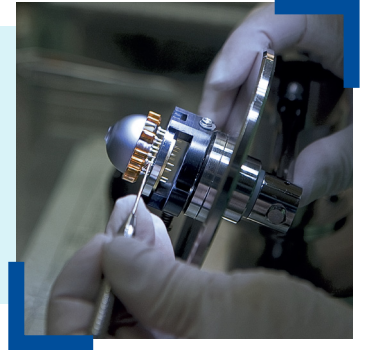


SAFRAN FEDERAL SYSTEMS

IMU Application Guide

Inertial Measurement Units (IMUs) are a critical component to a wide range of systems,

from Unmanned systems, munitions and other applications for today's harshest environments. Safran designs and manufactures High Accuracy Gyro and IMU solutions with industry best SWaP to cost ratio.



What is an IMU?

A combination of accelerometers, rate gyros and electronics

- Three accelerometers in the orthogonal sensor axes
- Three rate gyros on the same sensor axes
- Inertial electronics (IE) to process and output the signals
- Outputs are digital rates, accelerations, and status
- May be installed in a standalone chassis with a power supply or used as an Inertial Sensor Assembly (ISA) within a navigator

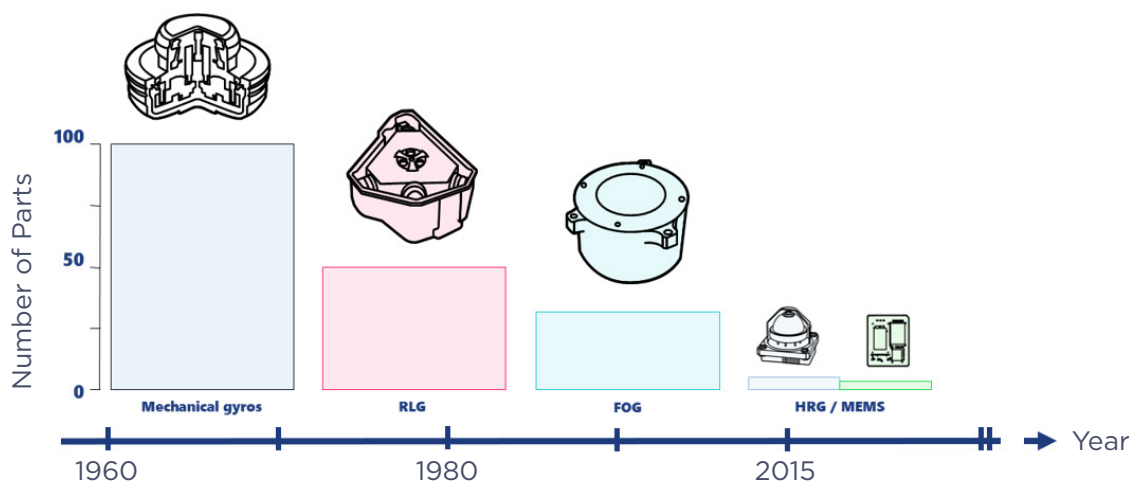
IMUs provide rate and acceleration data in the 'x', 'y' and 'z' axis offering systems live feedback on their movement. In the case of a guided missile, this feedback data ensures the ordinance stays on target while in aircraft they are a critical component ensuring the avionics suite operates and controls the platform as expected.

This guide discusses several different IMU types, their applications and how to choose the best variant for your platform.

Evolution of Gyroscope Technologies

Safran has invested in the next generation of MEMS and Hemispherical Resonating Gyro (HRG) technologies. These implementations offer optimized Size, Weight and Power (SWaP) characteristics, along with industry-leading reliability at both the component and system levels. MEMS gyro technology takes form in our STIM products offering stabilization, guidance and

control capabilities to platforms which are SWaP constrained. HRG technologies range from Tactical to Navigation and Navigation+ grade offering platforms northfinding and navigation capabilities. The next page breaks down these applications and how our IMU systems are best suited for various applications and environments.



IMU Applications

Matching the right IMU technologies to the appropriate application types is critical to ensuring systems react as expected to their environment. Fundamental gyroscope and accelerometer technology types each have their own strengths, Safran's experts can help in ensuring the right match for your application. Below are 4 common application types along with an example use case.



STABILIZATION

Stabilization of gimballed systems requires high speed (low latency) measurement of platform rotations and vibrations, with low latency feedback to servo mechanisms that cancel out the motion, enabling stable pointing of cameras, other optical systems, or remote weapons.

Applications

Stabilization of cameras or other optical systems. Stabilization of Remote Weapon Systems

Key Attributes

High bandwidth/ low latency/ shock and vibrate resilience

GUIDANCE/CONTROL

Guidance refers to the determination of the desired path of travel, or trajectory, to a designated target. Control refers to the manipulation of the forces, by way of steering controls, thrusters, etc., needed to execute guidance commands while maintaining vehicle stability.

Applications

Missile guidance, guided munitions, space launches where inertial data are used to control wings and thrusters

Key Attributes

High bandwidth/ low latency/ shock and vibrate resilience. Low cost for attritable systems.

ORIENTATION/AHRS

Orientation is the ability to provide a local level and a heading reference such as azimuth and elevation (ground applications) or pitch, roll and heading (airborne applications). Orientation can be achieved with medium performance gyros and accelerometers.

Applications

Provides a navigation aid to smaller aircraft including private jets. May be used as a backup to a full navigation system in a larger commercial aircraft.

Key Attributes

Good short term bias instability, low noise. Low cost for price sensitive commercial markets.

NORTHFINDING

Northfinding refers to the precise measurement of Earth's rotational rate to determine true north. True north is the standard reference for the heading or pointing vector of a vehicle or system. Safran has offerings which are gun-hardened and offer angle accuracy of better than 0.3 mils seclat.

Applications

Pointing of weapons, determination of heading to target, determination of vehicle heading as an aid to navigation.

Key Attributes

Low noise and good bias stability

NAVIGATION - GPS/INS

Navigation refers to the determination, at a given time, of the vehicle's location and velocity (the "state vector" as well as its attitude (roll, pitch, and yaw). High accuracy position and heading solutions can be obtained from filtered combination of GPS and inertial sensor inputs.

Applications

Ubiquitous in both commercial and defense aircraft, ground based defense vehicles, surface sea vessels, uncrewed aerial and ground vehicles.

Key Attributes

Navigation grade bias stability for inertial sensors

NAVIGATION - GPS DENIED

Navigation in GPS challenged theaters requires inertial sensors with extremely high long term stability, enabling high accuracy position and heading determination even when GPS is jammed or spoofed.

Applications

Necessary for long range undersea navigation, increasingly relevant for defense aircraft due to GPS denial.

Key Attributes

Long term bias stability of inertial sensors

STIM PRODUCT SUITE

Safran manufactures IMUs and sets a new standard for precision and performance by utilizing our proprietary inertial sensor technology. Our IMUs are engineered to excel in the Defense, Industrial, Aerospace, and Commercial sectors.



Gyro range: Up to 1200°/s
Gyro bias: 0.3°/hr
Gyro ARW: 0.1-0.15°/hr
Gyro scale factor: 500 ppm 1sigma

Accelerometer Specs
Range: Up to 80g
Bias: 700µg
Scale Factor: 200 ppm 1sigma

ICONYX

ICONYX™ is a high-performance tactical grade Inertial Measurement Unit (IMU) for guidance and control applications. ICONYX™ is designed to meet the most demanding environmental conditions with extreme accuracy and reliability.

Gyro range: Up to 2000°/s
Gyro bias: 0.15 °/h 1sigma
Gyro ARW: 0.001 °/√h max
Gyro scale factor: 50 ppm 1sigma

Accelerometer Specs
Range: Up to 100g
Bias: Down to 100µg 1sigma
Scale Factor: 200 ppm 1sigma



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