Moog UnderSea Integrated Control Interface And Navigation System (MUSICIANS™) is a navigation and control system for unmanned underwater vehicles:

- Offers Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV) operators unmatched, leading-edge capability not available elsewhere
- Allows fast and efficient implementation and eliminates integration problems to provide a complete solution for both navigation and vehicle control
- Six MUSICIANS products available to support work class survey to the inspection class ROV / AUV
- All products have the same software that will integrate all sensors, navigate the vehicle, control the vehicle (i.e. auto pilot) and report status via MUSICIANS graphical user interface (GUI) and via output to end user’s subsea mapping display programs
- Product options include core inertial unit type and number and the level of integration required (PCB level solution up to fully integrated subsea bottle)
MUSICIANS™ is an accurate, robust and independent navigation system for unmanned underwater vehicles built on an inertial core engine. Using any available sensor data on the vehicle for aiding measurements (USBL, GPS, depth sensor, DVL, Gyro, altimeter), MUSICIANS outputs a fully integrated navigation and attitude solution for the vehicle. MUSICIANS is more than another navigation instrument, it is a complete control solution providing thrust vector control, autopilot interfaces and even direct actuator control for waypoint navigation, positioning and attitude control. Through its flexibility and support of most UUV sensors, it delivers an unparalleled value to vehicle developers, integrators and system operators.

**Integration** is solved by the MUSICIANS GUI that lets the end user quickly setup the system by identifying all the navigation sensors on the vehicle. MUSICIANS then configures itself to offer the best possible navigation solution for the given sensor mix. When a sensor is changed, the user simply updates the system setup and MUSICIANS is re-compiled for the new sensor mix. Optimization is accomplished via MUSICIANS sensor fusion software and flexible Kalman filter which determines at any point in an operation which sensor (or set of sensors) to believe and how to weigh outputs from multiple sensors with differing solutions. From this fused data a navigation solution is calculated.

**Navigation** is forwarded to the vehicle control system that calculates the thrust vector mix required to achieve a given navigation solution. Signals are sent from the MUSICIANS control modules to the vehicle motor controllers and actuation is achieved. Navigation sensor inputs on the vehicle feed into the navigation system and the feedback loop is completed and thrust mix optimized for the navigation solution desired. The vehicle control system allows for both helmsmen autopilot and full autopilot capability.

**Product Options**
- 2 IMU sensor options:
  - Fiber Optic Gyro (FOG)
  - MEMs Inertial Measurement Unit (IMU)
- Available as OEM board level solution or packaged in a subsea pressure housing
- Available in pressure housing with fully integrated DVL and pressure sensor, creating a turnkey subsea navigation and control solution
- Meets requirements of all classes of ROVs and AUVs
- MUSICIANS GUI is configurable for the user’s personal display

**Software / GUI**
MUSICIANS configurable software (via GUI) supports the following third-party sensor types and mission support tools:
- 4 IMU / AHRS types
- Most compass types
- 4 serial depth sensors
- Most analog depth sensors
- Most altimeters
- General purpose IO
- All DVLs currently on the market
- All GPS systems
- All USBL / LBL systems
- All subsea mapping systems

MUSICIANS uses the open system architecture and vehicle control technology by Greensea Systems, Inc. (www.greenseainc.com).
Software Modules

- **Vehicle heading and attitude module**: Calculates vehicle heading and attitude (high resolution and filtered) from the primary IMU device aided by any available third-party sensors on the vehicle.
- **Relative navigation module**: Calculates navigational solution in the relative navigation frame of reference (X,Y, and Z). Coordinates are computed from on-board sensors via custom kalman filter.
- **Absolute navigation module**: Calculates navigation solution in the Earth navigation frame of reference (Latitude and Longitude). Coordinates are computed from on-board sensors via custom a kalman filter. Initial reference is GPS fix.
- **Thrust Vector Control module**: Provided heading, attitude, depth, altitude, or waypoint commands the unit will output a vectored thrust solution to achieve the control inputs. The controller can be configured generically as a helmsman display or specifically for the vehicle for closed loop control integration.
- **Direct drive closed-loop navigation control module**: Provided heading, attitude, depth, altitude, or waypoint commands the unit will output control commands to the thrust actuators to achieve the control inputs. This module requires integration to the thruster control system and a full understanding of the host vehicle.
- **General purpose IO module**: Provides for analog and digital inputs and outputs. Discrete signals can be mapped to alarms, signals, or GUI display fields.
- **Navigation output module**: Output strings to support third-party mapping program integration (Winfrog, SeaScape, and Hypack). Initially standard format strings or NMEA outputs will be supported. Future upgrade will include proprietary Moog strings.
- **Standard output Module**: “Canned” outputs strings for any data signal in the device to support auxiliary devices such as NMEA devices, data loggers, chart recorders, video overlay units, or remote navigation stations.
- **Mirror display module**: Network distribution of navigation data to any instance of the Moog GUI on the Local Area Network.
- **Data Logging module**: Internal data logging on the Moog GUI. Data logging is also possible in the device itself for

![MUSICIANS Graphical User Interface](image)

### PRODUCT OFFERING

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<tr>
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<th>AHRS</th>
<th>FOG</th>
<th>DVL</th>
<th>Housing</th>
<th>Pressure Vessel</th>
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<th>Sensor Fusion Engine</th>
<th>Power Supply Unit (UPS)</th>
<th>Depth Sensor</th>
<th>Connectors and Cables</th>
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Specifications and information are subject to change without prior notice. Photo credit for the Autonomous Underwater Vehicle (AUV) to Bluefin.

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