

Wireless Reef Monitoring with CSignum EM-2Q

Enabling Sustainable, Subsurface Data Collection in Sensitive Marine Ecosystems

THE IMPORTANCE OF REEF MONITORING

Coral reefs are among the most biodiverse and ecologically valuable ecosystems on Earth, providing habitat for over 25% of all marine life, supporting fisheries, protecting coastlines from erosion, and contributing to local economies through tourism.

However, reefs are increasingly under threat from rising ocean temperatures, acidification, pollution, and destructive human activities. In response, organizations like the U.S. National Oceanic and Atmospheric Administration (NOAA) and UNESCO have emphasized the urgent need for data-rich, continuous reef monitoring to assess ecosystem health and guide conservation strategies.

Effective reef monitoring requires accurate, real-time data on environmental parameters such as current, temperature, salinity, pH, dissolved oxygen, flow, and nutrient levels. Traditional monitoring solutions often involve invasive infrastructure, acoustic emissions, or manual sampling methods that can disrupt the fragile reef environment and limit long-term deployment.

A non-intrusive, low frequency wireless solution is essential for collecting the critical data needed to protect and preserve reef systems without contributing to their degradation.



A BREAKTHROUGH IN NON-INVASIVE REEF MONITORING

CSignum's EM-2Q wireless monitoring system, powered by patented Electromagnetic Field Signaling (EMFS), enables seamless subsurface data transmission from reef sensors to cloud-based systems without acoustic emissions, cables, or surface disruption.

This breakthrough provides marine researchers, environmental agencies, and conservation groups with a new way to monitor reef health in real time, while preserving the integrity of the habitat.

CSignum's EM-2Q system, equipped with a sonde and/or an ADCP (Acoustic Doppler Current Profiler) can be placed offshore, discreetly within the reef on the sea floor. Aided by an EM-2 relay device, the EM-2Q transmits real-time data through the water surface to an EM-2 gateway equipped with a cellular modem.

The gateway, which can be installed on the shore, uploads data via cellular networks to cloud services for remote analysis. In some cases, a portable EM-2 gateway, offshore structure, or drone can be used for data retrieval.

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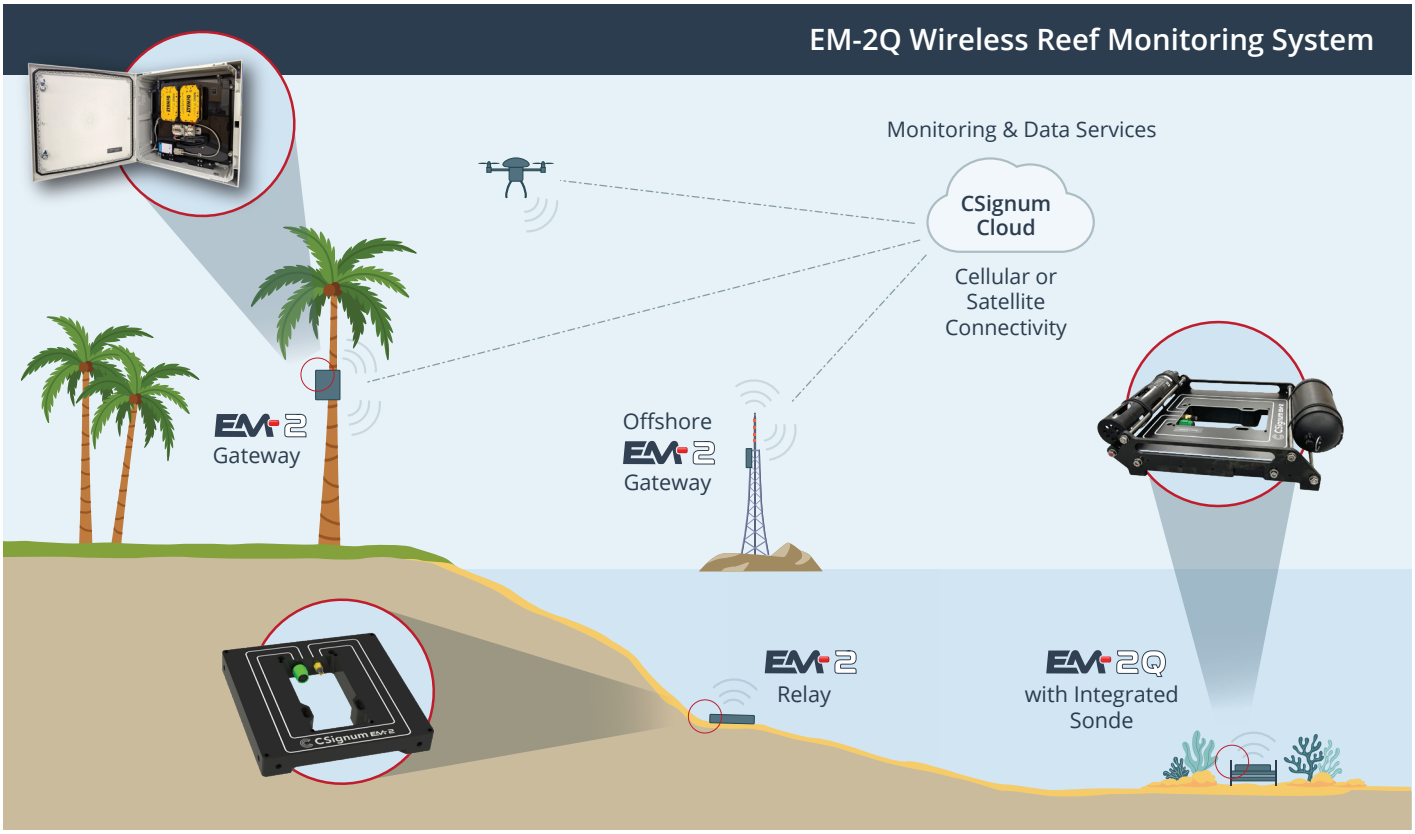

ENVIRONMENTALLY FRIENDLY BY DESIGN

CSignum's EM-2Q solution was purpose-built for low-impact deployments in sensitive aquatic environments:

- **No Acoustic Disturbance:** EMFS technology uses low-frequency electromagnetic signaling eliminating sonar, pings, and risk to marine mammals or fish behavior.
- **Cable-Free Deployment:** No surface cabling or buoys are required, eliminating entanglement risks and visual pollution.
- **Fully Submersible, Concealed System:** Designed to be placed directly on or near reef beds with minimal visibility or disruption.
- **Low Maintenance, Long Life:** Submerged EM-2Q units run on rechargeable batteries (up to 3 months), while the surface EM-2 gateway requires only semi-annual battery servicing.
- **Rapid Deployment & Retrieval:** A built-in buoyancy bag can be remotely activated to lift the EM-2Q system to the surface for maintenance or redeployment; no divers or heavy equipment required.

REAL-TIME DATA FROM BELOW THE REEF SURFACE

The EM-2Q integrates with industry-standard multi-parameter sondes and ADCPs to capture key reef health indicators such as:

- Dissolved Oxygen
- Temperature
- pH and Salinity
- Turbidity and Nutrient Levels
- Chlorophyll-a and Algal Growth
- Current and Flow

Data is transmitted wirelessly through the water and seabed to a nearby EM-2 gateway, which uploads information via cellular or satellite to the CSignum Cloud or customer data platform for immediate analysis.

This allows researchers and conservationists to monitor reef health across time to detect trends, respond to bleaching events, or validate restoration efforts without revisiting the site or disturbing the environment.

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MONITORING MODULAR REEF RESTORATION STRUCTURES

Modular reef restoration systems are rising in use along degraded coastlines to provide shoreline protection while facilitating reef habitat regeneration. These reef modules are designed to attenuate wave energy, stabilize sediment, and create microhabitats for coral and marine life. Sensor arrays and dashboards for real-time coastal performance tracking are necessary to monitor and evaluate the growth and overall health of the new reefs.

For these types of installations, CSignum's EM-2Q reef monitoring solution offers significant advantages:

- **Low impact integration:** Our wireless, submersible EM-2Q equipped with multiparameter sondes and/or ADCPs can be discretely embedded into or adjacent to reef modules without altering the structural integrity or aesthetics.
- **Real-time feedback on hydrodynamic and water quality metrics:** Data such as temperature, dissolved oxygen, turbidity, current, and salinity provide insight into local conditions that influence module performance and ecological success.
- **No surface infrastructure required:** Because the system requires no above-water booms or cabling, there is minimal visual or ecological disturbance, critical in sensitive coastal and marine protected projects.
- **Long-term monitoring without repeated disturbance:** Remote retrieval, low-maintenance operation, and secure data transmission reduce the need for diver-based servicing, preserving the restoration area.

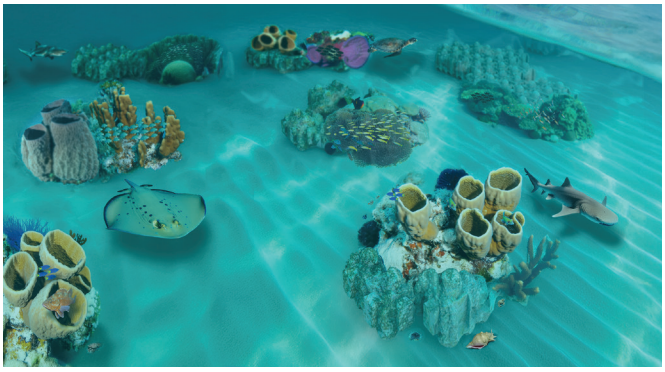
By integrating CSignum's wireless monitoring into modular reef systems, project teams gain continuous, high-resolution environmental data. That feedback loop helps optimize placement, fine-tune hydrodynamic performance, observe ecological colonization, and support adaptive management over time without compromising the integrity of the reef structure or habitat.

SCALABLE, SUSTAINABLE, AND PROVEN

Already deployed in demanding environments, including beneath ice, in coastal estuaries, and in urban water systems, the EM-2Q system has demonstrated its reliability, ruggedness, and scientific value.

With no wires, no noise, and no surface footprint, it offers a reef-friendly alternative for marine monitoring teams who value data integrity as much as environmental stewardship.

Learn more about reef-safe, real-time data monitoring with CSignum.



Modular reef example. Picture courtesy of ReefStarter

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