Bluefin SandShark™ Autonomous Underwater Vehicle

Payload Interface Control Document (ICD)

Bluefin Document: 000-020-764

Revision: B

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Revision History

Revision	ECO	Description	Incorporated	
			Date	Initials
A	3261	Initial Release	3/20/2017	ARU
B	3358	Addition of Standard Dry Payload Info	7/10/2017	ECK

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1.0. SCOPE

This document provides a description of the electrical, mechanical, and software interface between a Bluefin SandShark™ Tail Section and a user-defined payload. This document is intended to be used by a payload integrator, for guidance during payload design. Adhering to the interface specifications herein is critical to successful payload integration.

1.1 System Overview

The Bluefin SandShark™ system is composed of a wetside component – the Bluefin SandShark™ AUV – and a topside component – the mission support equipment. Figure 1 presents a system block diagram.

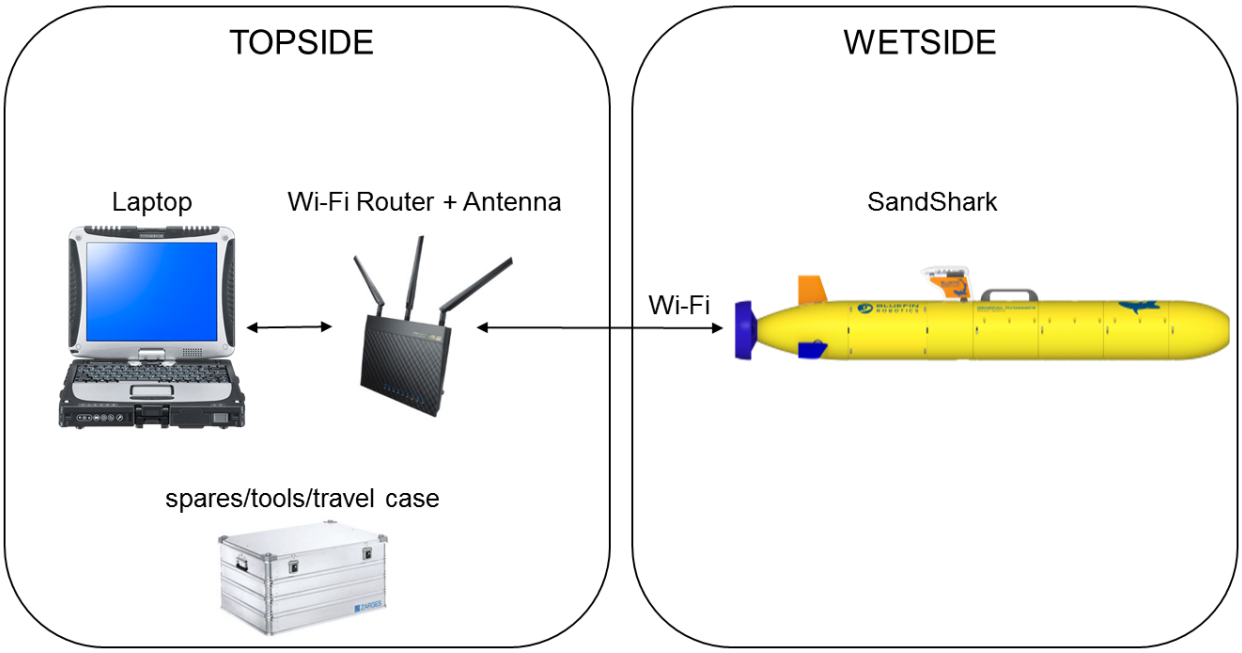

Figure 1 – Bluefin SandShark™ AUV System Block Diagram

The Bluefin SandShark™ system is designed to be a flexible, low-logistics, cost efficient AUV for rapid technology development. The 4.875in diameter, single-man portable vehicle is designed to operate in depths up to 656ft (200m). The vehicle currently runs the Bluefin Huxley software suite. Huxley is Bluefin's proprietary software suite with over 12 years of development, a published "Standard Payload Interface", and capabilities to match the needs of military, survey, and salvage missions.

For details related to operating the vehicle, see the Bluefin SandShark™ Operations Manual (000-018-604), which is provided as part of the Customer Technical Data Package.

1.2 Document Overview

Section 1.0 provides an overview of the Bluefin SandShark™ AUV and a brief outline of the topics covered within this ICD.

Section 2.0 lists documents referenced within this ICD.

Section 3.0 provides an interface overview between the Bluefin SandShark™ and a payload.

Section 4.0 details the electrical interface between the Bluefin SandShark™ and a payload.

Section 5.0 details the mechanical interface between the Bluefin SandShark™ and a payload.

Section 6.0 details the software interface between the Bluefin SandShark™ AUV and a payload.

Section 7.0 provides definitions for words, concepts, and acronyms used within the ICD.

2.0 REFERENCED DOCUMENTS AND PRODUCTS

This section lists the number and title of all documents and products referenced in this design document. This section also identifies the source for all documents not available through normal Government stocking activities.

2.1 Reference Documents

Table 1 – Referenced Documents

Document PN	Document Title
000-020-327	Engineering Requirements for the Bluefin SandShark™ micro-AUV
000-018-604	Bluefin SandShark™ Operations Manual
000-018-605	Bluefin SandShark™ Quick Reference
000-020-763	Bluefin SandShark™ Software Design Document
000-020-900	Mechanical ICD (MICD), Payload Section, Bluefin SandShark™
000-021-858	Interface Control Drawing, Standard Dry Payload, Bluefin SandShark™

2.2 Reference Products

Please note that the Bluefin SandShark™ Motion and Control Section is more commonly referred to as the Bluefin SandShark™ Tail Section. However these terms are interchangeable and both refer to product PNs 000-019-550-01 & -02.

Table 2 – Referenced Products

Product PN	Product Description
000-019-600-01	Assembly, Vehicle, SandShark
000-019-550-01	Assembly, Motion and Control Section **(Tail Section)**
000-019-550-02	Assembly, Motion and Control Section, Machined **(Tail Section)**
000-017-515-02	Assembly, Payload, Flooded, Long, Modular
000-020-115-01	Assembly, Payload Section, Flooded, Short, Handle
000-020-115-02	Assembly, Payload Section, Flooded, Short, No Handle
000-016-632-01	Assembly, Fairing, Payload, Top
000-016-633-01	Assembly, Fairing, Payload, Bottom
000-016-631-01	Fairing, Payload, Nose
000-016-395-01	Assembly, Battery, 7S3P PCM
000-018-581-01	Assembly, Battery, 7S1P PCM
000-020-742	Penetrator, Subconn, Micro 4, MCBH4MAS, 6061-T6
000-020-412	Penetrator, Subconn, Micro 8, MCBH8FAS, 6061-T6
000-021-189	Connector, Plug, Power Loopback
000-015-032	Dummy Plug, MCDC8M, Micro-Series Connector 8 Pin, Male
21-0801-03	Screw, Pan HD Phil, Self-Sealing, .190-32 UNF-2A X .38L, 316SS
000-016-436-01	Sacrificial Anode, Zinc Alloy, .500 DIA X .188 T, #4 NOM
000-016-747-01	Ballast Weight, Brass, 1.00 Dia, 25g
000-018-053-01	Wedge, Jacking Key, Tail Section
000-020-424-01	Assembly, Control Fin, Blue
000-020-424-02	Assembly, Control Fin, Orange
000-020-422-01	Assembly, Wet Cable, Payload Comms, Short
000-020-422-02	Assembly, Wet Cable, Payload Comms, Long
000-020-809-01	Assembly, Standard Dry Payload PV
000-001-245	Electrical Insulating Compound, Dow Corning 4
000-001-461	Lubricant, Aquashield, 8oz Tube

Bluefin SandShark™ AUV

Payload ICD

SECTION 3.0: VEHICLE OVERVIEW

3.0 VEHICLE TECHNICAL OVERVIEW

This following table provides basic vehicle information, including physical size and performance.

Table 3 – Bluefin SandShark™ AUV Technical Specifications

Physical Properties	
Diameter	4.875 in (0.12 m)
Length	20.2 in (0.51 m): Tail Section only 40.7 in (1.03 m): Tail Section with 3 Flooded Payload Sections
Dry Weight	13.5 lbs. (6.1 kg)
Displaced Volume	352.09 in^3 (0.00577 $m^{3)}$
Performance Specs	
Depth Rating	656 ft (200 m)
Speed	2-4 knots (1-2 m/s)
Endurance	6 hrs @ 2.5 knots, with no payload
Control	Active roll, pitch, and heading control
Navigation	GPS, 9-axis IMU, Depth Sensor, Altimeter, DVL (Optional)
Communications	Wi-Fi 2.4 Ghz, Ethernet (See Section 4.1)
Power	
Voltage Bus	24 VBUS (22.0 – 29.4 VDC)
Battery	UN 38.3 Certified, no HAZMAT training required for ground transport when installed in vehicle.
Payload Supply	24 VBUS (22.0 – 29.4 VDC), 1.6 A nominal, 4 A maximum

Bluefin SandShark™ AUV

Payload ICD

SECTION 4.0: ELECTRICAL INTERFACE

4.0 ELECTRICAL INTERFACE

This specification describes the electrical interface between the Bluefin SandShark™ Tail Section and an attached payload. Figure 2 shows a front view of the Tail Section and labels the important interfaces for integrating a payload with the Tail Section including the payload and shore power connectors.

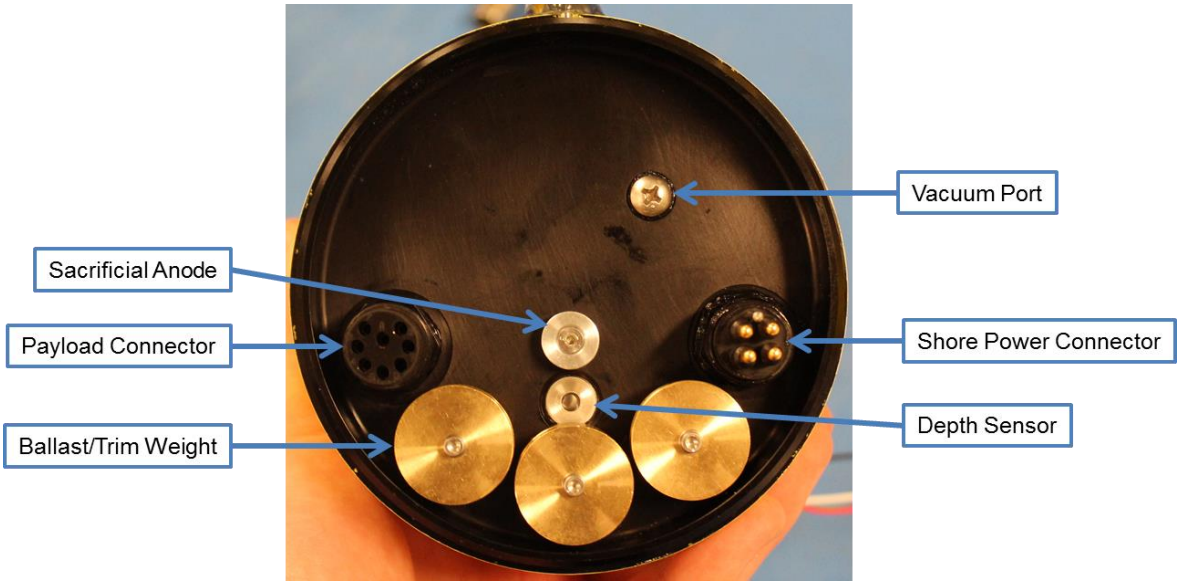

Figure 2 – Labeled Endcap, Front View

Table 4 – Electrical Specifications Quick Reference

Electrical Specs						
Subsystem	**Vmin (V)**	**Vnom (V)**	**Vmax (V)**	**Imin (A)**	**Inom (A)**	**Imax (A)**
Shore Power		24			2	
Payload Power	22	26.6	29.4	-	1.6	4
7S3P Battery	22	26.6	29.4	-	1.8	10
7S1P Battery	22	26.6	29.4	-	1.8	10
Trigger Input						
Input Voltage Range	-30 Vmin		+30 Vmax	Note: shared ground (pin 5)		
Input Threshold Low	0.6 Vmin	1.3 Vnom				
Input Threshold High		1.6 Vnom	2.4 Vmax			
Input Resistance	3 Vmin	5 Vnom	7 Vmax	kΩ		
Pulse Per Second (PPS) Output						
Output Voltage Swing (RS-232)	-10 V to 10 V			Note: shared ground (pin 5)		
Output Resistance	300 kΩ					
Short-Circuit Current (RS-232)	±11 mA					

4.1 Payload Connector

The payload connector on the Bluefin SandShark™ Tail Section provides Ethernet, power, and PPS (RS-232 level) to the payload. The connector is capable of accepting a trigger input (RS-232 level) from the payload.

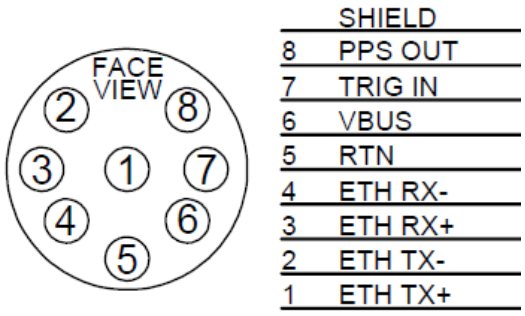

Figure 3 – Payload Connector Pinout (Female)

Figure 3 is the payload connector pinout. It is a female aluminum shell SubConn Micro Circular Series 8-Pin Bulkhead Connector, MCBH8FAS. Note that for male bulkheads connectors, the pin orientation is mirrored. Pin numbers and their respective signals are consistent, regardless of the gender of the connector. Mating connectors for the MCBH8FAS include all SubConn Micro Circular 8-pin male connectors. When not in use, this connector must be capped with the 8-pin male dummy plug, MCDC8M, before in-water operations.

4.1.1 Power

Power to the payload is provided directly from the battery; 26.6VDC nominal, 21-30 VDC range. The Bluefin SandShark™ AUV accommodates demanding payloads, supplying up to 4 Amps. Table 5 details the power supply available to the payload from the Tail Section.

Table 5 – Payload Power Supply Specifications

Component	Vmin (V)	Vnom (V)	Vmax (V)	Imax (A)	Pmax (W)
Payload	21	26.6	29.4	4	117

The vehicle and payload both run off of a common power source. Total endurance will be heavily dependent on the payload's power consumption, and the vehicle's operating speed during missions. To extend vehicle endurance, the user should consider adding a battery in the payload section. See Section 4.3 for more information on integrating a payload battery.

4.1.2 Communications

Ethernet (10/100 Mbps) communication is provided to the payload as the interface to the Tail Section.

4.1.3 Trigger Input

The trigger input can be received by the Tail Section through the payload connector, using pin 7 (TRIG IN) and pin 5 (RTN). Trigger signals received by the Tail Section from a payload should be shifted to RS-232 voltage levels, in order to maintain signal quality across the interface. The Tail Section will accept a trigger input ranging between ±30 VDC.

4.1.4 PPS Output

The Tail Section enables a 1PPS output with a 100ms pulse width positive transition. The PPS output is conditioned to output at RS-232 voltage levels, ±10 VDC. RS-232 voltage levels are used in order to maintain signal quality across the interface.

4.1.5 Payload Connector Breakout Wet Cable

GDMS offers a payload connector breakout cable (BFPN: 000-021-385), which can be plugged into the tail section payload connector to provide access to the following:

- Tail Section's Ethernet interface terminated to an RJ45 connector
- Tail Section's payload power output (pins 5 and 6) terminated to color-coded banana plugs
- Tail Section's trigger input and PPS output lines, flying leads

Custom molded wet cables can be provided upon request. Contact us[1] with information regarding your desired wet cable.

4.1.6 Payload Communications Wet Cable

GDMS offers a payload communications wet cable (BFPN: 000-020-422-01 & -02), which can be used to connect the tail section to a payload. This cable uses 4 twisted pair 22 AWG conductors and has a 1 to 1 pinout of the Tail Section payload connector. The cable is shielded however the drain wire is left disconnected on each end. There are two configurations of this cable with the only difference being the overall cable length. The -01 short configuration is ideal for connecting the Tail Section to the payload with only a single short flooded section in between the dry volumes. The -02 long configuration can be used for connecting the Tail Section to the payload with up to two short flooded sections in between the dry volumes. Please note that the -02 configuration of this cable comes with the Standard Dry Payload (BFPN: 000-020-809-01). See Section 5.3 for more details about this dry payload offering.

4.2 Shore Power Connector

The shore power connector on the Tail Section is used to charge the internal battery, or power the vehicle from an alternative source.

The Bluefin SandShark™ Starter Kit comes with a simple charging brick (BFPN: 000-021-131), which will charge the battery at 2A, but will not allow the vehicle to be powered on simultaneously. You may run the vehicle off of shore power, while charging the battery, using

[1] http://www.bluefinrobotics.com/about/contact-us/

the Bluefin smart charging power brick (BFPN: TBD). This Bluefin smart charging power brick will charge the battery at 4A. Contact us[2] for more information.

Both power bricks plug into a 120VAC outlet. When not charging or running off of shore power, this connector must be dummied with the Bluefin SandShark™ specific dummy plug (BFPN: 000-021-189, provided with tail section), in order to run. This 4-pin female dummy plug is labeled "AUV MASTER ARM", to differentiate it from standard dummy plugs.

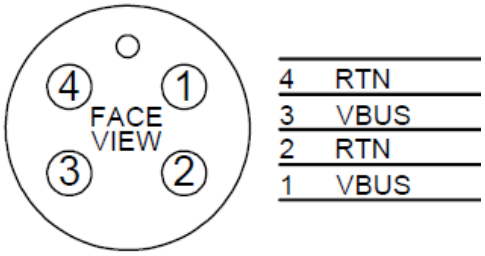

Figure 4 – Shore Power Connector Pinout (Male)

Figure 4 is the shore power connector pinout. It is a male aluminum shell SubConn Micro Circular Series 4-Pin Bulkhead Connector, MCBH4MAS. Note for female connectors, like the pigtail connector MCIL4F, the pin orientation is mirrored. Pin numbers and their respective signals are consistent, regardless of the gender of the connector.

4.3 Payload Batteries

GDMS offers both the full-size 250 Watt-hour (Wh) 7S3P Bluefin SandShark™ battery (BFPN: 000-016-395-01), and a smaller form-factor 85Wh 7S1P Bluefin SandShark™ battery (BFPN: 000-018-581-01). Should you have a standalone (not installed or connected to the tail section) Bluefin SandShark™ battery powering your payload, you may charge the battery with a Bluefin smart shore power brick. Ensure the battery is connected to the shore connector as shown in Figure 3. The battery pinout, along with information on the mating connector, is provided in

Figure 5. Figure 6 and Figure 7 show the mechanical dimensions of the Bluefin SandShark™ batteries.

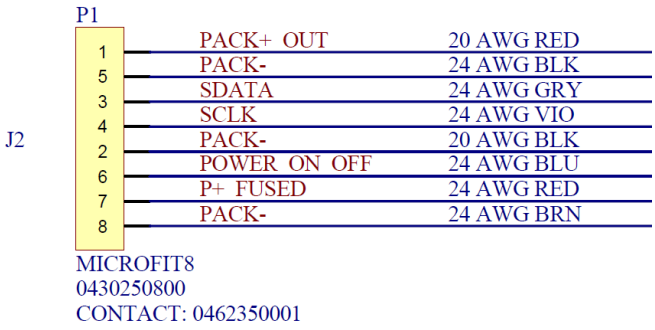

Figure 5 – Battery Molex Microfit 8 Pinout with Mating Cable Harness Details

[2] http://www.bluefinrobotics.com/about/contact-us/

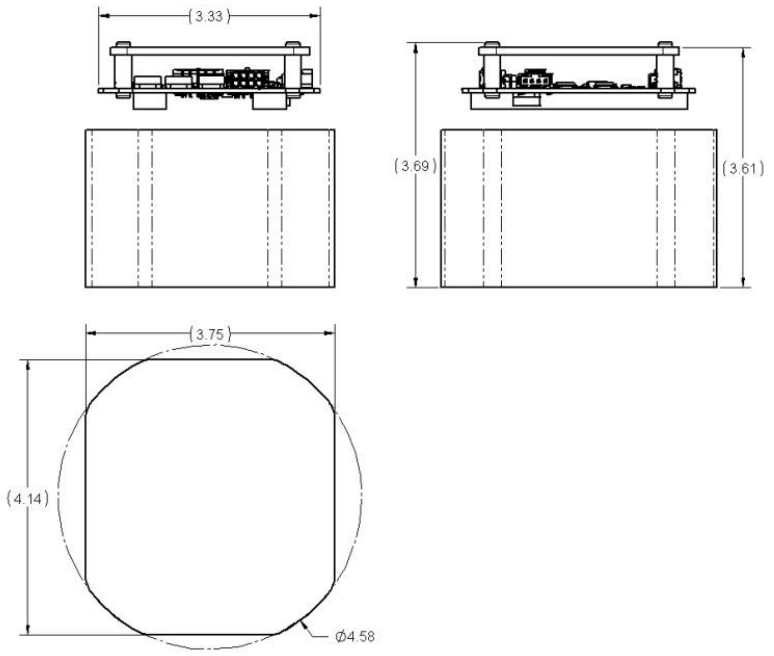

Figure 6 – 250Wh 7S3P Bluefin SandShark™ Battery

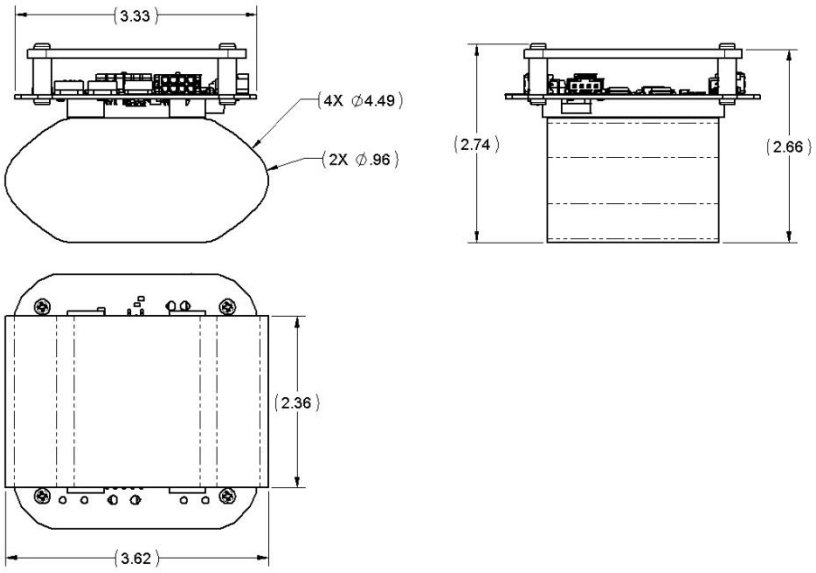

Figure 7 – 85Wh 7S1P Bluefin SandShark™ Battery

Table 6 provides nominal battery specifications for both the 250Wh and 85Wh battery. The final capacity of the battery is dependent on the cell brand used to create the pack, which in turn is dependent on the ability to source higher capacity cells at the time of manufacture.

Table 6 – Nominal Battery Specifications

Main Battery Specs	85 Wh 7S1P	250 Wh 7S3P
Vnom (V)	26.6	26.6
Vmax (V)	29.4	29.4
Imax (A)	10	10
Ishort circuit (A)	20	20
Capacity (AH)	2.8	8.4
Energy Capacity (Wh)	74.48	223.44
Dimensions	See Figure 6	See Figure 5
Weight (Lbs)	1.15	2.83

4.3.1 Payload Battery Integration with the Tail Section

The Bluefin SandShark™ is designed to be capable of extending its range by integrating with a power source in the Payload section. The user may choose to install a standalone battery to power payload electronics, decreasing the load on the Tail Section battery.

A gas gauge may be accessed on every Bluefin SandShark™ Battery Pack. This gas gauge will provide you with battery state of health, including capacity, voltage, state of charge, current output, and temperature. On the 8-pin Molex Microfit connector, pins 3 and 4 are SDA and SCL, respectively. Information on how to interface with the gas gauge is provided by the manufacturer[3].

4.3.2 Battery Maintenance

If you wish to charge the battery in a lab environment, you may use a variable DC power supply. The power supply must be capable of outputting 28VDC at 2A. Pins 1 and 2 on the battery's 8-pin Molex Microfit connector will be used. Pin 1 corresponds to BATT+, Pin 2 corresponds to BATT- (GND). These pins should be connected to the respective power supply outputs. The battery will do the necessary cell balancing.

The battery has completed charging when the current draw from the power supply drops below 0.5 Amps. To preserve battery capacity, Bluefin SandShark™ batteries should not be left charging, unattended, for longer than 6 hours. Continuously trickle-charging the battery will gradually deplete the battery's total capacity. A depleted 250Wh battery will reach 100% state-of-charge (SOC) in approximately 4.5 hrs. A depleted 85Wh battery will reach 100% SOC in approximately 2 hrs.

Lithium batteries require maintenance to keep cells balanced and charged. Bluefin strongly encourages monthly maintenance (charge to 80% SOC) to extend battery life and maintain maximum capacity. A lithium-ion battery that has been over-discharged may require replacement.

[3] http://www.ti.com/lit/ds/symlink/bq34z100.pdf

Bluefin SandShark™ AUV

Payload ICD

SECTION 5.0: MECHANICAL INTERFACE

5.0 MECHANICAL INTERFACE

This specification describes the mechanical interface between a Tail Section and an attached payload.

The mechanical interface presented in this document is applicable to the Bluefin SandShark™ Product, and backwards compatible with the Bluefin SandShark™ Beta.

5.1 Mass Properties

All mass properties listed in this section are for Bluefin SandShark™ Product Tail Section (BFPN: 000-019-550-01 & -02). For Bluefin SandShark™ Beta Tail Section information, Bluefin Customer Support[4].

Table 7 – Bluefin SandShark™ Product Tail Section Mass Properties

Physical Properties	
Diameter	4.875 in (0.12 m)
Length	20.2 in (0.51 m) Tail Section Only 40.7 in (1.03 m) w/ 3X Short Flooded Payload Fairings and Nose Fairing
Mass Properties – 000-019-550-02: Tail Section	
Mass	10.84 lbs (4.92 kg) Note: Assuming 2 brass ballast weights are mounted
Displaced Volume	303.3 in^3 (0.00497 m^3) Note: Assuming 2 brass ballast weights are mounted
CB Location	-8.39, 0, -.072 in (-213, 0.002, -1.84 mm)
CG Location	-8.66, 0.003, 0.007 in (-220, 0.07, 0.17 mm)
Coordinate System	+X = FWD, +Y =STBD, +Z = Down
Origin	Forward most face of the tail section endcap on the vehicle centerline
Mass Properties – 000-020-115-01: Short Flooded Payload Fairings with Handle	
Mass	0.61 lbs (0.275 kg)
Displaced Volume	13.43 in^3 (0.00022 m^3)
CG Location	-2.94, 0, -0.23 in (-74.6, 0, -5.9 mm)
Coordinate System	+X = FWD, +Y =STBD, +Z = Down
Origin	Forward most face of the fairing on the vehicle centerline
Mass Properties – 000-020-115-02: Short Flooded Payload Fairings No Handle	
Mass	0.55 lbs (0.251 kg)
Displaced Volume	12.81 in^3 (0.00021 m^3)
CG Location	-2.93, 0, -0.005 in (-74.4, 0, -0.12 mm)
Coordinate System	+X = FWD, +Y =STBD, +Z = Down
Origin	Forward most face of the fairing on the vehicle centerline

[4] Bluefin_CustomerSupport@gd-ms.com

The mass of the Tail Section is approximately 10.84 lbs (4.918 kg). It is ballasted to be 0.115 lbs (0.052 kg) positive in freshwater (999.9 kg/m^3). To re-ballast for salt water, the operator may add ballast weight to the endcap of the Tail Section. When designing a payload, the developer should allocate volume in the payload for ballast and trim. Confirmation of vehicle ballast and trim should be completed prior to in-water operations. Recommend not exceeding +0.75 lbs (0.34 kg) net buoyancy for optimal vehicle performance. Bluefin operators more commonly use +2% of the Bluefin SandShark vehicle's total dry mass for its operating net buoyancy.

The maximum recommended length of the vehicle is approximately 60 inches (1.52 m). Should it be necessary to exceed this payload length, the user can consider increasing the operating speed in order to increase control authority. If the speed range of the vehicle is not sufficient, or if endurance is desired to be maintained, it is possible to increase the control fin size; Bluefin Customer Support[5] for more information.

5.1.1 Coordinate System Axes

- +X = Forward
- +Y = Starboard
- +Z = Down

5.1.2 Center of Gravity (CG)

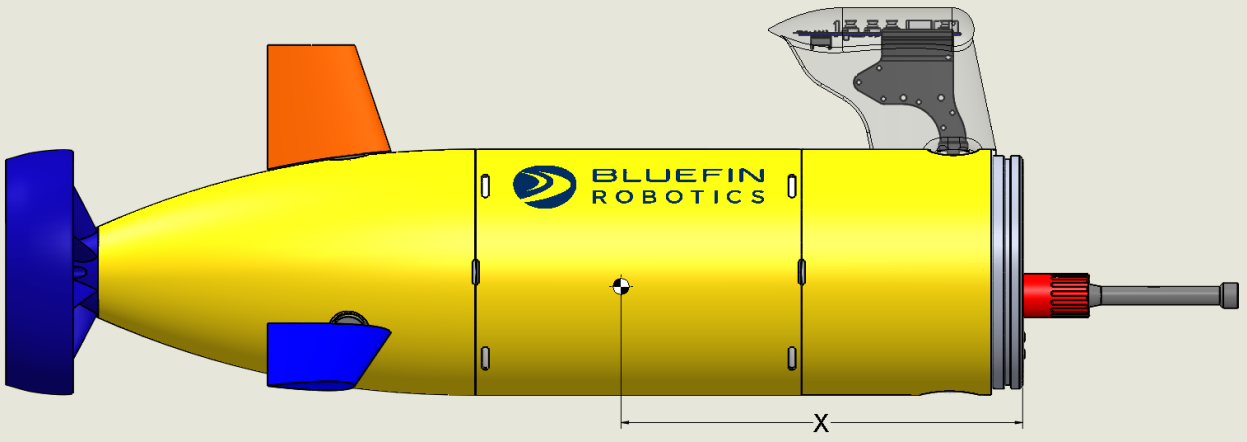

Figure 8 – Tail Section Center of Gravity

The X measurement is taken off the forward face of the Tail Section, indicated in Figure 8. The Y and Z measurements are taken off the vehicle centerline.

- X = -220.03 mm
- Y = 0.07 mm
- Z = 1.71 mm

[5] Bluefin_CustomerSupport@gd-ms.com

5.1.3 Center of Buoyancy (CB)

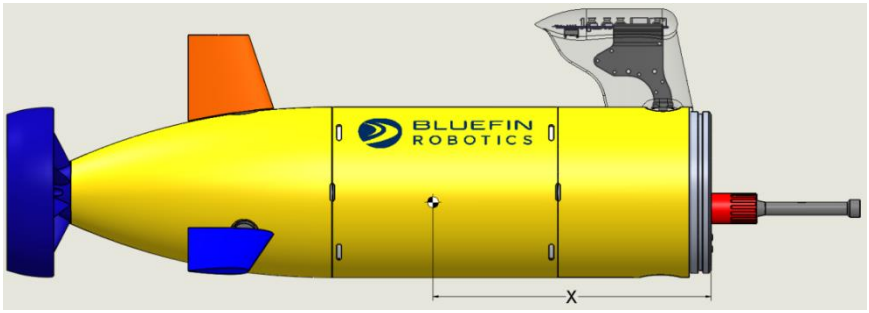

Figure 9 – Tail Section Center of Buoyancy

The Tail Section, in its as-shipped configuration, is 0.052 kg buoyant. The X measurement is taken off the forward face of the Tail Section, indicated in Figure 9. The Y and Z measurements are taken off the vehicle centerline.

- X = -213.34 mm
- Y = 0.002 mm
- Z = -1.84 mm

5.2 Flooded Section Interface Drawing

The following subsection provides a detailed drawing defining the mechanical interface between a Tail Section FWD endcap, a flooded payload section, and a nose. Should you wish to create a payload to attach to the Tail Section, the dimensions provided in the below drawing, see Figure 10, should be used to ensure the correct interface. Recommend keeping the space in the flooded section just forward of the tail section connectors clear of components since during in-water operations the tail section connectors must be capped with dummy plugs or wet cables.

Please reference the Payload Section Mechanical ICD (BFPN: 000-020-900) for better quality details of Figure 10 below.

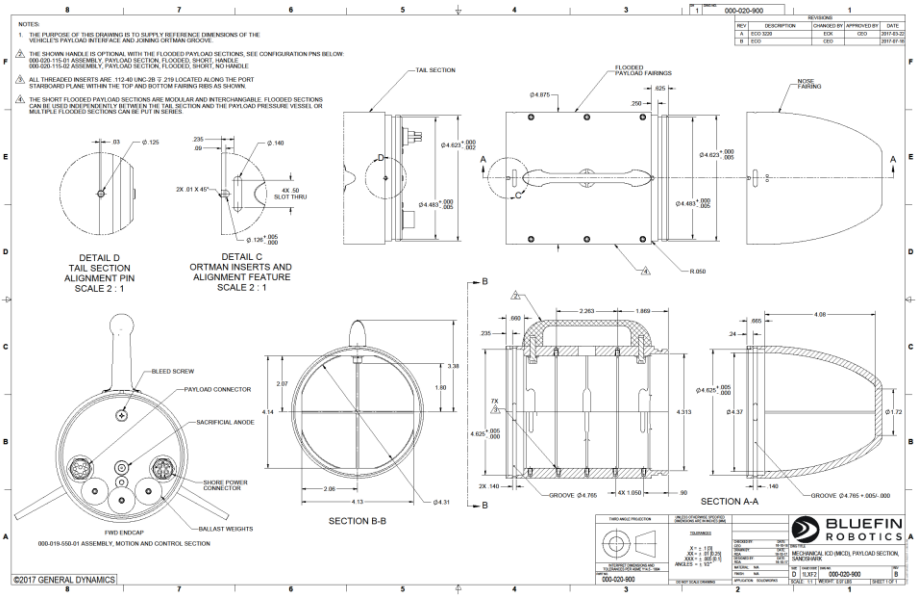

Figure 10 - Mechanical Interface of Flooded Fairings

5.3 Standard Dry Payload

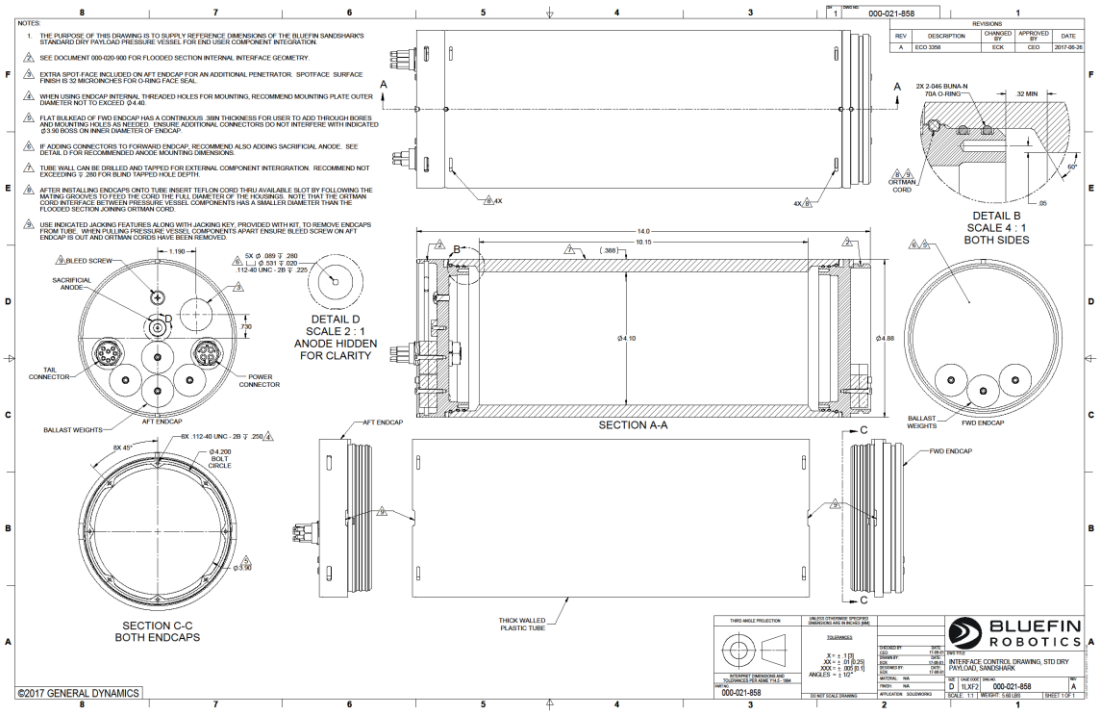

Figure 11 - Bluefin SandShark™ Standard Dry Payload Offering

Please reference the Standard Dry Payload ICD (BFPN: 000-021-858) for better quality details of Figure 11 above.

Standard dry payload sections are offered by GDMS for the Bluefin SandShark™ AUV. The standard dry payload shown in Figure 11 includes a pressure vessel and a wet cable (BFPN: 000-020-422-02) to communicate with the Tail Section as described in Section 4.1. The dry payload was designed with complete end-user customization in mind. The internal volume of the pressure vessel is completely empty and intended for keeping desired payload components dry. The forward endcap has a thick bulkhead for the end user to add penetrations and/or mounting holes. Through bores and tapped holes can also be added to the thick walled plastic tube for payload components external to the Bluefin SandShark™ outer diameter, such as sonar transducers. The aft endcap includes two male SubConn Micro Circular series connectors, one 4 pin MCBH4MAS and one 8 pin MCBH8MAS. The aft endcap also includes an extra, pre-finished spot face if the user desires to add another penetrating connector. Both endcaps have identical hole patterns for mounting internal electronics chassis. See Figure 11 for detailed information on interfacing with the internal geometry of the standard dry payload pressure vessel.

The internal packaging dimensions are 4.1in ID x 10.75in. The external dimensions are 4.875in OD x 14in length. Bluefin Customer Support[6] for more information on how to use and customize the standard dry payload to meet your needs.

The standard dry payload is designed to mate with all standard Bluefin SandShark™ flooded

[6] Bluefin_CustomerSupport@gd-ms.com

sections, as well as the Tail Section. Users should reference Figure 10 for the flooded payload mating geometry if designing custom flooded sections.

Custom payload pressure vessels can be provided upon request including modifications to the standard dry payload described in this section as well as completely custom pressure vessel designs. Contact us[7] with information regarding your payload requirements.

5.3.1 Standard Dry Payload Mass Properties

The mass properties presented in Table 8 are for a standard dry payload pressure vessel with all 14 provided ballasted weights mounted to the endcaps. The provided payload communications wet cable (BFPN: 000-020-422-02) is not included in these mass properties.

Table 8 - Standard Dry Payload Mass Properties

Mass Properties – 000-020-809-01 Standard Dry Payload Pressure Vessel	
Mass	5.44 lbs (2.468 kg)
Displaced Volume	245.36 in^3 (0.00402 m^3)
CG Location	-7.27, 0.001, 0.222 in (-184.54, 0.03, 5.65 mm)
CB Location	-7.10, 0, 0.021 in (-180.32, -0.005, 0.53 mm)
Coordinate System	+X = FWD, +Y =STBD, +Z = Down
Origin	Forward most face of the fwd endcap on the vehicle centerline

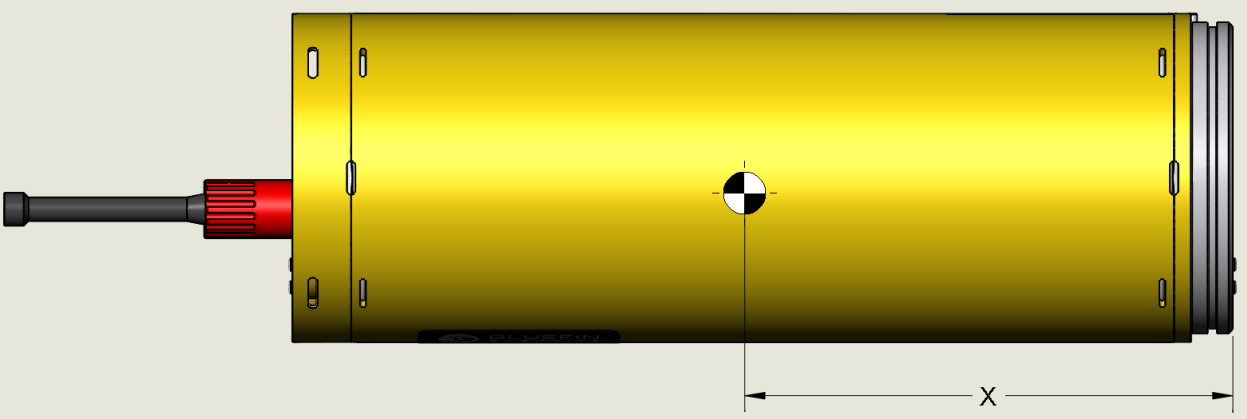

Figure 12 - Standard Dry Payload Pressure Vessel Center of Gravity

[7] http://www.bluefinrobotics.com/about/contact-us/

5.4 Endcap Removal Using Jacking Key

Standard Bluefin SandShark™ pressure vessels such as the Tail Section and Standard Dry Payload come with similar mechanical mating interfaces. These include an Ortman groove and slotted jacking features. The Ortman groove provides the axial mechanical locking mechanism between vehicle sections. It works by inserting a round Teflon cord into mating male and female grooves. For the Bluefin SandShark™ Product the Ortman cord interface between pressure vessel components has a smaller diameter cord than the flooded section joining interfaces. Prior to jacking pressure vessel components apart ensure that the Ortman cords and bleed screw have been removed. Use the slotted jacking features on the pressure vessel and the provided jacking key (BFPN: 000-018-053-01) to remove endcaps from tube. Avoid crooked endcap removal by repeatedly switching from side to side with jacking key and evenly applying removal force. This removal force should be applied by the jacking key with a twisting motion, as depicted by the green arrow in Figure 13, not a prying motion. If it feels like excessive force is necessary to remove the endcap it is likely that the endcap has been jacked up unevenly and is slightly jammed. If this happens it's best to push the endcap back into its installed position and start the removal process over. Excessive force applied to the jacking key will likely result in damage to the pressure vessel components and/or the jacking key itself.

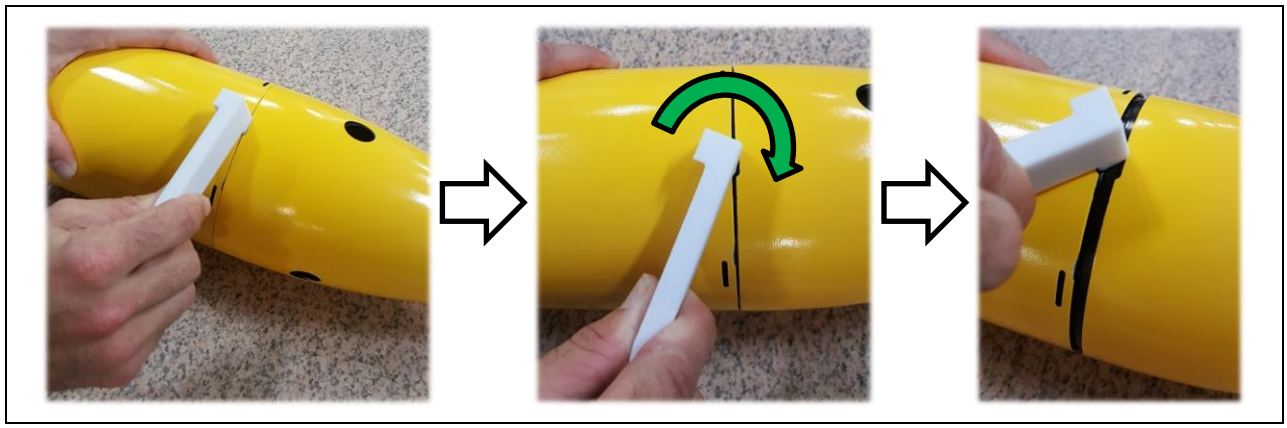

Figure 13 - Proper Jacking Key Technique

5.5 Compatible COTS parts

The following parts are suitable to house a quick prototype payload that fits inside the standard short flooded payload fairings. However General Dynamics Mission Systems doesn't warranty, expressed or implied, of the depth rating of these COTS parts. Vehicle operator and/or prototype designer are responsible for assessing chosen COTS items for purpose or function including depth rating.

Table 9 – Payload Compatible COTS parts (for rapid prototyping)

PVC Pressure Vessel		
Description	**Vendor**	**Vendor PN**
Standard-Wall White PVC Pipe Fitting, 3 Pipe Size, Coupling	McMaster	4880K77
Standard-Wall White PVC Pipe Fitting, 3 Pipe Size, Plug	McMaster	4880K849

5.6 Additive Manufacturing for Underwater Components

Rapid prototyping technologies are likely to be utilized during a Bluefin SandShark™ payload integration phase. Additive manufacturing is one of these commonly used rapid prototyping technologies.

WARNING: Some additive manufacturing processes are inherently porous; therefore extreme caution should be taken prior to using these components for underwater applications. Porous parts can lead to leaks and/or loss of buoyancy. Various secondary surface finishing techniques exist to seal these porosities. Recommend seal testing and/or pressure testing additive manufacturing parts before declaring them mission ready.

Bluefin SandShark™ AUV

Payload ICD

SECTION 6.0: SOFTWARE INTERFACE

6.0 SOFTWARE INTERFACE

6.1 Huxley

The Bluefin Standard Payload Interface (SPI) for Huxley is published on the Bluefin website and can be found on the "Downloads[8]" page.

[8] http://www.bluefinrobotics.com/media/downloads/

7.0 NOTES

7.1 Definitions

Table 10 – Example Definitions Table

Term	Definition
Huxley	Bluefin's proprietary software suite that runs on all Bluefin AUVs.
Payload	The forward section of the Bluefin SandShark™ designed to perform the science or specific task for the mission.
QGroundControl	Open-source ground control station user interface designed for UAVs.
Tail Section	The aft section of the Bluefin SandShark™ that is contained within a single pressure vessel. The section that provides the AUV with propulsion, control, autonomy, and navigation.
Topside	Support equipment in a dry environment (eg. boat, dock)

7.2 Acronyms & Initialisms

Table 11 – Acronyms and Initialisms

Acronym	Meaning
AUV	Autonomous Underwater Vehicle
BFPN	Bluefin Part Number
COTS	Commercial Off The Shelf
DVL	Doppler Velocity Log
FWD	Forward
GDMS	General Dynamics Mission Systems
GND	Ground
ICD	Interface Control Document
IMU	Inertial Measurement Unit
LED	Light-emitting Diode
MVC	Main Vehicle Computer
PTH	Pressure-Temperature-Humidity Sensor