COMMON SPECIFICATIONS FOR INSTRUMENTS ON FIXED PLATFORMS

Version 1-19
Document Control Number 1336-00000
2020-08-27

Woods Hole Oceanographic Institution
Woods Hole, MA
www.whoi.edu

in Cooperation with

University of Washington
Oregon State University
Rutgers University

Document Control Sheet

Version	Date	Description	Originator
0-01	5/12/2010	Initial Draft	Rob DelCoco
0-02	5/13/2010	Minor updates	Rob DelCoco
0-03	5/19/2010	Includes suggestions from Sheri and questions.	Rob DelCoco
0-04	5/19/2010	Updates from 5/19 SWG included.	Rob DelCoco
0-05	6/1/2010	Updates from suggestions by Sheri at CG. Removed field replaceability and sampling specs.	Rob DelCoco
1-00	6/3/2010	Spec Approved; rev version and formatting	Lorraine Brasseur
1-01	8/10/2010	Control number for this document changed from 1330-00000 to 1336-00000.	Rob DelCoco
1-02	2010/09/22	Ported to the revised template; Included revisions from SWG review on 09/01/2010 and 09/08/2010	Noblis
1-03	2010/09/30	Updates as a result of the open 5-day Program Revision and Approval Process	Noblis
1-04	2010/10/05	Updates as a result of the CCB liens	Ed Chapman
1-05	2011/02/17	Updates to material coatings (MECH-006), added OPER-008 re: attachment with other instruments, added INTF-016 re: bulkhead connector, added appendix 4.1 re: preferred connector types	OL/Noblis
1-06	2011/02/25	Updates as a result of the CCB liens. ECR 1300-00123	Ed Chapman
1-07	2011/03/10	Removed watermark	Ed Chapman
1-08	2011/04/07	Added “This is an objective” to ELEC-001.	Rob DelCoco
1-09	2011/06/01	Multiple changes based on lessons learned from procurements (OPER-006, MECH-001 through 008, ELEC-001, and SHIP-002)	Ed Chapman
1-10	2011/06/03	Minor edits	Arthur Salwin (Noblis)
1-11	2011/06/08	Minor edits	Ed Chapman
1-12	2011/06/28	Changes per CCB on ECR 1300-00178	Arthur Salwin (Noblis)
1-13	2011/08/01	Minor administrative updates – incorrect references	Rob DelCoco
1-14	2011/10/07	Change to shipping standard in accordance with ECR 1303-00413	Ed Chapman

1-15	2019/12/31	Update for OOI 2.0 Tech Refresh	S. White, Al Plueddemann, Jon Fram, Dana Manalang, CGSN & EA Instrument Team and Engineers
1-16	2020/2/26	Further review and updates	MIO Instrument Team
1-17	2020/3/11	Final updates, re-numbering, re-formatting and re-organization; posted to ECR-342	S. White
1-18	2020/3/18	Addressed liens to ECR-342. Released to Alfresco	S. White
1-19	2020/08/27	Add Vendor Requirement (ECR-470)	MIO Instrument Team

Table of Contents

1 General

1.1 Ocean Observatories Initiative (OOI) Overview

Although the ocean is central to the habitability of our planet, it is largely unexplored. Biological, chemical, physical, and geological processes interact in complex ways in the ocean, at the seafloor, and at the air-sea interface. Our ability to learn more about these processes is severely limited by technical infrastructure, and developing a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation and experimentation.

The Ocean Observatories Initiative (OOI) lays the foundation for future ocean science observations. OOI enables powerful new scientific approaches by transforming the community's focus from expedition-based data gathering to persistent, controllable observations from a suite of interconnected sensors. The OOI's networked sensor grid collects ocean and seafloor data at high sampling rates over years to decades. Researchers can make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, oceanographic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).

The OOI enables multiple scales of marine observations that are integrated into one observing system via common design elements and an overarching, interactive cyberinfrastructure. Coastal-scale assets of the OOI expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms 'wire' a single region in the Northeast Pacific Ocean with a high speed optical and high-power grid. Global components address planetary-scale changes via moored open-ocean buoys linked to shore via satellite. Through a unifying cyberinfrastructure, researchers can control sampling strategies of experiments deployed on one part of the system in response to remote detection of events by other parts of the system.

More details on the current configuration of the OOI System can be found on the Ocean Observatories Initiative website: https://oceanobservatories.org/

1.2 Document Scope and Purpose

This document contains the common specifications applicable to instruments integrated with fixed platforms and selected mobile platforms. Fixed platforms for the OOI include buoys, cabled and uncabled moorings, and seafloor packages. Select mobile platforms include cabled and uncabled profilers. The unique specifications for each particular instrument are contained in separate instrument specifications documents. In case of conflicting specifications between documents, the unique instrument specifications shall have precedence. Contractual terms and other non-technical information are not part of this document.

1.3 Documents

1.3.1 Informational

The documents and links listed in this section are for informational purposes only and may not be referenced in this specification.

- Consortium for Ocean Leadership, Inc. 2010, “Final Network Design”, Washington, DC. [Online] Available: http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/network-design/
- Oceans Observatories Initiative Webpage: https://oceanobservatories.org/
- OOI Data Portal: https://ooinet.oceanobservatories.org/

1.4 Definitions

1.4.1 Glossary and Acronyms

- **Accuracy** – Closeness of the agreement between the result of a measurement and the value of the measurand (or true value of the measurement). (Taylor and Kuyatt, 1994).
- **Cabled** – Any OOI platform that is connected to a communications/power cable connected to shore. The platforms on the backbone cable in the Northeast Pacific are examples.
- **Coastal** – For OOI, a coastal or coastal ocean site is located on the continental shelf or upper slope at a depth of 1000 m or less.
- **EIA** – Electronics Industries Association
- **Instrument** – A device that contains one or more sensors and a method for converting the information from the sensor into a transmittable and storable form.
- **Objective Value** – The desired value of a technical parameter. This value, if provided, may be more challenging to achieve than the Threshold value. It is a goal, not a requirement, for the instrument.
- **OOI** – Ocean Observatories Initiative
- **Open Ocean** – Open ocean site is any site located at an ocean depth greater than 1000 meters or more than 500 km from shore.
- **Operate** – Correctly performing designed functionality.
- **Precision** – The closeness of agreement between independent measurements obtained under stipulated conditions of repeatability, generally expressed as a standard deviation (or standard uncertainty) of measurement results. Used as a measure of stability of an instrument/sensor and its capability of producing the same measurement over and over again for the same input signal (Taylor and Kuyatt, 1994).
- **Resolution** – The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78). PSS defines salinity as a dimensionless conductivity ratio.
- **Sensor** – A device that will convert a physical phenomenon into an electrical signal that can in turn be digitized through the use of an analog to digital converter. A sensor is normally housed in an instrument. Data coming from sensors is normally raw and needs to be calibrated.
- **Survive** – Experience an event without major loss of hardware integrity. System might experience loss of functionality requiring repair to return to normal mode functionality. An example of this is knockdown of a global mooring or loss of mooring flotation resulting in the instrument descending to the bottom. Any internal memory in the instrument would remain accessible, but the sensors might need to be replaced to return to normal functionality.

- **Sustain** – Experience an event (environmental extreme or condition) without permanent loss of normal mode functionality. System may experience reduction of functionality during event.
- **Threshold Value** – The limiting acceptable value of a technical parameter. If this item does not meet the performance as specified by the threshold value, it may not be sufficient for inclusion in the OOI system.

1.4.2 Conventions

All values contained in this document are Threshold Values unless specifically stated otherwise.

The bidder shall ignore the references in angle brackets < > at the end of each specification. They are for internal OOI use only.

2 Specifications

The unique specifications for each particular instrument are contained in separate instrument specifications documents. For any subsection of this document that does not contain text, refer to the individual instrument specification document and any relevant platform specification documents.

2.1 Measurement

See individual instrument specification documents.

2.2 Operational

2.2.1 Environmental

a) Salinity

OPER-001 The Instruments shall be capable of operating in water salinities from 0 to 40 on the PSS. <L2-SR-RQ-3497, L4-CG-IP-RQ-443>

b) Temperature

OPER-002 The Instruments shall be capable of operating in sea water temperatures from -2 to 35 °C. <L2-SR-RQ-3494, L4-RSN-IP-RQ-530, L4-CG-IP-RQ-442>

c) Biofouling

OPER-003 Mitigation shall be identified and/or provided for sensors that are subject to performance degradation due to biofouling. < L2-SR-RQ-3610, L4-CG-IP-RQ-446>

OPER-004 The biofouling mitigation should provide for operation within the specified accuracy for the defined deployment intervals. This is an objective. <L2-SR-RQ-3608, 3609> See section 2.2.4 for the defined deployment intervals.

2.2.2 Calibration Requirements

OPER-005 Instruments should maintain calibration within the specified accuracy for the defined deployment intervals. This is an objective. <L4-CG-IP-RQ-286, L4-RSN-IP-RQ-680> See section 2.2.4 for the defined deployment intervals.

OPER-006 Instruments calibrations should remain stable in storage for up to 1 year (drift-in-storage as opposed to drift-during-deployment). This is an objective.

2.2.3 Maintenance

OPER-007 Instruments should meet all performance requirements for the defined deployment intervals without the need for physical maintenance. This is an objective. See section 2.2.4 for the defined deployment intervals.

2.2.4 Deployment

The deployment interval for uncabled, open ocean platforms is 13 months.

The deployment interval for uncabled, coastal platforms is 7 months.

The deployment interval for cabled, open ocean and coastal platforms is at least 13 months.

OPER-008 Instruments shall be capable of being deployed, recovered, and redeployed without impairment of the performance of any of their components.
<L4-RSN-IP-RQ-78>

OPER-009 Instruments should require mminimal human interaction at the time of deployment. This is an objective.

2.2.5 Instruments with pumps

OPER-010 Instruments should be designed to prevent air locking of internal plumbing (i.e., self-priming). This is an objective.

OPER-011 Instrument pumps should be capable of running in air for short periods of time (e.g., 2 minutes) without damage. This is an objective.

2.3 Mechanical/Physical

This section of the document provides specifications for the mechanical properties of instruments. See section 2.7.1 for specifications for the mechanical interface between instruments and platforms.

2.3.1 Materials

MECH-001 All instrument components exposed to seawater shall be designed to be corrosion resistant (e.g., Non-corrosive metal, plastic or composite materials – not stainless-steel). <L4-CG-IP-RQ-288>

MECH-002 Instruments fixed on cabled platforms should have components exposed to seawater built of titanium alloy or non-metallic materials. This is an objective.

MECH-003 Dissimilar metals on an instrument shall be electrically isolated from one another (except in the case of sacrificial anodes).

MECH-004 Instruments housings shall meet operational depth ratings (see instrument-specific deployment depths).

MECH-005 Titanium material having threaded connections or sliding fittings should have a form of galling protection at contact surfaces, such as anodizing per AMS 2488 type 2 or galling lubricants. When contact surfaces for electrical current are involved, the change in resistivity should be evaluated to determine if a surface should be protected. This is an objective.

2.3.2 Size

MECH-006 Instrument form factor should be as small as practicable. This is an objective.

MECH-007 Instruments mounted on uncabled platforms in the water column (i.e., not on surface buoys or seafloor nodes) should be less than or equal to 8.7" in diameter and 36" in length. This is an objective.

2.3.3 Weight

MECH-008 Instrument in-air weight should be minimized for ease of handling. This is an objective.

2.4 Electrical

This section of the document provides specifications for the internal electrical properties of instruments. See section 2.7.2 for specifications for the electrical interface between instruments and platforms.

2.4.1 Grounding

ELEC-001 Instruments shall ground all circuitry internally with no electrical connection to the seawater. This requirement means that there should be no low resistance connection between either side of the power supply, or any communications line, and the ground (or seawater) at or within the instrument.

2.4.2 Internal Batteries

ELEC-002 Instruments required to be powered by internal batteries shall have battery capacity to operate the sensors at the typical sampling frequency for the defined deployment interval. <L4-CG-IP-RQ-298> See section 2.2.4 for the defined deployment interval.

Typical sampling frequencies are found in the individual instrument specification documents.

ELEC-003 Internal batteries should be diode protected.

ELEC-004 Instruments shall run off of external power if external power is provided at a higher voltage than the internal batteries.

ELEC-005 Internal batteries shall be optimized for efficient performance in the defined temperature range (see 2.2.1b))

ELEC-006 Depletion of internal batteries shall not inhibit normal operation with external power.

2.4.3 Modes/State of Operation

ELEC-007 Instruments shall return to a defined operational state upon being depowered and repowered. <L4-RSN-IP-RQ-80, L4-CG-IP-RQ-447>

ELEC-008 Instruments should return to their prior operational state upon being depowered and repowered. This is an objective.

2.4.4 Isolation

ELEC-009 The Instrument shall provide galvanic isolation between power/data pins and the pressure case in the presence of +/- 50VDC.

ELEC-010 All instrument electronics and electrical connections shall be isolated from seawater by greater than 10 MΩ.

ELEC-011 All instrument electronics and electrical connections should be isolated from seawater by greater than 100 MΩ. This is an objective.

2.5 Data Storage and Processing

2.5.1 Storage Capacity

DATA-001 Instruments should provide internal data storage on uncabled moorings. This is an objective.

Specific data storage capacities will be identified in the individual instrument specifications

2.6 Software/Firmware

SWFW-001 Instruments shall be controllable via a documented command line software interface.

SWFW-002 Instrument software should be OS-agnostic. This is an objective.

2.7 Platform Interfaces

2.7.1 Mechanical

INTF-001 Mounting and un-mounting should not affect the calibration of the instrument. This is an objective.

2.7.2 Electrical

a) Voltage

INTF-002 Instruments shall be powered by two-wire (+VDC, -VDC) voltages which are electrically isolated from the housing. <L4-RSN-IP-RQ-85>

INTF-003 Uncabled Instruments shall operate from a supply voltage of either 12 VDC +/- 5% or 24 VDC+/- 5% unless otherwise specified in the instrument specification. <L4-CG-IP-RQ-287>

INTF-004 Cabled instruments shall operate from a supply voltage of either 12 VDC +/- 5%, 24 VDC+/- 5% or 48 VDC+/-5% unless otherwise specified in the instrument specification.

b) Current

INTF-005 Instruments should be designed to minimize in-rush currents. This is an objective.

c) Power

INTF-006 Instruments should be designed to minimize power consumption (e.g., power management, sleep mode). This is an objective.

d) Connector

INTF-007 The instrument shall include a standard (commercially available) underwater bulkhead connector on the instrument housing.

2.7.3 Data and Communication

a) Timing

INTF-008 Instruments shall provide time-stamping capabilities or fully characterize the latency between data sampling and appearance of the data at the output connector. Preferences for instrument time stamping capabilities are as follows (best first):

1. Time stamp embedded in every data record to the design accuracy of the instrument's clock, using ISO 8601 compliant timestamp
2. Time stamp embedded in every data record to the design accuracy of the instrument's clock, using another described, parse-able timestamp format
3. Time stamp every data sequence, with fixed time between every data record
4. Fully characterize the latency between data sampling and appearance of the data at the output connector
5. Time stamp embedded in every data record, with precision that is less than the accuracy of the instrument's clock, using ISO 8601 compliant timestamp
6. Time stamp embedded in every data record, with precision that is less than the accuracy of the instrument's clock, using another described, parseable timestamp format. <L4-CG-IP-RQ-450>

b) Clock Synchronization

INTF-009 Instruments should have an internal clock capability. This is an objective.

INTF-010 Instruments with internal clocks shall have the ability to time synchronize the clock and/or set the clock over the interface. <L4-CG-IP-RQ-449>

INTF-011 Instrument internal clocks shall not drift more than 5 min per year (preferably better).

c) Data Rate

INTF-012 Instruments communicating via serial interfaces shall communicate at a minimum data rate of 9600 bits/sec.

INTF-013 Instruments should have a user-settable data rate, up to 115,200 bits/sec for serial interfaces. This is an objective.

d) Data Format

INTF-014 Instrument serial number shall be included in data output or be able to be queried by the user.

INTF-015 Data output should include associated metadata/configuration. This is an objective.

e) On-board Processing

INTF-016 Uncabled instruments should be capable of minimal on-board processing to provide summary data. This is an objective.

INTF-017 Instruments should include on-board diagnostics for instrument status. This is an objective.

f) Protocols

INTF-018 Instruments with an Ethernet interface shall include the ability to set a static IP address that is permanently stored.

INTF-019 Instruments shall acknowledge command execution, including an indication as to whether a command has succeeded or failed <L4-RSN-IP-RQ-92>

g) Hardware Flow Control

INTF-020 Serial RS-232 instruments should either use standard RS-232 flow control, or no flow control. This is an objective.

h) Electrical Interface

INTF-021 Instruments shall communicate (Data and Commands) while deployed with the OOI infrastructure (e.g., CI device driver or platform interface) via at least one of the following interfaces: Ethernet (10/100 Mb), or serial EIA standards: RS-422, RS-485, or RS-232. < L4-CG-IP-RQ-291, L4-CG-IP-RQ-297, L4-RSN-IP-RQ-88>

i) Remote Access

INTF-022 Instruments shall be capable of being remotely accessed and controlled via a non-proprietary, well-documented communication interface. <L4-CG-IP-RQ-294, L4-RSN-IP-RQ-91>

INTF-023 Instruments should support remote firmware installation. This is an objective.

INTF-024 All data stored on the instrument shall be accessible remotely over the communication interface.

INTF-025 Instruments shall only recognize a defined break sequence as a break (i.e., low susceptibility to random intermittent noise on the data line).

INTF-026 Instruments shall respond to a non-confirmed break by resuming the prior operating schedule.

j) Modes

INTF-027 Instruments should allow polled and asynchronous mode operation. This is an objective.

k) Modem

INTF-028 Instruments on uncabled, open ocean moorings shall be able to communicate (bi-directionally) via inductive modem. <L4-CG-IP-RQ-463>

INTF-029 Instruments using inductive communications should include hand-shaking to ensure data is not dropped. This is an objective.

2.8 Compliance

COMP-001 To the greatest extent practical, all OOI infrastructure should be compatible with applicable national and international standards, including those of the IEEE, ANSI, and IEC. This is an objective.

2.9 Safety

SAFE-001 1-atm pressure housings should incorporate a pressure relief valve or vent plug to enable venting of the housing after recovery (e.g., in case the housing leaked during deployment and is it at higher pressure).

2.10 Shipping and Storage

2.10.1 Shipping

SHIP-001 Instruments shall be provided with reusable transportation cases that meet or exceed ASTM-D3951 "Standard Practice for Commercial Packaging." <L3-CG-RQ-432>

2.10.2 Storage

SHIP-002 Instruments should be capable of being stored without damage or degradation between -20 and 50°C for periods of up to twelve (12) months. This is an objective.

2.10.3 Safe Handling

SHIP-003 Instrument transportation cases shall have external labels specifying safe handling precautions.

2.11 Identification

2.11.1 Physical Markings

IDEN-001	Instruments shall be marked indelibly on an exterior surface. Marking shall include manufacturer's part number, unit serial number, and OOI provided identification numbers.
IDEN-002	Instruments shall be capable of being marked indelibly by OOI without damage to the instrument or housing.
IDEN-003	Instrument serial numbers shall be unique.

2.12 Quality

2.12.1 Product Quality

QUAL-001	The materials used in construction of the instrument body, sensors, and sensor mounts shall be chosen and treated in such a way as to reduce the levels of wear, corrosion and deterioration to allow multiple deployments of each unit.

2.13 Vendor Requirements

2.13.1 Documentation/Information

VEND-001	Specifications, operational description (user's manual), and preparation/maintenance best practices shall be provided.
VEND-002	Instructions for proper mounting and clearances will be provided.
VEND-003	Vendors shall provide characterization of instrument current during start-up (i.e., in-rush currents) and normal operations.
VEND-004	Calibration information should be provided in a machine-parsable format. This is an objective
VEND-010	Vendors shall provide code, algorithms or an equivalent detailed description that can be used to process raw measurement data into the required OOI data products.

2.13.2 Notification

VEND-005	Changes to specifications and/or functionality of hardware and software shall be communicated to the user in conjunction with refurbishment and calibration servicing.
VEND-006	FW/SW updates will be communicated to the OOI Program prior to implementation.

2.13.3 Service

VEND-007	An estimate of standard refurbishment and recalibration service shall be provided.
VEND-008	Refurbishment/recalibration should be able to be completed to enable deployment every 5-7 months (e.g., serviced by vendor within 3-4 months). This is an objective.
VEND-009	Instruments shall be serviceable such that they can be restored to a fully operable state.