

Through-Ground Monitoring & Control with CSignum EM-2S

A WIRELESS PATH FROM BELOW THE SURFACE

THE CHALLENGE BENEATH THE SURFACE

Embedded structural and geotechnical sensors can be difficult to connect reliably to accessible surface locations. Cabled communications introduce vulnerable interconnects through dynamic construction phases and long-term monitoring deployments, while conventional radio-based wireless networks can only penetrate the ground or solid structures over short distances.

In addition, most through ground real world operating scenarios comprised of mixed media, including water, soil concrete, and even ice, produce rapid attenuation of radio-based wireless signals.

A BREAKTHROUGH IN THROUGH-GROUND COMMUNICATION

CSignum's patented electromagnetic field signalling (EMFS) technology enables sensor data to travel through ground, structures and mixed media to a surface network. The compact EM-2S is designed for embedded, buried and submerged monitoring applications, providing a robust alternative to physical communications cabling. Wireless signals from EM-2 systems can travel up to 100m through rock, concrete and freshwater and cross the air boundary with negligible loss.

The EM-2S solution provides bi-directional communications, allowing organisations to retrieve data, control connected sensors and remotely configure measurement schedules from above the surface.

KEY ADVANTAGES

- **Wireless through-ground:**
  solid structures and mixed-media environments
- **Embedded in concrete:**
  installed underground or submerged
- **Bi-directional communication:**
  for data retrieval and instrument control
- **Orientation-tolerant:**
  communications during installation and settlement with novel multi-axis antenna design
- **Surface gateway:**
  multiple monitoring locations can be served by a single surface gateway



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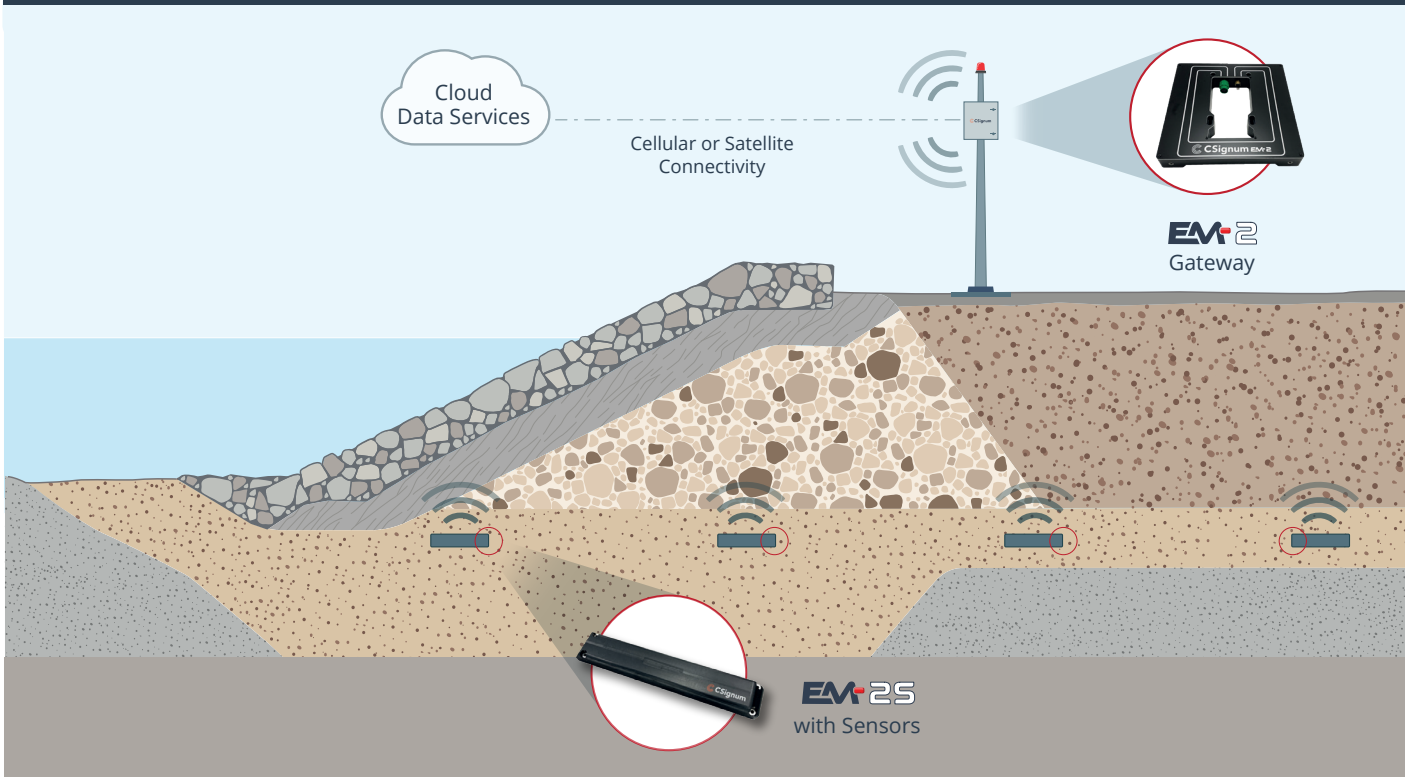
EM-2S Through-Ground Monitoring System



SYSTEM ARCHITECTURE

The CSignum EM-2S communications platform combines the three-dimensional receiver, data logging, edge processing and internal battery in a single, compact and robust resin-filled housing. Connected sensors can be activated on demand or a programmed schedule, with the EM-2S controlling sensor power directly and transmitting the resulting data through the ground to a topside EM-2 gateway.

The embedded EM-2S connects to conventional geotechnical sensors supporting RS232, RS485, Modbus and 4-20 mA interfaces. A number of industry leading sensors are supported including vibrating wire pressure sensors and water quality monitoring sondes. Additional sensor types can be integrated as required.

The buried or submerged EM-2S transmits real-time data through the ground to a topside EM-2 gateway. The EM-2 gateway, equipped with cellular or satellite connectivity, is discreetly housed, and can be installed up to 100 meters away directly. EM-2S nodes support static mesh networking between buried sensor locations, allowing measurements to be relayed beyond the distance achievable with a single communications link. It is possible to serve multiple monitoring locations from a single gateway with a flexible network addressing system.

The installed gateway uploads data via LTE cellular or satellite networks to cloud services for reporting and analysis. CSignum offers an integrated Cloud service with a flexible API or works with partners to integrate with existing dashboards.

ENGINEERED FOR BURIED DEPLOYMENT

INTEGRATED, ROBUST AND ORIENTATION TOLERANT

EM-2S platform is designed as a self-contained communications and data-logging platform for challenging embedded and underground deployments. Close integration of the low-frequency antennas with the active electronics reduces exposed interconnects and supports a compact, mechanically robust installation.

DESIGN HIGHLIGHTS

- **Solid resin-filled housing** for long-term stability and reliability
- **Integrated transmit modem** and three-dimensional receiver
- **Integrated data logging,** edge processor and battery
- **Mechanical robustness** and reliable water exclusion

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EM-2 Gateway
Topside - Cellular or Satellite

EM-2S
Through-Ground Node

BUILT FOR TRANSMISSION THROUGH COMPLEX MEDIA TO THE SURFACE

- Embedded structural monitoring
- Buried geotechnical monitoring
- Underground pipelines
- Submerged tunnels
- Storm drains and mixed-media installations

WHY EMFS

Conventional radio-wave wireless systems are limited by ground and solid structures. CSignum uses modulated electromagnetic field signalling to communicate across physical barriers and through layered media, providing a wireless route for data where a direct radio link is ineffective and a physical communications cable may be undesirable or impractical.

The topside EM-2 gateway can be discreetly housed and installed up to 100 metres from the buried EM-2S node. Cellular or satellite backhaul carries data onward to cloud services. In suitable deployments, one gateway can serve multiple monitoring locations.

TECHNICAL SPECIFICATIONS

Wireless Communications Rate	200 - 400 bps
Wireless Range	Up to 100m through-ground
Ambient Operating Temperature	-25°C to +55°C
Dimensions	75x120x760mm
Weight	9kg
Data Interfaces	RS232, RS485, 4-20mA, Modbus
Serial Interface Rate	9600 bps default (adjustable)
Configuration Method	Graphical User Interface and ASCII commands: remotely configurable via wireless communications
Internal Battery	800WH exceptionally low self-discharge; up to 20 year deployment
Power Input	Internal or external battery 17 to 25V
Integrated Data Logging	Store up to 3000 measurement points; configure measure/sleep schedules, control sensor power
Receive Mode Power Consumption	< 110mW
Ultra-low Power Receive Mode (duty cycled)	< 5mW
Sleep Mode (no active Rx)	0.8mW (wake on RS232 activity or schedule)
External Sensor Interface	12-way Female Subconn (MCBH12F)
External Sensor Power Out	12V @1A (12W)
Receive Antenna	Integrated 3-axis omni-directional, suitable for fixed and mobile deployments
Scheduled Wake	Real Time Clock with short term backup over cable/battery swap
Operating Modes	Low power always-on Receive; ultra-low power duty cycled receive; RTC wake; ultra-low power wake on serial data
Networking	Up to 117 modems individually addressable

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CONCLUSION

The fully encased EM-2S protects the integrated electronics and battery during installation handling and demanding underground or underwater operation. Operational life of up to 20 years can be achieved through management of the geotechnical measurement interval.

The CSignum EM-2S solution brings sensing, data logging and through-ground wireless communications together in a single integrated device providing a seamless way to retrieve data and communicate back to buried sensor systems in vital construction projects.

Learn more about wireless through-ground monitoring with CSignum.

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