angular rate (X-axis and Y-axis)		
Range	deg/sec	±150 *2
Sensitivity (1LSB)	deg/sec	0.01
Noise density	deg/sec/√Hz	0.005
Bandwidth	Hz	20
Offset temp characteristics	deg/sec	±1.0 over full temp range
Acceleration (X-axis, Y-axis and Z-axis)		
Range	G	±5
Sensitivity (1LSB)	mG	0.2
Noise density	μG/√Hz	50
Bandwidth	Hz	20
Offset temp characteristics	mG	±15 over full temp range

*1: The sensor outputs signals even during the startup time, although the accuracy is not assured.
*2: This range can coincide with the maximum acceleration and becomes larger with smaller acceleration.

The above specifications are subject to change without prior notice.

TYPICAL OUTPUT

Acceleration — 0.06deg Tilt (1mG Step)

Angular Rate — ±0.1deg/s

TOKYO KEIKI INC. R&D Center
2-16-46 Minami-Kamata, Ohta-ku, Tokyo 144-8551
Phone 81-3-3739-6995 Fax 81-3-3731-5263
http://www.tokyo-keiki.co.jp/

Electrostatically levitated ring rotor type rotational gyro (2 axis rotation and 2 axis acceleration)
(Tohoku University – Tokimec (at present Tokyo Keiki))

Reference : T.Murakoshi, Y.Endo, K.Sigeru, S.Nakamura and M.Esashi: Electrostatically levitated ring-shaped rotational-gyro/accelerometer, Jpn. J. Appli. Phys., 42, Part1 (2003) 2468-2472