



# DATA PRODUCT SPECIFICATION FOR SHORT PERIOD GROUND VELOCITY FROM THE SHORTPERIOD SEISMOMETER

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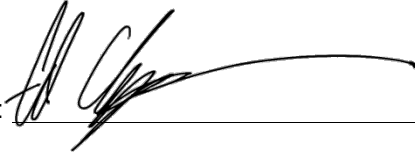
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### Signature Page

This document has been reviewed and approved for release to Configuration Management.

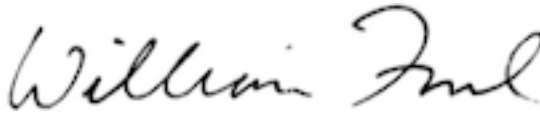
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This document has been reviewed and meets the needs of the OOI Cyberinfrastructure for the purpose of coding and implementation.

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## 1 Abstract

This document describes the computation used to calculate the OOI Level 1 Short Period Ground Velocity (SGRDVEL) core data product, which is the time-series seismic signal sensed from the Short Period Seismometer (OBSSP) instruments. This DPS applies to instrument class OBSSP only. This document is intended to be used by OOI programmers to construct appropriate processes to create the L1 SGRDVEL core data product.

## 2 Introduction

### 2.1 Author Contact Information

Please contact the Data Product Specification lead ([DPS@lists.oceanobservatories.org](mailto:DPS@lists.oceanobservatories.org)) for more information concerning the computation and other items in this document.

### 2.2 Metadata Information

#### 2.2.1 Data Product Name

The OOI Core Data Product Name for this product is

- SGRDVEL

The OOI Core Data Product Descriptive Names for these products are

- Short Period Ground Velocity

#### 2.2.2 Data Product Abstract (for Metadata)

- The OOI Level 1 Short Period Ground Velocity core data product, SGRDVEL, is the time-series seismic signal sensed by a short period seismometer (OBSSP) and digitized by channels of the seismometer digitization system onboard the instrument. The transformation of the L0 seismic signal to L1 will consist of converting digital counts into meters/sec and correction for the applied gain.

#### 2.2.3 Computation Name

N/A

#### 2.2.4 Computation Abstract (for Metadata)

The OOI Level 1 Short Period Ground Velocity core data product is computed by decoding binary format data digitized by the short period seismometer instruments into short period seismic data. The raw data stream from the OBSSP instrument is parsed to create the L0 data products for each of the three seismic sensors. After parsing and decoding, a linear calibration factor, Gain, will be applied to transform the L0 digital counts into the L1 core data product SGRDVEL for each of the three seismic sensors.

#### 2.2.5 Instrument-Specific Metadata

- See Section 4.4 for instrument-specific metadata fields that must be part of the output data.

#### 2.2.6 Data Product Synonyms

Synonyms for this data product are

- Short Period Seismic Time Series

#### 2.2.7 Similar Data Products

Strong Motion Ground Acceleration (GRNDACC) and Broadband Ground Velocity (GRNDVEL) from broadband seismometers.

Additional information regarding the similar products can be found in OOI Data Product Specifications for GRNDACC (DCN 1341-00100) and GRNDVEL (DCN 1341-00090).

## 2.3 Instruments

For information on the instruments from which the L1 Short period Ground Velocity (SGRDVEL) core data product inputs are obtained, see the OBSSP Processing Flow document (DCN 1342-00110). This document contains information on the instrument class and make/models; it also describes the flow of data from the OBSSP instruments through all of the relevant QC, calibration, and data product computations and procedures.

OBSSP instruments are deployed on the RSN system at Hydrate Ridge (PN1B, Hydrate Summit) and Axial Volcano (PN3B, Axial Caldera). There will be three orthogonal Short Period Seismometers in the system, one oriented vertically, and two oriented horizontally.

Please see the Instrument Application in the SAF for specifics of instrument locations and platforms.

## 2.4 Literature and Reference Documents

The electronic files of the reference documents are stored on Alfresco under REFERENCE>Data Product Specification Artifacts (1341-00110\_SGRDVEL).

<a href="http://www.seiscomp3.org/wiki/doc/applications/seedlink">http://www.seiscomp3.org/wiki/doc/applications/seedlink</a>	Seedlink Manual
slink2orb.1.pdf	slink2orb man page
orbserver.5.pdf	orbserver interface man page
dbbuild.5.pdf	Antelope dbbuild parameter file description
packets.5.pdf	Antelope packet description
dm24_mk3.pf.pdf	Datalogger configuration description
css30.pdf	css3.0 schema description
tar_data	tar file of test data

<http://www.guralp.com/fir-filter-configuration-of-the-cmg-dm24-mk3/> Guralp fir filters (This file is not stored in Alfresco. Please consult the website directly.)

Of Poles and Zeros: Fundamentals of Digital Seismology (Modern Approaches in Geophysics) by F. Scherbaum. Publisher: Springer; 2nd edition (January 19, 2007). Language: English. ISBN-10: 0792368355 ISBN-13: 978-0792368359

## 2.5 Terminology

### 2.5.1 Definitions

Definitions of general OOI terminology are contained in the Level 2 Reference Module in the OOI requirements database (DOORS). The following terms are defined here for use throughout this document.

**Transfer Function** - A transfer function is a mathematical representation, in terms of temporal frequency, of the relation between the input and output of a linear time-invariant system with zero initial conditions and zero-point equilibrium.

**Poles and Zeros** – solutions for Laplace's transform in a linear time-invariant system.

**FIR Filter** - a finite impulse response (FIR) filter is a filter whose impulse response (or response to any finite length input) is of finite duration, because it settles to zero in finite time.

**Sensor Sensitivity** – Nominal conversion factor from ground velocity in the middle of the seismometer passband to Volts.

**ADC** – Analog to Digital Converter, hardware that provides a conversion at a specified rate and bit-depth. For example in this case, the analog signal will be digitized by the Guralp DM24S3EAM at 24-bit resolution at 1000 Samples per second.

### 2.5.2 Acronyms, Abbreviations and Notations

General OOI acronyms, abbreviations and notations are contained in the Level 2 Reference Module in the OOI requirements database (DOORS).

## 3 Theory

### 3.1 Description

The complete transfer function of a seismometer is provided by the manufacturer. The complete transfer function of the seismometer is specified by a set of poles and zeros.

The seismometer output is digitized by an ADC. An example of a seismometer transfer function is shown in Figure 1. Please refer to Scherbaum (2007) if more details are needed.

The ADC converts the analog voltage output from the seismometer into a digital stream at a maximum rate of 1000 samples per second (sps) with a resolution of 24-bits. This digital binary stream will represent the time-series seismic velocity at the seismometer. The output of the ADC will be passed through a cascade of FIR filters to achieve the desired sample rate. In the case of the SGRDVEL sensor, it will produce data streams at 200 sps, 40 sps, and 1 sps. Please refer to Scherbaum (2007) if more details are needed.

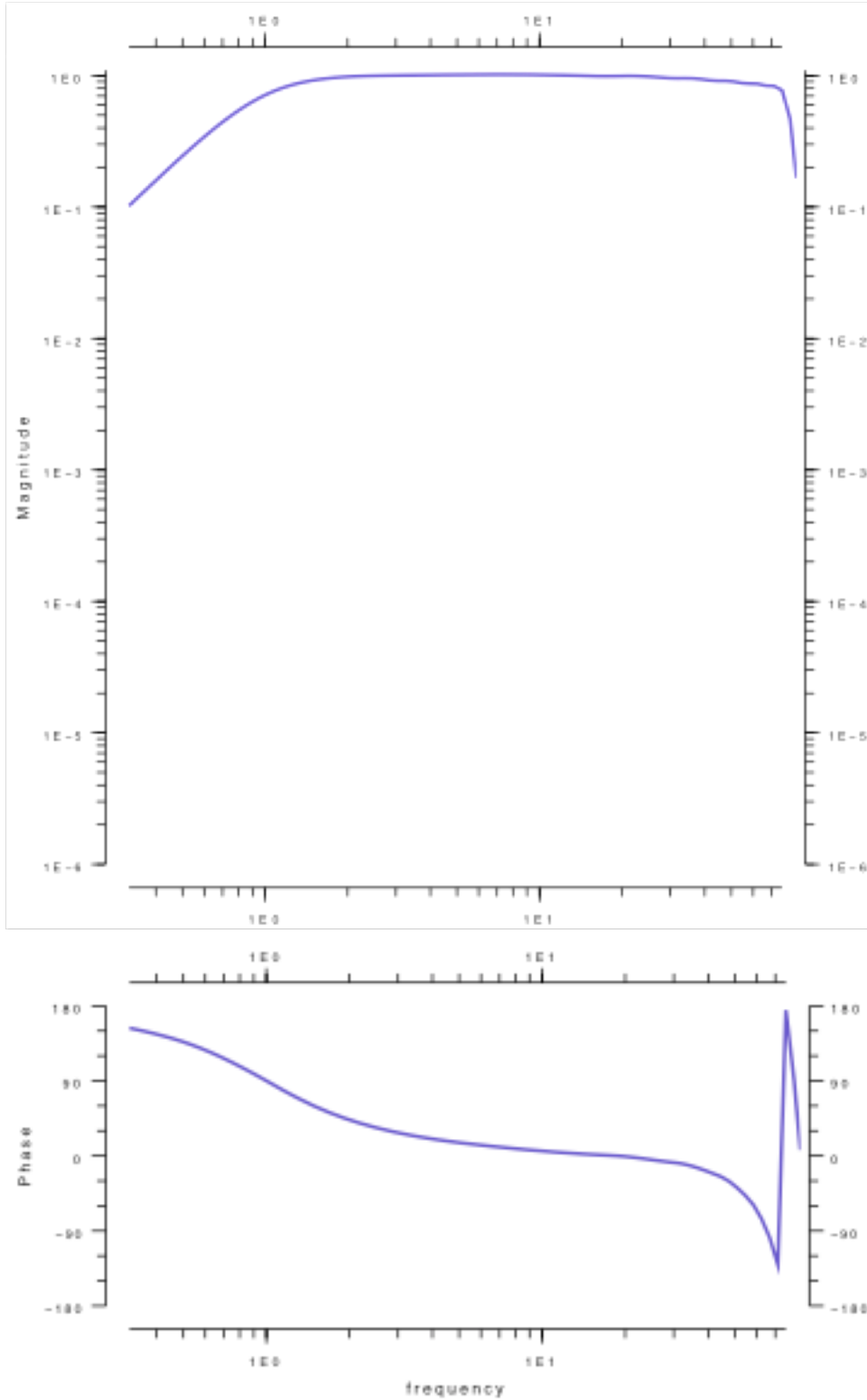


Figure 1. Typical Seismometer Response Curve

### 3.2 Mathematical Theory

Please refer to Scherbaum (2007)



### 3.3 Known Theoretical Limitations

None.

### 3.4 Revision History

No revisions to date.

## 4 Implementation

### 4.1 Overview

The output of the OBSSP instruments includes the seismic data and is formatted for transmission via SEEDlink protocol and diverted by the US Navy for inspection using Antelope Orb. After Navy inspection of the data, it is returned, with its time-stamps, to the OOI ION system for storage. Some data may not be returned, for security reasons. The output of the OBSSP instrument comprise SEED blockettes using the SEEDlink protocol. Data are acquired using slink2orb, which takes SEEDlink packets and inserts into an import BRTT Antelope Orb in the US Navy data diversion switch and is not accessible to OOI. Data are exported from the US Navy data diversion switch from another Orb that makes these data available to the OOI. The original SEED blockettes (L0 data) can be pulled from the above mentioned export orb and converted to standard OOI format for L1 data.

All reference documents are listed in section 2.4 above.

This is the same data stream process as for the broadband ground acceleration, broadband ground velocity and low frequency acoustic pressure waves data products. See OOI Data Product Specifications for GRNDACC (DCN 1341-00100), GRNDVEL (DCN 1341-00090) and HYDAPLF (DCN 1341-00821) for additional details.

### 4.2 Inputs

Inputs are: Miniseed packets acquired from an Antelope Orbserver.  
Dbbuild parameter file for metadata

Input Data Format

- See observer.5.pdf, packets.5.pdf, css3.0.pdf, and the SEED manual referenced in Section 2.4

### 4.3 Processing Flow

The specific steps necessary to create all calibrated and quality controlled data products for OBSSP core instruments are described in the instrument-specific Processing Flow documents (DCN 1342-00110). These processing flow documents contain flow diagrams detailing all of the specific procedures (data product and QC) necessary to compute all levels of data products from the instrument and the order in which these procedures occur.

The processing flow for the broadband seismogram computation is as follows:

1. Build seismic metadata using command  
***dbbuild -b rsnsp rsnsp-dbbuild***
2. Generate dataless seed using command  
***mk\_dataless\_seed rsnsp***
3. Send *rsnsp\_dataless\_seed* to IRIS Data Management Center
4. Establish connection to diversion switch export orb at *ip\_address:port\_number*
5. Write data to disk using command  
***orb2wf -dbm dbmaster/rsnsp ip\_address:port\_number rsnsp***

## 4.4 Outputs

The output of the calibration computation is

- L1 SGRDVEL Time-series in meters/sec
- Attachment – dataless seed file named `rsnsp_dataless_seed`

See Appendix B for a discussion of the accuracy of the output.

Automated QC algorithms are performed using range checks, which will generate QC flags for SGRDVEL (see DCN 1342-00110 Data Processing Flow Diagram for OBSSP).

## 4.5 Computational and Numerical Considerations

### 4.5.1 Numerical Programming Considerations

These codes and APIs depend on the Antelope software.

### 4.5.2 Computational Requirements

Linux platform with Antelope installed

## 4.6 Code Verification and Test Data Set

Gain = 1500 Volts/meter/sec \* 787401.57 counts/volt;

- 1) Untar the file `tar_data`
- 2) Cd data
- 3) Run program `trsample` to show L0 data values for first 10 data points

```
trsample -T -n 10 rsn
```

```
SUM1 LHZ 10 (calib=0.503809) 1/15/2013 (015) 0:00:00.000
```

```
1/15/2013 0:00:00.000 3371
```

```
1/15/2013 0:00:01.000 3113
```

```
1/15/2013 0:00:02.000 2378
```

```
1/15/2013 0:00:03.000 2130
```

```
1/15/2013 0:00:04.000 2649
```

```
1/15/2013 0:00:05.000 3419
```

```
1/15/2013 0:00:06.000 2988
```

```
1/15/2013 0:00:07.000 2382
```

```
1/15/2013 0:00:08.000 2413
```

```
1/15/2013 0:00:09.000 2627
```

- 4) Run program `trsample` to show L1 data values for first 10 data points in units of nanometers/sec

```
palapa% trsample -c -T -n 10 rsn
```

```
SUM1 LHZ 10 (calib=0.503809) 1/15/2013 (015) 0:00:00.000
```

```
1/15/2013 0:00:00.000 1698.339444574
```

1/15/2013 0:00:01.000 1568.356775722  
1/15/2013 0:00:02.000 1198.057312132  
1/15/2013 0:00:03.000 1073.11273122  
1/15/2013 0:00:04.000 1334.589495306  
1/15/2013 0:00:05.000 1722.522266686  
1/15/2013 0:00:06.000 1505.380676472  
1/15/2013 0:00:07.000 1200.072547308  
1/15/2013 0:00:08.000 1215.690619922  
1/15/2013 0:00:09.000 1323.505701838

**Appendix A**      **Example Code**

N/A

## **Appendix B            Output Accuracy**

The time-series voltage is digitized at 24-bits resolution, and has an accuracy of better than 1 / (1500 Volts/meter/sec \* 787401.57 counts/volt.)

The following requirements in the DOORS database describe short period ground velocity requirements:

Short Period seismic measurements shall be time stamped to an accuracy of 100 microseconds //UTC.

Short period seismic measurements shall be calibrated to an accuracy of 5% in all frequencies in the pass band.

Short period seismic measurements shall be calibrated to a precision of 0.1% in all frequencies in the pass band.

**Appendix C      Sensor Calibration Effects**

None.