

Temperature & Pressure Recorder with Inductive Modem SBE 39-IM

The SBE 39-IM is a high-accuracy temperature (pressure optional) recorder with built-in Inductive Modem. The modem provides reliable, low-cost, real-time data transmission for up to 100 sensors — all 39-IMs or a mix with other IM-capable sensors — using a single, plastic-coated, steel mooring wire. IM sensors clamp anywhere along the inherently rugged mooring wire; expensive and potentially unreliable multiconductor cables are not required.

IM sensor moorings are easily reconfigured to meet changing deployment scenarios. Because sensor positions can be altered (or sensors added/deleted) by sliding and re-clamping sensors on the wire, there is no need to design and purchase a new cable with different breakout locations. IM systems permit data telemetry from sensors located anywhere along the mooring wire, making them far more efficient and flexible than acoustic modem types that place serious demands on battery capacity and return data from a single underwater position only. At the surface (typically in a buoy), a Surface Inductive Modem (SIM) completes the link between the sensors and a computer or data logger. Data from the sensor string can be stored and transmitted via satellite link, cell phone, or radio telemetry. As insurance against real-time data loss, the 39-IM simultaneously stores data in its non-volatile memory.

The 39-IM's thermistor, the same as used in the SBE 39, has a long history of exceptional accuracy and stability; drift is typically less than 0.002 °C/year. Two thermistor configurations are offered: thermistor embedded in titanium end cap (25.0-second time constant) for rugged conditions; or external thermistor in pressure-protected sheath (0.5-second time constant) for fast sampling. The 39-IM's optional Druck pressure sensor employs a micro-machined *silicon diaphragm* in which the strain elements are implanted with semiconductor fabrication techniques. Unlike metal diaphragms, silicon's crystal structure is perfectly elastic, so the sensor is essentially free of pressure hysteresis. Compensation of temperature influence on pressure is performed by the 39-IM's CPU.

COMMUNICATIONS AND INTERFACING

The bottom of the insulated mooring wire is grounded to seawater, typically via a padeye swaged to its steel core; a padeye at the top completes a conductive loop through the water. A coupling transformer — similar to the one in the 39-IM but clamped to the mooring cable just under the buoy — connects to the SIM (SIM and transformer available separately). Communication with the SIM is full-duplex RS-232C or half-duplex RS-485. Communication between the SIM and 39-IM is half-duplex using DPSK (differential-phase-shift-keyed) telemetry. Full ocean-depth mooring cables can be used. The system provides a high degree of immunity from *fishbite* or other cable degradation. Lab diagnostics, setup, and data extraction may be performed by looping any insulated wire through the inductive core and connecting the wire ends to the SIM.

Each 39-IM (or other IM-sensor) has a programmable address. Upon receipt of a wake-up command, the SIM sends a tone for 2 seconds, waking all IM sensors on the cable. When a 39-IM receives a command, it replies and then returns to listening. A global power-off command returns all 39-IMs to a quiescent, standby state; they automatically return to quiescent state after no line activity for 2 minutes.

OPERATING MODES

User-selectable operating modes include:

- **Polled:** On command, 39-IM takes one sample and transmits the data.
- **Autonomous:** At pre-programmed 10-second to 8.3-hour intervals, 39-IM wakes up, samples, records data in FLASH memory, and powers off.
- **Combo:** Data is stored in FLASH memory; the SIM can request the last stored data.
- **Averaging:** Data is stored in FLASH memory; the SIM can request the average of the samples acquired since the last request.

DATA STORAGE AND UPLOAD, AND BATTERY ENDURANCE

The 39-IM has a 4 Mbyte non-volatile FLASH memory. Temperature and time are always stored (total of 7 bytes/sample); pressure adds 2 bytes/sample. Data extraction can be done via the internal RS-232 connector; binary upload capability provides **fast upload** of large data sets. A 39-IM uploads its full memory (466,000 samples of T, P, and time) in only 55 minutes — including error checking each block of data. Calibration coefficients are stored in EEPROM, and uploaded data is in ASCII engineering units (°C and decibars).

With its two 3.6-volt, non-hazardous, AA lithium batteries, the 39-IM can acquire more than 400,000 samples of T, P, and time. Because of the low power consumption when not sampling, deployments of 3 years or more are possible.

CONFIGURATION

A standard 39-IM is supplied with plastic housing for depths to 600 meters, internal thermistor, and wire guide and clamp.

Options include:

- External thermistor in pressure-protected sheath
- Titanium housing for depths to 10,500 meters
- Strain gauge pressure sensor - available in eight pressure ranges, to a maximum depth of 7000 meters
- Net fender / fairing - conical ends are shaped to shed fishing lines and nets



SBE 39-IM with external thermistor



SBE 39-IM with fairing and external thermistor



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CALIBRATION

The 39-IM's inherent accuracy, resolution, and stability, combined with a rigorous 11-point temperature calibration, yields a true research-quality tool. Primary temperature standards (water triple point and gallium melting point cells) and state-of-the-art equipment are maintained in our NIST-traceable calibration facility. Pressure calibrations are referenced to specially maintained (at Sea-Bird) Digiquartz sensors that trace to Paroscientific's pressure standard.

SOFTWARE

The 39-IM is supplied with a powerful Win 95/98/NT/2000/XP software package, SEASOFT®-Win32, for communication, data upload, data conversion, plotting, and export to other programs.

SPECIFICATIONS

Measurement Range

Temperature: -5 to +35°C
 Pressure (optional)*: 20/100/350/600/1000/
 2000/3500/7000 m

*Expressed in meters of deployment depth capability.

Initial Accuracy

Temperature: $\pm 0.002^\circ\text{C}$
 Pressure (optional): 0.1% of full scale range

Typical Stability (per month)

Temperature: 0.0002°C
 Pressure (optional): 0.004% of full scale range

Resolution

Temperature: 0.0001°C
 Pressure (optional): 0.002% of full scale range

Clock Accuracy 5 seconds/month

Power Supply/Endurance

Two 3.6V non-hazardous AA Lithium Batteries: > 400,000 samples

Quiescent Current 20 microamps

Communication Current 0.6 milliamps

Communication Time 0.5 seconds/sample

Acquisition Current (per sample)

T & time only 0.0042 amp-second
 T, P, & time 0.0108 amp-second

Memory

4 Mbyte non-volatile FLASH
 Memory capacity* — T & time: 599,000 samples
 Memory capacity* — T, P, & time: 466,000 samples
 *T=3 bytes/sample; time=4 bytes/sample; P=2 bytes/sample

Housing (Depth Rating)

PET plastic: 600 m (1960 ft)
 Titanium (optional): 10500 m (34,400 ft)

Weight (without fairing)

Titanium housing, embedded thermistor:
 In air 1.6 kg (3.6 lbs)
 (Other configurations vary).

