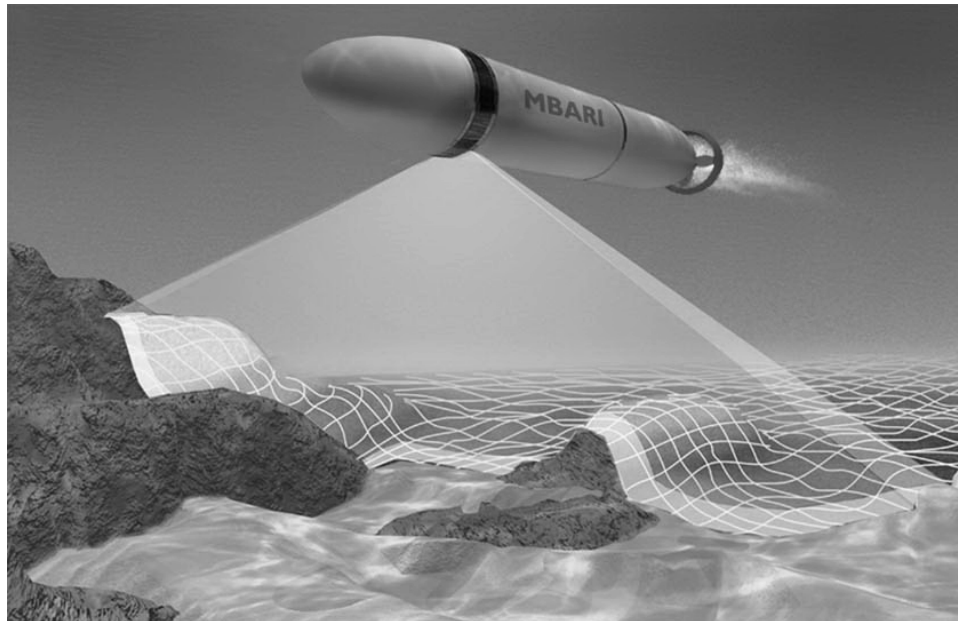


SeaBat 7100 (MBARI)
Multibeam Echosounder System
OPERATOR'S MANUAL
Draft Version 1.01



Document Number 11384

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RESON strives to maintain up-to-date information and may, as necessary, review and revise this handbook. If the information contained in this manual is unclear, please contact your nearest RESON office for clarification.



Preface

The installation procedures in this document are written for personnel who may be novice sonar operators, but are familiar with computer systems, basic electronics and wiring. Procedures are described in a step-by-step sequence. We recommend proceeding from chapter to chapter until the installation is completed and basic operation is familiar.

Manual Overview

This manual is organized as follows:

Chapter 1, Equipment Description, provides an introduction to the SeaBat 7100 (MBARI) system as well as a general description of each unit plus weights and technical data.

Chapter 2, Installation, provides additional descriptions and installation guidelines for each unit of the system plus post-installation testing.

Chapter 3, Pre-Launch Checks, describes pre-launch deck checks.

Chapter 4, Post-Recovery, describes post-mission deck checks.

Electronic File Version

This document is available from RESON in the Adobe Acrobat Portable Document Format (PDF). The selected PDF process preserves the interactive index and cross-reference features of the original Microsoft Word document.

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Chapter 1, General Information

1.1 Introduction

This manual describes the SeaBat 7100 Multibeam Echosounder System. It is written both for the first time user and for the experienced operator who wishes to use a particular section as a reference guide. This manual provides data on installation, operation, and maintenance of the system.

1.2 What is a SeaBat 7100?

The SeaBat 7100 Multibeam Echosounder System (MBES) is a specially configured sonar system designed for use in an Autonomous Underwater Vehicle (AUV). All system components, with the exception of the Projector and Receiver Units, are housed within the customer-provided Payload Pressure Housing.

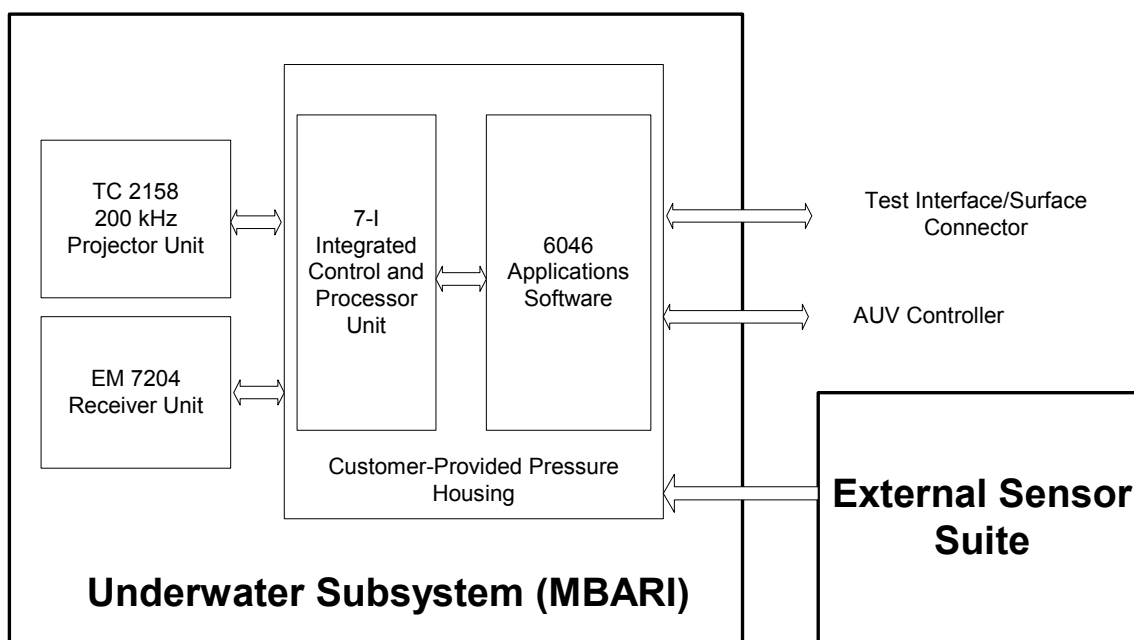


Figure 1, 7K System Block Diagram – AUV Configuration

1.3 How does the SeaBat 7100 work?

The Projector Unit transmits a pulse of acoustic energy which travels through the water and is reflected by any objects in its path. The reflected signal is received by the Receiver Unit where it is filtered, amplified, and digitized by internal electronics. This information is passed to the Integrated Control and Processor Unit which executes beam forming, other processing, and data storage.

1.4 How Far Does the SeaBat 7100 “See”?

The SeaBat 7100 system illuminates a swath on the seafloor that is 150° across-track by 1° along-track. The beam forming process yields a swath consisting of 349 individual 1° by 1° beams with a bottom detection range resolution of <7mm. The designed bottom detection range is from 5 to 500 meters of altitude.

1.5 How Much Seafloor Does it Measure?

With an across-track subtended angle of 150°, and a hard bottom, the SeaBat 7100 measures a swath width of 7 times the altitude at ranges of 5 to 100 meters. At altitudes greater than 100 meters, the ratio of altitude to swath width decreases, as noted in Table 1 (all calculations assume the center of the swath to be vertical).

Table 1, Seafloor Coverage

Depth in meters	Coverage (X water depth)
5 - 100	7
200	5*
300	3*
	* typical value

1.6 Safety Precautions

The SeaBat 7100 system should be handled with attention to protection of the hardware components and operator safety. General precautions include:

- DO NOT** Connect or disconnect cables with the power on.
- DO NOT** Attempt to open and service either the Projector Unit or the Receiver Unit.
- DO NOT** Operate the system while divers are in the water.
- DO NOT** Touch or handle any internal printed circuit boards without specific instructions from RESON.
- DO NOT** Run the SeaBat 7100 at anything but the lowest possible power setting while operating in air. A higher setting may damage the Projector Unit transmit array ceramics.
- DO NOT** Operate or submerge the Sonar Head Assembly unless all connectors are terminated in cables or protective endcaps.

Chapter 2 provides detailed procedures for the correct installation of the SeaBat 7100 system. Follow the steps provided for safety and to obtain the best system performance.

1.7 Sonar Sub-System Components

The basic components of the Sonar Sub-System are:

7-I	Integrated Control and Processor Unit (ICPU)
6046	Payload Controller and Data Visualization Software
EM 7204	200 kHz Receiver Unit
TC 2158	200 kHz Projector Unit

1.7.1 7-I Integrated Control and Processor Unit

The 7-I ICPU resides within the AUV Payload Pressure Housing. It is contained within a custom electronics frame assembly which attaches to the Pressure Housing endcap with a mounting adaptor. The ICPU is responsible for beam forming, signal conditioning, and managing the other functions of the MBES system.

1.7.1.1 ICPU Technical Specifications

The following technical specifications apply to the 7-I ICPU:

Table 2, ICPU Technical Specifications

Processor Speed	Pentium III, 800 MHz
Hard Drive Capacity	37 GB
Power requirements	+24 VDC
Dimensions	20 cm wide 15 cm high 37 cm long (43 cm long with mounting adaptor)
Weight	7.8kg (17.25 lb)
Temperature	Operating: -5° to +30°C Storage: -30° to +55°C

1.7.2 6046 Payload Controller & Data Visualization Software

The RESON 6046 software consists of a Payload Controller that resides on the ICPU, as well as the Data Visualization Utility that resides on a customer-provided PC.

1.7.2.1 Payload Controller

The Payload Controller (PLC) coordinates the acquisition of data from each sensor module and is responsible for sequencing, logging and time tagging the acquired data. It also monitors system status, manages alarm reporting and performs general quality control.

1.7.2.2 Data Visualization Utility

The Data Visualization Utility (DVU) receives and translates information provided in realtime by the PLC and provides playback capabilities for information gathered during previous missions.

Note: Refer to the **Reson 6046 Software Manual** for further information with regards to the RESON 6046 Payload Controller and Data Visualization Utility Software.

1.7.3 EM 7204 Receiver Unit

The Receiver Unit is comprised of the piezoelectric receive array, pre-amplifiers, band pass filters, and control microprocessor circuitry. The control microprocessor manages communications between this unit and the ICPU.

Table 3, EM 7204 Receiver Unit, Technical Specifications

Power requirements	To Be Determined
Dimensions	See Figure 2
Depth rating	Operational: 6,000 meters Maximum Limit: 6,500 meters
Housing material	Aluminum (AlMg5), hard anodized and painted, Delrin, polyurethane
Weight	Air: 28 kg (61.6 lb) Sea Water: 14 kg (30.8 lb)
Center of gravity	13 mm below center line
Temperature	Operating: -5° to +30°C Storage: -30° to +70°C

Table 4, EM 7204 Receiver Unit, Acoustic Properties

Frequency	200 kHz
Altitude range	5 meters to 500 meters
Number of beams across-track	349 beams
Along-track beamwidth	27° (-3db)
Across-track beamwidth	1° (-3db)
Beam Offset	.432°
Across-track coverage	150°



The Projector Unit is the system's transmitting array. The piezoelectric array converts the electrical transmit energy, developed in the ICPU, to acoustic energy for transmission into the seawater medium.

Dimensions	See Figure 3
Depth Rating	Operational: 6,000 meters Maximum Limit: 6,500 Meters
Weight	Air: 13 kg (28.67 lb) Sea Water: 8 kg (17.64 lb)
Temperature	Operating: -5° to +30°C Storage: -30° to +70°C

Table 6, TC 2158 Projector Unit, Acoustic Properties

Frequency	200 kHz
Along-track beamwidth (-3dB)	1° @ 200 kHz
Across-track beamwidth (-3dB)	140°
Maximum sound pressure level	+220 dB re 1 μ Pa @ 1 meter
Waveform	Gated CW
Max and min pulse length	240 μ sec and 60 μ sec
Maximum pulse repetition rate	40 pulses/sec

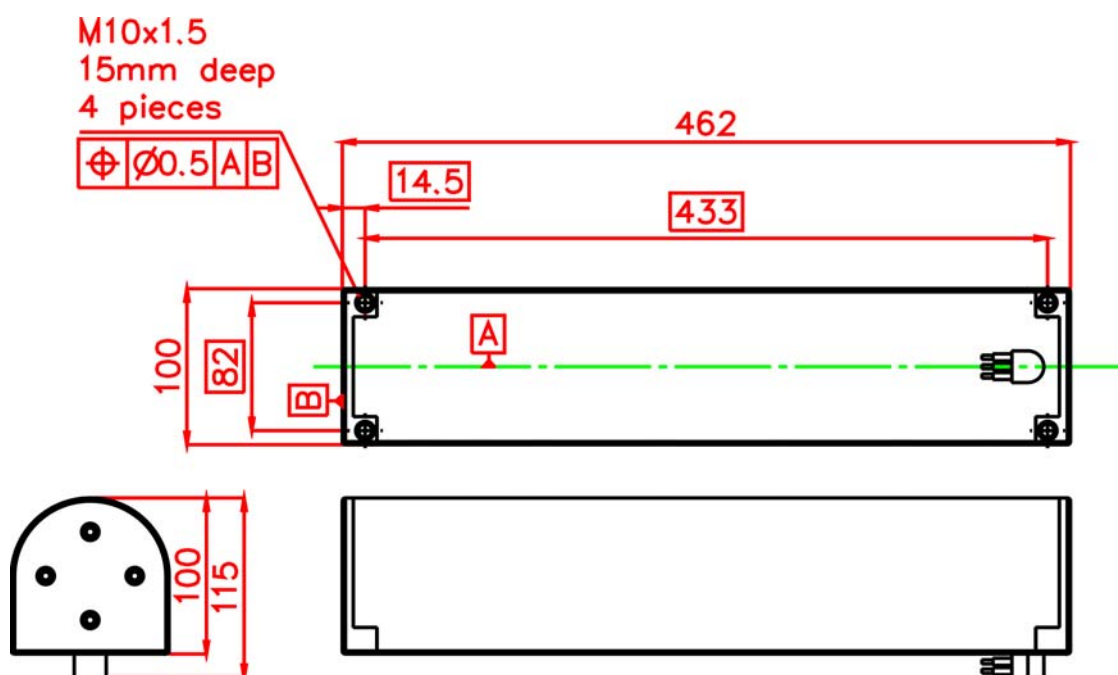


Figure 3, TC 2158 Projector Dimensions (in mm)

1.8 Warranty Information

Your SeaBat warranty gives you specific legal rights. You may also have other rights which vary from country to country.

1.8.1 One-Year Limited Warranty

RESON warrants the SeaBat 7100 system against defects in materials and workmanship for a period of one year from acceptance of the system. During the warranty period, RESON will, at its option, either repair or replace components which prove to be defective.

The warranty period begins on the day the SeaBat System is accepted. The system must be serviced by the RESON office which sold the system. The customer shall prepay shipping charges (and shall pay all duty and taxes) for products returned for service. RESON shall pay for the return of the products to the customer, not including duty and taxes.

1.8.2 Exclusions

The warranty on your SeaBat System shall not apply to defects resulting from:

- Improper or inadequate maintenance by customer.
- Unauthorized modification or misuse.
- Opening of the sonar head assembly by anyone other than an authorized RESON representative.
- Operation outside of the environmental specifications for the product.
- Improper site preparation and maintenance.
- Service provided by any but Authorized Service Facilities (see paragraph 1.6).

1.8.3 Warranty Limitations

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. RESON specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

1.8.4 Servicing During Warranty Period

If your system should fail during the warranty period, please contact your nearest RESON representative immediately to protect your warranty rights (refer to paragraph 1.9).



1.9 Service and Assistance

For additional information and technical assistance with the SeaBat 7100 system, contact the nearest RESON office.

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NOTE

Before returning any equipment for service, you will need to follow the RESON return procedure:

1. Contact a RESON office to obtain an approved Return Material Authorization (RMA) number.
2. Pack the equipment in the original shipping containers.
3. Ship the equipment to your RESON representative at the applicable address. Insure that the RMA number is included on all shipping documents and, most importantly, marked on the shipping container's address label.
4. Include a note with a brief but thorough description of the problem.

Chapter 2, Installation

2.1 Introduction

This chapter provides basic guidelines for the installation of the SeaBat 7100 Multibeam Echosounder (MBES) in the MBARI Autonomous Underwater Vehicle.

RESON recommends that the installer review the installation requirements as noted in this chapter and develop a check list prior to actual installation. This list can be used to verify proper installation as part of post-installation testing (see 2.7 Post Installation Tests).

2.2 Handling Equipment Safely

Each SeaBat major component, while in its own transit case or shipping box, is sufficiently robust for shipboard storage and requires only normal care and handling to prevent breakage.

The transit cases provide handles, which allow two people to carry each piece of equipment easily, and tie-down rings for securing the cases in shipboard storage.

To ensure safe handling of the equipment:

1. Inspect each transit case or shipping box for physical damage prior to opening.
2. Inspect each component for physical damage before installation. (Check for obvious damage and abuse including splits, dents, cracks, broken controls, scratches, lodged foreign objects, damaged connectors, excess moisture and burn marks.
3. Use adequate packaging and shock-absorbing materials to ship or store any equipment or accessories that are stored outside the supplied transit cases.
4. Do not drop equipment or place the Sonar Head Components in an area where the face of the projector or hydrophone may be scratched or damaged.
5. Do not place liquids on or near the equipment where the liquid might spill into the electrical components.
6. Do not smoke or spill ashes on or near the pointer device.
7. Ensure that all equipment is properly secured before putting out to sea.

2.3 Location of System Units

Dimensions, weights, and power requirements are provided in Chapter 1 of this manual. Final determination of attachment points, cable routing, and vehicle weight distribution/center of gravity are the responsibility of the customer.

2.4 ICPU Installation Details

2.4.1 Structural Details

The Integrated Control and Processor Unit (ICPU) has been mounted in a custom electronics frame assembly. This assembly is affixed to the inside of the customer-provided Payload Pressure Housing (PPH).

The interface to the PPH is an adaptor ring that mounts to one end of the assembly. The other end of the adapter ring bolts to the housing endcap. It is secured by eight 0.221 inch (0.561 cm) bolts, equally spaced on a 7.75 inch (19.685 cm) bolt circle. (See Figure 4 for details).

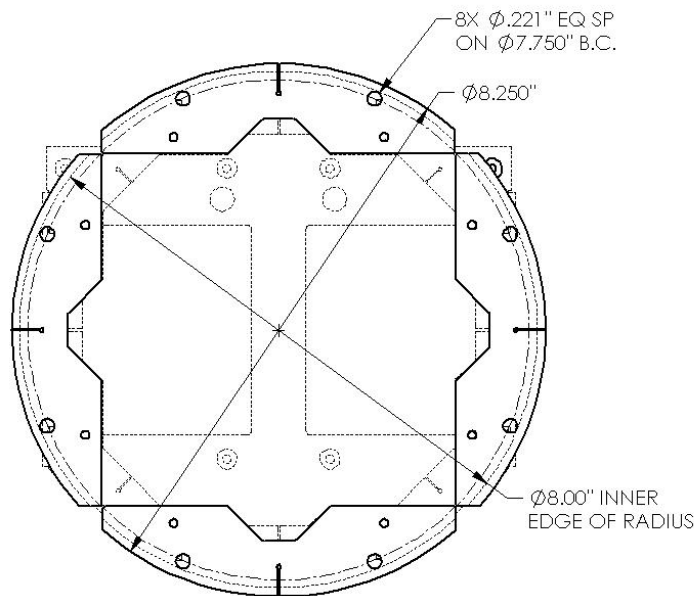


Figure 4, End Cap Interface

2.5 EM 7204 Receiver Unit Installation Details

2.5.1 Interface to ICPU

The EM 7204 Receiver Unit interfaces to the ICPU through a single cable. At the Receiver Unit end of the cable, there is a male 8-pin connector (Model LPMIL-8-MP). At the end of the cable that interfaces with the Pressure Vessel housing the ICPU, there is a female connector (Model MCIL-8-FS). The maximum allowable length for this cable is 3 meters.

The connections are as follows:

Pin 1	LNK1A+ (Positive)
Pin 2	LNK1A- (Negative)
Pin 3	LNK1B+ (Positive)
Pin 4	LNK1B- (Negative)
Pin 5	LNK1C+ (Positive)
Pin 6	LNK1C- (Negative)
Pin 7	DC Power (Positive)
Pin 8	DC Power (Negative)

Table 7, EM 7204 Receiver Unit Pinout

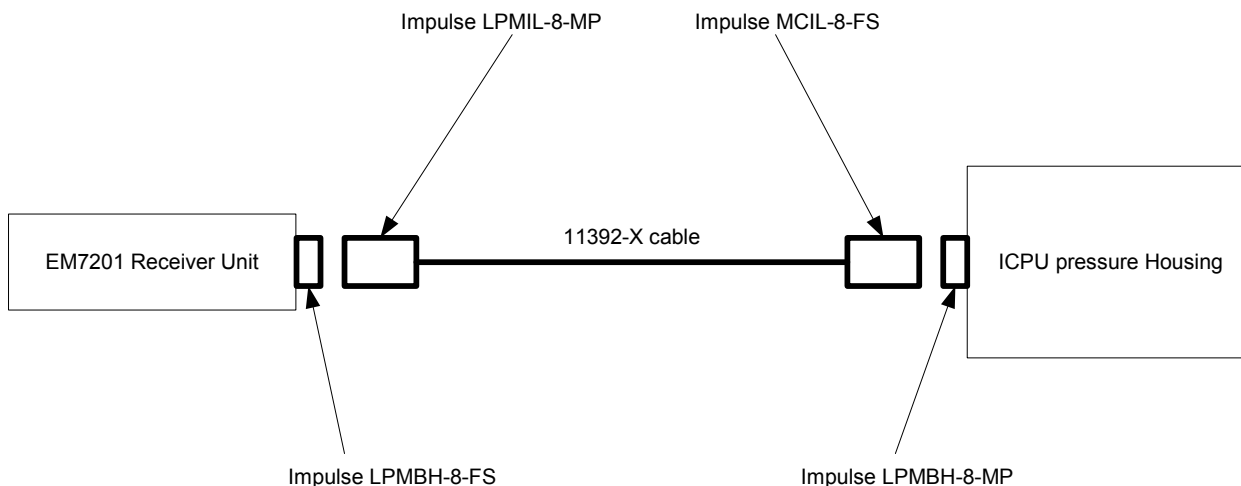


Figure 5, EM7204 to ICPU Interface

2.5.2 Structural Details

The receiver unit has been designed as a structural member of the vehicle. Its shape is a hollow cylinder with the same Outside Diameter as the vehicle and, for structural integrity purposes, will remain rigid under the same stresses that the vehicle itself has been designed to withstand.

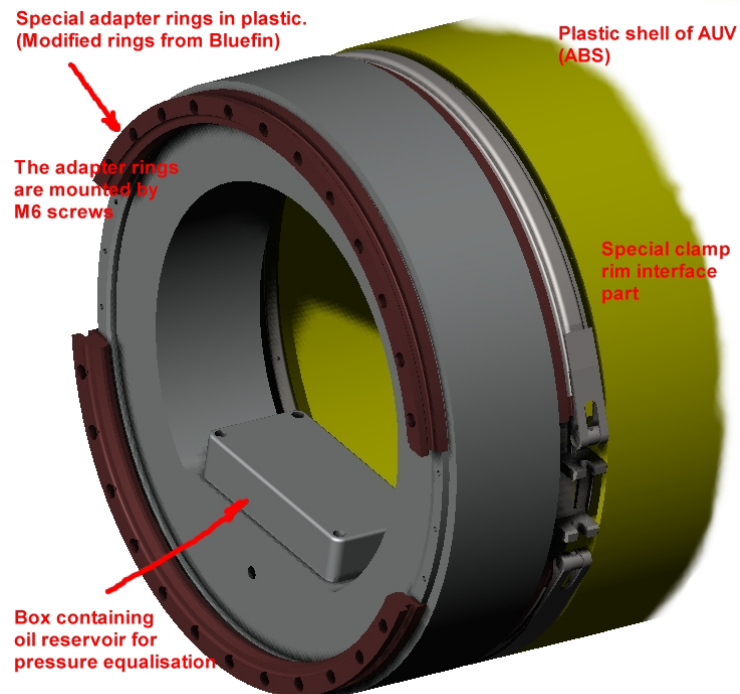


Figure 6, Adapter Ring Interface

Special adapter rings act as the interface between the AUV sections and the Receiver Unit. Figure 7 and Figure 8 show the details of rings and attachment process.

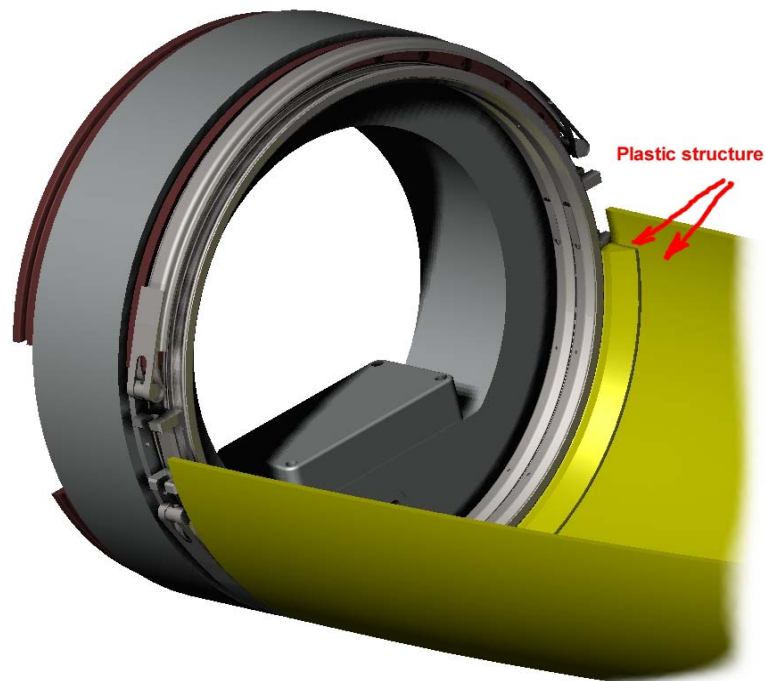


Figure 7, Tension Band Assembly

Rim sections are welded together and combined with a special tension band to hold the sections together.

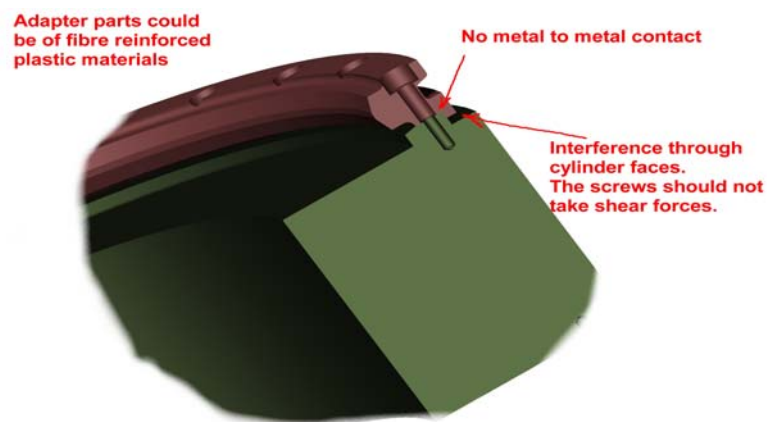


Figure 8, Housing and Adaptor Ring Interface

The shear force at the interface between the housing and the ring will be carried by the cylinder-face friction. The attachment screw does not see any shear forces.

2.5.3 Compensation Details

The housing is pressure compensated by means of a small oil reservoir. Figure 9 shows the location of this reservoir.

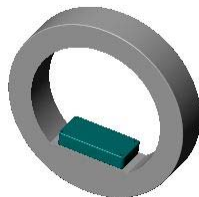


Figure 9, Receiver Unit with Pressure Compensation Reservoir

2.5.4 Mounted EM 7204 and TC 2158 Details

The physical relationship between the source of acoustic energy transmitted into the seawater medium and the hydrophone area at which the returning bottom echoes are received is important for proper operation of the SeaBat 7100 system. The Receiver Unit and Projector Unit each have an index structure to ensure correct spacing and axis orientation with respect to each other and to the vehicle. Figure 10 illustrates this relationship.



Figure 10, EM 7204 and TC 2158 Physical Relationship

2.6 TC 2158 Projector Unit Installation Details

2.6.1 Interface to ICPU

The TC2158 Projector Unit interfaces to the ICPU through a single cable, as shown below. At the Projector Unit end of the cable is a female 8-pin connector (Impulse Model LPMIL-8-FS). At the end of the cable that interfaces with the ICPU Pressure Housing, there is a male connector (Impulse Model MCIL-8-MP). The maximum allowable length for this cable is 3 meters.

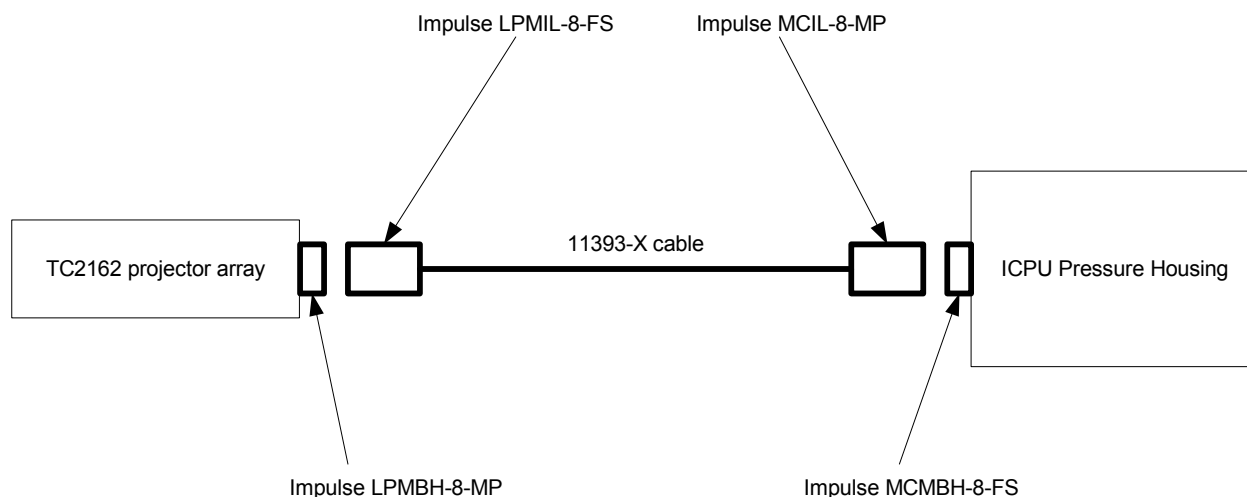


Figure 11: TC2158 to ICPU Interface

The connections are as follows:

Table 8, TC 2158 Projector Unit Connections

Pin 1	Pin 2 of Sensors (Data)
Pin 2	Pin 1 of Sensors (Return)
Pin 3	Not Used
Pin 4	Not Used
Pin 5	Not Used
Pin 6	Not Used
Pin 7	Transmit Drive Voltage (Positive) in Parallel with Pin 5
Pin 8	Transmit Drive Voltage (Negative) in Parallel with Pin 6

2.6.2 Structural Details

The projector unit is attached to a mounting plate within the vehicle by four M10 x 1.5 15 mm screws. The threaded holes, for the screws, are located at the corners of a 433 mm by 82 mm rectangle. The electrical connection to the projector unit is made via a right-angle bulkhead connector mounted on the flat longitudinal surface of the unit. Screw holes and connector details are shown in Figure 3, TC 2158 Projector Dimensions (in mm)."



2.6.3 Compensation Details

The projector unit is pressure compensated by means of an internal volume of oil. Ambient pressure is transmitted to the internal oil reservoir via a flexible area in the polyurethane encapsulation.

2.7 Post Installation Tests

2.7.1 Hardware and Cables

1. Review the installation check list developed during the installation process and verify that all attachment hardware is properly secured and that all electrical connectors are mated securely.
2. Check cable routing to verify that no cables are pinched or damaged due to handling.
3. Verify that all cables are connected and that all bulkhead connectors are properly terminated.
4. Make applicable resistance checks to verify electrical isolation of system components (See 2.8.1, "Corrosion Avoidance Guidelines" for information regarding housing-to-housing electrical isolation.).

2.7.2 Power On Checks

1. With the vehicle power on, energize the SeaBat 7100 system and verify normal current draw on vehicle power bus.
2. If applicable, make power bus ground detector checks.

2.7.3 Vehicle Communications

1. Verify basic communications between the 7100 ICPU and the vehicle's main electronics housing monitor circuits.
2. Energize the MBES and set transmit power to two or three and listen for ping 'clicks' at the face of the projector. If the projector is not accessible for this test, stop and shut down the system until access to the face of the projector is possible. At the conclusion of the test, set transmit power to one or off.

CAUTION

When the vehicle is out of the water, turn the transmitter power to the lowest possible setting. When transmitting in air, limit the time to five minutes or less to avoid possible damage to the projector's ceramic elements.

3. Rub the face of the receiver unit with the palm of the hand and verify an increase in broadband noise in the vehicle's system monitor display.

2.8 Corrosion Avoidance Guidelines

2.8.1 Aluminum Alloy

The standard housings for the EM 7204 and the TC2158 are composed of aluminum alloy. These housings are provided with zinc alloy sacrificial anodes to protect them from galvanic corrosion while immersed in seawater. If the system is to be used in fresh water, magnesium alloy sacrificial anodes will be provided. Do not paint the anodes. The anodes should be inspected periodically for cleanliness and good physical condition. If an anode is loose, it must be tightened or replaced immediately; if not firmly attached, its effectiveness is greatly reduced.

In addition, it is imperative that the Projector and Receiver Units be isolated electrically from the mounting structure, as stray currents may exist on the mounting structure, and if the sonar head is not electrically isolated from these currents, the attached anodes will attempt to protect the entire structure from corrosion, rather than just the Sonar Head Components. This will result in the anodes being used up more quickly than intended.

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Chapter 3, System Operation

3.1 Introduction

This chapter focuses on the Pre-Launch and Post-Recovery checks required for the AUV itself. Remote control of the vehicle and realtime viewing of data during collection are handled by the RESON 6046 PLC and DVU software. Information regarding the operation of the RESON 6046 software can be found in the document entitled “RESON 6046 Software Manual.”

3.2 Pre-Launch Checks

The SeaBat 7100 Sonar system is a sub-system of the MBARI Autonomous Underwater Vehicle. As such, the pre-launch checks offered here may be superseded by the overall vehicle pre-launch procedures.

Until such time as this manual is revised, or a specific series of checks has been provided by MBARI, RESON recommends the same series of checks described in 2.7 Post Installation Tests. At the operator’s discretion, resistance checks may be omitted.

3.3 System Operations

Refer to the **RESON 6046 Software Manual** for details as to how the SeaBat 7100 system can be managed during a mission.

3.4 Post –Recovery Checks

At the time of post-mission recovery, the shipboard system will download the bathymetry data collected by the 7100 system. When the download is complete, the vehicle must be inspected and individual systems checked.

The MBARI shipboard system may have detected an anomaly during the course of the mission. Prior to routine 7100 system checks, the operator should consult with the responsible vehicle maintenance supervisor to schedule any corrective maintenance that may be required.

3.4.1 Deck Checks

1. When the data download process is complete, use the communication link to the vehicle to conduct a series of checks to verify that the MBES is functional (this procedure and specific checks must be integrated into the MBARI post-recovery check list).
2. Verify that the 7100 system power is set to OFF.
3. Visually inspect the EM 7204 Receiver Unit and TC 2158 Projector Unit attachment points and cable connectors for proper tightness.



4. Visually inspect the polyurethane encapsulation at the faces of the Receiver and Projector units for damage.
5. If not already accomplished by the MBARI post-recovery process, use fresh water to liberally flush the surfaces of the Receiver and Projector units to remove any accumulated salt encrustation.

3.4.2 Post Mission Data Verification

As soon as possible, verify that the collected data is valid and matches the criteria established for the particular mission.

Chapter 4, Glossary

4.1 Introduction

The following glossary is provided to assist the reader in a more complete understanding of the technical terms used in this manual.

4.2 Glossary

AC	Alternating Current
Across-Track	The direction 90° to the path of the vessel or towfish, the range dimension. This is the opposite of the along-track (transverse) dimension. These two terms are used to describe sonar phenomena and dimensional corrections.
ADC	Analog-to-Digital Converter
Along-Track	The dimension of the seabed or data record in a direction parallel to the track of the vessel. This is the opposite of the cross-track dimension. These two terms are used to describe sonar phenomena and dimensional corrections.
Array	Piezoelectric Ceramic elements arranged in a series / parallel configuration. An array may be designed for either transmission (projector) or reception (hydrophone)
AUV	Autonomous Underwater Vehicle
DVU	Data Visualization Utility Software
ICPU	Integrated Control and Processing Unit
MBES	Multibeam Echosounder
PLC	Payload Controller Software
PPH	Payload Pressure Housing
Projector Unit	A sonar <u>transducer</u> that translates an electrical signal into pressure waves (sound signals) and transmits them through the water.
Receiver Unit	A hydrophone functioning by transforming underwater sound signals (pressure waves) into electrical signals.
Sonar Head Assembly	The combination of the projector and receiver units.

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