SEA-BIRD SCIENTIFIC

TECHOLOGY GUIDE

Simplifying Subsurface Data Collection with Inductive Modem Telemetry

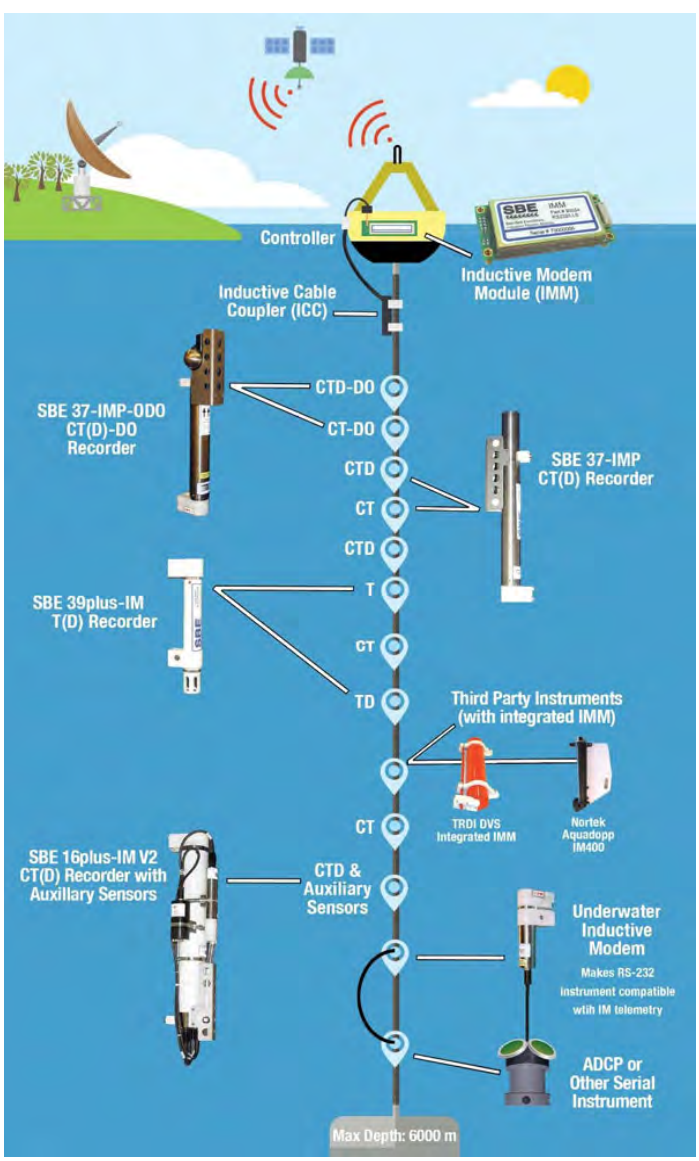
Ocean scientists, researchers, and offshore engineers are leveraging inductive modem technology to enable seamless, cable-free data transmission between subsurface instruments and buoy systems—streamlining deployment and enhancing long-term monitoring capabilities.

Inductive Modem Telemetry in Ocean Observing Systems

Real-time ocean observing systems are vital for understanding and managing marine environments. They provide continuous data streams that inform research on ecosystems, water quality, fisheries, and long-term climate trends. The rise of wireless telemetry—via satellite and mobile networks—has revolutionized oceanography by enabling unattended, remote data collection from even the most inaccessible locations.

However, traditional mooring systems have long faced limitations:

- **Fragile Infrastructure:** These setups often rely on physical cable breakouts to connect instruments, which are prone to failure due to corrosion, mechanical stress, or biofouling.
- **Rigid Design:** Instrument placement is fixed during cable manufacturing, making it difficult to adapt or reconfigure deployments without costly and time-consuming redesigns.



Sea-Bird Scientific's IM system transmits commands and data between an Inductive Modem Module (IMM) in the surface buoy and up to 100 IM-enabled instruments on a plastic-jacketed steel mooring line, without the need for breakouts

Sea-Bird Scientific's Inductive Modem (IM) System addresses these challenges with a robust, flexible solution for real-time subsurface data transmission:

- **Cable-Free Communication:** Instruments communicate through electromagnetic signals transmitted along the mooring cable, eliminating the need for direct electrical connections.
- **Scalable Architecture:** Up to 100 instruments can be deployed on a single mooring line, each at any depth and repositionable as needed.
- **Dual Operation Modes:**
  - » Instruments can operate autonomously, collecting and storing data at set intervals.
  - » Alternatively, they can be remotely commanded to take measurements and transmit data on demand.
- **Global and Targeted Commands:**
  - » A single command can instruct all instruments to take and store a measurement simultaneously.
  - » Individual instruments can be queried by their unique ID to retrieve specific datasets.

This inductive telemetry approach dramatically reduces deployment complexity, enhances reliability, and enables dynamic configuration of ocean observing systems—making large-scale, long-term monitoring more practical and cost-effective than ever before.

IM System Components

An inductive modem system enables data transmission between underwater instruments and surface installations without direct electrical connections. Key components include subsurface instrumentation connected to an inductive modem module, which communicates through an inductive cable coupler mounted on the mooring cable. Data travels up to a buoy controller housed in the surface buoy, which relays information to a shore installation for monitoring and analysis.

SUBSURFACE INSTRUMENTATION

Up to 100 IM-enabled instruments can be on a mooring cable, including:

Instrument	Temperature	Conductivity	Pressure (optional)	
SBE 16plus-IM V2	■	■	■	Up to 7 auxiliary sensors, such as dissolved oxygen, turbidity, fluorescence, PAR, etc.
SBE 37-IM	■	■	■	
SBE 37-IMP	■	■	■	
SBE 37-IMP-ODO	■	■	■	Dissolved oxygen
SBE 39plus-IM	■		■	
UIMM				Adapts RS-232 instruments (acoustic current meters, Doppler profilers, optical sensors, etc.) for IM Moorings

INDUCTIVE MODEM MODULE (IMM)

Small printed circuit board housed in buoy that communicates with IM instruments and interfaces to a computer/data logger via RS-232 serial connection. Commands to IM instruments can be global (for example, command all instruments to take and store a measurement now) or addressed to an individual instrument (for example, send your data now). Data can be received from only one instrument at a time.

INDUCTIVE CABLE COUPLER (ICC)

Couples mooring line to IMM via a waterproof bulkhead connector through the buoy hull. Clamps along the plastic-jacketed portion of mooring cable, below the seawater ground. For typical moorings; optional.

MOORING CABLE*

Plastic-jacketed steel mooring line, used as both the data transmission line and the mooring support line for the instruments. This type of rope is frequently also used for non-inductive oceanographic moorings because of the corrosion resistance provided by the plastic jacket. It is not necessary to provide any electrical connection between instrument and cable; expensive and unreliable electro-mechanical cables and terminations are not needed to get real-time data.

BUOY CONTROLLER*

Housed in buoy and connected to IMM via RS-232. Programmed to send commands to IMM to poll each underwater IM instrument for data and send data to shore via mobile or satellite transmission.

SURFACE BUOY*

Houses IMM, controller/data logger, telemetry transmitter/receiver, and power supply.

SHORE INSTALLATION*

Houses telemetry receiver (and optional transmitter, permitting shore control of buoy function) and computer for logging, processing, and displaying data.

SBE 39plus-IM Temperature (optional pressure) recorders with titanium housings on a mooring line

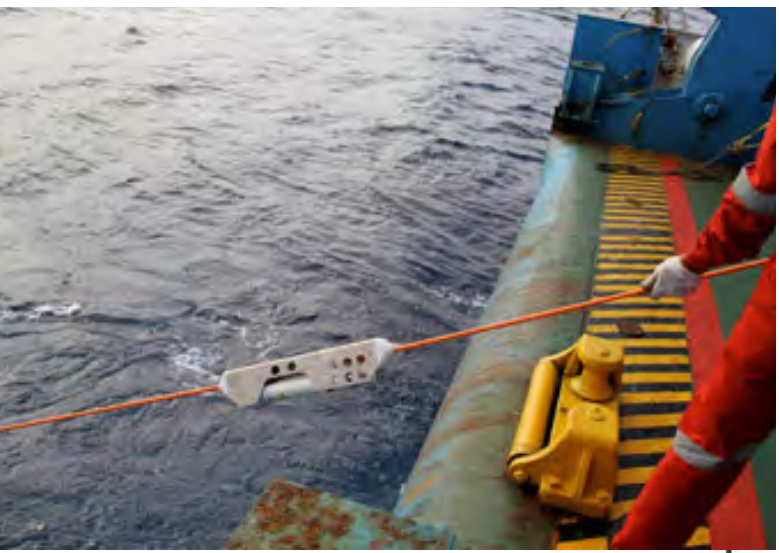
**Not an offering of Sea-Bird Scientific*

Underwater Instruments

The IM system can accommodate a wide variety of instruments for nearly any type of measurement. Sea-Bird Scientific manufactures IM versions of a number of instruments, measuring various combinations of temperature, conductivity, pressure, dissolved oxygen, and data from integrated auxiliary sensors.

Also available is an Underwater Inductive Modem Module (UIMM) that allows instruments from other manufacturers to be integrated with an IM system. The UIMM consists of an IMM in a small pressure housing, with a built-in inductive cable coupler and cable clamp. The UIMM is user-configured via RS-232 to send and receive commands to control the serial instrument and receive or retrieve data. An RS-232 serial output instrument simply plugs into the UIMM end cap for deployment.

An IMM and a cable coupler can also be integrated at the development stage in RS-232 serial output instruments from other manufacturers.



SBE 16plus-IM V2 SeaCAT CTD sensor with auxiliary sensors for dissolved oxygen and fluorescence

SBE 16plus-IM temperature (pressure optional) sensor

Technical Details

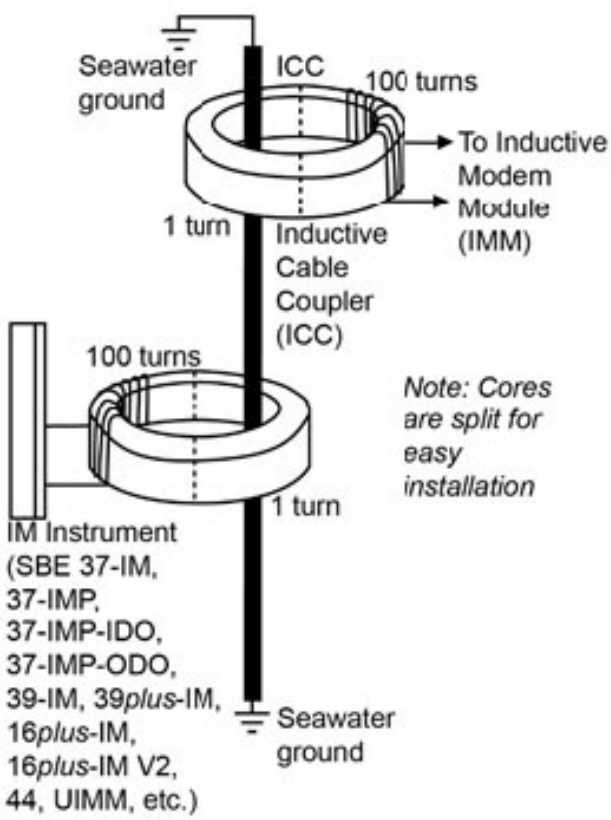
An inductive modem uses electrical current loops to transmit information; current flowing in a wire loop induces current to flow in a loop that passes through it. In Sea-Bird Scientific's s IM system:

- The **first loop** is formed by the coupler connection of the surface buoy to the mooring cable.
- The **second loop** is formed by the mooring cable and the seawater; the cable is bare metal on the top and bottom and insulated in the middle.
- The **third loop** is at each underwater instrument.

Because all coupling is done in loops, no cable breakouts are required.

Each cable coupler contains a transformer. The toroidal transformer consists of a circular ferrite core and two coils that share a magnetic field. Each coupler is made up of two halves, allowing it to clamp around the cable, so the cable does not need to be threaded through the unit.

For typical saltwater applications, the maximum transmission length is approximately 6,000 meters. In fresh water, with its lower conductivity, good communications can be obtained over 1,000 meters.



Field-Proven Triton Array

The first Sea-Bird Scientific IM systems, utilizing SBE 37-IM MicroCAT CT and CTD instruments, were deployed in the western Pacific in **1998** by JAMSTEC (Japan Agency for Marine – Earth Science and Technology) for the **Triton Array**.

The Triton Array is **still in operation today** and continues to use IM telemetry to deliver real-time data from sensors placed at depths up to 750 meters on a 4,000-meter mooring. The present buoy configuration includes 11 Sea-Bird MicroCAT CT and CTD instruments programmed to take a measurement every 10 minutes and report an hourly mean to the buoy controller via the IM system.

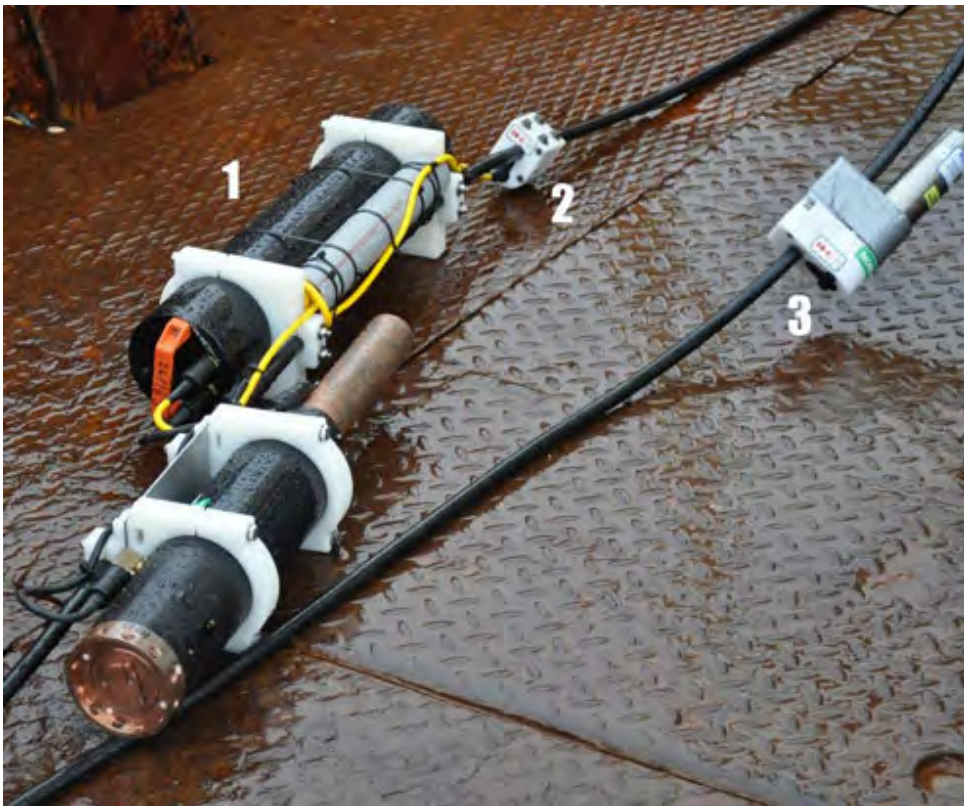
More than 3,000 Sea-Bird Scientific IM instruments have been deployed worldwide in the ensuing 18 years.

Field-Proven Fehmarnbelt Fixed Link

Sea-Bird's IM system was used in dredge monitoring for the **Fehmarnbelt Fixed Link** project (an immersed tunnel that is being constructed to connect the Danish island of Lolland with the German island of Fehmarn).

Anders Jensen, business area manager for survey and monitoring for the project's environmental consultant DHI, had this to say about their experience:

"We built our buoy systems for the Fehmarnbelt Fixed Link project with (Sea-Bird Scientific) WQMs and Sea-Bird Scientific Inductive Modem technology, with great success. As a full-service provider of marine environmental-monitoring systems, DHI expects and our clients demand reliability. We build our buoys to provide this with near real-time delivery of data to the web and data redundancy in the instruments on the buoy as back up. DHI's Aquaguard controller communicates with the instruments using Sea-Bird Scientific's Inductive Modem technology, which has been the key to providing robust communication capability. Data transmission from the monitoring site assures our clients that their monitoring program is meeting their specifications and saves time and effort for everyone by reducing servicing trips."



1 –WQM with BPA50-IM Inductive Modem Battery Pack

2 –SBE Inductive Cable Coupler connects to Inductive Modem Module in buoy

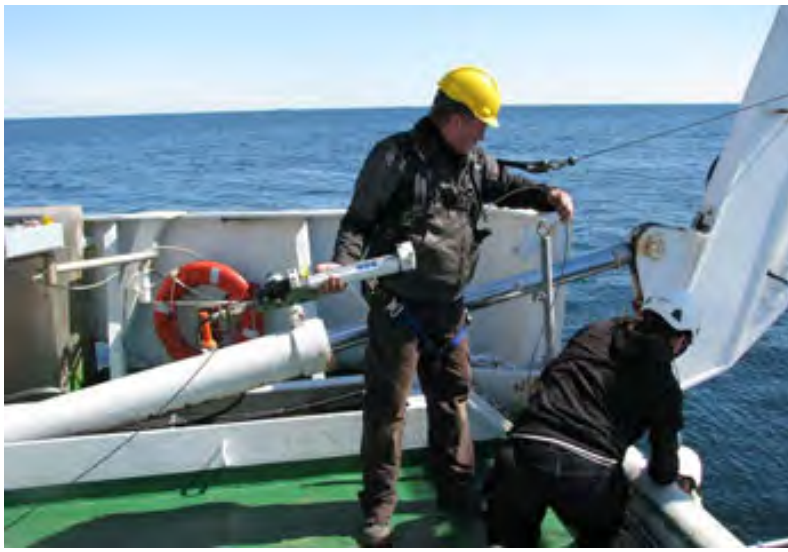
3 –SBE Underwater Inductive Modem Module integrates RS -232 instrument to IM mooring

Photo: TAMU Geosciences Communications and Media Relations

Field-Proven Finnish Meteorological Institute

The Finnish Meteorological Institute (FMI) deployed an IM system in the Baltic Sea near Utö Island. Tero Purokoski of FMI stated, "Oceanographic measurements at Utö have been conducted since 1900. Traditionally, the data has been used for monitoring climate change and variability in the Baltic Sea, but now the Station is also part of the European Integrated Carbon Observation System (ICOS). One of the science questions examines the role of the ocean physical processes on atmosphere-ocean gas exchanges. The data is also assimilated into operational oceanography models, improving our forecasting skill for the Baltic Sea."

FMI's system consists of a surface buoy with an SST (sea surface temperature sensor), GPS, controller, and Iridium satellite connection. Underwater are SBE 37-IMP CT (4), SBE 37-IMP CTD (1), and SBE 37-IMP-ODO CTD with integrated optical dissolved oxygen (2) instruments. The CT and CTD instruments take a measurement every five minutes, the CTD-DO instruments take a measurement every thirty minutes, and the controller queries for data from the last measurement every thirty minutes. The surface buoy has enough battery power to operate for twelve months of uninterrupted data collection.



Deployment of SBE 37-IMP-ODOs on IM mooring in Baltic Sea for Finnish Meteorological Institute

Photo: Heini Jalli, FMI

Simplify Your Subsurface Data Collection with Inductive Modem Solutions from Sea-Bird Scientific

At Sea-Bird Scientific, we partner with ocean professionals across research, government, and industry to reduce the cost and complexity of subsurface data acquisition. Our Inductive Modem technology enables reliable, cable-free communication between instruments and surface systems—making deployment faster, safer, and more scalable.

Whether you're integrating a single sensor into an existing mooring, building a modular array of instruments, or managing a fleet of long-term deployments, our Inductive Modem solutions offer the flexibility and performance you need to succeed.

Ready to connect? Connect with our team today to start your next subsurface sensing project with confidence.