ESTC 2020 – Virtual company visit to Sensonor
Reidar Holm
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Welcome to Sensonor

• Reidar Holm
• Manager for Product Development
• Not born, but raised at Sensonor. Started at Sensonor in 1988 as a fresh engineer from University of Manchester (UMIST)
Brief history of Sensonor

1985: Silicon MEMS pioneer work in Horten, Norway

1992: Medical, Defense, Aerospace, Automotive
       - Medical
       - Defense
       - Aerospace
       - Automotive
       - Pressure sensors
       - Accelerometers
       - 100k units produced

1992: Automotive safety
       - 35M, 250M, 2M units
       - Airbag accelerometers
       - Tire pressure sensors
       - Rollover gyros

2009: Defense, Aerospace, Industrial
       - 10k/year, 35k units
       - Tactical grade IMUs
       - and gyro modules

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The diagram illustrates the timeline and milestones of Sensonor's historical development, highlighting key years and product categories.
Extensive Experience and History

Major global product introductions:

- **1965** AE800 The first silicon sensor beam
- **1980** AE880 Micro machined silicon pressure sensor
- **1987** S64A Electronic crash sensor
- **1992** SA20 Low-cost crash sensor
- **1998** SP13 Tire pressure sensor
- **2003** SAR10 Automotive gyro sensor
- **2009** STIM202 High Precision gyro module
- **2012** STIM300 High Precision IMU
- **2019** STIM318 High Precision IMU
Sensonor
Location: Horten, Norway

MEMS Fabrication

MEMS Wafer Fab
- State of the art 150mm MEMS line
- Line upgraded 2016
- Production / clean room area: 2600m²

Capacity
- 700 triple stack wafer starts per week
- Foundry services available

Gyro Module and IMU Production

Assembly, Calibration and Test
- Fully automated flexible assembly line
- Development and qualification lab
- Production / clean room area: 4000m²

Capacity
- 10,000 Gyro Modules per year
- 5,000 IMUs per year
Previous applications

Airbags:

Tire Pressure:

Rollover:

New for SUVs in 2001
Current Applications

Application space for tactical-grade inertial sensors

- Soldier navigation
- High-end military training system equipment
- ROV navigation
- Satcom antenna stabilization
- Radio antenna pointing
- Aerial, land & maritime survey equipment
- Life science and medical testing
- Oil prospection – directional drilling
- Precision robotics
- High-speed train stabilization
- Aircraft safety instruments
- Missile guidance
- Rockets and ammunition guidance
- Raytheon Extended Range Guided Munition (ERGM)
- Autopilot for UAV
- G-NIUS Unmanned Ground Systems
- Watchkeeper 450
- KVH antenna stabilization system
- Applanix
- Xsens
- Icefield Tools Gyro Shot
- Raytheon Extended Range Guided Munition (ERGM)
- Airbus
- Sagem Felin V1
- RUAG
- KVH antenna stabilization system
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- American Ground Station
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Gyro/IMU application areas

- **Navigation**
  - True Inertial Navigation
    - Stand by instruments
    - Satellite back-up navigation
    - Missile separation IMU
  - GNSS supported systems
    - Surveying or land surveying
    - Surface navigators
    - UAV Back up
    - General Aviation supplement
    - Satellite navigation
- **Stabilization**
  - Real Time
    - Weapon systems
    - Observation cameras
    - Flight control
    - Missile control
    - Anti-missile systems
    - Laser communications
  - Post processing
    - LIDAR systems
    - Ocean mapping
    - Inspection systems
    - Pipelines
    - Railways
    - Road surface

Main usage area of Sensonor gyros/IMUs
Sensonor MEMS gyro

- Developed for automotive roll-over applications -> High reliability and robustness over long lifetime
- Mature: >15 years in production -> TRL 9
- Ideal-elastic mono crystalline Si material -> No intrinsic wear-out mechanisms
- Butterfly balanced design for high mechanical common mode rejection
- High overload and shock capability
- Wafer level sealing with controlled Q-factor
- Simple design: same electrodes used for drive and read-back, no complex finger-structures
- Intrinsic self-test possible -> Excitation frequency will reflect the integrity of the complete mechanical system
Legacy from automotive

• Understanding harsh environments (e.g. temperatures and vibrations)
• Safety focus (self-test)
• Serving high-demanding customers
• Volume production (focus on removal of freaks)
• Continuous improvements
Leadframe based technology/production (1994 – 2009)
Fully automatic production line
Process control – die shear, ball shear, wire pull
(Small) size matters

STIM210/202 is superior to FOG’s in respect to robustness, reliability, size/weight, power and cost

A system of 3 single axis conventional FOG (fiber optical) gyros – **1000 grams**

Improved solution using STIM202
3-axis MEMS gyro
**50 grams**
STIM202 – exploded view
STIM202 PCB and sensor assembly
FEM simulations – mechanical and thermal
Hermetic: STIM277H and STIM377H

• Hermetic:
  • Form-fit-function to non-hermetic
  • Polymer plug replaced by glass-metal seal
  • Lid: laser-welded
  • Packaged in dust-free environment
  • No paint

• STIM277H:
  • Form-fit-function to STIM210

• STIM377H:
  • Form-fit-function to STIM300

Gyro bias drift: HTOL 1000 hours, 85°C, mean +1 sigma

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Future

• Packaging challenges related to extremely high shocks: 20,000 – 50,000g
• Further miniaturization: e.g. PCBs with embedded components
• Reliable interconnects in 3D: e.g. 3D printed PCBs
• Cost-effective hermetic sub-assemblies
enabling a world in motion