# Single Point Velocity Instrument Package Specification for Fixed Platforms

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**Coastal and Global Scale Nodes**
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## Revision History

| Version | Description | Originator | ECR No. | Release Date |
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| 1-00 | Initial Release in new template | S. White | 1303-00131 | 06 October 2010 |
| 1-01 | Updated definitions, added SOFT-001, INTF-013, QUAL-004, Appendix 4.1 | S. White | 1303-00212 | 16 February 2011 |
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## Signature Page

This document has been reviewed and approved for release.

OOI Senior Systems Engineer: _____

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## 1.0 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) will lay the foundation for future ocean science observations. OOI will enable 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 will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will 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 will enable 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 will expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Regional cabled observing platforms will '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 will 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.

A more detailed discussion of the Oceans Observatories Initiative can be found in the OOI Final Network Design.

### 1.2 Document Scope and Purpose

The purpose of this specification is to provide the requirements for a single point velocity instrument package to be purchased for use on fixed platform of the Coastal and Global Scale Nodes (CGSN) of the Ocean Observatories Initiative. Single point velocity instruments will be deployed on surface buoys, moorings, and seafloor packages at coastal locations (water depths up to 600 m).

This document describes the physical, functional and electrical characteristics of single point velocity instrument packages required by CGSN.

### 1.3 Documents

#### 1.3.1 Informational

The documents listed in this section are for informational purposes only and may not have been 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/

1.3.2 Applicable

N/A

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)
- **Burst Sampling** – Intermittent rapid sampling at or near the maximum sampling rate for short intervals between longer quiescent periods.
- **CGSN** – Coastal and Global Scale Nodes
- **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
- **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 (Taylor and Kuyatt, 1994). 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.
- **Resolution** - The smallest amount of input signal change that the instrument/sensor can detect reliably.
- **Response Time** - The time required for an output to reach a specified fraction of its final value as a result of a step change in input.
- **PSS** – Practical Salinity Scale, the UNESCO Practical Salinity Scale of 1978 (PSS78) 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. System may 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 some part of the mooring resulting in the instrument descending to the bottom. Any internal memory in the instrument shall remain accessible, but the sensors may 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 minimal limiting acceptable performance value that this item must meetof 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.

Specification items are assigned unique identification numbers specific to this document. Items tied directly to requirements maintained in the OOI requirements database are followed by the requirement number in brackets (e.g., [L4-CG-IP-RQ-XXX]). The requirement number is intended for internal OOI use only.

## 2.0 Specifications

### 2.1 Measurement

Values provided are threshold unless otherwise stated.

#### 2.1.1 Single Point Water Velocity

a) Measurement with unit(s) (e.g., Temperature (°C))

Water Velocity – speed (meters per second), direction (degrees)

PVEL-001 Single Point Water Velocity instruments should be capable of measuring 3-axis water velocity. This is an objective.

b) Minimum Value

PVEL-002 Single Point Water Velocity instruments shall have a speed range with a minimum value of 0 m·s-1. [L4-CG-IP-RQ-255]

PVEL-003 Single Point Water Velocity instruments shall have a direction range with a minimum value of 0 degrees. [LR-CG-IP-RQ-485]

c) Maximum Value

PVEL-004 Single Point Water Velocity instruments shall have a speed range with a maximum value of 4 m·s-1. [L4-CG-IP-RQ-255]

PVEL-005 Single Point Water Velocity instruments shall have a direction range with a maximum value of 360 degrees. [LR-CG-IP-RQ-485]

d) Accuracy

PVEL-006 Single Point Water Velocity instruments shall have a speed accuracy of +/-1% of measured value +/-1 cm·s-1. [L4-CG-IP-RQ-248]

PVEL-007 Single Point Water Velocity instruments shall have an absolute direction accuracy of +/- 2 degrees. [L4-CG-IP-RQ-256]

e) Precision

PVEL-008 Single Point Water Velocity instruments shall have a single sample speed precision of no greater than 3.0 cm·s-1. [L4-CG-IP-RQ-484]

f) Resolution

PVEL-009 Single Point Water Velocity instruments shall have a speed resolution of 0.1 cm·s-1. [L4-CG-IP-RQ-250]

PVEL-010 Single Point Water Velocity instruments shall have a direction resolution of 0.1 degrees. [L4-CG-IP-RQ-257]

g) Drift

N/A

h) Response Times

N/A

i) Sampling Frequency

PVEL-011 Single Point Water Velocity instruments shall be capable of sampling at a frequency of 1 Hz. [L4-CG-IP-RQ-254]

PVEL-012 Single Point Water Velocity instruments shall be capable of burst sampling. [LR-CG-IP-RQ-487]

j) Dependencies

N/A

k) Measurement interference

PVEL-013 Single Point Water Velocity instruments should have a means of minimizing flow distortion. This is an objective.

## 2.2 Operational

### 2.2.1 Operational Depth Range

OPER-001 The operational depth rating of the instrument shall be 600 m. [L4-CG-IP-292]

### 2.2.2 Environmental

a) Salinity

OPER-002 Instruments shall be capable of operating in water salinities from 0 to 40 PSU. [L4-CG-IP-RQ-443]

b) Temperature

OPER-003 Instruments shall be capable of operating in water temperatures from -2° to +35° C. [L4-CG-IP-RQ-442]

c) Biofouling

OPER-004 Sensors shall utilize biofouling mitigation to enable nominal operations over the defined deployment interval. [L4-CG-IP-RQ-446; L3-CG-RQ-867]

### 2.2.3 Service Requirements

N/A

### 2.2.4 Calibration Requirements

OPER-005 Sensors shall maintain their calibration over the required deployment intervals. [L4-CG-IP-286]

### 2.2.5 Deployment Interval

OPER-006 The designed deployment interval for instrument packages on moored assets shall be 7 months. [L3-CG-RQ-496; L3-CG-RQ-497]

## 2.3 Mechanical/Physical

### 2.3.1 Materials

MECH-001 Instrument electronics housings shall be designed to be corrosion resistant. [L4-CG-IP-288]

MECH-002 Instruments fixed on Coastal moorings shall have electronics housings capable of sustaining immersion in seawater to 600 m. [L4-CG-IP-435]

### 2.3.2 Size

N/A

### 2.3.3 Weight

N/A

## 2.4 Electrical

### 2.4.1 Interference Requirements

N/A

### 2.4.2 Voltage

N/A

### 2.4.3 Current

N/A

### 2.4.4 Power

N/A

### 2.4.5 Grounding

N/A

### 2.4.6 Battery Life

ELEC-001 Instruments should be capable of operating on internal batteries. This is an objective.

ELEC-002 Battery powered instruments shall have battery capacity to operate at the default sampling rate for the defined deployment interval. [L4-CG-IP-298]

### 2.4.7 Modes/State of Operation

ELEC-003 Instruments shall return to a defined operational state upon being depowered and repowered. [L4-CG-IP-447]

### 2.4.8 Isolation

ELEC-004 All instrument electronics and electrical connections shall be isolated from seawater by greater than 10 megaohms.

## 2.5 Data Storage and Processing

### 2.5.1 Storage Capacity

DATA-001 Instruments shall provide non-volatile internal data storage. The data storage size shall accommodate data taken at the typical rate over the duration of the deployment interval.

DATA-002 Instruments should internally store calibration and sensors serial numbers. This is an objective.

### *2.5.2* Data Processing

DATA-003 Single Point Water Velocity instruments shall be capable of internally vector averaging their data and reporting the averaged data. [L4-CG-IP-RQ-258]

DATA-004 Single Point Water Velocity instruments shall calculate and report velocity in geographic coordinates. [L4-CG-IP-486]

## 2.6 Software/Firmware

SOFT-001 Serial instruments requiring a break signal should be capable of emulating the break by a software character sequence. This is an objective.

## 2.7 Platform Interfaces

### 2.7.1 Mechanical

N/A

### 2.7.2 Electrical

INTF-001 The instrument package shall connect to the platform controller for power and communications (the connector type iss on the CGSN platform controller housing are TBS and will be detailed in an interface control document).

INTF-013 The instrument should include a standard type of OOI bulkhead connector on the instrument housing (see Appendix 4.1). This is an objective.

INTF-002 The instrument package shall operate from a supply voltage of either 12 VDC +/- 5% or 24 VDC +/- 5%. [L4-CG-IP-RQ-287]

### 2.7.3 Data and Communication

a) Timing

INTF-003 Instruments shall provide time-stamping capabilities or latency characterization between data sampling and data output. [L4-CG-RQ-450]

Preferences for instrument time stamping capabilities are as follows (best first):

- Time stamp embedded in every data record to the design accuracy of the instrument's clock, using ISO 8601 compliant timestamp
- Time stamp embedded in every data record to the design accuracy of the instrument's clock, using another described, parseable timestamp format
- Time stamp every data sequence, with fixed time between every data record
- Fully characterize the latency between data sampling and appearance of the data at the output connector
- 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
- 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.

b) Clock Synchronization

INTF-004 Instruments should have an internal clock. This is an objective.

INTF-005 Instruments with internal clocks shall be capable of time synchronization. [L4-CG-RQ-449]

c) Data Rate

INTF-006 Instruments should have a user-settable baud rate, up to 115,200 baud for serial interfaces. This is an objective.

d) Data Format

N/A

e) Protocols

INTF-007 Instruments with an Ethernet interface should provide an auto-discovery mechanism, (e.g., PUCK, Universal Plug'n'Play', ZeorConf/Bonjour). This is an objective.

f) Physical Interface

N/A

g) Electrical Interface

INTF-008 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-297, L4-CG-IP-RQ-291]

h) Remote Access

INTF-009 Instruments shall be capable of being remotely accessed and controlled via the communication interface. [L4-CG-IP-RQ-294]

INTF-010 All data stored on the instrument shall be accessible remotely over the communication interface.

INTF-011 Instruments should support remote firmware installation. This is an objective.

i) Modes

INTF-012 Instruments should allow polled and asynchronous mode operation. This is an objective.

j) Inductive Modems

N/A

## 2.8 Compliance

COMP-001 To the greatest extent practical, all CGSN infrastructure shall be compatible with applicable national and international standards, including those of the IEEE, ANSI, and IEC.

## 2.9 Safety

N/A

## 2.10 Shipping and Storage

### 2.10.1 Shipping

SHIP-001 Instruments shall be provided with a reusable transportation case with shock mounting.

SHIP-002 Instrument Transportation Cases must fit within an ISO shipping container. [L3-CG-RQ-494]

SHIP-003 Instruments in their transportation cases shall be capable of surviving shipping conditions defined by ASTM D4169 truck assurance level 1. [L3-CG-RQ-432]

2.10.2 Storage

SHIP-004 Instruments shall be capable of being stored without damage or degradation between -20° and 50° C for periods of up to 12 months.

2.10.3 Safe Handling

SHIP-005 Instrument transportation cases shall have external labels specifying safe handling precautions.

## 2.11 Identification

### 2.11.1 Physical Markings

IDNT-001 All components of the Single Point Velocity instrument package shall be marked indelibly on an exterior surface. Marking shall include:

- Manufacturer's part number
- Unit serial number
- CGSN part number as defined below:
  - P/N 3305-00010-00001

## 2.12 Quality

### 2.12.1 Product Quality

QUAL-001 Instrument packages shall be manufactured in accordance with the manufacturer's best practices. Records of quality assurance tests and inspections shall be available for review by the purchaser.

QUAL-004 A First Article Testing report shall be provided with each first article unit delivered.

QUAL-002 A certificate of compliance shall be provided with each delivered unit. The certificate of compliance shall be supported with copies of the Factory Acceptance Test report and calibration records for each sensor following integration into the unit.

QUAL-003 The materials used in construction of the instrument packages 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.

## 3.0 Documentation and Support

N/A

## 4.0 Appendices

4.1 Preferred OOI Standard Connector types.

Instruments should use an MCBH connector installed on the housing. The number of pins, and pinout assignments, should be appropriate to the communication protocol of the instrument, and as shown in the table below. This is an objective.

If the instrument is deployed below the surface, the underwater connector should be water blocked so that there is a back-up o-ring seal in the event that the elastomeric sealing surface delaminates from the metal shell. This is an objective.
(An example of a 6 pin water blocked connector is the MCBH(WB)-6-FS-Ti, manufactured by Teledyne Impulse.)

| **Protocol** | **RS-232** | **RS-232** | **RS-485 (half duplex)** | **RS-485 (full duplex)** |
|---|---|---|---|---|
| **Pin #** | **4 Pin** | **6 Pin** | **6 Pin** | **8 Pin** |
| 1 | Gnd | Pwr Gnd | Pwr Gnd | Data Gnd |
| 2 | RXD | RXD | Data B+ | RD B+ |
| 3 | TXD | TXD | Data A- | RD A- |
| 4 | 12Vdc | 12Vdc* | 12Vdc* | Reserved |
| 5 | | 24Vdc* | 24Vdc* | TD A- |
| 6 | | Data Gnd | Data Gnd | TD B+ |
| 7 | | | | Pwr Gnd |
| 8 | | | | +Vdc |
| 9 | | | | |
| 10 | | | | |

* Only one voltage will be populated, depending on instrument input power needs.

Preferred vendors include:

Teledyne Impulse
9855 Carroll Canyon Road
San Diego, CA 92131
impulse@teledyne.com

SubConn, Inc.
www.subconn.com

mac-us@macartney.com

*p*($CO_2$) Instrument Package Text Verification Matrix (TBS)