

Advanced Navigation presents IMU developments



Advanced Navigation has unveiled an expansion of its Boreas digital fibre-optic gyroscope (DFOG) range with the introduction of the new A Series. This development showcases the company's commitment to meeting the escalating demand for ultra-high-accuracy solutions, even in the most challenging conditions. Advanced Navigation is a renowned provider of artificial intelligence (AI) for

robotic and navigation technologies.

The Boreas A Series, comprising the [A90 and A70](#), are strategic-grade inertial measurement units (IMUs) that offer great precision, stability and reliability in providing acceleration and orientation data without relying on GNSS. One of their standout features is automatic gyrocompassing, boasting significant reductions in size, weight, power and cost (SWaP-C) when compared to competing systems in the market.

Xavier Orr, CEO and co-founder of Advanced Navigation, expresses his enthusiasm about the latest technology: "Our world-first Boreas DFOG technology represented a step-change for fibre-optic gyroscopes. The addition of the A Series ensures we have greater ability to meet the rapidly growing demand for ultra-high-accuracy solutions, even in the most demanding conditions."

Orr further emphasizes the impact of the A Series across various industries. "The A Series is an embodiment of industry-leading performance and cost-effectiveness. We look forward to seeing this technology unlock new possibilities across an expanse of fields, from autonomous vehicles and land surveying to subsea navigation and mining," he states.

Both the Boreas A90 and A70 IMUs come equipped with ultra-high-accuracy DFOG and high-performance closed-loop accelerometers. The Boreas A90 offers ultra-high performance, while the A70 offers high performance. With their ultra-fast gyrocompassing capabilities, these systems ensure precise heading acquisition and maintenance under all conditions without depending on GNSS. This makes them particularly well-suited for a wide range of applications, including surveying, mapping and navigation in subsea, marine, land and air scenarios. Additionally, users have the option to acquire a licence to add inertial navigation system (INS) capabilities and integrate with external GNSS receivers using Advanced Navigation's comprehensive range of interfaces and communication protocols.

DFOG technology: a revolution in fibre-optic gyroscopes

The Boreas range has been specifically tailored for applications that demand always-available, ultra-high-accuracy orientation and navigation. Industries such as marine, surveying, subsea, aerospace, robotics and space are the primary targets of this cutting-edge technology. The range incorporates Advanced Navigation's revolutionary sensor fusion algorithm, which surpasses typical extended Kalman filters by utilizing human-inspired AI to extract more information from data. The algorithm prioritizes control applications, ensuring a high level of health monitoring and instability prevention for stable and reliable data. Moreover, the Boreas range has been designed and rigorously tested to adhere to safety and environmental standards.

DFOG technology, the patented innovation by Advanced Navigation, represents the culmination of over two decades of research involving two prestigious institutions. It was developed to meet the need for smaller, more cost-effective fibre-optic gyroscope (FOG) technology while enhancing reliability and accuracy.

High-end technology in one single chip

The first generation of FOG, introduced in 1976, employed analogue signals and processing. The second generation, developed in 1994 and still in use today, utilizes a hybrid approach with analogue signals in the coil and digital signal processing. In 2021, the third-generation DFOG emerged, setting itself apart with its complete digitization resulting in higher performance and reliability while offering up to 40% reductions in SWaP-C. To achieve this, three complementary technologies were developed to enhance FOG capabilities:

- Digital modulation techniques:** DFOG employs a specially developed digital modulation technique that passes spread spectrum signals through the coil. This technique enables the measurement and removal of in-run variable errors in the coil, significantly enhancing DFOG's stability and reliability, outperforming traditional FOGs. It also allows for a smaller FOG with a reduced coil length to achieve the accuracy of larger counterparts.
- Revolutionary optical chip:** Advanced Navigation integrated five sensitive components into a single chip while eliminating all fibre splices, resulting in substantial reductions in size, weight and power consumption. This significant advancement not only improves

reliability and performance, but also contributes to the impressive SWaP-C reduction.

3. **Specially designed optical coil:** DFOG incorporates a specially designed closed-loop optical coil, optimized to take full advantage of the new digital modulation techniques. This design ensures optimal sensing of in-run variable coil errors, offering enhanced accuracy. Additionally, the coil provides excellent shock and vibration protection for the optical components.

Professor Arnan Mitchell, an authority on microtechnology and nanotechnology from RMIT University, played a crucial role in the development of DFOG technology alongside Advanced Navigation. Professor Mitchell focused on shrinking the components of a fibre-optic gyroscope onto a single chip, a key aspect of DFOG's revolutionary technology. This breakthrough enables DFOG to achieve significantly lower SWaP-C compared to other similar FOGs, all while delivering higher accuracy and reliability. "By printing optical components onto a tiny chip, we are creating more compact and reliable fibre-optic gyroscopes with Advanced Navigation," Professor Mitchell explains, highlighting the groundbreaking potential of the technology.



The Boreas A Series, comprising the A90 and A70. (Image courtesy: Advanced Navigation)