

# PIONEER

## INTEGRATION GUIDE



P/N 95B-6133-00 (July 2023)

© 2022 Teledyne RD Instruments, Inc. All rights reserved.



<https://www.teledynemarine.com>

Use and Disclosure of Data  
Information contained herein is classified as EAR99 under the U.S. Export Administration Regulations. Export, reexport or diversion contrary to U.S. law is prohibited.

## TABLE OF CONTENTS

<b>GETTING STARTED WITH THE PIONEER</b> .....	<b>1</b>
<b>CONNECTING TO THE PIONEER</b> .....	<b>3</b>
<b>MECHANICAL INTEGRATION</b> .....	<b>10</b>
<b>ELECTRICAL INTEGRATION</b> .....	<b>12</b>
<b>ACOUSTIC INTEGRATION</b> .....	<b>13</b>
<b>OPERATIONAL &amp; SETUP INTEGRATION</b> .....	<b>14</b>
<b>WANT TO KNOW MORE?</b> .....	<b>16</b>

## HOW TO CONTACT TELEDYNE RD INSTRUMENTS

If you have technical issues or questions involving a specific application or deployment with your instrument, contact our Field Service group:

Teledyne RD Instruments	Teledyne RD Instruments Europe
14020 Stowe Drive Poway, California 92064	2A Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude, France
Phone +1 (858) 842-2600	Phone +33(0) 492-110-930
Sales – <a href="mailto:rdisales@teledyne.com">rdisales@teledyne.com</a>	Sales – <a href="mailto:rdie@teledyne.com">rdie@teledyne.com</a>
Field Service – <a href="mailto:rdifs@teledyne.com">rdifs@teledyne.com</a>	Field Service – <a href="mailto:rdiefs@teledyne.com">rdiefs@teledyne.com</a>
Client Services Administration – <a href="mailto:rdicsadmin@teledyne.com">rdicsadmin@teledyne.com</a>	

Web: <https://www.teledynemarine.com>

For all your customer service needs including our emergency 24/7 technical support, call +1 (858) 842-2700

### Self-Service Customer Portal

Use our online customer portal at <https://www.teledynemarine.com/support/RDI/technical-manuals> to download manuals or other Teledyne RDI documentation.

### Teledyne Marine Software Portal

Teledyne RD Instruments Firmware, software, and Field Service Bulletins can be accessed only via our Teledyne Marine software portal.

To register, please go to <https://tm-portal.force.com/TMsoftwareportal> to set up your customer support account. After your account is approved, you will receive an e-mail with a link to set up your log in credentials to access the portal (this can take up to 24 hours).

Once you have secured an account, use the Teledyne Marine software portal to access this data with your unique username and password.

If you have an urgent need, please call our Technical Support hotline at +1-858-842-2700.

# Getting Started with the Pioneer

## Identifying what's in the Box

### Pioneer Inventory

Kit	Part Number	Name	Description
N/A	70B-9023-xx 70B-9024-xx	Pioneer DVL	The Pioneer DVL 300 kHz or 600 kHz system includes the transducer and dummy plugs. When unpacking, use care to prevent physical damage to the transducer face and connectors. Use a soft pad to protect the transducer.
	MC-DC-8F	DVL Power/COMM dummy plug	The dummy plugs are installed on the DVL. When the cables are not connected, use the dummy plugs to protect the connectors.
	MC-DC-8M	Sensor COMM dummy plug	
75BK6065-00 Accessories Kit	97B-7005-00	Shipping Case	Shipping case with foam inserts.
	73B-3004-005	DVL/Power/Comm Cable	The DVL/Power/Comm cable is used for serial communications and power.
	73B-6046-00	Power Adapter Cable	Power adapter to banana plugs cable.
	MCIL8F	DVL PWR/COMM Pigtail Cable	The DVL PWR/COMM cable connects the Pioneer to the computer and external power supply.
	MCIL8M	Sensor Communication Pigtail Cable	Sensor Communication Cable connects the Pioneer to the sensors.
	MC-DLS-F	Locking Sleeve	Locking sleeves (2) for pigtail cables.
	75BK6070-00	Tools and Spare Parts kit	See Chapter 4, Maintenance in the Pioneer DVL Guide for a list of parts included in this kit.
75BK6069-00 Documentation Kit	95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	95B-6134-00	Pioneer Getting Started	A printed quick start sheet showing test setup is included.
Download from website		TRDI Toolz	TRDI Toolz is a utility and testing software package that can be used to test the DVL.
		NavUI	The Navigation User Interface (NavUI) is designed to setup Tasman systems with a focus on ease of use and accessibility.



This list only shows the parts included with the standard Pioneer DVL. See the packing slip for additional options. If you are missing parts, contact TRDI support [rdifs@teledyne.com](mailto:rdifs@teledyne.com) or call +1 (858) 842-2700.

## Included with the Pioneer 4500-meter system:

Kit	Part Number	Name	Description
N/A	70B-9026-xx	Pioneer DVL	The Pioneer DVL 300 kHz 4500-meter system includes the transducer and dummy plugs. When unpacking, use care to prevent physical damage to the transducer face and connectors. Use a soft pad to protect the transducer.
	MC-DC-8F	DVL Power/COMM dummy plug	This dummy plug is installed on the DVL. When the cable is not connected, use the dummy plug to protect the connector.
75BK6065-00 Accessories Kit	97B-7008-00	Shipping Case	Shipping case with foam inserts.
	737-3155-005	DVL/Power/Comm Cable	The DVL/Power/Comm cable is used for serial communications and power.
	95B-6134-00	Pioneer Getting Started	A printed quick start sheet showing test setup is included.
	75BK6076-00	Tools and Spare Parts kit	See Chapter 4, Maintenance in the Pioneer DVL Guide for a list of parts included in this kit.
75BK6069-00 Documentation Kit	95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	95B-6134-00	Pioneer Getting Started	A printed quick start sheet showing test setup is included.
Download from website		TRDI Toolz	TRDI Toolz is a utility and testing software package that can be used to test the DVL.
		NavUI	The Navigation User Interface (NavUI) is designed to setup Tasman systems with a focus on ease of use and accessibility.

## Included with the Pioneer 150 kHz systems:

Kit	Part Number	Name	Description
N/A	70B-9109-xx (6000 meter)	Pioneer DVL	The Pioneer DVL 150 kHz system includes the transducer and dummy plug. When unpacking, use care to prevent physical damage to the transducer face and connectors. Use a soft pad to protect the transducer.
	70B-9060-xx (1000 meter)		
Accessories Kit	MRDI1173	Shipping Case	Shipping case with foam inserts.
	73B-6092-005 (6000 meter)	DVL/Power/Comm Cable	The DVL/Power/Comm cable is used for serial communications and power.
	73B-6088-xxx (1000 meter)		
	95B-6168-00	Pioneer 150 kHz Getting Started	A printed quick start sheet showing test setup is included.
	97Z-6034-00	Spare Parts	Set of spare O-Rings.
97Z-6036-00			
75BK6069-00 Documentation Kit	95Z-6007-00	Download instructions	This sheet has instructions for downloading the software and manuals.
	95B-6134-00	Pioneer Getting Started	A printed quick start sheet showing test setup is included.
Download from website		TRDI Toolz	TRDI Toolz is a utility and testing software package that can be used to test the DVL.
		NavUI	The Navigation User Interface (NavUI) is designed to setup Tasman systems with a focus on ease of use and accessibility.

# Installing Documentation and Software

The Pioneer documentation and software are downloaded.

1. Follow the instruction sheet on downloading TRDI software and manuals.
2. Software is available on <https://tm-portal.force.com/TMsoftwareportal>. Install *TRDI Toolz* and *NavUI*.
3. Use our online customer portal at <https://www.teledynemarine.com/support/RDI/technical-manuals> to download manuals or other Teledyne RDI documentation. Download the Pioneer Guide. PDF versions of all Pioneer documentation are available for download.



## Connecting to the Pioneer

### Power Overview

The Pioneer requires a DC supply between 10.7 to 36 VDC (32 VDC typical) for the 300/600 kHz systems and 28 to 48 VDC (32 VDC typical) for the 150 kHz Pioneer. Either an external DC power supply or battery can provide this power.

- The power supply should be able to source at least two Amps for a bench test setup (no ping in air).
- Assuming that typical operation will be in water, TRDI recommends a power supply that can provide 6A to 10A at 32VDC for a 300 kHz Pioneer DVL.



See the Pioneer DVL Guide, Table 4, page 32 for a full review of the recommended power supply for system installation.

**Power on Cycle** - The power supply must be able to handle the inrush current as well. Inrush current is the current required to fully charge up the capacitors when power is applied to the Pioneer. The capacitors provide a store of energy for use during transmit. The inrush current is as much as 9 amps if plugged in after the transducer is fully discharged. The Pioneer will draw this amperage until its capacitors are fully charged (less than 200ms).



*If the power supply limits the current or the power drop on the cable is significant, then the power on cycle will fail or the system will reset during pinging. Therefore, TRDI recommends a 6 to 10A power supply to cover all performance cases.*

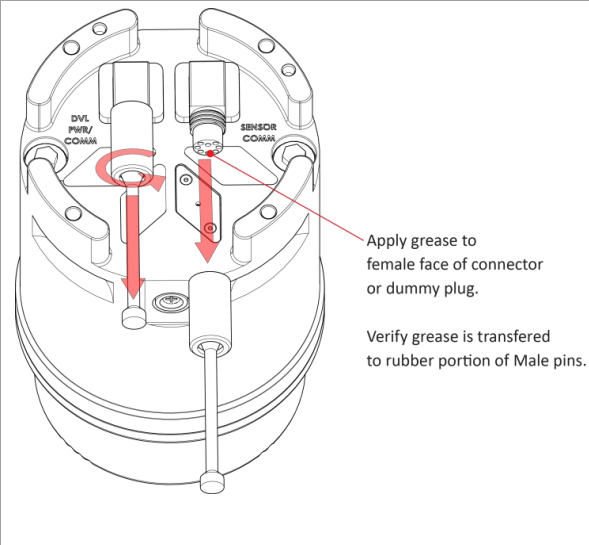


*If the Power is put in then removed within a very short time (few secs) and then applied again, then the Inrush limiter will not be able to limit the current pulled from the DVL which would result in a higher than 4Amps Inrush current spike.*

# Bench Testing the Pioneer System

## Connect to the Pioneer:

1. The Pioneer cable connectors must be lubricated **before each connection**.



Apply grease to female face of connector or dummy plug.


Verify grease is transferred to rubber portion of Male pins.

**Prior to each connection:**

Apply a thin film of silicon-based lubricant to the face of the female cable socket mating surfaces using latex gloves. Silicon lubricant is included in the spare parts kit. Ensure that the inner edge of the female socket is completely covered, and a thin transparent layer of lubricant is left visible on the face of the connector. The lubricant should extend one to two millimeters into the socket holes of the female cable connector.

After lubricating, fully connect the male and cable female connector in order to spread the lubricant onto the pins and in the sockets. Wipe away any excess lubricant off the outside of the connector.

To confirm that the lubricant has been sufficiently applied, disconnect the cable and check for lubricant on all male pins (rubber portion). If the male pins do not have lubricant on them, apply more lubricant to the female connector and then reconnect the cable.

 Silicone lubricate is provided in the Tools and Spare Parts kit.



Use **ONLY** silicone-based lubricants. **DO NOT** use petroleum-based lubricants.

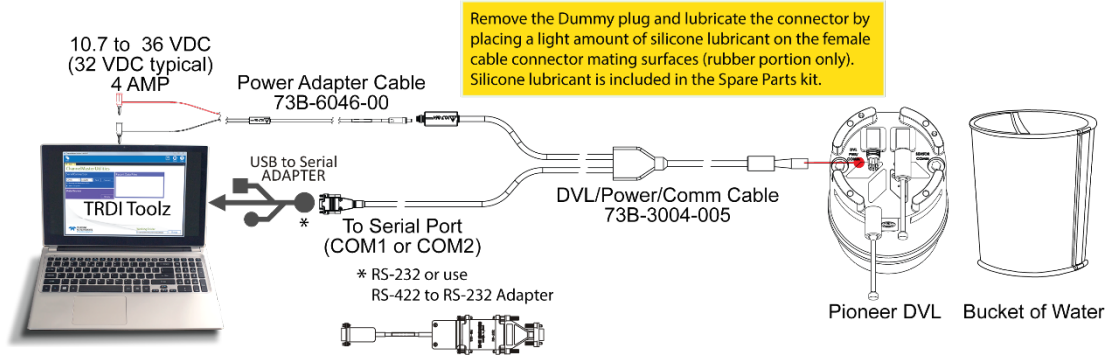
Do **NOT** use spray-based silicone lubricant. The use of some oil-based propellants in spray cans can cause conductivity problems in neoprene.

2. Place the DVL on its transducer face on a soft pad. Remove the DVL/Power/Comm dummy plug and push the cable straight onto the DVL Power/COMM connector ensuring the pins are properly aligned. While keeping a slight inward pressure on the cable connector and ensuring that the connector is straight, thread the locking sleeve onto the receptacle to complete the connection.

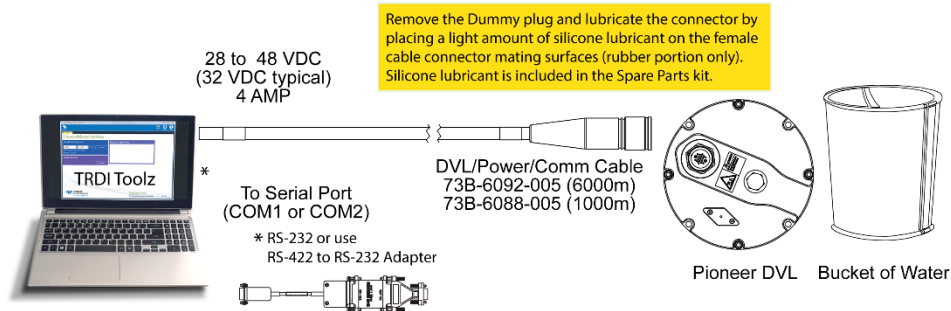


Do **NOT** use any tools to tighten the locking sleeve. It should only be “finger tight”.

3. Attach the DVL/Power/Comm cable to the computer’s serial communication port. Use an RS-422 to RS-232 adapter if the DVL is configured with port 1 as RS-422.
4. Place the Pioneer system in water (at least a few inches to cover the transducer face).
5. Connect the power adapter cable to the 300/600 kHz DVL/Power/Comm cable power connector by pushing it all the way in until it “clicks”. Connect +10.7 to 36 VDC (32 VDC typical) power using the banana plugs. Use 28 to 48 VDC (32 VDC typical) for the 150 kHz Pioneer. The power supply should be able to source at least four Amps.



**Pioneer 300/600 kHz Connections with Optional Test Cable Kit**



**Pioneer 150 kHz Connections**



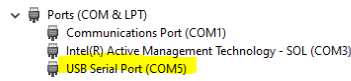
The Optional Test Cable Kit 75BK6143-00 includes the 73B-3004-005 test cable, 73B-6046-00 power adapter cable, and the USB adapter.

If you purchase your own USB adapter, TRDI recommends: [sales@connectiveperipherals.com](mailto:sales@connectiveperipherals.com) <https://us.connectiveperipherals.com/products/ft232r-chipset?variant=32248004476987>. Possibly any device with FTDI drivers and devices will also work.

**Installing the USB Adapter Driver**

If there is an available internet connection, Windows 10/11 will install the USB driver on first connection. If necessary, install the Virtual COM port (VCP) driver to make the USB adapter appear as an additional COM port. The free FTDI driver download page is available here: <https://ftdichip.com/drivers/>

Use Windows Device Manager® to determine the USB to Serial adapter COM port number. Remove the adapter, wait a moment, note the list of ports, reinsert the adapter and note the new port.



## Communicate with the Pioneer:

To establish communications with the Pioneer:

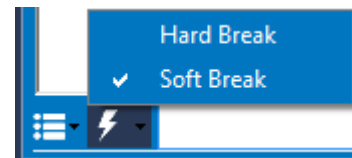
1. Connect the system and apply power.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the Pioneer’s communication settings.

### Serial Communications:

Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop-down list to 115200



5. Click the **Connect** button. Once connected, the button will change to **Disconnect**.
6. Click the **Break** (⚡) button. From the **Break** button drop down menu, select **Soft Break** (= = =). The wakeup banner will display in the terminal window.




```
Pioneer DVL
Teledyne RD Instruments (c) 2021
All rights reserved.
Firmware Version: 57.xx
>
```


## Changing the Baud Rate to the highest baudrate:

BAUD RATE	CB-command
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

Connect and power the system as shown in Figure 1. Use *TRDI Toolz* to send the CB command that selects the baud rate. The table on the left shows the CB command settings for different baud rates with no parity and 1 stop bit. For example, to change the baud rate to 115200, at the ">" prompt in the communication window, type **cb811** then press the **Enter** key.

 The **CB?** command will identify the communication setting.

```
>cb?
CB = 411 ----- Serial Port Control (Baud [4=9600]; Par; Stop)
>cb811
>CK
[Parameters saved as USER defaults]
>cb?
CB = 811 ----- Serial Port Control (Baud [8=115200]; Par; Stop)
>
```

 The Pioneer DVL must be set to 115200 baud if the AHRS Ellipse sensor is installed.

*TRDI Toolz* will send the command **CK** to save the new baud rate setting. The Pioneer is now set for the new baud rate. The baud rate will stay at this setting until changed again with the CB command.



## Testing the Pioneer DVL:

```
>PA
ROM Test...PASS [ 3aad ]
RAM test...PASS
FRAM test...PASS
Receive Buffer Test...PASSED
XMIT RAM Test...PASSED
Receive Path Test (Hard Limited)...PASSED
Transmit/Receive Continuity Check...PASSED

Composite Result:
  GO for Deployment
```



Avoid running the PA test in AIR as it may damage the instrument.

Submerge the transducer face in a few inches of water. **The PA test may fail in air.** Only a failure with the transducer in water is a relevant test.

At the ">" prompt in the communication window, enter the command **CR1** then press the **Enter** key. This will set the Pioneer to the factory default settings.

At the ">" prompt in the communication window, enter the command **CK** then press the **Enter** key. This will save the factory default setting.

Place the Pioneer in a bucket of water (at least a few inches to cover the transducer face).

At the ">" prompt in the communication window, enter the command **PA** then press the **Enter** key. This will run the Pioneer deployment test.

## Testing the Sensors:

```
>ps0
Serial Number: 3003
Frequency: 307200 Hz
Configuration: DVL : 4-beam velocity.
Transducer Type: PHASEDARRAY
Beamformer Rev: XA0
Beam Angle: 30 Degrees
Beam Pattern: CONVEX
Sensors: AHRs TEMP
CPU Firmware: 57.00
FPGA Version: 7.00.002 [0x7002]

Board Serial Number Data:
F5 00 00 05 D0 A8 7D 28 DS18B20 TMP SNS
4F 00 00 01 DA 1E E8 23 PER72B-2353-06A
C8 00 00 01 E8 69 89 23 XDR72B-1001-00A
ED 00 00 01 E8 51 49 23 PIO72B-2301-03A
75 00 00 01 DA 1D 2D 23 DSP72B-2212-00C
15 00 00 01 E1 DA 27 23 RCV72B-2243-14E
```

At the ">" prompt in the communication window, enter the command **PS0** then press the **Enter** key. This will display the Pioneer system configuration data.

Note the sensors attached to your system. In this example, the system includes an AHRs and Temperature sensor.

```

>sr

Initializing sensor 12 on port 3.

>pc2
NOTE: Depth sensor source currently configured to manual
settings.
See EZ command.

Sensor data is sampled and displayed in a loop.
The number to the right of each backslash indicates the
ID of the
    sensor used for that data.
Press any key to exit the loop.


    Temp (degC)    Press (kPa)    Depth (m)    Hdg (deg)
Pitch(deg)    Roll(deg)    Vin
/ 23.12/ 8      0.000/ 0      0.000/ 0      2.48/12      0.27
/12      -0.19/12      25.84
>

```

At the ">" prompt in the communication window, enter the command **SR** then press the **Enter** key. This will initialize all the sensors attached.

At the ">" prompt in the communication window, enter the command **PC2** then press the **Enter** key. This will display real-time data from all the sensors attached.

Press any key to exit the test.

 The /12 on the Heading, Pitch, and Roll output indicates that the sensor information is from the AHRS sensor.

## Zero Pressure Sensor:


```

>ps0
Serial Number: 3003
Frequency: 307200 Hz
Configuration: DVL : 4-beam velocity.
Transducer Type: PHASEDARRAY
Beamformer Rev: XAO
Beam Angle: 30 Degrees
Beam Pattern: CONVEX
Sensors: AHRS TEMP PRESS 10BAR
CPU Firmware: 57.00
FPGA Version: 7.00.002 [0x7002]

Board Serial Number Data:
F5 00 00 05 D0 A8 7D 28 DS18B20 TMP SNS
4F 00 00 01 DA 1E E8 23 PER72B-2353-06A
C8 00 00 01 E8 69 89 23 XDR72B-1001-00A
ED 00 00 01 E8 51 49 23 PIO72B-2301-03A
75 00 00 01 DA 1D 2D 23 DSP72B-2212-00C
15 00 00 01 E1 DA 27 23 RCV72B-2243-14E

>sz
Keller 30 Pressure sensor successfully zeroed.

```

 The pressure sensor must be zeroed at the location the closest to where the DVL will be deployed.

At the ">" prompt in the communication window, enter the command **PS0** then press the **Enter** key. This will display the Pioneer system configuration data.

Note the sensors attached to your system. In this example, the system includes an AHRS, Temperature, and a 10BAR Pressure sensor.

If you have a pressure sensor attached, at the ">" prompt in the communication window, enter the command **SZ** then press the **Enter** key. This will zero the pressure sensor.

## Calibrate the AHRS Sensor:

```

>sm12
SBG Ellipse-A Auxiliary Menu
0 ----- Help
D ----- Display SBG Status and Settings
H ----- Display Heading, Pitch & Roll
M ----- Modify Settings
P ----- Pass-Through Mode
2 ----- 2D Magnetometer Calibration
3 ----- 3D Magnetometer Calibration
S ----- Save Settings and Calibration
F ----- Restore Factory Settings and Calibration
T ----- Restore Internal Settings and alignment.
R ----- Reboot SBG Ellipse-A AHRS
X ----- Exit
2

Verify location data:
48.8688 deg 2.1577 deg 30.00 m 2014/04/20
Do you want to change location data (y/n)? y
Enter LLA & Date [lat long alt yyyy mm dd]
32.94 -117.0281 263 2015 06 29 (Note this is the San Diego office location: Use
http://www.latlong.net/ to enter your LLA. Enter the current date.
Verify location data:
32.9400 deg -117.0281 deg 263.00 m 2015/05/22
Do you want to change location data (y/n)? n
SBG Ellipse: Acquiring magnetic field data for a 2D calibration.
SBG Ellipse: Will use up to 1000 points for calibration.
SBG Ellipse: Press any key to pause the magnetic field acquisition.
SBG Ellipse: and display the current results.
  | nPoints= 93, Q=Optimal (Note user rotates the DVL around Mast/Z axis and
  | presses any key on keyboard when result says Optimal)
Magnetic calibration report:
Quality: Optimal
Confidence: Medium
Used Points: 93
Max Points: 1000
Magnetic field deviations (degrees):
      Mean Stdev Max
Before 25.02 0.24 25.50
After  0.12 0.09 0.41
Accuracy 0.00 0.00 0.01
Advanced status bits: 00000000 00000000
Press ESC to stop calibration, or any other key to continue. (User presses <ESC>)
Calibration quality is Optimal. Number of points collected is 93
Do you want to save the new calibration (y/n)? y

SBG Ellipse: The new magnetic calibration has been saved.
Magnetic calibration report:
Quality: Optimal
Confidence: Medium
Used Points: 93
Max Points: 1000
Magnetic field deviations (degrees):
      Mean Stdev Max
Before 25.02 0.24 25.50
After  0.12 0.09 0.41
Accuracy 0.00 0.00 0.01
Advanced status bits: 00000000 00000000
SBG Ellipse: reboot

>sm12 h

Heading: +310.06 deg +/- 0.32 deg (1 sigma)
Pitch:   +0.04 deg +/- 0.13 deg (1 sigma)
Roll:    +0.03 deg +/- 0.13 deg (1 sigma)

```



An AHRS calibration should be conducted at each measurement location, and whenever the mounting fixture, boat/float, or ancillary equipment such as batteries or radios are changed or rearranged.

If the Pioneer DVL is mounted on a vehicle then the best magnetic field correction results will be obtained by rotating the entire vehicle in a non-magnetic field.

A 3D Calibration should always be used when possible. Please refer to the Pioneer DVL manual for more information about the 3D calibration.

The AHRS is mounted near the end-cap and should be the center of your rotations during calibration. Too many translations of the AHRS position during the calibration will lower the calibration performance results.

At the ">" prompt in the communication window, enter the command **SM12 2** then press the **Enter** key. This will start the 2D calibration procedure which can be easily ran in the lab as a bench verification or minimum calibration by placing the DVL in the same orientation that it will be used and rotating it around its Z (aka mast) axis.



For more information about the AHRS calibration procedure, please refer to Chapter 3 – Collecting Data in the Pioneer DVL Guide.




Exit *TRDI Toolz* so the communication port is available for use with other programs.

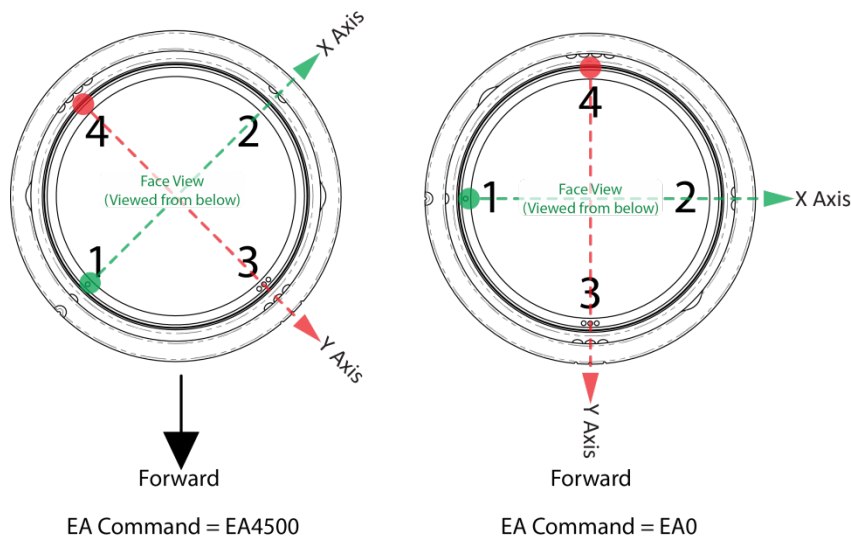
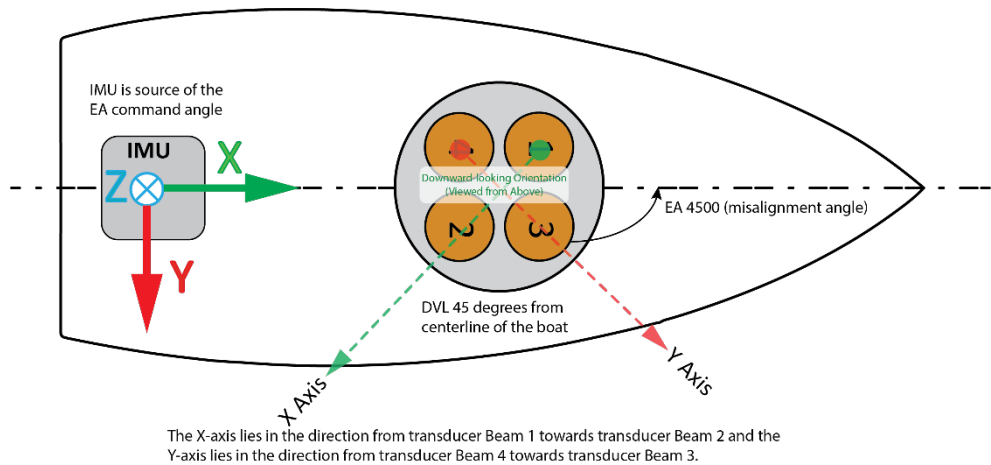
# Mechanical Integration

## Alignment

The mechanical alignment of the transducer head is important to DVL data accuracy. Mechanically mount the head as close as possible to your reference point. You also must mount the transducer head as level as possible using the ship's roll and pitch references.

 TRDI recommends mounting the transducer head with Beam 3 (instrument Y-axis) rotated 45° relative to the ship forward axis.

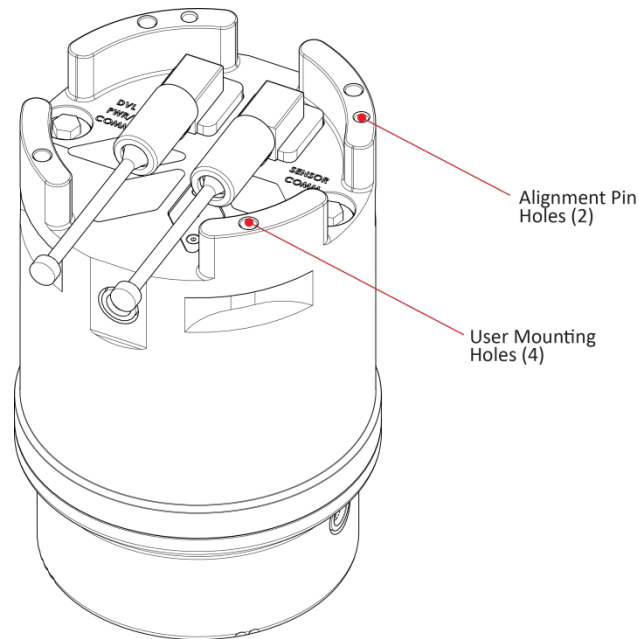
Mounting the transducer head with Beam 3 (instrument Y-axis) rotated 45° relative to the ship forward axis causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing, and increases the Pioneer's effective velocity range by a factor of 1.4. If Beam 3 is aligned at an angle other than zero, use the EA command to describe the rotation between instrument Y-axis (beam 3) and ship forward axis.



**Transducer Alignment Reference Points**

# Installing the DVL on the ROV

There are many options for mounting the Pioneer systems and they depend on the application. Use the four mounting holes on the transducer.



**End-Cap view of the transducer showing mounting holes**



Your Pioneer DVL transducer housing is made of aluminum that is protected by sacrificial anodes and a hard anodize coat. **Do not connect other metal to the DVL.** Other metals may cause corrosion damage.

Use M6 isolating bushings and washers when mounting the DVL to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the vehicle.



For more information, see the Pioneer Guide, Chapter 6 – Specifications, Outline Installation Drawings.

# Electrical Integration

## Grounding Issues

Multiple grounds connected to a vehicle hull or to a vehicle chassis can have undesirable consequences. Grounding problems can be avoided by implementing prudent grounding schemes.

The DVL has three isolated grounds in order to achieve the desired performance levels of the instrument. The grounding systems are as follows:

- Communication ground
- Power ground
- Chassis ground

Bypassing or shorting the DVL isolation / ground noise filter circuit will increase the sensitivity of the DVL to vehicle noise, which will increase noise floor in the instrument and in the data, thereby resulting in a reduced operational range and data contamination from interference. Additionally, bypassing of the DVL isolation/ground filter can lead to accelerated corrosion.



Your Pioneer DVL transducer housing is made of aluminum that is protected by sacrificial anodes and a hard anodize coat and paint. **Do not connect other metal to the DVL.** Other metals may cause corrosion damage.

Use M6 isolating bushings and washers when mounting the DVL to a metal structure. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the vehicle.

## Electro-Magnetic Interference (EMI)

The main sources of EMI are induced voltages from signal and power lines that are located in proximity to the effected component or signal. These problems are avoided or minimized by the proper routing of wires, proper shielding of wires and proper location of individual systems components. EMI is also caused by unwanted differences in potential on signal or ground electronic lines.



For more information, see the Pioneer Guide, Chapter 2 – System Integration, Identifying EMI.

# Acoustic Integration

The following items must be taken into consideration when using the Pioneer DVL.

**Flow Noise** – Water flowing over the transducer faces increases the acoustic noise level, which in turn decreases the operational range of the DVL. Flow noise can be reduced across the transducer faces by mounting the DVL behind a sea chest, fairing, or acoustic window. Flow noise can also be reduced by optimizing the transducer head type and design to conform to the platform hull form being used.

**Cavitation** – Cavitation is the formation of air bubbles due to the reduction of ambient pressure because of hydrodynamic flow conditions. Cavitation at the edges of the transducer or surrounding area near the transducer often results in increased acoustic noise, and a corresponding reduction in operating range. As with flow noise, cavitation can also be reduced by optimizing the transducer head type and design to the platform hull form being used.

**Ringling** – Ringing occurs in DVLs when the energy from the side lobes of the transmitted signal excites the metal portion of the DVL transducer such that a resonant condition occurs. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. While some ringing is normal in DVLs, its magnitude must be minimized.

**Windows Use Considerations** – Windows can be used to produce overall performance improvements in vessel-mounted DVLs. There are several advantages and disadvantages to consider before using an acoustic window.

## Advantages

- Well will not fill with air bubbles caused by the ship moving through the surface water.
- Flow noise is reduced.
- The well can be filled with fresh water to limit corrosion.
- Barnacles cannot grow on the transducer faces. Barnacle growth is the number one cause of failure of the transducer beams.
- The transducer is protected from debris floating in the water.

## Disadvantages

- The range of the DVL may be reduced because the window can and will absorb some of the transmit and receive energy.
- The transmit signal could be reflected into the well, causing the well to “ring”. This will cause the data being collected during the ringing to be biased. Some vessels have reported a loss in range as great as 50 meters. As noted, the ringing may be damped by applying sound absorbing material on the well walls (standard neoprene wet suit material has been found to work well).
- The transmit signal could be reflected off the window and back into the other beams.

**SONAR Interference Considerations** – Interference from other acoustic and electromagnetic devices can cause velocity and direction bias. In extreme cases, interference may prevent the DVL from operating.



For more information, see the Pioneer Guide, Chapter 2 – System Integration.

# Operational & Setup Integration

The following items must be taken into consideration when using the Pioneer DVL.

**Unfavorable Environments** – There are certain environmental conditions where the DVL's errors may be large or where the instrument does not function at all.

- In the surf zone where waves are actively breaking, the acoustic beams may not be able to penetrate the bubble clouds, and even if they do, the sound speed may be significantly affected by the high concentration of bubbles. This changes the Doppler scale factor.
- The dense growth of weeds or kelp on the bottom may prevent the DVL from detecting the true bottom. If the DVL locks onto the top of the weeds by mistake, they may have motion relative to the bottom due to wave action, which would give inaccurate velocity measurements.
- In areas of high salinity (>35ppt), the absorption of the sound by the water column will reduce the altitude capability of the DVL. Absorption (maximum range) can also be affected by water temperature.
- In areas where the salinity varies as a function of location and/or time, the Doppler scale factor will be varying and it may be necessary to integrate a speed-of-sound sensor into the navigation system to keep the velocity measurement errors to an acceptable value. Temperature gradients can cause similar issues. This is only for the Z-axis velocity, as Speed of Sound does not impact 2D velocities on a Phased Array Transducer.

**Triggering** – There are two methods for triggering the DVL:

- **Sending ASCII Character through Serial Port.** When the system is interfaced to a serial port (e.g. a navigation computer), the system can be setup to wait for an input before each ping. To setup the DVL in this fashion, clear the Auto Ping Cycle bit in the CF command by sending CFx0xxx, where the x's represent the settings of the other parameters. Start the DVL pinging with the CS command. The DVL will output a '<' before each ping and wait for input. Send any valid ASCII character to trigger the ping. The instrument will not enter sleep mode while it is waiting for the trigger.
- **Using Low-Latency Triggering.** The trigger methods shown above all have latencies ranging from a few milliseconds to a few hundred milliseconds, which may be excessive for high-precision applications. Consequently, TRDI has developed a low-latency trigger method (see CX command). To configure the DVL for low-latency triggering, set the CX command to enable trigger input. Start the DVL pinging with the CS command. The DVL will then wait for a trigger before each ping. Setting the trigger lines to a break state for no less than 10 microseconds sends the trigger. The DVL will then ping within 1 millisecond of the leading edge of the break pulse. Note that it is possible through the CX command settings to set a timeout for the DVL to wait for a Trigger and then if no Trigger occurs during that time it will either Self Deploy and never look for Trigger again or Ping once and then go back to waiting for Trigger. The input trigger voltage is 3.3VDC to 7VDC.



For more information, see the Pioneer Guide, Chapter 2 – System Integration and Chapter 7 - Commands.



# Choosing a Data Format

Deciding on which output data format to use depends on the needs of the deployment. The following describes the basics of the formats available.

- **PD0** – PD0 is Teledyne RD Instrument’s standard format. PD0 is a binary output format. It provides the most information possible including a header, fixed and variable leader, bottom track, and water profile information. The fixed and variable leader is a recording of time, DVL setup, orientation, heading, pitch, roll, temperature, pressure, and self-test diagnostic results. Data fields to be output are user selectable. PD0 has distance made good in the output if the Bottom Track High Resolution Velocity Output Format is selected. This format is selected via the #BJ command.



The Bottom-Track High Resolution Velocity (5803h) and Navigation Parameters Data (2013h) blocks provide aid in the velocity measurement resolution and quality information for use in an Extended Kalman Filter (EKF) Inertial Navigation System (INS) solution.

- **PD4** – PD4 is a binary output format of bottom track speed over the bottom, speed through the water, and range to bottom information.
- **PD5** – PD5 is a superset of PD4 and includes information on salinity, depth, pitch, roll, heading, and distance made good.
- **PD6** – PD6 is a text output format. Data is grouped into separate sentences containing system attitude data, timing and scaling, and speed through the water relative to the instrument, vehicle, and earth. Each sentence contains a unique starting delimiter and comma delimited fields.
- **PD13** - PD13 outputs similar to PD6, except it adds Pressure and Range-to-bottom for all four beams and omits the System Health Monitor Data line.



For more information, see the Pioneer Guide, Chapter 8 – Output Data Formats.

## PDDecoder Library in C language

The Teledyne Marine PDDecoder library is an open source library written in C language to decode the PDO data formats that are commonly output by Teledyne Marine/Teledyne RD Instruments ADCPs. The definition and details of the PDO format can be found in any of the manuals under the section, Output Data Format.

Available for download from the Teledyne software portal:

<https://tm-portal.force.com/TMsoftwareportal>

# Want to know more?

Congratulations! You have completed the Pioneer Integration Guide. Read the following chapters in the Pioneer Guide for more detailed information.

- 🔗 **Chapter 1 – At a Glance**  
This chapter includes an overview of the Pioneer features, options, computer and power requirements, and connecting to the Pioneer.
- 🔗 **Chapter 2 – System Integration**  
This chapter covers in detail how to integrate the Pioneer onto your vehicle.
- 🔗 **Chapter 3 – Collecting Data**  
Use this chapter to create a command file, calibrate the compass, and start data collection.
- 🔗 **Chapter 4 – Maintenance**  
This chapter covers Pioneer maintenance. Use this section to make sure the Pioneer is ready for a deployment.
- 🔗 **Chapter 5 – Returning Systems to TRDI for Service**  
If the Pioneer needs to be returned to TRDI, use this information on how to obtain a Return Material Authorization (RMA) number.
- 🔗 **Chapter 6 – Specifications**  
This chapter includes specifications and dimensions for the Pioneer (including outline installation drawings).
- 🔗 **Chapter 7 – Commands**  
This chapter defines the commands used by the Pioneer.
- 🔗 **Chapter 8 – Output Data Format**  
This chapter defines the output data formats used by the Pioneer.

The Bottom-Track High Resolution Velocity (5803h) and Navigation Parameters Data (2013h) blocks provide aid in the velocity measurement resolution and quality information for use in an Extended Kalman Filter (EKF) Inertial Navigation System (INS) solution. TIME-OF-VALIDITY output for highly accurate coupling with an INS further improves your resulting DVL aided INS position accuracy. See the Navigation Parameters Data Format, bytes 54-69.