

Ventana Control System Upgrade

System Requirements Specification

Subject: *This document defines the navigation, control and interface capabilities of the Ventana Control System.*

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Revision History

Revision 007

<i>Revision</i>	<i>Initials</i>	<i>Date</i>	<i>Comments</i>
001	jdr	2014/08/15	Standard Greensea control system requirements
002	jdr	2014/10/12	Addition of Ventana requirements
003	Bwk	2014/10/14	Review
004	jdr	2014/10/14	Cleanup
005	jdr	2014/10/14	Additional clarifications, traceability matrix added
006	jdr	2014/11/21	Updates following face to face discussion at MBARI
007	Jdr	2014/12/08	Updates to prepare for CDR

Table 1: Revision history

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1 Introduction

This requirements specification is based on the standard capability of the Greensea ROV control system, extended with requirements defined by MBARI that are unique to the Ventana control system. Greensea's control systems are built on the Open Software and Equipment Architecture (openSEA). This technology has been developed and matured over the past eight years by Greensea and provides a fully integrated ROV control and navigation system capability.

This document defines the complete set of functional requirements that the control system must meet. It also identifies the external interfaces between Greensea software and both external software and hardware. More detail on interfaces will be found in the Ventana Control System ICD, which is still in development. The MBARI produced Ventana Control System Upgrade requirements document and IO map further define the implementation details that will be followed in developing this control system product.

1.1 Purpose and Scope

The purpose of this Software Requirements Specification (SRS) is to provide a detailed description of the functional requirements for the Ventana Control System. Where appropriate, this document details what the system must accomplish and not specifically how it will do so.

This document is intended to be used as an agreement between MBARI and Greensea on the functionality of the final deliverable. It will also be used to define the scope of the Quality Assurance process. In addition to defining the required software functionality, this document also specifies or references the hardware and software interfaces.

Each requirement is designated with a unique number in the format of "RXXX.YYY". The XXX is the revision in which the requirement was last modified and the YYY is a project-unique number to track the requirement.

1.2 Deliverables

MBARI PO 1411162 covers preliminary and final design reviews and supporting documentation only. Additional deliverables such as software and source code will be defined in a subsequent contract.

1.3 Project Information

<i>Project Information</i>	
Project Title	Ventana Control System Upgrade
Project Number	302114
Customer	MBARI
Customer Contracts POC	Thomas Dawe
Customer Technical POC	Mike Risi
Project Manager	Joel Richter
Project PO	1411162
Greensea Proposal	201714-003
Security	Corporate Confidential

Table 2: Greensea internal project information

1.4 References

- Ventana Control System Upgrade document, revised 9/15/2014, provided by MBARI
- Ventana IO Map, revised 9/30/2014, provided by MBARI

2 Overview

This document defines the Greensea ROV control system software requirements, extended as necessary to meet the intent of the Ventana Control System Upgrade document provided by MBARI. The general configuration of the Ventana topside architecture is shown in Illustration 1 and the subsea architecture is shown in Illustration 2 on the following pages. The requirements of the control system are broken down into general categories of navigation, control, devices and the overall workspace integration.

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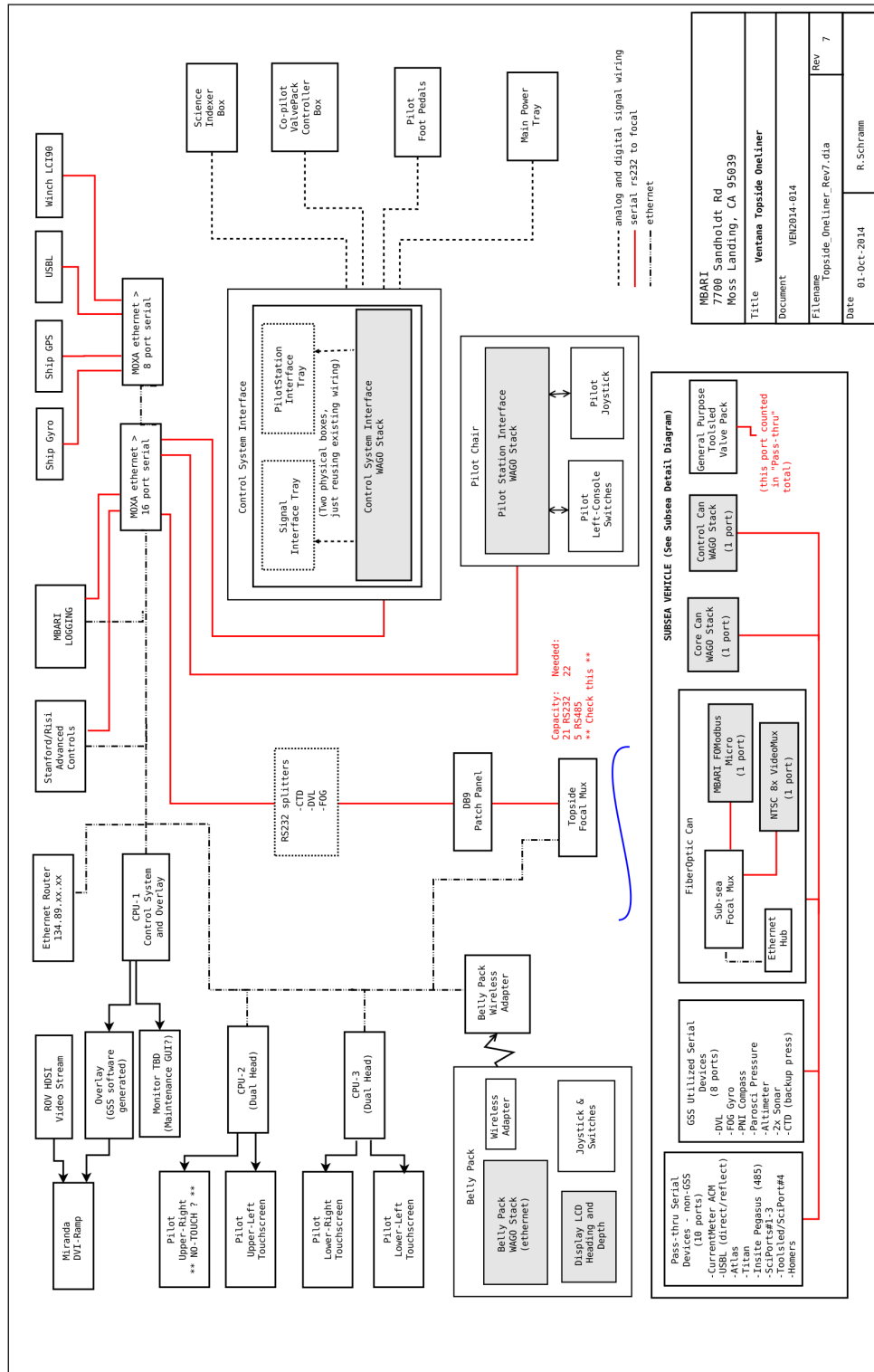


Illustration 1: Topside Architecture

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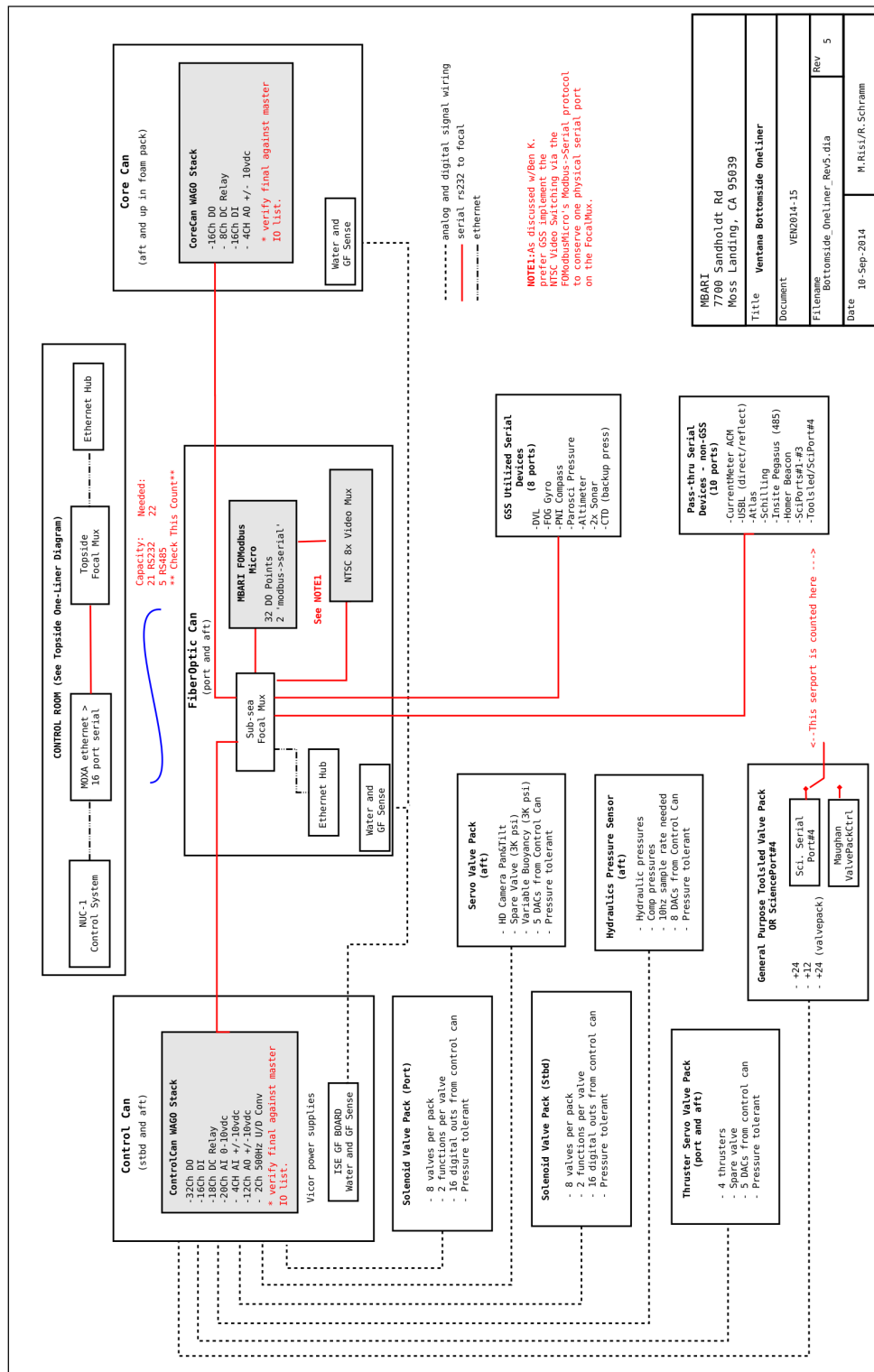


Illustration 2: Subsea Architecture

3 Requirements

The requirements for the Ventana Control System (VCS) have been allocated down to 4 subsystems: navigation, control, devices and general workspace integration. Those sections follow.

3.1 Navigation

The navigation capabilities of the control system are dependent on the available sensors to provide navigation data input. The following requirements define the full range of supported sensor types and a navigation capabilities when all sensor types are present and functional.

3.1.1 Interfaces

- R001.101 VCS will accept an ROV velocity input from a Doppler Velocity Log.
- R001.102 VCS will accept an ROV position input from GPS and USBL.
- R001.103 VCS will accept an ROV depth input.
- R001.104 VCS will accept an ROV altitude.
- R001.105 VCS will accept an ROV heading input.
- R003.106 VCS will accept an attitude, acceleration and/or rotational rate inputs from an IMU or AHRS as available.
- R001.141 VCS will accept a ship heading input.
- R001.142 VCS will accept a ship position input.
- R002.151 VCS will accept a winch payout input in the Measurement Technology Northwest protocol for the LCI90i. The raw message rate of 20 Hz will be averaged and displayed in the UI at 2 Hz. The format is:
RD,-TTTTT.TT-SSSS.SSS,-PPP.PPP,CCCC<cr><lf>
(T=tension,S=speed,P=payout,C=checksum), and checksum is not validated.
- R007.152 VCS will output a serial stream at one Hz with user-defined navigation parameters in ASCII CSV format. In addition, every 10 seconds # followed by text of column headings will be published.
- R005.153 VCS will accept an ROV depth measurement from the USBL input.

3.1.2 Functions

The performance of the Ventana Control System navigation system depends on the type and quality of sensor inputs. Position or velocity input is required to output an absolute position. Otherwise the output will be based on any of the available measurements: heading, pitch, roll, depth and altitude. Rates are also available with suitable sensor inputs.

- R001.201 VCS will use available navigation sensor inputs to calculate an ROV navigation solution that includes the following parameters: heading, pitch, roll, depth, altitude, latitude, longitude. This navigation solution utilizes Kalman filtering to provide a best estimate of position from available sensor data.
- R007.202 VCS will use available topside sensor inputs to utilize and display the topside position and heading.

- R001.203 VCS will display ROV and ship heading in a compass rose graphic along with a trail of past heading values. In addition, pitch and roll will be displayed on an artificial horizon.
- R001.204 VCS will display depth and altitude on a vertical plot along with a trail of past depth and altitude values.
- R001.205 VCS will provide the ability to add and configure supported sensors.
- R001.206 VCS will provide diagnostic information for the types of sensors shown in the table below:

<i>Sensor Type</i>
GPS
USBL
DVL
IMU
Compass
Depth
Altimeter

Table 3: Sensor types with diagnostic capabilities

- R001.207 VCS will load charts and other geographic images onto the map.
- R001.208 VCS will apply deviation from true north to heading measurements. This can be based on user selected or automatically calculated value of deviation.
- R001.209 VCS will allow the user to measure distance on the map.
- R001.210 VCS will allow the user to mark positions of interest on the map.
- R003.251 VCS will calculate depth using pressure and latitude based on the algorithm in Saunders and Fofonoff Deep Sea Research 1976,23,109-111.
- R002.252 VCS will calculate and display velocity in all three axes.
- R006.253 VCS will provide a ROV to ship relative turns counter. The turns counter will allow both reset and manual input of turns value in case of system reboot or other contingency.
- R002.254 VCS will allow user configuration of the duration of heading, depth and altitude trails displayed. The default value will be 120 seconds.
- R002.255 VCS will display clump depth from cable_out minus a user-set clump_delta.

3.2 Vehicle Control

The VCS control system allows the ROV pilot to provide direct control inputs to the vehicle as well as implementing autopilot functionality. A physical definition of the ROV is required in order to implement the thrust mixing program. Required information is the location, orientation and force curve for each thruster.

3.2.1 Interfaces

- R003.301 VCS will interface with vehicle thrusters to provide control signals.

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- R001.302 VCS will accept a thrust curve for each vehicle thruster in order to linearize thruster response to command inputs.
- R002.351 VCS will interface with the Pilot Station Interface via RS232 MODbus in accordance with the signals defined in the Ventana IO Map spreadsheet.
- R002.352 VCS will interface with the Belly Pack via TCP MODbus in accordance with the signals defined in the Ventana IO Map spreadsheet.
- R002.353 VCS will interface with the Control System Interface via RS232 MODbus in accordance with the signals defined in the Ventana IO Map spreadsheet.
- R002.354 VCS will respond to control signals provided by MBARI software provided they comply with the openCMD Interface Control Document. These control signals will be summed with pilot joystick inputs prior to acting on them.
- R002.355 VCS will provide a mechanism to switch between responding to native control signals and those provided by MBARI software.
- R004.356 VCS will accept an external navigation solution provided by MBARI software that complies with the openINS Interface Control Document.
- R004.357 VCS will provide a mechanism to switch between the openINS navigation solution and that provided by MBARI software.
- R006.358 VCS will disable input from the vertical slide for depth control when in auto depth mode.

3.2.2 Functions

- R001.401 VCS will translate pilot inputs via an input device (physical console or software) into thruster commands when in open-loop mode.
- R007.402 VCS will provide heading autopilot. The mode is activated and deactivated by a physical latching button on the pilot chair. When in heading mode, joystick inputs to change heading will result in a change in the heading set point.
- R006.403 VCS will provide depth autopilot. The mode is activated and deactivated by a physical latching button on the pilot chair. The analog input for depth must be disabled when in auto depth mode and the control is via a digital rocker switch. The change in set point is 0.1 meters per click.
- R006.404 VCS will provide altitude autopilot. The mode is activated and deactivated by a physical latching button on the pilot chair. The analog input for depth must be disabled when in auto altitude mode and the control is via a digital rocker switch. The change in set point is 0.1 meters per click.
- R006.405 VCS will provide station keeping and go-to position capability.
- R006.406 VCS will provide a waypoint mode with the capability to travel to a series of waypoints specified as latitude and longitude.
- R006.407 VCS will display thruster effort on a graphic representing the ROV configuration and thruster locations. Vertical thruster RPM will also be displayed numerically.
- R006.408 VCS waypoint mode will allow the pilot to specify either speed or effort to maintain when traveling to a waypoint.

- R006.409 VCS waypoint mode will allow the pilot to specify the vehicle heading be controlled to point toward the next waypoint or remain in manual or auto heading control.
- R006.410 VCS waypoint mode will allow the pilot to specify the vehicle depth or altitude to be reached at every waypoint or remain in manual or auto depth/altitude control.
- R006.411 VCS will provide stick lock mode which maintains the output of the three joystick axes when engaged. Further joystick movement when in stick lock mode is summed with the locked values. This mode is activated and deactivated by a physical latching button on the pilot chair.

3.3 ROV Device Interfaces

OpenSEA provides the capability to read and transmit digital and analog signals. The typical purpose of these signals is to actuate valves and relays and read sensor values. Many devices that provide digital outputs and analog outputs are supported and new devices can be easily added to Greensea's extensive library. Greensea also has a large library of serial and Ethernet device interface programs and can integrate almost any device into openSEA upon request.

- R001.501 VCS will provide a means to receive digital and analog inputs.
- R001.502 VCS will enable the user to label, organize and visualize digital and analog input values.
- R001.503 VCS will provide a means to transmit digital and analog outputs.
- R001.504 VCS will enable the user to label, organize and define digital and analog output values. Buttons will be capable of triggering multiple output signals.
- R001.505 VCS will provide a means of routing general commands to a specific device by activating software or physical buttons. For example a joystick input could be directed to any one of a number of camera pan/tilt units.
- R001.506 VCS will allow software buttons to be configured as momentary or latching and to lock them in their present state so they can not be changed without first unlocking them. Group functions such as "all on" will respect the state of locked buttons and not override the lock.
- R002.551 VCS will interface with the MBARI Insite camera control software defined in <TBD-003>
- R002.552 VCS will select the ground fault channel by automatically cycling through two digital outputs at a user-selectable rate (default 2.5 seconds). The channels are:

<i>Channel</i>	<i>Circuit</i>
00	Ship 480 VAC
01	Console 120 VAC
10	Hotel 2300 VAC
11	Hydraulic 2300 VAC

Table 4: GFI channel definitions

- R002.553 VCS will communicate with the ROV Control Can via RS232 MODbus in accordance with the Ventana IO Map spreadsheet.
- R002.554 VCS will communicate with the ROV Fiber Optic Can via RS232 MODbus in accordance with the Ventana IO Map spreadsheet.

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- R002.555 VCS will communicate with the ROV Core Can via RS232 MODbus in accordance with the Ventana IO Map spreadsheet.
- R002.556 VCS will communicate with the ROV NTSC Video Mux via the MODbus to serial conversion on the FOModbus Microcontroller. Microcontroller interface information is <TBD-005>. Mux interface is defined in the Video Switch Interface Guide, 6/30/2004.
- R002.557 VCS will provide an “enable” function that allows analog values to be set without transmitting them, and transmitting once the function is enabled.
- R002.558 VCS will display two axis analog values on a single graphic to visualize parameters such as camera pan/tilt position.
- R002.559 VCS will provide a grouping capability for digital outputs such that a maximum of one item from a group can be selected at a time.
- R002.560 VCS will monitor telemetry for loss of communications with the vehicle and after a user-selectable time, set a digital output in the Control System Interface that will be wired to cut all hydraulic power.
- R006.561 VCS will interface with the Mini Zeus (Sony) Camera to transmit zoom and focus commands. Any other commands sent to this camera are <TBD-008>.
- R006.562 VCS will use the state of a set of digital inputs from a selector knob on the pilot chair to determine which camera should receive commands.
- R006.563 VCS will select the subsea ground fault channel by cycling through digital outs to monitor each channel at a user-selectable rate (default 2.5 seconds) per the channels defined in the IO Map.
- R007.564 VCS will allow the user to define control loops gains for the camera pan/tilt system from the user interface.

3.4 Workspace Integration

3.4.1 General Functions

- R001.601 VCS will allow logging all system data to a file for later playback or export.
- R001.602 VCS will allow playback of previously recorded logs.
- R001.603 VCS will allow export of logged data to a comma separated variable file format.
- R001.604 VCS will provide a diagnostic tool to view and plot all system data.
- R001.605 VCS will support a distributed architecture with multiple synchronized instances of the user interface.
- R007.606 VCS will provide a video overlay stream via a DVI output with a compass strip at the top of the display and the ability to insert text and values from any signal in the control system to any location in a grid on the screen. User-entered text from the user interface will also be available to insert in the overlay.
- R005.607 VCS will provide a <TBD-006> method of organizing and archiving configuration data files. Under <TBD-007> conditions, modifying configurations will be restricted.
- R005.608 VCS will run on the 32 bit Debian Wheezy operating system with the KDE desktop environment.

- R005.609 VCS will interface with serial devices through Moxa serial server products.
- R006.610 VCS will use PST/PDT <TBR-003> as the standard time zone wherever time information is used or displayed.
- R006.611 VCS will provide resource utilization statistics on each computing node it runs on.

3.4.2 Alarm Manager

The alarm manager allows specific events to prompt a visual warning to the pilot. In simple cases this is used to trigger warnings for events such as ground fault or leak being detected. In combination with the signal mapper, complex, multi-input cases can be monitored.

- R001.621 VCS will provide an alarm manager that can trigger based on a logical comparison with any signal in the system data.
- R001.622 VCS will allow selection of alarm severity to affect how the alarm is displayed.
- R001.623 VCS will record a history of past alarm events.
- R001.624 VCS will change an alarm event's state when the operator has acknowledged the alarm.
- R006.625 VCS will require confirmation before accepting any change to an existing alarm.

3.4.3 Signal mapper

The signal mapping function enables the user to control many key features of the control system. In the simplest implementation it is the mechanism to take a button press or joystick position on an input device and route that to a command signal for the control system to act upon. More complicated implementations allow mode switching through the use of profiles to modify mapping behavior during operations. Transforms can also be applied to scale analog inputs to meaningful values such as converting an analog 16 bit integer into a pressure in PSI.

- R001.631 VCS will provide a feature to map any signal on an input channel to a new signal on a different output channel.
- R007.632 VCS signal mapper will support profiles which allow switching between output channels or changing scaling during operation.
- R001.633 VCS signal mapper will allow the triggering of an output based on logical comparisons.
- R001.634 VCS signal mapper will allow the transforming of values based on first order math functions.
- R002.635 VCS signal mapper will allow the transforming of values based on trigonometric and inverse trigonometric functions.
- R006.636 VCS signal mapper will require confirmation before accepting any change to an existing mapping.

4 Testing and Qualification

Greensea will perform QA testing to verify all requirements in this document have been closed prior to customer delivery.

5 Open Work

5.1 To Be Determined (TBD)

TBD Number	Description
TBD-003	Need to receive ICD for the Insite camera control software
TBD-005	Information on the MODbus to serial conversion performed by the FOModbus microcontroller.
TBD-006	Proposal for configuration file management will be provided at CDR
TBD-007	Proposal for configuration file management will be provided at CDR
TBD-008	Waiting for MBARI to send requested Mini Zeus camera initialization command sequence. May implement depending on complexity.

Table 5: Summary of To Be Determined Items in the Document

5.2 To Be Resolved (TBR)

TRD Number	Description
TBR-003	All system clocks need to be set to the same time zone. Should this be PST/PDT?

Table 6: Summary of To Be Resolved Items in the Document

6 Requirements Traceability Matrix

MBARI Rqmt	Greensea Rqmt	Notes	Updated
2	Heading Only		Y
2.1	R.608		
2.2	Heading Only		Y
2.2.1	Software License		
2.2.2	Software License		
2.2.3	Software License		
2.2.4	Software License		
2.3	Heading Only		Y
2.3.1	New Contract	Greensea needs to define 1 year software support period in some contractual document with MBARI	
2.3.2	New Quote	Greensea needs to provide quote for annual support package.	
2.3.3	New	Greensea needs to define source code, libraries and physical media deliverables for	

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MBARI Rqmt	Greensea Rqmt	Notes	Updated
	Contract	MBARI	
3	Heading Only		Y
3.1	Heading Only		Y
3.1.1	R.607		
3.1.2	R.607		
3.1.3	Delete?	We have a multi-user architecture where all user interface applications see the same system data and any can send control signals they are configured to send. It is inherently non-conflicting because critical control elements are only installed and configured on a single computer.	
3.1.4	R.607		
3.1.5.1	See 3.1.5.X		Y
3.1.5.1	R.351		
3.1.5.2	R.352		
3.1.5.3	R.353		
3.1.6	See 3.1.6.X		Y
3.1.6.1	R.553		
3.1.6.2	R.554		
3.1.6.3	R.555		
3.1.6.4	R.556		
3.1.7	R.560		
3.1.8	R.601, 604		
3.1.9	R.152		
3.1.10	R.302		
3.1.11	R354, 355		
3.1.12	R.606		
3.1.13	R.251		
3.1.13.1	R.251		
3.1.13.2	R.631, 632		
3.1.13.3	R.634		
3.1.13.4	Delete?	Can we not just use ROV or ship latitude, does this have to be set independently?	
3.1.13.5	R.607		
3.1.13.6	Intrinsic	Every system parameter including these is logged	
3.1.14	See 3.1.14.X		Y
3.1.14.1	R.151		
3.1.14.2	R.151		
3.1.14.3	R.151		
3.2	Heading Only		Y

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MBARI Rqmt	Greensea Rqmt	Notes	Updated
3.2.1	R.605	Need to verify MBARI selected touch screen is supported by Debian.	
3.2.2	Delete?	Each instance of the UI is independently configurable, but not all items are configurable.	
3.2.3	Delete?	The Greensea UI takes a different approach to configuration by the user.	
3.2.4	R.606		
3.2.4.1	R.607		Y
3.2.4.2	Delete	Per discussion with MBARI on 11/10/14	Y
3.2.5	R.501-504		
3.2.6	R.502		
3.2.7	R.504		
3.2.7.1	R.557		
3.2.8	R.502		
3.2.9	R.635		
3.2.10	Delete?	The signal mapper has tools to speed calibration, but it will still require a few steps with the trig transform.	
3.2.11	R.564	For camera control only, per discussion with MBARI on 11/10/14	
3.2.12	R.203, 253, 254		
3.2.12.1	R.105		
3.2.13.1.1	Intrinsic		Y
3.2.13.1.2	Intrinsic		Y
3.2.13.1.3	Delete	We do not typically mix USBL depth data into the navigation solution because other sensors are more accurate	Y
3.2.12.2	R.208		
3.2.12.3	R.141		
3.2.12.4	Delete?	There is only one compass rose which shows the navigation solution heading. The heading source can be switched if multiple sensors are available. Backup heading sensors can be displayed on general analog indicators.	
3.2.13	R.204, 242, 254, 255		
3.2.13.1	R.103, 153		
3.2.13.2	R.151		
3.2.14	R.631		
3.2.14.1	R.402		
3.2.14.2	R.403		
3.2.14.3	R.404		
3.2.14.4	R.405		
3.2.15	R.203, 407, 558		
3.2.16	R.504, 505,	Refer to requirement during setup of signal mapper	

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MBARI Rqmt	Greensea Rqmt	Notes	Updated
	559		
3.2.17	R.504, 505, 559	Refer to requirement during setup of signal mapper	
3.2.18	Moved by MBARI		
3.2.19	R.407	Refer to requirement during setup of signal mapper	
3.2.20	R.206, 621, 623	Refer to requirement during setup of alarm manager	
3.2.21	R.551		
3.2.22	R.503, 504, 506		
3.2.23	R.621, 622, 623, 624	Refer to requirement during setup of alarm manager	
3.3	R.354, 356		
3.3.1	R.354		
3.3.2	R.356	Refer to requirement during setup of signal mapper	
3.3.3	R.355	Refer to requirement during setup of signal mapper	
4	Description only		Y
5	Heading Only		Y
5.1	Heading Only		Y
5.1.1		Refer to requirement during setup of signal mapper	Y
5.2	Heading Only		Y
5.2.1		Interlock implemented in electronics, not software	Y
5.2.2		Assume DO is set for as long as telemetry is lost	Y
5.2.3	R.552		Y
5.2.4		Refer to requirement during setup of signal mapper	Y
5.2.5	R.563		Y
5.2.6		Refer to requirement during setup of signal mapper	Y
5.2.7		Refer to requirement during setup of signal mapper	Y
5.3	Heading Only		Y
5.3.1	Deleted by MBARI		Y
5.3.2		Refer to requirement during setup of signal mapper	Y
5.3.3		Refer to requirement during setup of signal mapper	Y
5.4	Heading Only		Y
5.4.1		Refer to requirement during setup of signal mapper	Y

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MBARI Rqmt	Greensea Rqmt	Notes	Updated
5.4.1.1		Refer to requirement during setup of signal mapper	Y
5.4.1.2		Refer to requirement during setup of signal mapper	Y
5.4.1.3		Refer to requirement during setup of signal mapper	Y
5.4.1.4		Refer to requirement during setup of signal mapper	Y
5.4.2		Refer to requirement during setup of signal mapper	Y
5.4.2.1		Refer to requirement during setup of signal mapper	Y
5.4.2.1		Refer to requirement during setup of signal mapper	Y
5.4.2.2		Refer to requirement during setup of signal mapper	Y
5.4.2.3		Refer to requirement during setup of signal mapper	Y
5.4.2.4		Refer to requirement during setup of signal mapper	Y
6	Heading Only		Y
6.1	Heading Only		Y
6.1.1	Intrinsic		Y
6.1.2	R.402		Y
6.1.3	R.632		Y
6.1.4		Refer to requirement during setup of signal mapper	Y
6.1.5	R.505	Refer to requirement during setup of signal mapper	Y
6.1.6	R.505	Refer to requirement during setup of signal mapper	Y
6.1.7	R.505	Refer to requirement during setup of signal mapper	Y
6.1.8	R.632		Y
6.2	Heading Only		Y
6.2.1		Refer to requirement during setup of signal mapper	Y
6.2.2		Refer to requirement during setup of signal mapper	Y
6.2.3		Refer to requirement during setup of signal mapper	Y
6.2.4		Refer to requirement during setup of signal mapper	Y
6.2.5		Refer to requirement during setup of signal mapper	Y
6.3	Heading Only		Y
6.3.1	R.358		Y
6.3.2		Refer to requirement during setup of signal mapper	Y
6.3.3		Refer to requirement during setup of signal mapper	Y
6.3.4		Refer to requirement during setup of signal mapper	Y
6.4	Heading Only		Y
6.4.1		Refer to requirement during setup of signal mapper	Y
6.4.2		Refer to requirement during setup of signal mapper	Y
6.4.3		Refer to requirement during setup of signal mapper	Y

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MBARI Rqmt	Greensea Rqmt	Notes	Updated
6.4.4		Refer to requirement during setup of signal mapper	Y
6.4.5		Refer to requirement during setup of signal mapper	Y
6.4.6	R.403	Modification: do not speed up jog rate if switch is held down, user can type in new depth value if a large change is desired. Refer to requirement during setup of signal mapper	Y
6.4.7		Refer to requirement during setup of signal mapper	Y
6.4.8		Refer to requirement during setup of signal mapper	Y
6.4.9		Refer to requirement during setup of signal mapper	Y
6.4.10	ICD 3.3.4.8- 3.3.4.10	Refer to requirement during setup of signal mapper	Y
6.4.11		Refer to requirement during setup of signal mapper	Y
6.1.12		Refer to requirement during setup of signal mapper	Y
6.4.13		Refer to requirement during setup of signal mapper	Y
6.4.14		Refer to requirement during setup of signal mapper	Y
6.4.15	ICD 3.3.4.8- 3.3.4.10	Refer to requirement during setup of signal mapper	Y
6.4.16		Refer to requirement during setup of signal mapper	Y
6.4.17		Refer to requirement during setup of signal mapper	Y
6.4.18		Refer to requirement during setup of signal mapper	Y
7	Description only		Y
8	Description only		Y

Table 7: Requirements Traceability Matrix to MBARI-provided Ventana Control System Requirements

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